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Abstract: A panel estimation of county prevalence of obesity indicates that while the percentage of the population with a completed college degree and the number of food stores available per thousand population are negatively and significantly correlated to county obesity rates, mean commuting time, average annual wage and the total number of business establishments per thousand population positively and significantly contribute to obesity. Educational attainment that raises both human and social capital, as well as changes in the built environment can play a vital role in controlling obesity in West Virginia (WV).

Keywords: built environment, educational attainment, human capital, obesity, panel data

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Introduction

Although overweight and obesity exists across the United States many geographic regions and demographic groups bear a greater burden than others. Appalachia is one such region, with some states, most notably West Virginia (WV), more adversely affected than others. Obesity prevalence in West Virginia has been consistently higher than for the U.S. as a whole. In 1990, the rate of adult obesity in WV was 15%, compared with a U.S. rate of 12%. By 2000, the rate of obesity in WV had climbed to 23%, compared with 20% nationally. (WV Dept. of Health and Human Resources 2002). Currently, WV is the state with the third highest prevalence of obesity in the U.S., after Mississippi and Alabama. A major policy concern regarding obesity is its external costs, which create a welfare loss to society through increased health-care costs. In 2000, the economic cost of obesity in the U.S. was estimated at $117 billion, with $61 billion in direct costs, such as medical expenditures, and $56 billion in indirect costs such as lost wages, disability, or premature deaths (Kuchler and Ballenger 2002).

Increased consumption of high caloric foods, in association with a more sedentary lifestyle, is believed to be the primary cause for the rapid increase in the prevalence of overweight, obesity and related non-communicable diseases. However, these lifestyle choices are greatly influenced by the tradeoffs between labor and leisure that are important constituents of rational consumers' utility functions. Guthrie, Lin, and Frazao (2002) noted that food prepared away from home not only contained more calories per eating occasion but were also higher in fat. However, in the face of rising incomes and increasingly hectic work schedules, a nearly insatiable demand for convenience will continue to drive fast food sales (Guthrie, Lin, and Frazao 2002). Along with additional leisure, households with more income tend to buy more variety and other dining amenities. Thus, households with higher incomes tend to spend more on fast food and full-service meals and snacks (McCracken and Brandt 1987; Byrne, Capps, and Saha 1998). Also, households that spend long hours working outside the home prefer consuming fast foods, if such meals are accessible within a reasonable location (Mancino and Kinsy 2004). In addition to increasing hours of labor force participation and household income, household size, and household manager's age, ethnicity, and educational level, along with region of residence, are also contributing factors for demand for food away from home (Hiemstra and Kim 1995; McCracken and Brandt 1987; Friddle, Mangraj, and Kinsey 2001). A multivariate analysis of data from the 1994-96 Continuing Survey of Food Intakes by individuals and the 1994-96 Diet and Health Knowledge Survey by Mancino, Lin, and Ballinger (2004) showed that individuals who exercise more frequently, watch less television, drink fewer sugary beverages, and eat a higher quality diet are more likely to have a healthy body weight.

Knutson, Penn, and Boehm (1995) found that poor health leads to poor nutrition, and poor nutrition results in poor health and conclude that poverty, hunger, and poor health foster one another. Many health disparities in the United States are linked to inequalities in education and income. Drewnowski (2003) showed that wealth and poverty have profound effects on diet structure, nutrition and health. Drewnowski and Specter (2004) found evidence that groups with the highest poverty rates and the least education have the highest obesity rates. Also, poverty and food insecurity are associated with lower food expenditures, low fruit and vegetable consumption, and lower-quality diets. Their results suggest that energy-dense foods composed of refined grains and added sugars or fats are a low cost option for food insecure, low-income consumers (Drewnowski and Specter 2004). An investigation of the economic determinants and dietary consequences of food insecurity and hunger in the U.S. by Rose (1999) showed that income, along with food stamp participation, homeowner occupancy, level of education, age of household and ethnicity, have an impact on food insecurity. Even though there is evidence to link food insecurity, hunger, and poverty, their causation of health consequences such as obesity seems to still be a paradox (Rose 1999).

