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A note on the relationship between obesity and driving

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ABSTRACT

Vehicle travel and obesity rates in the United States have surged in recent decades. This paper contributes to the mounting evidence of a link between them by drawing attention to a very close relationship between trends in miles driven per licensed driver and adult obesity rates six years later. It also presents evidence on why the effect might be expected to be lagged by six years. A simple model is produced, which predicts reductions in obesity rates over the next few years. If these reductions come about, the model will be seen to offer a powerful insight into the relationship between driving and obesity. If the relationship is more than coincidental, it has implications for transport policy and supports the development of a multi-pronged, interdisciplinary approach to tackle increased driving and obesity.

1. Introduction

Escalating obesity rates are a significant challenge faced by the United States. Individuals who are obese are more likely to suffer from conditions such as coronary heart disease, type 2 diabetes, and high blood pressure (Must et al., 1999), with as much as US$147 billion estimated to have been spent on healthcare related to obesity in 2006 (measured in 2008 US$), representing almost 10% of healthcare expenditures, and further straining the healthcare system (Finkelstein et al., 2009).

There is mounting evidence of a potential link between automobile travel and obesity, centering on the influence of the built environment (e.g., Frank et al., 2006; Li et al., 2008; Sallis et al., 2009; Smith et al., 2008; Van Dyck et al., 2009). Consistent with these studies, the Centers for Disease Control and Prevention (CDC) has developed a set of environmental strategies, to be implemented at the community level, to address the pervasive and persistent spread of obesity in the United States. In addition to strategies advocating dietary change, the CDC has suggested the promotion of walking and cycling infrastructure and mixed-use land development (Centers for Disease Control and Prevention, 2009). By suggesting such strategies, the CDC implicitly assumes a link between obesity rates and transportation choices.

Analysis on the relationship between automobile travel and obesity in the United States has shown that automobile use tends to be lower in the regions that exhibit lower levels of obesity (e.g., Frank et al., 2004; Lopez-Zetina et al., 2006; Pendola and Gen, 2007). A recent study in Atlanta, Georgia, found that spending an additional hour per day in a car increased an individual's odds of being obese by 6% (Frank et al., 2004). A cross-national analysis of obesity in European countries found that obesity rates were higher in countries with more automobiles and higher densities of roadways (Rabin et al., 2006). Finally, Courtemanche (in press) investigates the relationship between obesity and fuel prices, and estimates that a permanent US$1 increase in real gasoline prices will reduce obesity in the United States by 10% in seven years, if people respond with increased walking and less frequent restaurant visits.

Our daily life experiences may provide an intuitive rationale for the interplay between obesity and transportation choices: consider a person who wants to purchase a newspaper at a convenience store five blocks away from their home. This distance is sufficiently short that walking and cycling are reasonable alternatives to driving. If the person chooses one of these two alternatives, the desired objective is achieved by expending physical activity energy instead of using gasoline. Indeed, the choice to drive rather than walk or cycle increases fuel consumption and reduces physical activity energy expenditures.

If a general association between automobile travel and obesity were to exist, it might offer new opportunities for reducing obesity. However, before drawing such a conclusion we need to explore the possibility that any apparent correlation between obesity and car use is not simply the result of the fact that they both are correlated to a third variable such as personal wealth.

To explore the potential link between obesity and automobile travel, this paper tracks their evolution at the national level using simple linear regression models, which have been lagged to

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reflect the fact that any effect would take time to emerge. Observing this trend at the national level can provide support for a more general tradeoff between driving and active transport (such as walking and cycling) while also providing evidence that the results of local studies of obesity and vehicle use can be extended to the nation as a whole. Trends in personal wealth are examined in order to establish whether they offer a better explanation of trends in obesity. Numerous limitations to this kind of analysis are discussed.

