FAST TRACK ARTICLE

Use of a Normal Impairment Factor in Quantifying Avoidable Productivity Loss Because of Poor Health

John E. Riedel, MPH, MBA
Jessica Grossmeier, MPH
Laura Haglund-Howieson, MBA
Cherie Buraglio, BA, BAS
David R. Anderson, PhD
Paul E. Terry, PhD

Objective: *Growing evidence demonstrates a relationship between excess health risk and preventable productivity loss. There is a need to quantify how much lost productivity is avoidable through employer-sponsored health management interventions. This study introduced the Normal Impairment Factor (NIF) to recognize the amount of productivity loss that cannot be mitigated through health management interventions.* ***Methods:*** *A health assessment questionnaire was administered to 772,750 employees, representing 106 employers within five industry sectors. Researchers used multivariate regression procedures to examine the association between preventable health risks and self-reported productivity loss.* ***Results:*** *Back pain, mental well being, and stress risk were the strongest predictors of on-the-job productivity loss. A strong association was also detected between the number of health risks and productivity loss ranging from 3.4% for those at lowest risk (the NIF group) to 24.0% loss for those at risk for eight risks.* ***Conclusions:*** *This study demonstrated the utility of the NIF in estimating the level of productivity loss that cannot be regained through health management interventions.* (J Occup Environ Med. *2009;51:283–295*)

From Reidel and Associates Consultants, Inc. (Mr Reidel), Conifer, Colo; StayWell Health Management (Ms Grossmeier, Ms Haglund-Howieson, Ms Buraglio, Dr Anderson, Dr Terry), Saint Paul, Minn.

Address correspondence to: John Riedel, MPH, MBA, Riedel and Associates Consultants, Inc., 11065 McDonald Avenue, Conifer, CO 80433; E-mail: jriedel@riedelandassociates.com.

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Employers increasingly recognize the role of employee health in contributing to organizational productivity. A growing, but still limited body of literature demonstrates a strong association between poor employee health and employee productivity loss.[1–12] Some studies suggest that the health-related cost of lost productivity significantly exceeds the costs associated with direct medical care.[13,14]

A focus on health management as a way to optimize employee productivity is intuitively appealing. If health risks and disease are associated with decreased productivity, then reductions in risk and improvements in physical and mental health may lead to enhanced productivity. Riedel et al[15] suggest that positive worker health can lead to improved quality of goods and services, greater creativity and innovation, enhanced resilience, and increased intellectual capacity.

To realize the potential of health-related productivity improvements, employers need reliable and valid productivity data to inform their health policy and programming decisions; for many employers, those data are not available. Most chief financial officers do not receive reports on the incidence or impact of presenteeism in their organizations according to a 2006 Integrated Benefits Institute survey.[16] Another recent survey by Hewitt Associates concurs, finding that productivity measurement is challenging for employers and most do not have the level of information needed to guide decision making related to health and productivity initiatives.[17]

Still another survey found that the use of productivity information in making health-related decisions was "frequent and systematic" among only 14% of respondents.[18]

Although many employers focus on health care cost data when formulating a business case for health and productivity management initiatives, this may be in part because they do not have ready access to productivity data. The minority of companies that do have access to productivity data tend to focus less on direct health care costs and more on indirect (eg, productivity) outcomes.[19] This suggests that helping employers obtain and use health and productivity data may help them shift from a short-term focus on medical cost containment to a long-term focus on investment in human capital, defined to be the value of a workforce to a company.[20] Employees bring to the workplace a number of human capital assets that support the productive output of the employer. These assets include education, skills, knowledge of the company, outlook, and attitude. Employee health and mental well being are also important assets. Berger et al[20] conclude that "although human capital is not currently captured in a company's annual financial statements, its value is quite large, representing upwards of one fourth of its book value."

One emergent question that senior managers are increasingly asking is how much of their human capital costs are related to employee health. They also want to know the potential value of investments in improving or maintaining the health of their human capital. Although the association between poor health and reduced productivity is reportedly quite large, employers do not know how much productivity loss can realistically be recaptured. There is a need to better quantify the portion of productivity loss that can potentially be regained based on health management strategies. Even with excellent health status, employees will experience some health-related loss of productivity. There is a certain amount of work-based productivity impairment incurred by someone who has no identified health risks but there is a lack of evidence to quantify the level of productivity impairment experienced by those with no health risks.

A recent review of the evidence on health and productivity identifies at least four gaps that remain to be addressed in the published literature.[21] First, as indicated above, although the association between poor health and reduced productivity is reportedly quite large, employers do not know how much of that productivity loss can realistically be recaptured. There is a need to better quantify the portion of productivity loss that can be regained through well-designed health management strategies.

Second, most of the research has been focused on productivity loss associated with chronic conditions rather than on productivity loss associated with specific modifiable health risks.[21] Because many population health management initiatives focus on health risk reduction, it is important to understand the health risk factors that are most highly associated with productivity loss.

Third, much of the research to date has been conducted either with data provided by individual employers[3,13,22–24] or using absenteeism as the productivity outcome.[9,11,25,26] Although the contribution of these studies is invaluable to a field still in its infancy, they limit our ability to generalize findings across companies and industry sectors. As Schultz and Edington[21] point out in their review, it is necessary to conduct studies across multiple employers and industries.

Finally, related to the first gap, there is a need to account for unavoidable productivity loss when attempting to monetize the financial costs associated with avoidable health-related productivity loss. Some studies assume that each employee's productivity is worth at least 100% of their total compensation in terms of the value they contribute to the company's bottom line. However, if some portion of that value is lost because of reasons other than health as defined in the analysis, monetization procedures that do not account for non–health-related productivity loss may overstate the potential cost impact of health management interventions.

