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Public Transportation, Automobiles and Walking: Using State Level Data to Examine Obesity in the U.S.

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Abstract

Recent data indicates that people are gaining weight around the world at a record pace and Americans are not immune to this chronic issue. In fact, data from the Centers for Disease Control and Prevention indicate that the average adult obesity rate in the United States was 12% in 1990 and grew to 35% in 2014. Given the severity of this problem, governments are obviously concerned with the growing obesity rate and have many reasons to encourage better nutrition and exercise. In this paper, we examine the effects of transportation mode choices on the incidence of obesity. This analysis extends the previous literature by including a series of transportation variables in a regression model examining state obesity rates using pooled data for the periods 2000, and 2004 to 2009. The results show that levels of obesity increases as automobile usage increases. Thus, public transportation has a positive influence on reducing obesity rates.

Keywords: Obesity, State, Transportation Mode Choices, Driving, Public Transportation Walking

1. Introduction

Data from the World Health Organization indicates that obesity rates around the world have doubled since 1980 and are the fifth leading risk factor for global death in the world (http://www.who.int/mediacentre/factsheets/fs311/en/). In fact, the Centers for Disease Control and Prevention reported that the obesity rate in the United States was 35% in 2014. That is a 23% increase since 1900. The data also reveals that obesity rates in the U.S. are consistently rising despite campaign efforts to reduce the rate (Reeve et al 2015). Why is this issue so critical? Research has shown that obesity is linked to other illnesses such as diabetes, kidney failure, hypertension, depression, heart disease, gallbladder disease, osteoarthritis, gout, and cancer (McTigue, Garrett, & Barry, 2002; Peterson & Schwarz, 2010; Callahan, 2013). As a result, the American Medical Association redefined obesity as a disease in 2013 (

Since the 1960s, due to increased automobile ownership and use, Americans have become more automobile dependent and more favorable to automobile travel. The trend in travel behavior indirectly points to a substantial decline in physical activity levels associated with the over-reliance on automobile travel (Transportation Research Board, 2005). Several studies have found that automobile dependence and the dramatic decline in active transportation (walking and public transportation) contribute to the rise of obesity at the local and national level (Bell, et al., 2002; Frank, et al., 2004; Jacobson, King, &Yuan, 2011). Despite these findings, there are no studies which examine the relationship between transportation model choice and obesity rates at the state level. This void in the research is important because obesity rates vary widely across the American states.

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To fill the gap in the literature, the main objective of this research is to explore the relationship between transportation mode choice and obesity rates at the state level in the U.S. In addition, we examine the impact of demographic, economic, health, education, nutritional, and physical activity factors on obesity levels. Hence, we test the following directional hypotheses: as the percentage of employees commuting to work increases obesity rates increase.

American Traveler Behavior since the 1960s

Shortly after World War II, the U.S. economy began to improve quickly and automobiles became more affordable to more people. Table 1 show that the number of licensed drivers increased by 141% from 87 million in 1960 to 210 million in 2010. The annual growth rate in the number of licensed drivers is nearly twice the population growth. In addition, the share of drivers in the total population increased from less than half (48.33%) of the total population to more than two thirds (68%) during this period. More importantly for this research, the number of registered vehicles more than tripled from 1960 to 2010, which subsequently led to a four-fold increase in the number of miles traveled by automobile.

