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Health Risk Disparities among Employed Adults with COPD Living in Central Appalachian U.S. States

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ABSTRACT

Background: Little is known about risk factors associated with poor health among employees with COPD living in Central Appalachia. **Purpose**: Determine variability in health distress based on risk factors, including race and income, among employees with COPD from Central Appalachian U.S. States. **Methods**: 2016–2017 BRFSS data were analyzed from employed adults with COPD living in KY, NC, TN, and WV (N = 1,326). Health risks included (1) comorbidities; (2) substance use/abuse; and (3) limited healthcare access as predictors of mental and physical distress, with race and income entered as covariates. **Results**: Respondents reporting several comorbidities were more likely to report physical and mental distress compared to those without comorbidities. Workers who used e-cigarettes on some versus no days were more likely to report physical distress. Those reporting cost preventing access to medical care versus no cost barriers were more likely to report physical and mental distress. Low-income workers were more likely than higher-income workers to report distress. **Discussion**: Comorbidities, e-cigarettes, and high medical costs are potential causes of occupation-related disability among employees with COPD working in Central Appalachian U.S. States. **Translation to Health Education Practice**: Worksite interventions should address risks negatively associated with health outcomes among workers with COPD from Central Appalachia.

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Background

Approximately 1.9 million United States (U.S.) residents of Central Appalachia are living with COPD,[1] a progressive respiratory condition that causes dyspnea (i.e., shortness of breath) which increases risks for physical immobility and emotional distress.[2–5] The highest quartile of COPD prevalence is concentrated in South Central Appalachia, one of the most disadvantaged regions in the U.S.[3] with states that have higher rural populations.[6,7] The Appalachian Region's COPD mortality rate (53.5 deaths per 100,000 population) is 27% higher than the national rate.[8] Of the 420 U.S. counties in Appalachia, 163 counties (39%) have COPD mortality rates in the worst-performing national quintile.[8,9] Excessive COPD-related hospitalizations are concentrated in Central Appalachia, with rates 39% higher in rural counties.[8,10]

Despite the high prevalence of COPD in the Central Appalachian region, little attention has been given to employed adults with COPD living in Central Appalachian U.S. states where many pernicious health disparities exist.[3,11] Harmful workplace exposures account for about 15–20% of all COPD cases.[11,12] Although the exact nature of workplace risks on COPD remains unclear,[13] several studies indicate that occupational airborne exposures to dust, fumes, gases, and vapors are associated with increased COPD risk.[14–17] Unfortunately, among workers living with COPD in Central Appalachian U.S. states, the major contributors to disparities in health-related quality of (HRQoL) are largely unknown.[10,11] HRQoL measures dysfunction and disability related to chronic diseases at various ecological (e.g., individual, community) levels. Currently, there is a dearth of information specifying behavioral and health system risk indicators that may independently influence HRQoL among employees with COPD who live in Central Appalachia. This gap in the literature leaves Health Education researchers and practitioners at a disadvantage when attempting to address and modify unique health risks that are associated with poor health in this unique working population.

The prevalence of COPD is also inversely related to socioeconomic factors such as education and income, both of which restrict access to care and treatment, especially for the disproportionate number of patients with low socioeconomic status (SES) who experience considerable

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morbidity due to COPD.[11] Patients with COPD are typically older and living with multiple comorbidities, including depressive symptoms, which often contribute to feelings of social isolation and disempowerment.[12,13] While COPD is primarily diagnosed in Caucasians, it also affects African Americans who are highly susceptible to cigarette smoke and experience higher rates of hospitalization and emergency room visits due to shortness of breath exacerbations than do susceptible non-Hispanic Caucasians.[14,15] Other population-based studies examining disparities in COPD show that the presence of other chronic conditions such as arthritis is associated with a higher prevalence of COPD.[16]

There is also growing attention being paid to health disparities and health inequities associated with COPD that are often the result of the avoidable and unjust distribution of social, economic, or healthcare resources between different population groups who are living with COPD.[11,17] Because of systematic differences between COPD population groups, patients with COPD represent the paradigm of a group of people at risk for health disparity and health inequity.[17] And yet COPD does not typically garner the sympathy or attention it deserves in Health Education circles due to it primarily being caused by tobacco smoking.[18] The idea of "therapeutic nihilism" or that nothing can be done for patients with COPD remains rampant, despite a robust evidence base to the contrary.'[19,20] Thus, there is a clear and important need for additional population-based research that targets diagnosed COPD to modify known risk factors, including racial and income disparities which can disproportionately impact employees with COPD living in this disadvantaged region of the U.S.

