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Investigating the relationship between hazardous waste sites, cancer, obesity, and diabetes prevalence in Mississippi

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Abstract

Mississippi ranks high nationally in terms of obesity, diabetes, and cancer prevalence rates in its population, and in the total amount of hazardous waste disposed and/or released into the environment. The U.S. Environmental Protection Agency and the Mississippi Department of Environmental Quality have identified many dangerous chemicals at hazardous waste sites which have been linked to the illnesses of cancer, diabetes, and obesity. Using data obtained from the Mississippi Department of Environmental Quality and the Mississippi State Department of Health, this study examined relationships between hazardous waste sites, population, environmental quality, cancer, obesity, and diabetes prevalence rates at the county level in Mississippi. Findings from this study indicated there was a statistically significant linkage between hazardous waste sites and diabetes; but not hazardous waste sites and obesity and/or cancer rates. Study findings also indicated the possibility of many other factors influencing or explaining the obesity, diabetes, and cancer rates examined in this study. This study also found substantial open and "hidden" healthcare/non-healthcare costs possibly associated with hazardous waste sites. Taken collectively, these findings are consistent with research literature findings of possible, but not definitive, linkages existing between hazardous waste sites at the local level and local health problems. The public policy implications of this study include the need to re-examine planning, siting and the regulatory enforcement of hazardous waste sites at the local level, and the need to re-examine the planning and allocating of healthcare resources to combat possible illnesses associated with hazardous waste sites.

Introduction

This study examined the impact of hazardous waste sites on selected health indicators in Mississippi's 82 counties. The State of Mississippi has been identified as being among the least healthy states in the country (America's Health Rankings, 2013). Some research has found a link between poor health outcomes in some communities and geographic proximity to hazardous waste sites (Brender, 2011). This study specifically investigated whether there is a statistically significant relationship between obesity, diabetes, and cancer rates, and the number of hazardous waste sites at the county level in Mississippi.

The major areas discussed in this study include the amount of hazardous waste being disposed and/or released in Mississippi; significant health issues prevalent in Mississippi; research literature examining possible linkages between selected health indicators and hazardous waste sites; the study's methodology and resulting data analysis findings; and the policy implications connected with study findings. The goal of this study was to provide additional insight regarding possible linkages between hazardous waste sites and selected health indicators in Mississippi counties. As Mississippi continues to move forward with the recruitment of various types of industries and businesses that emit high volumes of hazardous waste, great care should be taken to consider all costs including those healthcare costs that may not be overtly evident. This study's intent is to encourage Mississippi officials to more fully consider the "open and hidden impact" of economic development and healthcare decisions involving hazardous waste facilities.

Defining Hazardous Waste

Hazardous waste is defined as any waste or combination of waste which because of its quantity, quality, concentration, physical, chemical, or infectious characteristics could cause or significantly contribute to adverse effects in the health and safety of humans or the environment if improperly managed (United States Environmental Protection Agency [EPA], 2013). General characteristics of hazardous waste include the qualities of ignitability, corrosivity, reactivity or toxicity (EPA, 2011a). Improperly disposed hazardous waste has been linked to infections, chemical instability, damage to ecosystems and natural resources (Grasso, Kahn, Kaseva, & Mbuligwe, 2013). Sources of hazardous waste include chemical and industrial manufacturing companies, research laboratories, mining sites, agricultural facilities, healthcare facilities, contaminated waste sites, domestic households, commercial facilities (e.g., dry cleaners, auto repair shops, gasoline stations, photo processing centers, and other facilities that discharge harmful liquid, gaseous, or solid wastes into the environment) (EPA, 2013; Grasso, Kahn, Kaseva, & Mbuligwe, 2013). One of the difficulties in linking specific illnesses to hazardous waste is that often several different mixtures of contaminants comprise the hazardous waste. This mixture of contaminants makes it difficult to link specific illnesses to specific types of hazardous waste materials (Hu, Shine, & Wright, 2007).