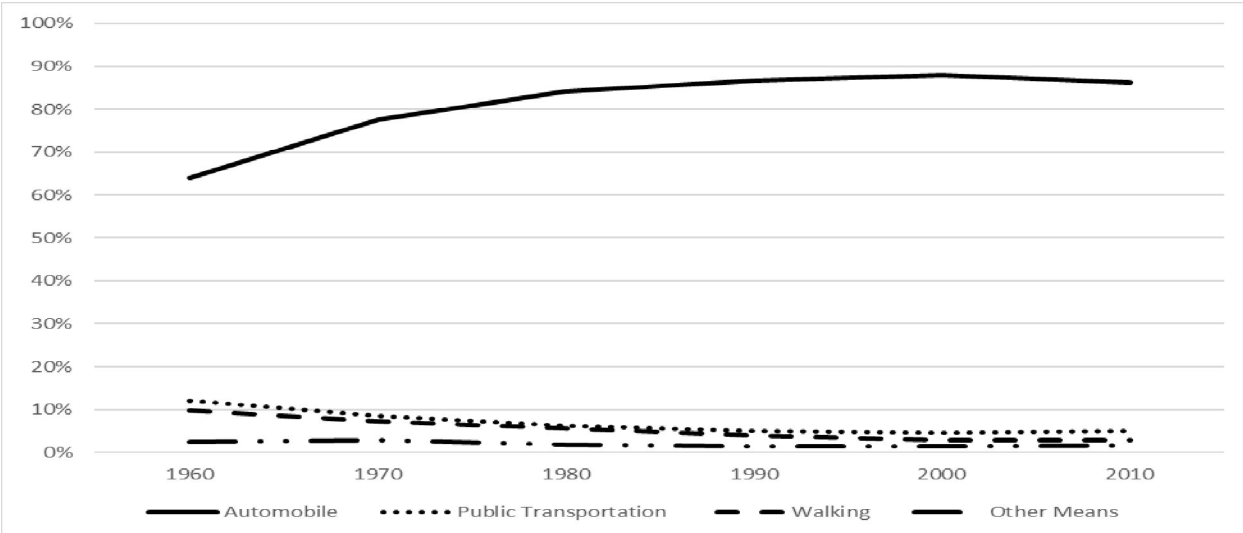
Table 1 Vehicle Registrations, Drivers, and VMT: 1960-2010

	1960	1970	1980	1990	2000	2010
Population (Millions)	180	204	227	248	285	309
Drivers (Millions)	87	112	145	167	191	210
% of Drivers in Total Population	48.33%	54.90%	63.88%	67.34%	67.02%	67.96%
Vehicles Registered (Thousands)	73,858	111,242	161,490	193,057	225,821	242,061
Number of Vehicles per Driver	0.85	0. 99	1.11	1.16	1.18	1.15
Vehicle-miles traveled (Millions)	718,762	1,109,724	1,527,295	2,144,362	2,746,925	2,966,506
Average miles traveled per vehicle (Thousands)	9.7	10.0	9.5	11.1	12.2	12.3

Source: 2010 National Highway Statistics.

Due to increased automobile ownership and use, Americans have become more automobile dependent and clearly have a tendency to favor the automobile over other forms of travel. When automobile use is compared to other forms of transportation, the difference is remarkable over time. The data in Figure 1 shows that the percentage of personal transportation usage is increasing as other forms of transportation has decreased since 1960. More specifically, in 1960, only 64% of the population drove an automobile to work. Meanwhile, 12.10% people took public transportation to work, and nearly 10% walked to workplaces. In contrast, by 2010, 86.3% of the working population drove an automobile to work while less than 5% of population used public transportation. Additionally, the share of people walking to work decreased to 2.80%. This fact is important because research shows that dependence on the automobile has led to lower level of physical activity, an important factor contributing to the rise of obesity (Bell, et al., 2002; Edwards, 2008; Frank, et al., 2004; Jacobson, King, &Yuan, 2011).

Figure 1: Means of Transportation to Work (Commuting to work) for the U.S.: 1960-2010



Source: U.S. Census Bureau, Decennial Census, 1960, 1970, 1980, 1990, 2000; U.S. Census Bureau, American Community Survey (ACF), 2010. Retrieved from: http://www.census.gov/hhes/commuting/data/commuting.html

Note: Automobile use includes: cars, trucks, or vans-drove alone and carpools. Other means include: taxicabs, motorcycles, bicycles, or other means of motorized transportation.

Previous Research

Prior to examining the research it is important that we define obesity. The Mayo clinic defines obesity as an excessively high amount of body fat or adipose tissue in relation to lean body mass (www.mayoclinic.com). The amount of body fat (or adiposity) includes concern for both the distribution of fat throughout the body and the size of the adipose tissue deposits. Body fat distribution can be estimated by skin fold measures, waist-to-hip circumference ratios, or techniques such as ultrasound, computed tomography, or magnetic resonance imaging. Obesity has been examined by medical and health care scholars from a variety of different perspectives over the last few decades. In fact, our review leads us to the conclusion that the number of issue briefs, white papers, articles, and books has increased dramatically over time as the levels of obesity has risen in both children and adults. While there are a number of medical remedies to obesity (Ogden, 2005; 2008), we focus our review on non-medical studies as we are more interested in the policy implications of rising obesity rates. More specifically, we segregate the literature into three categories: demographic and socioeconomic factors, public policy, and physical activity and transportation factors.