2. Data and methods

To analyze the association between obesity rates and automobile travel in the United States, data are taken from publicly available national statistics published by the United States government. Although using nationally aggregated data departs from typical practice in public health statistics, and although we are aware of the possibility of errors in national statistics, especially ones that are computed from other statistics, such aggregation was necessary because we wished to measure data consistently across time periods (individual-level data are difficult and costly to collect for the same individuals across time periods). Obesity is measured by its prevalence in the adult population and noncommercial automobile travel is measured by the average noncommercial vehicle miles traveled per licensed driver and per adult. Trends in personal wealth are examined via data on real GDP per adult.

National obesity rates are reported by the Behavioral Risk Factor Surveillance System (BRFSS) between 1995 and 2007 (Centers for Disease Control and Prevention, 2007). These data quantify the percentage of adults in the United States whose BMI exceeds 30 kg/m^2, the medical definition for an adult to be considered obese.

Noncommercial automobile travel is captured by the annual vehicle miles traveled (VMT) by passenger cars and light trucks. The analysis is restricted to noncommercial vehicles, since it may be possible to eliminate a non-negligible fraction of their travel by walking or cycling, whereas commercial vehicle use is less likely to be eliminated in such a manner. Statistics describing annual vehicle miles traveled by noncommercial vehicles are gathered between 1985 and 2007; data used between 1990 and 2007 are from the annual National Transportation Statistics summary report, while data from 1985 to 1989 are computed from a Highway Statistics summary report and individual annual reports from 1985 to 1989 (Bureau of Transportation Statistics, 2009; Federal Highway Administration, 1986–1990; Federal Highway Administration, 1997). To estimate the noncommercial automobile travel at a personal level and help control for national population growth, annual VMTs are divided by the number of licensed drivers (LD) between 1985 and 2007 (Federal Highway Administration, 1994–2007) and by adult population (age 18 years or older) in the United States as reported by the United States Census Bureau (1995, 2001, 2010). GDP statistics are taken from the United States Bureau of Economic Analysis (2011).

3. Results

Fig. 1 (supported by data in Table 1) shows trends in VMT/LD, VMT/adult, and GDP/adult between 1985 and 2007 and in adult obesity between 1995 and 2007 (obesity data are not available prior to 1995). It is clear that all four trends have increased in recent decades but that obesity rates were fairly stable between 1996 and 1997 while VMT/LD was rising quickly whereas, since 2004, VMT/LD has been level or falling while adult obesity has been rising. The trends in VMT/adult and in GDP/adult are broadly similar to those in VMT/LD in that they show a rising trend, which faltered around 1990. However, the trends do differ from one another in various respects, for example, the GDP/adult trend has continued to rise while the VMT/adult trend has flattened out since 1999.

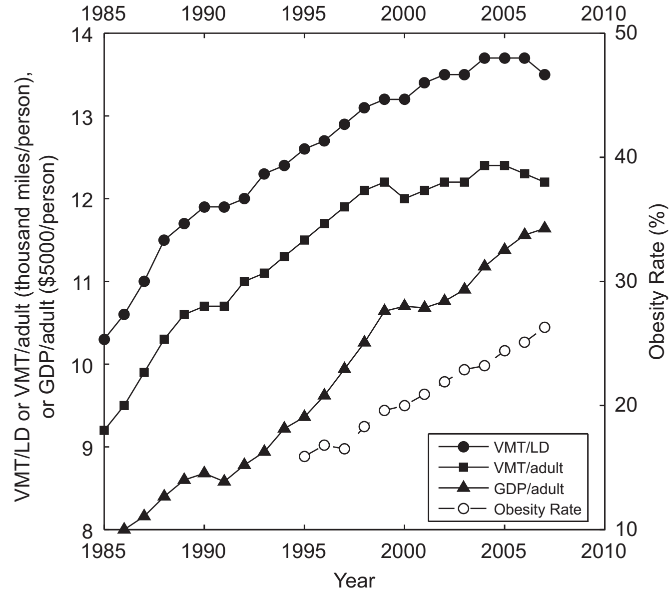

Fig. 1. Time series for VMT/LD, VMT/adult, GDP/adult (1985–2007) and adult obesity rate (1995–2007).

