



Environmental and Health Disparities in Appalachian Ohio: Perceptions and Realities

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Abstract

Background. Appalachia is a region of the United States that faces significant environmental and health disparities. Understanding these disparities and the social determinants that contribute to them will help public health practitioners make better decisions. The purpose of this research is two-fold. First, through secondary data analysis, we document environmental and health disparities as well as demographic and economic conditions that may contribute to these disparities between Appalachian and non-Appalachian Ohio. Second, we examine perceptions of environmental health practitioners about the differences in environmental conditions between Appalachian and non-Appalachian Ohio.

Methods. We gathered secondary data about economics, health, and the environment from the Ohio Department of Health, Healthy Ohio Community Profiles, the U.S. Environmental Protection Agency, and the U.S. Census. In addition, we conducted an online survey of 76 environmental health professionals across Ohio.

Results. The secondary data indicates that there are significant differences between Appalachian and non-Appalachian Ohio in terms of socioeconomic, health, and environmental indicators. In addition, environmental health professionals perceive worse environmental conditions in the Appalachian region and indicate that there are environmental and health disparities found in this part of the state that do not exist elsewhere.

Conclusions. The results contribute to understanding environmental and health conditions that contribute to health disparities in the Appalachian region as well as suggest approaches for public health practitioners to reduce these disparities.

Keywords

Appalachia; Social Determinants; Environment; Disparities

Cover Page Footnote

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Environmental and Health Disparities in Appalachian Ohio: Perceptions and Realities

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ABSTRACT

Background Appalachia is a region of the United States that faces significant environmental and health disparities. Understanding these disparities and the social determinants that contribute to them are critical to reducing health inequities. The purpose of this research is two-fold. First, through secondary data analysis, we document environmental and health disparities as well as demographic and economic conditions that may contribute to these disparities between Appalachian and non-Appalachian Ohio. Second, we examine perceptions of environmental health practitioners about the differences in environmental conditions between Appalachian and non-Appalachian Ohio.

Methods We gathered secondary data about economics, health, and the environment from the Ohio Department of Health, Healthy Ohio Community Profiles, the U.S. Environmental Protection Agency, and the U.S. Census. In addition, we conducted an online survey of environmental health professionals across Ohio. Comparisons were made between the 32 Appalachian counties in the state and the 56 non-Appalachian counties.

Results The secondary data indicates that there are significant differences between Appalachian and non-Appalachian Ohio in terms of socioeconomic, health, and environmental indicators. In addition, environmental health professionals perceive worse environmental conditions in the Appalachian region and indicate that there are environmental and health conditions found in this part of the state that do not exist elsewhere.

Conclusions The results contribute to understanding environmental and health conditions that may contribute to health disparities in the Appalachian region.

Keywords: Appalachia, environment, social determinants

INTRODUCTION

The U.S. Centers for Disease Control and Prevention (CDC, 2013) and other public health agencies (AHRQ, 2012) are calling attention to the importance of documenting and understanding health disparities in order to improve the nation's health. To understand disparities

fully, we need to examine social determinants that contribute to health. The World Health Organization Commission on Social Determinants of Health (WHO, 2008) contends that focusing on social determinants of health, such as living conditions and economic inequality, is critical to reducing health disparities and achieving social justice. Social determinants of health “are the conditions of daily life” in which people are born, grow, live, work and age, and “are responsible for a major part of health inequities between and within countries” (WHO, 2008, 26).

In the United States, the national plan for improving health, *Healthy People 2020*, refers to the work of the WHO Commission and includes social determinants of health as critical benchmarks for achieving its goals (DHHS, 2013). The social determinants in *Healthy People 2020* include both social and physical factors that are important to address in order to reduce health disparities. Social factors include access to education and health care, socioeconomic conditions, and culture. Environmental conditions, such as green space, the built environment, and exposures to toxic substances, are examples of physical factors in *Healthy People 2020*. Because social determinants have a geographic scope, they contribute to a “place-based” approach to improving health, which is the overarching goal of *Healthy People 2020*.

Economic conditions substantially contribute to health and environmental disparities. Decades of research has documented that poor people are more likely to live in areas with worse environmental conditions than wealthier people (Bullard et al., 2008). In addition, research is demonstrating this relationship between living in poverty and adverse health outcomes in specific neighborhoods (Ludwig et al., 2011). Although both environmental and economic conditions contribute separately to health disparities, they also interact, amplifying disparities and enhancing vulnerability.

