HHS Public Access

Author manuscript

J Occup Environ Med. Author manuscript; available in PMC 2023 March 03.

Published in final edited form as:

J Occup Environ Med. 2017 December ; 59(12): 1135–1139. doi:10.1097/JOM.0000000000001120.

Influenza and Workplace Productivity Loss in Working Adults

Jeffrey J. Van Wormer, PhD,

Jennifer P. King, MPH,

Anna Gajewski, MPH,

Huong Q. McLean, PhD,

Edward A. Belongia, MD

Center for Clinical Epidemiology and Population Health, Marshfield Clinic Research Institute, Marshfield, Wisconsin.

Abstract

Objective: Few studies have examined how acute respiratory illnesses (ARI) influence workplace productivity. We examined the association between laboratory-confirmed influenza and combined absenteeism/presenteeism.

Methods: Linear regression was used to model the association between influenza (by seasonal vaccine status) and productivity loss over 7 to 17 days following symptom onset in 1278 employed adults in an influenza vaccine effectiveness study during the 2012 to 2013 through 2015 to 2016 seasons.

Results: Influenza was significantly associated with workplace productivity loss ($P < 0.001$), but there were no significant differences between virus type/subtypes or seasonal vaccine status. Regardless of vaccination, participants with H1N1pdm09, H3N2, or B infection had the greatest mean productivity loss (range, 67% to 74%), while those with non-influenza ARI had the lowest productivity loss (58% to 59%).

Conclusions: Compared with non-influenza ARI, those with influenza lose an additional half day of work due to absenteeism/presenteeism over the week following symptom onset.

Poor health is a principal driver of productivity loss in the workplace, with lost productivity costs due to illness or injury accruing up to three times greater than medical care costs.[1] Due to their frequent and widespread occurrences, acute respiratory illnesses (ARI) are perhaps the most common health-related cause of absenteeism (ie, not attending work) and presenteeism (ie, task impairment while at work). ARIs are known to cause about one-third of all sick days in working populations,[2] and these costs far exceed the tens of billions of dollars in annual ARI-related medical care expenditures in the United States.[3,4] Influenza is a frequent cause of ARI and, depending on the severity of the season, results in an estimated 114,000 to 624,000 hospitalizations and 4900 to 27,000 deaths each year in the United States.[5]

Address correspondence to: Jeffrey J. VanWormer, PhD, Center for Clinical Epidemiology and Population Health, Marshfield Clinic Research Institute, 1000 North Oak Ave, Marshfield, WI54449 (vanwormer.jeffrey@mcrf.mfld-clin.edu).

Conflicts of Interest: None declared.

The medical burden of influenza tends to be concentrated in elderly and immunocompromised groups, with limited study of the economic consequences of influenza in working age adults. Precise and comprehensive estimates of workplace productivity loss secondary to influenza are particularly scant. Most previous research linking influenza to workplace productivity has focused on absenteeism alone. An early study in 1977 reported that adults with self-reported influenza-like-illness (ILI) lost an average of 3.2 work days after symptom onset.[6] This is consistent with more recent national estimates of influenza-related absenteeism,[7] though some prior studies have observed less severe absenteeism in adults with influenza, seemingly dependent on the season, patient age range, and geographic location. For example, relative to the Kavet[6] and Tsai et al[7] investigations, three studies observed about half as much sickness absence (~1.5 work days lost) in workers following an ILI episode.[8–10] But these were all single-season investigations, two were limited to a single state,[9,10] and another only surveyed older workers age 50 to 64 years.[10]

Almost all prior studies of influenza-related productivity loss have relied on nonspecific clinical endpoints such as ILI symptoms. But other respiratory viruses cause similar symptoms, and assessment of laboratory-confirmed influenza is needed to avoid exposure misclassification and estimate the productivity burden that is potentially preventable by (influenza) vaccination. Only one prior study examined laboratory-confirmed influenza and found that adults with influenza had 37% higher absenteeism than those with other ARI (21 vs 15 work hours lost per illness episode, respectively).[11] Those with influenza also reported significantly less sleep and involvement in general activities, as well as greater work impairment.