Hazardous wastes are regulated by the United States Environmental Protection Agency (EPA) in Washington, DC through the Resource Conservation and Recovery Act (RCRA). As discussed later in this article, Mississippi is home to many hazardous waste sites emitting many different chemicals and substances found hazardous to humans and wildlife. All of Mississippi's 82 counties contain at least one hazardous waste site.

Hazardous Waste in the United States

Since World War II, it has been estimated that millions of hazardous waste tonnage has been produced and distributed across the United States annually (Hu, Shine, & Wright, 2007). In the United States, over 40 million tons of hazardous waste is produced each year by more than 20,000 hazardous waste generators (EPA, 2013). These estimates also include over 15,000 hazardous waste sites of which approximately 1,400 are listed on the EPA's National Priorities List, commonly known as Superfund Sites (Hu, Shine, & Wright, 2007). A study conducted by the U.S. Agency for Toxic Substances and Disease Registry of 3,000 contaminated sites found approximately 20% of the sites have waste exposures "above acceptable risk levels"; 40% of the sites were found "not to represent a public health hazard"; and approximately 1% of the sites were considered "urgent public health hazards" that could cause an immediate threat to life or health" (Dearwent, Mumtaz, Godfrey, Sinks, & Falk, 2006). A study by the U.S. Centers for Disease Control and Prevention ([CDC], 2009) of the U.S. population's exposure to 212 environmental chemicals found wide-spread exposure (via representative blood and urine samples) to the following chemicals: polybrominated diphenyl ethers used in fire retardants; bisphenol A found in epoxy resins and polycarbonates used as protective coatings in metal and plastic containers; and perfluorinated chemicals used to create heat-resistant non-stick coatings in cookware. The chemicals included in the CDC study were found to be "present in air, water, food, soil, dust, and/or other environmental media" (CDC, 2009).

Roughly one fourth of all people in the United States live within four miles of a highly polluted toxic waste site and between three and four million of these people are children under the age of 18 (Landrigan, 1997). The increasing number of hazardous waste sites has been found to contribute to poor environmental health conditions (Landrigan, 1999). Evidence has also been found that links exposure to chemicals and other environmental substances to heart health illnesses and diseases (Weinhold 2004). Several studies have found that many economically impoverished communities are exposed to greater health hazards in their homes, on the jobs, and in their neighborhoods when compared to their more affluent counterparts (Bullard and Johnson, 2000; Bryant & Mohai, 1992; Lipfert, 2004). A study conducted by the United Church of Christ (2007) found host neighborhoods with commercial hazardous waste facilities had a racial composition of 56% minority group members; whereas non-host areas had a racial composition of 30% minority group members. Thus, the location of hazardous waste facilities appears to be in communities that have minority members comprising the largest racial category (Bullard and Johnson, 2000).

Hazardous Waste in Mississippi

According to the EPA for Fiscal Year 2011, Mississippi disposed of and/or released approximately 56,288,300 pounds of waste materials by way of air, surface water, and landfills (EPA, 2011b). In comparison to other states for FY 2011, this amount ranked Mississippi 18th nationally in terms of the total amount of waste disposed of and/or released. This amount includes liquid, solid, and air-born chemicals and metals that could potentially have adverse effects on human health and the environment. (Pease, 2013) Again using FY 2011 data, the largest sources of reported contaminated releases were air emissions (17,479,500 pounds), surface impoundments (10,239,652 pounds), and surface water discharges (4,676,879 pounds) (EPA, 2011b).

