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ABSTRACT

Nearly two-thirds of the American population is now overweight, and the rate of obesity has doubled since the early 1960s. The state of Indiana has elected to forgo Medicaid expansion available through the Affordable Care Act of 2010 (ACA), which includes funding specific to obesity and obesity-related comorbidities. Utilizing the Robert Wood Johnson Foundation 2014 Health Statistics, causative obesity factors found in current research literature is examined for Indiana's 92 counties. The variables are examined to determine significant correlation with adult levels of obesity. The significant variables (smoking, unemployment levels, physical inactivity) found in the correlation are then placed in a multivariate regression. The three combined variables explain 16 percent (R^2 = .16) of Indiana's current obesity percentage (31 percent). The only 0significant variable found in the regression matrix is the physical inactivity percentage ($\beta = .21$, $t = 2.29$, $p < .05$). Funding found within the ACA, specifically Community Transformation Grants (CTG), provide an opportunity for Indiana to address the physical inactivity found statewide. CTG grants are available to states, counties, and municipalities, provided the funds address physical inactivity, healthy living improvements, obesity reduction, or smoking-cessation efforts.

KEY WORDS Obesity; Physical Inactivity; Smoking; Unemployment; Indiana

In the early 1960s, obesity affected roughly 13 percent of the American population. Obesity rates were not routinely measured during the '60s, but examining older medical files to establish body mass index (BMI) levels, causes of death, and life expectancy allows the estimation of obesity's prevalence (City of New York 2012). By 2002, an estimated 200 million U.S. residents were overweight and American obesity rates had doubled to nearly 30 percent. The direct and indirect financial costs of overweight Americans surpassed $147 billion in 2008, accounting for nearly 10 percent of all medical spending (Hammond & Levine 2010).

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The American lifestyle has changed dramatically from the 1970s to a technology-dependent working class as a result of the consumption of easy processed meals, job outsourcing, fluctuating employment trends, and the degradation of physical labor employment and education (Tomer 2012). The sedentary transition has created an environment that does not require high-energy food ingestion, yet caloric standards have not transitioned to meet current energy needs. The introduction of high fructose corn syrup and of trans fats into the food supply has created the unexpected burden of burgeoning waistlines, as the chemical reformulations of corn syrup and fats are not readily digestible and excesses are maintained in fat storage for later energy needs (Swinburn et al. 2011). Myriad studies have attempted to link obesity and its related comorbidities to a variety of causative effects to best determine the impact on the healthcare economy and ways to equitably treat obesity, along with its associated complications.

The variety of causative studies are examined to follow and explore the multifaceted approach employed by the Department of Health and Human Services in the Affordable Care Act (ACA) construction and implementation. The literature illuminates the broad-based structure of federal, state, and local obesity remediation efforts. Following review of existing causative literature, a multivariate regression analysis of the Robert Woods Johnson Foundation 2014 health statistics for the state of Indiana will be presented. The multivariate regression analysis measures the relationship between physical inactivity, unemployment, risky behaviors (smoking and excessive drinking), food insecurity, and insurance status on the incidence of statewide obesity. The following analysis seeks to answer an important question: Do social, economic, and environmental factors help explain obesity rates and which factor(s) best explain(s) and predict(s) community obesity levels? The results are placed in context to provide Indiana policy makers with a more accurate gauge of obesity causation that can sharpen the medical focus to better direct resources to improve the overall resident health status while reducing the impact of obesity on the state's health-care economy.

LITERATURE REVIEW OF OBESITY'S CAUSATIVE FACTORS

Considerable research seeks to connect physical activity levels and dietary consumption to the health of the average American citizen. The measures employed to gauge dietary transitions and BMI growth are documented in research, but the effects of physical inactivity are not well chronicled. Programs designed to increase activity seem to be more intuitive than satisfactorily measured through statistical research. The existing research documents the aftereffects of choreographed programs rather than fully illustrating the programs' structures that achieved obesity reduction. The following research literature includes analyses that chronicle the effects of risky health behaviors, namely smoking and excessive drinking, unemployment, food access, and physical inactivity.

