Green Space and Adult Obesity Prevalence in the United States

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Abstract:

Natural amenities like green open space are a valuable resource to support quality of life and public health. However, limited studies have analyzed the relationship between such resources and specific indicators of public health. We investigate the relationship between natural green space and publicly managed recreation lands and adult obesity prevalence in United States counties. We find that counties with larger percentage of green spaces and those with access to public open space, such as state and national parks do have significantly fewer numbers of obese people.

Key words: Adult obesity prevalence, body mass index, green space, outdoor recreation, public health

1. Introduction

Obesity is a major public health problem in the United States. It is estimated that one in every three adults and one in every six children are obese in the United States and the prevalence of overweight and obesity has increased steadily over the past four decades with significant implications for healthcare expenditures (Flegal, Carroll, Ogden, & Curtin, 2010; Ogden, Carroll, Kit, & Flegal, 2014). Although body weight is the result of genetic as well as cultural factors, overweight and obesity are often linked to human behavior and environment (US DHHS, 2001). For example, it is well documented that engaging in less physical activity, sedentary behavior, and less healthy eating patterns significantly increase the risk of being overweight and obese (Bishop, Middendorf, Babin, & Tilson, 2005). Physical and social environment in which people live are also believed to play important roles in the food and activity choices they make (Booth et al., 2001; French, Story, & Jeffery, 2001). Hence, being physically active is more than a personal decision. This is particularly true in the short run. In the long run people are, in theory, less conditioned by their environment, as they can move to a different location.

Body weight is significantly associated with physical activity and existing studies find that environmental amenities such as milder climate, topographical variations, proximity to water bodies and availability of and access to outdoor recreation facilities and outdoor recreation resources, such as national and state parks promote higher levels of physical activity, which could eventually be related to lower body mass index (BMI) (Michimi & Wimberly, 2012; Pitts et al., 2013). Green open space is a valuable resource for physical activity and hence has potential to contribute to reducing obesity prevalence and improving public health. However, very few studies have analyzed the link between green space and obesity prevalence in the United States. Moreover, these studies tend to ignore various types of natural green spaces (e.g., cropland, pastureland, rangeland, etc.) that could also be a valuable resource to improve public

health (Grahn & Stigsdotter, 2003; Ulrich, 1984). Hence, the objective of this study is to investigate the relationship between green spaces of various types and obesity prevalence in the United States.

A study analyzing the relationship between adult obesity prevalence and green space is policy relevant for a number of reasons. First, because of population growth, urbanization, and land use changes, per capita area of green space is decreasing. The finding that, in addition to other ecosystem services, green space provides additional benefits in terms of reduced obesity would be a factor that would help enhance their preservation. Second, despite the federal initiative of Healthy People 2020 for a reduction in obesity prevalence, little progress has been made toward reducing obesity prevalence in the United States (CDC, 2015). In addition to higher morbidity and mortality risk, overweight and obesity have a significant economic impact on the U.S. health care system. Medical care costs associated with obesity is estimated to be 147 billion per year (in 2008 constant dollar), half of which is paid by the government, through Medicare and Medicaid (Finkelstein, Trogdon, Cohen, & Dietz, 2009). Because of the increase in obesity prevalence, these costs are expected to increase in the future. In this regard, findings of this study could help policy makers inform the obesity problem beyond the measures taken by the traditional healthcare system.

2. Green Space and Obesity

Green space could be a valuable resource for improving human wellbeing and public health. Previous studies have found that natural land cover is positively associated with mental well-being and life satisfaction (Kopmann & Rehdanz, 2013; White, Alcock, Wheeler, & Depledge, 2013), and many document direct and indirect effects of green space on public health. Availability of green space, such as forests, public parks, and other open space in the