In the realm of public health vulnerability “refers to groups who, because of their position in the social strata, are commonly exposed to contextual conditions that distinguish them from the rest of the population” (Frohlich and Potvin, 2008, 218). These contextual conditions include environmental exposures, poverty, and health factors that are related to health outcomes. In both urban and rural areas in the U.S., those who live in poverty are more likely to be subject to environmental factors that can affect their health, including air pollution, facilities that emit toxic substances, and living conditions that contribute to specific health outcomes, such as lead poisoning. Because access to health care is often inadequate, the health impact of environmental exposures can be exacerbated by poverty. This can be viewed as a cycle in which poor people are more likely to suffer from poor health and are exposed more frequently to harmful environmental conditions that in turn contribute to their poverty and poor health.

In developing countries, environmental factors such as minimal or no access to clean water, indoor air pollution associated with cooking and heating, and lack of vector control result in acute illnesses such as diarrhea, respiratory disease, and malaria. While there appears to be higher rates of environmentally-related diseases in developing countries than developed countries (Prüss-Ustün, Bonjour, & Corvalán, 2008), social determinants affect public health in both. Regardless of a country’s development stage, poor people are more likely to live in areas which may contribute to adverse health outcomes that include both acute and chronic disease. Even though the poorest countries bear the greatest overall burden from environmental-related disease, it is the poorest people within any given country (including the United States) that suffer the most (PEN, 2008). In the United States some of the poorest people live in the Appalachian region and, like people in developing countries, their poverty makes them vulnerable to health impacts from environmental exposures (Hunter et al, 2011).

Because of historic and current economic, health, and environmental factors, the Appalachian region of the United States, which includes 420 counties in 13 eastern states, provides an opportunity to examine the relationship between social determinants and health disparities. Federal legislation first passed in 1965, and amended several times since, defines Appalachia as “abundant in natural resources and rich in potential,” but also a region that “lags behind the rest of the Nation in its economic growth and [whose] people have not shared properly in the Nation's prosperity” (Appalachian Regional Commission, n.d.). In defining Appalachia and providing targeted support for economic development of this area, U.S. Congress explicitly stated that Appalachia is different from the rest of the country. In other words, Appalachian people are vulnerable because of contextual conditions in which they live. This includes environmental conditions derived from the region's legacy of resource extraction (coal mining in particular) that are related to documented health disparities (Hendryx, 2008).

Despite past research in Appalachia, there are challenges to drawing conclusions about the relationship between poverty, the environment, and health factors that may result in disparate health outcomes. Measuring relationships between social determinants and health outcomes is compounded by the fact that health status is often measured qualitatively and sometimes anecdotally. Studies that assess actual health status through diagnostic testing are rare, and most of the research related to health disparities, specifically in Appalachia, relies instead on secondary data and self-reported measures of behavior and health (Fisher et al., 2008; Morrone, 2008). This situation suggests that research should include both objective and subjective data related to realities and perceptions of health disparities. Recently, public health professionals and community health researchers have been focusing on not only quantifying health disparities in Appalachia, but also seeking strategies for reducing these disparities including addressing health behaviors and perceptions of health (McGarvey et al., 2011; Griffith et al., 2011).

Within Appalachia, Ohio offers an interesting case study for identifying factors that may contribute to health disparities. Of Ohio's 88 counties, 32 are designated “Appalachian” by the Appalachian Regional Commission (ARC). With slightly more than one-third of the state located in Appalachia, comparisons can be drawn between the Appalachian and non-Appalachian portions of Ohio. In addition, there are distinct ecological, demographic, and economic differences between Appalachian and non-Appalachian Ohio. Ecologically, Ohio is divided into five major physiographic regions and the two regions that comprise the counties in Appalachia are part of what is identified as the “Appalachian Plateaus” (Brockman, 1998). While southeastern Ohio might not conjure up images of mountains, this unglaciated region of the state consists of hills and valleys, shale and sandstone, and is home of the Wayne National Forest.

The largest city in the 32 Appalachian Ohio counties is Youngstown which has a population of approximately 65,000 people; otherwise, the region is mostly rural. However, Appalachia is different from rural areas in the rest of Ohio in that, due to its rolling terrain, crop agriculture is not a major component of the local economy. The Appalachian counties are bordered by the Ohio River to the east which is a major shipping and industrial corridor. Some of the largest coal-burning power plants in the country are located in this region along with many significant manufacturing facilities. Appalachian Ohio also suffers from a legacy of poor environmental conditions related to resource extraction, specifically coal mining. Because of geology, there are significantly more acres of past, current and permitted coal mines in Appalachian than non-Appalachian Ohio. Water quality in the region has been affected by both past and present mining activities and specific attention is currently being paid to surface mining impacts on water quality in region (Hopkins et al., 2013).