After identifying smoking, physical inactivity, and poor nutrition as the three most modifiable risks for mortality, the Centers for Disease Control (CDC 2013) funded

50 communities in 2010 to implement policy, systems, and environmental (PSE) controls meant to register successes in reducing obesity and smoking incidence. The interventions focused mostly on media outreach interventions, physical environment improvements (lighting and access) and healthy living “nudge” signage incentives to reach and influence the population. Nudging theory uses simple visual and auditory reminders to eat healthier or to take stairs rather than elevators (Khan 2011). The CDC study focused on the media saturation rates in the communities rather than on the impact on actual smoking rates, nutrition transitions, and activity levels yet successfully implemented 65 percent of the media saturation strategies (healthy reminder leaflets and billboards, signage, food knowledge radio public service announcements (PSAs), and Internet food and activity resources) planned in 39 communities within the first 12 months of the two-year program (Bunnell et al. 2012).

The 2008 Bright Start study of Lakota schoolchildren involved 454 children in 14 schools and sought to catalog activity time and to alter the composition of school lunches while educating parents to continue the behaviors in the home (Story et al. 2012). Bright Start successfully increased physical activity at school to 60 minutes per school day by incorporating physical activities in the classroom while educating the children. Parents were encouraged to limit screen time in the home and to encourage children to play outside. The school lunch attendants replaced 2 percent and whole milk with 1 percent milk, substituted low-fat dressing for salads, and allowed second helpings only of fruits and vegetables. Families were provided take-home supplies that encouraged healthier behaviors and included basketballs, jump ropes, water-filtering pitchers, vegetable steamers, and fresh fruits and vegetables. Although remission in weight status was found in only nine children, the incidence of new obesity diagnosis was practically eliminated and per-pound weight gain slowed.

The Bright Start study was illuminating but was focused in a relatively safe, tightly knit community and is not easily applicable to communities with highly obesogenic environments or high crime rates. The built environment (parks, walking/bike trails, playgrounds, neighborhood streets, staircases) has not readily changed since the 1970s and cannot adequately explain changes in physical activity (Swindburn et al. 2011). Politically, investing in the built environment would affect all citizens without providing preferential consideration for overweight societal members. The remodeling of the built environment would be available for the physical consumption of every resident, obese or normally weighted. National Institutes of Health in 2013, via the *Economics and Human Biology Journal*, published a paper submitted by a collaborative that included Indiana University–Purdue University Indianapolis (IUPUI) and examined the effects of urban recreational trails on childhood weight status. The study examined the urban trails in and around Indianapolis, Indiana, which includes the largest, the Monon Trail, which is built near a defunct railroad track. The majority of the trails are built near railroads but benefit a variety of communities that include urban, rural, and mixed-use neighborhoods. The IUPUI study found that older children were more likely to reap the physical benefits of trail usage but that the activity was largely dependent on the crime rate of the surrounding neighborhood. By incorporating available medical data, the study determined that older children living in an average neighborhood shaved 1.86 BMI points during the study. The BMI change translates to approximately eight pounds lost. Local crime statistics were incorporated to measure neighborhoods (Sandy et al. 2013). Additional studies have shown that children are 1.2 times more likely to be obese if their neighborhoods do not contain green spaces or access to parks (Khan 2011).

Many of the neighborhoods lacking public access to green spaces suffer from many of the same economic and social deficits, including food insecurity, risky behaviors, lack of access to healthy foods, and higher unemployment levels. In 2004, the U.S. Department of Agriculture reported that 11.9 percent of U.S. households experience some level of food insecurity in a 12-month period and that these households may experience disrupted eating patterns that negatively affect metabolic regulation (Martin and Ferris 2007). Additionally, adults in food-insecure households are at greater risk of obesity, and the risk is magnified in households headed by single mothers. A bright spot in food-insecure households in near "food deserts" is the extension of healthy food offerings at all Wal-Mart locations. In 2011, Wal-Mart made the commitment to streamline sourcing and transportation measures while negotiating better contract prices for fresh fruits and vegetables to extend the savings to their customer base. Additionally, Wal-Mart altered the specifications for store-branded products to reduce salts and sugar while eliminating all trans fats in their bakeries. This is a particularly impactful move in areas with fewer food choices in rural areas across the country (Klimczak 2012).