This study addresses each of these gaps. We address the first gap by introducing the "Normal Impairment Factor" (NIF). The NIF captures the amount of productivity loss experienced by individuals who are at low risk for the health risk areas measured in this study, thus representing the level of productivity loss that health improvement initiatives targeting these risks will not affect. NIF provides the lowest level of productivity loss that can be expected in the workforce based on the set of health risks included in our study. The NIF group does not represent "perfect health." A small percentage of employees at risk for all the measured health risks, however, have chronic conditions and, while our set of health risks is quite broad, it does not account for every conceivable lifestyle-related risk factor. With these caveats in mind, comparing the NIF group to the measured productivity losses of groups of workers with health risks provides a gauge for the amount of productivity loss that may be avoided through health risk reduction. It is important to recognize that this analysis does not try to capture the portion of productivity loss because of other work-related factors like job dissatisfaction, entitlement mentality, or social aspects of work.

We address the second gap, the past focus on chronic conditions, by assessing the impact of individual health risks and combinations of risks on employee productivity loss using a database with health risk and productivity information on a very large number of individuals. More specifically, this study describes the amount of productivity loss associated with multiple health risks compared with employees at low risk for all assessed health risk factors. Furthermore, it measures the contribution of each health risk to employee productivity loss, controlling for covariates and all other risks.

The third gap is addressed by using data collected across multiple employers. To address issues of generalizability, this study analyzed a database of over 750,000 employees, representing over 100 employers and five major industry sectors. All health risk measures were from one health assessment (HA) instrument, which also embedded a measure of self-reported productivity loss because of poor health. Use of consistent measures across all companies and sectors may bolster the reliability of our findings.

The fourth gap is addressed by demonstrating how the concept of NIF can be used in monetization procedures to develop more conservative and, possibly, more accurate estimates of the financial impact of health-related productivity loss. These monetization procedures also take into account industry differences in compensation and introduce a set of easily modified assumptions that can be adjusted to tailor financial estimates based on employer-specific work schedules.

Materials and Methods

Design and Measurement

This study used a cross-sectional design and HA questionnaire data obtained from the StayWell Health Management (StayWell) book of business database. The StayWell HealthPath HA was first developed in 1987 and has been subjected to rigorous reliability and validity tests.[27–31] The HA was administered to employees in web-based and paper formats based on client preferences. It consisted of 47 questions about demographics, chronic conditions, lifestyle health behaviors, health care utilization, psycho-behavioral factors (eg, readiness to change, self-efficacy), drug and alcohol use, and ergonomic issues. Questions addressed major health risks identified in national consensus and other expert health guidelines.[32–41] In 2003, StayWell added a measure of presenteeism to the HA, which was adapted from an item on the World Health Organization's Health and Work Performance Questionnaire, or HPQ.[42] The original HPQ item asked respondents to rate their usual job performance over the past year or 2 using a 0 to 10 scale. The adapted StayWell item asked respondents to report how much health problems limited their job performance over the past year, also using a 0 to 10 scale. The presenteeism measure was added to the version of the HealthPath HA (Version 5.0) used for this study. This study relies on HAs completed by employees during the most recent 3-year time frame (January, 2005 to December, 2007).

Definitions

Health Risks. The HA used national consensus and other expert health guidelines to classify health behaviors into risk scores (ie, low, moderate, high); these risk scores have been associated with coronary heart disease, health care costs, and productivity costs.[28,30,31] An employee was considered to be at low risk for a particular health area if his or her risk was within recommended parameters or nonexistent. This study included 10 health risk areas: alcohol, back pain, blood pressure, cholesterol, driving, physical activity, stress, tobacco use, weight, and mental well being (ie, depression). Health risk scores were recoded as dichotomous measures so that employees were considered to be "at risk" or "low risk" for each of the 10 health risk areas (Table 1 for definitions of "at risk" health status used in this study). A composite measure of health risk status was then created by summing the number of health risk areas that an individual was "at risk" for. Because blood pressure and cholesterol risk assessment relied on biometric screening data (only offered by a minority of employers in the database), a majority of employees had missing data for those areas. Therefore, blood pressure and cholesterol risks were not included in primary analyses. Instead, all data analysis procedures were run first without these two areas and then repeated with them included in secondary analyses. Results were reported based on both sets of analyses where meaningful.

NIF Group. The NIF was based on health-related productivity loss for employees considered to be at low risk for a specified set of health risks including back pain, physical activity, mental well being, stress, tobacco use, weight, and driving behavior. These health risks were selected based on consistent evidence from the published literature that an increase in risk was associated with increased productivity loss.[1–4,8,12–14,22,23] We also included blood pressure, cholesterol, and alcohol. Although some studies show that these health risks have an inverse relationship with productivity loss, we included them to determine the consistency of our findings with other published studies.[2,10,24,26] The NIF group was considered to represent the level of productivity loss in a population free of the measured health risks, in which the productivity loss would not be further reduced by health risk reduction interventions. Health improvement interventions focused on other aspects of health could potentially further reduce health-related productivity loss, but no health improvement intervention would be expected to reduce productivity loss resulting from non–health-related factors (eg, job satisfaction).

The measure of productivity gain represented by using the NIF as a benchmark for comparison provides a realistic target against which we can gauge the amount of productivity loss that might be eliminated using a best-practice health risk reduction strategy. It also helps quantify the lost productivity a company would likely continue to incur if it chose to do nothing. Armed with these two measures, a company would be able to make more informed cost benefit estimates of a range of health management initiatives. Because NIF represents those at low risk for all of

