FAST TRACK ARTICLE

Health and Productivity as a Business Strategy: A Multiemployer Study

Ronald Loeppke, MD, MPH
Michael Taitel, PhD
Vince Haufle, MPH
Thomas Parry, PhD
Ronald C. Kessler, PhD
Kimberly Jinnett, PhD

Objective: *To explore methodological refinements in measuring health-related lost productivity and to assess the business implications of a full-cost approach to managing health.* ***Methods:*** *Health-related lost productivity was measured among 10 employers with a total of 51,648 employee respondents using the Health and Work Performance Questionnaire combined with 1,134,281 medical and pharmacy claims. Regression analyses were used to estimate the associations of health conditions with absenteeism and presenteeism using a range of models.* ***Results:*** *Health-related productivity costs are significantly greater than medical and pharmacy costs alone (on average 2.3 to 1). Chronic conditions such as depression/anxiety, obesity, arthritis, and back/neck pain are especially important causes of productivity loss. Comorbidities have significant non-additive effects on both absenteeism and presenteeism. Executives/Managers experience as much or more monetized productivity loss from depression and back pain as Laborers/Operators. Testimonials are reported from participating companies on how the study helped shape their corporate health strategies.* ***Conclusions:*** *A strong link exists between health and productivity. Integrating productivity data with health data can help employers develop effective workplace health human capital investment strategies. More research is needed to understand the impacts of comorbidity and to evaluate the cost effectiveness of health and productivity interventions from an employer perspective.* (J Occup Environ Med. *2009;51:411–428*)

From the Alere (Dr Loeppke), Brentwood, Tenn; Alere (Dr Taitel, Mr Haufle), Rosemont, Ill; Integrated Benefits Institute (Dr Parry, Dr Jinnett), San Francisco, Calif; and Department of Health Care Policy (Dr Kessler), Harvard Medical School, Boston, Mass.

Address correspondence to: Dr Ron Loeppke, MD, MPH, 5166 Remington Dr. Brentwood, TN 37027; E-mail: ron.loeppke@alere.com.

DOI: 10.1097/JOM.0b013e3181a39180

Businesses face a host of critical challenges impacting their profitability and viability. Chronic health conditions are on the rise across all age groups, and these conditions create a significant economic burden, costing employers heavily as they provide medical benefits for employees and absorb the costs of sickness absence and long- and short-term disability claims.[1,2] One study found that more than 80% of medical spending goes toward care for chronic conditions.[3] Moreover, nearly 50% of Americans have one or more chronic health conditions.[4] Employers are the ultimate purchasers of health care for the majority of Americans, spending approximately $13,000 per employee per year on total direct and indirect health-related costs.[3,5] U.S. Department of Labor statistics indicate that there are approximately 137 million non-farm employees and the overall annual cost impact of poor health on the workplace is estimated at $1.8 trillion.[6]

Although many employers now are concerned about workforce health, their efforts to address this problem have tended to focus on medical costs without considering the impact of health on workforce productivity. After identifying their major medical and pharmacy cost drivers, many employers have attempted to relieve their cost burden by shifting a portion of these costs to employees through higher copays and deductibles and other managed care approaches. But these strategies do not address the cost of reduced productivity, which can be substantial. The approaches that many employers have taken may have actually created the opposite of their intended effect: By shifting costs to employees they have created barriers to access that lead to delay of care, which in the end worsens clinical outcomes and negatively impacts productivity.[5]

This view of employee health as a cost to be reduced, rather than an investment to be managed, needs to be reconsidered in light of the overwhelming demographic trends toward an older workforce and growing research evidence documenting substantial costs of worker health problems on work performance. Some forward-thinking employers have become receptive to a new model that focuses on health-related productivity—not mere medical and pharmacy spending—as their most compelling cost issue related to worker health. This is a comprehensive view of health in the workplace, which places a true business value on health and views human capital as an investment. It recognizes that, to date, employers have given inadequate attention to factors such as presenteeism, absence and disability as they have attempted to understand the impact of poor health. It acknowledges that the business community needs a new and improved methodology to measure the relationship between health and productivity, as well as a new lexicon to help articulate its value to all stakeholders.

In an effort to advance better understanding of these emerging concepts, the American College of Occupational and Environmental Medicine (ACOEM) and Integrated Benefits Institute (IBI) initiated a program of research aimed at assessing the full impact of health conditions in the workplace, factoring in not only medical or pharmacy cost but also health-related productivity costs such as absenteeism and presenteeism. ACOEM and IBI, working in strategic collaboration with Alere (formerly Matria Healthcare) and faculty from Harvard Medical School, focused this "Health and Productivity as a Business Strategy" study on identifying leading chronic health conditions that drive health-related costs. In phase 1 of this study, Loeppke et al[7] identified the total cost impact of health on the financial bottom line for four employers with a total of 57,000 employees. This multiemployer study integrated medical and pharmacy claims data with employee self-reported health-related absenteeism and presenteeism data from the validated Health and Work Performance Questionnaire (HPQ) survey to determine the "full cost" of health.

The results of phase 1 provided important new insights into the health conditions which have the greatest productivity-related impact on employers included in the study. In addition, the true value of health-related lost productivity was found to exceed the direct medical and pharmacy costs for most of the health conditions studied. The first phase of this study confirmed what other published studies have suggested—that on average, for every 1 dollar employers spend on worker medical or pharmacy costs, they absorb at least 2 to 4 dollars of health-related productivity costs.[7,8]

Health-related productivity costs in the study were manifested in the form of absenteeism and presenteeism associated with 25 chronic conditions selected for study. Even without disability costs being included, the study found that when looking at the combined medical, pharmacy, absenteeism and presenteeism costs of these health problems, some conditions such as back or neck pain, depression, and fatigue are far more costly than employers have previously realized. Furthermore, the cost ranking of health conditions that have been measured through the lens of productivity loss is significantly different from the more traditional cost ranking of medical or pharmacy costs alone.[7] Phase 1 of our study concluded that an integrated approach of combining medical or pharmacy costs with lost productivity costs provides a more complete and actionable financial assessment of health for employers.

This article presents an overview of results from all 10 companies participating in our study, with a more detailed focus on the results of phase 2. In phase 2, we increased the power of the analysis by increasing the number of employers and employees measured and investigated more subtle aspects of the relationship between the targeted health problems and productivity. We explored a number of methodological refinements in measuring productivity, estimating the lost productivity associated with health problems and blending productivity costs with medical and pharmacy claims costs to create estimates of total health-related workplace costs. We also provide significant new findings about the workplace effects of comorbidities. In addition, we present results that continue to support the need for a new, productivity-focused health model in the workplace and a new language and methodology to help determine the true business value of health. We also offer insights from participating companies on how the study helped shape their corporate health strategies.

Methods

Sample

Ten participating companies were identified based on size, availability of medical and pharmacy claims data and either availability of HPQ survey data or a willingness to implement an HPQ survey in their workforce, along with an agreement to allow the merging of these data sources. For each of the 10 companies in the study, Table 1 shows the phase, industry type, number of eligible employees, number of HPQ respondents, and response rate. The companies ranged in size from 1407 to 38,413 eligible employees and had response rates from 11.5% to 65.0%; the combined response rate was 34.3%. Company C was dropped from subsequent analysis because it did not include the absenteeism measure used in the phase 2

TABLE 1
Sample Details

Phase	Company	Industry Type	No. of Eligible Employees	No. of Valid HPQ Respondents	Response Rate (%)
Phase 1	Company A	Chemical Manufacturer	12,000	3,929	32.7
	Company B	Computer Hardware Manufacturer	1,407	347	24.7
	Company C*	Tele-Communication Information Technology	6,000	2,072	34.5
	Company D	Tele-Communication Information Technology	38,413	10,678	27.8
Phase 1 sub-total			57,820	17,026	29.4
Phase 2	Company E	Hospitality and Entertainment	20,100	2,311	11.5
	Company F	Energy Corporation	9,184	4,377	47.7
	Company G	Aerospace and Defense	22,237	10,928	49.1
	Company H	Industrial Manufacturer	16,349	3,434	21.0
	Company I	Healthcare Consulting	22,000	11,809	53.7
	Company J	Insurance	2,712	1,763	65.0
Phase 2 sub-total			92,582	34,622	37.4
Total			150,402	51,648	34.3
Combined (9 employers)			144,402	49,576	34.3

*Dropped from final analysis due to missing data.

analysis. The phase 1 HPQ surveys were administered in 2005–2006; phase 2 surveys were administered in 2007–2008. The analysis included 49,576 valid HPQ respondents, with 14,954 in phase 1 and 34,622 in phase 2.

Measures

Health Conditions. Health conditions were assessed by self-report with a standard chronic conditions checklist based using WHO HPQ.[9,10] The HPQ conditions checklist is based on US National Health Interview Survey (http://www.hcp.med.harvard.edu/hpq/) and (http://www.cdc.gov/nchs/nhis.htm).[11,12] Checklists of this sort have been widely used in prior population-based studies and have been shown to yield more complete and accurate reports than estimates derived from responses to open-ended questions.[13] Methodological studies in both the US and UK have documented good concordance between such condition reports and medical records.[14–16]

In the surveys carried out in phase 1, the HPQ was administered as an independent on-line instrument in three companies and integrated into an on-line health risk assessment (HRA) in one company; we used the standard HPQ question series to ask respondents "Do you have any of the following conditions" and, if yes, "mark whether you never, previously, or currently receive professional treatment." For all the companies in phase 2, the survey process was changed in several ways. The HPQ survey was integrated into an existing on-line HRA instrument and administered as part the companies' annual assessment. This was a practical change reflective of companies' desire to integrate productivity measures into their wellness programs, as well as, simplify data collection and reduce the administrative burden of population assessment. As a trade off, the question about health condition was asked in a more restrictive manner common to many HRAs. In phase 2, respondents were asked "has your doctor ever told you that you have or have had any of the following health problems." If yes, then indicate "yes, I am receiving treatment and I am taking medication; yes, I am receiving treatment but I am not taking medication; No, I am not currently receiving treatment." This change allows us to see the impact of instrument variation on condition and treatment prevalence as well as on health-related productivity assessment. Individuals frequently misclassify their perceived weight status relative to their calculated body mass index (BMI) based on self-reported height and weight.[17] Because we had self-reported height and weight available, we calculated BMI (BMI = weight kg/[height meter^2]; if BMI $\geq$30 then obese) to determine a more accurate assessment of obesity. However, this change also eliminated the self-report of treatment for this health condition.