The remaining economic and social variables (smoking, drinking, and unemployment) are related and seemingly interdependent. Most research focused on adult obesity has included the depression associated with unemployment, as well as excessive drinking as mitigating factors in weight fluctuations and increased BMI. One article (Deb et al. 2011) finds no statistical significance between job loss and obesity, nor between excessive drinking and obesity. The empty calories and nutritive deficits associated with alcoholic beverages can lead to accompanying negative physiological effects. In fact, the article's analysis employed a finite mixture model methodology (individually measuring subpopulations that cluster around a mean) to address the complex relationship between drinking and unemployment. Deb and colleagues found no connection and drew the conclusion that cycles of unemployment would reduce the funds available to purchase alcohol and that excessive drinkers were more prone to unemployment, yet neither unemployment nor drinking directly increased BMI. Smoking, however, presents a more complicated relationship with obesity.

Smokers who have attempted to quit smoking often gain weight and turn to food as a "reward" for their nonsmoking behaviors. As the struggling nonsmokers gain weight, they often revert to smoking as a weight-loss measure. The smokers then alternate between the two vices to manage weight levels with a net weight gain and a continuing smoking habit. Approximately 10 percent of smokers who quit gain 30 pounds within eight years after their last cigarette. Though CDC grant funding targets healthy living and smoking cessation, the two comorbidities are approached as separate health disparities rather than as symbiotic risks for mortality (Audrain-McGovern and Benowitz 2011). The ACA includes specific funding for Community Transformation Grants (CTG) specifically designed to improve smoking-cessation efforts, reduce obesity, improve nutrition, and increase physical activity (CDC 2013). CTG funding is categorized by population size and includes state and city government, municipalities, tribal communities, nonprofit hospitals, schools, and grant-issuing foundations. The grants were extended in 2012 to include smaller communities serving populations below 500,000 individuals. Previous CTG funding was available only to larger communities (more than 500,000 individuals) and did not allow the creativity and flexibility that smaller communities can provide. Guidelines are broadly written to allow more planning freedom based on community needs but must address nutrition, physical activity, disease identification and prevention, and smoking-cessation programs. The variables included in the research are included in the following multivariate analysis to truly determine their impact on obesity in the state of Indiana and consider policy alterations that can improve Indiana's obesity remission efforts.

RESEARCH DESIGN

The data used for this study are derived from the Robert Wood Johnson Foundation (RWJF) 2014 County Health Statistics data set. The data found within the RWJF statistics originate from a variety of sources, including the Behavioral Risk Factor Surveillance System (BRFSS), the National Center for Health Statistics, the National Center for Chronic Disease Prevention and Health Promotion, the Health Resources and Services Administration, and the U.S. Department of Agriculture. A variety of variables were presented for all health-related categories with independent variables represented by their mean percentages to allow comparable, continuous variables that allow hypotheses to be constructed. RWJF county data were available in Microsoft Excel format and imported into SPSS to provide a basis for analysis. The RWJF data were subdivided by county (N = 92 Indiana counties); the data specific to this study were cleaned after the 92 counties were further divided into six geographic regions (Northeast, Northwest, Central East, Central West, Central East, Southwest, and Southeast) and estimates were produced for any missing variables based on the geographical regional average for the specified variable. The regions were crafted from 15 county areas; however, the Southwest and Southeast regions contained 16 counties to approximate regional population averages.

The goal of this study is to explain county mean obesity rate by examining relative social, economic, and environmental factors represented as significant indicators in the literature review. Multivariate regression seeks to explain and predict the relationship between a dependent variable and two or more independent variables. The collection of independent variables seeks to also offer an opportunity to address the specific social policy (physical environment, smoking policy) and health disparity (uninsured, unemployed) challenges that explain the variance in the dependent variables. The adult obesity rate is the dependent continuous variable for the multivariate regression analysis and is an average of self-reported BMI (presented as a percentage) found within the BRFSS. The independent variables most often found in the literature are physical inactivity and food insecurity/access. Physical inactivity is also a self-reported BRFSS measure in which respondents report no physical activity during leisure periods (after work, on weekends) but does not measure physicality of employment in the county inactivity averages. Food insecurity and access are elements of the RWJF food environment index, but only comparable obesity measures (percent food insecure, percent with limited food access) are analyzed against the literature. The *limited access* variable represents percentage of a county's residents that are low income without access to local grocery outlets, whereas *food insecure* represents the percent of residents that do not have a reliable year-round food source. All dependent and independent variables are presented as continuous percentages.