Scientific gaps remain on the relationship between influenza and workplace productivity. Objective measures of ARI are uncommon in workplace studies, and there are no known prior studies on influenza that have examined a comprehensive productivity loss outcome that simultaneously accounts for both absenteeism and presenteeism. The impact on workplace productivity may also differ by influenza type or subtype. For example, seasons dominated by influenza A/H3N2 tend to have more hospitalizations and deaths compared with other seasons,[12,13] but it is not known if A/H3N2 leads to greater workplace productivity loss relative to A/H1N1pdm09 or type B. Such knowledge could influence workplace health policies, such as more aggressive workforce-level influenza vaccination strategies used in more severe ARI seasons.

We analyzed data from four seasonal studies of influenza vaccine effectiveness to examine the association between laboratory-confirmed influenza and workplace productivity loss in working adults. Participants with medically attended ARI were tested for influenza, and then later followed up by telephone to assess their productivity. The primary objective was to determine if influenza, stratified by participants with and without a seasonal influenza vaccination, was associated with greater workplace productivity loss relative to other ARI. A secondary objective was to determine if workplace productivity loss varied by influenza type or subtype.

METHODS

Design

This was a cross-sectional analysis of data from four annual studies (2012 to 2013 through 2015 to 2016 ARI enrollment seasons) of influenza vaccine effectiveness among residents of a 14 ZIP code area surrounding Marshfield, WI (USA). As described in more detail elsewhere,[14–17] a given study enrollment season begins at the start of influenza transmission (late fall/early winter) and ends 12 to 15 weeks later when influenza transmission has typically declined. Study staff recruited patients seeking care for an ARI during seasonal periods of influenza transmission in primary care departments at the main Marshfield Clinic campus and a satellite clinic in another nearby community. Patients with medically attended ARI were eligible if symptoms included cough with illness duration less than or equal to 7 days. After informed consent, combined nasal and throat swabs were collected and tested for influenza A and B virus types using real-time reverse transcription polymerase chain reaction (RT-PCR). Positive samples were further tested for subtype determination (ie, H3N2, H1N1pdm09). All participants with a positive influenza test, and a sequential sample of the first 50 participants with a negative influenza test per week,[18] were contacted by telephone 7 to 10 days after enrollment (which was, by definition, 7 to 17 days after ARI symptom onset) to complete a brief interview that included an assessment of workplace productivity loss.

Participants

Eligibility criteria for this analysis included: (1) enrolled during 2012 to 2013 through 2015 to 2016 seasons, (2) age greater than or equal to 18 years, (3) completed follow-up telephone survey, (4) greater than or equal to 20 expected work hours per week, (5) not pregnant, (6) identifiable influenza type/subtype, and (7) all covariate measures available. For participants enrolled more than once in a given ARI season, only their first enrollment was included in the analysis. Study procedures were approved by the Marshfield Clinic Institutional Review Board.

Measures

Laboratory-Confirmed Influenza—The primary predictor was influenza test status, categorized by those who tested positive and negative (ie, other non-influenza ARI) for influenza. A secondary predictor was influenza type or subtype, including B, A/H3N2, and A/H1N1pdm09. Influenza B virus lineage was not assessed in this analysis.

Workplace Productivity Loss—The outcome was overall ARI-related workplace productivity loss, as measured from the follow-up telephone interview. A modified version of the work productivity and activity impairment (WPAI) questionnaire for specific health conditions was used to assess ARI-related workplace productivity loss.[19] This tool captures the percent decrement in total expected work time (ie, work hours lost) as a result of absenteeism (ie, job unavailability) and presenteeism (ie, job impairment) due to ARI. For absenteeism, participants report how many hours they missed from work and for presenteeism, they self-rate their productivity level on a 10-point scale during the hours they were in attendance at work during the recall period. Instead of the standard 7-day

recall period in the WPAI, productivity loss was queried about the timeframe between ARI symptom onset and follow-up (which could span from 7 to 17 days for a given participant). This was done in order to more precisely assess the relevant timeframe of interest, which included the days between the onset of ARI symptoms and follow-up interview completion. Total expected work hours during this timeframe were estimated based on the reported number of work hours in a work week. Scores ranged from 0% to 100% productivity loss relative to expected total work hours between ARI symptom onset and follow-up, with lower scores indicative of less productivity loss (eg, a perfectly productive employee would score 0%) and higher scores indicative of more productivity loss (eg, a completely unproductive employee would score 100%). The reliability and validity of the WPAI has been established for a variety of health conditions, including chronic (but not acute) respiratory illness patients.[20,21] Previous reviews have also recommended the WPAI as among the best short-form instruments for self-reported workplace productivity assessment.[22]