Workplace Outcomes. The HPQ measures absenteeism through a self-report assessment of sickness absence days in the month (28 days) before the survey, which was defined for purposes of this article as the amount of time the respondent reported missing work due to their health conditions. These results were multiplied by 13 to project to an annual absenteeism value. An alternative would have been to assess total amount of time of missed work for any reason, which is the method used for estimating absenteeism in our earlier article.[7] We chose the narrower focus for phase 2 of the study because it reduces variability in lost time from work due to vacation and other reasons. However, this approach may not capture any lost time from work that the respondent fails to recognize as due to health reasons, such as "vacation" days associated with low-level physical (eg, fatigue) or psychological (eg, depression) symptoms. Separate questions were asked about number of full days (which we assigned 8 hours of missed time) or partial days (which we assigned 4 hours of missed time) the respondent missed "because of problems with your physical or mental health." Also, unlike the unrestricted approach to assessing hours of missed work, this more restricted approach does not account for workers coming in early or leaving late on other days to make up for hours of missed work.

The HPQ measures presenteeism through a self-report assessment of on-the-job work performance. The survey asked "On a scale from 0 to 10, where 0 is the worst job performance and 10 is the top job performance, how would you rate your overall performance on the days you worked in the past 4 weeks (28 days)." The results were converted to a percentage and annualized by assuming a 250 day work year. Furthermore, we adjusted the presenteeism score by the amount of absenteeism so that we did not allocate presenteeism for time the employee was absent. Validation studies have documented significant associations ($r = 0.61$ to 0.87) between HPQ absenteeism reports and objective employer payroll records,[9] significant associations between HPQ presenteeism reports and supervisor assessments ($r = 0.52$),[10] and significant associations between HPQ reports and other administrative indicators of performance ($r = 0.58$ to 0.72).[9]

Control Variables. All of the regression analyses described below controlled for respondent gender, age, and occupation. Occupation was divided into eight self-reported categories used in the HPQ to approximate the categories specified in the first digit of the 2000 Census Classified Index of Occupations (http://www.census.gov/hhes/www/ioindex/overview.html). These include: executive, administrator, or senior manager; professional; technical support; sales; clerical or administrative support; service; precision production of crafts; and operator or laborer.

Medical Claims. We analyzed paid medical claims incurred during the 12 months before each respondent's HPQ completion date. We matched the medical claims to the HPQ results by mapping the claims' primary International Classification of Diseases, Version 9, Clinical Modification (ICD-9-CM) diagnoses to the HPQ medical conditions. We first applied the identification algorithms developed by Alere to map most of the chronic health conditions. Because the HPQ includes only chronic conditions, we recognize that there are many expensive acute or traumatic health conditions that are not currently measured by the HPQ and others that are vague and difficult to determine a match. For example, abdominal pain could be attributed to indigestion, bladder, gynecological, or many other sources and general symptoms could be any or no condition.

This study used primary diagnosis codes from ICD-9-CM to map the medical claims into the HPQ condition and allocate medical costs. The later are defined as the actual costs the employer paid on that claim. Although the paid amount is influenced by other factors such as benefit plan design elements (eg, network discounts, employee deductibles, coinsurance and copays) and does not include costs paid by the employee, we focus on the paid claim because it represents the employers' cost burden.

Pharmacy Claims. We also analyzed pharmacy paid claims incurred during the 12 months before each respondents HPQ completion date. To map pharmacy claims to HPQ health conditions, we used the National Drug Data File Plus from First Databank, Inc. Pharmacists, physicians, nurses, and analysts from Alere collaborated on the development of an algorithm that groups National Drug Codes (NDC) into drug categories associated with certain health conditions for the purposes of standardizing NDC identification. The team used several drug information indicators (Therapeutic Drug Group, First Databank Class, Generic Code Number, and Route) to help facilitate the categorization of NDCs.

These drug categories are the foundation on which pharmacy claims are matched to HPQ conditions. Many of the drug categories have one to one indication relationships with the HPQ conditions. For example, insulin medications are directly associated with diabetes. Alere researchers also recognized that these categories are not completely sufficient to account for the multiple indications of certain drugs classes. We therefore developed a process to systematically distribute the corresponding claim dollars to the appropriate conditions by matching the individual's pharmacy claims to the HPQ conditions identified from the medical claims.

For example, beta blockers like Carvedilol are typically prescribed for heart condition management. Carvedilol can be prescribed to patients with Congestive Heart Failure (CHF), Coronary Heart Disease (CHD), and hypertension. To properly distribute the pharmacy claims dollars among the multiple conditions, we matched each pharmacy claim to the individual's HPQ conditions identified in their medical claims. If an individual's medical claims indicate they have CHF and do not have CHD or hypertension, then all the dollars for that claim will be allocated to CHF. If an individual's medical claims indicate simultaneous condition prevalence of CHF and hypertension, then 50% of the claim dollars will be allocated to CHF and 50% will be allocated to hypertension. In instances where all three conditions are indicated, 33% of the claim dollars would be allocated to each of the three conditions.

Impact Survey. Once we analyzed the data collected in the HPQ surveys and medical or pharmacy claims, we presented the results to health benefit decision-makers in each of the participating companies. We then developed and subsequently administered a semi-structured interview to gather information from these decision-makers about how they were influenced by their company's results.

Analysis Methods

Simple cross-tabulations and calculations of means were used to examine the demographic distribution of the sample, to estimate the prevalence of individual health conditions and comorbidities, and to estimate the magnitudes of absenteeism and presenteeism in the sample. Linear regression analyses were used to estimate the effects of health conditions on absenteeism and presenteeism, controlling for respondent gender, age, and occupation.

For the various analyses, the data were segmented into three groups: 1. Respondents with a specific focal health condition selected from the chronic conditions checklist (with condition); 2. Respondents with none of the measured health conditions on the chronic conditions checklist (no conditions); and 3. Respondents who do not have a specific focal health condition (without focal condition). The without focal condition group includes respondents who may have other chronic health conditions on the checklist but not the specific focal condition and respondents who do not have any health conditions on the checklist.

A number of different bivariate (only one condition included in each equation) regression equations were estimated. They examined the focal conditions compared to the no condition group or the without focal condition group, difference among the treatment groups and differences among occupation groups. The bivariate equations additionally varied depending on whether they compared workers with single condition (ie, those with the focal condition who had none of the other conditions) and comorbid conditions (ie, those with the focal condition who also had at least one of the other conditions) versus all those with the focal condition (ie, whether single or comorbid) to other workers. A final set of regression equations examined the associations between the number of conditions and the outcomes. The controls for gender, age and occupation were included in all the regression equations. Statistical significance in the regression equations was consistently evaluated using 0.05-level, two-sided tests without corrections for design effects.

Although most of the regression analysis results are examined at the individual level, we also carried out some analyses that made projections to the workforce. This was done by multiplying the estimated effect of the condition on absenteeism or presenteeism at the level of the individual worker by the prevalence of the condition to arrive at an estimate of the number of sickness absence days or presenteeism day-equivalents per 1000 workers in the workforce due to the condition.

To monetize the impact of lost time we multiplied the absenteeism and presenteeism estimates of days of work lost per year by the average daily salary-plus-fringe equivalents of workers with the condition. In addition, we multiplied the result by an industry-specific worker absence multiplier. This last step is used to recognize that simple "replacement costs" of absent employees significantly underestimates the real cost to the employer. Nicholson et al[18] found that these opportunity costs are a function of three factors: 1) the ease with which replacement workers can be found, 2) the time value of output (eg, can the employer sell to the market all the goods and services it produces as soon as they are available) and 3) the degree to which employees work in teams. In response, they also developed a series of industry and occupational multipliers to represent additional employer financial lost productivity costs. These multipliers are used in the analysis of absenteeism and presenteeism.

In the case of presenteeism, the ratio scores were converted to day-equivalents by assuming that a presenteeism score of X can be interpreted as indicating (100-X) percent lost productivity on days at work (ie, taking into consideration the decrease in total days at work due to the effects of the focal condition on absenteeism).

To observe the total cost of health conditions, we aggregated phase 2 companies' medical claims, pharmacy claims, absenteeism and presenteeism costs for each of the health conditions. We used the methodology as described above to monetize the productivity results. All the costs were converted into a per 1000 FTE metric which allowed us to combine the medical, pharmacy, absenteeism and presenteeism costs.

Results

Demographic Distributions

Table 2 shows the distribution of gender, age, and occupation segmented by study phase and comparison group. There are several differences in the demographic composition between phases. This can be attributed to the mix of companies and respondents included in the study. Phase 1 employee respondents had a larger proportion of males and professionals (72.4%, 80.1%) than phase 2 (58.1%, 48.7%). Also, phase 2 employee respondents included more Executives/Managers (8.4%), Technical Support staff (12.3%), and Clerical Support staff (12.7%) than phase 1 (1.1%, 3.6%, and 3.0%). Both phase 1 and phase 2 employee respondents had the same percentage (7.9%) of Operator/Laborers.

