Increased Risk of Depression for People Living in Coal Mining Areas of Central Appalachia

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Abstract

This study examines the relationship between depression symptoms and living in areas where mountaintop removal coal mining is practiced. Data were analyzed from a survey of 8,591 adults residing in Central Appalachian areas both with and without coal mining. The survey included a validated measure of depression severity. Results showed that diagnosable levels of major depression were present in almost 17% of respondents in mountaintop removal mining areas, compared to 10% of residents in non-mining areas. This disparity was partly attributable to socioeconomic disadvantage, but after statistical control for income, education, and other risks, depression risk for residents in the mountaintop removal area remained significantly elevated (odds ratio = 1.40, 95% confidence interval 1.15–1.71). This study contributes to the empirical evidence in support of the concept of solastalgia and indicates that persons who experience environmental degradation from mountaintop removal coal mining are at elevated risk for depression.

Introduction

Numerous writers have argued that human beings have an innate connection to the living world (Kellert & Wilson, 1995). Wilson (1984) describes this phenomenon as "biophilia," or the human bond that we all have with other species both plant and animal. Studies have documented this connection, finding that both physical and mental well-being are enhanced by proximity to parks, gardens, wilderness areas, and other natural features (Grinde & Patil, 2009; Maller et al., 2006.) It follows that the disturbance or elimination of these natural features may lead to distress or psychological harm. In this study, we examine evidence for the effects of one form of severe environmental disturbance, mountaintop removal coal mining, on psychological health as measured by symptoms of depression including symptoms indicative of diagnosable major depression.

Depression is a serious mental health disorder characterized by clinically significant psychological distress and impairment of daily functioning. Symptoms include depressed mood, fatigue, loss of interest in activities, insomnia or hypersomnia, suicidal ideation, psychomotor retardation or agitation, large weight changes, and/or excessive feelings of guilt or worthlessness (American Psychiatric Association, 1994).

Major depressive disorder impacts approximately 7% of the US population (Kessler et al., 2005) and is second only to ischemic heart disease in terms of years lost either to disability or premature death (U.S. Department of Health and Human Services, 1999). Minor depressive disorder, in contrast, is associated with fewer depressive symptoms and less functional impairment than major depression (Rapaport et al., 2002). However, minor depression has been linked with increased medical care service utilization, increased risk of developing major depressive disorder, impairments in social function, low quality of life, and reduced psychological well-being (Johnson et al., 1992, 2009; Nierenberg et al., 2010; Rapaport et al., 2002).

Appalachia is the mountainous, largely rural area of the eastern United States extending from southern New York through northern Mississippi. Individuals who reside in areas of Central Appalachia, a

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region dominated by coal extraction, may be disproportionately exposed to risks for depression due to socioeconomic problems and environmental disturbances. A meta-analysis of research on depression and socioeconomic status found that low socioeconomic status was associated with higher odds of being depressed, developing a new depressive episode, and of persistent depression. Dose-response relationships were found for income and education level (Lorant et al., 2003). Poverty rates in Appalachia are higher than rates for the nation and, within Central Appalachia, are highest in coal mining areas compared to other portions of the region (Hendryx, 2011).

Depression risks may be exacerbated in areas with mountaintop removal mining (MTR), a form of large-scale surface coal mining that impacts approximately 12 million acres in portions of Central Appalachia including eastern Kentucky, eastern Tennessee, southern West Virginia, and western Virginia (EPA, 2011). MTR uses explosives and heavy machinery to remove forests, rock, and soil above coal seams, and it deposits the resulting spoil, or overburden, in adjacent valleys (EPA, 2011; Epstein et al., 2011). These activities are highly destructive of local environments and occur in close proximity to human settlements.

Environmental problems in MTR areas include deforestation and pollution of local air and water (Cordial et al., 2012; Esch et al., 2011; Palmer et al., 2010). Increased levels of ambient particulate matter, sulfur dioxide, and carbon monoxide are present in areas close to coal extraction, processing, and transportation (Ghose, 2007). Each of these air pollutants has been linked with greater incidence of emergency room visits for depression among those with preexisting depression (Szyszkowicz, 2007, 2011; Szyszkowicz et al., 2009). A significant association has also been found between elevated levels of ambient respirable particulate matter and suicide risk (Kim et al., 2010).