Studies by Philipson and Posner (2003), Ruhm (2000), Cutler, Glaeser, and Shapiro (2003) and Variyam (2005) shed evidence on the influence of economic growth and technological change on obesity growth. Chou, Grossman, and Saffer (2002) identified smoking, unemployment and job strenuousness as factors that could lead to obesity. Cutler, Glaeser, and Shapiro (2003) suggested that technological innovations—including vacuum packing, improved preservatives, deep freezing, artificial flavors, and microwaves—have enabled food manufacturers to cook food centrally and ship it to consumers for rapid and increased consumption. Obesity also has been accompanied by innovations that economize on time previously allocated to the non-market or household sector (Philipson and Posner 2003). New innovations have reduced the time spent on food preparation at home and have also increased the number of fast food and full-service restaurants. An investigation of the health response to fluctuations in economic conditions (Ruhm 2000) shows that health improves when the economy temporarily deteriorates. The author's results also show that smoking and obesity increase when the economy strengthens, whereas physical activity is reduced and diets become unhealthy.

A recent hypothesis is that urban sprawl (characterized by widely dispersed low-density residential development, rigid separation of homes, shops, and workplaces, a lack of distinct thriving activity centers, and poor street connectivity) contributes to obesity (Ewing et al. 2003; Lopez 2004). While time spent on transportation has increased, street design, land use patterns and suburbanization reduce the amount of physical activity that can be achieved through transportation (Sturm 2004; Salens et al. 2003; Frank and Pivo 1995; Frank, Anderson, and Schmid 2004; Handy et al. 2002; Pratt et al. 2004). Frank, Anderson, and Schmid (2004) pointed out that the likelihood of obesity apparently declines with an increase in mixed land use, but rises with time spent per day in a car. Handy et al. (2002) stated that a combination of urban design, land use patterns, and transportation systems that promote walking and bicycling will help create more active, healthier and livable communities.

Urban sprawl may not only reduce time available for physical activity because parks or fitness facilities are more distant, but also affect diets by increasing travel time to supermarkets or by the increased cost of nutritious foods caused due to the conversion of farmland to urban uses (Frumkin 2002). Derry (2004) emphasized that the built environment may play a major role in controlling weight by shaping food access and availability. According to Blanchard and Lyson (2003), the establishment of “supercenter” retail grocery stores tends to create food deserts for the rural population. This places low-income earners at a disadvantage when it comes to finding low cost grocery stores.

Even though there is a growing economic literature examining the determinants of obesity, few studies have investigated how the changing socioeconomic structure of economically lagging regions contributes to obesity. Thus, the focus of this study is an examination of the current obesity problem in WV, a state with growing obesity rates, an aging population, and a mix of rural, urban, and metropolitan counties. By contributing to an understanding of the causes of the current obesity epidemic in predominantly low-income and rural areas, the results of this study should facilitate the development of strategies and policies to overcome obesity, not only in WV but also in similar economically disadvantaged regions in the U.S.

Theoretical Framework

Becker (1965) and Lancaster (1966) used household production models in which consumers maximize utility derived from desirable attributes created at home from marketed goods combined with household labor, subject to budget and time constraints. Grossman (1972) extended this framework to derive the demand for the commodity "good health." Health can be considered a desirable attribute that is produced by a household which enters into the household's utility function. Gross investment in health capital can be produced by a household's production function whose direct inputs include the time of the consumer and market goods such as medical care, diet, exercise, recreation, and housing as well as exogenous or given socio-economic and demographic characteristics (Grossman 1972). In this analysis, it is also assumed that a rational consumer allocates time and other resources to produce the commodity "good health" together with other desirable attributes that yield utility or satisfaction. Thus, the i^{th} individual's utility maximization problem can be represented as:

