Published in final edited form as:

J Occup Environ Med. 2016 October ; 58(10): 974–978. doi:10.1097/JOM.0000000000000839.

Chronic Condition Combinations and Productivity Loss Among Employed Nonelderly Adults (18 to 64 Years)

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Abstract

Objective—We examined the relationship between specific chronic condition combinations and productivity loss measured by missed work days among nonelderly employed adults with at least two physical chronic conditions of arthritis, diabetes mellitus, heart disease, and hypertension.

Methods—We analyzed data from the Medical Expenditure Panel Survey for the years 2004 to 2012.

Results—Adults with arthritis/diabetes/heart disease had the highest average missed work days (14.42). In the adjusted model, compared with adults with arthritis/hypertension, adults with diabetes/heart disease and arthritis/heart disease/hypertension had significantly higher missed work days, while adults with diabetes/hypertension had significantly lower missed work days.

Conclusion—Specific chronic condition combinations have a high burden of disease in terms of productivity loss. Work-place health programs that address multiple health conditions at the same time should be implemented to reduce missed work days.

The prevalence of chronic conditions has increased dramatically in the United States (US).^{1,2} The presence of chronic conditions is common even among nonelderly adults.³ In 2012, 117 million (one in two) adults lived with at least one chronic condition from a list of selected 10 conditions, and among these adults, 60 million lived with two or more chronic conditions.² Among adults aged 18 to 44 years, 5.1% had two chronic conditions and 2.0% had three conditions or more, while among those aged 45 to 64 years, 18.5% had two chronic conditions and 13.8% had three conditions or more.² The increase in the number of nonelderly adults with chronic conditions can increase the direct and indirect health care expenditures.^{3–7} Nonelderly adults under 65 years of age accounted for \$239 billion in direct health care expenditures with a per-capita annual average health care expenditures of \$10,391.³ The indirect expenditures and productivity losses because of missed work days

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The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or nonfinancial interest in the subject matter or materials discussed in this manuscript.

The authors have no conflicts of interest to disclose.

Supplemental digital contents are available for this article. Direct URL citation appears in the printed text and is provided in the HTML and PDF versions of this article on the journal's Web site (www.joem.org).

due to illnesses are also substantially high among nonelderly adults with chronic conditions.⁷⁻⁹

For the period between 2001 and 2003, 3.6 billion days were lost annually due to illnesses.⁸ The missed work days associated with chronic conditions accounted for \$127 billion in lost personal income.⁹ During the period from 2011 to 2013, seven selected chronic conditions (arthritis/rheumatism, cancer, diabetes, heart disease, hypertension, lung disease, and stroke) accounted for 28.2 million workdays lost per year and resulted in \$4.95 billion dollars in lost personal income per year.⁷ The impact of number of chronic conditions and comorbid conditions within a single disease has been well documented. For example, previous studies have suggested that single chronic conditions such as asthma, arthritis, diabetes, cancer, heart disease, hypertension, lung disease, and stroke are associated with missed work days due to illnesses.¹⁰⁻¹⁶ Also, prior research has shown that missed work days increased as the number of chronic conditions increased.¹⁷ In 2011, the average missed work days were 7.4 days for adults with two or three chronic conditions and 14.5 days for those with four or more chronic conditions.¹⁷ In one study from Canada, adults suffering from chronic pain (caused by fibromyalgia, arthritis/rheumatism, back problems, or migraine headaches) and major depression had higher risk of missing work days than those without major depression.¹⁸ In the US, one study quantified the effect of certain specific combinations of two or three diseases and reported that adults with some specific combinations (eg, diabetes and hypertension or stroke and inflammatory bowel disease) were more likely to have disability days as measured by missed work days.¹⁹

However, little is known about the relationship between all combinations of chronic conditions and missed work days. Further research is required to focus on exhaustive combinations of highly prevalent and expensive chronic conditions in the US. It is crucial to analyze the relationship between the exhaustive combinations of highly prevalent chronic conditions and missed work days, so that policymakers, providers, and other stakeholders can tailor work-place education about the effects of chronic condition combinations and design wellness programs that target individuals with specific chronic condition combinations.