Purpose

The primary purpose of this study was to determine variability in HRQoL based on individual and health system risk factors impacting employed adults with COPD living in the Central Appalachian region. The secondary purpose was to investigate how racial and income disparities might impact the relationships between health distress and discrete risk factors such as comorbidities, substance use and abuse, and lack of healthcare access. The objective of our secondary data analysis directly aligns with the COPD National Action Plan (Goal 3) that aims to collect, analyze, and report COPD-related public health data that drive systems' change.[12]

Methods

The Behavioral Risk Factor Surveillance System (BRFSS) hosts a population-based survey that empirically monitors numerous correlated and interdependent domains associated with HRQoL, including social ecological risk factors at multiple levels,[21] such as smoking (individual), employment status (occupational), and limited healthcare access (community). The validity and reliability of BRFSS items have been reported elsewhere.[22] In this study, we analyzed 2016 and 2017 BRFSS data from all respondents (N = 1,326) living in four Central Appalachian U.S. States (Kentucky, North Carolina, Tennessee, and West Virginia) who answered "Yes" to the question "Has a doctor, nurse, or other health professional EVER told you that you have chronic obstructive pulmonary disease (COPD), emphysema or chronic bronchitis?" and indicated being "employed for wages" or "self-employed" at the time of their interview. BRFSS indicators were grouped into (1) comorbid health conditions; (2) substance use and abuse; and (3) limited access to healthcare as predictors of mental and physical distress.

Independent variables

Seven BRFSS responses indicated living with specific comorbid health conditions. We identified if respondents reported ever being told by a health professional if they had any of the following comorbidities (yes/no): asthma, diabetes, abnormal BMI (i.e., underweight, overweight, or obese), cardiovascular disease, rheumatoid arthritis, cancer, and stroke. Ten variables addressed substance use and abuse: (1) smoked 100 cigarettes during lifetime (yes/no); (2) tobacco smoking (every day, some days, or not at all); (3) ever used e-cigarettes (yes/no); (4) use of e-cigarettes or other electronic "vaping" products (every day, some days, or not at all); (3) use of smokeless tobacco (every day, some days, or not at all); (4) binge drinking in past 30 days (males having ≥5 drinks on one occasion or females having ≥4 drinks on one occasion); and (5) heavy drinking (men having >14 drinks per week and women having >7 drinks per week). Four questions assessed access to healthcare: (1) enrolled in a health insurance plan (yes/no); (2) having a designated primary care physician (yes/no); (3) cost preventing access to care in the past year (yes/no); (4) having checkup in the past year (yes/no). Potential racial and economic disparities were assessed in multivariable analyses by entering race and annual income as covariates.

Outcome variables

Poor HRQoL was assessed for physical health ("Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?") and mental health ("Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?"). Both the variables "physical health" and "mental health" reflect the general aspects of health. Quantifying these estimates in terms of days in the most recent month avoids the need to use more complex weights in aggregating and comparing data based on multiple-choice questions.[23] People who experience distress for at least 2 weeks (14 days) over the course of a month tend to function at lower levels.[24,25] Therefore, two dependent variables – (1) physical health and (2) mental health – were dichotomized in the following manner: 14 or more days (*frequent distress/limitation*), and 0 to 13 days (*infrequent distress/limitation*). Several prior studies have coded BRFSS items similarly to identify distress impacting mental and physical HRQoL.[16,26]

Data analysis

Logistic regression modeling was conducted with three identified social ecological domains (i.e., comorbidities, substance use and abuse, and healthcare access) as the independent variables and two measures of HRQoL (i.e., mental and physical distress) as the outcome variables. To test the relationship between HRQoL and health risk factors, two steps of analyses were conducted. First, we conducted univariate logistic regression to investigate associations to identify health risk variables in each domain associated with each outcome with race and income as the covariates. The odds ratios, 95% confidence intervals (CIs), and *P* values were examined to evaluate the significance of the predictors and the model fit. Marginally significant variables ($P < .10$) identified during the variable screening process for each domain were retained in the second step of the analysis where multivariate logistic regression was conducted to evaluate the statistical significance of behavioral and health system risk factors associated with mental and physical distress, with race and income entered as covariates. SAS version 9.4 Survey procedures were used to perform all analyses.

Results

Demographic characteristics

Over half of employed adults with COPD living in Central Appalachian US states were 45–64 years of age (55.5%) and female (57.3%). The majority were White (87.9%), with over 10% identifying as Black or African American (8.07%) or American Indian or Alaskan Native (4.03%). Only 2% of respondents reported being of Hispanic ethnicity. Almost 40% of respondents completed high school or their GED, and slightly more than 50% were college educated. Annual incomes varied considerably with 20% of respondents earning less than 20 K USD per year, 18.25% earning 35 K USD-49,999 K USD, and 18.33% earning more than 75 K USD per year. Almost 50% (47.62%) of respondents were married; however, over 20% were divorced and the rest were either widowed (9.54%), separated (3.18%), never married (14.16%), or a member of an unmarried couple (3.41%).

Comorbid conditions

Table 1 presents the univariate and multivariate analysis of comorbidity conditions and the mental distress outcome. For the univariate analysis, respondents reporting a physician diagnosis of asthma were more likely to report frequent mental distress (OR = 1.87, 95% CI: 1.39–2.52) compared to respondents who did not report asthma. As expected, those reporting a depressive disorder were about five times more likely to report frequent mental distress (OR = 5.51, 95% CI: 3.99–7.62) than those without a depressive disorder. Both asthma (OR = 1.53, 95% CI: 1.11–2.11) and depressive disorder (OR = 5.23, 95% CI: 3.75–7.29) variables remained statistically significant when they were included in the multivariate logistic regression, though the magnitude of the ORs became smaller. Annual income was also statistically significant in the multivariate logistic regression model. Workers with COPD with higher incomes (OR = 0.39–0.72) were less likely to experience mental distress as compared to those with lower incomes (<20,000 USD per year).