neighborhood significantly increases the likelihood of engaging on physical activity, especially in urban areas where gaining access to the open countryside can be difficult (Coombes, Jones, & Hillsdon, 2010; Maas, Verheij, Groenewegen, De Vries, & Spreeuwenberg, 2006). In many cases, these open spaces are equipped with various recreational amenities including walking, hiking, and cycling trails. Green space also helps to keep people healthy, indirectly. Research on environmental public health has shown that direct interaction (e.g. viewing, playing, etc.) with natural areas could also help to increase the psychological well-being and recovery from illness (Grahn & Stigsdotter, 2003; Parsons, Tassinary, Ulrich, Hebl, & Grossman-Alexander, 1998; Ulrich, 1984). In addition, a larger percentage of green space (e.g., croplands) may mean a greater opportunity to consume locally grown healthy foods and also to engage the local population in physically challenging jobs, thus, enhancing physical health (Poudyal, Hodges, Bowker, & Cordell, 2009).

However, empirical findings on the role of green space on weight outcomes are mixed and inconclusive. For instance, Giles-Corti et al. (2005); Nielsen and Hansen (2007); Roemmich et al. (2006); Smith et al. (2008) and Frank, Andresen, and Schmid (2004) found that green space is positively associated with higher level of physical activities and hence with lower BMI. In contrast, Hillsdon, Panter, Foster, and Jones (2006); Hoehner, Brennan Ramirez, Elliott, Handy, and Brownson (2005); Maas, Verheij, Spreeuwenberg, and Groenewegen (2008); Potwarka, Kaczynski, and Flack (2008) found no statistically significant relationship between green space and the level of physical activities participation, and hence with BMI. Part of the reason for this inconsistent result is the analysis presented in those studies failed to capture the direct measure of obesity prevalence and natural green spaces.

This study aims to improve our understanding of the relationship between green space and obesity prevalence in several ways. First, we used a more complete set of green spaces (e.g., forestland, rangeland, cropland, and pastureland) and access to these green spaces (e.g., state and national parks), which as the literature suggests could enhance physical activities and public health. Second, in contrast to earlier studies, we used disaggregated data at the county level to explain the relationship between adult obesity prevalence and green space in the United States. Although, county level data is still aggregated, it is measured at much finer scale compared to the state or country level data.

3. Methods

We modelled adult obesity prevalence (number of obese people aged 20 and above) *(OP)* at a county level is a function of percentage of green space at that county *(G)*, access to public open space *(S)*, other environmental amenities *(EA)*, unhealthy eating habit *(UE)*, government policy for obesity prevention *(P)*, and other controls *(C)*.

$$OP = f(G, S, EA, UE, P, C). \quad (1)$$

Obesity prevalence data comes from the Centers for Disease Control and Prevention (CDC) (2013). Although green space (*G)* could be a valuable resource to make people physically active and healthy, it may take different forms and the public might have different degrees of access to these lands for physical activities (Snyder & Butler, 2012). Compared to the public lands, recreational access to private lands is limited to landowners and/or their friends and relatives. Further, all green space may not be suitable for outdoor activities because of landscape, physical location, and physical safety (human and non-human factors). Accordingly, we distinguished among four different forms of green spaces; farmland, forestland, pastureland, and rangeland to see their effects on obesity prevalence in the US with the green spaces data from the USDA

Forest Service RPA Recreation Supply Amenities Database (2010). Similarly, access to green space *(S)*, such as state or national parks increases the probability to engage on physical activities and hence, helps to reduce body weight (Coombes et al., 2010; Kaczynski & Henderson, 2007). Accordingly, we controlled for distance (in miles) to the nearest national parks from the county centroid and availability of state parks in the county with data from Cordell and Betz (1997). It should be noted that not all categories of open spaces are primarily used for recreation or physical activities, but they could have indirect ecosystem service benefits to enhance public health. Coverage of green spaces varies across geographic regions. For instance, while the South and North do have relatively larger percentage of forestlands, the Mid-West has relatively larger percentage of other open spaces, such as those covered by crops or grasses (Figure 1) (US Geological Survey, 2012).