The difference between phase 1 and phase 2 on the percent of respondents with a condition is considerably larger than we would expect based on the demographic differences between the samples in the two phases. It is noteworthy in this regard that there was a difference in the question relating to whether a doctor told someone that they had the condition(s) or the individual thought

TABLE 2
Demographic Distributions

	Phase 1			Phase 2		
	With Condition	No Conditions	Total	With Condition	No Conditions	Total
N	14,434	520	14,954	24,439	10,183	34,622
%	96.5%	3.5%		70.6%	29.4%	
Gender						
Male	72.3%	76.0%	72.4%	56.0%	63.2%	58.1%
Female	27.7%	24.0%	27.6%	44.1%	36.8%	41.9%
Age						
18–29	7.0%	7.1%	7.0%	12.7%	20.9%	15.1%
30–44	58.3%	44.2%	57.8%	38.4%	44.4%	40.2%
45–59	33.3%	47.9%	33.8%	42.9%	32.3%	39.8%
≥60	1.5%	0.8%	1.4%	6.0%	2.5%	4.9%
Occupation						
Executive, administrator, senior manager	0.8%	6.9%	1.1%	8.3%	8.7%	8.4%
Professional	81.6%	39.6%	80.1%	47.1%	52.6%	48.7%
Technical support	3.4%	8.5%	3.6%	12.1%	12.2%	12.3%
Sales	0.5%	1.9%	0.6%	5.2%	6.1%	5.5%
Clerical or administrative support	2.8%	8.3%	3.0%	14.1%	9.3%	12.7%
Service occupation	0.3%	0.6%	0.3%	1.8%	1.5%	1.7%
Precision production or craft workers	3.2%	8.9%	3.4%	2.9%	2.6%	2.8%
Operator or laborer	7.3%	25.4%	7.9%	8.3%	7.0%	7.9%

TABLE 3
Health Condition Prevalence From HPQ Survey and Rank Order

	Phase 1		Phase 2			
	Adjusted Prevalence (%)	Rank	Adjusted Prevalence (%)	Rank	% Difference	*P**
Allergy	48.1	1	34.0	1	14.1	<0.001
Anxiety	8.0	15	11.1	7	−3.1	<0.001
Arthritis	14.9	6	16.2	4	−1.3	<0.001
Asthma	9.3	13	7.9	8	1.4	<0.001
Back/neck pain	27.4	2	7.5	9	19.9	<0.001
Bladder/urinary	8.8	14	4.5	16	4.3	<0.001
Chronic bronchitis/ emphysema	2.8	21	0.5	23	2.3	<0.001
Congestive heart failure	1.2	23	0.3	24	0.9	<0.001
COPD	0.4	25	0.2	25	0.2	<0.001
Coronary heart disease	1.0	24	2.0	20	−1.1	<0.001
Depression	12.6	9	11.2	6	1.5	<0.001
Diabetes	4.7	18	4.7	15	0.1	0.725
Fatigue	13.3	7	5.3	13	8.0	<0.001
GERD	15.5	5	12.6	5	2.8	<0.001
Headache	12.2	10	5.2	14	7.0	<0.001
Hypertension	17.4	3	18.0	3	−0.6	0.116
Irritable bowel	10.3	12	5.5	12	4.8	<0.001
Migraine	13.1	8	7.2	10	5.9	<0.001
Obesity	17.0	4	29.3	2	−12.3	<0.001
Osteoporosis	2.8	20	1.6	21	1.2	<0.001
Other cancer	2.4	22	2.1	19	0.3	0.076
Other chronic pain	7.3	16	3.1	17	4.2	<0.001
Skin cancer	3.2	19	0.7	22	2.5	<0.001
Sleeping problem	11.4	11	5.7	11	5.7	<0.001
Ulcer	5.0	17	2.4	18	2.6	<0.001

*T-test for pairwise differences between adjusted prevalences $r_s = 0.89$, $P < 0.001$.

they had the condition(s). In phase 1, only 3.5% indicated having no conditions. However, in phase 2, 29.4% indicated they had no conditions, as defined by whether or not a doctor told them they have a health condition. Within phase 2 we are able to observe the differences between the with condition group and the no conditions group. The subsequent analyses control for gender, age, and occupation.

Health Condition Prevalence From HPQ Survey

Table 3 displays a comparison of the estimated prevalences of the health conditions for phase 1 and phase 2 respondents adjusted for the age, gender, and occupation differences. Adjusting the prevalences allows us to consider explanations other than demographics for the similarities and differences between the condition prevalences in the phases.

Wide variation exists in the adjusted prevalence of the conditions considered here, from a maximum of more than one third of respondents in both phases who reported having seasonal allergies to a minimum of less than

1% who report such severe, but comparatively uncommon conditions as chronic obstructive pulmonary disease and CHF. The rank-order of prevalence estimates is very similar in the two phases ($r_s = 0.89$, $P < 0.001$). Four of the five most commonly reported conditions are the same in both phases. Seasonal allergies are reported to be the single most prevalent condition in both phase 1 (48.1%) and phase 2 (34.0%), with Gastroesophageal Reflux Disease (GERD) (15.5% and 12.6%), hypertension (17.4% and 18.0%), and obesity (17.0% and 29.3%) also among the top five most common conditions in both phases. The only discrepancy in the top five is arthritis, which is in the top five in phase 2 (16.2%) but not phase 1 (14.9%), and back or neck pain, which is in the top five in phase 1 (27.4%) but not phase 2 (7.5%).

A plausible interpretation of the differences in the reported condition prevalences between the phases is due to the fact that, as noted above, respondents in phase 1 were asked if they experienced the condition, whereas respondents in phase 2 were asked if a doctor ever told them they had the condition. For example, back or neck pain has a dramatically higher prevalence in phase 1 then compared with phase 2. As back or neck pain often goes undiagnosed, it would not be surprising to find that many more people report having this condition than reporting being told by a doctor they have the condition.

Consistent with this interpretation, prevalence estimates are higher in phase 1 than phase 2 for almost three quarters (18/25) of the conditions in the checklist. Furthermore, the higher prevalence in phase 1 has the greatest magnitude for symptom-based conditions (ie, conditions that are apparent to people who have them without a doctor's diagnosis) that are often not diagnosed or treated by a physician, most notably fatigue, irritable bowel and migraine, along with back or neck pain. The difference in the prevalence of obesity between the phases (17.0% and 29.3%) is in large part due to a difference in methodology in which phase 1 was based on self-reported obesity and phase 2 was calculated based on self-reported height and weight.

Table 3 also highlights similarities in the prevalences of certain conditions consistent with our expectations of condition reporting. The between phase prevalences of diabetes, hypertension, and other cancer are not significantly different from each other. These conditions are often diagnosed only by a doctor and therefore we would not expect respondent to report these conditions without a doctor diagnosis.

It needs to be noted, though, that the differences in prevalence between the two phases could also be due to differences in any number of other unmeasured variables that differ between the two groups.

Estimates of Aggregate Bivariate Associations

The most basic regression equations we estimated were bivariate equations that compared absenteeism and presenteeism scores of respondents with and without each condition, one condition at a time, using two kinds of comparisons. The first compared employees with the focal condition to employees of the same gender, age and occupation who reported none of the conditions in our checklist. The second compared employees with the focal condition to employees of the same gender, age and occupation who did not report the focal condition (but who might have reported other conditions). These comparisons were made separately in phase 1 and phase 2 for absenteeism and presenteeism. The regression coefficients for presenteeism were converted into day-equivalents (β = days lost per year) so as to facilitate comparison of coefficients in the absenteeism and presenteeism equations. With 25 conditions, two samples, and two outcomes (ie, absenteeism and presenteeism), we had exactly 100 coefficients for each of the two comparison methods.

Several broad patterns can be seen on inspection of these coefficients (Table 4). First, the vast majority of the coefficients (98.5%) are positive and statistically significant (88.5%) at the 0.05 level, documenting clearly that the conditions considered here are significantly associated with elevated absenteeism and presenteeism. Second, every one of the coefficients in the model that compares respondents with condition to respondents with no conditions is larger than the parallel coefficient in the model that compares respondents with condition to respondents without focal condition. Third, roughly two thirds of the coefficients in the model predicting presenteeism are larger than in the parallel model predicting absenteeism, although this pattern is confined in the models where the comparison is with respondents with no conditions (76%) rather than the models where the comparison is with respondents without focal condition (54%). Fourth, the coefficients based on analysis of phase 2 are almost entirely (96%) larger than those based on analysis of phase 1 when we focus on absenteeism but for the most part smaller than those based on phase 1 when we focus on presenteeism (80%).