It is very challenging to disentangle the relationship between combinations of all chronic conditions and outcomes. For example, in a selected list of 11 conditions, there will be 550 possible combinations of two, three, or four chronic conditions. To keep the number of combinations manageable and relevant for policy, program, and clinical practice, we selected arthritis, diabetes mellitus, heart disease, and hypertension to study the relationship between specific chronic condition combinations and missed work days. It has to be noted that these four chronic conditions were among the most prevalent conditions among adults in the US²; arthritis, heart diseases, and diabetes were among the leading causes of death and disability.¹

METHODS

Study Design

The study used a cross-sectional design to examine the relationship between specific chronic condition combinations and productivity loss measured by missed work days.

Data Source

For this study, household and medical conditions files of the Medical Expenditure Panel Survey (MEPS) for the years 2004, 2006, 2008, 2010, and 2012 were used. Data from these years were pooled to gain sample size. The MEPS is a household survey of noninstitutionalized civilian population, and it is conducted annually.²⁰ Information on health status, demographic and socioeconomic characteristics, employment, access to care, and satisfaction with health care of the participants in the survey were extracted from the household component of the survey.²⁰ Medical conditions reported by the participants were available in the medical conditions file. The medical conditions were recorded as texts, and these texts were translated into International Classification of Diseases, 9th Edition, Clinical Modification (ICD-9-CM) codes by professional coders.²⁰ In addition, the MEPS data provide clinical classification codes, which are aggregated ICD-9-CM codes into clinically meaningful categories that group similar conditions.²⁰

Study Sample

The sample consisted of 5190 employed nonelderly adults (18 to 64 years) with at least two of the following four chronic physical conditions: arthritis, diabetes mellitus, heart disease, and hypertension.

Measures

Dependent Variable

Missed Work Days: Missed work days were defined as the number of workdays missed due to illness or injuries. Household component of the MEPS provides the annual missed work days due to illness or injury for the participants.²⁰

Key Independent Variable

Chronic Condition Combinations: Adults with at least two conditions of arthritis, diabetes mellitus, heart disease, and hypertension were classified into 11 mutually exclusive categories: 1) arthritis/diabetes; 2) arthritis/heart disease; 3) arthritis/hypertension; 4) diabetes/heart disease; 5) diabetes/hypertension; 6) heart disease/hypertension; 7) arthritis/diabetes/heart disease; 8) arthritis/diabetes/hypertension; 9) arthritis/heart disease/hypertension; 10) diabetes/heart disease/hypertension; and 11) arthritis/diabetes/heart disease/hypertension. We used arthritis/hypertension as the reference group in our analyses because this combination was the most prevalent dyad in our sample.

Other Independent Variables: The selection of other independent variables was guided by the expanded Andersen health behavior model of health services and outcomes.²¹ Andersen health behavior model posits that health outcomes are influenced by (1) predisposing factors (sex and race); (2) enabling factors (poverty status and health insurance); and (3) each individual's level of need (chronic conditions and physical and mental health status). Also, prior research has shown that socio-demographic factors, health insurance, other comorbid conditions, and poverty status are associated with missed work days.^{13,14,22,23}

Predisposing factors consisted of sex (women, men) and race/ethnicity (white and other). Enabling factors included health insurance coverage (private, public, uninsured), and poverty status; individuals were divided into four groups on the basis of their poverty status: poor (less than 100% federal poverty line), near poor (100% to less than 200%), middle income (200% to less than 400%), and high income (greater than or equal to 400%). Need factors included perceived health status (excellent; very good; good; fair; and poor); perceived mental status (excellent; very good; good; fair; and poor); and the presence of other co-occurring chronic conditions (asthma, cancer, chronic obstructive pulmonary disease, gastro-esophageal reflux disease, thyroid, anxiety, and depression).

Statistical Techniques

Chi-square tests were used to examine the associations between chronic condition combinations and independent variables in the bivariate analysis. As our dependent variable was the count of missing work days, ordinary least square regression cannot be applied. Four count-data regression models are available for researchers to analyze count data: Poisson regression, negative binomial regression (NBR), zero-inflated Poisson regression (ZIP), and zero-inflated negative binomial regression (ZINB). Model selection for count-data regression models is often based on the Likelihood Ratio Test, Wald test, Vuong test, Akaike Information Criterion (AIC), and Bayesian Information Criterion (BIC).^{24–27} As these tests are not available for complex survey data, one can only rely on the graphical comparison of predicted and observed counts of missing days for the four models. This approach has been used in previous studies especially in dental research.²⁸ For our data, both NBR and ZINB regressions suggested that observed counts were similar to predicted counts of missing work days (“Appendix A,” <http://links.lww.com/JOM/A300>). However, NBR models are simpler to interpret.^{29,30} Therefore, we selected NBR as our primary analytical model.