Table 2 presents the univariate and multivariate analyses of comorbidity conditions and the physical distress outcome. For the univariate analysis, respondents reporting a physician diagnosis of asthma were more likely to report frequent physical distress (OR = 1.80, 95% CI: 1.35–2.41) compared to respondents without asthma. Those reporting diabetes (OR = 2.05, 95% CI: 1.44–2.93) and arthritis (OR = 1.93, 95% CI: 1.43–2.60) were about two times more likely to report frequent physical distress compared to those without these comorbidities.

Those reporting a depressive disorder were also more likely to report frequent physical distress (OR = 1.65, 95% CI: 1.22–2.24) than those without a depressive disorder. All comorbid condition variables (i.e., asthma, diabetes, arthritis, depressive disorder) remained statistically

Table 1. Univariate odds ratios of frequent mental distress by comorbidity and multivariate odds ratios of frequent mental distress by comorbidity, race, and income of employed adults with COPD living in KY, NC, WV, and TN, BRFSS, 2016–2017.

Predictor	Univariate[a] Odds Ratio (95% CI)	Multivariate Odds Ratio (95% CI)
Comorbidity		
Asthma – Yes vs No[b]	1.870*** (1.386, 2.522)	1.528** (1.107, 2.107)
Diabetes – Yes vs No[b]	1.152 (0.779, 1.704)	
Abnormal BMI – Yes vs No[b]	0.986 (0.627, 1.551)	
Heart Disease – Yes vs No[b]	0.986 (0.599, 1.625)	
Arthritis – Yes vs No[b]	1.344 (0.996, 1.813)	
Cancer – Yes vs No[b]	0.887 (0.542, 1.452)	
Stroke – Yes vs No[b]	1.521 (0.827, 2.799)	
Depressive Disorder – Yes vs No[b]	5.512*** (3.985, 7.624)	5.230*** (3.753, 7.288)
Annual Income		
20,000 USD-34,999 USD vs Less than 20,000 USD[b]	0.67* (0.46, 0.98)	0.717 (0.470, 1.095)
35,000 USD-49,999 USD vs Less than 20,000 USD[b]	0.42*** (0.26, 0.67)	0.527* (0.317, 0.876)
50,000 USD-74,999 USD vs Less than 20,000 USD[b]	0.41*** (0.25, 0.66)	0.550* (0.323, 0.937)
75,000 USD or more vs Less than 20,000 USD[b]	0.32*** (0.19, 0.52)	0.388*** (0.224, 0.671)
Race		
Black or African American vs White[b]	0.61 (0.34, 1.08)	0.706 (0.353, 1.411)
Other vs White[b]	1.16 (0.62, 2.25)	0.917 (0.417, 2.015)

*$P< .05$; **$P< .01$; ***$P< .001$.
[a]Univariate analyses were adjusted for race and annual income.
[b]Reference values.
Frequent mental distress was defined as reporting 14 or more mentally unhealthy days in the last 30 days.
Abbreviations: CI = confidence interval.

significant when entered into multivariate logistic regression, though, similar to mental distress, the magnitude of the ORs became smaller for each variable (see Table 2). Annual income was also significant in the multivariate model. Workers with COPD with incomes over 50,000 USD per year (OR = 0.43–0.56) were less likely to experience physical distress as compared to those with lower incomes (<20,000 USD per year).

Substance use and abuse

Table 3 presents the univariate and multivariate analyses of substance use and abuse on the mental distress outcome. In the univariate analysis, respondents who smoked at least 100 cigarettes in their lifetime (OR = 1.54, 95% CI: 1.06–2.23) or had ever used e-cigarettes (OR = 1.84, 95% CI: 1.34–2.48) were more likely to report frequent mental distress when compared to respondents who did not. Respondents who reported binge (OR = 1.87, 95% CI: 1.26–2.77) or heavy (OR = 1.70, 95% CI: 1.22–2.37) drinking were also more likely to report mental distress compared to those who did not report such alcohol abuse over the past 30 days. However, none of the significant smoking, chewing tobacco, and drinking variables in the univariate analyses remained statistically significant when they were included in the multivariate logistic regression model. In the multivariate model, only annual income remained statistically significant, with those reporting incomes over 35,000 USD per year (OR = 0.31–0.43) less likely to experience mental distress when compared to those with incomes less than 20,000 USD per year. Also, multivariate analysis suggested that African Americans showed less mental distress than Whites (OR = 0.52, 95% CI = 0.273, 0.996).

