Plenary Session - Built Environment and Childhood Obesity

Urban Design, Lifestyle, and the Development of Chronic Conditions

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Each decade, millions of acres of rural land are being converted into urbanized areas as our society is growing. How land is developed affects people's lifestyles and possibly their health, but there is surprisingly little empirical evidence. Obviously, the typical developments of the last half century, with separated residential, shopping, and business areas, limited street connections, and lower population density increase dependence upon automobiles for transportation and commuting distances. Some plausible pathways exist through which this type of "sprawling development" can adversely affect health, compared with more compact developments that have more connected street networks (e.g. a grid), mixed land use, and higher densities. [1-4] However, some positive outcomes have also been hypothesized. In fact, some of the factors that encourage more sprawl are exactly what public health recommended a century ago, such as the separation between industry and housing, issues that, in fact, are still relevant today in the environmental justice movement.

Empirical research has shown several adverse outcomes associated with sprawl, including increased traffic fatalities, increased air pollution from motor vehicles, decreased walking trips, and higher body mass index. [5-10] No studies exist on the prevalence of common medical and mental health disorders in relationship to suburban sprawl, although one study found an association between sprawl and increased hypertension. [11]

Comprehensive measurement of the multidimensional phenomenon of suburban sprawl is recent. Previous indices focused on a single dimension, like population density, including the well-known sprawl index published by USA Today.[12] Ewing, Pendall, and Chen developed more comprehensive measures, including four dimensions of sprawl (residential density; land use mix; degree of centering; street accessibility) and an overall index, which is a significant predictor of vehicle miles driven per capita, ozone levels, traffic fatalities, vehicle ownership, and decreases in walk trips to work.[6]

Using national US household survey data collected between 1998 and 2001, we studied whether suburban sprawl is correlated with chronic physical and mental health conditions and health-related quality of life.[13] We are interested in whether objectively measured characteristics of suburban sprawl for metropolitan areas have independent associations with the physical and mental health of residents, after controlling for the well-established effects of individual characteristics and, in a sensitivity analysis, of social neighborhood characteristics. Of course, the issue of chronic conditions like diabetes, hypertension, arthritis, chronic pain, heart disease, is not very relevant for children or adolescents because the onset is generally in middle or old age among adults, even if current childhood obesity plays an important role in the incidence of those conditions – but that is 30 years from now.

In this talk, I will first discuss what we know about chronic conditions and the built environment and at the end tell you what is different for children and adolescents. Indeed, there are a few very important differences and what encourages more physical activity among adults may not have the same effects for young children. A cul-de-sac, a prototypical suburban design, can encourage more outside activities among young children, whereas it discourages utilitarian walking among adults and limits active travel among older children and adolescents, thus having opposite effects on physical activity across age groups.

We analyzed data from Healthcare for Communities (HCC), a nationally representative US household phone survey fielded in 1998 (wave 1), and 2000/2001 (wave 2). HCC was clustered in 60 sites and the suburban sprawl indicators (described below) are available for 38 metropolitan areas that correspond to HCC sites. Combining the two waves results in a total sample size of 8,686 observations in the 38 sites for which sprawl indicators are available.

The central dependent variables measure physical health, mental health, and health-related quality of life. For health-related quality of life, we have validated scales for physical and mental well-being. For chronic conditions, we study 16 chronic health conditions or symptom clusters based on self-report in response to the question "Here is a list of health problems some people have. Please indicate if you now have any of these problems," followed by a probe for asthma; diabetes; hypertension; arthritis/rheumatism; physical disability such as loss of arm, leg, eyesight, or hearing; trouble breathing (emphysema or chronic obstructive pulmonary disease, COPD); cancer; neurological condition; stroke or paralysis; angina/heart failure/coronary artery disease; chronic back problems, abdominal problems (ulcer, colitis, enteritis), chronic liver disease, migraine or chronic severe headaches; chronic bladder problems or problems urinating; other chronic pain conditions. We also examined each condition individually. For mental health, we used clinical screeners for depressive and anxiety disorders.

Ewing, Pendall, and Chen developed a metropolitan sprawl index to measure urban form at the metropolitan level; 38 metropolitan areas also correspond to HCC sites.[6] Each metropolitan area was rated in four urban form dimensions, extracted from multiple variables through principal component analysis (factor analysis). The four dimensions are:

1. Residential density was defined in terms of population densities and proportions of population living at different densities; seven variables make up this factor.
2. Land use mix was defined in terms of how land uses are mixed and balanced within subareas of the region; six variables make up this factor.
3. Degree of centering was defined as the extent to which development is focused on the region's core and regional subcenters; six variables make up this factor.
4. Street accessibility was defined in terms of the length and size of blocks; three variables make up this factor.

