FAST TRACK ARTICLE

The Assessment of Chronic Health Conditions on Work Performance, Absence, and Total Economic Impact for Employers

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Objective: *The objective of this study was to determine the prevalence and estimate total costs for chronic health conditions in the U.S. workforce for the Dow Chemical Company (Dow).* ***Methods:*** *Using the Stanford Presenteeism Scale, information was collected from workers at five locations on work impairment and absenteeism based on self-reported "primary" chronic health conditions. Survey data were merged with employee demographics, medical and pharmaceutical claims, smoking status, biometric health risk factors, payroll records, and job type.* ***Results:*** *Almost 65% of respondents reported having one or more of the surveyed chronic conditions. The most common were allergies, arthritis/joint pain or stiffness, and back or neck disorders. The associated absenteeism by chronic condition ranged from 0.9 to 5.9 hours in a 4-week period, and on-the-job work impairment ranged from a 17.8% to 36.4% decrement in ability to function at work. The presence of a chronic condition was the most important determinant of the reported levels of work impairment and absence after adjusting for other factors (*$P < 0.000$*). The total cost of chronic conditions was estimated to be 10.7% of the total labor costs for Dow in the United States; 6.8% was attributable to work impairment alone.* ***Conclusion:*** *For all chronic conditions studied, the cost associated with performance based work loss or "presenteeism" greatly exceeded the combined costs of absenteeism and medical treatment combined.* (J Occup Environ Med. *2005;47:547–557*)

Clinicians, policymakers, employers, and insurers are intently focused on the cost of health care. As the current healthcare situation is analyzed, it is important to have a full appreciation of the total economic impact of health conditions on business and our society. To enable the best investment of limited societal resources, it would be helpful to have a more comprehensive understanding of the link between illness and overall economic impact.

Health conditions increase work-related absences and reduce workplace productivity, creating a substantial economic burden for industry.[1–3] Although this may not be disputed in the abstract, it is much more difficult to assess the impact of poor employee health on a specific company's productivity. First, most employers do not systematically track absenteeism or do so for only a portion of their workforce. Second, methods to assess the impact of a health condition on work performance, known as presenteeism, have only been developed in the last few years.

From the perspective of an individual company, demonstrating the financial impact of health conditions is critical for developing budgetary priorities, including the amounts allocated for employee benefits such as health insurance, health promotion programs, and disease management interventions. Most studies have focused on a particular disease or condition and have not characterized the impact on all employees. Various

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DOI: 10.1097/01.jom.0000166864.58664.29

chronic health conditions, including asthma, allergic rhinitis, migraine headaches, depression, respiratory difficulties, back pain, and diabetes, have been shown to reduce productivity.[4–18] However, little is known about the relative contributions of each to a company's overall work loss or how work loss varies by job type, demographics, or other factors. Limited data support the contention that interventions into disease states and health risk can increase worker output,[19] but more is needed.[6,15,19]

Some studies have suggested that health-related absences are less important than health-related impairment on the job or "work impairment." Work impairment, however, had not been assessed until very recently.[4,17,20–22] Two studies estimated that work impairment may reduce total work hours by one fifth.[22,23] Thus, focusing only on absenteeism may significantly underestimate lost productivity.[5–18]

Since 1997, the Dow Chemical Company (Dow) has been implementing an integrated health management approach to help minimize health-related costs and maximize health-related productivity. Dow defines the total economic impact related to health as the sum of direct healthcare costs and the indirect costs of absenteeism and presenteeism performance losses. Until recently, Dow had no estimate of the cost of presenteeism or health-related work performance. We report the results of a comprehensive characterization and economic analysis of chronic health conditions on Dow's U.S. workforce. To our knowledge, this study is the most comprehensive survey of its kind to date and provides the most complete picture of the impact of chronic health conditions on a diverse workforce. Given that the majority of the nonelderly in the United States obtain their health insurance through their employers, employer decisions have profound influence in the healthcare system generally. This case study can inform policymakers, payers, and providers regarding the total economic impact of chronic conditions on business and our society and provides an important framework for considering investments in interventions that improve functioning for individuals with chronic health conditions. For Dow, it establishes a baseline against which future assessments can be compared.