Table 4 presents the univariate and multivariate analysis of substance use and abuse on the physical distress outcome. In the univariate analysis, respondents using e-cigarettes on some days were almost two times more likely to report frequent physical distress (OR = 1.94, 95% CI: 1.16–3.23) compared to respondents who did not use e-cigarettes. Using e-cigarettes on some days versus no

Table 2. Univariate odds ratios of frequent physical distress by comorbidity and multivariate odds ratios of frequent physical distress by comorbidity, race, and income of employed adults with COPD living in KY, NC, WV, and TN, BRFSS, 2016–2017.

	Univariate[a]	Multivariate
Predictor	Odds Ratio (95% CI)	Odds Ratio (95% CI)
Comorbidity		
Asthma – Yes vs No[b]	1.800*** (1.345, 2.409)	1.733*** (1.272, 2.362)
Diabetes – Yes vs No[b]	2.054*** (1.440, 2.930)	1.770** (1.219, 2.570)
Abnormal BMI – Yes vs No[b]	0.738 (0.466, 1.171)	
Cancer – Yes vs No[b]	1.455 (0.922, 2.296)	
Arthritis – Yes vs No[b]	1.925*** (1.427, 2.598)	1.568** (1.141, 2.154)
Cancer – Yes vs No[b]	1.256 (0.796, 1.982)	
Stroke – Yes vs No[b]	1.753 (0.975, 3.153)	
Depressive Disorder – Yes vs No[b]	1.653** (1.221, 2.238)	1.423* (1.028, 1.969)
Annual Income		
20,000 USD-34,999 USD vs Less than 20,000 USD[b]	0.60** (0.41, 0.88)	0.682 (0.450, 1.035)
35,000 USD-49,999 USD vs Less than 20,000 USD[b]	0.52** (0.33, 0.81)	0.637 (0.395, 1.027)
50,000 USD-74,999 USD vs Less than 20,000 USD[b]	0.45** (0.28, 0.73)	0.562* (0.336, 0.941)
75,000 USD or more vs Less than 20,000 USD[b]	0.36*** (0.23, 0.59)	0.434** (0.259, 0.726)
Race		
Black or African American vs White[b]	1.17 (0.73, 1.87)	1.438 (0.842, 2.457)
Other vs White[b]	0.88 (0.44, 1.78)	0.789 (0.366, 1.701)

*$P< .05$; **$P< .01$; ***$P< .001$.
[a]Univariate analyses were adjusted for race and annual income.
[b]Reference values.
Frequent physical distress was defined as reporting 14 or more physically unhealthy days in the last 30 days.
Abbreviations: CI = confidence interval.

days remained statistically significant when included in the multivariate logistic regression model, with the OR remaining essentially the same. Annual income was also significant in the multivariate logistic regression model. Across all categories, workers with COPD reporting higher incomes (OR = 0.36–0.60) were less likely to experience physical distress as compared to those with lower incomes (<20,000 USD per year).

Healthcare system access

Table 5 presents the univariate and multivariate analysis of healthcare system access on the mental distress outcome. In the univariate analysis, respondents without a primary care physician (OR = 1.57, 95% CI: 1.09–2.26) and those who reported that cost of care prevented access to health care (OR = 2.28, 95% CI: 1.67–3.12) were more likely to report frequent mental distress compared to those who reported otherwise in the past year. Only cost as a barrier to medical care remained statistically significant in the multivariate model, with a larger OR = 2.18 (95% CI: 1.59–3.00). Moreover, workers with COPD with higher incomes (OR = 0.37–0.45) were less likely to experience mental distress as compared to those with lower incomes (<20,000 USD per year). Race was also significant, with African Americans being less likely to report mental distress compared to Whites (OR = 0.49, 95% CI: 0.26–0.93).

Table 6 presents the univariate and multivariate analysis of healthcare system access on the physical distress outcome. For the univariate analysis, respondents who reported that cost restricted access to health care were more likely to report frequent physical distress (OR = 1.68, 95% CI: 1.23–2.29) compared to respondents who did not report cost as a barrier in the past year. Cost as a barrier to medical care remained statistically significant when included in the multivariate logistic regression model predicting physical distress, with the OR remaining the same. Workers with COPD with higher incomes (OR = 0.42–0.60) were less likely to experience physical distress as compared to those with lower incomes (<20,000 USD per year).

Table 3. Univariate Odds Ratios of Frequent Mental Distress by substance use/abuse and multivariate odds ratios of frequent Mental Distress by substance use/abuse, race, and income, employed adults with COPD living in KY, NC, WV, and TN, BRFSS, 2016–2017.