Hazardous Waste and Health Problems

Human health problems that have been found to result from exposure to hazardous waste materials include dizziness, headaches, infections, nausea, skin irritations, mental and physical disabilities, sensory organs' failures, musculosketal impairments, neurological impairments, cancer, respiratory illnesses, cardiovascular system failure, liver and gastrointestinal system failure, slow growth and development, reproductive system failure, kidney failure, birth defects, immune system impairments, and death (EPA, 2011a; Grasso, Kahn, Kaseva, & Mbuligwe, 2013; Pease, 2013; U. S. General Services Administration , 2012) 2012; Vrijheid, 2000). Some of the more common chemicals found to be linked to the previous illnesses/diseases include arsenic, ammonia, cadmium, nickel, aluminum, methyl mercury, lead, silica, tetrachloride, trichloroethylene, polybrominated biphenyls, dioxins, chlorobenzene, and vinyl chloride (Pease, 2013). The type of illness/disease resulting from exposure to hazardous waste is dependent upon such factors as the duration of the exposure, the amount of waste encountered, the toxicity level of the waste, the method of exposure encountered (e.g., inhaled, ingested, dermal), and a person's susceptibility level to certain types of waste (EPA, 2011a).

The research literature on human health problems related to hazardous waste is varied regarding the extent to which such problems are directly connected to hazardous waste. Several studies have found mixed-to-inconclusive results regarding the impact of certain hazardous waste contributing to illnesses such as cancer (Russi, Borak, & Cullen, 2008; Vrijheid, 2000). Factors impacting the conclusiveness of hazardous waste on human health include researcher biases, the presence of confounding factors (e.g., personal, environmental stress, and sociological determinants), the use of single-site versus multi-site studies, the lack of epidemiological and toxicological studies linking specific chemicals to specific health problems, the lack of accurate biomarkers, difficulty in isolating specific causes of health illnesses, the use of self-reported data regarding health problems, poor data quality, difficulty in determining actual exposure levels, and the latency period between waste exposure and the emergence of illnesses/diseases (Ritter, et al., 2002) (Russi, Borak, & Cullen, 2008; Vrijheid, 2000). There is also research which strongly cautions against making assumptions solely based upon using "proximity as a surrogate for exposure" (Golden & Schell, 2008). All of these factors should be kept in mind when reviewing and interpreting the results of this study.

Prevalent Health Problems in Mississippi

Mississippi is among the nation's leaders in many chronic disease indicators (CDC, 2013). For example, Mississippi ranks 50th among states in cardiovascular disease mortality rates, infant mortality rates, obesity prevalence rates, and life expectancy rates (Kaiser, 2013). Mississippi also consistently ranks high among states in terms of cancer mortality rates, diabetes mortality rates, chronic obstructive pulmonary disease mortality, and premature mortality rates among adults (CDC, 2013). In a national comparison ranking of overall health indicators, Mississippi has consistently been ranked among the bottom three states since 1990 (United Health Foundation, 2012). Due to the chronic nature of obesity, diabetes, and cancer rates in Mississippi, these health conditions have been selected as the focus of this study.

Open and "Hidden" Costs of Health Care and Economic Development

In 2004, Mississippi spent a total of $14.6 billion on healthcare (Dorgan, 2009). The estimated annual healthcare cost attributed to adult obesity (in 2003 dollars) was $757 million, of which $223 million was covered by Medicare, and $221 million was covered by Medicaid (Mississippi Department of Education's Office of Healthy Schools). These costs, when coupled with the costs of tax and business incentives provided by state and local governments, begin to reveal a more accurate cost of economic development and healthcare in Mississippi. The next section provides a brief summary of research examining the overall costs of tax and business incentives provided by state and local governments. This section is included to highlight how the recruitment of large-scale hazardous waste producers can often contain hidden costs that appear "before and after" a facility is operational.

The use of economic incentives such as tax credits and business assistance programs have a long history with Mississippi being among the first states to utilize such policies (American Federation of Teachers [AFT], 2009). There is an ongoing debate among some researchers and economic development practitioners as to whether the use of such economic development incentives can be justified when all costs are considered against the proposed benefits such as the total number of jobs created (AFT, 2009; Rolnick, 2007; Moore, Meck, & Ebenhoh, 2006). Issues such as whether financial investments made by state and local governments are better spent on public goods (e.g., education, healthcare) than in providing various economic development incentives to private firms are central to debate (AFT, 2009; Rolnick, 2007; Austrian & Norton, 2002).