The ARC monitors economic status of the Appalachian counties annually. Using three economic indicators, three-year average unemployment rate, per capita market income, and poverty rate, ARC categorizes the conditions in each county. The five categories that classify economic status are: 1) distressed, 2) at-risk, 3) transitional, 4) competitive, and 5) attainment. None of the 32 Appalachian Ohio counties are identified as competitive or attainment, which are the categories indicative of strong economies based on employment, income, and poverty levels. According to ARC, in 2014, seven Appalachian Ohio counties are distressed, meaning that they are among the worst 10 percent of the counties in the country. Eleven counties are at-risk and the remaining 14 are transitional.

These differences between Appalachian and non-Appalachian Ohio make examining the contextual conditions that may be related to health disparities possible. Thus, the goals of this research are two-fold: 1) to explore and compare documented and perceived socioeconomic, health, and environmental factors between Appalachian and non-Appalachian counties in Ohio, and 2) to examine relationships among economics, health factors, and the environment that could contribute to place-based health disparities.

METHODS

To better understand how socioeconomic, environmental, health factors and health outcomes differ between Appalachian and non-Appalachian Ohio and to examine the relationships between the environment, poverty, and health, we first analyzed existing secondary data. This data is used to exemplify some of the realities of contextual conditions between the two regions. In order to assess perceptions, we conducted primary research through the use of an online survey of Ohio environmental health professionals.

Secondary data analysis Table 1 summarizes existing data that was used to explore the relationships among the environment, poverty, and health throughout the state of Ohio. In an attempt to use the most current data, we consulted several sources for economic and demographic indicators including 2010 U.S. Census, the Ohio Department of Job and Family Services, the Ohio Department of Development, the 2010 American Community Survey, and the Economic Research Service of the U.S. Department of Agriculture (USDA). The U.S. Environmental Protection Agency (EPA) 2010 Toxic Release Inventory (TRI) is the source of emissions data, specifically the total pounds of pollution emitted reported by required facilities. The U.S. EPA's *Envirofacts* is the source of the numbers of facilities in each county in Ohio that have permits to emit pollution to the land, water, and air.

Table 1.

Summary of Publicly-available (Secondary) Data Sources Used in Analysis (All data collected on the county level, N= 88)

Indicator category	Variables	Data source
ECONOMIC	Per capita income	2010 US Census
	Median household income, 2010	USDA Economic Research Service
	Percent below poverty level	Ohio Department of Development, Ohio Poverty Report, 2011
	Percent unemployed	Ohio Department of Job and Family Services, 2011
ENVIRONMENTAL	Number of manufacturing jobs	2010 American Community Survey
	Total TRI releases in pounds	2010Toxic Release Inventory (US EPA)
HEALTH (Outcomes and Factors)	Number of permitted facilities	USEPA Envirofacts
	<u>Outcomes:</u> Cancer incidence per 100,000, (age adjusted)	Healthy Ohio Community Profiles, 2008, Ohio Department of Health
	Cancer mortality per 100,000, age adjusted	
	Asthma prevalence	
	<u>Factors:</u> Percent smoker	
	Percent with no physical activity	
	Percent overweight	
Percent obese		

To explore the consequences of pollution and the relationship between environmental conditions, health, and poverty, we gathered data related to health status. The health status

indicators include the health outcomes of cancer incidence and mortality per 100,000 in each county. Health factors are the second component of health status and include the percent of population in each county in regards to specific behaviors and characteristics. The Ohio Department of Health is the source of the cancer incidence and mortality data. The behavioral health indicators and characteristics were compiled from the 2008 Healthy Ohio Community Profiles.

For the data analysis, counties were coded as “1” if they are part of the 32 Ohio counties in the Appalachian region and “0” if they were not. This coding allowed for comparisons of Appalachian data with non-Appalachian data. The data were analyzed using descriptive statistics, correlations, and t-tests to identify significant differences in means between the two regions.

Survey of environmental health professionals In addition to examining existing secondary data, we conducted a survey of environmental health practitioners to gather professional judgment and perceptions about Ohio’s environment in general, important environmental health issues, and differences in conditions between Appalachian and non-Appalachian Ohio.

