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ORIGINAL RESEARCH

The Impact of COPD on Quality of Life, Productivity Loss, and Resource Use among the Elderly United States Workforce

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Abstract

To address the gap in knowledge about the impact of chronic obstructive pulmonary disease (COPD) on older working adults, this study examined quality of life, worker productivity, and healthcare resource utilization among employed adults aged 65 and older with and without COPD. Among 2009 National Health and Wellness Survey (a cross-sectional, internet-based survey representative of the US adult population) respondents, employed adults aged 65 years and older, with COPD (n = 297) and without COPD (n = 3061), were included in analyses. Impact of self-reported COPD diagnosis on mean quality of life (using health utilities and mental, MCS, and physical, PCS, component summary scores from SF-12v2), work productivity and activity impairment (using the WPAI questionnaire), and resource use were examined. Adjusting for demographic and health characteristics such as co-morbidities (weighted to project to the US population) in regression models (linear, negative binomial, or logistic, as appropriate given the outcome measure), older workers with COPD reported significantly lower MCS (52.1 vs. 53.4, p < .05), PCS (40.3 vs. 47.2, p < .05), and health utilities (0.72 vs. 0.79, p < .05) than those without COPD, and significantly greater percentages of impairment while at work (presenteeism) (12.6% vs. 8.7%, p < .0001), overall work impairment (absenteeism and presenteeism combined) (19.3% vs. 10.0%, p < .05), and impairment in daily activities (23.9% vs. 13.7%, p < .05). There were no significant differences in absenteeism or healthcare use. Quality of life and work productivity suffered among employed adults aged 65 years and older with COPD, emphasizing the need for disease management in this population.

Keywords: Chronic Obstructive Pulmonary Disease, Quality of Life, Work Productivity, Activities of Daily Living, Resource Use

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Introduction

A diagnosis of chronic obstructive pulmonary disease (COPD), as defined by the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, should be considered in any person with dyspnea (shortness of breath), chronic cough or sputum production, or a history of exposure to risk factors such as smoking or air pollutants (1). Prevalence of COPD rises with age (2) and has been shown to have a substantial impact on health-related quality of life (HRQoL) (3,4), resource use (5), and work productivity (5–7). Yet, how COPD affects health outcomes in older adults is not well understood.

Some studies have shown an improvement in HRQoL with age among those with airway obstruction (8). Older patients may be more tolerant of the effects of airway obstruction than younger patients due to decreased

expectations of life, that is, they experience less perceived burden (8). Other studies, however, have shown HRQoL deteriorating with age (4). Unfortunately, many studies pool together younger and older adults (3,4, 8–11), assuming a level of homogeneity that may not be present (12,13). As the literature above suggests, both clinical features and HRQoL appear to change with age (8), although it remains unclear of the directionality.

Less is known about the impact of COPD on healthcare resource use, particularly among the elderly. In 1995, patients aged 65 years and older made up 30% of the COPD population, yet accounted for 57% of all hospitalizations (5). Most published studies on resource use among older COPD patients use a top-down approach (14) (estimating resource use by using total US healthcare spending and estimating the sole contribution of COPD from this figure) which may not properly control for potentially confounding factors. Given the high comorbidity among elderly COPD patients (2), this is an especially important consideration when assessing the excess costs due to the presence of COPD.

Similar to resource use, the relationship between COPD and work productivity is largely unknown. Although absenteeism (time missed from work) has been associated with clinical outcomes of COPD (7), few studies assessing presenteeism (impairment while working) have been published. Furthermore, studies on the impact of COPD on work productivity typically exclude those aged 65 or older (6, 15).This is an important consideration. In 2000, 4.27 million U.S. adults aged 65 years and older were employed (16). By 2009, this number grew to 6.27 million (16). As the general population in the United States ages and older adults remain in the workforce, it is important to understand and address the particular needs of these workers and the impact COPD has on them. The current study assesses the impact of COPD on HRQoL, resource utilization, and work productivity and activity impairment among older employed adults.

Materials and Methods

Sample

Data were obtained from 75,000 respondents who completed the 2009 US National Health and Wellness Survey (NHWS), an annual, cross-sectional study of adults aged 18 years or older. This self-administered, Internet-based questionnaire was given to a sample population identified through a web-based consumer panel whose members were recruited through opt-in emails, co-registration with panel partners, e-newsletter campaigns, online banner placements, and both internal and external affiliate networks. All panelists explicitly agreed to become panel members, registered through unique email addresses, and completed in-depth demographic registration profiles. A stratified random sampling procedure was implemented, using quotas based on gender, age, and race/ethnicity in order for the sample to be representative of the demographic composition of the general US adult population. The study was approved by Essex Institutional Review Board (Lebanon, NJ).

Of 501,239 persons contacted, 92,759 responded (an 18.5% response rate). Of those who responded, 75,000 gave their informed consent, met the inclusion criteria (aged 18 or over), and completed the survey instrument. The demographic composition of the U.S. NHWS sample is comparable to that of the U.S. adult population as assessed by the Current Population Survey (CPS) of the U.S. Census Bureau, and the prevalence estimates of various conditions from NHWS are consistent with other well-established sources (17).

Because the focus of the current study was on older workers, only those who were currently employed (full-time, part-time, or self-employed) and were at least 65 years old were included in the current study (N = 3358).

Measures

COPD diagnosis. Workers aged 65 years and older who responded they had experienced chronic bronchitis, emphysema, or COPD and who reported having been diagnosed by a physician for at least one of those conditions were included in the analysis as being diagnosed with COPD. These older workers with diagnosed COPD were compared with older workers not diagnosed with COPD (see Figure 1).