Mountaintop removal mining in Appalachia profoundly alters the landscape and damages surrounding ecological systems in long-term and perhaps irremediable ways (Palmer et al., 2010). A few studies have identified links between environmental degradation and psychological health (Higginbotham et al., 2006; Sartore et al., 2008; Van Haaften & Van De Vijver, 1999), and previous researchers have suggested that MTR may increase the risk of mental health problems, but empirical evidence specific to MTR has been largely missing (Cordial et al., 2012; Zhang et al., 2008). One study examining health-related quality of life (HRQOL) found that individuals residing in areas where mountaintop removal is practiced experienced significantly more poor mental health days (Zullig & Hendryx, 2011). Extending this prior work, the current study specifically measures diagnostic symptoms of major depression. We test the hypotheses that (1) depression scores will be significantly higher in MTR areas in Central Appalachia compared to areas characterized by either other forms of coal mining or no mining and (2) there is a unique contribution of living in MTR environments that contributes to elevated depression risk after accounting for other socioeconomic, behavioral, and demographic variables.

Methods

Design

The study is a cross-sectional analysis of 2006 Behavioral Risk Factor Surveillance System (BRFSS) data on the association between depression symptoms and residence in MTR communities, controlling for other depression risks. Data for the current study were constrained to the four Central Appalachian states where MTR occurs (Kentucky, Tennessee, Virginia, and West Virginia). The BRFSS is an annual telephone-based, random, stratified survey established in 1984 to gather information on health risk behaviors, preventive health practices, and health care access primarily related to chronic disease and injury, and is weighted to reflect the population of the United States (CDC, 2012).

Data

The 2006 BRFSS data were collected in all 50 states, the District of Columbia, Puerto Rico, and the US Virgin Islands with a median response rate of 51% (CDC, 2007). We choose 2006 because in that year the county of the respondent was available on the public use data set and because the depression module questions were available in the MTR states. In 2006, 60% of BRFSS respondents were women (compared with 51% nationally). Race/ethnicity and age characteristics were as follows: White non-Hispanic (80% vs. 75% nationally); aged 18–24 years (6% vs. 14% nationally), aged 25–34 years (13% vs. 17% nationally), aged 35–44 years (18% vs. 19% nationally), aged 45–54 years (22% vs. 19% nationally), aged 55–64 years (18% vs. 14% nationally), and aged ≥ 65 years (21% vs. 17% nationally). The combined large sample size and overall demographic differences suggest that despite the moderate response rate, little nonresponse bias was experienced in 2006.

Depression measures. Dependent variables included the eight BRFSS items that measured depression symptoms. These items constitute the PHQ-8, which is recognized as a valid screening tool to identify persons likely to have diagnosable depression (Kroenke et al., 2009). These items are shown in Table 1. Each of the eight items measures one depression symptom. Respondents are asked how many days,

Table 1. List of PHQ-8 Items. Respondent Was Asked, "Over the Last Two Weeks, How Many Days Have You…"

Had little interest or pleasure in doing things?
Felt down, depressed, or hopeless?
Had trouble falling asleep or staying asleep or sleeping too much?
Felt tired or had little energy?
Had a poor appetite or ate too much?
Felt bad about yourself or that you were a failure or had let yourself or your family down?
Had trouble concentrating on things, such as reading the newspaper or watching the TV?
Moved or spoken so slowly that other people could have noticed? Or the opposite—being so fidgety or restless that you were moving around a lot more than usual?

over the previous 14 days, they had experienced the symptom. Using the scoring protocol previously established for the PHQ-8 (Kroenke et al., 2009), in our analyses a person was given a score of 0 to 3 on each item as follows: a score of 0 for experiencing the symptom 0 or 1 day in the last two weeks; a score of 1 for experiencing the symptom for 2–6 days; a score of 2 for experiencing the symptom for 7–11 days; or a score of 3 for experiencing the symptom for 12–14 days. These scores were then summed, as per protocol, resulting in a total score for each person of 0 to 24. Respondents were then classified by total score into one of four groups: no depression (score <5), at least mild depression (score ≥ 5), at least moderate depression (score ≥ 10), or severe depression (score ≥ 15). Scores of moderate depression, 10 or greater, have high sensitivity and specificity in the diagnosis of major depression (Kroenke et al., 2009). In addition, a recent meta-analysis using the PHQ-9 found that cut-off scores between 8 and 11 were all acceptable and comparable in their ability to detect major depressive disorder (Manea et al., 2012). (The PHQ-9 includes one additional item on suicide ideation that is not included on the PHQ-8; this item is deleted from the PHQ-8 because there is no realistic way to respond to suicide risk during a telephone survey.) The standardized Cronbach's alpha reliability for these eight items in the current sample was .85.