(1) $$Max U_i = U_i[X, Y, Z, L, L_a, H_i(X, Y, Z, L_a, S)],$$

where X is a numeraire good, Y is fast food, and Z is healthy food (such as fruits and vegetables), L is passive leisure (time spent socializing with family and friends, watching TV, etc.), whereas L_a is active leisure, such as time spent at the gym or on other strenuous physical activities that help maintain good health, H_i; and S is a vector of socioeconomic and demographic factors that also affect health. It is assumed that the i^{th} individual's utility function is separable with its arguments, quasi-concave and continuously differentiable. Therefore, these marginal utilities, $\delta U_i / \delta X$, $\delta U_i / \delta Y$, $\delta U_i / \delta Z$, $\delta U_i / \delta L$, and $\delta U_i / \delta H_i$, are all greater than or equal to zero, implying that some positive marginal utility is derived from consuming the numeraire good, fast food and healthy food. It is also assumed that passive leisure and better health yield positive marginal utility to the consumer. The impact of active leisure on health, $\delta U_i / \delta L_a$, can be greater than, equal to, or less than zero, as its impact depends on the individual's subjective preference towards physical activities.

The individual's health production function, $H_i(X,Y,Z,L_a,S)$, is assumed to be a continuously differentiable function with respect to its inputs. The marginal impact of a numeraire good, $\delta H_i / \delta X$, can be greater than, less than, or equal to zero, however the impact of fast food on health $\delta H_i / \delta Y$ is considered to be less than or equal to zero. The marginal contributions of fruit and vegetable consumption, $\delta H_i / \delta Z$, and active leisure, $\delta H_i / \delta L_a$, are considered to have a positive impact on health.

Utility is maximized subject to the budget constraint:

(2) $$P_Z Z + P_Y Y + P_X X + D(H(\cdot)) \leq I + w(T - L - L_a)\,,$$

where P_Y, P_Z, and P_X are respective prices of goods *Y*, *Z* and *X*; $D(H(\cdot))$ depicts expenditures on medical services that are assumed to be a function of an individual's health status, *I* represents non-wage income, *w* is the wage and *T* is total time available for market and non-market activities, thus, $w(T - L - L_a)$ represents the labor income earned after spending time on both inactive and active leisure activities. Solving the first order conditions for utility maximization, and invoking the implicit function theorem yields the individual demand function for health as well as other goods:

(3) $$H_i = f(I, w, P_X, P_Y, P_Z, D_H, S)\,.$$

Individual health is a function of income other than wages, the wage rate, prices of marketed goods and the marginal implicit price of health, D_H , i.e., the marginal expenditure that an individual would spend to remain healthy, and socioeconomic and demographic characteristics, *S*. The first order conditions also imply that:

(4) $$\frac{U_X(\cdot) + U_H H_X}{P_X + D_H H_X} = \frac{U_Y(\cdot) + U_H H_Y}{P_Y + D_H H_Y} = \frac{U_Z(\cdot) + U_H H_Z}{P_Z + D_H H_Z} = \frac{U_L(\cdot)}{w} = \frac{U_H(\cdot) + H_{L_a}}{w} = \frac{U_H(\cdot)}{D_H} = \lambda\,.$$

This equi-marginal principle of optimality says that a rational consumer will allocate his/her resources up to the point where marginal benefits derived from the last dollar spent should be equal across all commodities consumed as well as for the other factors such as health and leisure that provide utility or satisfaction.

Methodology

Panel data analysis allows explicit consideration of both random and unobserved time invariant (fixed) effects between geographic entities (Mundlak 1978; Baltagi 2001). In this study, county level health differences regarding the percentage of the population considered obese are investigated using a panel data structure. County level health status is used to represent an aggregation of each individual's demand for health and can be represented as $\sum_{j=1}^{n} H_{ij}$; $j = 1,2,...,n$, where n is the number of individuals classified as obese in a particular county, i. The fixed effects panel specification for the i^{th} county can thus be represented as:

(5) $$H_{it} = \mu + \beta' x_{it} + a_i + e_{it} \qquad i = 1,2,...,55 ,\ t = 1,2 .$$

The subscript t denotes the 2 time periods used in this study, and there are 55 counties in WV. Not having a count of the number of obese individuals in a county, the dependent variable, H_{it} , represents the percentage of the population which is obese in the i^{th} county at time period t. The scalar, a_i , represents an unobserved latent component and could be either fixed or random among the counties. β is a vector of parameters to be estimated and x_{it} is a vector of explanatory variables; e_{it} represents the error terms, assuming $e_{it} \sim IID(0, \sigma_e^2)$.