Demographics. Gender, race/ethnicity (non-Hispanic White, non-Hispanic Black/African-American, Hispanic, or other), highest educational level attained (college degree or more vs. less than college degree), previous year's household income (<$25K, $25K to <$50K, $50K to <$75K, $75K or more, or decline to answer), health insurance (yes vs. no), and health insurance with prescription coverage (yes vs. no) information was assessed. All workers reported their type of employment ("what is your employment status?", with full-time, part-time, or self-employed being the only response options related to an actively working population; other response options included: on disability, not employed and not looking for work, not employed but looking for work, retired, student, and homemaker). No information about the type of occupation or industry was included for those employed.

Health history. Body mass index (BMI) level (categorized by reported weight and height: underweight (<18.5), normal (18.5–24.9), overweight (25.0–29.9), obese (≥30), and missing BMI information), smoking status (current smoker, former smoker, or never smoker), exercise behavior (exercised in the past month vs. not exercised in the past month), alcohol use (current drinker vs. non-drinker), and asthma diagnosis (a self-reported diagnosis of asthma) were also assessed for all workers. Additionally, co-morbidities were calculated

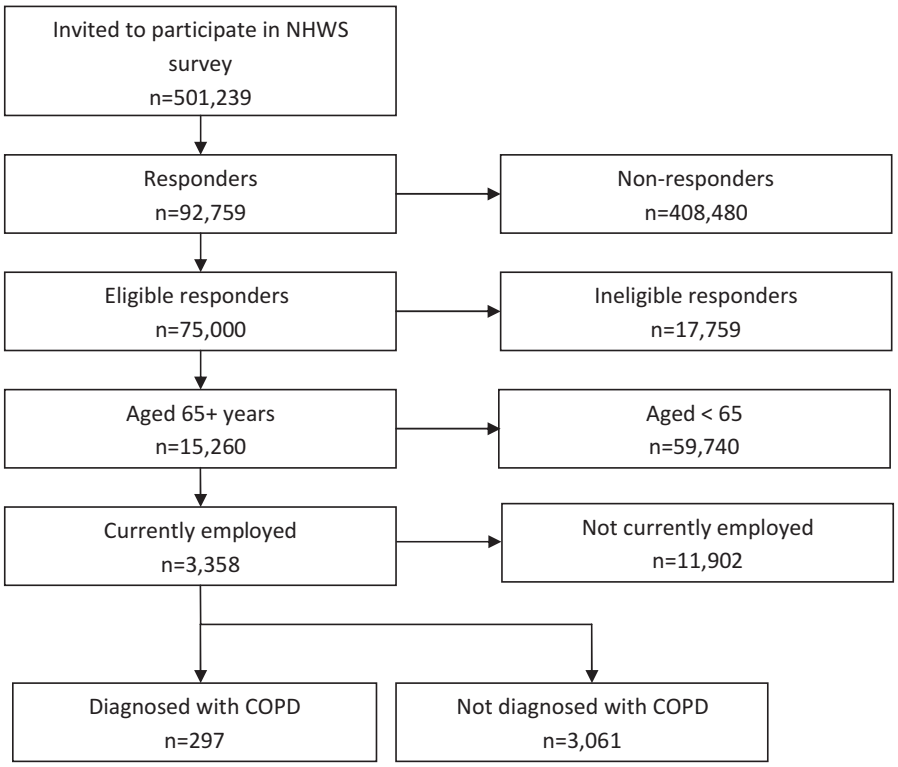

Figure 1. Flow chart depicting the inclusion and exclusion criteria.

for each worker using the Charlson co-morbidity index (18). The Charlson co-morbidity index is an index score measuring the degree of co-morbidity burden calculated by weighting the presence of the following conditions and summing the result: HIV/AIDS, metastatic tumor, lymphoma, leukemia, any tumor, moderate/severe renal disease, hemiplegia, diabetes, mild liver disease, ulcer disease, connective tissue disease, chronic pulmonary disease, dementia, cerebrovascular disease, peripheral vascular disease, myocardial infarction, and congestive heart failure. The presence of diabetes with end organ damage and moderate/severe liver disease were not assessed in the NHWS and were not included in the index score calculation.

Health-related quality of life. Health-related quality of life (HRQoL) was assessed using the SF-12 version 2, a multipurpose, generic HRQoL instrument comprising 12 questions (19) The current study included the physical component summary (PCS) and mental component summary (MCS) scores, with a range from 0 to 100 (higher scores indicate better health status). Both components were normed to the U.S. population, with a mean of 50 and standard deviation of 10. As well as generating profile and summary PCS and MCS scores, the SF-12 can also be used to generate health state utilities through the SF-6D. This index takes 6 items from the SF-12 and converts them to a single score on a 0–1 scale, with higher scores indicating greater health status.

Work productivity and activity impairment. Work productivity and impairment were assessed using the Work Productivity and Activity Impairment Questionnaire: General Health (WPAI-GH) (20). There were 4 metrics derived from this questionnaire: absenteeism (the percentage of work time missed due to health in the past 7 days), presenteeism (the percentage of impairment while at work due to health in the past 7 days), overall work loss (the total percentage of missed time due to absenteeism and presenteeism in the past 7 days), and activity impairment (the percentage of impairment suffered during daily activities in the past 7 days). Each metric varies from 0% to 100% with higher scores indicating greater impairment.

Absenteeism was assessed by first asking about time missed from work because of health reasons ("During the past 7 days, how many hours did you miss from work because of your health problems?") and then about time spent working ("During the past 7 days, how many hours did you actually work?"). These variables were then entered into the following WPAI-GH formula to produce a percentage for absenteeism:

$$\text{Absenteesim} = \frac{\text{Time missed from work}}{\text{Time missed from work} + \text{Time spent at work}} * 100\%$$

Presenteeism was assessed using a Likert-type scale (range: 0–10; anchors: "Health problems had no affect on my work," and "Health problems completely prevented me from working", respectively) that accompanied the question: "During the past 7 days, how much did your health problems affect your productivity while you were

working?" The score was then multiplied by 10 to give a percentage of impairment while at work.