Demographic and Socioeconomic Factors and Obesity

Using data obtained from the Behavioral Risk Factor Surveillance System, Mokdad, et al. (2003), examined the prevalence of obesity, diabetes, and other obesity related health factors in U.S. residents. Their analysis determined that the body mass index (BMI) of women was higher than that of men. Also, African Americans had the highest rates of obesity followed by Hispanics and Caucasians. The researchers also found that southern states had the highest levels of obesity and diabetes. Lastly, their results indicated that adults with less than a high school education had the highest rate of diabetes.

In a similar study, Ogden et al. (2006) found comparable evidence using data from the National Health and Nutritional Examination Survey. More specifically, the researchers found the prevalence of overweight among non-Hispanic white male children and adolescents did not differ significantly from non-Hispanic black male children. When compared with non-Hispanic white female adolescents, Mexican American and non-Hispanic black females were more likely to be overweight. In an earlier study using 2004 survey data, Ogden (2004) found no difference in the prevalence of obesity between the genders.

Miech, et al. (2006) examined the prevalence of overweight among older adolescents by family poverty status using national cross sectional data sets from 1971-2004. The researchers found that young adolescents aged 12-14 were much less likely to be overweight than older adolescents aged 15-17. This disparity was consistent across gender and racial lines. The authors also found that dietary trends had disproportionately affected older adolescents in poverty (Miech et al., 2006). Older adolescents had more choices and these choices included: an increase in sweetened beverage consumption; skipping breakfast; increases in the percentage of calories consumed while eating away from home; and snacking between meals (see also Briefel & Johnson, 2004). The increases in consumed sweetened beverages and skipping breakfast were strongly associated with being overweight, while eating away from home and snacking between meals were not. Adolescents aged 15-17 in impoverished families were more likely to consume these sweetened beverages. Skipping breakfast was not significantly associated with poverty status for adolescents aged 12-17 (Miech et al., 2006). However, among older adolescents aged 15-17, the relationship between skipping breakfast and poverty increased significantly (Miech et al., 2006).Freedman et al (2005) used a longitudinal design to determine if racial and gender differences were related to childhood overweight and adult obesity.

They found that 65% of the overweight white girls and 84% of the black girls in the study became obese adults and that black girls were less likely to engage in physical activity. Similar results were found with black and white males, but white men were more likely to be thinner in earlier years and gain weight at a faster rate in their adult life. This study, as well as other studies, supports the notion that overweight children are likely to become obese adults (Freedman et al., 2005; Guo et al., 2002; & Garn et al., 1985). Collectively, the authors postulated several theories with respect to this trend: increases in the per capita availability of food energy; availability of processed foods; increased television viewing; and the frequency of eating away from home are likely contributors to weight gain.

Kries et al. (2002) used data that examined the effects of smoking on childhood obesity among school aged children in Germany during the period 1999-2000. They found a higher prevalence of obesity among children of mothers who smoked during pregnancy. The authors also found that the amount of smoking was affected by other factors such as watching television and playing video games. Using a prospective mortality study in the U.S., Freedman et al. (2006) also found that smoking and obesity were positively correlated with increased mortality.

Using data from the Medical Expenditure Panel Survey, a national longitudinal survey, Wee et al. (2005) studied annual per capita health care expenditures associated with overweight and obesity among U.S. adults. The researchers found higher levels of expenditures related to all major forms of medical care. The data revealed similar findings for men and women, but varied substantially when race and age were controlled. The strongest relationship was found among white and older adults. Among black adults and those younger than 35 years of age, BMI was not related to higher health care costs. Last, the authors found that health care cost associated with obesity became progressively higher as adults increased in age.

Public Policy and Obesity

Research by Lawrence, Sacks, & Swinburn (2008) propose an Obesity Policy Action framework with three different types of public health policies that could influence obesity. These include, upstream policies that influence either the broad social and economic conditions of society or the activity environments to make healthy eating and physical activity choices easier, midstream policies that are aimed at directly influencing population behaviors, and downstream policies that support health services and clinical interventions.