For this model, the intercept ($\mu + a_i$) is estimable, but μ and a_i cannot be estimated separately unless arbitrary restrictions (such as $\sum_{i=1}^{N} a_i = 0$ or $\mu = 0$) are imposed to avoid the dummy variable trap. In order to reduce the large loss of degrees of freedom due to the incidental parameter problem (i.e., larger number of cross sectional units relative to time series) counties can be grouped into distinct regions, leading to estimation of regional effects instead of county-level effects.

If scalar a_i is uncorrelated with each x_{it}, then a_i is another unobserved factor affecting y_{it} that is not systematically related to the observable explanatory variables whose effects are of interest (Wooldridge 2002). The assumption of covariance (x_{it} , a_i)=0 leads to a random specification of the panel data structure which can be represented as:

(6) $$H_{it} = \mu + \beta' x_{it} + v_{it}, \quad t = 1, 2,$$

where $v_{it} = a_i + e_{it}$ is the composite error term. It is also assumed that expected values of the error term and the unobserved effects are: $\mathrm{E}(e_{it} | x_i, a_i) = 0$, $t = 1, 2$, and $\mathrm{E}(a_i | x_i) = 0$, where $x_i = (x_{i1}, x_{i2})$.

Orthogonality between a_i and x_i implies that knowing information about x_i does not reveal anything about a_i. As long as the vector a_i is stochastic, ordinary least squares (OLS) gives unbiased and consistent estimates, however, OLS estimates will be less efficient due to the composite error term, which is serially correlated and/or heteroskedastic due to the presence of a_i in each time period. Instead of OLS, a generalized least squares (GLS) estimator is the best linear unbiased and efficient estimator.

Data

Data complied for the empirical investigation are gathered from various secondary sources. The county prevalence of obesity in 1992 and 1997 and the associated data for the explanatory variables were pooled across the 55 counties of WV. A description of the variables used in this analysis and their sources are in tables 1 and 2. Descriptive statistics for the variables are in tables 4 and 5.

Relative price differences of goods, such as prices for fruits, vegetables, and fast foods, and costs of medical services are not included as the theoretical model suggested. No existing county level data on food prices were available, thus, it was assumed that these prices were constant across cross sectional units as suggested by Adelaja and Nayga (1997). There also were no medical expense data available directly attributable to obesity. Even though medical expenditures on hospital treatments for obesity-related diseases (e.g., heart disease) are available, these confidential data are not tabulated and are difficult to obtain for several time periods.

The percentage of the population in the county considered obese (OBESITY) is the dependent variable for both the random and fixed effect models. Socioeconomic and demographic explanatory variables are population density (PPSM), the poverty rate (PR), per capita income (PINC), percentage of the population who have completed a college education (AE), the unemployment rate (UR), and the average annual wage (WAGE)[1]. The percentage of the county population who smokes (PSMOKE) and which does not have health insurance (PNHINU) are variables which reflect county behavioral patterns. Federal spending is represented by social security program beneficiaries (SSPB), federal food stamp payments (PAFSTS), and Medicare benefits (PMCAREB), all per thousand people in a county.

The total number of business establishments (TESTB), food stores (FSTOR), eating and drinking places (EDPLA), health care service businesses (HESER), and physical fitness activity places (PPFAC), per thousand people in a particular county represent the built environment, along with TVTRT, which measures mean travel time to work for county residents. The Standard Industrial Classification codes (SIC) for the relevant built environment variables are Total

[1] Collinearity diagnostics indicate that average annual wage and per capita income are not highly correlated, precluding any multicollinearity issues.

number of Business Establishments (SIC52)[2], Food Stores (SIC5400), Eating and Drinking Places (SIC5800), Physical Fitness Activity Places (SIC7991), and Health Care Services (SIC8000). Food stores encompass a broad range of retail stores that sell food products, mainly grocery stores and other stores that sell food for home preparation and consumption. Eating and drinking places include retail establishments engaged in selling prepared food and drinks for consumption on the premises. Health care services include establishments primarily engaged in furnishing medical, surgical, and other health services.

