The Relationship of Income, Density, and Commuting Times on Overweight/Obesity Rates in North Carolina

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Abstract:

A major health problem that is increasing at an alarming rate in the state of North Carolina is obesity (NCDHHS, 2005). The preventable health costs for obesity have been rising all across the nation and account for $117 billion annually in direct ($61 billion) and indirect ($56 billion) medical costs (USDHHS. 2003). Even more alarming is that physical inactivity results in 400,000 preventable deaths in the United States each year and is steadily gaining on smoking as the number one cause of preventable deaths. It is estimated that about three out of every five Americans carry an unhealthy amount of excess weight. The number of adults that are reported as being obese in North Carolina has increased by eighty two percent from 1990 to 2002 (CDC, 2002). Approximately two-thirds of the adult population was overweight or obese in 2004, which is about 120,000 more adults than the year before (NCDHHS, 2005). In the same period the median household income of North Carolina has risen from $26,329 to $36,515 (US Census Bureau, 2000). Because obesity is commonly associated with minority and low income populations (Jeffery and French, 1996; Frank et. al., 2004), this dramatic increase in obesity during a decade of economic growth and rising income is surprising. This suggests that obesity is related to other factors, including those linked to increasing household incomes.

Keywords: obesity | public health | North Carolina | transportation | socioeconomic status

Article:

1. Introduction

A major health problem that is increasing at an alarming rate in the state of North Carolina is obesity (NCDHHS, 2005). The preventable health costs for obesity have been rising all across the nation and account for $117 billion annually in direct ($61 billion) and indirect ($56 billion) medical costs (USDHHS. 2003). Even more alarming is that physical inactivity results in 400,000 preventable deaths in the United States each year and is steadily gaining on smoking as

the number one cause of preventable deaths. It is estimated that about three out of every five Americans carry an unhealthy amount of excess weight. The number of adults that are reported as being obese in North Carolina has increased by eighty two percent from 1990 to 2002 (CDC, 2002). Approximately two-thirds of the adult population was overweight or obese in 2004, which is about 120,000 more adults than the year before (NCDHHS, 2005). In the same period the median household income of North Carolina has risen from $26,329 to $36,515 (US Census Bureau, 2000). Because obesity is commonly associated with minority and low income populations (Jeffery and French, 1996; Frank et. al., 2004), this dramatic increase in obesity during a decade of economic growth and rising income is surprising. This suggests that obesity is related to other factors, including those linked to increasing household incomes.

A possible explanation for rising obesity is lower urban density, which can be expected to increase commute times, and can in tum be linked to rising incomes, physical inactivity, and obesity. Communities that are less densely built may lead to more time spent driving and less walking or other kind of physical activities (Ewing and Cervero, 2001). These kinds of communities are also associated with a lack of nearby public services (e.g., parks) or entertainment opportunities, which may increase in television viewing and fast food consumption. Because many middle class people in search of affordable housing are forced to live in peripheral neighborhoods (Sultana, 2005), it can be expected that obesity rates will rise even as incomes rise.

Even though an increasing body of literature shows evidence that the physical design of metropolitan area can relate to individuals' commuting time and mode choices, very little research has looked at directly how these factors are related to obesity rates (Sui, 2003). Those studies that have done so focused at the national level or metropolitan scale, and analysis at county or city scales are still missing. This paper will therefore test the hypothesis that there is a correlation between population density, commuting time and high obesity races. using North Carolina counties as study locations.

2. Literature Review

The topic of obesity is receiving a considerable amount of attention today, and research in urban and transport planning literature has tried to investigate the relationship between obesity rates and the built environment and transportation mode choices (Crane, 2000; Sui, 2003) along with many other factors including age, gender, race, and income. Frank et al, (2004) looked into how the urban environment plays a role in obesity using Atlanta as a case study. The data were obtained from individual survey data at the neighborhood level. They used as variables land use mix, time spent in cars and distance spent walking in relation to obesity. The most important finding derived from this study was that each quartile increase in land use diversity reduces the prevalence of obesity by 12.2% across all ethnic groups and both genders. This means that the more spread out the city is, the greater the likelihood of obesity. It also found that each additional hour spent in a car resulted in an increase of obesity by 6%. At the same time this study found that each additional kilometer walked decreased the likelihood of obesity by 4.8%. Not only do their results clearly show that less dense cities greatly increases the chances for obese adults, it also shows that walking instead of driving reduces obesity in the study area. Similarly, after controlling for education, a recent national study found that the probability of being overweight

or obese, and to a lesser extent of being physical active, is significantly associated with the overall urban form of the county in which a person lives (Ewing et al., 2003).