Materials and Methods

Between July and September 2002, 12,397 Dow full-time active employees at five locations in Michigan and Texas (representing 56% of Dow's U.S. workforce) received an invitation to participate in an online health survey. Part-time, temporary, work-study workers, interns, and employees on extended leaves of absence were excluded. Workers in a broad cross-section of job types participated, including top leadership, technical, professional, office professional, and chemical production jobs. All participants provided informed consent and confidentiality was maintained by employing a third party for analysis of data. The protocol was reviewed and approved by an Institutional Review Board, and the study was designed and conducted using the principles of Good Epidemiology Practices.[24]

All participants were asked to complete the Short-Form Health Survey (SF-36)[25] and the Stanford Presenteeism Scale ("SPS") (Fig. 1). Validation of the SPS is reported

1. Do you have any of the following health conditions? Please check all that apply, and also check which one you consider your primary condition *(the condition that has affected you most in the past 4 weeks)*. If you have none of these conditions, please mark this box and do not complete the survey. (Choices: Allergies; Arthritis or joint pain/stiffness; Asthma; Back or neck disorder; Breathing disorder-bronchitis or emphysema; Depression anxiety or emotional disorder; Diabetes; Heart or circulatory problems-artery disease, high blood pressure, angina; Migraines/chronic headaches; Stomach or bowel disorder; and Other ____)

For 2-11: In thinking about how your primary condition affected your ability to do your job, how often in the past 4 weeks: (Always / Frequently / About half the time / Occasionally / Never / No answer)

2. Were you able to finish hard tasks?
3. Did you find your attention wandering?
4. Were you able to focus on achieving work goals?
5. Did you feel energetic enough to work?
6. Were the stresses of your job hard to handle?
7. Did you feel hopeless about finishing your work?
8. Were you able to focus on finding a solution when unexpected problems arose in your work?
9. Did you need to take breaks from your work?
10. Were you able to work with other people on shared tasks?
11. Were you tired because you lost sleep?

12. Given your primary health condition, what percentage of your usual productivity level were you able to achieve while working over the last 4 weeks?
(place X on continuous scale 1-100)

13. Because of your primary condition as you identified in question 1, how many work hours did you miss in the past 4 weeks?
(place X on continuous scale 0-40+)

Stanford Presenteeism Scale (SPS) is owned by Merck & Co., Inc., 2003

Fig. 1. Stanford Presenteeism Scale.

elsewhere.[4,21] A random sample of participants (10%) also completed the Work Limitation Questionnaire (WLQ)[26] as an additional measure of health-related work loss. The SPS (Fig. 1) assesses self-reported absence, work impairment, and work loss attributable to the identified "primary health condition." The first question asks the respondent to select their chronic health conditions from a list and to identify his or her "primary health condition," defined as the condition that has affected the individual most in the past 4 weeks. The chronic conditions listed on the SPS for this study are noted in Table 1. Work impairment for each survey respondent was calculated from the responses to 10 SPS items querying the frequency or intensity of specific manifestations of the primary health condition, and how these manifestations affected work (questions 2–11, Fig. 1). A five-point scale was used for scoring categorical responses: always, frequently, about half the time, occasionally, or never. Each individual's responses were summed and normalized to a percentage referred to as the Work Impairment Score (WIS). For example, an employee who responded "about half the time" to all 10 questions would have a WIS of 50% (50% impairment in ability to work), whereas employees who responded "occasionally" to all 10 questions would report a 25% impairment. As reported elsewhere,[21] the reliability of the WIS was high in this application (ie, Cronbach's alpha = 0.83), and evidence of content and construct validity through comparison to the SF-36 and the WLQ was included in that discussion.

The SPS also includes a single-item global assessment question that asks the respondent to estimate the percentage of "usual" productivity they were able to achieve in the 4-week period given the primary health condition (question 12, Fig. 1). We refer to this estimate as the work output score (WOS). We interpret the WIS as measuring the extent to which a health condition reduces a person's inputs into their job (eg, energy, ability to focus, ability to work with colleagues) and the WOS as measuring how much less output is produced as a result of the diminished inputs. Therefore, we use the WOS to quantify the monetary cost of productivity losses because economic theory indicates that people are paid according to the value of their output, but we examine how health and other demographic characteristics affect the WIS because we are interested in identifying factors that affect a person's underlying ability to work effectively.

The individual-level survey data were merged with information from many other sources, including medical and pharmaceutical claims and company records that reported demographics, job category, payroll absence data, and plant location. Biometric data collected from previous health risk appraisals were also merged, as was smoking status. The biometrics included high-, medium-, and low-risk categorical measures for diastolic blood pressure, systolic pressure, total cholesterol, the ratio of total cholesterol to high-density lipopro-