TABLE 1
Definition of Being at Low Risk and "At Risk" for Each Health Risk

Health Risk	Low Risk	At Risk	
		Moderate	High
Alcohol[33]	All: does not drink alcohol. Men: ≤14 drinks/wk and ≤4 drinks/d. Women: ≤7 drinks/wk, and ≤3 drinks/d.	Men: >14 drinks and ≤21 drinks/wk; or ≥5 drinks/d, ≤1 d/wk. Women: >7 drinks and ≤14 drinks/wk; or ≥4 drinks/d, ≤1 d/wk.	Men: >21 drinks/wk; or ≥5 drinks/d, ≥2 d/wk. Women: >14 drinks/wk; or ≥4 drinks/d, ≥2 d/wk.
Back pain[49]	Does not identify that back pain is an ongoing problem that interferes with daily activities.	Identifies that back pain is an ongoing problem that interferes with daily activities.	
Driving[50]	Always uses seat belts when driving or riding in a motor vehicle, and never drives while under the influence of alcohol or rides with a driver under the influence of alcohol.	Sometimes uses seatbelts when driving or riding in a motor vehicle or sometimes drives under the influence of alcohol or rides with a driver who is under the influence of alcohol, but not both.	Almost never wears a seatbelt when driving or riding in a motor vehicle; or quite often drives under the influence of alcohol or rides with a driver who is under the influence of alcohol; or sometimes wears a seatbelt when driving or riding in a motor vehicle and sometimes drives under the influence of alcohol or rides with a driver who is under the influence of alcohol.
Physical activity[39]	Exercises vigorously for at least 20 min ≥3 d a week; or a total of ≥5 d/wk of combined vigorous exercise and moderate-intensity physical activity.	Exercises vigorously for at least 20 min 1 or 2 d a week; or a total of 3 to 4 d/wk of combined vigorous exercise and moderate-intensity physical activity.	Does not exercise vigorously and participates in <3 d/wk of moderate-intensity physical activity.
Well being[41,51]	No indication of either current depression (ie, over past 2 wk) or chronic depression (ie, feeling depressed most of the time).	Some indication of current depression (ie, over past 2 wk) but does not report chronic depression (ie, feeling depressed most of the time).	Strong indication of current depression (ie, over past 2 wk) or reports chronic depression (ie, feeling depressed most of the time).
Stress[52]	Sometimes or almost never feels troubled by stress and handles stress well.	Sometimes feels troubled by stress and does not handle stress well; or almost always feels troubled by stress and handles it well.	Almost always feels troubled by stress and does not handle stress well.
Tobacco use[53]	Does not use tobacco.	Smokes less than a pack of cigarettes/d; or smokes a pipe or cigars; or uses snuff or smokeless tobacco.	Smokes one or more packs of cigarettes/d.
Weight[40,54]	Body mass index (BMI) ≥18.5 kg/m^2 and <25 kg/m^2.	BMI ≥25 kg/m^2 and <30 kg/m^2; or BMI <18.5 kg/m^2.	BMI ≥30 kg/m^2.
Blood pressure[34,35]	If no history of CVD* or major CVD factors (ie, cigarette smoking, obesity, hyperlipidemia, diabetes): Systolic blood pressure <140 mm Hg and Diastolic blood pressure <90 mm Hg.	If no history of CVD* or major CVD factors (ie, cigarette smoking, obesity, hyperlipidemia, diabetes): Systolic blood pressure of 140–159 mm Hg or Diastolic blood pressure of 90–99 mm Hg.	If no history of CVD* or major CVD risk factors (ie, cigarette smoking, obesity, hyperlipidemia, diabetes): Systolic blood pressure ≥160 mm Hg or Diastolic blood pressure ≥100 mm Hg.
	If history of CVD or one or more CVD risk factors: Systolic blood pressure <120 mm Hg and Diastolic blood pressure <80 mm Hg.	If history of CVD or one or more CVD risk factors: Systolic blood pressure of 120–139 mm Hg or Diastolic blood pressure of 80–89 mm Hg.	If history of CVD or one or more CVD risk factors: Systolic blood pressure ≥140 mm Hg or Diastolic blood pressure ≥90 mm Hg.
Cholesterol[36,37]	If has CHD† or CHD risk equivalent‡: Total cholesterol measure (mg/dL) <200, HDL ≥40, or LDL <70.	If has CHD† or CHD risk equivalent‡: LDL of 70–99.	If has CHD† or CHD risk equivalent‡: Total cholesterol measure (mg/dL) ≥200, HDL <40, or LDL ≥100.
	If 2+ CHD risk factors§: Total cholesterol measure (mg/dL) <200, HDL ≥40, or LDL <100.	If 2+ CHD risk factors§: LDL of 100–129.	If 2+ CHD risk factors§: Total cholesterol measure (mg/dL) ≥200, HDL <40, or LDL ≥130.
	If 0–1 CHD risk factors§: Total cholesterol measure (mg/dL) <200, HDL ≥40 or LDL <160.	If 0–1 CHD risk factors§: Total cholesterol measure (mg/dL) of 200–239, HDL <40 or LDL of 160–189.	If 0–1 CHD risk factors§: Total cholesterol measure (mg/dL) ≥240, or LDL ≥190.

*Cardiovascular disease.
†Coronary heart disease.
‡Risk equivalents: diabetes; CHD risk factors conferring 10-yr risk >20%.
§CHD risk factors: cigarette smoking; hypertension (BP ≥140/90 mm Hg or on antihypertensive medication); HDL <40 mg/dL (HDL ≥60 mg/dL counts as a "negative" risk factor and removes one risk factor from the total count); Family history of premature CHD (males <55 yr & females <65 yr); Age (men ≥45 yr; women ≥55 yr).
BMI indicates body mass index.

the measured health risks, individuals at moderate or high risk for one or more health risks were placed in the non-NIF group. The NIF group thus represented the healthiest individuals in the studied employee group. Given the assumption that even the healthiest of employees are not 100% productive on-the-job 100% of the time, the NIF group served as a reference point to estimate achievable health-related productivity loss.

Productivity Level. The presenteeism question asked respondents to respond to the question, "During the time you were at work in the last 12 months, how much did health problems limit you in the kind or amount of work you could do?" with the number between 0 and 10 that best described how much health problems limited their work. The 0 to 10 scale was anchored with 0 corresponding to "did not limit my work at all" and 10 to "completely prevented me from working." The data were prepared for analysis by inverting the scale and converting it to a percentage so 0 corresponded to 0% productive, 1% to 10% productive, and so on up to 10, which corresponded to 100% productive.