Results

The results of the random specification, which considers the unobserved latent effects among counties to be a random phenomenon, are presented in table 5. The GLS estimates are based on the "proc tscsreg" (time series cross section regression) procedure of SAS which specifies the Fuller and Battese (1974) method of variance component error structure.

The estimation results show that the percentage with a completed college education (AE) has a significant negative impact on obesity, with a 1% increase in those with a college education decreasing the obesity rate by about 0.3%. In addition, a $1,000 increase in the average annual wage (WAGE) in a county would raise the obesity rate by 0.3%. The percentage of the county population who smoke (PSMOKE) also has a positive impact on the county obesity rate; a 1% increase in those smoking would increase the obesity rate by 0.1%.

Several built environment measures are significant contributing factors to obesity. While the number of food stores (FSTOR) has a negative impact on county-level obesity, the total number of business establishments (TESTB) has a positive effect. A one unit increase in the

[2] An establishment is a single physical location at which business is conducted or services or industrial operations are performed. It is not necessarily identical with a company or enterprise, which may consist of one or more establishments. When two or more activities are carried on at a single location under a single ownership, all activities generally are grouped together as a single establishment.(Economic Census 1993;1997)

number of business establishments (per 1,000 population) in a county will raise obesity prevalence by 0.2%, whereas a one unit increase in the number of food stores (per 1,000 population) will lower obesity by 2.6%. Average travel time to work (TVTRT) is shown to be positively correlated with the county obesity rate. A one minute increase in mean commuting time would raise the obesity rate by 0.2%.

The computed R^2 measure for this GLS model shows that 37% of the variation in obesity prevalence across counties is captured by the explanatory variables included in the regression. A Hausman specification test indicates that there is no evidence to conclude that there are unobserved fixed effects that are correlated with explanatory variables contributing to county obesity rates. This lack of correlation is further confirmed by Hausman and Breusch-Pagan Lagrange Multiplier (LM) tests.

Regional Differences in Obesity

The incidental parameter problem which arises due to a large number of cross sectional units (55) relative to the number of time dimensions (2) can be overcome by grouping counties into different regions within the state. Accordingly, a regional comparison of the obesity rate across the state was also investigated. Currently, WV epidemiological disease surveillance is operating under 7 distinct regions. The regional fixed effects are captured here by including regional dummy variables in the estimations. Regions of WV used for the analysis are North (N), Northeast (NE), Northwest (NW), Southeast (SE), Southwest (SW), West (W), and Central (C), the base category. In addition, a dummy variable is included to capture time effects, with 1997 the base category. The estimated results for the regional random and fixed effects models are presented in table 6. Obtained coefficients are restricted maximum likelihood (REML) estimates of the “proc mixed” procedure of SAS.

Similar to the GLS estimates, regional random effects results show that completing a college education (AE), total number of establishments per thousand population (TESTB), number of food stores per thousand population (FSTOR), percentage of smokers (PSMOKE) in a county, mean travel time to work (TVTRT), and average annual wage (WAGE) have a significant impact on county obesity rates. A 1% increase in the percentage of the population with a completed college education would decrease county obesity rates by about 0.2%. If average annual county wage (WAGE) increases by $1,000, the county obesity rate increases by 0.2%. As the proportion of smokers in a county increases by 1%, county obesity rates increase by 0.1%. While an increase in the total number of establishments per thousand population (TESTB) in a county has a positive impact on county obesity rates, an increase in the number of food stores (FSTOR) has a negative impact. Results show that a unit increases in TESTB will raise county obesity rates by about 0.2%; however, a unit increase in FSTOR will reduce the county obesity rate by 3%. A one minute increase in mean travel time to work (TVTRT) raises county obesity prevalence by 0.2%.