The obesity literature suggests a number of environmental and behavioral factors that affect individuals' physical activity participation and/or consumption habits and hence body weight. Availability of recreation facilities in neighborhood significantly increases the probability to engage on physical activities (Coombes et al., 2010; Kaczynski & Henderson, 2007). Hence, we control for the number of recreation facilities available to the public from the Food Environment Atlas of USDA ERS (2014) to account for individual's access to recreation facilities *(S)*. Recreation facilities were defined by North American Industry Classification System (NAICS Code 713940) and such facilities included those sports facilities featuring exercise and other physical fitness or recreational activities, such as swimming pools or skating rinks. Environmental amenities *(EA)*, such as pleasant climate, topographic variation, and proximity to water bodies help to engage people on physical activities and lower their body weight (Michimi & Wimberly, 2012; Pitts et al., 2013). Accordingly, we controlled for number

of sunny days in January and topographic variation with data from USDA ERS (2014), and coastal county with data from the National Outdoor Recreation Supply Information System (NORSIS) (Cordell & Betz, 1997) as proxy for the environmental amenities *(EA)* that affect people's physical activity participation.[1]

Consumption of less healthy food (e.g., fries, sugared beverages, high-fat sandwiches, and high calorie candy and desserts) can significantly increase the risk of overweight and obesity (French et al., 2001; Triches & Giugliani, 2005). We accounted for the number of fast food restaurants in a county as a proxy of unhealthy eating habit *(UE)*. Government can provide economic incentives to reduce body weight and keep people healthy (Powell & Chaloupka, 2009). To account for government policy for obesity prevention *(P)*, we controlled for soda price with the data from the Food Environment Atlas of USDA ERS (2014).[2]

Other controls (C) included were percentage of Black and other ethnic population, percentage of population with at least bachelor's degree level of education, median household income, gini coefficients, and percentage of population on farm occupation from the Measure of America (2014) and county land area from the USDA Forest Service RPA Recreation Supply Amenities Database (2010). Obesity prevalence is higher in the Southern geographic region, compared to other geographic regions in the United States (Figure 2) (CDC, 2014). Accordingly, we controlled for this using the South dummy that equals one if the county belongs to the Southern region, and zero otherwise.[3] Table 1 summarizes descriptive statistics of variables used in this analysis.

[1] Land topography is a continuous variable measuring topographical steepness of county, starting from 1 for flat plains to 21 for high mountains.
[2] Soda price could be different at counties because of tax rates. Hence, soda price could be a good proxy of government policies for obesity prevention.
[3] For geographic regions divisions of the United States, please see https://www.census.gov/geo/maps-data/maps/pdfs/reference/us_regdiv.pdf

Multicolinearity, which if present makes the estimates imprecise, was checked using the variance inflation factor (VIF) (Gujarati, 2012).[4] The VIF is less than 10, indicating no multicolinearity problem (Bruin, 2006; Gujarati, 2012) (Table 1).

We used the ordinary least square (OLS) regression model to estimate the relationship between natural green space and publicly managed recreation lands and adult obesity prevalence as summarized in equation (1).

4. Results and discussion

Table 2 summarizes the results. The coefficients on variables, percentage of cropland and percentage of pastureland are significant and negatively related with obesity prevalence at a county level. In contrast, the coefficients on variables, percentage of forestland and percentage of rangeland are not statistically significant to explain the obesity prevalence. Hence, green space could have different effect on public health and obesity. As the literature suggests, the availability of cropland and pastureland would have two effects. It may provide opportunity to consume locally grown and healthy foods and also tend to engage the local population in physically challenging jobs. In contrast, forestland and rangeland, although, could be a place for outdoor recreation, access to these lands may be restricted to the general public for outdoor recreation. According to Butler (2008), 56 percent of the forestland in the United States are privately owned and recreational access to these lands are generally restricted to friends and relatives, or those who can lease. Because of topography and landscape, rangeland may not be suitable for varieties of recreation activities. According to the U.S. Forest Service (2013), rangelands are generally used to gain experience of solitude and/or bird/nature viewing rather than physically challenging activities.