The median value of the regression coefficients for absenteeism are 3.6 (phase 1) and 6.4 (phase 2) days per year in models that compare respondents with condition to respondents with no conditions. The comparable coefficients in models that compare respondents with condition to respondents without focal condition are 1.7 (phase 1) and 5.1 (phase 2). The inter-quartile range (IQR; 25th–75th percentiles) of the coefficients in absenteeism models that make the first type of comparison are 2.9 to 4.7 (phase 1) and 5.3 to 10.8 (phase 2), whereas the IQR of the coefficients in models that make the second kind of comparison are 1.2 to 3.2 (phase 1) and 3.9 to 9.2

TABLE 4
Estimates of Aggregate Bivariate Associations by Phase and Comparison Group

	Phase 1								Phase 2							
	With Condition vs No Conditions				With Condition vs Without Focal Condition				With Condition vs No Conditions				With Condition vs Without Focal Condition			
	Absenteeism		Presenteeism		Absenteeism		Presenteeism		Absenteeism		Presenteeism		Absenteeism		Presenteeism	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Allergy	2.1*	0.7	7.0*	1.4	0.4	0.3	1.8*	0.5	2.3*	0.3	3.7*	0.4	1.1*	0.3	1.3*	0.4
Anxiety	5.0*	1.0	13.2*	2.0	3.2*	0.6	7.9*	1.1	5.7*	0.5	9.4*	0.6	4.4*	0.4	7.1*	0.5
Arthritis	3.6*	1.0	8.9*	1.6	1.8*	0.5	3.4*	0.9	5.3*	0.5	6.0*	0.6	4.1*	0.4	3.1*	0.5
Asthma	3.6*	1.2	9.1*	1.8	1.6*	0.5	3.3*	0.9	4.0*	0.5	4.4*	0.7	2.6*	0.5	1.6*	0.6
Back/neck pain	2.9*	0.8	9.7*	1.6	1.4*	0.3	5.1*	0.6	7.2*	0.6	6.9*	0.7	5.8*	0.5	4.0*	0.7
Bladder/urinary	4.6*	0.9	10.1*	1.9	1.8*	0.6	3.9*	1.0	5.3*	0.7	7.9*	0.9	3.4*	0.7	4.7*	0.9
Chronic bronchitis/ emphysema	3.9*	0.8	7.0*	2.2	1.7	1.0	1.5	1.7	19.2*	2.5	13.0*	3.4	16.1*	2.8	8.7*	3.6
Congestive heart failure	3.0*	0.9	7.6*	2.6	1.1	1.3	1.1	2.5	28.4*	2.3	16.8*	3.0	25.7*	2.5	12.9*	3.2
COPD	6.7*	2.0	10.0*	4.2	4.5	2.6	2.8	4.7	21.1*	2.7	9.8*	3.8	18.7*	3.1	6.0	4.0
Coronary heart disease	6.7*	1.9	11.5*	3.8	4.5	2.9	2.4	3.7	14.6*	1.1	4.9*	1.3	12.2*	1.0	1.3	1.3
Depression	5.9*	1.1	16.8*	1.9	4.0*	0.5	12.9*	0.9	6.9*	0.5	12.9*	0.6	5.6*	0.4	10.8*	0.6
Diabetes	2.5*	1.0	7.8*	2.0	0.7	0.8	2.4	1.4	6.3*	0.7	4.2*	0.9	4.4*	0.6	0.7	0.8
Fatigue	4.6*	0.9	15.4*	1.8	3.0*	0.5	10.3*	0.9	10.8*	0.7	12.8*	1.0	9.2*	0.7	9.5*	0.9
GERD	2.7*	0.6	9.6*	1.7	1.2*	0.4	3.9*	0.8	5.2*	0.5	6.3*	0.6	3.8*	0.4	3.6*	0.5
Headache	3.8*	0.9	10.8*	1.8	2.2*	0.5	4.8*	0.9	6.6*	0.7	9.6*	0.9	5.1*	0.7	6.6*	0.9
Hypertension	2.6*	1.0	8.2*	1.5	0.8	0.4	1.8*	0.8	3.7*	0.4	4.6*	0.5	2.2*	0.4	1.4*	0.5
Irritable bowel	3.0*	0.7	12.3*	1.8	1.1*	0.5	6.1*	0.9	5.6*	0.6	7.7*	0.8	3.9*	0.6	4.9*	0.7
Migraine	3.6*	0.8	8.3*	1.7	1.6*	0.5	2.5*	0.9	6.3*	0.6	6.0*	0.8	4.9*	0.6	3.0*	0.7
Obesity	3.7*	1.2	9.3*	1.6	2.4*	0.5	4.3*	0.9	3.1*	0.4	5.1*	0.5	2.1*	0.3	3.1*	0.4
Osteoporosis	2.5*	0.9	9.7*	2.6	−0.4	1.2	2.5	2.2	7.5*	1.2	5.7*	1.7	4.2*	1.2	0.3	1.6
Other cancer	7.6*	2.2	10.1*	2.4	5.6*	1.1	3.2	1.9	9.8*	0.9	5.4*	1.2	7.6*	0.9	1.4	1.2
Other chronic pain	6.7*	1.5	14.0*	1.9	5.3*	0.7	8.4*	1.2	12.9*	0.9	10.9*	1.2	11.1*	0.9	7.6*	1.2
Skin cancer	1.4*	0.6	5.7*	1.8	−0.6	0.9	−0.6	1.6	12.2*	1.7	8.5*	2.3	9.9*	1.8	5.1*	2.3
Sleeping problem	3.9*	0.9	12.8*	1.7	2.5*	0.5	7.9*	0.9	6.2*	0.6	8.9*	0.8	4.4*	0.6	6.2*	0.7
Ulcer	3.9*	1.0	9.5*	1.9	1.8*	0.7	3.0*	1.3	7.1*	0.9	4.2*	1.2	5.3*	0.9	0.9	1.2

*Significant at the 0.05 level, two-sided test.

(phase 2). The median value of the regression coefficients for presenteeism, in comparison, are 8.8 (phase 1) and 6.9 (phase 2) days per year in models that compare respondents With condition to respondents with no conditions. The comparable coefficients in models that compare respondents with conditions to respondents without focal condition are 2.4 (phase 1) and 4.0 (phase 2). The IQR (25th to 75th percentiles) of the coefficients in presenteeism models that make the first type of comparison are 2.4 to 5.1 (phase 1) and 5.3 to 9.6 (phase 2), whereas the IQR of the coefficients in models that make the second kind of comparison are 2.4 to 5.1 (phase 1) and 1.3 to 6.6 (phase 2).

There is little consistency across the two phases in the conditions that are estimated to have the strongest adverse effects on work performance. This is perhaps not surprising given the differences in sample composition and in the assessment of conditions. However, several consistencies in the results are especially noteworthy in light of this general lack of consistency. First, chronic obstructive pulmonary disease and CHD are found in both phases to be among the strongest predictors of absenteeism but not among the strongest predictors of presenteeism. Second, depression and fatigue are found in both phases surveys to be among the strongest predictors of presenteeism but not among the strongest predictors of absenteeism. Third, other chronic pain is found in both phases to be among the strongest predictors of both absenteeism and presenteeism.

Estimates of Disaggregated Bivariate Associations Based on Treatment Status in Phase 2

We noted earlier that information was obtained in our surveys about whether respondents received treatment for each of the conditions assessed in the checklist. The existence of selection biases into treatment on the basis of severity makes it impossible to make inferences about treatment effects by comparing the outcomes of people who did receive treatment to the outcomes of people who did not receive treatment. However, comparison of the effects of conditions in the presence versus absence of treatment can nonetheless be helpful in considering potentially useful intervention targets.

If it turns out that the significant positive association between the condition and reduced work performance is confined to respondents who are in treatment for the focal condition, then the most plausible interpretation is that severity of the condition motivates people who are most impaired by the condition to seek treatment. Any intervention to reduce the impairment caused by the condition, in such a case, would have to focus on treatment quality improvement.

In addition, a potential impact of treatment on presenteeism and absenteeism is when a physician prescribes work restrictions, work limitations or modified duty and whether the manager at the employer allows the employee to return to work before they are fully recovered. However, that typically is more relevant to injuries or acute illnesses rather than chronic illnesses.

If, however, it turns out that the significant positive association between the condition and reduced work performance is confined to respondents who are not in treatment for the focal condition, then the most plausible interpretation is that treatment is effective and that further intervention should focus on increasing the proportion of cases that seek treatment. In the more typical case where the significant positive association between the condition and reduced work performance is found both among those who are in treatment and those not in treatment, information about the relative sizes of the coefficients in the treatment sub-samples and not-in-treatment sub-samples can be used to evaluate the opportunities associated with quality improvement versus screening and outreach interventions.

Based on Treatment Status in Phase 2

Some indication of the complexities encountered in carrying out disaggregated analyses of this sort can be seen by considering the results of bivariate analyses that compare respondents with focal conditions to respondents with no conditions in phase 2 as a function of treatment status (Table 5). We see that all the coefficients that are significant in the total sample remain positively significant in the sub-sample of respondents not in treatment in predicting both absenteeism and presenteeism, that the vast majority of these same coefficients remain positively significant in the sub-sample of respondents who are in treatment with medication (92%), and that two thirds of the coefficients remain positively significant in the sub-sample of respondents who are in treatment without medication.

Focusing on absenteeism, we see that two thirds of the coefficients in the sub-sample of respondents who are not in treatment are smaller than those in one or both sub-samples of respondents who are in treatment. This pattern does not hold, though, for presenteeism, where there is no overall difference in the coefficients as a function of treatment (54% of the time the coefficient in the sub-sample not in treatment is larger than the sub-sample in treatment). Comparative analyses of similar data across a number of different samples might find more subtle patterns of consistency related to particular disorders, possibly depending on particular modalities of treatment.