Sample

The sample for this study began with the StayWell normative employee database ($N = 848{,}754$), which contained HealthPath HAs completed between January 1, 2005 and December 31, 2007. This database excluded HA data submitted by spouses and retirees as well as all individuals over 64 years of age at the time they completed the HA. In addition, data from other StayWell HA tools were excluded because they did not contain productivity measures before 2007. These additional selection criteria reduced the data set to a total of 812,149 employees. Lastly, the sample was refined by requiring that eligible employee respondents have complete data for the productivity (presenteeism) variable, along with the demographic and health risk variables used in the analysis.

In summary, the data set consisted of eligible employees between the ages of 18 and 64 at the time they completed the HA in 2005 through 2007 who had complete data for the variables included in the study. The final full data set contained 772,750 completed HAs, representing 106 employers grouped by five Bureau of Labor Statistics (BLS) industries including finance, all goods-producing, education or health services, professional or business or information services, and other services.[43] The NIF group (based on eight health risk areas, which excluded blood pressure and cholesterol) consisted of 59,569 HAs, with the non-NIF group consisting of the other 713,181 HAs. Table 2 describes the total study sample as well as the NIF and non-NIF groups.

Statistical Methods

Data preparation and analysis relied on SPSS (Version 16.0, Chicago, IL). Descriptive statistics were run to describe the study sample and compare the NIF group to the non-NIF group. Chi square tests were used for comparisons of nominal variables and independent samples t tests were used for comparisons of ratio variables.

TABLE 2

Demographics of Eligible Employees With Completed Health Assessments

Characteristics	Categories	All $N = 772{,}750$ (%)	NIF (Low Risk) $N = 59{,}569$ (%)	Non-NIF (At Risk) $N = 713{,}181$ (%)
Age	<35*	38.8	44.9	38.3
	35–44*	27.7	24.8	28.0
	45–54*	23.2	20.3	23.5
	55–64	10.3	10.1	10.3
	Mean*	39.0	37.8	39.2
Gender	Female*	51.1	56.1	50.7
	Male*	48.9	43.9	49.3
Salaried or hourly	Salaried*	65.3	72.0	64.7
	Hourly*	34.7	28.0	35.3
BLS industry category	Finance*	26.6	25.1	26.7
	All goods-producing*	35.2	34.4	35.2
	Other services*	20.0	21.4	19.9
	Education and health services*	9.7	10.3	9.7
	Professional, business, and information services	8.5	8.7	8.5
Company size (Number of employees)	≤10,000*	16.6	15.0	16.7
	10,001–30,000*	33.1	35.7	32.9
	30,001–50,000*	23.8	21.6	24.0
	50,001–100,000*	10.8	15.9	10.4
	>100,000*	15.7	11.9	16.1
	Mean*	49,766	47,196	49,981
Sum of total health risks	0*	7.7	100.0	0.0
	1*	21.4	0.0	23.2
	2*	26.6	0.0	28.8
	3*	22.4	0.0	24.3
	4*	13.6	0.0	14.8
	5*	5.9	0.0	6.4
	6*	1.9	0.0	2.0
	7*	0.4	0.0	0.5
	8*	0.1	0.0	0.1
	Mean*	2.4	0.0	2.6

*Significant differences were detected between the NIF group and the Non-NIF group based on χ^2 tests of association and independent samples t tests, $P < 0.01$.

Bivariate analyses were used to assess associations between health risk level across eight health risk areas and productivity, with Pearson's correlation coefficients derived using two-tailed tests of significance. Associations were deemed significant when *P* values did not exceed 0.01.

Ordinary least squares (OLS) regression was used to associate each of the eight health risks with productivity after controlling for age, gender, employer size, job type (hourly versus salaried employee), and industry category. Any covariate found to be insignificant based on a *P*-value criterion of 0.05 was removed. Based on model output, the unstandardized coefficients from the linear regression equation were used to determine the level of productivity in the NIF group.

OLS regression was used to calculate the mean percent productivity loss for those with multiple risks. After recoding nominal variables as dummy variables, age, gender, employer size, job type (hourly versus salaried employee), and industry category were included in the model as covariates. Instead of entering each of the eight health risks into the model, one measure of multiple health risks was used to determine the level of productivity for each health risk level (eg, one risk, two risks, three risks). The result for each risk level was subtracted from 100 to arrive at the mean productivity loss for someone at risk for one to eight health risks, respectively.

To determine the practical significance of the relationship between poor health and productivity loss, three values were required to calculate annual cost for each individual. The first value was total hourly compensation including wages and benefits, which was based on the industry in which an individual worked and obtained from BLS tables.[44] The second value was the on-the-job productivity loss percentage reported by each person on the HA. The third value was number of annual compensated hours for full-time employees, which was assumed to be 2080 hours (ie, 40 hours per week times 52 weeks). Using these three values a new measure (annual cost of productivity loss for each person) was calculated. The annual cost of productivity loss for each person is equal to on-the-job productivity loss percentage multiplied by total annual compensation, which is the product of hourly compensation times 2080 hours per year.

Results

Demographics and Group Differences

The mean age for all employees at the time of HA completion was 39.0 years, and 51.1% were female (Table 2). Nearly, two thirds (65.3%) were salaried employees and more than one-third (35.2%) worked in the "all goods-producing" BLS industry category. The mean company size was just under 50,000 employees and the average respondent had 2.4 health risks. In comparing the NIF group to the non-NIF group (those at risk in at least one health risk area), statistically significant differences existed across all demographic variables. Compared with the non-NIF group, the NIF group was significantly younger (37.8 years vs 39.2 years) and more likely to be female (56.1% vs 50.7%) and salaried (72.0% vs 64.7%). Although statistically significant, the association between company size and health status was minimal. On average, non-NIF employees were at risk in 2.6 health risk areas.

