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Associations Between Natural Amenities, Physical Activity, and Body Mass Index in 100 North Carolina Counties

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Abstract

Purpose. To examine associations between county-level natural amenities, physical activity (PA), and body mass index (BMI).

Design and Setting. Cross-sectional study among 100 North Carolina counties.

Measures. We obtained percentage of county residents meeting PA criteria and county-wide means for reported height and weight from the North Carolina Behavioral Risk Factor Surveillance System, combining years 2003, 2005, and 2007. The county natural amenities scale was the independent variable. Potential county-level covariates were percentage rural, percentage black, median age, and median household income (Census 2000).

Analysis. We conducted weighted bivariate and linear regression analyses to examine relationships between natural amenities, aggregate PA, and aggregate BMI.

Results. BMI and natural amenities were negatively associated (parameter estimate = −.13 (.06), p = .03). When percentage meeting PA criteria was included, the parameter estimate attenuated 15%.

Conclusion. There was an inverse relationship between natural amenities and BMI, partially mediated by PA. (Am J Health Promot 2011;26[1]:52–55.)

Key Words: Environment, Physical Activity, Obesity, Prevention Research.

INTRODUCTION

Rural areas generally have higher rates of obesity and physical inactivity than do urban and suburban areas. These area-level disparities may be, in part, due to differences in physical environments. For example, rural areas are often less conducive to physical activity (PA) as residents live far from activity resources such as gyms and parks. Despite environmental barriers to PA, rural areas may have increased access to natural amenities, such as topographical variation and access to natural water areas, which may encourage a physically active lifestyle. Previously, natural amenities including climate, and topographical variation, and proximity to water have been examined for their hypothesized association with PA and body mass index (BMI). In U.S. counties, residents of counties with a climate more conducive to PA had lower BMIs. The positive relationship between black race and BMI was attenuated in climates more amenable to PA, suggesting that the natural environment may be more influential among racial minorities. The authors speculated that the association between amenable climate and BMI was mediated through a physically active lifestyle, yet did not examine PA as a mediator. Others have examined the association between PA and (1) national weather data and (2) topographical variation (hills), finding no associations between PA and objectively measured weather and hills. In New Zealand, residents with better access to beaches were more likely to meet national PA recommendations and had lower BMIs.
The mechanism by which such natural amenities are linked to BMI is unclear. It is hypothesized that the effect is mediated through increased PA of residents, yet, to our knowledge, only one study has tested the mediating effect of PA on the association between green space and general health (vs. BMI). The study did not find that PA mediated the relationship between green space and health.

Although measures related to the built environment have been developed, less work has examined and characterized associations between PA, obesity, and the physical environment across rural and urban areas. A scale combining characteristics of the natural physical environment would be useful, as an appealing outdoor environment may be particularly important to support PA in rural areas. The natural amenities scale is one such objective measure of the physical environment, combining objectively measured climate, topographical variation, and access to water. The natural amenities scale was used previously in studies of population change, yet it has potential applicability to research on the role of the natural environment in the obesity epidemic.

PURPOSE

The purpose of this study was to examine associations between county-level natural amenities, PA, and mean weighted BMI among all counties in North Carolina. We also examine PA as a potential mediator in the relationship between natural amenities and mean weighted BMI.

METHODS

Design and Study Setting

This study is a correlational analysis using data from all 100 North Carolina counties. Table 1 shows means, SDs, and ranges for all variables. The means in Table 1 represent the mean of the average of each variable across all 100 counties.

Sample

The sample included all 100 North Carolina counties.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD), Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Rural</td>
<td>65.15 (27.72), 3.76 to 100.00</td>
</tr>
<tr>
<td>% Black</td>
<td>21.53 (16.78), 0.19 to 62.34</td>
</tr>
<tr>
<td>Median age, y</td>
<td>37.52 (3.63), 25.00 to 46.70</td>
</tr>
<tr>
<td>Median household income</td>
<td>34.87 (5758), 25.177 to 54,988</td>
</tr>
<tr>
<td>% Meeting PA criteria</td>
<td>40.44 (7.92), 20.47 to 62.22</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>27.65 (0.84), 25.89 to 29.86</td>
</tr>
<tr>
<td>Natural amenities scale</td>
<td>0.36 (1.38), −2.93 to 3.33</td>
</tr>
</tbody>
</table>

Measures

The natural amenities scale reflects the sum of six standardized (mean = 0, SD = 1) items: average January temperature, average January days of sun, low January to July average temperature gain, low average July humidity, topographical variation, and the ratio of lake, pond, and coastal water area to land area. The scale has been used in population change studies.