Caution is needed in interpreting these results, as treatment is not randomly assigned. It is likely that workers whose conditions are seriously impairing are more likely than others with the same condition to obtain treatment, leading to an up-

TABLE 5

Estimates of Disaggregated Bivariate Associations Based on Treatement Status in Phase 2

	Not Currently Receiving Treatment				Currently Treated and Medication				Currently Treated No Medication			
	Absenteeism		Presenteeism		Absenteeism		Presenteeism		Absenteeism		Presenteeism	
	β	SE	β	SE	β	SE	β	SE	β	SE	β	SE
Allergy	1.8*	0.3	4.1*	0.5	3.3*	0.4	3.2*	0.6	3.6*	0.8	2.7*	1.1
Anxiety	4.0*	0.5	9.4*	0.8	7.5*	0.6	9.4*	0.8	8.8*	1.7	9.5*	2.4
Arthritis	3.6*	0.5	6.1*	0.6	9.6*	0.9	5.8*	1.0	10.3*	1.1	7.3*	1.6
Asthma	2.9*	0.6	4.9*	0.9	5.4*	0.7	3.7*	0.9	3.5*	1.3	5.1*	1.9
Back/neck pain	3.6*	0.6	6.0*	0.9	15.9*	1.1	9.0*	1.4	9.5*	1.0	7.9*	1.4
Bladder/urinary	3.6*	0.7	7.4*	1.0	9.8*	1.3	12.4*	1.9	12.5*	2.1	3.0	3.0
Chronic bronchitis/ emphysema	25.9*	2.8	17.9*	4.0	−1.0	5.1	−5.5	7.6	−2.7	9.9	12.0	14.6
Congestive heart failure	30.9*	3.7	14.6*	5.2	29.2*	2.8	18.3*	3.8	−0.9	10.0	9.4	14.6
COPD	15.9*	3.5	11.2*	5.0	36.6*	4.7	7.6	6.7	2.6	8.1	8.9	11.9
Coronary heart disease	11.2*	1.4	5.3*	1.9	17.4*	1.3	5.3*	1.7	7.7	4.8	−7.8	7.1
Depression	4.0*	0.6	11.2*	0.8	9.2*	0.6	14.3*	0.8	8.6*	1.7	13.3*	2.4
Diabetes	8.4*	1.6	7.6*	2.3	6.4*	0.7	3.6*	1.0	2.9	1.9	5.3	2.7
Fatigue	9.3*	0.8	12.2*	1.1	14.6*	1.4	13.2*	2.0	15.9*	2.3	17.1*	3.3
GERD	4.7*	0.6	7.3*	0.8	5.8*	0.6	5.9*	0.7	4.6*	1.4	4.9*	2.1
Headache	5.2*	0.8	9.4*	1.1	8.8*	1.1	9.1*	1.5	8.2*	1.8	12.1*	2.6
Hypertension	2.5*	0.6	7.4*	0.9	4.2*	0.5	3.5*	0.6	1.8	1.7	5.6*	2.5
Irritable bowel	5.8*	0.7	9.0*	0.9	6.1*	1.0	6.0*	1.4	2.3	1.5	4.7*	2.3
Migraine	4.3*	0.7	5.0*	1.0	9.4*	0.9	8.1*	1.2	5.7*	1.4	4.8*	2.1
Obesity†												
Osteoporosis	9.1*	1.8	7.5*	2.6	6.0*	1.5	4.9*	2.1	4.0	4.0	1.2	5.9
Other cancer	5.3*	1.0	3.4*	1.4	26.1*	2.1	9.2*	2.8	13.8*	2.2	10.9*	3.3
Other chronic pain	7.0*	1.2	8.2*	1.7	20.9*	1.4	14.4*	1.9	11.9*	1.8	10.8*	2.6
Skin cancer	8.5*	1.8	8.3*	2.5	73.5*	7.7	23.0*	11.1	18.2*	4.6	4.8	6.7
Sleeping problem	6.2*	0.8	8.1*	1.1	9.5*	1.4	10.8*	1.9	5.2*	0.8	9.0*	1.1
Ulcer	6.6*	0.9	4.2*	1.3	7.4*	1.9	2.2	2.7	24.1*	5.2	18.3*	7.6

*Significant at the 0.05 level, two-sided test.
†Treatment not available for obesity.

ward bias in the estimate of the productivity loss due to treated conditions. With this kind of underlying selection process in mind, the main conclusion we can draw from these data is that the significant positive associations of conditions with the outcomes exist for the vast majority of conditions regardless of treatment status. Further, there is reason to assess the quality of care received by those in treatment and try to identify opportunities for improvement that includes reducing work impairment.

Estimates of Disaggregated Bivariate Associations Based on Occupation

Another consideration is whether positive associations of health conditions with work performance vary by employee socio-demographic characteristics, such as their gender, age, or occupation. We examine one such possibility here by focusing on occupation. As in the last section, we consider the results of bivariate analyses that compare respondents with focal condition to respondents with no conditions. Only two conditions are considered, back or neck pain and depression, as the analysis is performed only for illustrative purposes. Back or neck pain has its lowest prevalence among Executives and Professionals and its highest prevalence among Clerical and Services Workers. Depression, in comparison, has its lowest prevalence among Executives and Precision Craft Workers and its highest prevalence among Clerical Workers and Laborers.

The slopes of absenteeism and presenteeism on back or neck pain and depression also vary significantly across the eight occupation sub-samples ($F_{7,34,615} = 3.7$ and 6.9, $P < 0.001$). In the case of back or neck pain, the coefficient predicting absenteeism is highest by far among Laborers, whereas the coefficient predicting presenteeism is highest among Sales Workers and Laborers. The situation is different for depression, where the coefficient predicting absenteeism is highest among Service Workers and the coefficient predicting presenteeism is highest among Executives/Senior Managers.

When we monetized the sum of slopes (ie, total days lost per year) for absenteeism and presenteeism combined, though, we see an interesting correlation. The average monetized lost productivity per year due to depression is highest for Executives ($15,889 compared with $3903 to $11,646 for other occupation groups). This reflects both the high salaries of Executives and the high coefficient associated with presenteeism among Executives.

The average monetized lost productivity per year due to back or neck pain per employee with that condition is also found to be highest for Executives.

Estimates of Disaggregated Bivariate Associations Based on Comorbidity

Up to now we have considered only the aggregated associations involving individual conditions. We know, though, that many of the people with individual conditions also have comorbidities. It is consequently not clear from the results reported so far if the coefficients associated with individual conditions are associated with those conditions themselves or with commonly occurring comorbid conditions. The health and productivity literature has not done a good job of distinguishing these two possibilities. Given the large number of respondents in our surveys, we are able to make a first attempt at distinguishing associations involving single and comorbid conditions. For this analysis, we define a Single Condition as respondents having a single focal condition and none of the other health conditions considered here; and a Comorbid Condition as respondents having a focal condition and at least one other health condition. We estimated a series of bivariate models that compare respondents with single conditions and comorbid conditions to respondents with no conditions.

Two clear patterns emerge from these results (Table 6). First, the high prevalence of comorbidity is striking, with over 90% of respondents with a focal condition having one or

TABLE 6
Estimates of Disaggregated Bivariate Associations Based on Comorbidity

Condition	*N*	Absenteeism β	Absenteeism SE	Presenteeism β	Presenteeism SE
Allergy					
Single	3,159	0.0	0.4	0.1	0.6
Comorbid	8,655	3.2*	0.3	5.1*	0.5
Anxiety					
Single	257	−0.8	1.2	3.0	1.9
Comorbid	3,383	6.2*	0.5	10.0*	0.6
Arthritis					
Single	470	−1.1	0.9	1.5	1.4
Comorbid	4,171	6.1*	0.6	6.7*	0.6
Asthma					
Single	184	−0.3	1.5	1.7	2.2
Comorbid	2,452	4.3*	0.5	4.7*	0.7
Back/neck pain					
Single	170	2.0	1.5	4.8*	2.3
Comorbid	2,070	7.6*	0.6	7.3*	0.8
Bladder/urinary					
Single	140	−0.1	1.7	6.9*	2.5
Comorbid	1,210	6.0*	0.7	8.1*	1.0
Chronic bronchitis/emphysema					
Single	8	−1.6	7.0	17.9	10.5
Comorbid	68	21.6*	2.6	12.6*	3.7
Congestive heart failure					
Single	5	−3.9	8.9	15.1	13.2
Comorbid	91	30.2*	2.3	17.1*	3.2
COPD					
Single	2	−2.6	14.0	−3.7	20.9
Comorbid	58	22.0*	2.8	10.3*	3.9
Coronary heart disease					
Single	60	12.0*	2.6	3.6	3.9
Comorbid	529	14.9*	1.1	5.1*	1.4
Depression					
Single	254	1.9	1.3	12.2*	1.9
Comorbid	3,302	7.2*	0.5	13.1*	0.7
Diabetes					
Single	168	−0.1	1.5	−3.8	2.3
Comorbid	1,285	7.3*	0.7	5.4*	0.9
Fatigue					
Single	35	−1.6	3.4	8.8	5.0
Comorbid	1,190	11.2*	0.7	13.0*	1.0
GERD					
Single	397	−0.6	1.0	0.2	1.5
Comorbid	3,675	5.8*	0.5	7.1*	0.6
Headache					
Single	60	0.7	2.6	7.6*	3.8
Comorbid	1,324	6.9*	0.7	9.8*	0.9
Hypertension					
Single	920	−0.4	0.7	1.1	1.0
Comorbid	4,858	4.5*	0.5	5.3*	0.6
Irritable bowel					
Single	195	−0.4	1.4	2.2	2.1
Comorbid	1,619	6.4*	0.6	8.5*	0.8
Migraine					
Single	170	2.2	1.5	6.4*	2.3
Comorbid	1,884	6.7*	0.6	6.0*	0.8
Obesity					
Single	2,196	−0.3	0.5	1.6*	0.7
Comorbid	6,911	4.3*	0.4	6.4	0.5
Osteoporosis					
Single	49	−2.5	2.9	0.6	4.3
Comorbid	359	8.7*	1.3	6.4*	1.8

(*continued*)

TABLE 6
(*Continued*)

Condition	N	Absenteeism β	Absenteeism SE	Presenteeism β	Presenteeism SE
Other cancer					
Single	120	11.5*	1.9	0.1	2.7
Comorbid	585	9.4*	1.0	6.5*	1.3
Other chronic pain					
Single	14	7.8	5.3	9.9	7.9
Comorbid	669	13.0*	0.9	11.1*	1.2
Skin cancer					
Single	25	1.3	4.0	9.7	5.9
Comorbid	149	14.0*	1.8	8.3*	2.5
Sleeping problem					
Single	79	3.8	2.3	5.6	3.3
Comorbid	1,729	6.3*	0.6	9.1*	0.8
Ulcer					
Single	65	−0.7	2.5	6.8	3.7
Comorbid	632	8.0*	0.9	4.0*	1.2

*Significant at the 0.05 level, two-sided test.