Independent variables. We took person-level independent variables from the 2006 BRFSS survey and from the county-level supplementary file provided by the Centers for Disease Control and Prevention for the 2006 BRFSS survey. Variables taken from the BRFSS included smoking, body mass index, alcohol consumption, age, sex, race/ethnicity, marital status, income, education, employment status, supply of medical doctors, and metropolitan residence status.

More specifically, we coded smoking as a dichotomous variable that contrasted current smokers with former smokers/lifetime nonsmokers. We coded body mass index as three dichotomous variables: neither overweight nor obese (BMI <25), overweight (BMI 25 to <30), or obese (BMI 30 or above). We coded alcohol consumption as any episode of binge drinking (yes or no) defined as five or more drinks on one occasion in the previous 30 days. We coded age in number of years. We coded race/ethnicity as a series of five dichotomous variables specifying African American, Native American, non-White Hispanic, Asian American, or White non-Hispanic. We coded marital status as married or cohabitating versus any other status. Income was measured in the BRFSS as an 8-level ordinal variable for annual household income with levels ranging from "<\$10,000" to "\$75,000 or more." For the current study we dichotomized income into low (<\$35,000) or high (≥\$35,000), which approximately divided the sample in half. We coded education into three variables specifying less than high school, high school graduate, or at least some college education; less than high school was used as the referent in statistical models. We coded employment status as a dichotomous variable that contrasted those who were unemployed with those of any other status (including retired, disabled, student, homemaker, employed for wages, or self-employed); this dichotomization was designed to capture effects of being unemployed on depression, given the possible association between employment conditions and mining. The BRFSS codes metropolitan status as a 5-level variable, with higher scores indicating a more rural environment. We dichotomized these responses as living in a city versus living in outlying suburban or rural areas; this division captures the distinction between persons living in larger population centers where mining does not occur versus persons living in smaller towns or rural areas where mining may occur. The final variable included from the BRFSS was the county-level 2005 supply of office-based general practice physicians per 100,000 persons.

Each county was classified as engaged in MTR, other non-mountaintop removal coal mining, or no coal mining. These codes were based on data from the Energy Information Administration and from satellite imagery (Amos, 2012) to identify surface mining sites that were specifically mountaintop removal sites. The Energy Information Administration reports include data for tons of coal at the county level mined using both underground and surface techniques.

For the current study, we identified a coal mining county as one with any amount of coal mining over the years 1994–2006. In practice, most counties with mining in 1 year have mining most or all years. We then classified each coal mining county according to whether it was in the MTR surface mining area (yes or no).

Of the 1,148 counties in the national 2006 BRFSS, 120 (10.4%) were located within the four-state region. The 120 counties represent 29.7% of the total 404 counties in the four states. This includes 19 of 32 (59%) MTR counties in the region, 23 of 58 (40%) other coal mining counties, and 78 of 321 (24%) non-mining counties.

Analysis

Analyses included descriptive summaries of the variables, followed by inferential analyses to examine depression symptoms in mining and non-mining areas. There were some respondents who did not answer all eight of the PHQ-8 items; following similar imputation procedures that have been reported for other uses of this instrument (Thombs et al., 2008), we used SAS version 9.3 Proc MI to impute values for the missing items based on the values of PHQ-8 items that were observed. Data were assumed to be missing at random, and imputed values were constrained to fall between 0 and 3 per the original scale. Five imputations were conducted resulting in a data set five times as large as the original; a weight of .2 was assigned to each observation to create a final data set with the original sample size and with no missing observations on the PHQ-8.

To account for the complex sampling design of the BRFSS, we analyzed unadjusted models using SAS version 9.3 Proc Surveyfreq, and covariate-adjusted models using Proc Surveylogistic, specifying the primary sampling unit as the cluster and stratifying within state. All variables in the models were treated as categorical variables except age and supply of physicians. We also conducted a number of sensitivity analyses to examine whether the mining effects remained significant under different model specifications.