The Mississippi Development Authority, the state's official economic development agency, offers over 25 tax exemptions, incentives, and credits to businesses and industries for the purposes of getting them to locate or remain in the state (Mississippi Development Authority [MDA], 2013). The yearly financial costs of such incentives are considerable. It has been estimated that for FY 2011, the costs of these incentives (known as "tax expenditures") to the Mississippi General Fund from the "Corporate Income Tax" category was estimated to be $64,027,000 (Center for Policy Research and Planning [CPRP], 2010). It should be noted that this amount does not include figures which were not made available for such programs as the Redevelopment Project Incentive

Fund, Growth and Prosperity Area program, and Fee-In-Lieu fund (CPRP, 2010) (AFT, 2009). Recent examples of state and local incentive packages offered to major manufacturing companies include the $363 million incentive package provided to the Nissan Canton Auto Assembly plant in 2000; and the $330 million incentive package provided to Toyota for its Blue Springs Auto Assembly plant in 2007 (AFT, 2009). For FY 2011, Mississippi reported an average monthly manufacturing employment total of 135,351 jobs, with an accompanying annual payroll of $5,657,827,080 (Mississippi Department of Employmenet Security [MDES], 2011). Using a 4% state payroll tax, the yearly amount of individual state tax generated (before personal exemptions and tax credits are applied) would equate roughly to $237,628,737. This amount is significantly less after personal exemptions and tax credits are applied.

In economic development circles, the use of such incentives and subsidies are viewed as acceptable as long as the revenue and jobs created are representative of the amount of public funds invested (Austrian & Norton, 2002; Moore, Meck, & Ebenhoh, 2006; Rolnick, 1993;). However, some research has shown that the benefits derived from such public investments have not been equal or close and that these types of public investments are not in the taxpayers' best interest (AFT, 2009; Rolnick, 2007). When the costs of health care for the treatment of cancer and obesity-related illnesses are also considered, the economic benefits become much smaller overall and detrimental.

Obesity, Cancer, Diabetes and Hazardous Waste

With obesity, cancer rates, and diabetes becoming national health problems impacting millions of individuals and families, the physical and economic costs of these three health conditions are considerable. The following narratives provide a discussion of these illnesses and their relationship to hazardous waste sites.

Based upon research by Kenneth E. Thorpe (2009), obesity is depicted as the fastest growing public health challenge this nation has ever encountered. The United States is expected to spend $344 billion on healthcare costs attributable to obesity in 2018 if rates continue to increase at their current levels, which will account for over 21 percent of the country's direct healthcare cost spending in 2018 (Thorpe, 2009). Medical costs for obesity in 1998 were estimated to be approximately $78.5 billion with an increased prevalence of obesity being responsible for almost $40 billion of increased medical spending through 2006, and it was estimated the medical costs associated with obesity would rise to over $147 billion per year by 2008 (Finklestein et al., 2009).

There is a growing body of research suggesting possible linkages between obesity, diabetes, cancer rates and chemicals commonly associated with hazardous waste sites (Cureton, 2011; Holden, 2007; Latini, et al., 2009). Much of this research is based upon the identification of chemicals such as bisphenol A (BPA), polybrominated diphenyl ethers (PBDE), phthalates, and tetrachlorodibenzo-p-dioxin (TCDD) negatively impacting the function of insulin and other human hormones resulting in inflammation and tumors (Belli, 2008; Holden, 2007; Latini et al., 2009). As was discussed earlier, many of these chemicals are used to make plastic, glass and metal items, and are used to coat cooking utensils. There is also research indicating that hazardous waste sites pose higher risks for certain types of illnesses such as cancer, asthma, lead poisoning, and obesity by way of transmission through air, water, and soil (via food) pathways (Cureton, 2011; Hellmich, 2003, p. 7D; Lawrence & Fudge, 2009;). Other health issues commonly associated with obesity are high blood pressure, high cholesterol, back pain, skin infections, ulcers and gallstones.