Based on these propositions, they asserted that the proposed framework could provide a comprehensive approach to mapping the policy environment related to obesity, and serve as a tool for identifying policy gaps, barriers and opportunities. Dodson et al (2009) interviewed legislators and staffers with the purpose of determining what qualitative factors impede state-level childhood obesity prevention legislation. They argued that national media exposure, introduction of the policy by a senior legislator, and support of parents, physicians, and schools could exert a positive influence on legislation that could curtail obesity and on companies that make unhealthy food options. Jacobson and Nestle (2000) argue that the traditional way to control obesity in an individual is not the proper strategy for controlling obesity on a societal level. They encourage the use of public health organizations and recommend that policies be implemented with regard to education, food labeling and advertising food assistance programs, health care and training, transportation and urban development, and taxes.

They also contended that "national leadership is needed to ensure the participation of health officials and researchers, educators and legislators, transportation experts and urban planners, and businesses and nonprofit groups in formulating a public health campaign with a better chance of success" (p. 12). Gortmaker et al., (2011) suggested a collaborative effort between science, policy, and action to control obesity. They argued that the empirical evidence that shows that interventions are effective is somewhat limited, but expanding. They identify several cost-effective policies that governments should prioritize for implementation. For example, "systems science provides a framework for organizing the complexity of forces driving the obesity epidemic and has important implications for policy makers" (p. 838). Many organizations (e.g., governments, international organizations, the private sector, & civil society) need to act together in order to achieve the greatest level of success. These collaborative efforts can strengthen the influence of policies that can monitor, prevent, and control obesity.

Ludwig and Murtagh (2011) focused on childhood obesity and suggested that state intervention might be the only realistic way to control behaviors that can cause it. They emphasized the role of parents in preventing obesity and posited that if there are parenting deficiencies, state child protective services, including foster care and legal intervention, might be effective in improving the situation. They concluded that "government can reduce the need for such interventions through investments in the social infrastructure and policies to improve diets and promote physical activity among children" (p. 217; see also Hill et al., 2011; and Ebdon et al., 2012).

Transportation and Obesity

One of the earliest studies that we located examined the impact of motorized transportation on obesity levels in China (Bell et al., 2002). Using a multistage randomized cluster sample, the authors found that the odds of being obese were higher for men and women in households where a motorized vehicle was present compared to those where a vehicle was not present. When the authors compared men who eventually acquired a vehicle to those who did not, they noted that they also were more likely to gain weight and had a 2 to 1 odds of becoming obese.

Frank et al. (2004) examined the relationship between the "built environment around each observation's place of resident and self-reported travel patterns, body mass index (BMI), and obesity for specific gender and ethnicity classifications" using data from a travel survey of 10,898 participants in the Atlanta area (p. 1). They found that obesity in the area, as measured by BMI, is associated with the amount of time spent in cars and negatively with mixed land-use and with walking. Overall, individuals who walked greater distances were less likely to be obese. However, despite being more likely to walk a greater distance, the BMI was greater for black participants than white participants. Edwards (2008), using National Household Travel Survey data, also found that walking associated with public transit can lead to substantial lower levels of obesity. That is, individuals who walk from the public transit station and walk to work were less likely to be obese. In addition, he found that increases in public transportation can also lead to decreases in medical cost.

Using survey data from 1994 and 2006, Bassett et al. (2008) found that countries with high rates of automobile use were more likely to have higher levels of obesity while countries with higher levels of active transportation were less likely to be obese. That is, people who used public transportation were more likely to couple this activity with walking or cycling. MacDonald et al (2010) found similar evidence when examining the use of light rail in Charlotte North Carolina. Jacobson et al (2011) also found that an increase in daily driving was positively correlated with an increase in obesity. However, they also determined that a decrease in driving had to be accompanied with an increase in active modes such as walking or cycling in order to lower obesity levels.

A more recent study by Brown et al (2015) examined the impact of bus and light rail usage on physical activity on 537 participants utilizing GPS data. They found that participants who utilized light rail along with street intervention were more likely to see decreases in BMI as opposed to those who did not utilize the transit system. In addition, individuals who used public transit and later stopped digressed in the progress achieved. In summary, the existing literature clearly shows that obesity is associated with demographic and socioeconomic factors, public policy, physical activity and transportation factors. However, the void in research examining the mode of transportation on obesity rates at the state level remains. The model below assesses that relationship.