[4] The estimates remain BLUE but the variance of the estimates will be high resulting imprecise estimates (and low *t*-values) (Gujarati, 2012).

Results also suggest that coastal counties are significantly associated with fewer obese people than non-coastal counties. The variable distance to national park is positively significant to explain obesity prevalence, indicating that counties located at greater distance from national parks are characterized by more obese people than did their close distance counterparts. In contrast, counties with state parks are characterized by significantly fewer percentages of obese people than those without a state park. Hence, availability of and access to public open space have a potential to make people physically active and improve public health.

The variable number of fast-food restaurants (per 1000 population) is significantly and positively related to number of adult with obese weight. Hence, counties with large number of fast food restaurants have greater number of obese people. In contrast, soda price is negatively associated with obesity prevalence, suggesting that counties with higher soda price are related with fewer obese people.

Socioeconomic variables are significant similar to the literature. Counties with higher income, and larger percentage of college graduates and people on farm occupation are associated with fewer numbers of obese people. In contrast, counties with larger percentage of black and other non-white population and large gini coefficient are related to more obese people. The results also indicated a non-linear relationship between income and obesity prevalence and gini coefficient and obesity prevalence.

5. Conclusion

Using county level data, we examined the effects of various forms of green space on obesity prevalence in the United States. Findings of this study have several implications in public health and natural resource economics and management. First, we established empirical evidence that obesity prevalence may well be associated with the area of farmland and rangeland in a county

and availability of and access to state and national parks. Hence, preserving farmland and rangeland could help to keep people physically active and improve public health. In addition, agencies may see a benefit in increasing availability and accessibility of outdoor recreation resources to improve public health. For instance, introducing outdoor recreation opportunities, such as state and national parks may help to maintain active living and enhance public health. Hence, the traditional approach of public health that focuses on controlling diseases or treating patients should be extended to a more comprehensive approach that acknowledge the role of natural amenities and nature-based outdoor recreation resources in maintaining active life and public health.

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Table 1: Descriptive statistics (number of counties = 2988)