There are 125 local health departments (LHD) in Ohio. All 88 counties have at least one local health department and several counties have both city and county health departments. We were able to locate e-mail addresses of environmental health directors or staff from 111 of the 125 LHDs. However, despite several attempts, it was not possible to identify environmental health contacts for the remaining 24 LHDs, primary due to position vacancies. We sent personal emails to each contact requesting their participation in our online survey. Five emails were returned as “undeliverable,” leaving a population of 106 environmental health directors. The email invited each director to complete the online survey and to forward the email to others inside and outside of their organization. This “snowball” approach to recruiting survey respondents has limitations which are noted below.

As part of a larger study, participants responded to several questions about their perceptions of Appalachian Ohio including differences between Appalachian and non-Appalachian Ohio. Specifically, participants identified the first word that came to their mind when they looked at a map that identified the Ohio Appalachian region. Then participants indicated whether they believed that the 32 Appalachian Ohio counties experience different environmental problems than the rest of the state. Finally, the environmental health professionals specified whether 15 public health problems are better, worse, or the same in Appalachian Ohio compared to non-Appalachian Ohio. Survey data was analyzed using descriptive statistics.

RESULTS

Secondary data analysis The secondary data analysis suggests relationships among variables and significant differences between Appalachian and non-Appalachian Ohio counties in terms of demographic, environmental, and health indicators. The relationship between economics and health emerges when examining the correlations between poverty and unemployment and cancer. As Table 2 shows, poverty is positively correlated with both cancer incidence and cancer mortality. Unemployment also shows a positive significant correlation with cancer mortality. Not shown in Table 2 are the relationships between the health factors and the health outcomes which were significant. Table 3 compares demographic, environmental, and health indicators between Appalachian and non-Appalachian counties and suggests the impact that health factors may have on cancer incidence and mortality.

Table 2.

Correlation Coefficients

	POP	POV	UNEMP	MHI	PIC	MFGJO	MFGEA	TRI	PERM	REMFG	CANCI	CANCM
POV	.029											
UNEMP	-.213*	.496**										
MHI	.125	-.734**	-.572**									
PIC	.400**	-.637**	-.529**	.895**								
MFGJO	.948**	-.074	-.260*	.168	.445**							
MFGEA	.242*	-.516**	-.393**	.793**	.842**	.272*						
TRI	.154	.272*	.022	-.175	-.019	.172	.094					
PERM	.970**	.046	-.187	.050	.351**	.966**	.186	.204				
REMFG	-.105	.396**	.126	-.245*	-.183	-.140	-.062	.739**	-.089			
CANCI	.235*	.290**	.195	-.059	.076	.174	.202	.354**	.205	.230*		
CANCM	.036	.391**	.311**	-.308**	-.264*	.000	-.105	.169	.043	.179	.306**	
ASTHM	.197	-.346**	-.146	.223*	.282**	.371**	.113	.014	.275**	-.232*	-.135	-.118

* p < 0.05 (2-tailed); ** p < 0.01 level (2-tailed)

Key: POP (total population); POV (% poverty); UNEMP (% unemployed); MHI (median household income); PIC (per capita income); MFGJO (manufacturing jobs); MFGEA (earnings per MFG job); TRI (toxic release inventory); PERM (permitted facilities); REMFG (release per mfg job); CANCI (cancer incidence); CANCM (cancer mortality); ASTHM (asthma).

Relationships between environmental and socioeconomic conditions are also evident in the correlations between mean toxic releases per manufacturing job and mean household income and poverty. Toxic releases are negatively correlated with household income such that lower income is associated with more toxic releases per manufacturing job. Similarly, poverty is positively correlated with toxic releases per job indicating that greater poverty is associated with more toxic releases per manufacturing job. Finally, correlation coefficients suggest a relationship between environmental conditions and specific health conditions; specifically, positive relationships between toxic releases and cancer incidence and the number of permitted facilities and asthma.

In regards to exploring differences between Appalachian and non-Appalachian counties, we computed t-statistics for many of the variables to compare means. Table 3 summarizes comparisons using the t-statistic and shows the 32 Ohio Appalachian counties have lower median household incomes, lower numbers of manufacturing jobs, and lower per capita income compared to the 56 non-Appalachian counties. Appalachian Ohio also has higher rates of unemployment and poverty. According to the Ohio Department of Job and Family Services, the

Appalachian region includes nine of the 11 counties in the state with unemployment rates higher than 10 percent. All eight of the counties in the state with poverty rates above 20 percent are in Appalachia.