Methodology

The main purpose of this paper is to examine the effects of transportation mode choices on the incidence of obesity. This analysis extends the previous literature by including a series of transportation variables in one model explaining obesity at the state level.

Model Specification

The primary regression model is expressed as follows:

$$\%\,Obesity_{it} = \beta_0 + \beta_1(Drivwork)_{it} + \beta_2(Transwork)_{it} + \beta_3(Walkwork)_{it} + \beta_4(Fruit\ and\ Vegetable)_{it} + \beta_5(Physical\ activity)_{it} + \beta_6(\%Smoking)_{it} + \beta_7(Region\ Dummy)_{it} + \beta_8(Per\ Capita\ Income)_{it} + \beta_9(\%\ Unemployment)_{it} + \beta_{10}(\%white\ population)_{it} + \beta_{11}(\%\ Total\ Uninsured\ Population)_{it} + \beta_{12}(Per\ Capita\ State\ Healthcare\ Expenditure)_{it} + \varepsilon_{it}$$

Where: Yi^{th} = Obesity Rate in the i^{th} state in year t

The dependent variable is the state-level obesity rate ($\%\ Obesity$), which is % state population whose Body Mass Index (BMI) scores are above 30 (U.S. CDC). The main explanatory transportation variables include *Walkwork* (% of workers commuting to work by walking), $Drivwork$ (% of workers commuting to work by driving automobile alone and carpooled), and *Transwork* (% of workers commuting to work by taking public transportation). Our alternative transportation variables are *VMTpc* (per capita vehicle miles traveled and *Tranpc* (per capita urban transit ridership). The control variables comprise of fruit and vegetable consumption, physical activity, smoking, race, per capita income, unemployment, uninsured population, per capita health care expenditures, and a region dummy variable.

Data and Variables

Table 2 provides summary statistics of the variables used for this study. These data were obtained from the U.S. Bureau of Transportation Statistics, National Transit Database, American Community Survey, U.S. Bureau of Economic Statistics, the United Health Foundation, Vital Statistics, the Centers for Disease Control and Prevention, National Center for Education Statistics, Statistical Abstract of the U.S., the Bureau of Labor Statistics, and National Center for Health Care Statistics.

Table 2: Descriptive Statistics

Variables	Description	Mean	SD	Min	Max	Data Sources
Dependent Variable						
Obesity	% state population whose Body Mass Index (BMI) scores are above 30	22.91	.62	2	35	Centers for Disease Control and Prevention
Socioeconomic Variables						
Income	Per capita income (dollars)	33,381	3,238	,221	311,156	Bureau of Economic Analysis
Unem	% of unemployed labor force	5.52	.02		14	Bureau of Labor Statistics
Wpop	% of white population	81.5	2.7	.0	99.0	Census Bureau
Reg2	Region dummy (South=0, Non-South=1)	0.8	0.4		1	
Health-Related Variables						
Fruits	% of the population that consumed fruit two or more times per day and vegetables three or more times per day	23.46	.05		37	Behavioral Risk Factor Surveillance System (BRFSS)
Phyact	% of the population that engaged in physical activity as recommended by the state	74.33	.90		86	BRFSS
Smoke	Persons 18 years and older who reported having smoked 100 or more cigarettes during their lifetime and who currently smoke every day or some days	21.66	.69		33	BRFSS
Healthcare Availability and Spending Variables						
Uninsuredtot	Total uninsured population are all people not covered by public or private insurance	14.25	.02		26	Census Bureau
Schs	Per capita state healthcare expenditure	5,164	,317	,702	9,278	Centers for Medicare & Medicaid Services
Transportation Variables						
Walkwork	% of workers commuting to work by walking	2.95	.31	.00	9.10	American Community Survey (ACS)
Drivwork	% of workers commuting to work by driving automobile (alone and carpooled)	88.37	.13	1.26	95.30	ACS
Transwork	% of workers commuting to work by taking public transportation	2.94	.09	.20	26.70	ACS
VMTpc	Per capita vehicle miles traveled	10,408	,859	,355	18,376	Highway Statistics
Tranpc	Per capita urban transit ridership	19.17	32.81	0.12	307	National Transit Database