Results

A descriptive summary of the study variables is provided in Table 2. There were a total of 8,613 individuals who completed the BRFSS survey in the four study states and responded to our questions of interest. However, missing data on individual items reduced the final sample size to 7,421 (86% of the original sample) with complete data on all items. Data were most often missing for income ($n = 1{,}170$ missing cases). To keep the sample as large as possible, we re-coded income into a categorical variable with three groups, where income was coded as high, low, or missing. This allowed us to retain a final sample for this study of 8,591. There were 1,054 respondents from

Table 2. Descriptive Summary of Study Variables ($N = 8{,}591$)

VARIABLE	*N*	%
Depression-dependent variables[a]		
PHQ-8 ≥ 5 (at least mild depression)	2481	28.9
PHQ-8 ≥ 10 (at least moderate depression)	972	11.3
PHQ-8 ≥ 15 (severe depression)	438	5.1
Mining residence		
Residence in a mountaintop removal mining area	1054	12.3
Residence in other coal mining area	1143	13.3
Residence in non-mining area	6394	74.4
Covariates		
Female	5395	62.8
African American	899	10.5
Asian American	149	1.7
Native American	347	4.0
Non-white Hispanic	164	1.9
High income	4223	49.2
Low income	3198	37.2
Missing income	1170	13.6
High school education	2729	31.8
Some college or more	4840	56.3
Unemployed	294	3.4
Current smoker[b]	1753	20.5
Binge drinking	777	9.0
Overweight	3033	35.3
Obese	2632	30.6
Married or cohabitating	4726	55.0
Living within a city	3856	44.9
	Mean	Standard Deviation
Age	52.6	16.4
Physicians per 100,000	29.3	12.6

[a]Depression estimates are based on imputation procedure as described in Methods.

[b]Smoking status was missing in 30 cases; the denominator for the smoking rate was therefore 8,561. Cases with missing smoking data were kept in the study because smoking was not used in the final models.

MTR areas, 1,143 respondents from other non-MTR areas, and 6,394 respondents from non-mining areas.

Table 3 presents the results of the chi-square frequency tests before control for covariates. The chi-square values indicate that all severity levels of depression were significantly associated with residence in mining areas. The highest depression percentages were observed among residents of MTR areas. Within the moderate depression category, which is based on PHQ-8 scores of 10 or higher and is indicative of diagnosable major depression, 16.8% of the respondents in the MTR area had positive depression scores, higher than the 10.0% found in the non-mining area and almost twice as high as the 8.6% reported by Kroenke et al. (2009) for the general US population. The corresponding percentage in the non-MTR areas was 14.1%, intermediate between the MTR and non-mining groups.

Next, covariates were added to the analysis. In the selection of covariates, the implied causal relationship is that covariates represent variables that may increase the risk of depressive symptoms. However, for some variables, including smoking, binge drinking, overweight, and obesity, the relationship may be bidirectional or reverse. Smoking may be a response to depression rather than a risk for it (Goodwin et al., 2013), as may overeating or binge drinking. Therefore, we first ran logistic regression models that included smoking, overweight and obesity, and binge drinking, and then ran the models again without these covariates, to test the sensitivity of the results to these different model specifications. We found that the statistical significance of the mining variables was not affected by the inclusion or exclusion of these covariates. To simplify the final models, the models in Table 4 are presented without smoking, binge drinking, overweight, or obesity among the covariates.

The results in Table 4 show that, after control for covariates, residing in an area where MTR is practiced was significantly associated with levels of mild and moderate depression but not severe depression. Levels of moderate depression are serious enough to indicate risk of major depression diagnosis. Living in an area with other forms of mining was significantly associated with the mild depression measure after control for covariates. Other risks for depression in these models included female sex, younger age, low or missing income, unemployment, less education, and not being married. The highest point estimate risks were for low income. African American race was associated with reduced depression risk after control for other variables, as was Hispanic ethnicity for mild depression.

Two final sensitivity analyses were conducted (results not shown). In the first, missing observations on the income measure were deleted rather than coded categorically, resulting in casewise deletion of these observations. In the second, imputation of missing observations for the PHQ-8 was not done, and only the observed values were used to estimate depression. In both of these analyses, the significance of the mining variables remained unchanged.

Table 3. Chi-Square Tests for Association Between Mining Activity and Depression, Before Control for Covariates

		MOUNTAINTOP REMOVAL MINING	OTHER MINING	NO MINING
At least mild depression[a]	Yes	380 (36%)	388 (34%)	1713 (27%)
	No	674 (64%)	755 (66%)	4681 (73%)
At least moderate depression[b]	Yes	176 (17%)	161 (14%)	635 (10%)
	No	878 (83%)	982 (86%)	5759 (90%)
Severe depression[c]	Yes	79 (7%)	73 (6%)	286 (4%)
	No	975 (93%)	1070 (94%)	6108 (96%)

Note. The cell figures are counts with percentages in parentheses. The percents give the percent of persons with and without depression by mining location (i.e., within each depression category and mining category pair, the percents sum to 100%).