Predictor	Univariate[a] Odds Ratio (95% CI)	Multivariate Odds Ratio (95% CI)
Substance Use & Abuse		
Smoked 100 cigarettes in lifetime – Yes vs No[b]	1.54* (1.06, 2.23)	1.111 (0.695, 1.775)
Tobacco smoking use – Every day vs Not at all[b]	1.60 (1.17, 2.19)	
Tobacco cigarette use – Some days vs Not at all[b]	1.58 (0.90, 2.79)	
Ever used e-cigarettes – Yes vs No[b]	1.84*** (1.34, 2.48)	1.360 (0.919, 2.012)
E-cigarette use – Everyday vs Not at all[b]	2.93* (1.22, 4.828)	
E-cigarette use – Some days vs Not at all[b]	1.66 (0.97, 2.83)	
Smokeless tobacco use – Everyday vs Not at all[b]	0.83 (0.38, 1.85)	
Smokeless tobacco use – Some days vs Not at all[b]	2.04 (0.88, 4.74)	
Binge drinking – At least 1 time in Past 30 days vs None[b]	1.87** (1.26, 2.77)	1.373 (0.812, 2.323)
Heavy drinking – Heavy Drinking Once in in Past 30 days vs No Heavy Drinking[b]	1.698** (1.218, 2.368)	1.323 (0.848, 2.066)
Annual Income		
20,000 USD-34,999 USD vs Less than 20,000 USD[b]	0.67* (0.46, 0.98)	0.717 (0.480, 1.071)
35,000 USD-49,999 USD vs Less than 20,000 USD[b]	0.42*** (0.26, 0.67)	0.430* (0.264, 0.701)
50,000 USD-74,999 USD vs Less than 20,000 USD[b]	0.41*** (0.25, 0.66)	0.453* (0.273, 0.753)
75,000 USD or more vs Less than 20,000 USD[b]	0.32*** (0.19, 0.52)	0.312** (0.183, 0.532)
Race		
Black or African American vs White[b]	0.61 (0.34, 1.08)	0.522* (0.273, 0.996)
Other vs White[b]	1.16 (0.62, 2.25)	0.843 (0.391, 1.816)

*P< .05; **P< .01; ***P< .001.
[a]Univariate analyses were adjusted for race and annual income.
[b]Reference values.
Frequent mental distress was defined as reporting 14 or more mentally unhealthy days in the last 30 days.
Abbreviations: CI = confidence interval.

Discussion

This study represents one of the first attempts to identify the extent to which individual and health system risk indicators influenced poor HRQoL outcomes among employed adults with COPD living in the Central Appalachian region. While employment rates among adults with COPD are lower than those without COPD,[27] very little is known about the factors that affect the health of COPD patients who are employed. This secondary analysis provided principal findings as discussed below according to the individual (comorbid conditions, substance use and abuse) and health system (access to care) risk domains.

Comorbid conditions

Employed adults with COPD who reported asthma and depressive disorders were more likely to report mental distress as compared to respondents without these comorbidities. Those who reported asthma, depressive disorder, diabetes, and arthritis were more likely to report physical distress as compared to respondents without these comorbidities. These findings are consistent with national analyses of BRFSS data from the general COPD population which indicates the largest proportion of multi-morbid patients with COPD has asthma, arthritis, and depression.[26] COPD is associated with significantly higher comorbidities that should be taken into consideration in COPD control strategies[16]; however, patients with COPD at risk for more comorbidities tend to report less mental distress than those with fewer comorbidities.[26] For employees with COPD, absence from work is often caused by comorbidities; thus, occupational guidance, especially in high-risk industries operating in Central Appalachia, should consider asthma, depressive disorder, diabetes, and arthritis

Table 4. Univariate odds ratios of frequent physical distress by substance use/abuse and multivariate odds ratios of frequent physical distress by substance use/abuse, race, and income, employed adults with COPD living in KY, NC, WV, and TN, BRFSS, 2016–2017.

Predictor	Univariate[a] Odds Ratio (95% CI)	Multivariate Odds Ratio (95% CI)
Substance Use & Abuse		
Smoked 100 cigarettes in lifetime – Yes vs No[b]	1.07 (0.76, 1.50)	
Tobacco cigarette use – Every day vs Not at all[b]	1.04 (0.76, 1.41)	
Tobacco cigarette use – Some days vs Not at all[b]	1.06 (0.60, 1.87)	
Ever used e-cigarettes – Yes vs No[b]	1.84*** (1.34, 2.48)	1.360 (0.919, 2.012)
E-cigarette use – Every day vs Not at all[b]	2.28 (0.94, 5.54)	
E-cigarette use – Some days vs Not at all[b]	1.94* (1.16, 3.23)	1.935* (1.158, 3.233)
Smokeless tobacco use – Every day vs Not at all[b]	1.40 (0.70, 2.80)	
Smokeless tobacco use – Some days vs Not at all[b]	0.88 (0.32, 2.38)	
Binge drinking – At least 1 time in Past 30 days vs None[b]	0.98 (0.64, 1.49)	
Heavy drinking – Heavy Drinking Once in in Past 30 days vs No Heavy Drinking[b]	0.904 (0.639, 1.279)	
Annual Income		
20,000 USD-34,999 USD vs Less than 20,000 USD[b]	0.60** (0.41, 0.88)	0.600* (0.406, 0.887)
35,000 USD-49,999 USD vs Less than 20,000 USD[b]	0.52** (0.33, 0.81)	0.512** (0.327, 0.802)
50,000 USD-74,999 USD vs Less than 20,000 USD[b]	0.45** (0.28, 0.73)	0.473** (0.293, 0.765)
75,000 USD or more vs Less than 20,000 USD[b]	0.36*** (0.23, 0.59)	0.363*** (0.224, 0.589)
Race		
Black or African American vs White[b]	1.069 (0.642, 1.782)	1.069 (0.642, 1.782)
Other vs White[b]	0.941 (0.456, 1.941)	0.941 (0.456, 1.941)

*$P< .05$; **$P< .01$; ***$P< .001$.
[a]Univariate analyses were adjusted for race and annual income.
[b]Reference values.
Frequent physical distress was defined as reporting 14 or more physically unhealthy days in the last 30 days.
Abbreviations: CI = confidence interval.

as potential causes of work disability in adults with COPD.[27] In particular, this analysis suggests that workers with COPD in Central Appalachia who are showing signs of depression may be especially vulnerable to poor physical and mental health outcomes.