The absence of a correlation between obesity and VMT/LD (as well as between VMT/adult and GDP/adult) in any given year would be unsurprising because increases in vehicle use are not likely to have an immediate impact on obesity. Chow and Hall (2008), using an energy balance approach, explain how changes in diet affect body weight over time. They conclude that, while most weight loss is achieved in less than 1000 days for both of their models, body weight achieves a steady state after approximately 2000 days (~5.5 years) have elapsed (see Figs. 3A and C of Chow and Hall). Fig. 2 depicts the VMT/LD trend along with an obesity trend that has been lagged by six years. The result is striking, with the pause in the rise in obesity rates between 1996 and 1997 matching the pause in the rise in VMT/LD between 1990 and 1991.

Regression models were estimated in which obesity rates were predicted as a function of VMT/LD, VMT/adult, and GDP/adult in the same year or a number of years earlier. The results are shown in Table 2. All the models show a high level of explanation (which is unsurprising given that the data sets have such a strong time trend) but the VMT/LD model with a six-year lag shows the highest level of explanation,[1] namely 98.44%. The coefficients of determination generated by the VMT/adult and real GDP/adult models are also quite high. In particular, all the R^2 values generated by the real GDP/adult model were greater than 91%, though none of these models reached 98.44%. While appropriately lagged VMT/LD, VMT/adult, and real GDP/adult trends all serve as good predictors of the obesity rate between 1995 and 2007, the VMT/LD model with a six-year lag provides the most accurate predictions.

Table 3 describes the regression lines for the VMT/LD model with different lags. The slope of each regression line measures the

[1] Though the highest level of correlation is observed with a six-year lag, this does not imply that VMT/LD affects obesity only after 6 years have passed. When a lag of less than 6 years is applied, the initial transient period observed by Chow and Hall may still be in effect, and this may explain why these lags yield lower levels of correlation than a six-year lag.

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Table 1
National adult obesity rates, transportation data, and economic data in the United States, 1985–2007.

Year	Obesity rate* (%)	VMT (billion miles)	LDs (millions)	VMT/LD (thousand miles per LD)	Adult population (millions)	VMT/adult (thousand miles per adult)	Real GDP ($ billion)	Real GDP/adult ($thousand per adult)
1985		1637.8	156.9	10.4	175.3	9.2	6849.3	39.1
1986		1694.1	159.5	10.6	177.3	9.5	7086.5	40.0
1987		1772.9	161.8	11.0	179.2	9.9	7313.3	40.8
1988		1872.5	162.9	11.5	181.3	10.3	7613.9	42.0
1989		1937.7	165.6	11.7	183.4	10.6	7885.9	43.0
1990		1983.0	167	11.9	185.3	10.7	8033.9	43.4
1991		2007.0	169	11.9	187.0	10.7	8015.1	42.9
1992		2079.0	173.1	12.0	188.9	11.0	8287.1	43.9
1993		2121.0	173.1	12.3	190.7	11.1	8523.4	44.7
1994		2171.0	175.4	12.4	192.4	11.3	8870.7	46.1
1995	15.9	2228.0	176.6	12.6	194.2	11.5	9093.7	46.8
1996	16.8	2286.4	179.5	12.7	196.1	11.7	9433.9	48.1
1997	16.5	2353.3	182.7	12.9	198.2	11.9	9854.3	49.7
1998	18.3	2417.9	185	13.1	200.3	12.1	10,283.5	51.3
1999	19.6	2470.1	187.2	13.2	202.5	12.2	10,779.8	53.2
2000	20	2523.3	190.6	13.2	209.8	12.0	11,226.0	53.5
2001	20.9	2571.5	191.3	13.4	212.3	12.1	11,347.2	53.4
2002	21.9	2624.5	194.3	13.5	214.8	12.2	11,553.0	53.8
2003	22.9	2656.2	196.2	13.5	217.1	12.2	11,840.7	54.5
2004	23.2	2727.1	198.9	13.7	219.6	12.4	12,263.8	55.9
2005	24.4	2749.5	200.5	13.7	222.0	12.4	12,638.4	56.9
2006	25.1	2773.0	202.8	13.7	224.6	12.3	12,976.2	57.8
2007	26.3	2782.3	205.7	13.5	227.2	12.2	13,228.9	58.2

* Obesity rates are unavailable prior to 1995.