In comparison to the regional random effects model, the regional fixed effects model shows that only AE, TESTB and FSTOR have a significant impact on county rates of obesity. The magnitude and directional impacts of these variables are quite similar to the regional random-effects model. In addition, the significant regional dummy variable Southwest (SW) implies that the obesity prevalence in that region was significantly higher than for the base Central region during the base year 1997. However, during 1992, the prevalence of obesity was 0.8% lower than the base Central region. The significant negative time dummy for 1992 implies that the obesity prevalence in the base Central region during this year was significantly lower than that for the 1997.

Conclusions

This study attempts to integrate both theoretical and empirical insights and information to facilitate understanding of the current obesity problem in WV. In meeting this objective, this study employed a panel estimation to unravel possible socioeconomic and built environment factors contributing to obesity. The empirical estimations suggest that there are no time invariant unobserved effects impacting county obesity rates. However, the time trends clearly indicate that prevalence of obesity within the state has increased from 1992 to 1997 with significant presence in the southwestern (SW) region.

Similar to findings of previous studies, educational level has a significant impact on decreasing county prevalence of obesity. In addition, the county annual per capita wage and the percentage of smokers in a county positively and significantly contribute to obesity. Total number of business establishments and total number of food stores per thousand population as well as mean travel time to work are significant built environment determinants of county-level obesity. While travel time to work and number of business establishments positively contribute to obesity, a higher number of food stores reduces obesity.

The empirical results suggest that as the annual wage increases the county prevalence of obesity also increases. This may be surprising as one might expect higher wages would lead to better food choices, such as more fruit and vegetable consumption, which would be expected to reduce obesity. This counterintuitive result may be a reflection of the relatively low annual wage levels in WV. The mean annual wage for WV counties from 1992 to 1997 ranged from $16,839 to $24,991. For the same period, the mean annual wage for the U.S. ranged from $25,478 to $29,859 (Bureau of Economic Analysis 2005). At relatively low wage levels, as the wage increases purchases of more energy-dense foods may also increase, leading to higher county obesity rates. In addition, the comparatively low earnings in WV may require residents to work more, perhaps in sedentary environments, and also to engage in less leisure time physical actives, at the expense of their health outcomes. A rational consumer who works long hours to earn limited income may also be inclined to consume convenience foods, which may go beyond their daily caloric needs, contributing to obesity.

In addition to socioeconomic factors, the empirical findings suggest that built environment factors are significant determinants of county prevalence of obesity. The total number of business establishments per thousand population in a county has a positive impact on obesity. As this variable reflects the presence of economic activity in a particular county, one could conclude that as the economy thrives, more people engage in longer hours of work, perhaps in sedentary environments, which may be contributing to higher rates of obesity. This variable might also be capturing the influence of sprawl. As the number of establishments increases, widely dispersed business developments in suburban areas of WV may encourage people to drive more and engage in less biking or walking. This increased reliance on less energy-expending physical activities may have led WV residents to gain weight and become obese. Additional evidence for this comes from the positive effect of mean travel time to work on the obesity rate. Frank, Anderson, and Schmid (2004) also found that the likelihood of obesity rises with the time spent per day in a car. Travel time to work may also be high in a predominantly rural state like WV where residents living in rural areas may have to travel to distant locations for employment.

The inverse relationship between the total number of food stores per thousand population and obesity is an indication of a food accessibility problem in some WV counties. As the number of grocery stores increases, people have improved opportunities for finding better quality foods.

Not only that, an increasing number of grocery stores creates competition, which, in turn, motivates these businesses to provide better quality food at lower prices. Halverson et al. (2004) indicated that many counties in WV do not have enough grocery stores and counties with the least favorable grocery store to population ratio occur largely in the southern part of the state where obesity rates are highest. As Derry (2004) noted, the built environment, including work places, stores, and transportation systems, could play a major role in controlling weight by shaping food accessibility.

In addition to built environment covariates, the empirical findings also show that the county behavioral risk factor, percentage of smokers, has a significant positive impact on obesity. While Chou, Grossman, and Saffer (2004) argue that smoking lowers the risk of being obese, Gruber and Frakes (2005) claim that smoking increases the risk of obesity. However, in this study, the significant correlation between smoking and obesity may be due to the fact that counties with several bad health behaviors were included in the regression analyses. On the other hand, this also raises the dilemma as to whether obesity induces people to smoke as a strategy of reducing weight.