Substance use and abuse behaviors

In univariate analyses, employed Central Appalachian adults with COPD who reported binge or heavy drinking at least once in the past 30 days were almost two times more likely to report mental distress compared to those that did not drink to excess. Previous studies report that alcohol misuse is about two times more prevalent in people with COPD as compared to those without COPD[28]; however, there is a lack of studies investigating the prevalence of alcohol misuse in patients with COPD.[26] This is concerning as psychological disorders such as alcohol abuse have been shown to be independently associated with higher all-cause 30-day readmission rates for Medicare beneficiaries with COPD.[29] However, when the substance use and abuse variables were entered into the multivariate model, they were no longer significant predictors of mental distress. This suggests that these substance use and abuse behaviors were likely only significant in univariate analyses due to their associations with other substance use and abuse predictors. Formal substance use and abuse model selection methods based on psychometric theory, such as Akaike's Information Criterion (AIC) or Schwarz' Bayesian Information Criterion (BIC),[30] should guide future analyses examining the causes of mental distress in the working COPD population.

Employed adults with COPD who reported the use of e-cigarettes on some days were more likely to report physical distress when compared to respondents who

Table 5. Univariate odds ratios of frequent mental distress by healthcare access and multivariate odds ratios of frequent mental distress by healthcare access, race, and income, employed adults with COPD living in KY, NC, WV, and TN, BRFSS, 2016–2017.

Predictor	Univariate[a] Odds Ratio (95% CI)	Multivariate Odds Ratio (95% CI)
Healthcare System Access		
Healthcare Plan – No vs Yes[b]	1.131 (0.745, 1.717)	
Designated Primary Care Physician – No vs Yes[b]	1.570* (1.091, 2.258)	1.312 (0.900, 1.913)
Cost of Care Prevented Healthcare Access – Yes vs No[b]	2.28*** (1.67, 3.12)	2.181*** (1.586, 2.999)
Checkup within Past Year – No vs Yes[b]	1.268 (0.908, 1.771)	
Annual Income		
20,000 USD-34,999 USD vs Less than 20,000 USD[b]	0.67* (0.46, 0.98)	0.700 (0.470, 1.041)
35,000 USD-49,999 USD vs Less than 20,000 USD[b]	0.42*** (0.26, 0.67)	0.455** (0.281, 0.735)
50,000 USD-74,999 USD vs Less than 20,000 USD[b]	0.41*** (0.25, 0.66)	0.460** (0.278, 0.763)
75,000 USD or more vs Less than 20,000 USD[b]	0.32*** (0.19, 0.52)	0.371*** (0.221, 0.625)
Race		
Black or African American vs White[b]	0.61 (0.34, 1.08)	0.489* (0.258, 0.928)
Other vs White[b]	1.16 (0.62, 2.25)	0.806 (0.384, 1.690)

*$P < .05$; **$P < .01$; ***$P < .001$.
[a]Univariate analyses were adjusted for race and annual income.
[b]Reference values.
Frequent mental distress was defined as reporting 14 or more mentally unhealthy days in the last 30 days.
Abbreviations: CI = confidence interval.

reported no e-cigarette use. This is the first study to demonstrate that periodic use of e-cigarettes was associated with poor physical health among Central Appalachian workers with COPD. Use of electronic cigarettes or "vaping" is significantly associated with self-reported COPD in adults,[31] even among vapers who never smoked[32] and nonsmokers.[33] Other studies of adults with COPD show that e-cigarette use is associated with a heavier conventional cigarette smoking history and poorer health outcomes.[34] It is possible that pulmonary toxicity associated with e-cigarette use exists across all the categories of cigarette smoking status, including among those who had never smoked tobacco cigarettes.[27,33,34] As the prevalence of e-cigarette use continues to rise,[33] more longitudinal research is needed to confirm the causal relationship between regular e-cigarette use and poor physical health among workers diagnosed with COPD. Differences in e-cigarette use may exist between employed adults with COPD as compared to unemployed patients, especially in underserved regions like Central Appalachia.