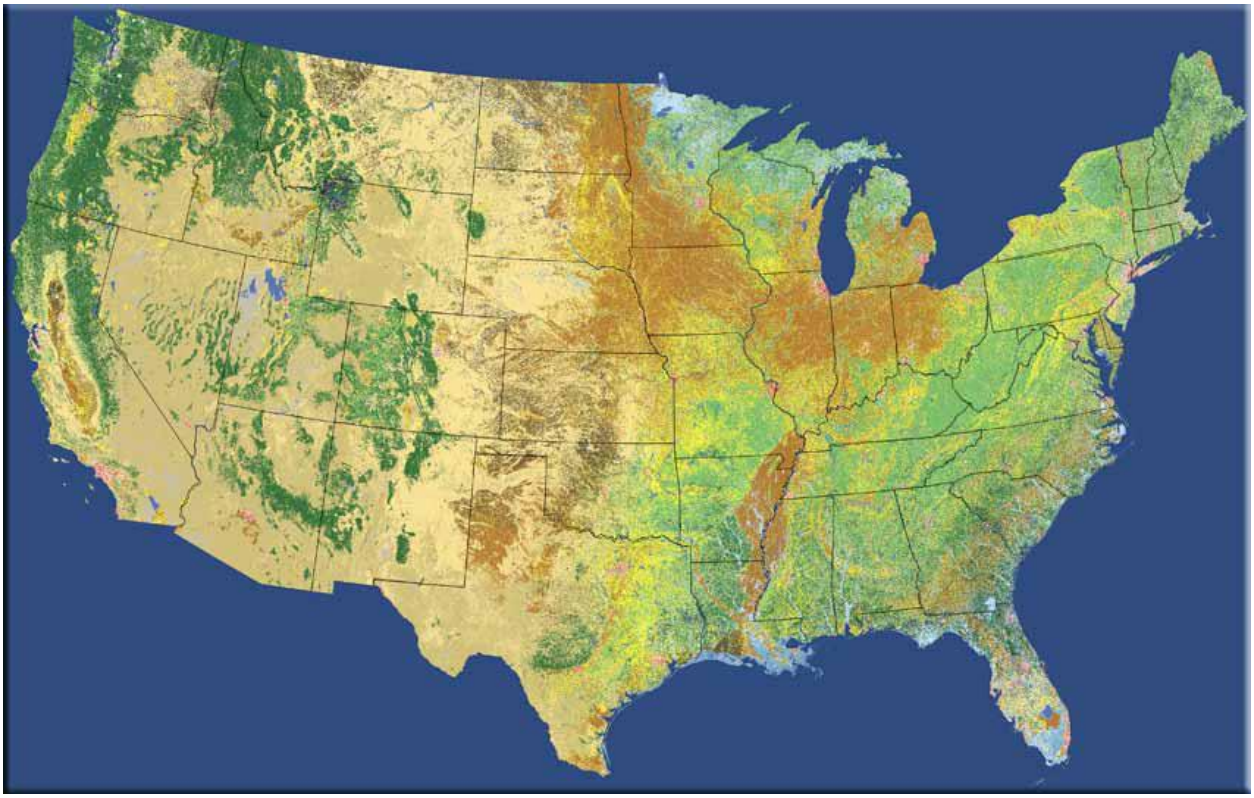
Variable	Mean	Std. Dev.	Min	Max	VIF
No. of adult obese aged 20 and above	19954.05	56205.45	22	1516570	
Percentage of cropland	0.26	0.26	0	0.93	2.08
Percentage of pastureland	0.09	0.10	0	0.69	1.14
Percentage of forestland	0.28	0.26	0	0.95	2.52
Percentage of rangeland	0.12	0.22	0	1.00	2.15
Distance to national park (in miles)	37.43	33.68	0.01	166.30	1.07
State park in the county (1 if yes)	0.49	0.50	0	1	1.18
No. of sunny days in January	151.55	32.47	48	258	1.28
Coastal county (1 if yes)	0.10	0.30	0	1	1.03
Land topography	8.76	6.54	1	21	1.17
No. of recreation facilities (per1000 population)	0.07	0.07	0	0.62	1.09
No. of fast-food restaurants (per1000 population)	0.56	0.30	0	5.78	1.10
Soda price (in $)	0.99	0.06	0.90	1.24	1.13
Percentage of black and other non-white population	10.38	14.32	0	86.80	1.32
Median household income (in $)	25351	5057	5043	55272	1.76
Gini coefficient	0.43	0.04	0.31	0.65	1.45
Percentage of population with at least Bachelors' degree	18.92	8.69	3.7	71	1.57
Percentage of population on farm occupation	2.10	2.67	0	37.90	1.20
County area ('000 square hectors)	595.35	756.09	14.69	12800	1.37
South (1 if belongs to the Southern region)	0.44	0.49	0	1	1.73

Table 2: Green space and adult obesity prevalence in the United States (2012)

VARIABLES	Coefficients
Percentage of cropland	-0.414***
	(0.145)
Percentage of pastureland	-0.744***
	(0.271)
Percentage of forestland	0.186
	(0.153)
Percentage of rangeland	-0.243
	(0.170)
Ln(distance to national park)	0.019**
	(0.010)
State park in the county (1 if yes)	-0.100*
	(0.055)
No. of sunny days in January	-0.000
	(0.001)
Coastal county (1 if yes)	-0.155*
	(0.087)
Land topography	-0.001
	(0.004)
No. of recreation facilities (per1000 population)	0.247
	(0.366)
No. of fast-food restaurants (per1000 population)	0.184**
	(0.087)
Soda price	-2.333***
	(0.466)
Percentage of black and non-white population	0.006***
	(0.002)
Ln(median income)	-19.326***
	(5.758)
Ln(median income)^2	1.013***
	(0.288)
Gini coefficient	41.150***
	(10.087)
Gini coefficient^2	-44.499***
	(11.371)
Percentage of population with at least Bachelors' degree	-0.010**
	(0.004)
Percentage of population on farm occupation	-0.044***
	(0.010)
South (1 if belongs to the Southern region)	-0.073
	(0.066)
Ln(county area)	0.049
	(0.040)
Constant	93.184***
	(28.595)
Observations	2,988
R-squared	0.081