Cancer is another medical condition that is potentially impacted by the number and types of hazardous waste sites near human populations. For example, Rachel Cernansky states, "There's a region in Louisiana known as cancer alley (or chemical corridor, take your pick).You can guess why. Cancer claims victims at an alarming rate along the 85-mile stretch of the Mississippi River between Baton Rouge and New Orleans, where more than 140 industrial plants spew pollution into the air and water" (Cernansky, 2011). Of all the chronic diseases, cancer is the second leading cause of death in the U. S., killing more than half a million Americans every year, according to CDC (2013). The costs associated with cancer rates are enormous. The National Cancer Institute (NIC) estimates the total cost for treating cancer escalated from $95.5 billion in 2000 to $124.6 billion in 2010, and is projected to be $158 billion for direct cancer care by 2020. (U.S. Department of Heatlh and Human Services [USDHH], 2011). In considering the increase in medications cost and other new treatments and technologies being marketed, NIC raises the 2020 cost projection to a possible $207 billion (USDHH, 2011).

Diabetes mellitus was the seventh leading cause of death in the United States in 2011 with 73,282 deaths, a rate of 23.5% (age adjusted death rate per 100,000 population) (Hoyert, 2011). The total health care cost for the treatment of diabetes in 2007 was approximately $174 billion (MSDH, 2007). Of this total, direct medical costs (e.g., hospitalizations, medical care, treatment supplies) account for about $116 billion with $58 billion of the total cost covering indirect cost such as disability payments, time lost from work and premature death (MSDH, 2007). According to a new study released by The American Diabetes Association March 6, 2013, the estimated total costs of diagnosed diabetes had risen to $245 billion in 2012, which is a 41% increase over a five-year period (Petersen, 2013).

According to 2008 CDC data, approximately 245,000 people in Mississippi (10.9% of the state's population) had diagnosed diabetes, and many suffer from serious diabetes-related complications or conditions (Hausner, 2008) In 2010, Mississippi ranked the second highest in the United States for overall diabetes prevalence, with 270,000 adult Mississippians having type 2 diabetes which is over 12% of the adult population, and a death total of 926 Mississippians (Petersen, 2013). In 2012, Mississippi's estimated cost for diabetes care (i.e., medical and indirect) was approximately $2.74 billion (Petersen, 2013). There has been some research linking diabetes and hazardous waste sites due to exposure from certain types of chemicals such as dioxins and "POPs" (persistent organic pollutants) (Brown, 2008; Haidong, Jian, & Bingheng, 2004; Kouznetsova, 2007). For example, researchers from the University of Albany found that people living near hazardous waste dumps are significantly more likely to be hospitalized for diabetes, indicating that environmental toxins might contribute to causes of diabetes risk (Kouznetsova, 2007). Given the current and projected costs associated with obesity, diabetes, and cancer rates, along with Mississippi being among this country's leaders in the total amount of waste disposed/ released into the environment, this study's intent was to investigate the relationship between hazardous waste sites, environmental quality, cancer, diabetes, and obesity.

Methods

Design. This study deployed a non-experimental, correlation methodology based upon the use of cross-sectional secondary data. One of the strengths of this design is its ability to identify associations between variables (Schutt, 2009) One of the weaknesses of this design is its inability to identify specific causal relationships.

Data Collected. Historical data were collected from the Mississippi Department of Environmental Quality (MDEQ), the Mississippi State Department of Health (MSDH), and the United States Census Bureau. Table 1 provides a listing, description, and location of the variables analyzed in this study.