[a]Rao-Scott chi-square = 54.6, $df = 2$, $p < .0001$.

[b]Rao-Scott chi-square = 51.7, $df = 2$, $p < .0001$.

[c]Rao-Scott chi-square = 21.6, $df = 2$, $p < .0001$.

Table 4. Final Logistic Regression Models for Associations Between Depression and Residence in Mining Areas, With and Without Covariates

	AT LEAST MILD DEPRESSION (PHQ-8 ≥5)	AT LEAST MODERATE DEPRESSION (PHQ-8 ≥10)	SEVERE DEPRESSION (PHQ-8 ≥15)
	Odds ratio (95% confidence interval)	Odds ratio (95% confidence interval)	Odds ratio (95% confidence interval)
No covariates			
Residence in MTR area	1.54 (1.34, 1.76)[a]	1.82 (1.52, 2.17)[a]	1.73 (1.34, 2.23)[a]
Residence in other mining area	1.41 (1.23, 1.61)[a]	1.49 (1.24, 1.79)[a]	1.45 (1.11, 1.89)[a]
Covariates			
Residence in MTR area	1.28 (1.10, 1.48)[a]	1.40 (1.15, 1.71)[a]	1.26 (0.93, 1.61)
Residence in other mining area	1.23 (1.07, 1.43)[a]	1.22 (0.99, 1.50)	1.10 (0.83, 1.47)
Female	1.48 (1.34, 1.65)[a]	1.37 (1.18, 1.60)[a]	1.21 (0.97, 1.50)[a]
Age	0.984 (0.981, 0.987)[a]	0.980 (0.976, 0.984)[a]	0.978 (0.973, 0.983)[a]
African American	0.82 (0.70, 0.97)[a]	0.67 (0.52, 0.86)[a]	0.58 (0.40, 0.85)[a]
Asian American	0.99 (0.67, 1.46)	0.90 (0.51, 1.58)	0.97 (0.45, 2.10)
Native American	1.55 (1.14, 2.11)[a]	1.19 (0.76, 1.85)	1.42 (0.81, 2.49)
Hispanic	0.42 (0.26, 0.68)[a]	0.55 (0.27, 1.12)	0.55 (0.22, 1.37)
Low income	1.98 (1.75, 2.24)[a]	2.75 (2.28, 3.31)[a]	3.65 (2.76, 4.82)[a]
Missing income	1.34 (1.15, 1.58)[a]	1.46 (1.15, 1.87)[a]	1.86 (1.29, 2.69)[a]
Unemployed	1.73 (1.34, 2.22)[a]	1.64 (1.21, 2.23)[a]	1.80 (1.23, 2.64)[a]
High school education	0.65 (0.56, 0.76)[a]	0.59 (0.49, 0.72)[a]	0.52 (0.40, 0.68)[a]
Some college or more	0.45 (0.38, 0.52)[a]	0.43 (0.35, 0.52)[a]	0.43 (0.33, 0.57)[a]
Supply of physicians	1.002 (0.998, 1.006)	1.005 (0.999, 1.010)	1.002 (0.994, 1.010)
Married	0.72 (0.65, 0.80)[a]	0.70 (0.61, 0.82)[a]	0.73 (0.59, 0.90)[a]
Urban residence	0.98 (0.88, 1.09)	0.92 (0.80, 1.07)	0.85 (0.68, 1.05)

[a]95% confidence interval excludes 1.00 and is significant at $p < .05$ or better.

Discussion

The results of this study demonstrate that residence in an area where mountaintop removal coal mining is practiced is associated with depression scores independently of income, education, race, sex, age, and other risks. The odds of a score indicative of risk for major depression were 40% higher in MTR areas compared to non-mining areas after statistical adjustment for other risks. After control for covariates, the risk of major depression was statistically elevated only in the MTR areas and not in the areas where other forms of mining were practiced, compared to the non-mining referent.

Results indicate two additional findings of note. First, before control for covariates the association between depression scores and mining was stronger than after control for covariates. That is, other depression risks such as income, education, and marital status could partially, but not completely, account for depression risk; and a unique mining contribution remained after covariates were added to the models. In addition to the mining effects themselves, mining communities are characterized by other socioeconomic disadvantages that place their populations at greater risk for depression. The second finding of note is that there is evidence of a dose-response effect in that MTR areas had the greatest risk for depression both before and after control for other risks, followed next by other coal mining areas, whereas risk was lowest in areas without coal mining. The characteristics of MTR environments have more profound links to depression than other types of mining environments, but there appears to be an effect from general mining environments that creates this stepwise pattern of increased risk as the extent of mining activity intensifies.