Healthcare system access

Of all healthcare system factors examined in this study, respondents who reported cost as a barrier to medical care reported more mental and physical distress as compared with respondents with no difficulty affording medical care. Other healthcare system access factors such as health insurance enrollment, having a primary care physician, and getting a regular checkup were not predictive of poor outcomes when entered into multivariate models. This suggests that the cost of care at the point of delivery is the primary healthcare access concern for workers with COPD in Central Appalachia. The cost burden of COPD in Central Appalachia may adversely affect working adults' ability to respond to their healthcare needs.[35] Other research describes the need to reduce costs to meet the unique healthcare needs of adults with COPD as compared to the general population.[36] Our study further establishes that unaffordable healthcare is a problem negatively associated with health outcomes that should be addressed by employers and healthcare providers of employed adults with COPD in the Central Appalachian region. Furthermore, it is possible that working-aged adults with COPD in Central Appalachian US states may be living with physical and mental health problems that they are not addressing with their healthcare providers due to cost concerns. Healthcare providers and insurance companies should address cost considerations to reduce the likelihood that COPD-related complications

Table 6. Univariate odds ratios of frequent physical distress by healthcare access and multivariate odds ratios of frequent physical distress by healthcare access, race, and income, employed adults with COPD living in KY, NC, WV, and TN, BRFSS, 2016–2017.

Predictor	Univariate[a] Odds Ratio (95% CI)	Multivariate Odds Ratio (95% CI)
Healthcare System Access		
Healthcare Plan – No vs Yes[b]	0.976 (0.638, 1.491)	
Designated Primary Care Physician – No vs Yes[b]	0.799 (0.538, 1.188)	
Cost of Care Prevented Healthcare Access – Yes vs No[b]	1.677** (1.229, 2.286)	1.677** (1.229, 2.286)
Checkup within Past Year – No vs Yes[b]	1.050 (0.750, 1.470)	
Annual Income		
20,000 USD-34,999 USD vs Less than 20,000 USD[b]	0.60** (0.41, 0.88)	0.598* (0.404, 0.884)
35,000 USD-49,999 USD vs Less than 20,000 USD[b]	0.52** (0.33, 0.81)	0.526** (0.335, 0.825)
50,000 USD-74,999 USD vs Less than 20,000 USD[b]	0.45** (0.28, 0.73)	0.483** (0.298, 0.783)
75,000 USD or more vs Less than 20,000 USD[b]	0.36*** (0.23, 0.59)	0.415*** (0.255, 0.675)
Race		
Black or African American vs White[b]	1.17 (0.73, 1.87)	1.073 (0.643, 1.790)
Other vs White[b]	0.88 (0.44, 1.78)	0.881 (0.427, 1.821)

*$P < .05$; **$P < .01$; ***$P < .001$.
[a]Univariate analyses were adjusted for race and annual income.
[b]Reference values.
Frequent physical distress was defined as reporting 14 or more physically unhealthy days in the last 30 days.
Abbreviations: CI = confidence interval.

will lead to avoidable emergency room visits and hospitalizations in rural Central Appalachia where geographic barriers limit access to medical treatment.

Income disparities

Results from this study showed that employed adults with COPD who reported higher incomes were less likely to report physical and mental distress as compared to respondents with low annual incomes, suggesting that poor physical and mental health is especially problematic for adults with COPD who earn lower wages. This finding is consistent with others that note a positive relationship between paid employment and the respiratory disease-specific quality of life in patients with COPD.[37] Workers in Central Appalachian industries where wages are lower may be experiencing more undue stress, which may be work-related or not, or both, as compared to those working for higher wages. Health disparities linked to income inequality may be especially apparent now given the economic shutdown caused by the COVID-19 pandemic. Another possible explanation is that other interpersonal factors, such as support from family and friends, which were not included in our study dataset, may play more important roles than income causing mental issues. Support from family and friends can mitigate mental issues and make up for the negative impacts of low income. More attention is needed to identify specific stressors among employees with COPD living in Central Appalachia at all income levels, particularly in select high-risk industries, that may trigger poor physical and mental health. Future needs assessments should identify particular types of health differences that disproportionately affect low-income workers with COPD.

Racial disparities

Our multivariate analyses examining associations between substance abuse, healthcare system access, and mental distress showed that African American workers with COPD were less likely to report mental distress as compared to white respondents. This finding is consistent with previous research indicating that, once race-related stress is adjusted, mental stress affects whites more adversely than African Americans.[38,39] Some possible reasons for this were suggested, including greater emotional flexibility and better access of African Americans to other coping resources.[39–41] It is important to further explore this finding in the future research to determine potential reasons for these racial differences in mental health. While African American workers with COPD in Central Appalachia may be less impacted by mental health issues, it is important to understand more about what might be causing these racial differences, especially those related to employment status.

Limitations

Second, BRFSS data are based on unvalidated self-reports via telephone survey. Reports of comorbidities, substance use, and healthcare access might be subject to social desirability bias, resulting in underreporting of these factors. Data could also be affected by respondent recall bias related to their health conditions and recent behaviors and experiences. For example, limited knowledge about COPD and uncertainty about its diagnosis can lead to patients misreporting COPD as asthma, especially among women[42] who made up nearly 60% of the sample in this study. Furthermore, some significant risk factors are not assessed in the telephone-based BRFSS, such as social support from family and friends, which may have significant impacts on physical and/or mental health. Future secondary analyses should utilize other national population health datasets besides BRFSS to examine the effects of risk factors on health disparities in this particular working population.