To calculate this outcome for a given participant, productivity loss due to absenteeism is first calculated by diving the reported hours missed due to ARI by the total number of expected work hours between ARI symptom onset and the follow-up interview. Productivity loss due to presenteeism is then calculated by dividing the reported productivity rating by 10, then multiplied by the remaining hours worked (after accounting for absenteeism), and dividing that product by the total number of expected work hours between ARI symptom onset and the follow-up interview. Overall productivity loss is the sum of the percent decrements due to absenteeism and presenteeism.

Analyses—Sample characteristics were compared between the influenza positive versus negative groups using chi-squared test and *t* tests. Unlike some prior studies with asymptomatic adults,[23] workplace productivity loss was not severely skewed in this sample with ARI, thus ordinary least squares regression was used with workplace productivity loss modeled as a continuous variable. A univariate model was first created to examine the crude association between influenza status and workplace productivity loss. Then a full linear regression model was fit by adding a two-way interaction term between influenza and seasonal influenza vaccine status (ie, vaccinated or not),[24] plus all a priori selected covariates. Covariates were selected to improve the precision of the influenza-productivity association and included age (~10-year age groups), sex, enrolled season, symptom onset week (modeled as early, middle, and late [reference group] tertiles of the enrollment seasons), days from symptom onset to follow-up, current smoker, body mass index (BMI; categorized as obese, overweight, or not overweight/obese[25]), high risk medical condition (ie, diagnosed pulmonary disease, diabetes, and/or cardiovascular disease—diagnosis codes available upon request), and asthma. To gauge the independent contribution of influenza type/subtype on workplace productivity loss, a secondary analysis was conducted that separated the primary predictor into type B, A/H3N2, or A/H1N1pdm09. Analytical procedures were conducted using SAS Version 9.3 (Cary, NC).

RESULTS

A participant flow diagram is outlined in Fig. 1. There were 1278 eligible individuals in the analysis from across all four influenza seasons. The majority of participants (65%)

were women. The mean (±SD) number of hours worked per week was 40.9 (±10.0). There were 470 individuals with RT-PCR confirmed influenza, including 179 with H1N1pdm09, 182 with H3N2, and 109 with type B. H3N2 predominantly circulated during two of the seasons (2012 to 2013 and 2014 to 2015), and two other seasons were dominated by H1N1pdm09 (2013 to 2014 and 2015 to 2016). Participants with influenza differed from those with non-influenza ARI on several factors (Table 1). Influenza was significantly more common in men, nonsmokers, and non-obese individuals. Age, along with the prevalence of asthma or a high risk medical condition, was similar in those with and without influenza. As expected, participants with influenza were significantly less likely to have received the seasonal influenza vaccine.

Overall workplace productivity loss was high following ARI symptom onset. The initial crude model indicated that influenza ($\beta \pm$ SE = 11.1 ± 1.6, $P < 0.001$) was associated with significantly greater workplace productivity loss relative to non-influenza ARI. Specifically, adults with influenza had 69% (±1) of expected work hours lost since illness onset, whereas workplace productivity loss among those with other ARI was lower at 58% (±1). There was little change in the influenza parameter estimate in the adjusted model (Table 2). Influenza status was again a significant predictor of workplace productivity loss, and at a similar magnitude relative to the crude model. Among those who were influenza positive, as well as those with non-influenza ARI, there was no significant productivity difference between those who did versus did not receive the seasonal influenza vaccine. Sex, age, smoking, symptom onset week, and days between ARI symptom onset and follow-up were also significant independent predictors of workplace productivity loss.

In the secondary analysis, all influenza types/subtypes had significantly greater workplace productivity loss as compared with non-influenza ARI, but there were no significant differences in productivity loss between H1N1pdm09, H3N2, and B infections (full model not shown). Also, within each infection type, there was again no significant productivity difference between those who did or did not receive the seasonal influenza vaccine (Fig. 2). Working adults with other ARI who were not vaccinated had the lowest level of workplace productivity loss at 58% (±2), whereas those with H1N1pdm09 who were not vaccinated had the greatest workplace productivity loss at 74% (±3).