Overall work loss was calculated as follows:

Overall work loss = Absenteeism + (1–Absenteeism)* Presenteeism.

Finally, activity impairment, a measure of productivity loss outside of the work place was assessed with the following question: "During the past 7 days, how much did your health problems affect your ability to do your regular daily activities, other than work at a job?" This was accompanied by an 11-point Likert-type scale from 0 to 10 and the anchors "health problems had no effect on my daily activities" and "health problems completely prevented me from doing my daily activities."

The validity of the WPAI-GH has been established in a number of disease areas, including COPD (21) and has been used to measure differences in patients with and without particular diseases to assess burden of illness (17,22,23).The scale has adequate reproducibility and construct validity, and was found to be significantly associated with general health perceptions and global interference with regular activity (21).

Healthcare resource use. Healthcare utilization was defined by traditional ("which of the following traditional healthcare providers have you seen in the past six months?"; e.g. general practitioner, internist, etc.). Additionally, the number of traditional healthcare visits, the number of ER visits ("how many times have you been to the ER for your own medical condition in the past six months?"), and the number of times hospitalized in the past six months ("how many times have you been hospitalized for your own medical condition in the past six months?") were included in the analyses.

Statistical analyses

Univariate analyses were conducted on all study persons in order to fully describe the sample demographically. Weights (calculated from the 2008 March Current Population Survey) were then applied to the sample so that projections could be made to the US employed population. Comparisons were made between each of the groups noted above (e.g. those diagnosed with COPD, 65 years or older, and employed vs. those not diagnosed with COPD, 65 years or older, and employed) on demographics, health history and outcomes. Specifically, chi-square tests were conducted on categorical variables, *t*-tests were conducted on continuous normally-distributed variables, and Wilcoxon-Mann–Whitney tests were conducted on continuous skewed variables. Because of the large number of bivariate statistical tests, a Bonferroni correction was introduced to keep the experimentwise α level at 0.05. The individual α level was set to 0.00125 for these analyses.

Multivariate analyses were performed to determine whether the COPD group differs from the control group on HRQoL, work productivity, and resource use after adjusting for demographic (reference categories: male, full-time employed, White, single, college educated, income of less than $25k, no health insurance) and health history variables (reference categories: not diagnosed with asthma, normal weight, never smoked). These covariates were selected because previous literature using the NHWS database has indicated significant independent effects of gender, employment, ethnicity, marital status, education, household income, BMI, and smoking status on work productivity variables (24). Therefore, these variables would need to be controlled for to properly isolate the impact of COPD. Similarly, asthma is a frequent co-morbidity of COPD (25) and has also demonstrated a significant relationship with a variety of health outcomes (26). For COPD diagnosis, not being diagnosed with COPD served as the reference category. Our statistical approach varied depending upon the nature of the dependent variable. Multiple regressions were used for HRQoL variables since the SF-12v2 is normed and generalized linear models (specifying a negative binomial distribution and a log-link function) were used for work productivity and resource utilization, to adjust for skewness in the WPAI-GH scores and resource use variables. It should be noted that regression estimates for the generalized linear models (work productivity and resource utilization) represent changes in adjusted log values in the given outcome, rather than adjusted values in the outcome itself. Although adjusted means are also reported for these models, only the regression outputs are included in tabular form. Logistic regressions were used to predict the presence or absence of traditional and non-traditional healthcare provider visits. All analyses were conducted using SAS 9.1. Two-tailed statistical significance was set a priori as $p < .05$.

Results

Summary statistics

A total of 3,358 adults aged 65 years or older were employed Of these workers, 297 (8.84%) were diagnosed with COPD and 3,061 were not diagnosed with COPD (91.16%) serving as a control sample. After applying sample weights, the majority of older workers were male (51.51%), White (79.77%), married or living with a partner (59.99%), college educated (86.13%), in possession of health insurance (96.50%), overweight or obese (68.91%), and had formerly smoked or were current smokers (61.07%). The vast majority of older workers reported visiting a traditional healthcare provider in the past 6 months (90.70%). Mean MCS scores were significantly higher than the U.S. population norm (53.88 vs. 50.00, $p < .01$), and PCS levels were significantly lower (46.89 vs. 50.00, $p < .01$) (see Table 1).

Unadjusted group comparisons

Workers with COPD were significantly more likely to be diagnosed with asthma (COPD = 16.99% vs. control

Table 1. Demographics and health history of employed persons aged 65 years and older