Estimation Methods

This study uses pooled cross sectional-time series regression methods to test the model. We pool the seven-year data set (2000, 2004 to 2009) to derive a total number of 350 observations for the empirical analysis. The rationale for pooling the seven-year data lies in data accessibility. The state-level data concerning the primary explanatory transportation variables Walkwork, Drivwork, and Transwork are only available for the years 2000 and 2004-2009. We estimate seven separate regression models. The diagnostics from the initial model reveal two specific econometric issues. First, the Modified Wald's test for group wise heteroskedasticity confirms the presence of heteroskedasticity in all seven regression models. In addition, we apply the Wooldridge test to examine serial correlation in the panel data. The null hypothesis of no first-order autocorrelation has been rejected for all seven regression models (p-value 0.001). All of the regression models demonstrate serial autocorrelation.

As a consequence, the researchers uses the Panel-Corrected Standard-Errors (PCSE) to account for panel-specific heteroskedasticity and autocorrelation, as suggested by Beck and Katz (1996) to control the econometric modeling issues created with the pooled panel data. Specifically, models one to six are estimated with panel specific AR (1) correlation. The use of panel specific AR (1) correlation is driven by the assumption that changes in obesity over time are not the same within each panel (state). These changes are more likely to be different within each geographic unit as the context of each state is place-specific. In model seven, the dependent variable is the annual growth rate of state obesity rates. The authors employ the fixed effect model with Driscoll-Kraay standard errors, which are used to correct the econometric issues of heteroskedasticity and autocorrelation.

Empirical Findings

Table 3 presents the results of the seven regression models showing the effects of the transportation variables on the state-level obesity rates. The R^2 values show that the independent variables included in models one to six explain more than 93% of variation of the dependent variable. Model 1 is the base model without the transportation variables. It shows that fruit and vegetable consumption, per capita income, per capita state health care expenditures and region are statistically significant in explaining the obesity rate. More specifically, the result shows that as fruit and vegetable consumption and per capita income increase in one state, obesity rate tends to decrease (Lantz et al., 1998; Mokdad, 2003). The region dummy variable indicates that southern states are more likely to be obese than non-southern states. Model 1 also shows that state obesity rates are positively associated with per capita state health care expenditures, although the coefficient of per capita health care spending (SCHS) is very small (0.003). This finding may suggest that governmental spending efforts, with respect to obesity, have not been successful. Thus, policy makers should be more targeted with preventive and educational material than what is currently being used to remedy the issue.

Model 2 is estimated with the addition of our primary transportation variables of Walkwork, Drivwork, and Transwork. The results show that fruit and vegetable consumption, per capita income, per capita state health care expenditures, and region dummy are still statistically significant in explaining the incidence of obesity. The coefficient for the total uninsured variable (Uninsuredtot) also is positive (0.21) and statistically significant ($p< 0.01$). More specifically, the data show that a one unit increase in the total uninsured population increases state obesity rates by 0.21 percent ($p< 0.01$). Regarding the main explanatory variables, we find that all incorporated transportation variables are statistically significant ($p< 0.01$) in the expected directions except Transwork (negative as expected, but statistically insignificant). It can be inferred that, other things held equal, a one percent increase in the share of workers commuting to work by walking will result in a 0.37 percent decrease in state obesity rates. To the contrary, a one percent increase in the share of workers commuting to work by driving will increase state obesity rates by 0.15 percent.

Instead of using the primary transportation variables, the authors consider per capita vehicle miles driven (VMTpc) and the percentage of employees commuting to work by taking public transportation (Transpc) as the alternative transportation variables in Model 3. Both variables are statistically significant ($p< 0.01$) in the expected directions. However, VMTpc has a very small positive sign (0.0004). Meanwhile, Transpc shows a relatively large magnitude of negative effects on obesity rate (beta=0.01). Other control variables changed very little, with the exception of the variable Uninsuredtot, which becomes insignificant in Model 3. Model 4 contains all independent transportation variables. It shows that Walkwork and Drivwork are consistently significant in the expected direction. The other transportation variables are statistically insignificant. Our control variables perform as expected. To account for the possible endogeneity between obesity and transportation variables, Models 5 and 6 are estimated with the lagged values of our independent transportation variables (one year lag). Compared with Model 2 (no lag period), the signs of the lagged variables of Walkwork and Drivwork perform as expected, but their magnitudes become larger in Model 5.