DISCUSSION

Influenza was associated with greater workplace productivity loss as compared with other (non-influenza) ARI in employed adults. Our findings were consistent with several previous studies that also showed ILI symptoms resulted in greater sickness absence from work,[6–10] as well as greater presenteeism among those with RT-PCR confirmed influenza.[11] Our study extends prior research on this topic by showing that medically attended, laboratory-confirmed H1N1pdm09, H3N2, and B infection types/subtypes were similarly detrimental to workplace productivity.

To better illustrate the statistical findings, a typical full-time employee could expect to lose about 3½ of their 5 work days in a given week (following symptom onset) due to absenteeism and presenteeism from an influenza infection. In contrast, a full-time employee

would lose about 3 work days in a week if infected by non-influenza ARI. This is also consistent with the known greater severity of influenza symptoms relative to other ARI,[26] which may have implications for workplace human resource policies/practices. The composite endpoint of overall productivity loss used in our study did not disaggregate the relative "contribution" of presenteeism or absenteeism by themselves, and the temporal order of absenteeism and presenteeism was not assessed. Future research should explore how these productivity factors covary in workers with influenza versus non-influenza ARI. For example, encouraging employees with influenza to stay home for 1 or 2 days could theoretically reduce the total productivity decrement if it completely mitigated presenteeism when the employee returns.

Several covariates were also associated with workplace productivity loss, including sex, age, smoking, symptom onset week, and days between symptom onset and follow-up. Males, older adults, and nonsmokers are known to have greater workplace productivity in general.[27] The significant association with the middle tortile of symptom onset week may reflect some collinearity in that those with influenza were also significantly more likely to experience symptom onset during the peak period of influenza circulation within the calendar timeframe of a given season. Also, those who were reached for telephone follow-up further from their symptom onset date tended to report less productivity loss, which may reflect some level of recall bias. More surprising perhaps, was the lack of correlation between the seasonal influenza vaccine and workplace productivity loss among those with influenza. Evidence is somewhat mixed on whether or not seasonal vaccination protects against some severe influenza medical outcomes such as hospitalization or length of intensive care unit stay,[28–30] but our findings were consistent with recent observations from the US Flu Vaccine Effectiveness (VE) Network where no significant differences were observed in sickness absence and work impairment among adults with influenza who did versus did not receive a seasonal influenza vaccine.[11] Similar influenza vaccine observations have been noted in children's sickness absence due to influenza from school as well.[18]

Strengths of our study included confirmation of influenza using the highly specific RT-PCR test and combining data over four ARI seasons. A significant limitation was the self-reported workplace productivity loss outcome as assessed by the (modified) WPAI. In addition to at least some susceptibility to recall and self-presentation biases (eg, participants were not blinded to their influenza status), the total expected work hours was estimated from this instrument, presumably with some level of imprecision. Also, this productivity assessment corresponded to a defined short-term timeframe following ARI symptom onset. If some participants were still symptomatic at the time of their study interview, it could essentially "truncate" their absenteeism and presenteeism reports, resulting in a more conservative observed influenza-productivity association. Selection bias is also possible because adults who did not receive medical treatment for their ARI were not enrolled, nor was it possible to compare productivity losses to an otherwise healthy non-ARI control group. Results could differ in comparing less severe forms of ARI that are not medically-attended. And given our relatively homogenous source population and the known regional variation in influenza-linked sickness absence,[7] our findings may have limited generalizability.

Respiratory illnesses have a negative impact on productivity in the days following symptom onset, with influenza having the strongest workplace productivity decrement relative to non-influenza ARI types. To the extent that the influenza vaccine is effective in preventing influenza infection in a given season, our findings underscore the importance of widespread vaccination in working populations. Future research should explore specific financial returns on employer investments in initiatives and policies designed to help their employees prevent seasonal influenza transmission and infection, and minimize the economic impact of ARI.

Acknowledgments

This research was funded by cooperative agreement U01IP000471 from the US Centers for Disease Control and Prevention, and in part through philanthropic support of Marshfield Clinic Research Institute's Summer Research Internship Program.