Other independent variables included but not well represented in literature include percentage of smokers (%smokers), excessive drinkers (%drinkers), unemployment percentage (%unemployed), and percentage of uninsured residents (%uninsured). Excessive drinking is defined by RWJF as percentage of individuals who have more than five alcoholic drinks per week, women who consume more than one drink daily, and men who consume more than two drinks daily. The adult smoking rate is the estimated percentage of county residents who smoke every day, smoke "most days," or have consumed 100 cigarettes or more in their lifetimes. Both of these measures were also derived from the Behavioral Health Risk Survey. The uninsured rate estimate is derived from modeling based on U.S. Census Bureau data, and the unemployment rate is taken from the Local Area Unemployment Statistics (LAUS), which does not measure employment cycles throughout a calendar year but provides a yearly average for the county.

For the first hypothesis, increased physical inactivity significantly explains county obesity rates. The second hypothesis reasons that counties with limited access to healthy foods and higher levels of food insecurity maintain significantly higher obesity rates and that the two variables help explain a county's obesity levels.

RESULTS

Descriptive analyses were constructed to contextualize the variation in health behaviors rates across Indiana (Table 1). The analysis provides the state mean score, maximum, minimum, range of scores, and standard deviation. Broad differences in self-reported health behaviors across the state require further analysis. Utilizing the full data set, each variable was placed in descending order to see if any connected health behaviors were expressed by the same county in representative relativity. Newton County (region 1) had the highest level of smoking (42 percent) and drinking (25 percent) but maintained an obesity rate relative to the remainder of its region. No other distinctive connections could be drawn statewide that would allow a judgment about regional (or individual county) behaviors to be rendered. Additionally, another relationship is notable between food insecurity (14 percent), percentage of residents without health insurance (16 percent), and the percent of excessive drinkers (16 percent) and presents an opportunity for later review and consideration. These relationships become the basis for a correlation analysis to determine the relevance and significance of the variables for further exploration

(Table 2). After determining significant variables from the correlation analysis, the multivariate regression will contain only the significant predictors of adult obesity levels (Table 3).

Table 1. Descriptive Analysis

	N	Range	Minimum	Maximum	Mean	Standard Deviation
% Adult obesity	92	.16	.22	.38	31.70	2.799
% Smokers	92	.29	.12	.42	24.02	4.933
% Physically inactive	92	.19	.20	.39	29.33	3.470
% Excessive drinkers	92	.18	.08	.25	15.69	3.883
% Uninsured	92	.16	.09	.25	16.48	2.409
% Unemployed	92	.06	.06	.11	8.48	1.292
% Limited food access	92	.10	.00	.10	4.27	2.988
% Food insecure	92	.10	.10	.20	13.74	2.054

Table 2. Correlation Analysis

		%smokers	Physical Inactivity	%drinkers	%uninsured	%unemployed	Limited Healthy Food Access	Food Insecure
Adult obesity	Correlation	.285**	.365***	.103	.202	.283**	–.028	.113
	Significance	.006	.000	.330	.054	.006	.793	.284
	Number	92	92	92	92	92	92	92

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

Table 3. Regression Coefficients

	Unstandardized Coefficients		Standardized Coefficients	
Model	Beta	Standard Error	Beta	t
(Constant)	21.867	2.480		8.818**
%smokers	.062	.066	.110	.943
%physical inactivity	.212	.093	.263	2.285*
%unemployed	.249	.250	.115	.993

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

The correlation matrix includes variables found in the literature review to either support or refute the research. The literature generally consists of geographic sampling that may or may not be translated more broadly. Uninsured residents, excessive drinkers, and the food-insecure variables did not reach statistical significance with obesity at the $p < .05$ level. The food insecurity finding is the most interesting, as a significant amount of research has been dedicated to the study of insecurity's effect on obesity rates. Additionally, many public programs (including Michelle Obama's Let's Move initiative) rely on the research to support funding for food-insecure neighborhoods. The percentage of smokers ($r = .285$, $p < .01$), physical inactivity ($r = .365$, $p < .001$), and the percentage of unemployed residents ($r = .283$, $p < .01$) have a positive significant and medium effect on county obesity rates. The physical inactivity connection has been well researched and documented and is supported in this analysis, but the connection (with obesity) between unemployment levels and smoking has been limitedly considered in the construction of anti-obesity campaigns.