Another study (Lopez, 2004) also found that urban form, contributes to an increased risk for being obese. This study is unique because it used data from the Behavioral Risk Factor Surveillance System (BRFSS) survey from 2000. This study used an urban sprawl index, which is a measure of how spread out a city is, and found that each point increase on the scale increased the rate of obesity by 0.5%. This research also states that because of increased driving distances to get to parks and other exercise locations people may develop a more sedentary lifestyle that is more favorable to gaining weight. In another case a variety of health measures were related to urban form at the level of metropolitan areas (Kelly-Schwartz et al, 2004). Different components of urban form were related to different health indicators, with low densities being related to better health as is a grid street network that is more typical of higher density areas. There are clearly many possible ways that urban form and health can be related. Another study examined how the spreading out of cities hinders exercise because the new location patterns are so dispersed that work, school and social activities are not as easily accessible to residents of peripheral locations (Vandergrift and Yoked, 2004).

However, other research found that higher incomes increase the probability of having time for leisure and physical activities (Ford et al., 1991). These studies reported a direct positive relationship between income and time spent on leisure. In fact, a significant amount of research has shown an inverse relation between obesity and income (Jeffery and French. 1996). They argued that low income people have more limited access to healthy foods, safe exercise and sound nutritional knowledge and that these factors contributed to higher rates of obesity. In support of these findings some researchers also argued that income growth does not necessarily result in low density dispersed development (Vandegrift and Yoked, 2004). In fact, middle to low-middle income people are generally forced to live in that area in order to be able to afford housing (Sultana. 2005). This may help account for lower income populations having higher obesity while remaining consistent with the idea that low density urban form promotes obesity. Based on the findings of these previous studies, it is hard to ignore the fact that density and commuting times play a role in obesity. However, to date, little research has been done that uses local data (e.g., county level), and so a more detailed look at the relationships between obesity and density is in order.

3. Study Area, Data, and Methodology

Almost every other study of obesity has used metropolitan, state or national data to find a relation between obesity rates and the built environment, or uses data from a few neighborhoods. This research uses counties as the analysis level, providing coverage for an entire state. The data for the overweight and obesity rates was obtained from 2004 Behavioral Risk Factor Surveillance System Survey of North Carolina. The BRFSS survey is conducted by the United States Centers for Disease Control and Prevention to determine health risks across the entire nation. For the 2004 survey, the North Carolina BRFSS Program conducted 15,053 interviews in both English and Spanish, making the NC-BRFSS the second largest state-based health survey in the nation. Local (county) level data are available for 22 of the largest counties and 13 county groups that consist of 63 counties (Fig 1). The county groups are listed in Table 1 and are treated

as being equivalent to counties in this research. Unfortunately, l5 rural Appalachian counties are not included in the survey.

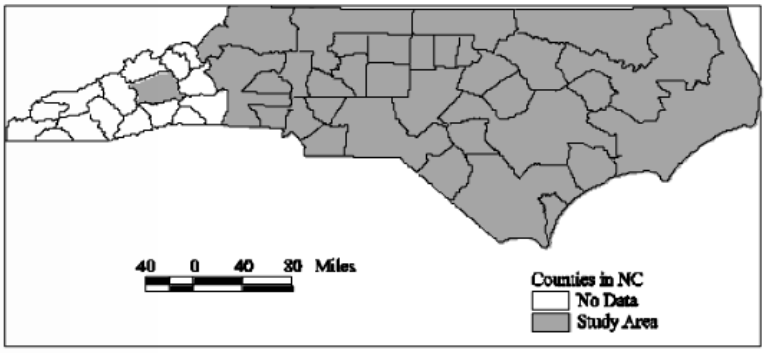

Figure 1. Study Area: Counties and County Groups in North Carolina

Table 1. Obesity Rates by Counties in North Carolina, 2004

Rank	County	Obesity Rates	Rank	County	Obesity Rates
1	Orange	52.5	18	Alamance	64.9
2	Wake	55.8	19	Group 4	64.9
3	Durham	57.0	20	Catawba	65.3
4	Rowan	58.3	21	Group 1	65.3
5	New Hanover	58.6	22	Iredell	65.5
6	Group 6	58.6	23	Pitt	66.4
7	Mecklenburg	59.0	24	Group 10	67.3
8	Buncombe	59.6	25	Randolph	67.4
9	Guilford	59.7	26	Group 7	68.2
10	Forsyth	59.8	27	Johnston	68.5
11	Union	62.0	28	Group 2	68.8
12	Group 8	62.2	29	Group 5	68.9
13	Davidson	62.3	30	Gaston	69.4
14	Onslow	63.6	31	Group 3	69.9
15	Cabarrus	63.7	32	NE Partnership 2	70.1
16	Cumberland	63.8	33	NE Partnership 1	72.0
17	Group 9	64.2	34	Robeson	75.0