Association Between Health Risks and Productivity

Bivariate procedures were applied to assess differences in productivity loss for those at risk and not at risk in each health risk area, and significant differences were detected for each health risk. Productivity loss was consistently associated with "at risk" health status for all eight of the health risks assessed (Fig. 1). Without controlling for any other factors, the biggest differences in productivity loss were observed for those at risk for back pain, stress, and mental well being. Those at elevated risk for back pain in this study sample reported 13.0% more productivity loss than those at low risk for back pain. Productivity loss associated with the psychosocial health risks were also large with those at risk for mental well being (ie, depression) reporting 7.4% greater productivity loss than those at low risk, whereas those at risk for stress reported 4.8% greater productivity loss than their low risk counterparts. Although all group differences were statistically significant, these three risk areas represent the greatest potential for meaningful improvement through intervention.

Because of the significant NIF and non-NIF group differences observed in demographics and the significant

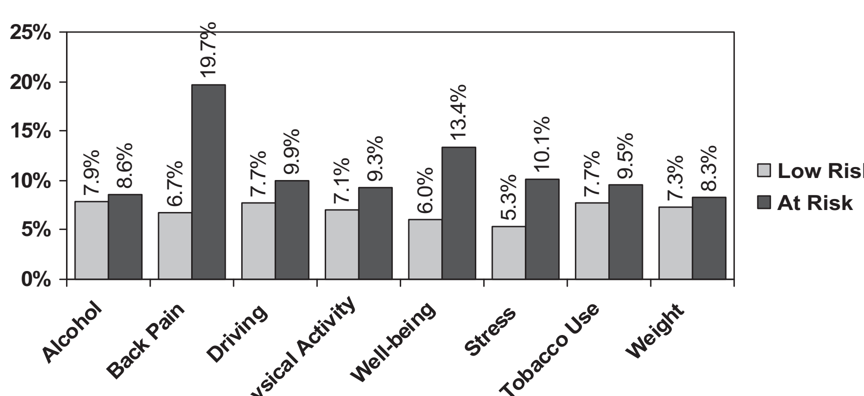

Fig. 1. Mean productivity loss for those at low risk and those at risk. All differences were significant based on independent samples *t* tests, $P < 0.001$.

relationships observed between each health risk and productivity loss, all of the examined variables were entered into an OLS regression model. The model was reduced by removing variables that did not contribute significantly to the model, ie, the "other services" dummy variable (Table 3). Using the constant (intercept) and the unstandardized coefficients from the model, together with the group means for each non–risk-related variable (age, gender, salaried or hourly, finance industry, all goods-producing industry, education or health services, and company size), average productivity of 96.6% for the NIF group was calculated, implying a "normal" productivity loss of 3.4%.

The health risk areas and the demographic variables together accounted for nearly 8% of the variation in productivity. Consistent with results of the bivariate analyses, ongoing back pain, mental well being, and stress demonstrated the strongest association with productivity loss. Of the demographic variables, gender demonstrated the strongest association with productivity loss. Holding all other factors in the model constant, female productivity loss is 2.4% greater than male productivity loss, suggesting that health-related factors not included in the study have a greater impact on female than male productivity.

The same regression procedure was repeated for the smaller subset of the sample that had data for all 10 health risks, including blood pressure and cholesterol. This was done to determine whether the same three health risks demonstrated the greatest degree of association with productivity loss when blood pressure and cholesterol were added. Overall, the model explained nearly the same amount of variation as the model based on only eight health risk areas. This finding supports our observation that blood pressure and cholesterol risk are minimally related to a loss in productivity independent of the effect of the eight core health risks. In addition, the same three health risk areas (back pain, mental well being, and stress) contributed most significantly to the model (Table 4).

Because gender emerged as the most significant demographic predictor of productivity loss, additional analyses were run to further explore its role in the model. Thus, the same regression procedures were run (with gender removed from the model) separately for men and for women. On average, men with zero health risks reported 3.0% productivity loss whereas women with zero health risks reported 3.9% productivity

TABLE 3
Regression Coefficients From Ordinary Least Squares Regression

Model	Standardized Coefficients	Unstandardized Coefficients (SE)	Group Mean	Product*
(Constant)		92.917 (0.097)		
Alcohol risk	0.006	0.330 (0.068)		
Back pain risk	−0.178	−10.922 (0.068)		
Driving risk	−0.014	−0.737 (0.061)		
Physical activity risk	−0.014	−0.519 (0.041)		
Well-being risk	−0.114	−4.645 (0.048)		
Stress risk	−0.061	−2.230 (0.042)		
Tobacco use risk	−0.019	−0.911 (0.054)		
Weight risk	−0.024	−0.906 (0.043)		
Age at time of HA	0.031	0.050 (0.002)	39.04	1.952
Gender	0.068	2.438 (0.043)	0.49	1.19462
Hourly vs salaried	0.027	1.037 (0.042)	0.65	0.67405
Finance industry	0.010	0.396 (0.054)	0.27	0.10692
All goods-producing industry	0.012	0.440 (0.053)	0.35	0.154
Education and health services industry	0.005	0.309 (0.077)	0.10	0.0309
Company size	−0.030	−0.000009 (0.000)	49,765.95	−0.4478935

R^2 = 0.079, SE = 17.303, all variables in the model are significant ($P < 0.001$).
*Product = unstandardized coefficient × group mean.

TABLE 4
Regression Standardized Coefficients for 8 and 10 Health Risks

Health Risks and Characteristics	Eight Health Risks* (N = 772,750)	Ten Health Risks (N= 159,076)
Alcohol risk	0.006	0.007†
Back pain risk	−0.178	−0.181
Driving risk	−0.014	−0.013
Physical activity risk	−0.014	−0.014
Well-being risk	−0.114	−0.113
Stress risk	−0.061	−0.057
Tobacco use risk	−0.019	−0.018
Weight risk	−0.024	−0.021
Blood pressure risk	NA	−0.017
Cholesterol risk	NA	−0.003†
Age at time of HA	0.031	0.033
Gender	0.068	0.059
Hourly vs salaried	0.027	0.038
Finance industry	0.010	0.003†
All goods-producing industry	0.012	0.015
Education and health services industry	0.005	0.003†
Company size	−0.030	−0.032

*$P < 0.001$ for all eight health risks shown.
†$P > 0.001$ for these health risks.
R^2 and SE for 8 health risks = 0.079 (17.303).
R^2 and SE for 10 health risks = 0.078 (16.808).

loss. Consistent with our analytical methods that included gender, the same three health risks (back pain, mental well being, and stress) emerged as the three most important contributors to both models.