While the four factors measure different dimensions of sprawl, they are highly correlated. A more parsimonious specification combines these factors into the overall Sprawl Index, which sums the four factors and adjusts for the size of the metropolitan area. See reference 6 for details on those measures.

Communities differ in many other dimensions that could affect health. We used hierarchical linear and logistic regression to adjust for other differences and to take into account the clustered data structure. In all regression models, we included age groups (under 24, 25-34, 35-44, 45-54, 55-64, and over 65), race (black, hispanic, other minorities; white-non-hispanic is the reference group), educational status (less than a high school diploma, college degree or more, with high school/some college as the reference group), household income, marital status, family size, current employment status (distinguishing employed, and out of the labor force), and gender. Climate moderates the effect of the environment and can have an independent effect on health. Rain, very hot or very cold days may make walking or other outdoor activities less attractive, regardless of other measures of land use. We include the average annual number of days with significant precipitation, hotter than 90 degrees or colder than 32 degrees as additional regressors. We also include other site variables that Ewing et al. used in their analysis, namely household size and the percentage of the population of working age (20-64). Finally, we

conducted sensitivity analyses to see whether the inclusion or exclusion of commonly studied contextual neighborhood characteristics (measured at the census tract level, using data from the 2000 Census) affects results: percent Black, percent Hispanic, percent in poverty, unemployment rate, percent with limited English speaking skills, percent home owners, population density (per square mile), number of liquor stores/bars per 1,000 population.

Per 1,000 population, there are 1,260 reported chronic medical conditions on average, ranging from a low site average of 930 (Chicago) to a high site average of 1,770 (West Palm Beach). This variation is accompanied by similarly large differences in the socioeconomic composition of the sites. Not surprisingly, the site with the largest proportion of adults over 65 (West Palm Beach) also has the most chronic medical problems, whereas the area with the fewest old respondents (Los Angeles) has less than average (but not the fewest). Aside from age, there are also very large differences across sites in race/ethnicity, educational achievement, and household income. Yet even after accounting for all those differences, the overall sprawl index is a significant predictor of the number of chronic medical conditions ($p<0.01$) and of physical health-related quality of life ($p<0.05$). A 50 point change from more to less sprawling (one standard deviation below to one standard deviation above the average) implies 96 fewer chronic medical problems per 1,000 residents (95 % confidence interval: [26, 165]), see Table 3. The health effect corresponding to the difference between Riverside/San Bernadino, CA (very sprawling) and Denver, CO, or Boston, MA (not sprawling), slightly over 100 points on the sprawl index, would be twice as large, about 200 fewer chronic medical problems or a reduction of 15% in the number of chronic problems.

How important are those effects substantively? In terms of chronic conditions, a 50 point change in the sprawl index is similar to aging 4 years and the difference between black and white race (after controlling for education, employment, income differences; without these controls, the black/white racial difference is 264 chronic conditions). The change in chronic conditions associated with a 50 point change in sprawl is also larger than the corresponding change associated with a doubling of income, but much smaller than the change associated with having versus not having a high school diploma, or having a college degree versus a high school degree. There were no statistically significant or robust associations between the prevalence of mental health disorders or the mental health inventory scale and the suburban sprawl index after adjusting for other characteristics.

Much research has focused on social contextual characteristics and we therefore study the robustness of the findings to including neighborhood characteristics. When we include percent Black, percent Hispanic, percent in poverty, median income, unemployment rate, percent with limited English speaking skills, percent home owners, population density (per square mile), number of liquor stores/bars per 1,000 population (all measured at the census tract level), the effect of sprawl becomes somewhat stronger, for all measures of sprawl, but magnitude is essentially the same. The overall index, for example, instead of being associated with 96 more conditions per 1,000 with 50 point more sprawl would now be associated with 112 conditions (95% C.I. 32, 193). However, most of the contextual measures, with the exception of poverty, are individually insignificant once individual characteristics are controlled. The absence of a significant association between sprawl and mental health is also robust to the inclusion of social contextual variables (although several of those contextual variables are significantly associated with mental health). The results for individual chronic conditions are also unchanged when social contextual variables are included, except that the association between sprawl and chronic headaches becomes statistically significant.

The most obvious mechanism through which a sprawling environment affects health is as an opportunity structure that constrains the amount of physical activity people routinely exert on a daily basis. Physical activity has a general salutary effect on health, as well as directly influencing a variety of diseases and symptoms, including hypertension, arthritis, and abdominal complaints such as from constipation or menstrual cramps, and even headaches and migraines. Sprawl also leads to more air pollution, which may explain our finding of significantly higher rates of trouble breathing from emphysema and COPD and in part may explain the higher rate of headaches in more sprawling cities.