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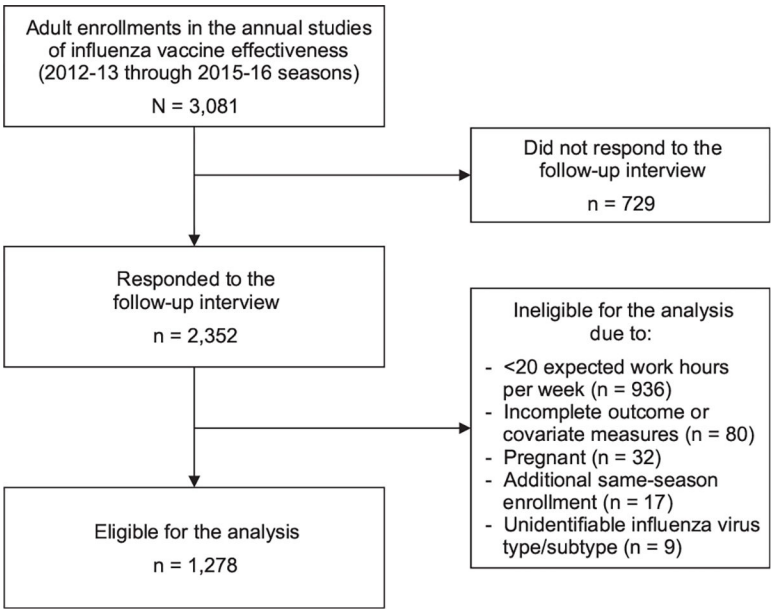

FIGURE 1.

Flow diagram of adult participants in four annual studies (2012 to 2013 through 2015 to 2016 seasons) of influenza vaccine effectiveness in central Wisconsin.

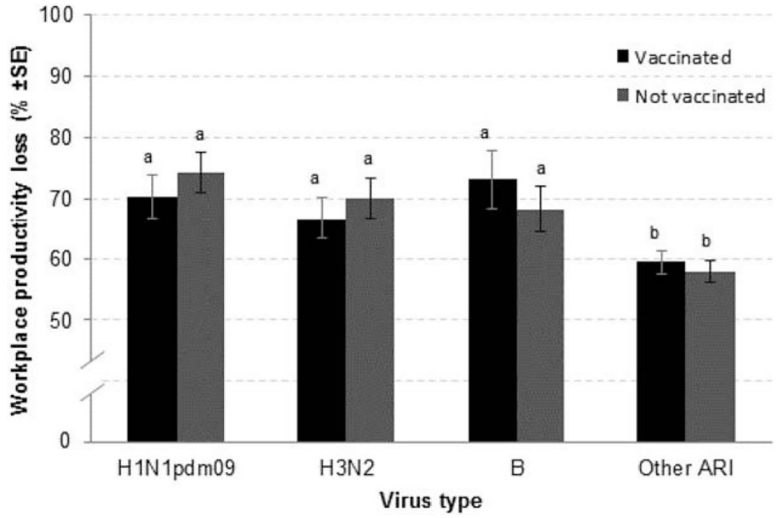

FIGURE 2.

Model-estimated workplace productivity loss, by virus type and influenza vaccination status, among working adults with acute respiratory illness (ARI) over four seasons *(N* = 1278). Values that do not share the same superscript letter are significantly different from each other ($P < 0.05$).

J Occup Environ Med. Author manuscript; available in PMC 2023 March 03.

TABLE 1.

Descriptive Characteristics of Working Adults with Acute Respiratory Illness (ARI) Over Four Seasons, Stratified by Influenza Types/Subtypes