In Model 6, the directions of the lagged variables of Transpc and VMTpc remain the same, but the magnitude of the lagged variable of VMTpc becomes larger in comparison with Model 3 (no lag period). The dependent variable in model 7 is the annual growth rate of state obesity rates. Drivwork is still positive and statistically significant ($p < 0.01$). It implies that a one unit increase in Drivwork raises the annual growth rate of state obesity rates by 0.07. The other two transportation variables are not statistically significant. In addition, we find that states with a large (percentage) white population experience a slow growth in obesity rates. On the contrary, a large uninsured population increases the annual growth rate of state level obesity rates. In summary, across models one to six, the coefficients for the control variables fruit and vegetables, per capita income, and region are consistent and statistically significant in the expected directions. The results suggest that non-white, low income residents who reside in the south and consume little fruits and vegetables are at the highest risk levels for obesity.

With respect to our primary independent variables, the coefficient for Walkwork ranges from -0.63 to -0.34 ($p < 0.01$). Meanwhile, the coefficient of Drivwork remains constant around 0.15 ($p < 0.01$). The variable of Transwork is statistically insignificant across all models. However, when we use the alterative public transportation variable Transpc, we did find empirical evidence showing a negative and statistically significant relationship between the urban transit ridership per capita and the state-level obesity rates (Beta= - 0.01). In Model 7, we find that race, income, uninsured total population, and Drivwork are the statistically significant predictors of the annual growth rate in state obesity rates.

The findings from these models are consistent with the expectations put forward by Bell, et al. (2002), Frank, et al. (2004), Jacobson, King, and Yuan (2011) who all argue that the dominant use of automobile significantly contributes to the rise of obesity. Yet, this research is the first study to indicate that at the state-level, a predominant auto-travel and a low share of active transportation in terms of workers commuting to work by walking and public transportation could contribute to a higher level of obesity rates. These findings are consistent with other research at the national and local levels (see Bassett, et al., 2008; Edwards, 2007; Lindstrom, 2007; MacDonald, 2010).

Table 3: Regression Results

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Fruits	-0.06***	-0.09***	-0.07***	-0.09**	-0.10***	-0.07***	-0.01
	(0.03)	(0.05)	(0.03)	(0.05)	(0.03)	(0.03)	(0.01)
Phyact	0.02	0.03	0.02	0.03	0.10	0.20	0.00
	(0.02)	(0.05)	(0.02)	(0.05)	(0.04)	(0.02)	(0.01)
Smoke	-0.01	0.06	-0.01	0.06	0.11***	-0.01	-0.01
	(0.03)	(0.06)	(0.03)	(0.06)	(0.04)	(0.03)	(0.04)
Race	0.01	-0.01	-0.00	-0.01	-0.01*	0.04	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Income	-0.001*	-0.001***	-0.001*	-0.001**	-0.001***	-0.001*	-0.001*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Unem	0.03	0.08	0.08	0.05	0.14	0.045	-0.05
	(0.09)	(0.15)	(0.10)	(0.12)	(0.10)	(0.09)	(0.05)
Uninsuredtot	-0.02	0.21***	0.05	0.20***	0.21***	0.05	0.04**
	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.02)
SCHS	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Region	-3.94***	-1.80***	-3.18***	-1.90***	-1.90***	-3.50***	
	(0.57)	(0.68)	(0.52)	(0.66)	(0.66)	(0.52)	
		-0.37***		-0.34***	-0.63***		0.02
Walkwork		(0.16)		(0.16)	(0.10)		(0.03)
Drivwork		0.15***		0.15***	0.16***		0.07***
		(0.02)		(0.04)	(0.02)		(0.03)
Transwork		-0.02		-0.02	0.02		-0.06
		(0.02)		(0.03)	(0.02)		(0.08)
VMTpc			0.0004***	-0.00		0.003***	
			(0.00)	(0.00)		(0.00)	
Transpc			-0.01***	0.00		-0.01**	
			(0.00)	(0.01)		(0.02)	
Constant	10.74***	-3.08	7.54***	-3.33	-7.75	8.511	-4.30
	(2.18)	(6.370	(2.41)	(6.97)	(5.23)	(2.268)	(2.72)
N	350	350	650	350	300	600	210
Wald-test	331.60	690.58	382.95	1116.9	1744.23	396.12	168.68
	p> chi2=0	p> chi2=0	p > chi2=0	p > chi2=0	p > chi2=0	p > chi2=0	p > F=0
R-Square	0.9378	0.9704	0.9421	0.9692	0.9856	0.9404	0.05