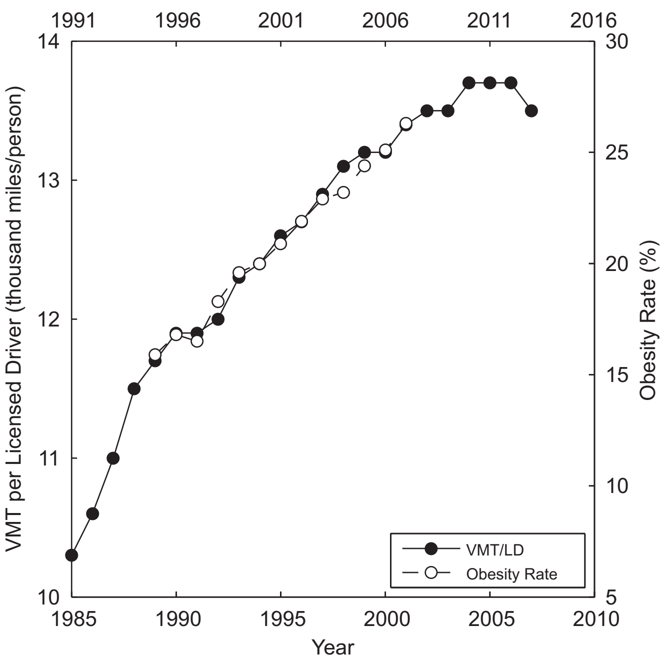

Fig. 2. Time series for VMT/LD (1985–2007) and adult obesity rate (1995–2007), with a six-year lag applied to the obesity rate trend.

increase in the obesity rate if each licensed driver were to drive an additional 1000 miles per year. The slope of the regression line in the model with the six-year time lag indicates that, historically, increasing daily vehicle travel by one mile per licensed driver (i.e., 365 miles per year) has been associated with a 2.16% increase in the adult obesity rate six years later. If the model is reliable, it would predict an obesity rate of 26.5% in 2008 and 2009, an increase to 27.6% in 2010 followed by stasis until 2012 and decrease back to 26.5% in 2013. Since this analysis was conducted, obesity rates for 2008 and 2009 have been released, and are 26.7% and 26.9%, respectively (Centers for Disease Control and Prevention, 2011). While both of these are relatively close to the values predicted by the model, they do deviate from these estimates and may foreshadow the predicted jump to 27.6% in 2010.

Table 2
Coefficients of determination (R^2) for models of obesity as a lagged function of VMT/LD, VMT/Adult, and GDP/Adult.

Lag (years)	R^2 for VMT/LD (%)	R^2 for VMT/adult (%)	R^2 for real GDP/adult (%)
0	85.32	73.43	94.42
1	95.64	83.79	95.27
2	96.14	87.34	95.55
3	96.39	90.78	95.36
4	96.33	91.18	95.84
5	98.39	92.83	95.50
6	98.44	95.50	94.99
7	96.36	96.06	92.62
8	94.95	96.17	91.64
9	93.56	95.68	93.75
10	93.84	95.59	95.48

Table 3
Linear regression results for the VMT/LD model, with lags of zero to ten years, given as the linear coefficient (β_1) for the model and test of significance for the linear coefficient.

Lag (years)	β_1 (%obese/(VMT/LD))**	*p*-value*
0	8.433	6.56×10^{-6}
1	7.591	7.93×10^{-9}
2	7.017	4.01×10^{-9}
3	6.360	2.76×10^{-9}
4	6.063	3.06×10^{-9}
5	5.969	3.21×10^{-11}
6	5.922	2.72×10^{-11}
7	5.710	2.92×10^{-9}
8	5.028	1.78×10^{-8}
9	4.493	6.80×10^{-8}
10	4.076	5.34×10^{-8}

* VMT/LD is measured in thousands of miles per licensed driver per year.
** This is the p-value for a t-test with the hypotheses H_0: $\beta_1 = 0$, H_A: $\beta_1 \neq 0$.