As noted in Table 1, hazardous waste sites' data were retrieved from the Mississippi Department of Environmental Quality (MDEQ, 2013). Data were collected and aggregated on 1,842 sites located in 81 Mississippi counties covering the time period of 1970 through 2013. The property sizes of these sites range from less than 1 acre to approximately 1,100 acres. The types of facilities composing these sites were diverse ranging from banks to gasoline stations to industrial factories (State of Mississippi CERCLA/Uncontrolled Sites List). Some of these sites have been listed on the EPA's National Priority List (NPI) as Superfund sites. Major waste contaminants documented at these sites by the MDEQ and/or U.S. EPA included benzene, petroleum, trichloroethene, lead, mercury, PCB, pentachlorophenol, arsenic, creosote, gasoline, benzidine, formaldehyde, asbestos, ammonia, dioxin, and toxaphene (MDEQ, 2013).

The environmental quality variable, as constructed in the MSDH Health Outcome Rankings report, was comprised of two measures: (1) average daily fine particulate matter defined as the average daily measure of fine particulate matter in micrograms per cubic meter in a county; and (2) drinking water safety defined as the percentage of the population getting drinking water from public water systems with at least one health-based violation (MDHS 2013). Obesity, diabetes, and cancer rates were transformed into rates per 100,000. The population data were gathered from the U.S. Census Bureau using actual population counts for each county. The county population totals ranged from 4,892 residents to 248,184 residents.

Table 1. Listing of Primary Variables Utilized in Study

Variables	Measurement	Source
Cancer	Average Annual Count by County	National Cancer Institute, State Cancer Profiles, 2005-2009, www.statecancerprofiles.cancer.gov /incidence rates (Mississippi)
Obesity	Total # Count for Each County (2009)	Centers for Disease Control and Prevention, Diabetes Public Health, OBESITY PREVALENCE, www.cdc.gov/diabetes/ atlas/countydata/County_EXCELstatelistOBESITY.html
Diabetes	Total # Count for Each County (2009)	Centers for Disease Control and Prevention, Diabetes Public Health, Diabetes Interactive Atlases http://www.cdc.gov/diabetes/atlas/countydata/atlas.html
Total Waste Sites	Total # of Hazardous Waste Sites by County	Mississippi Department of Environmental Quality, CERCLA / Uncontrolled Sites File List http://www.deq.state.ms.us/MDEQ.nsf/page/GARD_home?OpenDocument (Sites Listed Through 2012)
Envir.Quality (Composite Variable)	* Percentage of population exposed to water exceeding a violation limit during the past year	Robert Wood Johnson Foundation. (2013a). *County health rankings and roadmaps environmental quality.* Princeton: NJ. Available from http://www.countyhealthrankings.org/our-approach/health-factors/environmental-quality

	*The average daily measure of fine particulate matter in micrograms per cubic meter (PM2.5) in a county	
Population	Population counts (2011)	Robert Wood Johnson Foundation. (2013b). *County health rankings and roadmaps Mississippi rankings data 2011.* Princeton: NJ. Available from http://msdh.ms.gov/msdhsite/scripts/ExternalLinkHandler.cfm?returnURL=http://msdh.ms.gov/msdhsite/_static/31.html&destination=http://www.countyhealthrankings.org/mississippi

Procedures. Using aggregated hazardous waste sites data, environmental quality data, population data, and obesity, diabetes, cancer rates data, a two-phase statistical analysis was conducted. The first phase utilized correlational analysis comparing the independent variables (total hazardous waste sites, environmental quality) and dependent variables (obesity, diabetes, cancer rates per 100,000). The second phase utilized a between-group analysis examining rate differences between the dependent variables when viewed from two distinct population groupings. The next section presents this study's findings utilizing this two-phase analytical approach.

Results/Findings

Correlational Analysis

Table 2 shows the correlation findings involving the variables examined in this study. Cancer, obesity, and diabetes rates per 100,000 were the dependent variables. Total hazardous waste sites (THWS) and Environmental Quality (EQ) were the independent variables. The correlations findings between THWS, cancer rates per 100,000 and obesity rates per 100,000 indicated a weak negative relationship that was not statistically significant for those two variables. A weak negative, statistically significant relationship was found between THWS and the variable diabetes rates per 100,000.