	Unweighted n	Weighted n	Weighted%	Weighted SE
Age				
65 to 69 years	2269	3320150	54.13%	1.31%
70 to 74 years	770	1038819	16.94%	0.68%
75 to 79 years	239	1314072	21.43%	1.40%
80 years or older	80	460266	7.50%	1.03%
Male	1851	3159486	51.51%	1.26%
Race/Ethnicity				
White	3102	4892770	79.77%	1.45%
Black/African-American	116	469814	7.66%	1.01%
Hispanic	69	400802	6.53%	0.82%
Other	71	369922	6.03%	1.03%
Married/Living with partner	2148	3679522	59.99%	1.25%
College Educated	2855	5282378	86.13%	0.76%
Household income				
Less than $25,000	376	816426	13.31%	1.01%
$25,000 to $49,999	999	1830972	29.85%	1.10%
$50,000 to $74,999	747	1274580	20.78%	0.99%
$75,000 and over	989	1705491	27.81%	1.12%
Decline to answer	247	505839	8.25%	0.70%
Employment				
Full-time	1039	1712044	27.91%	1.06%
Part-time	881	1777972	28.99%	1.21%
Self-employed	1438	2643292	43.10%	1.24%
Health insurance	3241	5918554	96.50%	0.47%
Health insurance with Rx coverage	2827	5148008	83.94%	0.89%
BMI				
Underweight	81	152751	2.49%	0.37%
Normal	882	1753963	28.60%	1.23%
Overweight	1323	2445504	39.87%	1.23%
Obese	1072	1781090	29.04%	1.02%
Decline to answer	50	89972	1.47%	0.28%
Diagnosed with asthma	198	336897	5.49%	0.54%
Diagnosed with COPD	297	560657	9.14%	0.78%
Smoking Habits				
Never	1225	2387901	38.93%	1.29%
Former	1698	3057163	49.85%	1.25%
Current	435	688244	11.22%	0.64%
Resource Use (past six months)				
Visited traditional provider	3040	5563086	90.70%	0.82%
Visited ER	340	667562	10.88%	0.90%
Visited hospital	304	565303	9.22%	0.76%
	Unweighted Mean	*Weighted Mean*	*Weighted SD*	*Weighted SE*
Charlson Comorbidity index	0.68	0.69	0.84	0.02
Quality of life (SF-12v2)				
Mental component summary (MCS)	53.45	53.88	6.53	0.14
Physical component summary (PCS)	46.89	46.55	7.75	0.17
Health utilities	0.79	0.79	0.1	0

(Continues)

Table 1. Continued.

	Unweighted Mean	*Weighted Mean*	*Weighted SD*	*Weighted SE*
Work productivity				
Absenteeism%	2.33	2.79%	10.6	0.24
Absenteeism (number of hours)	0.78	0.88	3.62	0.08
Presenteeism%	10.22	9.63%	14.26	0.33
Presenteeism (number of hours)	2.86	2.78	4.64	0.11
Overall work impairment%	11.77	11.57%	17.29	0.39
Activity impairment%	15.53	15.36%	18.08	0.4
Number of provider visits in the past six months	4.76	4.81	4.2	0.09
Number of ER visits in the past six months	0.14	0.15	0.46	0.01
Number of hospitalizations in the past six months	0.11	0.11	0.31	0.01

SD = standard deviation, Rx = prescription, BMI = body mass index, MCS = mental component summary, PCS = physical component summary, ER = emergency room.

= 4.34%, $p < .0001$) and to currently smoke (COPD = 20.57% vs. control = 10.28%, $p = .0002$), and had a significantly greater co-morbidity burden as assessed by the CCI (COPD = 1.82 vs. control = 0.58, $p < .0001$) (see Table 2). All other measures of gender, race/ethnicity, household income, type of employment, BMI, and health insurance were similar between the COPD and control cohorts after adjusting the experimentwise error rate. Those with COPD reported significantly worse health outcomes, including HRQoL, work productivity, and healthcare resource use.

Health-related quality of life

After adjusting for demographics and health history differences between the COPD and control cohorts, the pattern remained the same (see Table 3). Those with diagnosed COPD reported significantly lower mean adjusted levels of MCS scores (b = –1.29; Adjusted means: COPD = 52.06 vs. control = 53.37, $p = .02$). In addition, several covariates had significant independent positive associations with the MCS: self-employment (b = .71, $p = .05$), other race (b = 1.78, $p < .01$), and household income of $75,000 or more (b = 1.55, $p < .01$). Conversely, the following covariates had significant independent negative associations with MCS: part-time employment (b = –.75, $p = .05$), less than college degree (b = –.95, $p = .03$), an asthma diagnosis (b = –4.36, $p < .01$), being obese (b = –1.83, $p < .01$), currently smoking (b = –2.39, $p < .01$), and the CCI (b = –.31, $p = .03$; interpreted as a .31 decrease in MCS for each additional point increase in the CCI).

Similarly, those with COPD reported significantly lower levels of PCS (b = –6.90; Adjusted means: COPD = 40.29 vs. control = 47.19, $p < .01$). Being married/living with a partner (b = .75, $p = .04$) and having a household income of $75,000 or more (b = 1.59, $p = .01$) both had significant positive associations with PCS. Conversely, being female (b = –1.12, $p < .01$), having part-time employment (b = –2.27, $p < .01$), an asthma diagnosis (b = –2.14, $p < .01$), being overweight (b = -.94, $p = .02$), being obese (b = –5.07, $p < .01$), and the CCI (b = –1.66, $p < .01$) had significant independent negative associations.

Health state utilities were also found to be significantly different among the groups after adjusting for demographic and health history variables. The COPD cohort reported an adjusted mean of 0.72, while the control cohort reported an adjusted mean of 0.79, which is a difference of 0.07, still greater than the commonly used clinically important difference of 0.03 (23).

Work productivity

After adjusting for demographics and health history (b = 0.99; Adjusted mean: COPD = 4.81% vs. 1.80%, $p = .06$), absenteeism (time missed from work) differences between the two groups were no longer significant (see Table 4). The COPD group reported significantly higher levels of presenteeism (impairment while at work) (b = 0.37; Adjusted mean: COPD = 12.6% vs. 8.71%, $p = .01$). Being female (b = .23, $p = .01$), having part-time employment (b = .24, p = .02), an asthma diagnosis (b = .46, p = .01), being obese (b = .45, $p < .01$), and the CCI (b = .30, $p < .01$) were all associated with higher levels of presenteeism as well. Conversely, self-employment (b = –.36, $p < .01$), and being Black/African-American (b = –.69, $p < .01$), were associated with lower levels of presenteeism.