Lastly, this study indicates that educational attainment in a county has a significant and negative impact on county prevalence of obesity. Previous health and economic studies (Grossman 1972; Kenkel 1991; Variyam, Blaylock, and Smallwood 1996; Adler and Ostrove 1999; Nayga 2000) also found that educational attainment has a powerful impact on lifestyles as well as health. At the same time, level of education is a remedial factor for other pressing socioeconomic problems like poverty and unemployment. Education, one of the key determinants of human capital, not only provides an economic return, increasing both employment rates and earnings, but also improves health, well-being and parenting (OECD

2001). Therefore, interventions which enhance educational attainment could also play a vital role in preventing obesity. The results presented in this study may be of use to researchers and policy makers to better understand the problem and to better prioritize resource allocation among WV counties. Allocation of physical and financial resources to improve community intervention strategies through educational programs as well as better built environment planning strategies would be helpful in promoting healthier communities and also in stimulating economic development in WV.

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Table 1. County Dependent, Socioeconomic and Demographic Variables

Variable	Definition	Source
Dependent variable		
OBESITY	% of obesity (1991 and 1997)	A
Socioeconomic and Demographic factors		
PPSM	Population density (persons/square mile) 1990 and 2000	B
PR	% of population below poverty line	B
PINC	Average per capita income 1990-94 and 1995-99 ($)	C
AE	% of population who completed college	B
UR	% of unemployment	B
SSPB	Social Security program beneficiaries per 1000 population	C
WAGE	Average annual wage 1992 and 1997	C
PAFSTS	Food stamp benefits per thousand population ($1000) 1992 and 1997	C
PMCAREB	Medicare benefits per thousand population ($1000) 1992 and 1997	C
PSMOKE	% of population who smoke (1992 and 1997)	A
PNHINU	% of population with no health insurance (1992 and 1997)	A

[A] WV Department of Health and Human Resources. *West Virginia County Health Profiles-2000*.

[B] Appalachian Regional Commission (ARC). *Regional Data*.

[C] Bureau of Economic Analysis (BEA), U.S. Department of Commerce. *CA35: Personal current transfer receipts*.

Table 2. Built-Environment and Dummy Variables

Variable	Definition	Source
TESTB	Total number of establishments per 1000 population 1993 and 1997	D
FSTOR	Total number of food stores per 1000 population 1993 and 1997	D
EDPLA	Eating and drinking places per 1000 population 1993 and 1997	D
HESER	Health care services per 1000 population 1993 and 1997	D
PPFAC	Physical fitness activity places per 1000 population 1992 and 1997	D
TVTRT	Average travel time to work 1990 and 2000	E
N	Dummy North	*
NE	Dummy Northeast	*
NW	Dummy Northwest	*
SE	Dummy Southeast	*
SW	Dummy Southwest	*
WT	Dummy West	*
C	Dummy Central	*
T	Dummy Time (0=1997 and 1=1992)	*

[D] U.S. Census Bureau. *Economic Census: County Business Patterns, 1993, 1997*.

[E] U.S. Census Bureau, *Decennial Census: Summary Files and Detailed Tables, 1990, 2000*.

* Created from WV Dept. of Health and Human Resources and BEA, U.S. Department of Commerce data.

Table 3. Descriptive Statistics: Dependent, Socioeconomic and Demographic Variables

Variable	Mean	Std Dev	Minimum	Maximum
OBESITY	18.92	4.2	10.2	30.3
PPSM	94.66	101.16	9.58	479.01
PR	20.32	6.36	9.30	39.20
PINC	15438.23	3006.40	9848.98	24363.89
AE	11.10	4.57	4.60	32.40
UR	7.57	3.03	2.4	17.1
SSPB	211.83	30.37	135.00	308.00
WAGE	20915.87	4076.85	14434.63	32826.85
PAFSTS	142.07	51.89	57.70	278.90
PMCAREB	3862.56	19021.40	355.50	195588.57
PSMOKE	26.01	4.82	18.40	40.20
PNHINU	23.23	5.60	10.70	36.10