To assess the relationship between chronic condition combinations and missed work days, unadjusted NBR was conducted as well as a model adjusting for sex, race, poverty status, type of insurance, physical and mental health status, and number of other chronic conditions. All analyses accounted for the complex survey design of the MEPS and were conducted using survey procedures in Statistical Analysis System (SAS) version 9.4 and STATA 14.1 (StataCorp LP, College Station, TX). Due to multiple comparisons, variables with *P* value less than 0.01 were considered statistically significant and those with 0.01 $P < 0.05$ were considered marginally significant.

RESULTS

Description of the Study Sample

Our study sample comprised 5190 employed nonelderly adults (18 to 64 years) with at least two of the following four chronic physical conditions (arthritis, diabetes, heart disease, and hypertension). Spearman correlation analysis showed very weak statistically significant correlation coefficients (ranging from –0.02 to –0.34) between many of the chronic condition combinations, suggesting that there was no multicollinearity. Spearman correlation coefficients are listed in “Appendix B” (<http://links.lww.com/JOM/A301>).

Among adults with two conditions, those with arthritis/hypertension were highly prevalent (30.96%), followed by diabetes/hypertension (18.57%), heart disease/hypertension (11.19%), arthritis/heart disease (9.05%), arthritis/diabetes (5.62%), and diabetes/heart disease (2.05%). The most prevalent triad combination was arthritis/diabetes/hypertension (8.65%) followed by arthritis/heart disease/hypertension (6.73%), diabetes/heart disease/hypertension (3.61%), and arthritis/diabetes/heart disease (1.03%). Of the adults in our study sample, 2.54% had all the four conditions (arthritis/diabetes/heart disease/hypertension).

There were significant differences in rates of specific combinations of chronic conditions by all the independent variables included in the study. The description of sample characteristics is listed in Table 1.

Missed Work Days

Among adults with combinations of two, three, or four chronic conditions, average missed work days differed by specific combinations. Adults with arthritis/diabetes/heart disease had the highest average missed work days (14.42), followed by adults with diabetes/heart disease (12.67), arthritis/heart disease/hypertension (10.4), arthritis/heart disease (9.55), and diabetes/heart disease/hypertension (8.25). Adults with diabetes/hypertension had the lowest average missed work days (5.46). The missed work days averages and standard errors for all the combinations are listed in Table 2.

Coefficient estimates, standard errors, and incident rate ratios from adjusted and unadjusted NBR are displayed in Table 3. Before adjustment, compared with adults with arthritis/hypertension, adults with arthritis/diabetes/heart disease, diabetes/heart disease, arthritis/heart disease/hypertension, and arthritis/heart disease had significantly higher missed work days. After controlling for sex, race, poverty status, type of insurance, physical and mental health status, and number of other chronic conditions, adults with diabetes/heart disease and arthritis/heart disease/hypertension had significantly higher missed work days than adults with arthritis/hypertension. Conversely, adults with diabetes/hypertension had significantly lower missed work days than adults with arthritis/hypertension after controlling for the above variables.

DISCUSSION

The current study examined the association between specific chronic condition combinations and missed work days. In this study, we included employed nonelderly adults (18 to 64 years) with at least two physical chronic conditions of arthritis, diabetes mellitus, heart disease, and hypertension. Adults with arthritis/diabetes/heart disease had the highest average missed work days, whereas adults with diabetes/hypertension had the lowest average missed work days.

After adjusting for sex, race/ethnicity, poverty status, type of insurance, perceived physical and mental health, and the presence of chronic conditions, adults with diabetes/heart disease and arthritis/heart disease/hypertension had significantly higher missed work days than adults with arthritis/hypertension. Conversely, adults with diabetes/hypertension had significantly lower missed work days than adults with arthritis/hypertension. On the basis of

these results, we conclude that average missed work days differed by specific combinations. Our results suggest that the combinations of arthritis/diabetes/heart disease and diabetes/heart disease are associated with high average missed work days. These results are consistent with the previous studies that these three diseases are among the leading cause of disability in the US.¹ Within a single disease framework, previous studies have reported that adults with arthritis missed 3 to 6 work days annually^{7,14}; adults with diabetes missed an average of 3 to 10 days annually,^{7,31,32} whereas adults with heart diseases missed an average of 3 to 12 work days.⁷ It is not surprising that in our study, adults with all three diseases had the highest number of missed work days (average of 14.42 days). Our study findings suggest that workplace health programs need to be personalized to reduce productivity losses, specifically missed work days.