Although absenteeism did not differ between the groups after adjusting for demographics and health history, overall work impairment, a composite calculation of the absenteeism and presenteeism metrics, was significantly higher in the COPD cohort (b = 0.66; Adjusted mean: COPD = 19.26% vs. control = 10.00%, $p < .01$). Activity impairment was also found to be significantly different (b = 0.56; Adjusted mean: COPD = 23.93% vs. control = 13.69%, $p < .01$). Much like the measures of work productivity loss, being female (b = .28, $p < .01$), having part-time employment (b = .28, $p < .01$), being

Table 2. Comparison of employed adults aged 65 years and older with and without COPD

	COPD Workers				Control Workers				
	n = 297				n = 3,061				
	n	Weighted n	Weighted%	Weighted 95% CI	n	Weighted n	Weighted%	Weighted 95% CI	p-value
Male	157	227157	40.52%	(32.7%–48.34%)	1694	2932329	52.62%	(50.05%–55.19%)	0.0115
Ethnicity									
White	281	477457	85.16%	(74.93%–95.39%)	2821	4415313	79.23%	(76.29%–82.17%)	0.2551
Black/African-American	7	47168	8.41%	(0.00%–18.43%)	109	422647	7.58%	(5.66%–9.5%)	0.8744
Hispanic	3	18293	3.26%	(0.00%–6.93%)	66	382510	6.86%	(5.14%–8.58%)	0.0816
Other	6	17740	3.16%	(0.57%–5.75%)	65	352182	6.32%	(4.11%–8.53%)	0.0741
Married/Living with partner	166	292322	52.14%	(43.36%–60.92%)	1982	3387200	60.78%	(58.57%–62.99%)	0.0601
College Educated	249	482049	85.98%	(80.84%–91.12%)	2606	4800330	86.14%	(84.59%–87.69%)	0.9528
Household income									
Less than $25,000	44	89122	15.90%	(10.04%–21.76%)	332	727303	13.05%	(10.95%–15.15%)	0.3674
$25,000 to $49,999	110	189147	33.74%	(26.1%–41.38%)	889	1641825	29.46%	(27.23%–31.69%)	0.2841
$50,000 to $74,999	56	85136	15.19%	(10.39%–19.99%)	691	1189444	21.34%	(19.28%–23.4%)	0.0303
$75,000 and over	72	164865	29.41%	(19.65%–39.17%)	917	1540626	27.65%	(25.45%–29.85%)	0.7337
Employment									
Full-time	87	132697	23.67%	(17.61%–29.73%)	952	1579347	28.34%	(26.14%–30.54%)	0.1739
Part-time	69	143932	25.67%	(18.44%–32.9%)	812	1634041	29.32%	(26.81%–31.83%)	0.3555
Self-employed	141	284029	50.66%	(41.84%–59.48%)	1297	2359263	42.34%	(39.85%–44.83%)	0.0918
Health insurance	287	547997	97.74%	(96.31%–99.17%)	2954	5370557	96.37%	(95.37%–97.37%)	0.134
Health insurance with Rx coverage	249	480341	85.67%	(80.63%–90.71%)	2578	4667667	83.76%	(81.9%–85.62%)	0.49
BMI									
Underweight	12	21468	3.83%	(0.93%–6.73%)	69	131283	2.36%	(1.63%–3.09%)	0.3346
Normal	93	213031	38.00%	(28.42%–47.58%)	789	1540933	27.65%	(25.2%–30.1%)	0.058
Overweight	113	187220	33.39%	(25.94%–40.84%)	1210	2258285	40.52%	(37.97%–43.07%)	0.0921
Obese	79	138939	24.78%	(18.16%–31.4%)	993	1642151	29.47%	(27.37%–31.57%)	0.1998
Diagnosed with Asthma	61	95277	16.99%	(11.91%–22.07%)	137	241620	4.34%	(3.28%–5.4%)	<.0001
Smoking Habits									
Never	46	131708	23.49%	(13.32%–33.66%)	1179	2256193	40.49%	(37.88%–43.1%)	0.0005
Former	175	313600	55.93%	(46.78%–65.08%)	1523	2743564	49.23%	(46.68%–51.78%)	0.1536
Current	76	115349	20.57%	(14.93%–26.21%)	359	572895	10.28%	(9.01%–11.55%)	0.0002
Resource use (past six months)									
Visited traditional provider	284	544479	97.11%	(95.5%–98.72%)	2756	5018607	90.06%	(88.32%–91.8%)	<.0001
Visited ER	53	130246	23.23%	(13.27%–33.19%)	287	537316	9.64%	(8.05%–11.23%)	0.0178
Visited hospital	44	78591	14.02%	(8.88%–19.16%)	260	486712	8.73%	(7.18%–10.28%)	0.0498

(Continues)

Table 2. Continued.

	M	Weighted M	Weighted SD	Weighted 95% CI	M	Weighted M	Weighted SD	Weighted 95% CI	p-value
Charlson Comorbidity Index	1.8	1.82	0.92	(1.68–1.96)	0.57	0.58	0.78	(0.54–0.62)	<.0001
Quality of Life (SF-12v2)									
Mental Component Summary (MCS)	50.91	51.69	7.71	(50.59–52.79)	53.7	54.1	6.38	(53.81–54.39)	<.0001
Physical Component Summary (PCS)	39.31	38.31	8.08	(37.15–39.47)	47.62	47.38	7.42	(47.05–47.71)	<.0001
Health state utilities	0.71	0.71	0.1	(0.69–0.73)	0.8	0.8	0.1	(0.8–0.8)	<.0001
Work Productivity									
Absenteeism%	4.45%	9.14%	20.66%	(6.06%–12.22%)	2.12%	2.17%	8.93%	(1.76%–2.58%)	<.0001
Absenteeism hours	1.08	1.88	4.32	(1.27–2.49)	0.75	0.77	3.53	(0.61–0.93)	<.0001
Presenteeism%	19.56%	18.72%	18.14%	(15.92%–21.52%)	9.33%	8.79%	13.66%	(8.14%–9.44%)	<.0001
Presenteeism hours	4.75	4.82	5.11	(4.04–5.6)	2.68	2.59	4.56	(2.37–2.81)	<.0001
Overall work impairment%	22.29%	25.42%	24.80%	(21.72%–29.12%)	10.76%	10.21%	16.00%	(9.47%–10.95%)	<.0001
Activity impairment%	29.60%	29.90%	20.82%	(26.92%–32.88%)	14.17%	13.90%	17.39%	(13.12%–14.68%)	<.0001
Number of provider visits in the past six months	6.24	7.00	4.86	(6.31–7.69)	4.62	4.59	4.09	(4.41–4.77)	<.0001
Number of ER visits in the past six months	0.27	0.30	0.54	(0.22–0.38)	0.13	0.14	0.45	(0.12–0.16)	<.0001
Number of Hospitalizations in the past six months	0.19	0.17	0.37	(0.11–0.23)	0.11	0.11	0.3	(0.09–0.13)	0.007