Notes:
Group 1: Carteret/Currituck/Craven/Dare/Hyde/Pamlico Counties
Group 2: Franklin/Nash/Wilson Counties
Group 3: Duplin/Greene/Harnett/Jones/Lenoir/Sampson/Wayne Counties
Group 4: Bladen/Brunswick/Columbus/Pender Counties
Group 5: Caswell/Granville/Person/Vance Counties
Group 6: Chatham/Lee/Moore Counties
Group 7: Anson/Hoke/Montgomery/Richmond/Scotland/Stanly Counties
Group 8: Davie/Rockingham/Stokes/Surry/Yadkin
Group 9: Alleghany/Ashe/Avery/Watagua/Wilkes Counties
Group 10: Alexander/Burke/Caldwell/Cleve./Lincoln
NE Partnership I (Bertie/Gates/Halifax/Hertford/Northampton/Warren)
NE Partnership 2 (Beaufort/Camden/Chowan/Edgecombe/Mattin/Pasq./Perq./Tyrrell/Wash. counties)

This survey used the Body Mass Index or BMI. which measures body fat based on height and weight to determine if the survey participants were overweight or obese. The BMI is divided into four categories that are underweight (BMI=< l8.5), recommended weight (BMI=18.5-24.9), overweight (BMI=25-29.9) and obese (BMI=>30). For this research all respondents with a BMI

of 25 or greater were grouped as the overweight or obese. Obesity rates are available by sex, race, age group, education level, and household income. In North Carolina over sixty percent of the population is either overweight or obese (CDC BRFSS 2002), and the obesity rate has been increasing over the last several years (Fig. 2). This creates an inviting area in which to conduct research on the overweight and obese.

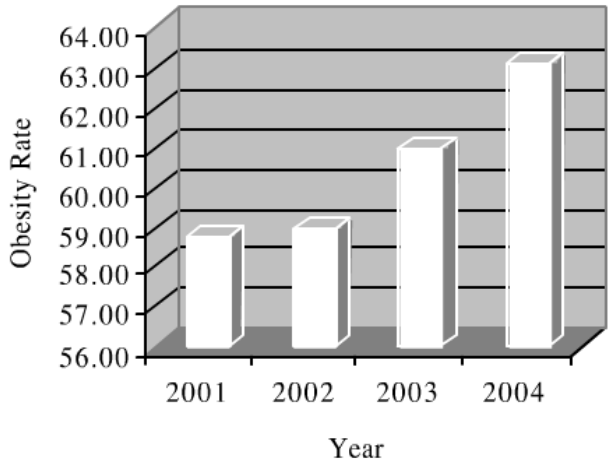

Figure 2. Obesity Rates in North Carolina, 2001-2004

The average income, commuting time, and population density per county was calculated from the 2000 Census Transportation Planning Package (CTPP) dataset. This is a special tabulation of the 2000 Census distributed by the Bureau of Transportation Statistics (BTS) to assist with transportation planning. This contains data on mode choice and travel times to work, and is cross-tabulated by a wide range of individual and household socioeconomic characteristics. Income, commuting time to work, and population were extracted from this dataset, with population density calculated once the area of counties and county groups had been measured using Arc View GIS.

In this study the dependent variable is the overweight and obesity rates for the selected counties and county groups of North Carolina. The three independent variables are expected to show a correlation with the obesity rates. It is expected here that obesity rates will be higher in counties that have lower population densities (reflecting a more spread out urban environment). It is also expected that lower average household income of the counties is related to overweight and obesity rates. finally, longer average commuting times should be associated with higher obesity rates, reflecting longer distances between home and work characteristics of low density environments.

4. Results and Discussion

The average obesity rate for the state of North Carolina was 63.1% in 2004. The highest obesity rate (75%) is found in Robeson County (a rural county in the south-central part of the state) (Table 1 and Figure 3) and the lowest obesity (52.5%) county was Orange (which includes Chapel Hill). All of the other urban counties, e.g. Wake (Raleigh, 55.8%), Durham (Durham and Research Triangle, 57.0%), Mecklenburg (Charlotte, 59.0%), Buncombe (Asheville, 59.6%), Guilford (Greensboro, 59.7%), and Forsyth (Winston-Salem, 59.8%) have a lower average

obesity than the state of North Carolina. As seen in Figure 3, counties with high obesity rates are generally rural and located some distance from metropolitan areas.