In examining the impact on productivity of multiple health risks, an inverse relationship was found between number of health risks and reported productivity ($r = -0.194$, $P = 0.000$), meaning productivity was higher when the total number of health risks was lower. OLS regression procedures using the total number of at risk health areas as a single risk-related predictor variable instead of the eight individual health risk variables, again including the demographic measures as covariates, indicated that each additional health risk increased productivity loss by approximately 2.4%. With an average of 2.6 risks in the non-NIF group, this equates to average health-related productivity loss in that group of 8.4%.

Discussion

Normal Impairment Factor

This analysis addressed the creation of NIF, which represents the amount of health-related productivity loss that occurs even among the healthiest of the studied individuals, ie, those at low risk for all risk factors measured. The NIF for our population was 3.4%, which amounts to approximately 1.8 weeks of lost productivity per year. This illustrates that there is some health-related productivity loss even in a group at low risk for all of the measured health risks. There is a "floor" to the amount of health risk-related productivity loss that can be eliminated by reducing all measured risk factors to low risk. It should be noted that the NIF does not imply that a person has no health problems. Some of the NIF group reported having chronic conditions that could account for some of the lost productivity. We also contend that this group still has some health-related productivity loss because of health problems that exist despite their lack of risk factors included in our definition. For example, lack of adequate sleep is a health risk not included in the study that could have a significant impact on employee productivity.

Although imperfect at this time, the NIF is an important concept that provides decision makers with a benchmark level of productivity loss that is not likely to be affected significantly through health management interventions aimed at health risk reduction. Health and productivity research has focused intensively on how much productivity loss is related to poor health, but little has been done to determine how much of that loss is truly manageable. The amount of achievable productivity gain is the difference between measured health-related productivity loss and the NIF. In our population of employees this is the difference between 8.4% average health-related productivity loss for those reporting any health risks and 3.4% loss for those reporting no health risks. This difference equals 5.0% or 2.6 weeks of lost productivity. We contend that this is the amount of productivity loss that an evidence-based health risk reduction program focused on the factors included in study could potentially mitigate.

Modifiable Health Risk Factors and Productivity Loss

A recent summary of the literature on health-related productivity showed that the predominant area of study was disease related.[21] Of the 37 well-designed studies reviewed only 11 were related to health risks and most of them addressed absenteeism as the productivity outcome. This clearly highlights the need for more research related to the association between productivity and health risks. Because our findings focused specifically on health risks and productivity (rather than absenteeism) we addressed the gap related to the limited number of studies focusing on modifiable risk factors.

Multiple Health Risks

Those who were at risk reported a greater percent of productivity loss than those at low risk for each of the eight health risks included in this study. A consistent relationship existed between number of health risks and productivity loss. Individuals in the study sample had 2.4 risks on average, and each additional risk increased productivity loss by 2.4%. A person at risk for all eight risks experienced a productivity loss of 24.0%. This parallels the findings of other researchers.[2,3] The magnitude of loss is quite close to Boles' findings but significantly less than those reported by Burton, who reported that one risk accounted for 13.9% productivity loss and seven or more accounted for 28.3% loss. This difference may be due to the different measurement tools used, differences in health risk definitions, differences in covariates included in the models, or differences in demographics of the workforce study populations.

Although our focus in this analysis established a NIF benchmark for program evaluation, policy making and future research, it is also noteworthy that our study results affirmed those of others seeking to understand the relationship between health and productivity. Our overall finding that additional risk factors were associated with decreased self-reported productivity is consistent with other studies linking poor health to lost productive work time[2,3] and with a recent comprehensive review equating multiple risks with lost productivity.[21]

Individual Health Risks

After controlling for demographics and all other health risks in a regression model, the largest predictors of productivity loss were ongoing back pain ($\beta = -0.178$, $P < 0.001$), lack of mental well being ($\beta = -0.114$, $P < 0.001$), and stress risk ($\beta = -0.061$, $P < 0.001$). According to the regression model in Table 3, the difference in lost productivity between those at excess risk and those at low risk for back pain was 10.9%; for mental well-being risk 4.6%; and for stress risk 2.2%. This suggests that these three health risks may be the most fruitful targets for intervention in terms of opportunity for productivity improvements.

Back Pain. The impact of back pain on lost workdays has been well researched. A study by Guo et al[45] found back pain to be the most common reason for filing of workers' compensation claims, resulting in about 40% of absences from work—second only to the common cold. Back pain has also been demonstrated to have a major impact on reducing an employee's on-the-job performance. The 10.9% differential in productivity loss between employees at risk versus those not at risk in our study represents 5.7 weeks of lost productivity per year. This differential is less than the back-related productivity loss estimated by Dow Chemical[13] but more than an estimate by the American Productivity Audit.[8]

Mental Well Being. Mental well being and stress were also significantly associated with productivity loss, amounting to 2.4 and 1.1 weeks of annual lost productivity, respectively. Our finding that stress and depression were among the strongest contributors to lost productivity supports the findings reported by Burton et al,[2] and is consistent with related research that indicates mental health issues are stronger drivers of medical expenditures than the more commonly attributed cost burden related to cardiovascular risk factors.[28,30] The significant influence of mental health issues cannot be overstated. Five studies show a consistent pattern of greater productivity loss by workers with major depressive disorder.[1,10,12–14] Lerner et al[46] found productivity losses of between 6% and 10% for workers with depression compared with 4% among healthy controls.