Due to a Bonferroni correction to adjust the experimentwise error rate, statistical significance was set a priori to $p < .00125$ for these bivariate comparisons.
CI = confidence interval, Rx = prescription, BMI = body mass index, ER = emergency room, M = Mean, SD = standard deviation.

obese (b = .46, $p < .01$), missing weight information (b = .64, $p < .01$), and the CCI (b = .24, $p < .01$) were associated with greater levels of impairment. Being Black/African-American (b = –.31, $p < .01$), and being of other race (b = –.40, $p < .01$) were associated with lower levels of impairment.

Healthcare resource use

After adjusting for demographics and health history variables, the number of emergency room visits (Adjusted mean: COPD = 0.14 vs. control = 0.11, $p = .27$), hospitalizations (COPD = 0.11 vs. control = 0.09, $p = .55$), and traditional healthcare provider visits (COPD = 4.74 vs. control = 4.30, $p = .15$) were not found to be significantly different between the COPD and control cohorts. Logistic regression analyses provided similar results. COPD patients were no more likely to be hospitalized (OR = 1.182, $p = .51$), or visit a traditional provider (OR = 1.307, $p = .60$) than controls. The odds of visiting the ER, however, were significantly greater for COPD patients (OR = 2.048, $p < .01$). Being Black/African-American (OR = 1.834, $p < .01$) and with a higher co-morbid burden (CCI: OR = 1.32, $p < .01$) were also associated with significantly greater odds of visiting an ER, independent of COPD diagnosis.

Discussion

The objective of the current study was to assess the burden of COPD in older adults in the workforce. Our findings show that COPD does, in fact, have significant deleterious effects on HRQoL, work productivity, and activity impairment among employed older adults. The majority of older workers diagnosed with COPD in our sample were female. Generally, it is believed that males make up a greater portion of the COPD population (11). Yet, differences in the under-diagnosis of COPD among males and females could lead to an overrepresentation of females in a study which relies on patient-reported data. A study of elderly Finns, for example, concluded for every reported case of COPD, 1.99 true cases of COPD existed for men and 1.62 for women (27). This may be due to the fact that because we focused on an employed population and females tend to have a lower severity than males (11), a lower proportion of male COPD patients may be in the workforce, which could have contributed to gender split in our current study.

Health-related quality of life

The results suggest a significant HRQoL burden on elderly workers with COPD. Both mental and physical

Table 3. The adjusted effect of diagnosed COPD on health-related quality of life component summary scores

	Mental component summary			Physical component summary		
	b	95%CI	p-value	b	95%CI	p-value
Intercept	52.76	(50.9–54.62)	<.0001	48.95	(46.9–51.01)	<.0001
Female	–0.12	(–0.74–0.51)	0.71	–1.12	(–1.81–0.43)	0.0014
Part-time employed	–0.75	(–1.49–0.01)	0.05	–2.27	(–3.09–1.45)	<.0001
Self-employed	0.71	(0.02–1.4)	0.04	–0.71	(–1.47–0.06)	0.0692
African-American	0.22	(–0.84–1.28)	0.68	–0.78	(–1.95–0.39)	0.1918
Hispanic	–0.86	(–1.99–0.26)	0.13	0.79	(–0.46–2.04)	0.2142
Other race	1.78	(0.59–2.97)	0.00	0.37	(–0.95–1.68)	0.5838
Married/Living with partner	0.39	(–0.25–1.03)	0.23	0.75	(0.04–1.46)	0.039
High school or less	–0.95	(–1.78–0.12)	0.03	–0.04	(–0.95–0.88)	0.9378
Income: $25k to $50k	0.65	(–0.28–1.57)	0.17	–0.06	(–1.08–0.97)	0.9149
Income: $50k to < $75k	1.00	(–0.03–2.03)	0.06	0.17	(–0.97–1.31)	0.771
Income: $75k+	1.55	(0.53–2.58)	0.00	1.59	(0.46–2.72)	0.006
Income: decline to answer	2.60	(1.34–3.87)	<.0001	1.26	(–0.14–2.65)	0.078
Insurance	0.62	(–1.07–2.31)	0.47	1.38	(–0.49–3.25)	0.1468
Insurance with Rx coverage	0.51	(–0.34–1.35)	0.24	0.28	(–0.66–1.21)	0.561
Diagnosed with Asthma	–4.36	(–5.59–3.13)	<.0001	–2.14	(–3.5–0.78)	0.0021
Underweight	0.66	(–2.12–3.43)	0.64	2.97	(–0.1–6.05)	0.0577
Overweight	0.04	(–0.64–0.73)	0.90	–0.94	(–1.7–0.18)	0.0153
Obese	–1.83	(–2.58–1.09)	<.0001	–5.07	(–5.89–4.25)	<.0001
Weight: decline to answer	0.91	(–1.44–3.26)	0.45	–7.62	(–10.21–5.02)	<.0001
Charlson comorbidity index	–0.31	(–0.59–0.04)	0.03	–1.66	(–1.97–1.35)	<.0001
Current smoker	–2.39	(–3.34–1.44)	<.0001	0.46	(–0.59–1.51)	0.391
Former smoker	0.36	(–0.24–0.96)	0.24	0.57	(–0.09–1.23)	0.0917
Diagnosed with COPD	–1.29	(–2.33–0.25)	0.02	–6.90	(–8.05–5.75)	<.0001