Table 3.
Comparisons of Means Between Appalachian and Non-Appalachian Counties in Ohio

Indicator	Appalachian Counties (32)	Non-Appalachian Counties (56)	<i>t</i> (df)†
Demographic/Economic Indicators			
Total county population	63,813	169,544	-2.97 (64) **
Percent below poverty ^a	17.23	11.21	7.32 (86)***
Percent unemployed	9.09	7.70	4.05 (50)***
Median household income	\$38,364	\$48,061	-7.52 (85)***
Per capita income	\$19,733	\$24,276	-7.22 (86)***
# of manufacturing jobs	4,565	12,740	-3.95 (73)***
Median manufacturing earnings ^a	\$36,161	\$40,496	-3.38 (86) ***
Environmental Indicators			
Mean TRI releases (lbs)	2,826,373	1,441,609	1.41 (38)
Mean number of permitted facilities	229	617	-2.99 (65)**
TRI releases per manufacturing job (lbs)	838	117	2.39 (28)*
Health Indicators			
Cancer incidence/100,000 ^a	465.64	448.12	2.88 (86)**
Cancer mortality/ 100,000 ^a	210.53	193.01	3.12 (86)**
Percent with asthma	5.78	6.92	-5.42 (49)***
Percent smoker	27.28	22.80	7.50 (35)***
Percent no physical activity	26.77	23.51	6.96 (37)***
Percent overweight	32.88	36.05	-5.89 (36)***
Percent obese	29.77	26.92	4.55 (36)***

Note. †All *t* values based on unequal variances, except items marked with an “a”

* *p* < .05, ** *p* < .01, *** *p* < .001

The pollution burden in each county is one indicator of environmental conditions that could lead to localized exposures. Table 3 shows that mean pollution releases per county, as reported by the TRI, are about 1.4 million pounds higher in Appalachian counties than in non-Appalachian counties; however, the difference is not statistically significant. Another way to assess pollution burden using the TRI is to look at the counties that report the most toxic releases. Of the top 10 counties in the state in terms of total releases reported in the TRI, seven of these are located in the Appalachian region and account for almost 45 percent of the total toxic releases in the state. A third way to look at the pollution burden of a community is to examine the mean toxic releases per manufacturing job (Matthews, 2010). In Ohio, Appalachian counties average 838 pounds of pollution per manufacturing job whereas non-Appalachian counties average only 117 pounds for each manufacturing job. Despite having greater toxic releases, Appalachian counties have significantly fewer permitted facilities per county indicating the localized impact of pollution from large emitters in the region.

Cancer incidence and mortality are two health outcomes that are significantly higher in Appalachian Counties. On the other hand, asthma incidence is higher in non-Appalachian counties. As Table 3 suggests, a main reason that cancer incidence is higher in Appalachian counties could be because people in Appalachia are more likely to smoke and less likely to be engaged in physical activity. These health factors should be taken into account as conclusions are drawn about differences between Appalachian and non-Appalachian counties in terms of health outcomes. Indeed, a significant challenge to health disparities research is that cause and effect relationships are difficult to identify and separate from confounding relationships, especially when it comes to complex, multi-causal health outcomes, such as cancer. There are myriad confounding factors that contribute to cancers, including chronic exposures to multiple environmental factors.

Survey of environmental health professionals In addition to exploring empirical data related to socioeconomic, environmental, and health indicators, we also documented perceptions of environmental health professionals. Seventy-six surveys were completed online, representing 43 counties, including 33 non-Appalachian and 10 Appalachian. Only 12 of the respondents represented city health departments, the remainder were affiliated with combined city/county or county health departments. Most of the respondents were environmental health staff or managers and 49 of the 76 respondents have been working in the field for more than 15 years. It is not possible to calculate a survey response rate because it is likely that the link to the online survey was shared within health departments, and this is one of the limitations of the purposive snowball sampling method.

The words that survey respondents most often associated with Appalachian Ohio were “poor” and “rural.” Survey results also indicate that environmental health professionals in Ohio perceive differences between Appalachian and non-Appalachian Counties. Nearly one-half of respondents indicated that Appalachian Ohio experiences different environmental health issues than the rest of the state (Figure 2). The environmental health professionals also perceived several issues, including the built environment, environmental justice, solid waste, oil and gas drilling waste, and oil and gas drilling, to be worse in Appalachia than the rest of the state (Figure 3).