	Non-Influenza ARI (*n* = 808)	H1N1pdm09 (*n* = 179)	H3N2 (*n* = 182)	*B* (*n* = 109)	*P*
Age (yrs)					
18–29	148 (18%)	19 (11%)	27 (15%)	10 (9%)	0.06
30–39	197 (24%)	43 (24%)	42 (23%)	24 (22%)	
40–49	156 (19%)	43 (24%)	34 (19%)	33 (30%)	
50–59	215 (27%)	58 (32%)	54 (30%)	28 (26%)	
≥60	92 (11%)	16 (9%)	25 (14%)	14 (13%)	
Gender					
Male	281 (35%)	84 (47%)	76 (42%)	56 (51%)	<0.001
Female	527 (65%)	95 (53%)	106 (58%)	53 (49%)	
Seasonal influenza vaccine					
Not vaccinated	373 (46%)	100 (56%)	97 (53%)	71 (65%)	<0.001
Vaccinated	435 (54%)	79 (44%)	85 (47%)	38 (35%)	
Enrolled season					
2012–2013	176 (22%)	1 (1%)	118 (65%)	56 (51%)	<0.001
2013–2014	165 (20%)	106 (59%)	8 (4%)	1 (1%)	
2014–2015	226 (28%)	0 (0%)	56 (31%)	48 (44%)	
2015–2016	241 (30%)	72 (40%)	0 (0%)	4 (4%)	
Symptom onset week					
1–3	140 (17%)	58 (32%)	38 (21%)	13 (12%)	<0.001
4–6	203 (25%)	57 (32%)	74 (41%)	24 (22%)	
7–9	196 (24%)	42 (22%)	50 (27%)	23 (21%)	
10–12	192 (24%)	21 (12%)	18 (10%)	18 (17%)	
13–16	77 (10%)	1 (1%)	2 (1%)	31 (28%)	
Days from symptom onset to follow-up	11.1 ±1.9	10.4 ±1.8	10.3 ±1.7	10.8 ±1.7	<0.001
Smoker					
Current	168 (21%)	24 (13%)	24 (13%)	19 (17%)	0.02
Not	640 (79%)	155 (87%)	158 (87%)	90 (83%)	
Body mass index (kg/m)					

	Non-Influenza ARI (*n* = 808)	H1N1pdm09 (*n* = 179)	H3N2 (*n* = 182)	*B* (*n* = 109)	*P*
≥30.0: obese	425 (53%)	76 (42%)	75 (41%)	53 (49%)	0.04
25.0–29.9: overweight	225 (28%)	60 (34%)	56 (31%)	30 (28%)	
<25.0: not overweight	158 (20%)	43 (24%)	51 (28%)	26 (24%)	
High risk medical condition					
No	505 (63%)	125 (70%)	109 (60%)	73 (67%)	0.2
Yes	303 (38%)	54 (30%)	73 (40%)	36 (33%)	
Asthma					
No	674 (83%)	151 (84%)	153 (84%)	97 (89%)	0.5
Yes	134 (17%)	28 (16%)	29 (16%)	12 (11%)	

All values are reported as mean ± standard deviation or frequency (% of group).

P value corresponds to the difference between the influenza vs other ARI group.

TABLE 2.

Multivariable Linear Regression Model of the Association between Workplace Productivity Loss and Influenza Among Working Adults with Acute Respiratory Illness (ARI) over Four Seasons

	Workplace Productivity Loss (%)		
Predictors	**β**	**SE**	***P***
N= 1,278			
Intercept	67.4	6.5	<0.001
Influenza by seasonal vaccine			
Influenza positive × vaccinated	11.5	2.6	<0.001
Influenza positive × not vaccinated	13.4	2.3	<0.001
Influenza negative × vaccinated	1.4	2.1	0.5
Influenza negative × not vaccinated	— ref. —		
Age (y)			
18–29	6.4	3.3	0.051
30–39	10.4	3.0	0.001
40–49	9.7	3.0	0.001
50–59	9.4	2.8	0.001
≥60	— ref. —		
Gender			
Male	−5.2	1.7	0.002
Female	— ref. –		
Enrolled season			
2012–2013	−1.8	2.2	0.4
2013–2014	−1.4	2.3	0.5
2014–2015	2.2	2.2	0.3
2015–2016	— ref. —		
Symptom onset week			
Tertile 1	0.1	2.2	0.95
Tertile 2	4.1	2.0	0.04
Tertile 3	— ref. —		
Days from symptom onset to follow-up	−1.5	0.4	<0.001
Smoker			
Current	7.9	2.1	<0.001
Not	— ref. –		
Body mass index (kg/m^2)			
≥30.0: obese	−1.6	2.1	0.4
25.0–29.9: overweight	−3.5	2.3	0.1
<25.0: not overweight	— ref. —		
High risk medical condition			
No	−1.4	1.9	0.4
Yes	— ref. –		
Asthma			

	Workplace Productivity Loss (%)		
Predictors	**β**	**SE**	***P***
No	−0.2	2.3	0.9
Yes	— ref. –		

B values are equal to the change in workplace productivity loss relative to the reference category (or 1-unit increase for continuous predictor variables).

Workplace productivity loss is the percentage of work hours lost due to health-related absenteeism and presenteeism combined. SE, standard error.