CI = confidence interval.

mean scores were significantly lower among COPD patients, even after adjusting for co-morbidities, smoking behavior, and other health characteristics. It should also be noted that the differences in health utilities between the groups could be considered clinically meaningful (28). Although difficult to make comparisons across studies with different samples and methodologies, the unadjusted physical health of COPD patients reported here (Mean = 38) was lower than studies that combined both older and younger patients (4). Further, this level of physical health was also lower than the under 65 group in a recent study in Spain (3). Because of the cross-sectional nature of this study, it cannot be determined if the HRQoL gap between workers with COPD and those without COPD increases over time, but these results do suggest a greater health detriment among older workers.

Apart from the impact of COPD, other factors in our study were associated with HRQoL: being male, being married or living with a partner, having a higher income, and having a higher educational attainment. Similar results have been reported in the literature (3, 10, 11, 29). Although the literature has shown disparities between HRQoL outcomes of Black/African-American and White patients (30), our study did not (perhaps, in part, because we focused exclusively on the employed population). Higher levels of BMI were found to be significantly associated with both mental and physical HRQoL in the current study, unlike previous research (3). Smoking, the biggest risk factor for COPD, was not found to be significantly related to physical HRQoL. Such a finding is not inconsistent with previous literature, which suggests COPD patients often continue smoking (31), and on measures of HRQoL, do not differ from their non-smoking peers (4).

Finally, a diagnosis of asthma had a large impact on both mental and physical HRQoL. This supports prior evidence suggesting COPD patients with asthma have higher healthcare resource utilization levels (32) and should be explored further since few studies have been published on the concomitant impact of asthma and COPD among elderly persons (32). Co-morbidity as assessed by the Charlson co-morbidity index was found to negatively impact both mental and physical HRQoL.

Table 4. The adjusted effect of diagnosed COPD on work productivity and activity impairment scores

	Absenteeism			Presenteeism			Overall work impairment			Activity impairment		
	b	95%CI	p-value	b	95%CI	p-value	b	95%CI	p-value	b	95%CI	p-value
Intercept	1.28	(–0.26–2.82)	0.1031	2.17	(1.66–2.68)	<.0001	2.25	(1.76–2.75)	<.0001	2.45	(2.07–2.83)	<.0001
Female	0.57	(0.07–1.07)	0.0249	0.23	(0.06–0.4)	0.0068	0.31	(0.14–0.48)	0.0004	0.28	(0.15–0.41)	<.0001
Part-time employed	–0.19	(–0.79–0.4)	0.5242	0.24	(0.04–0.43)	0.0169	0.19	(–0.01–0.38)	0.0618	0.28	(0.13–0.44)	0.0002
Self employed	–0.69	(–1.26–0.11)	0.0199	–0.36	(–0.55–0.18)	0.0001	–0.36	(–0.54–0.17)	0.0001	–0.05	(–0.19–0.09)	0.4774
African-American	0.30	(–0.72–1.33)	0.5587	–0.69	(–0.99–0.39)	<.0001	–0.09	(–0.39–0.21)	0.5613	–0.31	(–0.54–0.08)	0.008
Hispanic	–0.35	(–1.31–0.6)	0.4649	0.17	(–0.13–0.47)	0.2616	0.09	(–0.22–0.39)	0.578	0.07	(–0.17–0.31)	0.5563
Other race	–0.46	(–1.4–0.49)	0.3442	–0.17	(–0.49–0.14)	0.284	–0.24	(–0.56–0.08)	0.141	–0.40	(–0.65–0.16)	0.0014
Married/Living with partner	–0.12	(–0.64–0.4)	0.6515	0.09	(–0.08–0.26)	0.295	0.08	(–0.09–0.25)	0.3698	–0.02	(–0.15–0.11)	0.7643
Highschool or less	–0.47	(–1.2–0.26)	0.2062	0.04	(–0.18–0.25)	0.7544	0.00	(–0.23–0.22)	0.9906	–0.06	(–0.23–0.11)	0.5245
Income: $25k to $50k	–0.34	(–1.08–0.4)	0.3645	0.02	(–0.22–0.27)	0.8605	–0.07	(–0.32–0.18)	0.595	0.10	(–0.09–0.29)	0.2886
Income: $50k to < $75k	–0.18	(–0.98–0.63)	0.6662	–0.06	(–0.32–0.2)	0.6479	–0.09	(–0.36–0.18)	0.5147	0.14	(–0.07–0.35)	0.2003
Income: $75k+	0.23	(–0.57–1.03)	0.5705	–0.23	(–0.49–0.03)	0.0808	–0.13	(–0.39–0.14)	0.3551	–0.08	(–0.29–0.13)	0.4622
Income: decline to answer	0.18	(–0.77–1.13)	0.7106	–0.70	(–1.03–0.37)	<.0001	–0.39	(–0.72–0.05)	0.0225	–0.14	(–0.39–0.12)	0.2904
Insurance	–0.19	(–1.63–1.25)	0.7927	–0.27	(–0.72–0.19)	0.2507	–0.11	(–0.55–0.34)	0.642	–0.20	(–0.55–0.15)	0.2706
Insurance with Rx coverage	–0.45	(–1.09–0.19)	0.1717	–0.08	(–0.3–0.14)	0.4799	–0.20	(–0.42–0.02)	0.0817	–0.16	(–0.33–0.01)	0.067
Diagnosed with Asthma	0.21	(–0.81–1.24)	0.6809	0.46	(0.14–0.79)	0.0051	0.33	(0.01–0.66)	0.044	0.23	(–0.02–0.47)	0.0714
Underweight	–2.58	(–5.05–0.1)	0.0414	–0.63	(–1.41–0.14)	0.1076	–0.83	(–1.59–0.06)	0.035	–0.40	(–0.97–0.17)	0.167
Overweight	-0.02	(–0.6–0.56)	0.944	–0.01	(–0.19–0.17)	0.9085	0.05	(–0.14–0.24)	0.6177	0.00	(–0.14–0.14)	0.9578
Obese	0.02	(–0.63–0.67)	0.9518	0.45	(0.25–0.65)	<.0001	0.40	(0.19–0.6)	0.0002	0.46	(0.31–0.61)	<.0001
Weight: decline to answer	–0.62	(–2.39–1.16)	0.4951	–0.80	(–1.41–0.19)	0.0099	–0.78	(–1.4–0.16)	0.0134	0.64	(0.16–1.12)	0.009
Charlson comorbidity index	0.29	(0.04–0.54)	0.0235	0.30	(0.22–0.38)	<.0001	0.28	(0.19–0.36)	<.0001	0.24	(0.17–0.3)	<.0001
Current smoker	–0.17	(–0.92–0.58)	0.6573	0.21	(–0.04–0.46)	0.1059	0.11	(–0.14–0.37)	0.3771	0.08	(–0.11–0.27)	0.4154
Former smoker	0.13	(–0.4–0.65)	0.6323	–0.08	(–0.25–0.08)	0.3156	–0.09	(–0.25–0.08)	0.3005	–0.09	(–0.21–0.04)	0.171
Diagnosed with COPD	0.99	(–0.03–2)	0.0562	0.37	(0.09–0.66)	0.0092	0.66	(0.36–0.95)	<.0001	0.56	(0.35–0.77)	<.0001