Table 4. Descriptive Statistics: Built-Environment and Dummy Variables

Variable	Mean	Std dev	Minimum	Maximum
TESTB	20.48	5.84	7.75	37.36
FSTOR	0.88	0.27	0.27	1.78
EDPLA	1.38	0.64	0.30	4.37
HESER	1.36	0.72	0.14	3.96
PPFAC	0.04	0.07	0.00	0.58
TVTRT	26.12	5.77	17.10	36.10
N	0.11	0.31	0.00	1.00
NE	0.16	0.37	0.00	1.00
NW	0.11	0.31	0.00	1.00
SE	0.15	0.35	0.00	1.00
SW	0.13	0.33	0.00	1.00
WT	0.15	0.35	0.00	1.00
C	0.20	0.40	0.00	1.00
T	0.50	0.50	0.00	1.00

Table 5. Estimates of Random Effects Model (N=110)

Variable	Coefficient	Pr>|t|
CONSTANT	1.6880	0.796
PPSM	-0.0035	0.536
PR	0.1379	0.110
PINC	0.0003	0.272
AE**	-0.2551	0.027
UR	0.0429	0.796
SSPB	-0.0075	0.544
WAGE**	0.0002	0.033
PAFSTS	-0.0056	0.625
PMCAREB	-0.0000	0.292
PSMOKE*	0.1473	0.072
PNHINU	-0.0677	0.357
TESTB*	0.2409	0.086
FSTOR*	-2.6419	0.061
EDPLA	-0.5216	0.530
HESER	-0.3432	0.708
PPFAC	-1.4130	0.733
TVTRT**	0.2072	0.050

*Significant at 10% level, **Significant at 5% level.

Table 6. Estimates of Regional Random and Fixed Effects Models: Socioeconomic and Demographic Variables (N=110)

	Random Effects			Fixed Effects		
Variable	Estimate	Pr>|t|		Estimate	Pr>|t|	
CONSTANT	0.8127	0.918		4.8030	0.517	
PPSM	-0.0038	0.502		-0.0030	0.633	
PR	0.1380	0.112		0.1254	0.210	
PINC	0.0003	0.237		0.0003	0.388	
AE	-0.2506	0.031	**	-0.2319	0.079	*
UR	0.0414	0.804		0.0886	0.646	
SSPB	-0.0068	0.582		-0.0081	0.551	
WAGE	0.0002	0.031	**	0.0002	0.102	
PAFSTS	-0.0051	0.657		-0.0014	0.917	
PMCAREB	-0.0000	0.303		-0.0000	0.329	
PSMOKE	0.1411	0.085	*	0.1076	0.251	
PNHINU	-0.0624	0.396		-0.0462	0.573	

*Significant at 10% level, **Significant at 5% level.

Table 7. Estimates of Regional Random and Fixed Effects Models: Built-Environment and Dummy Variables (N=110)

	Random Effects			Fixed Effects		
Variable	Estimate	Pr>|t|		Estimate	Pr>|t|	
TESTB	0.2379	0.090	*	0.2927	0.051	**
FSTOR	-2.6570	0.062	*	-2.8526	0.099	*
EDPLA	-0.4823	0.562		-0.5130	0.575	
HESER	-0.3501	0.704		-0.9130	0.384	
PPFAC	-1.4966	0.718		-1.8288	0.670	
TVTRT	0.2170	0.038	**	0.1486	0.214	
C	-0.0571	0.746		-	-	
N	0.0183	0.918		1.4164	0.271	
NE	0.0135	0.939		1.7354	0.252	
NW	-0.0010	0.995		1.3866	0.362	
SE	0.0119	0.946		1.7530	0.177	
SW	0.0381	0.830		2.3380	0.084	*
W	-0.0236	0.894		0.7049	0.605	
1992	-1.0456	0.430		-3.1201	0.026	**
1997	1.0456	0.430		-	-	

*Significant at 10% level, **Significant at 5% level.