TABLE 7
Estimates of Multivariate Associations Based on Comorbidity

No. of Conditions	N	Absenteeism β	Absenteeism SE	Presenteeism β	Presenteeism SE
1	9,202	0.1	0.3	1.5*	0.4
2	6,102	1.4*	0.3	3.5*	0.5
3	3,666	3.1*	0.4	4.7*	0.6
4	2,217	4.4*	0.5	7.5*	0.7
5	1,322	5.9*	0.7	6.8*	0.9
6	807	6.6*	0.8	7.6*	1.1
7	470	8.0*	1.0	11.5*	1.5
8	280	8.7*	1.3	17.8*	1.9
9	157	14.7*	1.7	14.7*	2.5
10 or more	216	27.5*	1.6	9.9*	2.1

*Significant at the 0.05 level, two-sided test.

more comorbidities for 14 of the 25 conditions considered here and at least 75% of respondents with a focal condition having one or more comorbidities for the 11 other conditions. Second, there is a generally consistent pattern for the coefficients associated with the comorbid cases to be higher than those for the single conditions. This is true in 92% of the comparisons in the table, the only exceptions being cancer in predicting absenteeism and skin cancer, migraine, and ulcer in predicting presenteeism. In all four of these exceptions, the coefficients associated with single and comorbid conditions are very similar in magnitude.

For the vast majority of conditions, comorbid conditions are significant predictors of either absenteeism (23 of 25 conditions) or presenteeism (19 of 25 conditions). The exceptions, where single conditions are significant predictors, are cancer and CHD in predicting absenteeism and back or neck pain, bladder or urinary infections, depression, migraine, headache, and obesity for presenteeism. This conjunction of a high proportion of cases being comorbid and the associations of most conditions being confined to comorbid cases complicates efforts to pinpoint the source of the aggregate associations of individual conditions with work performance.

Estimates of Multivariate Associations Based on Comorbidity

Our investigation of the effects of comorbidity in the last section focused on single versus comorbid conditions without considering the number or type of comorbidities. We can learn more by investigating the implications of the extent of comorbidity; that is, by considering the associations between number of conditions and work performance. Results of such an analysis are examined here as an extension of the expanded bivariate models considered in the last section. As in those models, we focus on the phase 2 sample, but this time we estimate a multivariate model that includes a separate predictor that defines the total number of conditions each respondent has out of those in the checklist.

The distribution of the number of conditions is highly skewed in the phase 2 sample. Among respondents who reported having any of the 25 health conditions more than three fourths had between one and three conditions (37.7% one, 25.0% two, and 15.0% three); and the majority of others had either four (9.1%) or five (5.4%) (Table 7). Only 7.9% of respondents with conditions reported six or more of the 25 conditions. The associations between number of conditions and the outcomes are generally monotonic.

The coefficients are consistently high for respondents with a large number of comorbid conditions. In fact, these coefficients are so high that a substantial proportion of all the work impairment associated with these conditions is concentrated among respondents with high comorbidity. This can be seen by focusing on absenteeism and multiplying the number of respondents with a given number of conditions by the coefficient associated with that number of conditions and summing that product across number of conditions to arrive at the total number of annual absenteeism days due to the conditions.

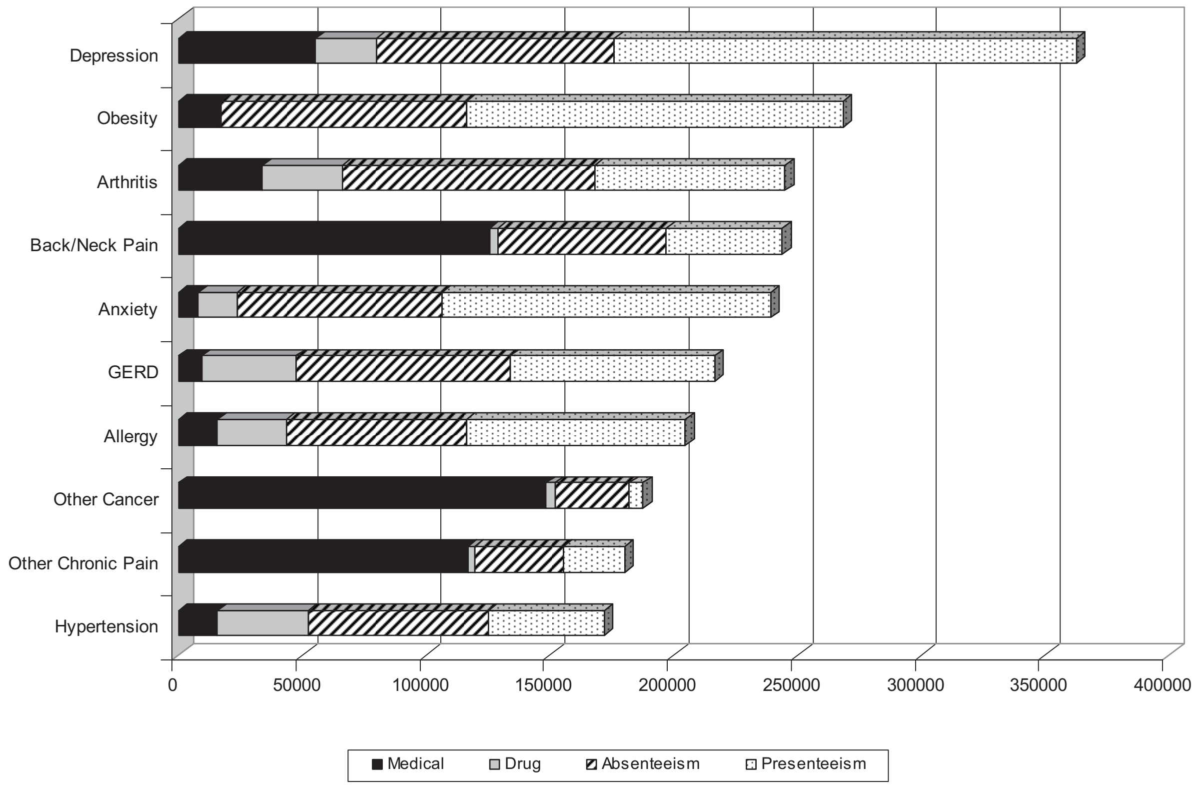

Fig. 1. Top 10 health conditions by annual medical, drug, absenteeism and presenteeism costs per 1000 FTEs for phase 2 companies.

This sum is equal to roughly 57,300 days of absenteeism. More than 33% of all these absenteeism days are concentrated in the 7.9% of respondents with six or more conditions. Close to 50% of all absenteeism days are concentrated among the 13.3% of respondents with five or more conditions. Similar, but somewhat less extreme, concentrations are found in examining the associations of number of conditions with presenteeism.

It should be noted that this model assumes that all combinations of conditions will be associated with the same levels of absenteeism as any other. This assumption is almost certainly incorrect, as we have already seen that the effects of single conditions vary substantially. Single CHD and single other cancer, for example, are each associated with more than 2 weeks of absenteeism per year compared with 0 days associated with single allergies and single chronic bronchitis. It is difficult to imagine that a combination of two conditions consisting of heart disease and cancer would be associated with the same average number of absenteeism days as a combination of allergies and chronic bronchitis. Further analysis is consequently needed to develop a more realistic model of the effects of comorbidity. Such a model would presumably include information about both number of conditions and types of conditions, although the most reasonable specification of these joint effects remains to be determined.

Top 10 Health Conditions by Total Cost

To further explore findings from our previous research[7] that ranked the health conditions with the greatest health-related workplace costs we replicated portions of phase 1 with a larger sample of companies and employees using an improved method for mapping medical and pharmacy claims and an alternative method of measuring productivity.

The results from combining medical and pharmacy claim costs to absenteeism and presenteeism costs found that the following are the top 10 health conditions in terms of total workplace costs: depression, obesity, arthritis, back or neck pain, anxiety, GERD, allergy, other cancer, other chronic pain, and hypertension (Fig. 1).

When looking at the ratio of health-related productivity costs to medical and pharmacy costs at a specific health-condition level across the 25 health conditions, the ratios range widely—from greater than 20 to 1 to less than 1 to 1. Combining costs across the 25 health conditions show that on average, for every 1 dollar of medical plus pharmacy costs there are 2.3 dollars of health-related productivity costs in absenteeism and presenteeism. This finding falls in a range typically reported in previous studies[7,8] using alternative methodologies.

Insights From Participating Companies

A company-specific health and productivity report was provided and reviewed with every participating company. This report documented the health conditions driving the broader medical, drug, absenteeism and presenteeism costs within their workforce. Some of the companies subsequently provided us information as to how they utilized their health and productivity report in designing their corporate health strategies.