TABLE 1
Chronic Health Conditions on SPS and Corresponding ICD-9-CM Codes*

Primary Chronic Health Condition on SPS	ICD-9-CM Codes
Allergies	287.0, 372.14, 379.93, 446.20, 446.29, 477.0–477.9, 478.8, 495.0–495.9, 558.3, 693.1, 708.0–708.1, 708.5–708.9, 995.1, 995.3, V14.0–V14.9, V15.01–V15.09
Arthritis or joint pain/stiffness	714.0–714.9, 715.00–715.98, 716.00–716.99, 719.40–719.59
Asthma	493.xx
Back or neck disorder	720.0–720.9, 737.0–737.9, 738.2, 738.5, 839.00–839.59, 846.0–846.9, 847.0–847.9
Breathing disorder (bronchitis, emphysema)	490, 491.0–491.9, 492.0–492.8
Depression, anxiety or emotional disorder	296.20–296.36, 296.4–296.7, 298.0, 300.4, 301.12, 309.0–309.1, 311, 293.84, 300.00–300.09, 300.20–300.30, 309.21, 309.24, 301.0–301.9, 308.0–308.9, 309.22, 309.23, 309.28–309.29, 309.3–309.9, 312.0–312.9, 313.0–313.9
Diabetes	250.xx
Heart and circulatory problems (artery disease, high blood pressure)	401.0–404.9, 405, 410.00–410.92, 411, 411.1, 411.0, 411.81–411.89, 412, 413, 414, 414.0, 414.1, 414.00–414.05, 414.10, 414.8–414.9
Migraine/chronic headaches	346.0–346.9, 307.81, 784.0
Stomach or bowel disorder	530.81, 531.00–534.91, 535.00–535.91, 536.0–536.9, 537.0–537.9, 556, 558.9, 560.0–560.9, 569.81–569.9, 562.00–562.13, 564.00–564.9, 782.7

* International Classification of Disease (ICD-9-CM) codes were used to find medical claims-based evidence of these conditions. Pharmacy codes were also used to find patients with evidence of having these conditions.

tein (HDL) levels, and body mass index (BMI).

Total annual health costs were defined as the sum of the medical treatment costs, absenteeism costs, and presenteeism costs. Treatment costs included the company's expenditures for employees' medical, mental health, and pharmacy costs for the 12-month period before the survey. Absenteeism costs were based on hours away from work resulting from the primary condition reported on the SPS (question 13, Fig. 1). These hours were annualized and multiplied by the average annual wage for the worker's job type to put absenteeism in dollar terms. Presenteeism or work performance losses were similarly estimated using the WOS. For example, if a person indicated she was 10% less productive than usual over the past 4 weeks as a result of her primary health condition, we assumed the value of the lost output over the entire year was equal to 10% of the average annual wage of that job type. For some people, the productivity impact over the past 4 weeks is likely to be larger or smaller than the impact for the year as a whole, but the reported impact should be an accurate measure on average. The prevalence of chronic health conditions by job type was used to project the costs from our sample to the entire U.S. Dow workforce.

Analysis

Two multiple regression analyses were conducted to estimate the impact of various factors on work impairment and absenteeism. These factors included the "primary" health condition reported on the survey, an indicator denoting whether more than one chronic condition was reported, the employee's job type, plant location, age, ethnicity, sex, and biometrics, and his or her average number of hours worked per week during the recall period. Ethnicity was reported by the study participants. The WIS was used as the dependent variable measure of work loss in the first regression analysis. Because almost 85% of the respondents reported no absence-associated lost hours in the 4-week reporting period, we used a binary (yes or no) indicator for absences as the dependent variable in a logistic regression analysis. We evaluated residual plots to assess the fit of the regression models, determine the influence of outliers, and assure regression assumptions were not violated. Condition indices were used to evaluate collinearity between independent variables.[7,27]

Self-reported survey prevalence of certain chronic conditions was compared with those same conditions generated from medical claims, using both International Classification of Diseases, 9th Revision, Clinical Modification codes for health conditions (Table 1) and evidence of the use of pharmacotherapy for these conditions. Medical and pharmacy claims files were then used to estimate the direct medical costs of treatment for the chronic conditions of interest based on inpatient, outpatient, emergency room, and pharmacy costs. Finally, the economic impact of the chronic conditions on the entire Dow U.S. workforce was estimated. This was done by multiplying the average total cost of work loss (based on medical and drug expenditures, absenteeism dollars, and work impairment dollars) in each job category by the number of workers in each job category throughout the Dow U.S. workforce and dividing the result by total salary and benefits paid to all Dow U.S. employees. This resulted in an estimate of the economic burden of chronic illness at Dow as a percentage of labor costs for the chronic conditions reported in the survey.