We should note that there was no difference in missed work days between adults with arthritis/diabetes/heart disease/hypertension and those with arthritis/hypertension. This finding is unanticipated, as we found that adults with diabetes/heart disease had higher missed work days than those with arthritis/hypertension. It would follow that having two disabling conditions such as arthritis and hypertension would increase the average missed work days. A study suggested that adults with higher number of chronic conditions received higher quality of care, measured as offered recommended services.³³ Therefore, one could speculate that adults with the four conditions received higher quality of care, so they missed fewer work days. On the contrary, among adults with all four conditions, only healthier adults were able to work and remained in the labor force and these adults are more likely to report fewer missed work days than others.

The current study examined the relationship between specific chronic condition combinations of arthritis, diabetes, heart disease, and hypertension—which are highly prevalent and expensive diseases—and productivity losses measured by missed work days. We used a national representative database. We controlled for a comprehensive list of variables, including poverty status, physical and mental health status, and number of co-occurring chronic conditions that may have an effect on productivity losses. However, our study had some limitations. First, information on medical conditions and missed work days are based on self-reported data. Therefore, recall bias may have an effect on the measures of the variables. Second, in our analysis, we included only four chronic conditions; hence, our results are not generalizable to other chronic conditions.

CONCLUSION

Our results suggest that average missed work days differed by chronic condition combinations. Adults with combinations of diabetes/heart disease and arthritis/heart disease/hypertension and arthritis/diabetes/heart conditions may have a very high burden of disease, which may have resulted in reduced productivity while at work. Workplace health programs that emphasize comanagement of chronic conditions should be implemented to reduce missed work days.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This project was supported by the National Institute of General Medical Sciences, U54GM104942. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

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TABLE 1
Description of Study Sample Characteristics by Chronic Condition Combinations, Weighted Row Percentages, Medical Expenditure Panel Survey, 2004–2012

	ARTH/DM	ARTH/HRT	ARTH/HTN	DM/HRT	DM/HTN	HRT/HTN	ARTH/DM/HRT	ARTH/HRT/HTN	DM/HRT/HTN	ARTH/DM/HRT/HTN	P
ALL	5.62	9.05	30.96	2.05	18.57	11.19	1.03	6.73	3.61	2.54	
Missed work days											
Missed days	5.94	10.44	30.22	2.5	15.29	11.54	1.35	7.42	3.66	2.86	<0.001
No missed days	5.23	7.33	31.89	1.5	22.62	10.76	0.63	5.89	3.54	2.14	
Sex											
Women	6.79	11.59	32.01	1.86	16.46	9.33	1.07	7.33	2.43	2.24	<0.001
Men	4.59	6.78	30.03	2.22	20.47	12.85	0.99	6.2	4.66	2.8	
Race											
White	5.47	10.12	31.81	1.96	15.45	12.1	1.18	7.61	3.56	2.68	
Other	6	6.46	28.91	2.27	26.12	8.98	0.67	4.6	3.7	2.2	
Poverty status											
Poor	6.89	10.03	29.85	1.13	19.4	5.51	1.54	9.04	2.29	2.63	0.01
Near Poor	6.85	8.4	29.38	1.87	22.99	8.69	0.98	5.84	4.42	2.77	
Middle Income	5.71	8.52	30.42	2.64	18.95	10.39	0.67	6.71	3.38	2.68	
High Income	5.13	9.42	31.8	1.84	17.18	12.91	1.2	6.7	3.69	2.38	
Health insurance											
Private	5.61	9.17	31	2.03	18.19	11.74	1.06	6.87	3.51	2.59	<0.001
Public	9.41	9.56	24.62	2.3	15.92	5.9	0.87	7.89	4.1	4.1	
Uninsured	3.63	7.73	34.21	2.08	23.38	9.4	0.8	4.92	4.15	1.18	
Perceived physical health											
Excellent/Very good	5.47	10.72	36.2	1.09	17.31	14.29	0.41	5.85	2.14	1.15	<0.001
Good	5.28	7.79	30.01	2.25	21.54	9.98	1.01	6.67	3.62	2.35	
Fair/poor	6.43	8.87	25.27	3.06	15.27	8.92	1.94	8.06	5.62	4.8	
Perceived mental health											
Excellent/Very good	5.3	9.8	31.31	1.92	20.19	11.85	0.82	6.35	2.93	2.03	<0.001
Good	5.94	7.56	30.29	2.08	17.26	11.56	1.11	6.57	4.64	2.99	
Fair/Poor	6.61	9.46	31.23	2.77	12.93	5.8	2.05	9.7	4.34	3.68	