Finally, only state-level public access BRFSS data from Kentucky, North Carolina, Tennessee, and West Virginia (i.e., Central Appalachian U.S. states) were analyzed due to lack of access to county-level BRFSS Industry and Occupational data during the study period caused by the COVID-19 national shutdown. As a result, this study cannot identify specific areas (i.e., counties) within these states where the studied factors may be a concern among workers with COPD. Future studies should consider replicating this analysis using BRFSS Industry and Occupational data[43] from Central Appalachian counties in each of these U.S. states. More granular analyses could provide unique insights about risk factors that affect worker health outcomes in specific Central Appalachian counties. For example, workers with COPD working in high-risk industries with excessive exposure to environmental toxins (e.g., agricultural, mining, construction) or those living in areas with poor air quality may be at particularly high risk for mental and physical distress.

Translation to Health Education Practice

This secondary analysis primarily relates to Area 1: Assessment of Needs and Capacity, within the framework of practice for certified Health Education specialists.[44] Area 1.2. involves obtaining secondary data and other evidence-informed sources. In this study, we obtained and procured secondary BRFSS data (Area 1.2.4), referenced the validity and reliability of this data (Area 1.2.5), adhered to established procedures for collecting managing the BRFSS data (Area 1.2.8), and developed a systematic data analysis plan (Area 1.2.9).

Area 1.3 calls on Health Education specialists to analyze the data to determine the health of the priority population(s) and the factors that influence health. Our secondary analysis helped to determine specific risk factors affecting the health and health status of workers with COPD living in Central Appalachia (Area 1.3.1). Findings supported that employees with COPD generally experience progressive declines in HRQoL that are exacerbated by risk factors such as comorbidities, regular e-cigarette use, and excessive medical costs. Working adults with COPD who are demonstrating signs of depression should be referred to worksite health promotion programs or mental health professionals who can help them with relevant issues such as stress management and substance use and abuse. Future research should examine how worksite health management interventions should address other underlying health conditions (i.e., asthma-COPD overlap, arthritis, depression/anxiety, and diabetes) in comorbid workers with COPD.

Employees with COPD who reported the use of e-cigarettes on some days were more likely to report physical distress when compared to workers who did not use e-cigarettes. Occasional use of e-cigarettes may be particularly detrimental to the physical health of workers with COPD who may be vaping to help with cessation of combustible cigarette use. Given the findings reported here, one logical next step would be to determine the antecedents (e.g., knowledge, attitudes, beliefs) of e-cigarette use among workers with COPD living in the Central Appalachian region. Health Education specialists are tasked with determining the knowledge, attitudes, beliefs, skills, and behaviors that impact the health and health literacy of the priority population(s) (Area 1.3.2). More data on these cognitive-behavioral variables will help determine how to prevent and/or reduce the impact of e-cigarette use on poor health outcomes experienced by Central Appalachian workers with COPD. Furthermore, results from this secondary analysis will help prioritize the potential harms of e-cigarette use within COPD education programs that can be delivered in worksites across Central Appalachia.

Health Education specialists are also all called to identify the social, cultural, economic, political, and environmental factors that impact the health and/or learning processes of the priority population(s) (Area 1.3.3). Inadequate access to healthcare represents one especially restrictive barrier that adversely impacts disease management for high-risk patients with COPD. Of all healthcare system factors examined in this study, employees who reported cost as a barrier to medical care experienced more mental and physical distress as compared to respondents with no difficulty affording treatment. None of the other healthcare system access factors (i.e., health insurance enrollment, having a primary care physician, getting a regular checkup) predicted poor outcomes when entered into the multivariate models. Other research suggests that while increased availability of pulmonary care specialists may reduce hospital utilizations in medically underserved areas with little or no access to pulmonary care specialists[45], seeking treatment from these specialists may also present burdensome economic costs for workers with COPD living in Central Appalachia. Additional quantitative and qualitative data is needed to understand the specific financial barriers (e.g. health insurance premiums, copays, prescription drugs) to care experience by Central Appalachian workers with COPD. Rigorous analyses of this type of needs assessment data (Area 1.3.6) would directly address several of the major goals and objectives outlined in the national COPD Action Plan.[12]

Findings from this secondary analysis of pooled 2016–2017 BRFSS data provide unique insights into individual and health system risk factors that contribute to health disparities among Central Appalachian workers with COPD. Area 1.4. requires Health Education specialists to synthesize assessment findings to inform the planning process. The synthesis of findings from this secondary analysis can be used by worksite Health Education specialists and others to inform the self-management program planning process for employees living with COPD. Further, data from this study should be compared to existing data and other evidence-based information that describes the multitude of environmental and occupational factors that can affect the health status of workers with COPD in Central Appalachia (Area 1.4.1). Logical next steps in this line of inquiry should include prioritizing Health Education and promotion needs of Central Appalachian workers with COPD (Area 1.4.2), summarizing the capacity of Central Appalachian workers with COPD to meet their own health needs (Area 1.4.3), and developing worksite health promotion recommendations for Central Appalachian workers with COPD based on the findings from this study (Area 1.4.4 & Area 1.4.5).

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