Results

Of the 12,397 workers contacted, 7797 responded (63%). Compared with nonrespondents, the respondents were similar in age, more likely to be female, less likely to be current smokers, and less likely to be union members. In addition, a majority of both responders and nonresponders were likely to have a BMI less than 30 and to have normal diastolic pressure (see Table 2). Because of missing values on health risk factors and incomplete surveys, the number of survey participants used in the regression analyses was 5108 for work impairment and 5240 for the absenteeism; the number of participants completing the entire survey was 5369. There were no major differences among the cases left out as a result of missing health risk factors when compared with those who were included in the regression analyses. Medical claims data were available for 95% (7410 of 7797) of respondents reporting a chronic condition, and these survey participants were used for the cost analysis.

Prevalence

Overall health status, as assessed by the single global question in the SF-36 for respondents, were reported as follows: excellent (12%), very good (45%), good (36%), fair (6%), and poor (0.5%). Almost two thirds (65%) of the survey participants reported one or more chronic health conditions. Those most frequently reported were allergies (37.1%), arthritis/joint pain or stiffness (21.8%), and back and neck disorders (16.3%). These results are similar to those reported in another survey.[28] If we examine only the primary health conditions, or the condition that affected the participant the most in the last 4 weeks (see Fig. 1, question 1), 58% of those surveyed reported a primary health condition. The most common primary health conditions reported were allergies (18.9%), arthritis/joint pain or stiffness (9.0%), heart or circulatory problems (7.1%), and back or neck disorders (7.0%). For all conditions, the general self-reported prevalences, whether a condition was designated as primary, were higher for all conditions than the prevalence of the same condition noted by examination of medical claims (Fig. 2).

TABLE 2
Characteristics of Survey Population

	Survey Respondents	Survey Non-Respondents
Number	7797	4600
Demographics		
Average Age	43.2 yrs	43.9 yrs
Female	72%	28%
Male	60%	40%
Union jobs	12.5%	33.3%
Site location		
#1	72%	28%
#2	63%	37%
#3	56%	42%
#4	72%	28%
#5	61%	39%
Outpatient visits	2.47 visits	2.18 visits
Health Indicators		
Current smoking status		
Yes	13%	19%
No	87%	81%
BMI		
<25	23%	18%
25–29.9	40%	39%
30+	36%	42%
Systolic blood pressure		
Normal (<140)	88%	83%
Low risk (140–159)	11%	15%
High risk (160+)	1%	2%
Diastolic blood pressure		
Normal (<90)	87%	85%
Low risk (90–99)	10%	13%
High risk (100+)	1.9%	2.2%
HDL		
Low risk (4.0–4.9)	54%	49%
Mild risk (5.0–5.9)	35%	39%
High risk (6.0+)	10%	12%
LDL		
Low risk	62%	59%
Mild risk	25.7%	26.6%
High risk	12%	15%
Total Cholesterol		
Low risk (<200)	54%	49%
Mild risk (200–239)	33%	35%
High risk (240+)	13%	16%

All characteristics were significantly different statistically ($P \leq 0.001$). Other characteristics that were checked that did not significantly differ between responders and non-responders were: Expenditures (total, inpatient, outpatient, emergency room, mental health and drug), inpatient admissions, inpatient days, ER visits, mental health utilization (inpatient admissions and days, outpatient visits, ER visits and drug scripts).

The differences were larger for the more symptomatic conditions such as allergies, arthritis, and migraine headaches, and smaller for heart disease and diabetes.

Across all job types except unskilled laborers, a majority of workers reported at least one chronic condition as follows: clerical and office workers (70.6%), craft workers–skilled (69.2%), officials and managers (68.5%), technicians (68.5%), professionals (66.6%), operatives–semiskilled (64.4%), service workers (60.5%), sales workers (58.2%), and laborers–unskilled (25.0%).

Work Loss

For those individuals reporting a primary chronic condition, the associated absenteeism during the 4-week recall period varied by chronic condition, ranging from 0.9 to 5.9 hours, whereas work impairment varied from a 17.8% to 36.4% decrement in ability to function (Table 3). Employees reporting depression, anxiety, or emotional disorders (36.4% decrement) or breathing disorders (bronchitis, emphysema; 23.8% decrement) had the highest work impairment. Employees with these conditions also reported the highest absences. Overall, greater work impairment was associated with lower health status according to the SF-36 and the correlation was strongly negative (−0.65).[21]

Factors associated with work impairment and absences are shown in Table 4. Important predictors for work impairment included sex ($P = 0.012$), age ($P = 0.000$), location ($P = 0.000$), job ($P = 0.000$), the presence of a chronic condition ($P = 0.000$), number of chronic conditions ($P = 0.000$), and hours worked ($P = 0.000$). Work impairment decreased with increasing age and was highest among the employees whose jobs were classified as service workers and operatives (semiskilled). Depression, anxiety, or emotional disorder responses were associated with the most work impairment, but migraine/chronic headaches, "other" conditions, breathing disorders, and back or neck disorders were also important predictors of work impairment. The degree of work impairment increased with the number of chronic conditions reported. Work impairment was highest for persons working less than 40 hours. This regression model explained 18% of the variance of work impairment.