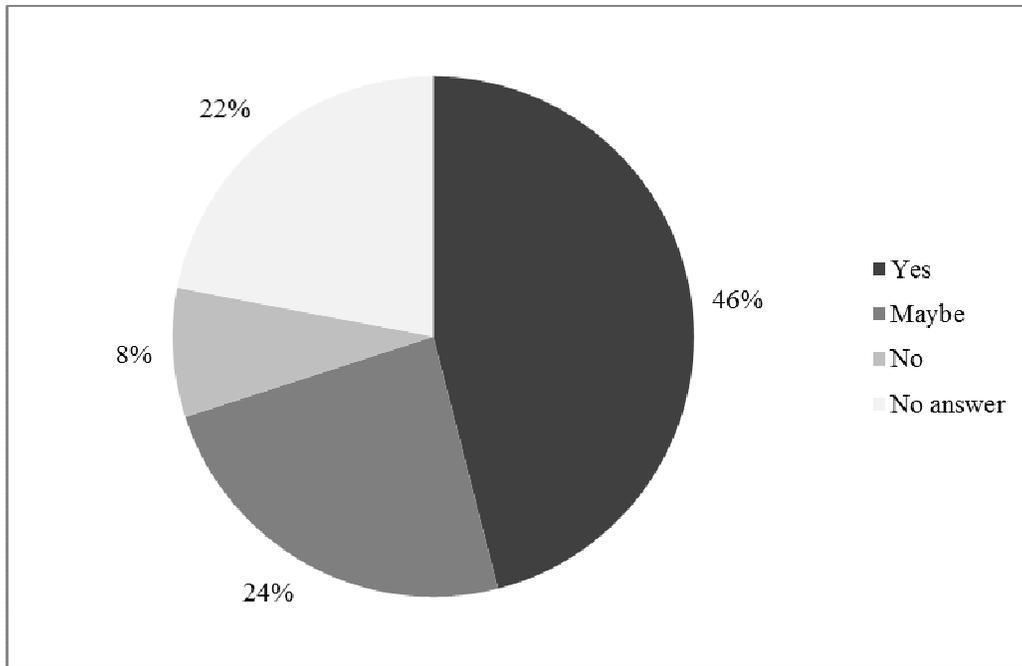


Figure 2. “In your opinion, do the 32 counties in Appalachian Ohio experience different environmental problems that the rest of the state?”
(n=76 environmental health professionals)

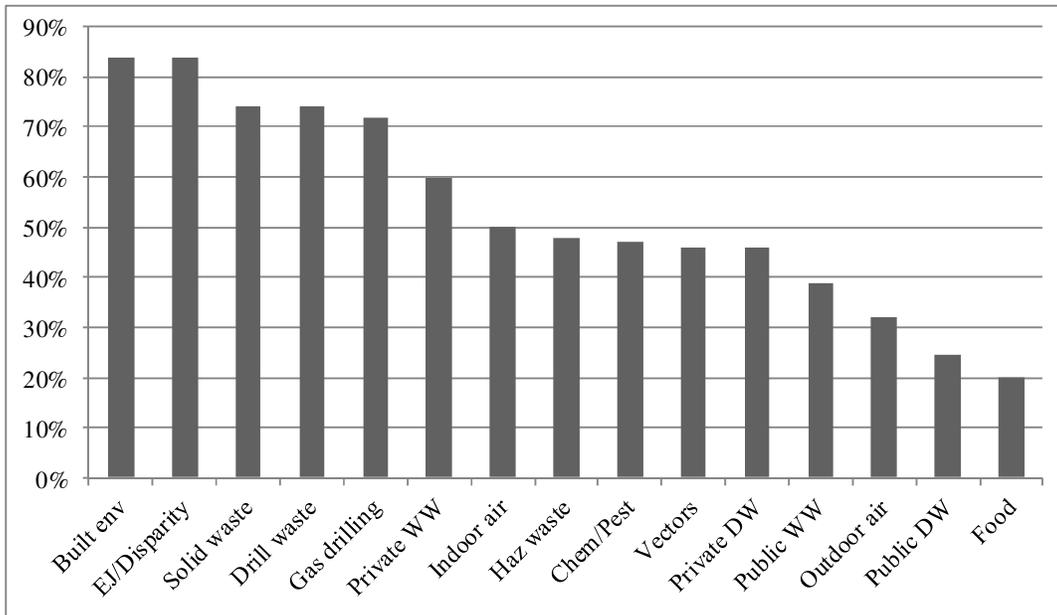


Figure 3. Percentage of respondents (EH Professionals) who believe these issues are worse in Appalachian Ohio than the rest of the state.