What these characteristics are has not yet been discovered through empirical study but can perhaps be suggested by examining the realities of MTR environments. The people of Appalachia have a strong sense of place (Behringer & Friedell, 2006), and MTR is antithetical to this sense. MTR deforests and destroys mountains within sight and sound of communities where families have lived for generations. Cemeteries have been surrounded or damaged, and entire communities have even been destroyed (Barry, 2011; Burns, 2007). In addition, jobs are in decline as machinery replaces labor, as coal reserves dwindle, and as other energy sources such as natural gas outperform coal in the marketplace (Burns, 2007; Joyce, 2013). Social capital in the region has been depleted as a consequence of depopulation and the struggles between union workers and the coal industry (Bell, 2009). The prospects for alternative economic development remain largely unexplored and undeveloped as political and corporate interests disregard citizen concerns and cling to old ways (Bell & York, 2010; Burns, 2007; Goodell, 2006; Ward, 2008). As a result, citizens are left disenfranchised, with little hope for economic advancement, while their surrounding environment, to which they have a profound attachment, is permanently defaced.

The connection that exists between the environment and psychological health has been advanced by recent work on the construct of "solastalgia" (Albrecht, 2012; Albrecht et al., 2007; Connor et al., 2004). Solastalgia refers to distress caused by environmental change and is most relevant for persons who have deep connections to their personal environments. In one study, residents of a "high-disturbance" open-cut mining area in Australia's Upper Hunter Valley, in comparison with residents of a nearby farming area, reported significantly higher environmental distress. Specifically, the high-disturbance group had higher exposure to dust, landscape alterations, vibrations, loss of vegetation and animal life, and edifice damage, and also greater trepidation concerning asthma and other air pollution–induced or air pollution–exacerbated physical illnesses (Higginbotham et al., 2006).

Coal mining has been linked with multiple adverse health outcomes including greater all-cause mortality (Hendryx, 2011), cancer mortality (Hendryx et al., 2010), coronary heart disease morbidity (Hendryx & Zullig, 2009), and chronic cardiovascular disease mortality (Esch & Hendryx, 2011). Associations have been found between all of these outcomes and depression (Atlantis et al., 2012; Carney & Freedland, 2003; Liu & Ziegelstein, 2010; Pinquart & Duberstein, 2010; Sullivan et al., 2012), and general decline in health has been found to predict onset and persistence of depressive illness in older adults (Kennedy et al., 1990, 1991). Although the causal relationships in the case of depression and illness in MTR areas are unclear, it seems likely that depression is both a result of and a contributor to the high prevalence of other forms of disease observed in MTR communities.

Limitations of the study include those imposed by the cross-sectional, self-report design. Depression scores are based on self-report and were not medically confirmed, although there is evidence that the PHQ-8 is a reliable and valid instrument in the identification of depression (Kroenke et al., 2009). The cross-sectional design does not allow for a definitive understanding of the causal role of MTR on the creation or exacerbation of depression. It is also not possible to completely disentangle the effects of mountaintop removal per se from other negative features of mining environments such as coal trucks and trains, coal processing facilities, stresses caused by conflict among opponents and proponents of the coal industry, depopulation (Bell, 2009), or the economic hardships of MTR economies.

The survey for this study was conducted in 2006, but there is evidence that conditions in Appalachian mining environments have not improved in more recent years. National Gallup polls conducted in 2012 identified the mining areas of Virginia, Tennessee, eastern Kentucky, and southern West Virginia as among the worst in the nation on measures of well-being (Gallup-Healthways, 2013a, 2013b, 2013c, 2013d). The 3rd Congressional District of West Virginia, which covers the southern portion of the state including the mountaintop mining areas, received the poorest score in the nation, 436th out of 436 districts in overall well-being. The 5th Congressional District of Kentucky, which covers the mountaintop mining areas of eastern Kentucky, was next to last at 435th.

In conclusion, this study documents significant connections between symptoms of depression and environmental disturbance. As such, this study contributes to the evidence base in support of solastalgia and biophilia. The health and well-being of humans cannot be divorced from our environments. In general, these connections may be expected to occur in a variety of settings where people face environmental disruption, and such disturbed environments are common in our highly industrialized world. More specifically, the current findings add to prior knowledge on the previously established physical illness consequences of MTR by showing that psychological health is also impaired in these environments.

Author Disclosure Statement

All authors declare that no competing financial interests exist.

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