Alcohol Risk. Alcohol risk, which in this study is based on self-reported alcohol consumption and usage patterns, contributed the least as a predictor of productivity loss ($\beta = 0.006$, $P < 0.001$). Our data from the regression analysis showed a slight productivity gain for those at risk for alcohol, which is consistent with other studies.[2,26] In the bivariate data presented in Fig. 1 alcohol risk was associated with decreased productivity; the reversal from the bivariate to the multivariate findings indicates a complex set of inter-relationships among the measures included in this analysis. This may be due to a social desirability response bias, differences in alcohol risk definition, or differences in the way productivity loss was measured.

Weight, tobacco use, driving, and physical activity risks occupied the mid ground in terms of overall productivity loss ($\beta = -0.024$, $\beta = -0.019$, $\beta = -0.014$, and $\beta = -0.014$, respectively) with modest differences observed between those at risk and those not at risk. Without controlling for other factors or risk areas, Fig. 1 indicates that the difference between those at risk and those at low risk for driving was 2.2%; for physical activity was 2.2%; for tobacco use was 1.8%; and for weight was 1.0%. Using the results of the regression model that controls for these factors decreases all of these estimates to less than 1%. Nonetheless, our findings are consistent with other published studies demonstrating some effect of each of these factors on productivity.[3,6]

Driving Risk. We found only one study associating the use of safety belts while driving with productivity loss.[6] Its finding that not regularly using seat belts was associated with more productivity loss is consistent with our study findings. It should be noted, however, that our definition of driving risk also included driving under the influence of alcohol. We suggest that this is an area that deserves more attention.

Tobacco Risk. Although based on a different measure of productivity, the association between tobacco use risk and productivity loss was consistent with results from the American Productivity Audit indicating smokers report lost productivity time twice as high as non-smokers,[7] a finding very similar to a recent study conducted by Bunn et al.[47] These findings may be conservative because individuals are self-reporting their perceived productivity loss. Halpern et al[23] showed that an employee's self-reported quantity of work affected by smoking was considerably lower than that reported by their coworkers and supervisors.

Weight Risk. Our finding of 0.9% excess productivity loss for those at risk for weight versus those with no risk builds on previous research. Based on findings using a different productivity scale, the "Work Limitations Questionnaire," Gates et al[22] found a 4.2% loss in productivity which was 18% higher than non-obese workers. Similarly, using findings from the American Productivity Audit, Ricci and Chee[48] found that obese workers (BMI >30) were more likely to report lost productive time in the previous 2 weeks (42.3%) than normal weight or overweight workers, 36.4% and 34.7%, respectively.

Blood Pressure and Cholesterol Risk. Blood pressure and cholesterol risk levels were measured at worksite biometric health screenings rather than through self-reported questionnaires, so most individuals in the study sample did not have these data available. However, for the 159,076 employees with data, neither of these risk factors seemed to add much explanatory power to the regression model. Other studies showed a similar pattern. Our findings that blood pressure and cholesterol risk levels do not substantially predict presenteeism are consistent with research indicating equivocal relationships between certain chronic conditions and productivity.[2,10,26] This may relate to the lack of additional information in this analysis relevant to productivity such as the severity or longevity of the condition and how well managed the condition may be. Schultz reviewed two studies showing poorer productivity for people with diabetes, noting that "research on diabetes and presenteeism is weak." Related to this, Schultz hypothesized that the relationship between a chronic condition and productivity likely intensifies for those who have had the condition for many years. Conversely, for other chronic conditions such as allergies or arthritis, Schultz and Edington[21] rated the research as moderate or high quality, and in these studies such conditions were found to have a consistent relationship to lost productivity. An additional explanation, which has also been reported elsewhere,[30] is that the health risks included in the model such as exercise and tobacco use, largely explain the association between these biometric factors and productivity loss.

Generalizability

This study extends the majority of published studies conducted with individual employers by demonstrating the relationship between modifiable health risks and on-the-job productivity loss across multiple employers of varying size, representing a diversity of industry sectors. Although employer size and industry sector contributed statistically to the regression models used for the study, model output indicates that the measured health risks and gender contributed most meaningfully to predicted variance. This bolsters our assessment of the generalizability of findings across employers of similar size and industry category.

Monetization of Productivity Loss

This study demonstrated that a higher number of health risks is associated with lower on-the-job productivity. This finding is consistent with the findings of others that detected a strong association between health risks and presenteeism. Furthermore, individuals who reduced their risks generally experienced an increase in productivity, whereas those who increased risks or remained "at risk" experienced deterioration in productivity.[6]

These results support the contention that helping employees reduce the number and severity of health risks may be a sound economic choice for an employer. Regression procedures indicated that mean productivity loss for those in the NIF group was 3.4%, whereas mean productivity loss for everyone else was 8.4%. On average, productivity loss was 5.0% higher for those at risk for one to eight health risks, than for those at low risk for all eight health risks. This 5.0% productivity gap represents a significant financial opportunity.

As mentioned previously, the annual cost of on-the-job productivity loss was calculated for each individual in the data set. To minimize health-related productivity loss, health management initiatives would need to move more employees closer to the NIF group. In effect, this would mean reducing health risks to the point where more employees were at low risk status for all eight health risks examined in this study. Figure 2 demonstrates that a person in the NIF group costs, on average, $1472 each year because of on-the-job productivity loss. The average number of health risks for the non-NIF group was approximately three health risks and it is possible to estimate the financial impact of moving more individuals into the NIF group. On average, a person with three health risks cost $5952 a year in on-the-job productivity loss, a difference of $4480 when compared with the NIF group. Making a simplifying assumption that all health risks are "created equal" when it comes to productivity loss and that productivity loss changes as number of risks change, if 100 individuals with three health risks were able to reduce just one health risk to low risk status, this would translate to annual savings of $149,400, (ie, $1494 × 100 where the $1494 is based on the difference in costs for those with three risks versus those with two health risks). Applying the same assumptions, if 100 individuals moved from three health risks to one, it would yield $298,700 in annual savings, and if 100 individuals moved from being at risk for three health risks to being at low risk for all eight health risks, it would yield $448,000 in annual savings. These computations illustrate the significant savings that may be realized when modest risk reductions are achieved with a fairly small population. Indeed, these estimates suggest that even small improvements in health, if they truly translate to lower health-related pro-