DISCUSSION

The results of this study contribute to health disparities research in several ways. First, it examines quantitative and qualitative data about the contextual conditions that distinguish two geographical regions. The quantitative data compares social determinants of health between Appalachian and non-Appalachian counties and suggests the presence of place-based disparities. The study further enhances health disparities research by including subjective perceptions of environmental health professionals in the state. The quantitative data are related to the *realities* of disparities in the state; the qualitative data are *perceptions* of disparities.

Realities Secondary data analysis indicates that Appalachian residents are poorer, less healthy, and exposed to worse environmental conditions than those who live elsewhere in Ohio. Statistically significant differences emerged between Appalachian and non-Appalachian Ohio in terms of demographic, environmental, and health factors, and since these conditions interact, Appalachian people are likely to be more vulnerable to disparate health outcomes than others. The health outcomes of cancer incidence and cancer mortality support the presence of disparities in Appalachia. In terms of socioeconomic factors, Appalachian Ohio has lower median household incomes, lower numbers of manufacturing jobs, lower per capita income, higher rates of unemployment, and higher poverty. Low income, poverty, unemployment and other socioeconomic indicators are associated with decreased access to health care (AHRQ, 2012), exacerbating disparities between Appalachian and non-Appalachian Ohio.

Appalachian Ohio has higher cancer incidence and mortality; however, these differences must be interpreted with caution since they may be related to lifestyle and behavior. Residents of Appalachia are more likely to smoke and self-identify as obese, but less likely to engage in regular physical activity than non-residents. On the other hand, those living outside of Appalachia in Ohio are more likely to have asthma. Health outcomes are used as one indicator of possible consequences from environmental exposures, but it is not possible to draw conclusions that environmental conditions cause health outcomes because there are too many factors that can contribute to cancer in particular.

Environmental indicators examined in this study suggest that Appalachian counties are vulnerable to pollution as measured by several sources of data. Although there are fewer facilities with permits to emit pollution in Appalachian Ohio, there are higher levels of reported pollution releases. This suggests localized, or place-based, environmental exposures because the average amount of pollution emitted from each facility in Appalachian counties is higher than non-Appalachian. This localized impact is found in the data that show significant differences between the two regions in terms of reported toxic releases per manufacturing job which is much higher in Appalachia. So, while there are fewer manufacturing facilities in Appalachia, they produce more pollution for every job that is associated with them. In other words, the TRI facilities in Appalachia report higher overall releases than those outside of the region.

The data also support the interactions between environment, health factors, and the economy that contribute to health disparities. First, since reported toxic releases are positively correlated with cancer incidence, questions can be raised about the impact that localized pollution may have on health. Second, poverty is positively correlated with cancer incidence and mortality and unemployment is also positively correlated with cancer mortality. This relationship suggests that, while employment status might not affect the diagnosis of cancer, it could affect treatment since higher unemployment rates are related to higher rates of cancer mortality. The higher levels of mortality are also likely the result of access to health care. Finally, lower income and greater poverty are associated with more toxic releases per manufacturing job, so poorer

people live near facilities that generally emit more pollution which further heightens their vulnerability to numerous health outcomes. Even though there are differences in health outcomes between the two regions, it is important to reiterate that it is not possible to draw conclusions about cause and effect relationships.

Perceptions The realities that the secondary data analysis suggests are both understood and misunderstood by environmental health (EH) professionals in Ohio. Survey data indicate that those most closely involved in managing environmental health conditions in order to prevent adverse health outcomes understand that there are differences based on where people live in Ohio. These professionals perceive Appalachia as poor and rural and identify specific environmental health conditions that they believe are worse in Appalachia than the rest of the state. Private wastewater management (e.g., septic systems), solid waste disposal, environmental justice, and the built environment are perceived as worse in Appalachian Ohio.

On the other hand, EH professionals believe that the region has better food quality, drinking water, and outdoor air quality than the rest of the state. Only 32 percent of the respondents perceive outdoor air quality worse in Appalachia, 24 percent perceive public drinking water worse, and less than one-half perceive hazardous waste as a bigger issue in the region. However, the secondary data examined in this study suggest that this may not be reality especially based on the magnitude of toxic releases in Appalachian Ohio.