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4. Discussion and conclusions

Our models have established that obesity rates are better explained by VMT/LD than by VMT/adult or GDP/adult. The models have established a lagged correlation between obesity and VMT/LD based on 13 years of data but they do not prove causality or reversibility. The data come from a period in which there were general increases in both VMT/LD and obesity and, although the lagged model appears to predict that the upward trend in obesity will cease, we have not yet observed any evidence of the effect of a fall in VMT/LD on obesity. Obesity data for the years beyond 2007 will establish whether the plateau in VMT/LD, which began in 2004, and the fall in VMT/LD, which occurred in 2007, are reflected, six years later, by similar trends in obesity. These future obesity data will provide critical evidence that either support or refute the model proposed in this paper.

If the correlation is maintained and the fall does follow, it will become possible to be more confident that the model is reflecting something more than a coincidence and that, if the relationship holds, each 1% reduction in annual VMT per LD from its current levels (i.e., about 135 miles per licensed driver per year) would be associated with a 0.8% drop in the adult obesity rate six years later. For the United States as a whole, given an adult population of around 230 million (United States Census Bureau, 2008), this implies that reducing daily vehicle travel by one mile per licensed driver (i.e., 365 miles per year) would lead to almost 5 million fewer adults being classified as obese after six years.

It is, of course, entirely possible that the correlation in the two trends is coincidental. The analysis did not control for factors such as diet, income, environmental contributors, and other lifestyle factors that can have a significant effect on obesity rates. Work is in process to establish the association with such factors but, since they were not included in our regression analysis, any impact that they exert on obesity may have been attributed to vehicle use. While our regression results must be regarded with caution, they are consistent with previous studies that posit an association between automobile use and obesity.

Although consideration of obesity and vehicle use at an aggregated national level has its uses for policymaking, the result may not be applicable at the individual level; the results presented here do not suggest that any one specific individual adult can reduce his/her likelihood of being obese by driving less.

Considerable study has been devoted to how the built environment can potentially influence both obesity and automobile use. Studies have shown that individuals tend to walk more and drive less when walking is a more attractive method of transportation than driving (e.g., Courtemanche, in press; Frank et al., 2006; Handy et al., 2006; Rodriguez et al., 2008)—either because of the nature of the built environment or because of cost differentials. Our analysis has suggested that reductions in driving may lead to reductions in obesity and thus that efforts to reduce automobile travel may have the added benefit of reducing obesity rates. It should be noted, however, that this effect likely requires reductions in driving to be accompanied by increased use of active modes such as walking or cycling—the substitution of driving by increased use of telecommunications, or simply spending more time in bed, would not have the desired effect.

If a causal link could be established, the association between driving and obesity may provide opportunities to reverse their rise. Achieving such a goal would require transportation and public health experts to look at these problems through a collaborative lens and recognize that problems in one field may be best addressed through the skills from another, just as Gawande (2007) notes several medical problems that arise out of non-medical issues and have non-medical solutions. The time may be ripe to recognize that it may be impossible to treat one problem without considering the other. Government agencies and private foundations in the United States are making substantial investments to reduce obesity rates by promoting healthy food choices and more physical activity. While personal choices—such as replacing the choices to drive to nearby locations and using elevators with healthier activities such as walking and cycling, and climbing stairs—certainly play a part, realizing a meaningful impact on both obesity and energy consumption will require a societal shift in how we arrange and operate our lives. A better strategy to curb both energy consumption and obesity rates may be to carve out a national energy policy, a national transportation strategy, an urban planning strategy, and a national public health obesity strategy using the same stroke of the pen. Some of the benefits and barriers to such policy integration have already been established (Stead, 2008) but without a multi-pronged, systems-thinking approach, it may be futile to expect any efforts in reducing obesity rates to provide effective and sustainable results.

Finally, although we have not yet established a causal link between automobile travel and obesity, the alignment between our results and those of Chow and Hall (2008) is striking and, if obesity data in the coming years turn out to be in line with our model's prediction, the case for the existence of such a link will be more compelling.

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