Important predictors of absence, defined as one or more absence hours in a 4-week period, included sex ($P = 0.002$), age ($P = 0.003$), location ($P = 0.000$), job ($P = 0.000$), chronic condition ($P = 0.000$), number of chronic conditions ($P = 0.000$), and hours worked ($P = 0.000$). Females were 40% more likely to report absence than males.

The risk of being absent decreased with age, with workers 56 and older being 50% (odds ratio = 0.5) less likely to be absent than workers less than age 25. The risk of being absent was lowest at the location 3 (70%) and highest at location 5 (130%). Sales workers (180%) and office and clerical workers (140%) had the highest risk of being absent, whereas craft workers (90%) and managers (100%) had the lowest risk. The largest risk for absence from chronic conditions occurred among workers with breathing disorder (bronchitis, emphysema; 440%), followed by depression, anxiety, or emotional disorder (220%) and then by migraine/chronic headaches (170%). The risk of absence also increased with the number of health condition reported. Finally, the risk of being absent decreased with the more hours worked: the risk being 50% lower among employees working 60 of more hours compared with employees working 40 to 44 hours. This regression model explained 11% of the variance of absence.

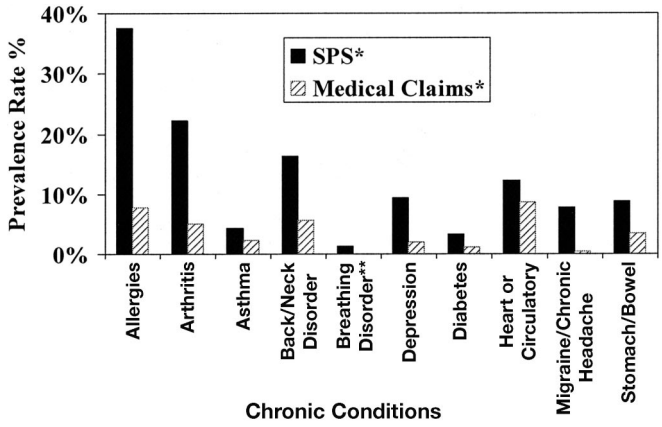

Fig. 2. *Prevalence rates from the SPS of any chronic conditions in the last 4 weeks and chronic conditions reported from medical and pharmacy claims in the last year.**Breathing disorders (bronchitis and emphysema).

Costs

Based on the experiences of those employees who reported a primary condition, we estimated the total cost of each condition individually (see Fig. 3). Among employees who reported at least one primary condition, the highest total cost per worker per year was for those reporting depression, anxiety, or emotional disorder as their "primary health condition" ($18,864 in year 2002 dollars), and

TABLE 3
Number of Respondents, Prevalence Rates, and Mean Impairment Scores (WIS) and Absence Hours by Self-Reported Health Conditions

Reported Chronic Health Condition	Number (%) of Respondents who Reported Having this Condition, Regardless of Whether it was Selected as Their Primary Health Condition	Number (%) of Respondents Who Chose Condition as Primary Health Condition and Answered Impairment Score Questions	Mean Impairment Score For Those Who Chose Condition as Primary Health Condition	95% Confidence Interval Around Mean Impairment Score	Number (%) of Respondents Who Chose Condition as Primary Health Condition and Answered Question on Absenteeism	Mean Hours Absent for Those who Chose Condition as Primary Health Condition	95% Confidence Interval Around Mean Hours Absent
Allergies	2890 (37.1)	1472 (18.9)	18.2	17.5,18.8	1482 (19.0)	0.9	0.7,1.1
Arthritis/joint pain . . .	1697 (21.8)	704 (9.0)	19.7	18.6,20.7	707 (9.1)	1.1	0.8,1.4
Asthma	348 (4.5)	99 (1.3)	17.9	15.2,20.5	98 (1.3)	0.9	0.5,1.4
Back/neck disorder	1274 (16.3)	545 (7.0)	21.7	20.5,22.8	549 (7.0)	2.1	1.5,2.6
Breathing disorder . . .	104 (1.3)	20 (0.3)	23.8	17.8,29.7	20 (0.3)	5.9	1.6,10.2
Depression, anxiety . . .	721 (9.2)	337 (4.3)	36.4	34.4,38.3	339 (4.3)	3.7	2.8,4.6
Diabetes	253 (3.2)	189 (2.4)	17.8	15.9,19.6	189 (2.4)	1.3	0.6,1.9
Heart/circulatory problem . . .	929 (11.9)	554 (7.1)	19.9	18.7,21.1	556 (7.1)	1.4	0.9,1.9
Migraines/chronic headaches	635 (8.1)	243 (3.1)	23.4	21.7,25.0	243 (3.1)	2.4	1.7,3.2
Stomach/bowel disorder	677 (8.7)	262 (3.4)	21.7	20.0,23.3	266 (3.4)	1.9	1,2.7
Musculoskeletal	49 (0.6)	46 (0.6)	21.5	17.6,25.4	49 (0.6)	2.6	0.5,4.7
Other	906 (11.6)	434 (5.6)	23.0	21.5,24.4	442 (5.7)	4.0	3.1,4.9