Sprawl appears to have a disproportionate impact on the physical health of the elderly and possibly the poor. This may be because the poor and the elderly have fewer resources to mitigate the limitations imposed by their environment, such as having less access to individual motorized transportation. The elderly may also suffer declining physical mobility and reduced vision/hearing, and thus may be less able to navigate environments with speeding cars or wide streets. They may have more difficulty in sprawling cities walking the greater distances to destinations such as markets or parks. Urban form may be an important contributor to elderly "shut- ins" and sedentary lifestyles.

Street accessibility/connectivity appears to be a central factor of encouraging or discouraging walking because of the influence of distance between destinations. In our data, the streets factor (but not the overall sprawl index) is significantly associated with a reduction in hypertension and heart disease, conditions for which a physical activity pathway is most plausible.

In contrast to prominent hypotheses, we find no effects of adverse effects on mental health. The absence of any significant statistical relationships between sprawl and depression, anxiety, or psychological well-being may be surprising because depressive and anxiety disorders are common in patient populations reporting high levels of physical symptoms, some of which are significantly associated with suburban sprawl in our data. Putnam has hypothesized that casual and informal social relationships contributing to social capital are reduced by environments in which more time is spent driving alone in cars and there are fewer face-to-face interactions in neighborhoods.[14] However, the urban environment might also be associated with fewer neighborhood interactions due to lack of safety and lack of familiarity with neighbors. Casual relationships with neighbors, merchants, or fellow employees may be less important to mental health than social support in close relationships (partners, family members, and long-standing friendships), although we find no association in our data between several measures social support and suburban sprawl either (results not reported). The absence of a mental health link also suggests that physical health effects are not just reflections of underlying psychological distress or mental health disorders.

The probability of 14 or more findings out of 16 trials in the hypothesized direction is 0.002, so we are confident that the statistical association between sprawl and physical health is not due to chance. But results for individual conditions should not be overinterpreted. The precision is low and one of the significant results could well be due to chance (at $p=0.05$, one statistically significant result is expected for every 20 comparisons even in the absence of a true statistical relationship). The main limitations of our study include the scale of measurement, the cross-sectional design, and the relatively small number of sites. While a metropolitan index may be the right level of measurement for some likely causal pathways (e.g. air pollution), it is not the right one for other pathways (e.g. walkability of the neighborhood). Other opportunity structures

that we have not yet been able to measure for a national data set may also be important, such as the availability of local parks and recreation areas. Important effects may only be found at smaller levels of aggregation, such as a neighborhood effect on mental health. It may be that measuring street or land use mix at smaller geographic units would result in stronger associations for pathways where walking is important, but also in weaker associations for other pathways. We do not have data at finer levels of resolution yet and cannot conduct sensitivity analyses. While we found a disproportionate impact of sprawl on the elderly (and the poor when using the streets or mix factors instead of the overall sprawl index) that is significantly different from the effects for other adults, the limitations of sample size prevented the detection of smaller, but nevertheless meaningful, differences in health effects across other socioeconomic or racial/ethnic groups. Finally, while we can be confident that the results are not due to chance, we cannot exclude the possibility that they are caused by unmeasured systematic differences across metropolitan areas that are correlated with sprawl.

This study provides some initial support to the hotly debated claim that suburban sprawl is bad for health. While research is at a very early stage, these results point to the possibility that urban form is a determinant of physical population health. Our results are consistent with findings about walking and obesity from the BRFSS, a totally different data set and conducted by a different research group. Given the data limitations, the research design of all studies is weak, so we have a long way to go, but if future research confirms our initial results, policies that address the built environment can play a critical role in the prevention of a wide variety of chronic diseases.

Now, all you heard so far was about adults and the reason is that we know much less about children and adolescents. Obviously, chronic conditions is not a particularly relevant issue for that population yet, but what about physical activity or obesity? As it turns out, the only national level data with local geographic identifiers is the ECLS-K. However, we find no strong or robust association between parent-reported physical activity or weight gain and urban form. But this is not really surprising because we are looking at young children (ages 5-9 in the data available so far): Susan Handy, based on case studies of 8 neighborhoods, reported last year that children in a more suburban neighborhood were more likely to play outdoors somewhere in the neighborhood. So there is a trade-off between some types of physical activity for children and their parents. It may not be very much because outdoor playing accounts for a fairly small fraction of time and it may easily be countered by changes in utilitarian walking (e.g. walking with the parents to school or to a grocery store), which is why our preliminary analysis shows no effects of urban form on BMI change. At this point, there are no similar data for older children, but I suspect that the relationship between urban form and physical activity changes among teens. As children get past elementary school age, unstructured outdoor playing becomes unimportant, and what they are interested in getting to places to meet friends.

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