We used the continuous form of the natural amenities scale. Although North Carolina has less variation in natural amenities than the entire country, the scale standard deviation for North Carolina is 60% of the standard deviation for all counties in the contiguous states. North Carolina’s highest-scoring counties are in the mountainous western region and its lowest-scoring counties are in the inland coastal plain. The central differences between Macon County (the highest score) and Martin County (the lowest score) are average July temperature (69°F vs. 80°F), topography (“low mountains” vs. “flat plain”), and lake/pond area proportion of county territory (.58% vs. .07%).

Because of potential independent associations with BMI, we used the following continuous covariates: percentage of rural residents, percentage of black residents, median age, and median household income. These variables were obtained from Census 2000 via the Log In to North Carolina (LINC) Web site (http://linc.state.nc.us/). Percentage of county residents residing in rural areas was determined by dividing number of rural residents by the total county population (2000). The predominant minority in North Carolina is black, and thus we calculated percentage black residents by dividing the number of individuals identifying themselves as black by the total county population. Median age and median household income were obtained from the LINC Web site.

We included data from the North Carolina Behavioral Risk Factor Surveillance System (BRFSS) as it includes self-reported PA, providing the opportunity to examine PA as a mediator between natural amenities and obesity. To measure PA, we calculated the percentage meeting the PA levels recommended at the time of the survey. These recommendations were for moderate (30 min/d) or for vigorous (20 min/d) PA. Because these are no longer the current PA recommendations, we called this variable “percentage meeting PA criteria.” Self-reported height and weight from the North Carolina BRFSS were used to calculate county-level mean weighted BMI for all counties. All BRFSS data were analyzed using SUDAAN and excluded missing values (don’t know/refused/missing). BRFSS data were then combined for years 2003, 2005, and 2007, in order to obtain stable estimates for counties with fewer sampled individuals. The 3 years of BRFSS data were used because these are the most recent years that both PA and weight and height (to calculate BMI) were asked of BRFSS respondents. All counties had 3 years of data. Sample sizes per county ranged from 20 (Tyrell County) to 1899 (Mecklenburg County) for BMI, and 20 (Tyrell County) to 1924 (Mecklenburg County) for PA. All estimates were county-level means, weighted to population characteristics by standard BRFSS weights. Counties were weighted by their
populations and scaled to reproduce the sample size of 100.

Analysis

We first examined bivariate associations between county-level natural amenities, PA, mean weighted BMI, and all covariates using Pearson correlation coefficients. We used the GLM procedure in SAS 9.1 (Cary, North Carolina) to conduct linear regression analyses, with backwards elimination of non-significant covariates. Covariates were eliminated from the model one at a time if the p value for the parameter estimate was >.05. If two covariates had p values >.05, the one with the larger p value was eliminated first. In these analyses, natural amenities was the independent variable, and both PA and BMI were dependent variables. Bivariate and regression analyses were weighted to account for county population, so that results would reflect population differences in PA and BMI estimates. Mediation analyses were conducted to determine if the association between natural amenities and BMI attenuated when percentage meeting PA criteria was included.

RESULTS

Bivariate associations revealed that natural amenities were negatively correlated with percentage black residents and BMI, and positively correlated with median age and percentage meeting PA criteria. Natural amenities were not correlated with percentage rural residents or median household income (Table 2). County-level mean weighted BMI was positively correlated with percentage rural, percentage black, and median age, and negatively correlated with median household income, natural amenities, and percentage meeting PA criteria.

In unadjusted linear regression models, the percentage meeting PA criteria and natural amenities were positively associated (parameter estimate = 1.66 [48], p = .0008), and the association remained significant in the adjusted model, controlling for percentage black and median age (parameter estimate = 1.42 [50], p = .00001). Mean weighted BMI and natural amenities were significantly negatively associated (parameter estimate = −.21 [06], p = .0002), and this association remained when controlling for covariates retained in the backward selection (percentage rural, percentage black, and median household income), with the parameter estimate = −.13 (.06), p = .0260.