TABLE 4
Predictors of Work Impairment and Absence Due to a Chronic Health Condition

	Work Impairment			Absence		
Variable	Linear Regression Coefficient	Variable *P*-value	Group *P*-value	Logistic Regression Odds Ratio	Variable *P*-value	Group *P*-value
Constant	12.5	0.000		NA	0.000	
Sex						
Male	0.0	Reference	0.012	1.0	Reference	0.002
Female	0.7	0.159		1.4	0.000	
Unknown	−3.4	0.022		0.9	0.640	
Race						
White	0.0	Reference	0.228	1.0	Reference	0.433
Black	−1.1	0.263		1.2	0.312	
Hispanic	−1.1	0.158		1.2	0.077	
Asian	0.6	0.631		1.1	0.613	
Amer. Indian	5.7	0.070		1.2	0.768	
Unknown	−1.3	0.672		0.6	0.595	
Age						
<25	2.8	0.091	0.000	1.0	0.932	0.003
26–35	0.0	Reference		1.0	Reference	
36–45	−1.4	0.017		0.7	0.000	
46–55	−2.8	0.000		0.6	0.000	
56+	−4.5	0.000		0.5	0.000	
Location						
1	0.2	0.688	0.000	1.1	0.322	0.000
2	1.2	0.016		1.1	0.441	
3	3.5	0.000		0.7	0.030	
4	0.0	Reference		1.0	Reference	
5	0.8	0.283		1.3	0.054	
Unknown	1.4	0.431				
Job						
Managers	0.0	Reference	0.000	1.0	Reference	0.000
Craft workers (skilled)	1.9	0.047		0.9	0.908	
Office & clerical	1.8	0.053		1.4	0.020	
Operatives (semi-skilled)	3.1	0.000		1.0	0.997	
Professionals	0.3	0.701		1.1	0.298	
Sales workers	2.5	0.237		1.8	0.087	
Service Workers	3.3	0.145		0.6	0.221	
Technicians	1.7	0.033		1.2	0.126	
Unknown	0.1	0.922		1.6	0.108	
Chronic Condition						
Arthritis	0.0	Reference	0.000	1.0	Reference	0.000
Allergies	−0.5	0.397		1.0	0.989	
Asthma	−3.5	0.014		1.0	0.856	
Back	1.6	0.034		1.2	0.086	
Breathing	1.7	0.574		4.4	0.007	
Depression	14.4	0.000		2.2	0.000	
Diabetes	−2.4	0.028		1.2	0.346	
Heart	0.4	0.592		0.9	0.396	
Migraines	2.3	0.022		1.7	0.001	
Stomach	1.0	0.297		1.3	0.037	
Other	2.3	0.004		1.0	0.910	
Number of Conditions						
Number	3.0	0.000	0.000	1.4	0.000	0.000
Body Mass Index						
<30	0.0	Reference	1.0	Reference		
30+	0.9	0.092	1.1	0.403		
Missing	0.1	0.922	1.2	0.124		
Smoking						
Non-smoker	0.0	Reference	1.0	Reference		
Smoker	0.6	0.402	1.0	0.987		
Unknown	0.4	0.592	1.0	0.985		

(*Continued*)

TABLE 4
(Continued)