The correlations findings between the independent variable Environmental Quality (EQ) and cancer rates per 100,000 indicated no statistical correlation (.000) between those two variables. A weak negative correlation (-.113) was found between EQ and obesity rates per 100,000, and a weak positive relationship (.038) was found between EQ and diabetes rates per 100,000. The relationships among all three dependent variables and EQ were found to be statistically insignificant at the $p < .05$ level (i.e., cancer.999, obesity.316, and diabetes .740).

In examining correlations among the three dependent variables, diabetes rates per 100,000 and obesity rates per 100,000 were found to have a strong positive relationship (.767) that was statistically significant. There was also a moderately positive relationship (.543) between diabetes rates per 100,000 and cancer rates per 100,000 that was also significant.

Between-Group Analysis

As discussed earlier, the analysis of between-group differences was derived by dividing the 81 counties into two groups based upon the mean population value (36,754) for those counties. The obesity, diabetes, and cancer (ODC) rates were then compared for those counties with a population above 36,754, and for those counties with a population below 36,754. As can be seen in Table 3, there are wide ranges in reported values across the 81 counties examined for this study. These wide ranges in population counts and number of hazardous waste sites makes accurate obesity, diabetes, and cancer (ODC) rates comparisons more challenging given the possibility of many other variables being present in the larger counties. However, these values do begin to describe the relationship of these variables to each other within the context of this study.

Table 2. Correlation Matrix

		Cancer per 100,000	**Obesity per 100,000**	**Diabetes per 100,000**
Total Hazardous Waste Sites (THWS)		-.118	-.144	-.257[b]
	Sig. (2-tailed)	.294	.201	.020
	N	81	81	81
Environmental Quality		.000	-.113	.038
	Sig. (2-tailed)	.999	.316	.740
	N	81	81	81
Diabetes per 100,000		.543[a]	.767[a]	1.000
	Sig. (2-tailed)	.000	.000	
	N	81	81	81

[a] Correlation is significant at the 0.01 level (2-tailed).

[b] Correlation is significant at the 0.05 level (2-tailed).

Table 3. Mean Values for Selected Variables

Variable	N	Minimum	Maximum	Mean
Population	81	4,892	248,184	36,754
Obesity per 100K	81	19,172	38,882	26,063
Diabetes per 100K	81	5,475	13,675	9,605
Cancer per 100K	81	318	715	507
Total Hazardous	1842	2	148	22

Waste Sites

Table 4 provides a comparison of ODC mean rates when counties are placed in two population groups (i.e., populations more than 36,754; and populations less than 36,754). As can be seen from reviewing Table 4, smaller counties tended to have higher prevalence rates per 100,000 population for all three health issues under review in this study.

Table 4. Obesity, Diabetes, and Cancer Mean Values by Population Group

Population Group	**Obesity per 100K / N**	**Diabetes per 100K / N**	**Cancer per 100K / N**
Less than 36,754	26,648 / 62	9,986 / 62	521 / 62
More than 36,754	24,152 / 19	8,362 / 19	461 / 19

* N = number of counties

Table 5 provides a summary of the ANOVA output values for the ODC variables. In reviewing this table, statistically significant differences were found for all three ODC variables when examined across the population groups constructed for this study. Based upon the strength of the p values, there are clearly one or more factors contributing to the differences in ODC rates between the two groups. The central issue for this study is whether the total number of hazardous waste sites present in a county accounts for these differences.