Strengths and limitations The results presented here must be understood in the context of the strengths and limitations of the data and methods. The strengths of this research are that it examined numerous data sources to explore the contextual conditions that could be related to health disparities between Appalachian and non-Appalachian Ohio. By using multiple sources for our secondary data, we avoid any systematic bias that might be present in one particular data source. Additionally, the combination of both objective realities and subjective perceptions suggests possible policy implications, especially when perceptions of health officials diverge from existing quantitative data.

Despite its strengths, this research also has limitations. Multiple data sources are also a limitation because of their temporal nature. While attempts were made to include data from the same year, this is not possible with all data sources. This is especially the case with data that compared Appalachian to non-Appalachian Ohio in terms of health outcomes since this comparison was only made in 2008 as part of a special report. In addition, we rely on data from both federal and state sources that are constantly evolving, so comparisons made here might not be consistent in future studies. The main source of environmental indicators, the Toxic Release Inventory, is a dataset with numerous limitations including the fact that it based on self-reported estimates of pollution releases and reporting requirements change periodically. Nevertheless, the TRI is considered the best source of quantitative emissions data for the purpose of comparing pollution in both time and place.

An additional limitation is found in using the county as the geographic level of analysis. Selecting the geographic level of analysis can significantly affect how exposures are documented (Chakraborty, Maantay, & Bender, 2011). When the county is the level of analysis, neighborhoods close to county borders may not be identified as being at risk from a polluting facility in the adjacent county, even if they are relatively close to the facility. However, using county boundaries has the advantage of being able to compare multiple sources of data including demographic, environmental, and health since Appalachian Ohio is identified by counties.

Finally, correlating variables and comparing means do not suggest cause and effect relationships between the environment, health, and economic conditions. Rather the results

indicate relationships among the variables and differences between Appalachian and non-Appalachian Ohio on factors that contribute to vulnerability to health disparities. Quantifying cause and effect relationships is very rare in environmental justice and health disparities research, often because there are too many confounding factors that contribute to the health outcomes (e.g. cancer and asthma) that also may be related to environmental conditions. It is also rare to find data sets that provide data on the same geographic scale that would enable cross-dataset comparisons. The small sample size of 88 counties, 56 non-Appalachian and 32 Appalachian, as well as the different dataset specificity inhibit the use of more sophisticated analysis that would enable the identification of causes and effects. Despite our inability to draw conclusions about causes and effects, this research presents relationships that are fruitful for additional study.

CONCLUSION

As the public health profession continues its focus on reducing health disparities and creating health equity, this research supports the fact that “health disparities are driven by a combination of social factors” (APHA, n.d.). It will take a coordinated approach that addresses socioeconomic, environmental, and health factors that lead to health disparities to make progress in improving everyone’s health. Even so, this research suggests that there are interactions among the social determinants of health, such that addressing one could result in changes to others. Reducing environmental exposures by focusing on areas with high poverty rates could improve health of vulnerable populations and reduce place-based health disparities. On the other hand, reducing environmental exposures caused by manufacturing facilities could also lead to policies that result in greater unemployment, which could negatively affect health outcomes.

Public health practitioners who make policy decisions should be aware of the realities and perceptions of conditions in the localities in which they work. Understanding why there are discrepancies or inconsistencies between reality and perception could lead to more effective programs and policies that could minimize health disparities. CDC notes that one of the first steps to reducing disparities is “to shine a bright light on the problem to be solved” (CDC, 2013) and this research offers compelling data that can assist public health practitioners in shining this light.

There are several unanswered questions that still persist when it comes to health disparities research. Even though data is suggestive of the impact that social determinants can have on health disparities and public health professionals are aware of these disparities, linking social determinants to actual health outcomes will remain an area ripe for research for many years to come. Combining quantitative research using geographic information systems, secondary data sources, and monitoring data with in-depth qualitative research such as health status surveys and professional opinion help us see potential relationships among poverty, health, and the environment. However, identifying cause and effect will endure as a research question related to health disparities.

Many health disparities are a function of multiple social determinants, including those that are specifically linked to place and culture. Future research that examines beliefs and perceptions of populations at risk could contribute to more effective strategies in reducing health disparities. This research should be community-based in order to increase the likelihood that public health interventions are realistic and tailored to the needs and capacity of the population at risk.

Appalachian Ohio has significant economic, environmental, and health factors that may contribute to health disparities compared to non-Appalachian Ohio. Only through the continued efforts of public health practitioners to address the social determinants and contextual conditions will we make progress toward reducing the disparities. This research is one step toward understanding the objective and subjective disparities that exist, the relationships between disparities, and implications for public health practice.

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