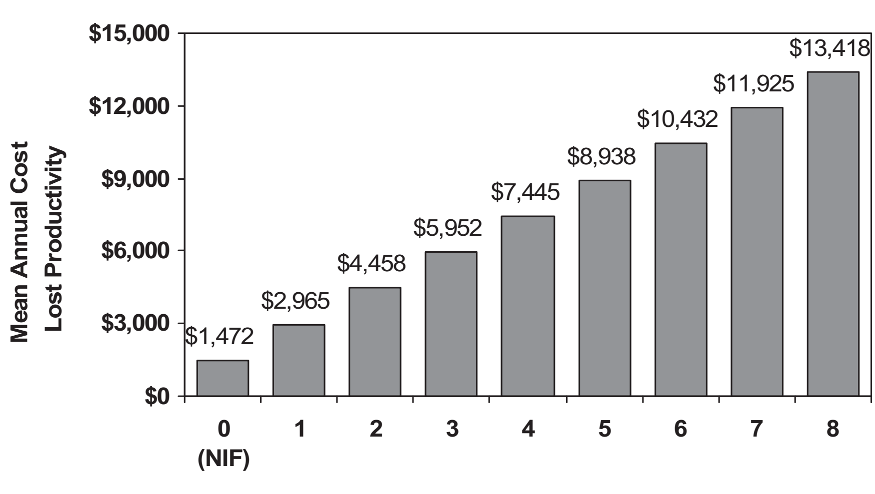

Fig. 2. Mean annual per person cost because of lost productivity.

ductivity impairment, would yield productivity-related cost savings that would pay for most health and productivity management programs many times over.

Limitations

These findings are based on multiple companies across several industries and so add substantially to the literature more often derived from single sites. There are, however, several noteworthy limitations to this study.

One limitation of this study relates to the adapted use of the WHO or HPQ questionnaire and the validity of a single-item productivity variable compared with the use of the entire HPQ. The scale's authors note the limitations of using short versions in their scoring instructions and note that several of their items relate to memory priming, while several more are intended to afford more complex analysis such as imputing relative versus absolute presenteeism or conducting internal consistency checks.

The HPQ authors note that adapted versions can be "quite useful in providing a quick assessment of lost work performance in a workplace sample." Regarding our use of an adapted productivity item that captures absolute productivity, we believed the vital need to minimize response burden and obtain high completion rates outweighed the incremental benefits of the long version, such as memory priming or the ability to compare our results to archival calibration studies or contribute data to the HPQ master data set. The authors further assert the consistency of this study's findings with that of others provides supportive evidence for the validity of this admittedly limited measure as it relates to group-level measurement. The authors also acknowledge a more precise measure should be used in applications requiring high levels of reliability and validity at the individual level (Kessler et al, memorandum, available at: http://www.hcp.med.harvard.edu/hpq/ftpdir/absenteeism%20presenteeism%20scoring%20memo%20050107.pdf).

Another limitation is that the authors did not differentiate between lost productivity because of mental versus physical health issues within the single productivity measurement item. This may be a limitation related to judging respondents perceptions about physical versus psycho-social affects on their productivity.

Although, we explain a significant proportion of variation in health-related productivity loss, this study leaves the majority of variation in productivity unexplained. Other research, for example, has demonstrated the powerful impact of job satisfaction and life satisfaction on productivity.[2] Although beyond the intended scope of this study, future research is needed to compare the relative contribution of these non-health variables and others such as income, family history, education and access to medical care, to the contribution of employee productivity loss of controllable health risk variables, which was the focus for this study.

Practitioners and researchers should also note the importance of demographic variables in their application of these findings. Because gender was a particularly strong contributor to the predictive model, employers with a strong representation of one gender may need to adjust their application of these findings. This study did not further explore the practical significance of industry type or employer size but such differences were detected. Although beyond the scope of this study, the authors intend to explore the influence of these factors on productivity loss in future research.

In addition, as mentioned, our HA questionnaire items do not account for the severity or longevity of high blood pressure and cholesterol, and adjusting for these may account for a substantial portion of the relationship between health and productivity. In addition, this study did not include in our model other measures of health status such as chronic conditions, health care utilization, and perceived health status. Setting these health variables, along with the measured health risks, to their healthiest levels would yield a NIF group with no measured health risks, chronic conditions, or avoidable health care utilization, which would represent an even healthier NIF group than the one created in this study. To the extent that reducing risks results in improvements in these other related factors, they would contribute to the total value of investment in health management initiatives. The authors intend to explore this further in future research.

Finally, based on this cross-sectional analysis of related variables, we cannot adequately interpret the directionality or causality of the reported relationships. Although it would be tempting to infer from the demonstrated relationships that a decrease in health risks will guarantee an increase in employee productivity, this direct relationship can only be speculated on based on this analysis. Further research that monitors health risk trends in large populations and links them to productivity trends is needed to better understand the contribution of NIF and the causal relationship between changes in health and improvements in productivity.

Conclusions

This study provides one approach to estimating manageable or avoidable productivity loss in the hope that future research will build upon this concept to compare findings and improve upon our initial efforts. It is not offered as an authoritative measure of unavoidable productivity loss, but rather represents a platform on which to stimulate further dialogue. In its current state, the research is useful for managing employer expectations about the achievable productivity gains that might be realized by health risk reduction programs targeting the health risk areas included in the study.

Our analysis and reporting on the relative contribution of select risk factors to presenteeism, as well as the overall contribution of multiple risk factors to productivity, responds to concerns about lack of specificity of existing research. Use of a large database representing multiple employers across a range of industry sectors bolsters our confidence that these findings can be generalized more readily than single-employer studies. Furthermore, the extent to which our findings are consistent with the few well-designed studies in the existing literature supports a still limited body of evidence highlighting the significant connection between modifiable health risks and on-the-job productivity loss.

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