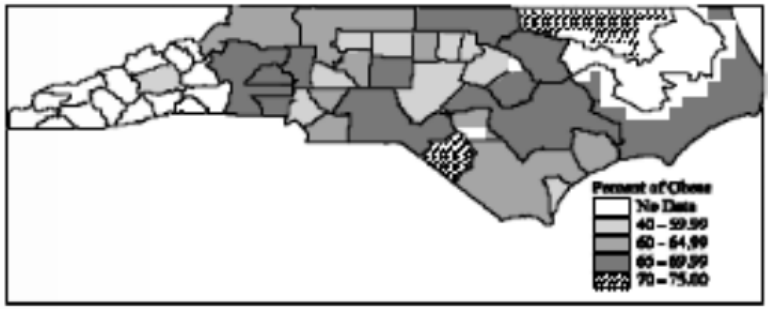

Figure 3. Obesity Rates by Counties in North Carolina, 2004

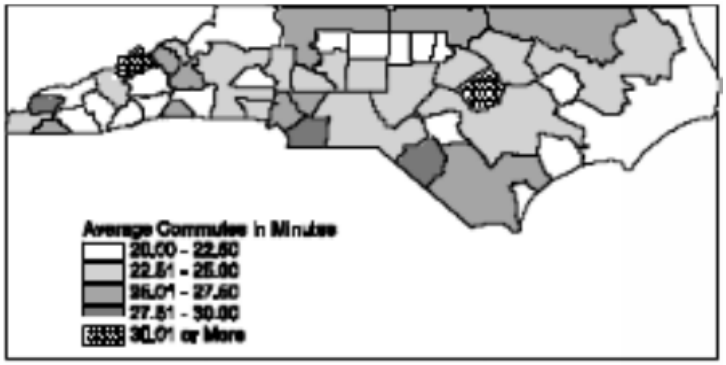

Figure 4. Average Commuting Time by Counties, 2000

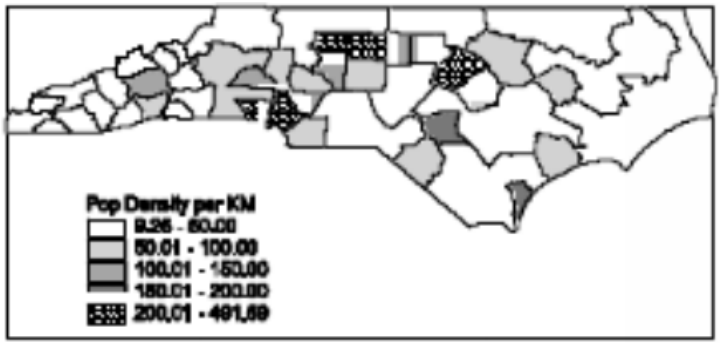

Figure 5. Population Density by Counties, 2000

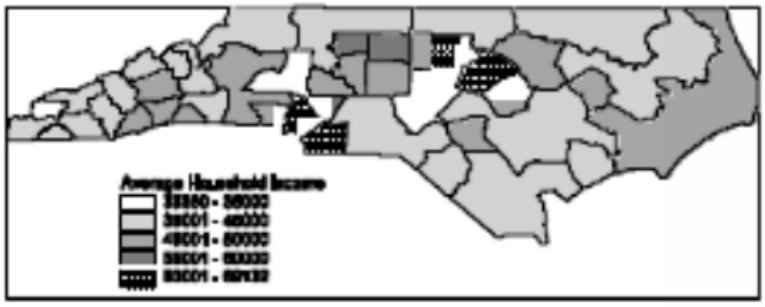

Figure 6. Average Household Income by Counties, 2000

Income and densities reflect similar patterns, with metropolitan counties having the largest values, and rural areas the smallest (Figures 4, 5, and 6). The pattern of commuting times provides the major exceptions, as counties in the Greensboro/Winston-Salem and Durham areas tend to have low commuting times while some rural counties in the northeast aid southeast have long commutes.

Table 2. Spearman's Correlations Between Obesity Rates and Selected Variables

	Correlation with Obesity Rates		
Variables	**All**	**White**	**Other**
Average Commute time	.385*	.479*	.035
Population Density	-.590*	-.456*	-.459*
Average Household Income	-.679*	-.440*	-.538*

*Statistically significant at the .05 level

To test the relationship between these patterns. Spearman's Correlation Coefficient was calculated between obesity and the three independent variables (Table 2) for all population, and after controlling for race. BFRSS only provides race categories as white and non-white at county level. Therefore, we are only able to control race as white vs. non-white. Table 2 clearly shows that there is a significant positive relationship between average commuting time and obesity rates, with longer times being associated with a greater percentage of the population being obese. A similar, but stronger relationship was observed between average commuting times and obesity rates for whites (but not for non-whites). The longer people commute, the greater the chance that

they will be either overweight or obese. This is consistent with the findings of other studies, especially that of Frank et al (2004), who used regression with individual data and found that each additional hour spent driving increased a person's chance of being obese by six percent.