Common themes from employers in this study of what insights were gained and how this integrated workforce health and productivity information was used include the following:

- Integration of their corporate health strategies is very important to them. Companies are seeking integrated solutions that span the health continuum from wellness to complex care. Therefore this integrated information was used as the foundation for the business case of justifying the continuation of current health-related strategies as well as the blueprint for action of future initiatives.
- This integrated health and productivity information was shared with members of their senior management and leadership teams often including members of their C-Suite (CEO, CFO, and COO).
- Employers found that the productivity of their employees at work (presenteeism) was significantly impacted by behavioral health issues (eg, depression, anxiety, GERD, fatigue, sleep disorders etc.), heightening the need for more integrated focus in this area. In several cases this led to integrating behavioral health resources through their Employee Assistance Programs more effectively with their chronic condition management providers.
- The study findings confirmed the need to focus on obesity and cardiometabolic risk reduction. Therefore, they increased efforts with workplace-based as well as on-line, phone-based and community-based weight management programs. In addition, some employers communicated with local health care providers so they could better leverage the provider-patient relationship and one employer even helped providers establish diabetic clinics and lipid clinics to reduce metabolic syndrome.
- Several employers are changing their benefit plan design to focus more on health improvement by trying to increase participation and more active engagement of their employees in their wellness, health management, and condition management programs.
- The companies with international workforces are keenly interested in health improvements and their link to productivity improvements. Therefore, even though in many countries the employer does not directly pay for the medical and pharmacy costs of health care, the costs of health-related productivity loss are compelling them to invest in global health and productivity enhancement strategies.
- They also expressed interest in seeing a more broad based adoption of health-related productivity metrics in the industry. They would like to see absenteeism and presenteeism as additional outcome measurements for evidence based medicine and provider pay for performance criteria. They think the evidence used to determine best practices needs to go beyond clinical outcomes or financial outcomes and include functional outcomes—impacts on health and productivity.
- They realize that the impact of a healthier, more productive workforce is quantifiable; when combined with other business measures it helps determine the overall economic value of an enterprise. They would like to see the business community, ranging from financial analysts to investors, develop and institutionalize additional accounting and valuation methods that include health and productivity metrics to more accurately determine the business value of workforce health assets in a company.
- They would like to foster a sharing of findings and innovations among the employer community so they can enjoy the economies of intellect and harness the collective consciousness of thought leadership in health and productivity strategies. Employers want to have a consistent, ongoing approach for measuring and benchmarking their results as they design and implement integrated health and productivity improvement initiatives. Therefore, they are encouraging the development of benchmarking comparison data sets and tools to help evaluate their total health-related costs so they can make the business case for necessary change as well as assess the impact of their programs.

Discussion

As noted in the introduction, the purpose of the "Health and Productivity as a Business Strategy" study was to assess the full impact of health conditions in the workplace, factoring in not only medical and pharmacy cost but also health-related productivity costs such as absenteeism and presenteeism. Phase 1 of the study supported the value of integrating medical and pharmacy claims with self-reported productivity toward understanding the full cost of health conditions. In phase 2, we expanded the power of the analysis by increasing the number of employers and employees measured; further investigated observations regarding the relationship of health and productivity; and explored a number of methodological refinements in determining health-related lost productivity and the full cost of health conditions. We examined the impact on productivity of a more restrictive method of determining health conditions; two different comparison groups; treatment status; occupational differences; and comorbidities. We also offered insights from participating companies on how the study helped shape their corporate health strategies.

Overall in phase 2, we observed that there are many factors that influence the assessment of health-related lost productivity. When measuring the magnitude of lost productivity it is important to understand the composition of the comparison group. A comparison group with no health conditions will likely show greater productivity loss than a comparison group without the focal condition but who may have other health conditions. Furthermore, analyses that focus on employees with a specific health condition (which includes those who may other comorbid conditions) show effect sizes to be larger than when we focus on employees who exclusively have only that single focal condition. We know that some conditions are more likely to be part of comorbid clusters than others merely by virtue of their high prevalence (eg, obesity, seasonal allergies), whereas other conditions are more likely to be significantly intercorrelated with each other even though they are less prevalent in the total population (eg, depression—anxiety and back or neck pain—arthritis). These findings need to be considered when developing and refining measures of health-related lost productivity.

This research gives employers a preliminary estimate of the likely effects of particular health conditions on work performance. This information can be used to help target specific health conditions for intervention even though they are clearly imperfect models. We can also develop tailored models that focus on particular conditions if we have reason to believe that these conditions are important or if new interventions exist. A good case in point is the model that was recently developed to evaluate the possible workplace effects of interventions to detect and treat workers with adult ADHD.[19] Models with a specific focus will inevitably be easier to develop than general-purpose models that consider all comorbidities among all conditions. In the ideal case, these interventions should be evaluated experimentally, but this will seldom be practical in commercial applications. Nonetheless, it should be feasible to obtain quasi-experimental evidence based on before-after case-control comparisons that closely approximate the kinds of evidence one can obtain from experimental studies. This study is an intermediate phase in the progression to those quasi-experimental studies.

Our study demonstrated that a substantial proportion of the productivity loss due to health conditions is found in people with other comorbid conditions, it poses a challenge for future non-experimental research on the effects of health problems on work performance. A sound approach is needed to investigate the joint effects of comorbid conditions on full health-related costs. This would be important where the medical conditions have insignificant associations with work performance and where it is likely that effects of comorbid condition clusters are found to be a joint function of both number of conditions in the cluster and types of conditions in the cluster. Therefore, future research should explore several aspects related to comorbidity such as which health conditions tend to cluster together in people, how do different combinations of conditions impact productivity, do certain conditions have a greater synergistic impact and what are the best methods to allocate lost productivity cost to health conditions?

Moreover, research should improve the understanding of potential confounding variables such as severity of condition, treatment and health behavior variations, and the relationship of lifestyle health risks to productivity loss. Finally, as this and other studies have demonstrated the value of integrating data from multiple sources, data sources should be expanded to include health-related productivity impacts when considering value based benefit plan design, time off policies and measures of corporate culture.

In addition to the methodological contributions, the results of this study continue to support the need for a new, productivity-focused health model in the workplace and a new language and methodology to help determine the true business value of health. Based on the quantitative findings from the measurement of health-related lost productivity and the qualitative findings from interviews with participating employers we offer insights that employers can consider as they evolve their employee health strategies.

1. Health conditions have impact beyond medical and pharmacy costs. For several years, the focus on appropriate approaches to prevention and treatment of chronic conditions has focused entirely on potential gains in medical and pharmacy cost savings. This research emphasizes that health-related lost productivity (absenteeism and presenteeism) are costs employers cannot ignore. At an aggregate population level across the 25 health conditions assessed in phase 2, the results show that on average, for every 1 dollar of medical and pharmacy costs there are 2.3 dollars of health-related productivity costs in lost work time from absenteeism and presenteeism. Employers need to explore new ways of integrating absence and presenteeism data into their current data collection and evaluation strategies.
2. Presenteeism relative to absence lost time is not trivial. For employers, absence has always been a tangible—and observable—consequence of poor health. This research, consistent with several research studies published over the past several years, emphasizes that presenteeism is typically of greater consequence to the employer than absence. This reality presents challenges to employers that are skeptical of employee self-reports as valid sources of data. However, with the growing number of validation studies of self-reporting tools, employers must find ways to integrate presenteeism management into their health strategy approaches. Because employers are hesitant to undertake multiple surveys of employees, they may want to integrate valid absence and presenteeism

self-reporting questions into the health-risk assessments and other self-reporting tools.

3. Opportunities to improve productivity may be found both in the strategies for delivering medical care and in access to treatment. The research suggests that people with chronic conditions under treatment still have work impairments manifesting as absence and presenteeism lost time. The data do not inform us as to whether this is due to sub-optimal care. However, research published in the *New England Journal of Medicine* in 2003 suggests that only about half of people getting treatment receive recommended care.[20] This finding indicates that there are opportunities to improve health-related lost productivity through more effective medical care to those in treatment—whether through improved quality, more effective plan designs or more active patient engagement. At the same time, those with chronic conditions not being treated also experience lost time from absence and presenteeism suggesting that employers ought to consider screening and outreach interventions to encourage employees to seek treatment. Employers will need to address how best to distribute scarce health management resources between improving strategies for care and improving access to treatment.
4. The complexity and impact of comorbidities must be recognized in any health management approach. Employers are in transition in their approach to workforce health management. Employers started with a singular focus on controlling medical costs, transitioned to managing individual diseases and have broadened to population health management. Whatever the approach individual employers and their supplier partners take, they must account for the impact of comorbidities. This research shows that, for the sample studied, employees with one comorbid condition comprise nearly 40% of comorbid cases and generate about 15,600 lost days from absence and presenteeism. Employees with six or more comorbidities make up about 8% of the group but contribute more than 36,000 lost days. Although more comorbidities generally are associated with more lost time, the types of conditions grouped together matter just as much if not more. An important next step is to investigate groupings of comorbidities and whether management approaches can be developed to minimize full costs of these comorbid condition groups.
5. What information is important to employers? Employers can use their medical and pharmacy claims data as a window into medical care expenses but they also need to integrate employee self-reported data on health conditions and their associated lost-time implications for the more complete view of the impact of health conditions on health-related costs. Employees reporting their own medical conditions tend to show higher condition prevalence over a variety of conditions compared to a more limited view of having a physician diagnose the problem. Yet both sources of information show significant amounts of absence and presenteeism lost productivity.
6. Analysis of non-experimental data is limiting. Cross-sectional, non-experimental data such as those reported here are a good starting point for employers to develop intervention strategies, particularly around whether targets should focus on conditions associated with high prevalence or low average lost time or low prevalence or high average lost time. However, cost-effectiveness of the intervention is key in this decision: high-cost strategies aimed at conditions with high prevalence or low time will have limited cost-effectiveness.
7. Not all lost time is equal. The research also indicates that employers need to look beyond simply the amount of lost time but also to the occupations and compensation of those losing time to understand the true productivity loss costs. Highly compensated individuals with concomitant high opportunity costs of lost time may be good targets for interventions even when condition prevalence may be low.
8. Primary, secondary, and tertiary prevention are all critical needs. Examples include: 1) Primary prevention of obesity and other health risks through wellness, 2) Secondary prevention of earlier diagnosis of conditions through screening, and 3) Tertiary prevention of disabling and high total cost conditions through earlier and higher quality of care with evidence based medicine.