Variable	Work Impairment			Absence		
	Linear Regression Coefficient	Variable *P*-value	Group *P*-value	Logistic Regression Odds Ratio	Variable *P*-value	Group *P*-value
Diastolic Blood Pressure						
<90	0.0	Reference		1.0	Reference	
90–99	−1.7	0.038		1.0	1.000	
100+	−0.3	0.882		1.0	1.000	
Systolic Blood Pressure						
<140	0.0	Reference	0.424	1.0	Reference	0.654
140–159	−0.2	0.782		0.8	0.051	
160+	−1.2	0.548		0.5	0.063	
Total Cholesterol						
<200	0.0	Reference		1.0	Reference	
200–239	−0.3	0.563		1.1	0.421	
240+	0.0	0.985		1.1	0.436	
Total Cholesterol/HDL						
<4.0	0.0	Reference		1.0	Reference	
4.0–4.9	0.1	0.480		1.2	0.015	
5.0–5.9	0.0	0.902		1.1	0.650	
6.0+	0.3	0.059		1.3	0.041	
Hours Worked						
<40	11.4	0.000	0.000	1.6	0.249	0.000
40–44	0.0	Reference		1.0	Reference	
45–50	0.6	0.166		0.7	0.000	
50–55	1.0	0.084		0.6	0.000	
55–60	3.4	0.000		0.6	0.000	
60+	1.3	0.127		0.5	0.000	
Missing	−5.0	0.107		0.4	0.439	
Regression						
Number		5108			5240	
R-Squared		0.179			0.111*	
Sign		0.000			0.000	

*Cox and Snell R-Squared.
Analysis in this table was based on linear multiple regression of the Work Impairment Score and logistic regression on reported absence.

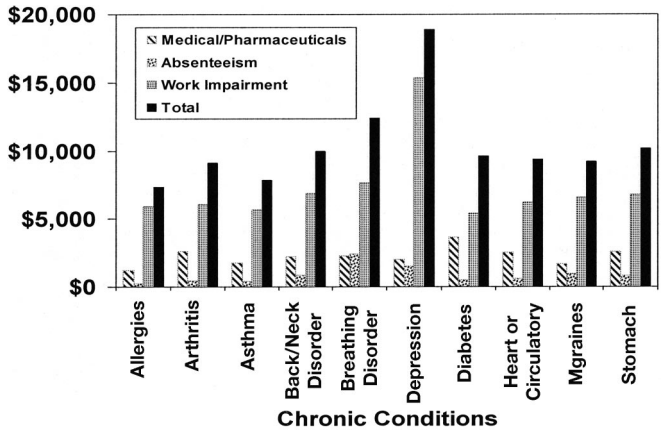

Fig. 3. Chronic Conditions.

the lowest was for those reporting allergies ($6947).

For all chronic conditions, with the exception of breathing disorders (bronchitis, emphysema), the direct costs of treatment through medical care exceeded the condition-related absenteeism costs. However, the cost of presenteeism, or work performance loss, was the largest component cost for every chronic condition. When weighted by the survey prevalence of each condition across all Dow U.S. workers, the average costs per employee in 2002 dollars were $2278 for medical care, $661 from absenteeism, and $6721 from work impairment. Projecting these results to Dow's entire U.S. workforce, the total cost estimate was 10.1% of total labor costs in 2002: 6.8% from presenteeism, 2.3% from use of medical care, and 1.0% from absenteeism.

Discussion

This survey represents the most comprehensive attempt by a company to assess the prevalence of work impairment from chronic health conditions in its workforce and to estimate the relative contributions of health-related absenteeism, work im-

pairment, and medical care. The response rate to the survey was high and although there were some differences between survey respondents and nonrespondents, the participants represented a broad cross-section of the Dow workforce. The study clearly shows that chronic health conditions affect a majority of workers across the broad range of knowledge-based and production-based jobs, and these conditions significantly impacted work impairment, absenteeism, and medial costs.

There are some important limitations to our study, which make causal assessments difficult. First, our survey was cross-sectional in design. A longitudinal study may provide a better assessment of the causes and impacts of work impairment and absenteeism. However, some aspects of our design are longitudinal. For instance, the biometric health indicators were collected before the survey. Second, it is likely that the existence of a chronic condition began well before the survey was conducted. The survey asks for information about productivity in a short, 4-week recall period. Acute flareups of some chronic conditions may be short-lived so we may not be accurately characterizing the impact of chronic illness. The relationship between chronic conditions and productivity may differ if a longer recall period had been used. Third, our information on work impairment and absences was taken from a survey and not directly measured. Also, we generalized the costs to the Dow U.S. locations based on the findings from several locations in two states. This decision was based on the similarity of the population, the fact that the survey group represented more than half of the U.S. workforce, and the high response rate. Our estimated costs may be different if we surveyed all Dow U.S. locations.