Note: Models 1-6 provide coefficients from linear regression estimations with PCSEs in parentheses. PCSE models corrected for heteroskedastic errors structure and panel-specific AR (1) serial autocorrelation. Model 7 is estimated by the fixed effects with Driscoll-Kraay standard errors. *** p<0.01, ** p<0.05, * p<0.10. Model 3 and 5 are estimated with a large data sample covering the years of 1997 to 2009.

Policy Implications and Conclusion

The prevalence of obesity has become a major public health concern in the U.S. and the level of intensity for the issue has not waned in recent years. The growing numbers of obese children and adults, along with obesity-related diseases and health problems have contributed to a tremendous increase in U.S. healthcare costs. Hence, combating rising obesity levels is a critical undertaking for the entire nation.

Data from the CDC show that Obesity rates vary widely across the American states. Anecdotally, states with the highest levels of obesity generally have the lowest share of active transportation and highest reliance on automobile travel. Therefore, it is important to empirically examine this variation in obesity rates among the states with a focus on transportation factors. This analysis extends the previous literature by examining the association between transportation mode choices and the state-level obesity rates. We found that the mode of transportation to work were significantly associated with the state-level obesity rates.

In particular, walking and taking public transportation to work are negatively associated with obesity rates. Research shows that people often walk or ride a bicycle to a metro stop/bus station/train station and often walk some distance to the job site (Bassett et al., 2008; Edwards 2008; MacDonald et al., 2010). Our analysis show that driving to work is positively associated with obesity rates among states. Previous research suggests that this may be due to the sedentary behavior of driving and riding a vehicle (Bell et al., 2002; Frank, et al., 2004; Jacobson, King, & Yuan, 2011).

The policy implication of this study is clear— there are many health benefits to regularly walking or taking public transportation to work. Reducing the heavy reliance on auto-travel and encouraging active transportation may be one way to fight the American obesity epidemic. To do so, first, integrating public health objectives into the transportation planning process may be a cost-effectiveness way to improve public health (Litman, 2003). Traditional transportation planning tends to focus on enhancing travel mobility, but overlook the adverse health impacts of increased auto-travel. Projects with the greatest public health gains should be given a higher priority in the transportation planning decision-making process. Second, in order to promote a more balanced transportation system, all levels of governments are encouraged to make substantial investments toward alternative transportation modes such as public transportation and increasing the number of sidewalks and bicycle lanes. Frank et al. (2006) contend that for every 5% increase in walkability, a community can expect more than a 30% increase in physically active travel and approximately a quarter-point reduction in individual body mass index. Last, we argue that governments cannot use a one pronged approach to solving this social ill. First, governments must use multiple avenues and venues to solving the issue at every level of government. Obesity is clearly correlated with other social ills, thus the government should seek an agenda that seeks to reduce all of these social ills rather than focus on them individually.

This may in fact require governments to reallocate health care funding to different programs or possibly different organizations that have programs that aggressively and comprehensively address the issue. Second, governments need be more proactive and collaborate with health and medical organizations, transportation planning organizations, food industries, education institutions to improve marketing campaigns and preventive efforts of combating obesity. With federal funding in hand, some states and local government has used programs such as the Farm to School/Institutions and Safe Routes to School, to work with different community partners, and have made progress in fighting obesity (Joshi, Azuma, & Feenstra, 2008; Staunton et al., 2003). Since we examine state level data, we are somewhat limited in our findings. However, we recommend that future research examine this subject at the individual or metropolitan level with the intent of determining how food deserts, processed food consumption, public transportation and other labor savings devices impact nutrition and physical activity (Beaulac et al 2009; Adams et al., 2010). By so doing, the goal to reduce obesity is America will become closer to reality.

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