We realize there may be selection bias in the employers that participated in this study by the mere fact they were interested in measuring the impacts of health conditions on the productivity of their workforce. As such, these employers may be more attuned to advanced corporate health strategies. However, we see an increasing number of employers of all sizes interested in how to leverage their investments in the health of their workforce as a key business strategy with economic value to their enterprise.

As an example, Eastman Chemical Company, one of the employers that participated in this study, summarizes its health strategy very succinctly:

> "Our health strategy is about the value of health. There are two broad categories of focus: improving the health of our people, and improving the quality of health care outcomes.
>
> The first component is changing the way people think about their health; motivating people to become more engaged in actively managing their health; increased focus on

prevention, identifying and addressing health risks, and managing chronic conditions.

The second component is improving the quality of health care in the U.S. by helping drive systemic change in the way care is delivered. This involves more transparency with regard to cost and quality of care; achieving consensus on consistent measurement standards for quality care; advancing the use of health information technology to enable clinicians to provide better and more timely medical decisions; and revamping the reimbursement process to pay for results rather than activity.

If we focus on these two areas, ie, if we are successful in improving the health of our people and the quality of care they receive, then cost improvement will follow.

In summary:

IF . . . . .

- Health: prevention & managing health risks
- Quality: health care outcomes & delivery

THEN . . . . .

Cost improvement will follow"

Limitations

We recognize there may be selection bias that cannot be accounted for in both the employers that volunteered to participate in this study as well as the employees within the participating companies that voluntarily completed the HRA that included the HPQ. Survey response rates for some employers in the study were less than optimal. Consequently, those employees that did respond may be a unique group and not representative of the employee population as a whole. However, when total employee population eligibility data was analyzed, we found the age, gender, and occupation distribution demographics of the respondents were reasonably consistent with the total employee population demographics of the participating companies. Furthermore, the controls for age, gender, and occupation were included in all the regression equations used in our analysis of the data for this article. Even with the refinements in the methodology to allocate pharmacy costs, it is still possible some of the pharmacy costs are misallocated among conditions.

Annualizing absenteeism and presenteeism assumes that the 1 month measured is representative of the whole year. This may not be the case due to seasonal variation, especially as HPQ surveys are typically carried out at a point in time rather than throughout the year. This problem could be addressed by administering HPQ surveys of workers' birthdays or anniversary date of being hired or in some other way that spreads out the surveys throughout the year, but our experience is that employers prefer one-short administration that leaves us with the problem of possible seasonal variation in associations. The coefficients associated with some conditions (eg, seasonal allergies) are more likely to be affected than others, but the problem has to be recognized as of potential importance in evaluating the associations involving all conditions and comorbidities.

Conclusions

As employers assess their employee health strategies, they will find that their most compelling cost issue is the link between poor health and reduced productivity. Findings from phase 1 of this study showed that on average, for every 1 dollar employers spend on worker medical or pharmacy costs, they absorb 2 to 4 dollars of health-related productivity costs. These costs are manifested largely in the form of presenteeism absence. Our earlier research also showed that in addition to common chronic conditions such as cancer, heart disease and diabetes, a host of other conditions—ranging from musculoskeletal or pain, depression, and fatigue to anxiety and obesity—are the most significant drivers of total health-related costs in the workplace.[7]

Phase 2 of this study refines those methods and examines variations by treatment, comorbidities and occupations, providing further validation to the concept of health and productivity as a business strategy.

Employers of all sizes and types can use strategies based on the relationship between health and productivity to lower health risks, reduce the burden of illness, improve wellness and human performance, and enhance the quality of life for workers and their families, while reducing total health-related costs. Such programs help employers more accurately determine which health conditions have the greatest impact on overall productivity and then design strategies to help their employees prevent or better manage these conditions.

As employers seek to gain a better understanding of key medical care issues, they struggle with sources of information on workforce health. Traditionally, employers and their supplier partners have relied upon medical and pharmacy claims data as their window into employee health. As employers have broadened their attention to health risks and "business-relevant outcomes" such as productivity, they are looking to new sources of information. Employee self-reported data, such as found in HRAs and absence and presenteeism measurement tools are becoming an important part of the employer's tool chest of information.

In an environment in which health costs are skyrocketing, health promotion and health protection measures aimed at the nation's workforce could have significant long-term impact, potentially saving billions in costs. Furthermore, the positive impact of reaching large populations through the workplace extends beyond those currently employed. Families of the employed, retirees and other beneficiaries could also benefit from integrated health and productivity strategies implemented by the nation's employers.

The fundamental philosophy driving the adoption of these strategies is that health is not only of great value to individuals and populations, but also of great value to business and industry. It is important for all employers—whether small, medium or large—to look beyond health care benefits as a cost to be managed and rather to the benefits of good health as an investment to be leveraged. Ultimately, a healthier, more productive workforce can help drive greater profitability for employers as well as a healthier economy for our nation.

Acknowledgment

We want to thank Gary Persinger and Jeffrey Warren, MPA, of the National Pharmaceutical Council as well as Dr Pamela Hymel, Corporate Medical Director of Cisco Systems and Paul Larson of ACOEM for their assistance in providing review and comment during the study and the development of this manuscript. We also thank David Sensibaugh, Director of Integrated Health at Eastman Chemical Company for participating in the study and sharing his company's health strategy to be included in this paper.

The study is funded by the National Pharmaceutical Council, a research and education organization supported by more than 20 of the nation's leading research-based pharmaceutical companies.

References

1. Blumenthal D. Employer-sponsored insurance—riding the Health Care Tiger. *N Engl J Med*. 2006;355:195–202.
2. Thorpe KE. Factors accounting for the rise in health-care spending in the United States: the role of rising disease prevalence and treatment intensity. *Public Health*. 2006;120:1002–1007.
3. Partnership for Solutions National Program Office. *Chronic Conditions: Making the Case for Ongoing Care: September 2004 Update*. Baltimore, MD: Partnership for Solutions, John Hopkins University; 2004.
4. Loeppke RR. The value of health and the power of prevention. *Int J Workplace Health Manage*. 2008;1:95–108.
5. Fronstin P, Collins SR. *Findings From the 2007 EBRI/Commonwealth Fund Consumerism in Health Survey*. New York, NY: The Commonwealth Fund; 2008.
6. Bureau of Labor Statistics. *The Employment Situation: December 2008*. Washington, DC: US Department of Labor; 2009.
7. Loeppke RR, Taitel M, Richling DE, et al. Health and productivity as a business strategy. *J Occup Environ Med*. 2007;49: 712–721.
8. Edington DW, Burton WN. *Health and Productivity. A Practical Approach to Occupational and Environmental Medicine*. Philadelphia: Lippincott Williams & Wilkins; 2003:140–152.
9. Kessler RC, Barber C, Beck A, et al. The World Health Organization Health and Work Performance Questionnaire (HPQ). *J Occup Environ Med*. 2003;45:156–173.
10. Kessler RC, Ames M, Hymel PA, et al. Using the World Health Organization Health and Work Performance Questionnaire (HPQ) to evaluate the indirect workplace costs of illness. *J Occup Environ Med*. 2004;46:S23–S37.
11. Schoenborn C, Adams P, Schiller J. Summary health statistics for the U.S. population: National Health Interview Survey, 2000. *Vital Health Stat 10*. 2003;(214):1–83.
12. National Center for Health Statistics. *National Health Interview Survey*. Hyattsville, MD: United States Department of Health and Human Services; 2004.
13. Knight M, Stewart-Brown S, Fletcher L. Estimating health needs: the impact of a checklist of conditions and quality of life measurement on health information derived from community surveys. *J Public Health Med*. 2001;23:179–186.
14. Baker M, Stabile M, Deri C. What do self-reported, objective measures of health measure? Cambridge, MA: National Bureau of Economic Research; 2001.
15. Edwards W, Winn D, Kurlantzick V, et al. Evaluation of National Health Interview Survey Diagnostic Reporting. *Vital Health Stat 2*. 1994;120:1–116.
16. Revicki DA, Rentz AM, Dubois D, et al. Gastroparesis Cardinal Symptom Index (GCSI): development and validation of a patient reported assessment of severity of gastroparesis symptoms. *Qual Life Res*. 2004;13:833–844.
17. Villanueva EV. The validity of self-reported weight in US adults: a population based cross-sectional study. *BMC Public Health*. 2001;1.
18. Nicholson S, Pauly MV, Polsky D, Sharda C, Szrek H, Berger ML. Measuring the effects of work loss on productivity with team production. *Health Econ*. 2006;15:111–123.
19. Kessler RC, Adler L, Ames M, et al. The prevalence and effects of adult attention deficit/hyperactivity disorder on work performance in a nationally representative sample of workers. *J Occup Environ Med*. 2005;47:565–572.
20. McGlynn EA, Asch SM, Adams J, Keesey J, DeCristofaro AH, Kerr EA. The quality of health care delivered to adults in the United States. *N Engl J Med*. 2003;348:2635–2645.