CI = confidence interval.

Previously, Yeo et al. (2) found higher co-morbidity among elderly COPD patients to be associated with lower HRQoL (assessed by the SGRQ) citing a high co-morbid burden among the elderly COPD diagnosed population.

Healthcare resource use

Instead of using a top-down approach, where resource use for COPD patients is estimated by factoring in total healthcare spending and prevalence rates of the disease, the current study used a bottom-up approach of collecting data on healthcare resource use directly from respondents. Although the pattern of means suggested that older workers with COPD used more healthcare resources than those without COPD, these differences were not statistically significant. Few studies have examined this research question previously and, as a result, it is difficult to speculate about the reason for the lack of effects. The level of resource use among COPD workers (number of physician visits in particular) in the current study was similar to that observed elsewhere (2). It is possible that due to the number of co-morbidities experienced by older workers there is a ceiling effect, and the burden of COPD on healthcare visits adds little incrementally beyond other co-morbidities. Further research is necessary.

Work productivity and activity impairment

To our knowledge, this was the first study to assess the effect of the presence of COPD on work productivity among older adults. The results suggest that presenteeism, but not absenteeism, was significantly associated with the presence of COPD. This is novel in that previous studies have looked at work productivity losses due to disability (15,32) reductions in labor force participation (6, 33), and absenteeism (7) – not partial work losses incurred by presenteeism. Although not focused on older workers, Sin et al. (6) found that a COPD diagnosis was associated with decreased work force participation. Activity impairment– or non-work related productivity loss – was also associated with the presence of COPD. Because the effects of COPD on disability have been noted in the literature (33), it should be expected that activity impairment would also be higher in this group.

Limitations

Several limitations should be noted from the results of this study. Given the cross-sectional design of the study, causal inference cannot be determined. Although alternative explanations have been included (asthma diagnosis, smoking, co-morbidities, etc), it is possible that other unmeasured variables might explain the relationship between COPD diagnosis and health outcomes. Because of the self-reported nature, recall bias may have introduced additional error into the observed associations. It should also be emphasized that although the NHWS is demographically representative of the U.S. population, the sample in the current study of COPD workers may differ in meaningful ways that could affect the size and direction of the relationships observed here.

Because the NHWS is an Internet-survey, older workers without Internet access would not be included within the sampling frame. Although speculation, it is possible that these workers without Internet access have lower socioeconomic status and poorer access to care. As a result, the exclusion of these workers may have underestimated the effect of COPD among the 65 and older population. It should also be noted that the impact of COPD was only examined here within the context of a working population. Because COPD may reduce the ability of those with the condition to be active in the workforce, the total indirect burden of COPD may be underestimated in the current study.

Conclusion

COPD is a significant burden among employed older adults. The effects of this burden may not be immediately apparent, as resource use and time missed from work were not significantly higher among those with COPD. Instead, the burden is more subtle in that these persons experienced significantly lower levels of quality of life and were impaired in their ability to perform at work and outside of work, which may go unnoticed by employers. Collectively, these findings emphasize the need for improved disease management for older working adults with COPD.

Declaration of Interest

Kantar Health conducts the National Health and Wellness Survey (NHWS). Boehringer-Ingelheim and Pfizer purchased access to the data from the survey and funded the analysis. Dr. DiBonaventura and Mr. Wagner are employees of Kantar Health. Drs. Paulose-Ram, McDonald, and Zou are employees of Pfizer, Inc. Drs. Su and Shah are employees of Boehringer-Ingelheim. The authors are responsible for the content and the writing of this paper.

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