When percentage residents meeting PA criteria was added into the adjusted model, with mean weighted BMI as the dependent variable, the parameter estimate for natural amenities attenuated 15% (parameter estimate = −.11 [06], p = .05). Thus, we concluded that the relationship between natural amenities and BMI was partially mediated by percentage meeting PA criteria.

DISCUSSION

Summary

The current study provides preliminary support for the notion that a more appealing natural environment is associated with a healthier weight status, which is potentially mediated by percentage of county residents meeting PA criteria. This is consistent with previous research demonstrating associations between BMI and climate and beach access. The current analysis, holding all covariates constant, the difference in county-level mean weighted BMI between the lowest 10% for natural amenities (−1.42) versus the highest 10% (2.20) is .47 kg/m². This is similar to the difference found in the Lin et al. study, which found that a person from a county with low climate amenity would have an additional .32 kg/m² BMI units compared to one from a high climate amenity county. Our study differs from the Lin et al. study in that our study uses the county as the unit of analysis, whereas the Lin et al. study uses the individual as the unit of analysis. However, the similarities between the measures of effect in the two analyses lend credence to the findings of both studies.

Limitations

The current study is limited by the ecological nature of the research design and the use of data aggregated over multiple years to examine relationships. Data from multiple survey years were combined so that we had adequate sample sizes within each county. Although a potential limitation, we do not suspect that health behaviors changed during these years, and by pooling these years we averaged out the effect of time to obtain more stable results. We also assumed that the control variables, drawn from the 2000 Census, did not change appreciably by overtime. An additional limitation is that we did not control for self-selection of residents into counties. Strengths of the current study include the examination of associations between natural amenities and both PA and BMI, as well as the use of the natural amenities scale, a stable and well-established objective measure of the physical environment as relevant to PA.

<table>
<thead>
<tr>
<th>% Rural</th>
<th>% Black</th>
<th>Median Age</th>
<th>Median Household Income</th>
<th>Natural Amenities</th>
<th>% Meeting PA Criteria</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>−0.20*</td>
<td>0.52***</td>
<td>−0.67***</td>
<td>0.53</td>
<td>0.07</td>
<td>−0.18</td>
<td>0.46***</td>
</tr>
<tr>
<td>% Black</td>
<td>−0.35**</td>
<td>−0.10</td>
<td>−0.62***</td>
<td>0.38***</td>
<td>−0.37**</td>
<td>0.33**</td>
</tr>
<tr>
<td>Median age</td>
<td>−0.32**</td>
<td>0.07</td>
<td>0.33</td>
<td>0.67***</td>
<td>−0.20*</td>
<td>0.19*</td>
</tr>
<tr>
<td>Median household income</td>
<td>0.07</td>
<td>0.23*</td>
<td>−0.51***</td>
<td>0.36**</td>
<td>−0.45***</td>
<td></td>
</tr>
<tr>
<td>Natural amenities</td>
<td>0.67***</td>
<td>0.07</td>
<td>0.33**</td>
<td>−0.36**</td>
<td>−0.45***</td>
<td></td>
</tr>
<tr>
<td>% meeting PA criteria</td>
<td>0.45***</td>
<td>0.07</td>
<td>0.67***</td>
<td>0.07</td>
<td>0.45***</td>
<td></td>
</tr>
</tbody>
</table>

*p ≤ .05.
**p ≤ .001.
***p ≤ .0001.

Table 2

Correlation Matrix Showing Pearson Correlation Coefficients Between Percentage Rural Residents, Percentage Black Residents, Median Age, Median Household Income, Natural Amenities, Percentage Meeting Physical Activity (PA) Criteria, and Body Mass Index (BMI)
Implications

The current study builds on previous research by using a standardized, well-studied measure of the natural environment, the natural amenities scale, among diverse North Carolina counties. Our findings support the notion that residents of counties with more natural amenities are more physically active and have lower BMIs. However, future work should include examination of these associations longitudinally in a larger geographic sample, and at an individual level. More work should be done to determine if there is a stronger association between PA, BMI, and amenities among counties with a high percentage of rural, minority, and low-income individuals. Such individuals may have fewer resources to buffer themselves from environments with fewer amenities compared to residents of more advantaged areas, and thus may be more responsive to the natural environment in which they reside.

Acknowledgment

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References