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	ARTH/DM	ARTH/HRT	ARTH/HTN	DM/HRT	DM/HTN	HRT/HTN	ARTH/DM/HRT	ARTH/DM/HTN	ARTH/HRT/HTN	DM/HRT/HTN	ARTH/DM/HRT/HTN	P
Other chronic conditions												
Yes	4.64	9.51	33.43	1.48	13.95	10.69	1.41	8.83	9.19	3.51	3.37	<0.001
No	6.55	8.62	28.67	2.58	22.88	11.66	0.67	8.48	4.44	3.69	1.76	

On the basis of 5190 employed nonelderly adults (18–64 years) with at least two of the following four chronic physical conditions: arthritis, diabetes mellitus, heart disease, and hypertension. Other chronic conditions include presence of any of following chronic conditions: asthma, cancer, COPD, GERD, thyroid, anxiety, and depression.

ARTH, arthritis; DM, diabetes mellitus; HRT, heart disease; HTN, hypertension.

TABLE 2

Mean, Standard Errors, 95% Confidence Intervals of Missed Work Days, by Chronic Condition Combinations, Medical Expenditure Panel Survey, 2004–2012

	Mean	SE	95% CI
ALL			
ARTH/DM	7.76	1.25	[5.29–10.22]
ARTH/HRT	9.55	1.10	[7.38–11.71]
ARTH/HTN	7.02	0.51	[6.02–8.02]
DM/HRT	12.67	2.38	[7.98–17.36]
DM/HTN	5.46	0.57	[4.33–6.58]
HRT/HTN	5.90	0.65	[4.61–7.18]
ARTH/DM/HRT	14.42	3.13	[8.26–20.57]
ARTH/DM/HTN	6.89	0.87	[5.17–8.60]
ARTH/HRT/HTN	10.40	1.42	[7.61–13.19]
DM/HRT/HTN	8.25	1.67	[4.97–11.53]
ARTH/DM/HRT/HTN	7.80	1.33	[5.18–10.42]

On the basis of 5190 employed nonelderly adults (18–64 years) with at least two of the following four chronic physical conditions: arthritis, diabetes mellitus, heart disease, and hypertension.

ARTH, arthritis; CI, confidence interval; DM, diabetes mellitus, HRT, heart disease; HTN, hypertension; SE, standard error.

TABLE 3

Parameter Estimates, Standard Errors, and Incident Rate Ratios of Chronic Condition Combinations, From Negative Binomial Regression on Missed Work Days, Medical Expenditure Panel Survey, 2004–2012

	Unadjusted			Adjusted		
	Beta	SE	IRR	Beta	SE	IRR
ARTH/DM	0.100	0.179	1.105	0.578	0.066	1.068
ARTH/HRT	0.308	0.137	1.361	0.026	0.271	1.311
ARTH/HTN	Reference group					
DM/HRT	0.590	0.209	1.804	0.005	0.640	1.896
DM/HTN	-0.252	0.130	0.777	0.053	-0.300	0.741
HRT/HTN	-0.174	0.133	0.840	0.190	-0.056	0.946
ARTH/DM/HRT	0.720	0.238	2.054	0.003	0.438	1.550
ARTH/DM/HTN	-0.018	0.136	0.982	0.893	-0.078	0.925
ARTH/HRT/HTN	0.393	0.160	1.481	0.014	0.469	1.598
DM/HRT/HTN	0.162	0.218	1.176	0.460	-0.027	0.973
ARTH/DM/HRT/HTN	0.106	0.192	1.112	0.582	0.044	1.045

On the basis of 5190 employed nonelderly adults (18–64 years) with at least two of the following four chronic physical conditions: arthritis, diabetes mellitus, heart disease, and hypertension.

Adjusted model included sex, race, poverty status, type of insurance, physical and mental health status, and number of co-occurring chronic conditions (reported having one of the following chronic conditions: asthma, cancer, COPD, GERD, thyroid, anxiety depression).

ARTH, arthritis; DM, diabetes mellitus; HRT, heart disease; HTN, hypertension; IRR, incident rate ratios; SE, standard error.