This study is unique in several ways, however. The availability of medical claims, biometric, and other data for most of the workers surveyed enabled us to develop a comprehensive assessment of workforce health status, work impairment, health-related absenteeism, and total costs. Dow has a diverse workforce and all job types were included in the survey. Although some previous studies have examined work loss in a variety of jobs, most have focused primarily on either production or administrative jobs.[4,8,17,22]

The prevalence of every chronic condition was higher based on the survey results as compared with the estimates from medical claims (see Fig. 2). This is expected, because not all individuals seek treatment, not all eligible claims are filed, not every diagnosis is coded, claims were not available for all respondents as some were enrolled in HMOs (<5%), and respondents may have had claims that occurred outside our 12-month study period. However, the magnitude of the differences in chronic condition prevalence by data source highlights the importance of looking beyond medical claims. Indeed, self-report of a chronic condition was the most important predictor of work impairment and absences.

Several previous studies have found a relationship between biometric risk factors such as body mass index and work impairment or absenteeism.[29–31] We did not find any such relationship, but we only examined the biometric risk factors when taking the chronic conditions into account. Because biometric risk factors often precede and are often associated with chronic conditions, it is not surprising we did find a relationship between these risk factors and work impairment or absenteeism when the chronic conditions are considered.

Consistent with other published findings, work impairment represented a far greater proportion of lost productivity compared with absenteeism.[17] Indeed, our study found that almost two thirds of total health and productivity management costs were attributable to work impairment. A similar magnitude (63%) was reported recently by Bank One, using a different instrument to assess work impairment.[32,33] These findings suggest that interventions that focus on absenteeism and ignore presenteeism not only underestimate the true magnitude of the impact of health on productivity, but also may not accurately characterize the financial return on various health interventions. These findings also suggest that the decision about what instrument should be used to assess presenteeism is less important than whether work impairment is assessed.

Because almost two thirds of workers reported one or more chronic health conditions, the annual financial impact on Dow is quite large. The current survey allowed Dow to quantify the magnitude in terms of direct and indirect costs for its U.S. workforce. Chronic conditions alone are estimated to cost Dow more than $100 million annually in lost productivity for its U.S. workforce. Interventions that prevent disease or improve treatment outcomes may reap significant returns for the company. Although some work impairment and absenteeism for chronic conditions is unavoidable even with the most successful health interventions, the high prevalence and total costs of the chronic conditions represent a significant opportunity for management to increase workforce productivity through improved worker health. Policymakers and healthcare providers would be well served to consider the total economic impact of health conditions, including direct and indirect costs as illustrated in this analysis. For healthcare providers, the importance and value of health outcomes and functional health status are reinforced.

Measurement of presenteeism is an evolving discipline. We note that the estimates reported here include the mitigating effects that current treatment had on health status and work loss; thus, the impact of these chronic conditions may be greater in other populations if they do not have

comparable health benefits. In this study, we employed the WIS to measure presenteeism. In other research, we are comparing the WIS with the single question of WOS, which provides a direct estimate of productivity. Although we believe that the WIS may be more sensitive to change over time and yield better detail for health program management and evaluation endeavors, we recognize that it may provide a different estimate of the magnitude of work impairment compared with the WOS (eg, the WIS provides greater values than the WOS to the extent that work impairment is not reflected in actual worker productivity). These differences, however, would not change our findings that work impairment represents a greater loss of value in comparison to absenteeism and direct medical costs combined.

We also note that the framework for assessing costs presented here is incomplete. The full impact of a worker's illness on productivity often reaches beyond the individual's work loss or equivalent wage. In related research, we have found that the costs associated with an employee's absenteeism will be largest when it is difficult to replace that employee, he or she operates as part of a team, and the employee's work cannot be easily postponed.[34] These three factors formed the basis for a set of multipliers for 35 different jobs, which we are applying to Dow's survey results in a separate analysis.[35] Applying these multipliers, the total costs of lost productivity at Dow would be significantly greater.

We have found that illness has a significant impact on the productivity of our worker in all types of jobs. This information can also helpful in guiding the development of cost-effective interventions for particular conditions, providing a baseline from which to assess intervention effectiveness, and design further research to investigate other illnesses.

Many CEOs have made statements that their employees are their companies' greatest asset. There is little doubt that the creativity and productivity of the workforce is the engine for corporate success. Chronic health conditions are common among all job types and have the potential to significantly impact a company's financial performance. Although most management attention to date has focused on direct medical costs and absenteeism, our experience suggests there is far greater loss of productivity resulting from decrements in presenteeism, representing a substantial management opportunity as well as a compelling focus for healthcare providers and policymakers.

Acknowledgments

The authors gratefully acknowledge the support and guidance of Drs. Ron Z. Goetzel and Steven M. Teutsch. This study was funded by a grant from Merck & Co, Inc.

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