A negative relationship exists between the population density of counties and obesity rates, whether obesity is measured for the entire population, whites, or others (predominantly African-Americans). This supports the expectation that the less dense a county is the more likely the residents will be overweight or obese. This finding is clearly also in agreement with the results of previous studies.

The strongest relationship of all the variables was also one that is consistent with our expectations about obesity. Between the average household income and the obesity rates strong bill negative correlation exists. This shows that the higher the income of the counties the lower the percentage of overweight and obese residents. This agrees with numerous studies conducted on obesity, but does not agree with the expectation that high-income areas, which can be expected to be low density, will therefore have higher obesity rates.

These relationships were refined by measuring obesity rates for different incomes and level of education (Table 3). The results for population density are unchanged, though the results are strongest for low income and highly educated populations. For these groups there also remains a significant positive relationship with average commuting time. Average county income retains its negative relationship with obesity regardless of the income or education of survey respondents. It is striking that similar patterns are seen for both lower income and highly educated individuals.

Table 3. Spearman's Correlations Between Obesity Rates and Selected Variables, Controlling for Income and Education

Variables	Household Incomes less than $50,000	Household Incomes more than $50,000	High school or less education	College or more education
Average Commute time	.321*	.263	.262	.406*
Population Density	-.571*	-.407*	-.403*	-.517*
Average Household Income	-.639*	-.429*	-.371	-.642*

*Statistically significant at the .05 level

5. Conclusions and Future Directions

This study found that lower incomes are positively related to being overweight or obese. It also found that longer commutes arc also associated with greater chances of being overweight or obese, as does lower population densities. County level patterns in North Carolina clearly match those identified elsewhere for major cities. This study has shown that these relationships can be identified throughout the state, which spans the continuum from heavily urbanized to sparsely serried counties (many with outstanding opportunities for exercise through outdoor recreation). In those counties where commutes are longer, there is a stronger correlation with obesity. Coupled with this is the fact that the counties that were the most sparsely populated also tended 10 have the highest rates of obesity. Long commutes and low densities both appear to be environments that increase the likelihood for people to become overweight or obese.

While the results confirm expected relationships between commuting times and densities with obesity, they show that the expectation that higher incomes are related to more cases of obesity appears to be false. The finding that lower incomes are associated with more obesity is very important, but as previous studies (Vandergrift and Yoked, 2004) have stated, they fail to account for why rising incomes have not resulted in a lowering of obesity levels. As noted in other studies, this could be due to the fact that lower income residents might not have knowledge of healthy eating habits, the financial capabilities for use of fitness centers, and could lack access to outdoor recreation and stores setting healthy foods. These issues obviously have implications that extend well beyond traditional urban and transportation planning approaches. This requires an examination of accessibility to recreation and grocery stores as well as the time and financial constraints on activities faced by these populations.

It has also been argued that low density urban expansion and economic decline within central cities are both manifestations of the same underlying growth process (Downs, 1999), which implies that the link between lower incomes and obesity may still be related to urban density. This may help explain the similarities seen in obesity relationships among lower income and highly educated individuals in Table 3.

One obvious and important limitation is that this research was conducted at the county level, which will conceal many relationships that are likely to be found at more fine spatial resolutions. Figure 6 clearly shows that urban counties tend to have higher average incomes, but focusing on counties conceals variations within metropolitan areas, such as exists between central cities versus dispersed suburbs. The CTPP allows the use of very small spatial zones, down to the level of Traffic Analysis Zones, which are smaller than Census Block Groups. If obesity rates were available at this zone it is highly likely that the observed relationships would change, in large part due to the Modifiable Areal Unit Problem (MAUP). Research on the MAUP has shown that the more disaggregate the spatial zones, the stronger the correlation between variables will likely be (Horner and Murray, 2002). Thus this research has identified such strong relationships at the county or regional level is therefore very significant.

While the idea of linking expanding cities with expanding waistlines is appealing and common (Sui, 2003), it should not be overlooked that obesity is actually greatest in rural counties within North Carolina. It is therefore necessary to extend the connection between urban density and health to rural areas that are not commonly associated with rapidly growing low-density cities. Additional studies examining causal relationships among these variables are also needed.

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