Table 5. Summary of the ANOVA Output Values for the ODC Variables

Variable	**Sum of Squares**	**df (Between / Within)**	**F**	**Sig.**
Obesity per 100K (Between Groups)	90625876	1 / 79	10.463	.002
Diabetes per 100K (Between Groups)	38341638	1 / 79	23.020	.000
Cancer per 100K (Between Groups)	51973	1 / 79	9.068	.003

Summary of Findings

Based upon an analysis of correlations and ODC between-group comparisons, the following points summarize the data findings of this study: (1) the total number of hazardous waste sites appears only to be significantly correlated with the diabetes rate per 100,000 population variable; (2) as constructed for this study, the environmental quality variable was not found to be significantly correlated with any of the ODC variables; (3) there are significant between-group differences in ODC rates when grouped and compared across county mean population values, with smaller counties tending to have higher prevalence rates per 100,000 population than larger counties; (4) the wide ranges between minimum and maximum values for the variables included in this study open the possibility of many other factors influencing ODC rates as much (if not more than) the independent variables selected for this study; and (5) due to the design of this study, the establishment of valid causal relationships between the independent variables of total hazardous waste sites (THWS) and environmental quality and the dependent ODC variables cannot be determined.

Discussion

The findings from this study suggest there is a statistically significant linkage between hazardous waste sites and diabetes that warrants further investigation. This finding, when coupled with the strong/moderate, statistically significant correlations between diabetes, obesity, and cancer rates, suggests that finding ways to reduce the number of hazardous waste sites may also help contribute to a reduction in these rates given the correlation levels. Findings from this study also raised questions as to why smaller population counties tended to have higher ODC (obesity, diabetes, cancer) rates per 100,000 while also tending to have fewer hazardous waste sites. As was also revealed in the findings, there were wide ranges involving the variables selected for this study. These ranges offer the possibility of many other factors influencing or explaining the ODC rates examined in this study. Taken collectively, these findings are consistent with literature review findings of some possible, but not definitive, linkages existing between the number of hazardous waste sites at the local level and local health problems. Clearly additional research is needed to provide greater clarity as to the exact relationship between hazardous waste sites and prevalent health conditions in Mississippi. Based upon this study's findings, one clear direction that research should follow involves the hazardous waste sites/diabetes linkage.

Conclusions/Policy Implications

This study's findings should not be interpreted as making the assertion that: (1) all of the cited obesity/diabetes/cancer-related rates and costs are directly attributable to hazardous waste sites in Mississippi; (2) hazardous waste sites are definitive contributors to higher diabetes' rates in Mississippi; or (3) hazardous waste sites are not definitive contributors to higher obesity and cancer rates in Mississippi. For as discussed earlier, research examining the relationship between health outcomes and hazardous waste sites is far from conclusive and contains many methodological issues that contribute to this inconclusiveness (e.g., comparability; aggregate verses individual exposure issues; impact of confounding factors). However, this does not diminish the fact that this study research (along with studies conducted by other researchers) has found statistically significant relationships among obesity, diabetes, cancer rates and hazardous waste sites (Brender, Maantay, & Chakraborty, 2011; Kouznetsova, 2007).

Therefore based upon this study's findings, several major public policy actions appear to be needed. These include re-examining criteria used in the industrial siting of hazardous waste sites; re-considering the allocation of healthcare resources based upon higher ODC rates occurring in smaller population counties; increasing the planning, regulatory and monitoring oversight of hazardous waste facilities emitting chemicals linked with diabetes and obesity (e.g., bisphenol A (BPA), polybrominated diphenyl ethers (PBDE), phthalates, and tetrachlorodibenzo-p-dioxin); increasing the use of planning and land use zoning to create protective buffer zones between residences and hazardous waste sites; and state and local officials expanding their review criteria to include potential health care and other costs when considering economic decisions involving the production of hazardous waste. The "hidden costs" of economic development discussed earlier are often not openly considered when state and local officials plan, implement, fund, and evaluate economic development and healthcare policy decisions involving hazardous waste. If nothing else, the results of this study indicate there is some evidence of hazardous waste sites being linked to certain health problems, and that the total costs (both open and "hidden") of health and non-health care expenditures should be considered as related to the operations of hazardous waste facilities in Mississippi.

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