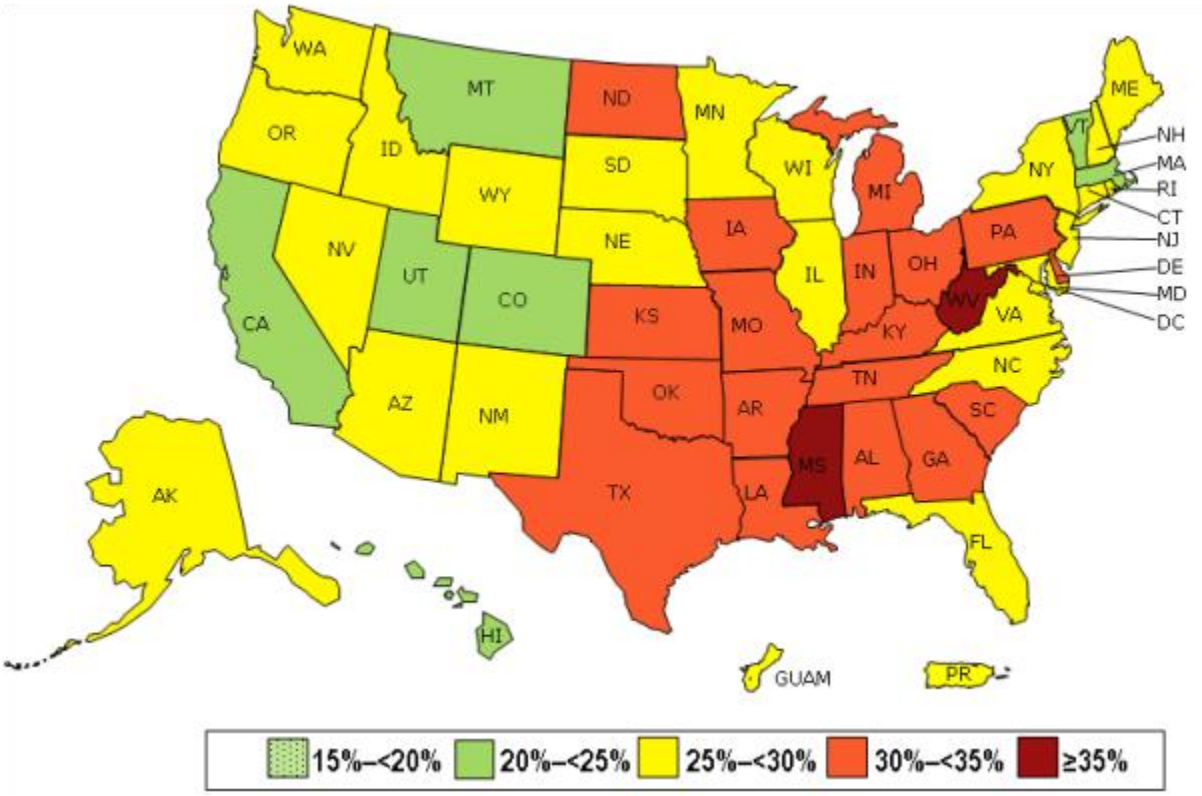
Note: Dependent variable – ln(number of adult obese aged 20 and above at a US county).
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Figure 1: Land cover in the conterminous United States, 2001



Source: US Geological Survey (2012)

Figure 2: Prevalence of self-reported obesity among U.S. adults by states, 2013



Source: CDC (2014)