As judged by the ANOVA table, the regression has a good model fit ($F = 5.58$, $p < .01$). Four assumptions need to be met to ensure the validity of the analysis and its ability to meet standard statistical protocols. The assumptions include independence of error terms, normality of residuals, linear relationship exists, and constant variance (dependent variable equally represented for all independent variables). The error terms of the analysis are independent, and autocorrelation is not an issue, as Durbin-Watson is 2.09. The acceptable range of independence is within 1.7 to 2.3 and indicates that the variables are not too closely correlated. The assumption of linearity and constant variance have been met as judged by the P-P plot and random pattern found on the scatterplot. The assumption of linearity has also been met as judged by the distribution displayed in the histogram. According to the model summary table, percentage of active county smokers, percentage of physically inactive residents, and local unemployment rate explain 16 percent of the variance in obesity rates ($R^2 = .16$). The only variable that significantly predicts obesity rates is the level of physical inactivity ($\beta = .21$, $t = 2.29$, $p < .05$). The physical inactivity finding has been well documented and researched and allows support for the first hypothesis, that physical inactivity helps explain and significantly predicts obesity rates.

Of the two hypotheses constructed earlier, the food-insecurity hypothesis, would be rejected, but the physical-inactivity hypothesis would remain (fail to be rejected), and further analysis of inactivity level effects should be conducted in Indiana to create a roadmap for obesity remediation. Though not significant predictors, the significant correlation between smoking, unemployment, and obesity should also be further studied relative to Indiana resident health. There is research suggesting that depression accompanies obesity and periods of unemployment, indicating that mental health should be incorporated into any further analysis.

LIMITATIONS

The variety of data sources available through the RWJF county health statistics has a variety of limitations in periods surveyed and in unit measurements. Of the variables found to be significantly correlated to obesity rates, the percentage of smokers was derived from a six-year average (2006–2012), is self-reported, and does not consider the total detrimental effects of the carcinogenic additives found in cigarettes. The excessive drinking rates are also self-reported measures over the same period (both from BRFSS) and provide a limited definition of excessive drinking levels (two per day for men and one for women). Additionally, the number of acceptable drinks for women was reduced to one per day in 2006, which increased the percentage of adult women considered excessive drinkers. There was not a statistic available to distinguish prescription narcotic use, which would exacerbate the effects of excessive drinking. The unemployment rate provided is derived from a household survey that was combined with local and national unemployment rates for Fiscal Year 2012. The unemployment level did not measure continuous unemployment over the course of 12 months, or part-time and seasonal employment, and did not consider the long-term unemployed or those voluntarily leaving the workforce because of disappointing economic conditions. The residents considered physically inactive also self-reported the activities, which may or may not be calorie-burning. Though household cleaning was included in the survey, the specific calorie-burning cleaning activities were not described. There are significant differences between using a vacuum cleaner and manually sweeping a floor that are not accounted for in the report. These self-reported measures are largely predicated on the social desirability response bias (a social fear of honestly reporting "bad" behavior).

Though few in number, any missing health behavior variables were based on regional averages rather than on directly reported numbers. Additionally, the RWJF food-environment statistic could not be easily converted and was broken into component parts that could be analyzed relative to the obesity rate. The environment score was divided into two variables—food insecurity and lack of access to reliable food source—and the mean percentage analyzed. Many other variables that could have been included in the initial correlation were not available in units that could be readily compared, so they were not utilized.

DISCUSSION AND CONCLUSION

The obesity rate in Indiana mirrors the national average and provides substantial room to address significant precipitating factors. The correlation between smoking (r = .29), physical inactivity (r = .37), and unemployment rate (r = .28) could be further studied so the ancillary factors can be properly addressed. Too often, health deficiencies are addressed individually rather than identifying the related issues and crafting a broader approach that can address all the affective factors. The creation of geographic regions did not allow any further connections to be made about regional concerns. The research identified in the literature review indicated that most of the measures found within the Robert Woods Johnson Foundation's 2014 County Health Rankings and Measures were significantly related to obesity. The literature, after verifying with a multivariate regression analysis, cannot be applied broadly to every state; however, the three independent variables (physical inactivity, unemployment, and smoking) jointly explain 16 percent of Indiana's obesity rate (R^2 = .16), suggesting that a more extensive combination of variables would be necessary to truly explain the magnitude of the state's obesity levels. Poor housing, single heads of household, water and air quality, crime rates, education, income levels, support systems, and many other variables have substantial effects on health status and quality of life.

The significance of physical inactivity levels on statewide rates of obesity was confirmed in this analysis for Indiana. The technological shift of the United States has been linked to obesity trends, and Indiana's agricultural economy is no longer reliant on physical labor (Swindburn et al. 2011). The connection between smoking, unemployment, and obesity has largely been ignored in research but confirmed to be significant in Indiana. The Let's Move campaign has connected unhealthy eating patterns with unemployment and receipt of SNAP benefits. The options available to the unemployed are limited, and many unemployed persons are forced to purchase cheaper, low-nutrient, calorie-dense foods to maintain energy levels (Barnes 2010). The significant variables in this analysis lead to a few policy suggestions found in further literature that may assist Indiana's effort to be a healthier state.

The ACA requires that all insurance coverage (including Medicare and Medicaid) incorporate obesity and diabetes screens, as well as smoking-cessation assistance. Additionally, the state of Oregon tested Medicaid expansion before agreeing to participate and found that diagnosis of obesity increased 3.8 percent along with a 10 percent decrease in obesity-related depression. The figures suggested that an entire set of residents was never identified with these afflictions and utilized emergency departments as regular sources of care (Baiker et al. 2013). The state of Indiana could benefit similarly should the legislature accept the Medicaid expansion funding within the ACA. An expansion of state insurance regulations to include the presentation of patient BMI at every visit, to offer materials and advice to improve physical activity levels, and to offer smoking-cessation information would alter the landscape of available insurer choices found on the Federal Health Exchange for Indiana residents. An investigation into weight-loss alternatives for existing Medicaid recipients to find more efficient and effective programs could also benefit statewide vulnerable populations. The state of Tennessee studied enrolling Medicaid recipients diagnosed as obese into Weight Watchers (WW) to compare pounds lost and funding reduced after a 12–26 session program completed. Tennessee previously covered bariatric surgery for obese enrollees but found that WW saved the state $50 per pound lost ($35 for WW and $85 for surgery), suggesting the program worked, provided the visits were recorded (Bleich and Herring 2012).

The ACA also includes funding (through the CDC) for CTG and Workplace Wellness Grants that could be promoted for county, industry, and municipality consideration. The grants are designed to address smoking cessation, improving physical activity, diabetes and obesity identification and counseling, and promotion of healthy environments. Many states and municipalities have applied for CTGs but have taken singular approaches addressing one facet of healthier living, rather than combining funding and efforts to improve each of these areas. The analysis has demonstrated the correlation, significance, and predictive effect of smoking, unemployment, and physical activity. A CTG could address all of these concerns alongside the reduction of the statewide rates of obesity. The funding could be utilized to make farmers' markets more prominent in communities that lack reliable sources of food, to place better signage in public buildings that "nudge" visitors to use the stairs in lieu of elevators, to install better lighting along the trails surrounding Indianapolis, and to employ contractors to conduct health education for school systems across the state. Indiana could follow the example of Chicago's public schools by utilizing CTG funding to provide physical education classes and recess in 100 percent of Indiana's public schools. The traditional singular measures employed by public administrators have not been effective in the fight to reduce obesity rates, yet the opportunity exists. Indiana may inadvertently lower unemployment rates by reducing obesity and improving physical activity. Healthier employees are less likely to be absent or to die prematurely, and a healthy workforce can make Indiana attractive to businesses seeking long-term operating locations.

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