



Examining human mobility patterns in restaurant visits: A social vulnerability perspective

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According to the U.S. Department of Agriculture (USDA)'s Food Expenditure Series (FES), more people choose to eat out than to cook at home—according to the latest FES summary, the overall spending on food prepared away from home surpassed that prepared at home by a margin of twenty percent (USDA, 2019). Most food prepared away from home, as consumed dominantly at fast-food restaurants, is comparably calorie-rich and nutrient-poor. While catering to the increasing demand for a faster-paced life, fast-food restaurants experienced a rapid and substantial surge, which paralleled the increasing obesity rate in the United States (Chou et al., 2004). Studying where and how people consume food daily provides evidence for policy initiatives to change both customers' food behaviors and transform communities' obesogenic foodscape, both of which will eventually help build a healthy and equitable community nutrition environment (Glanz et al., 2005).

Understanding this transition in food behaviors cannot be accomplished without a spatial perspective. The past two decades have witnessed a flourishing spatial evolution in community food research, emphasizing food provisioning locations. A wide array of spatial measures were proposed as proxies for gauging food distribution (Chen et al., 2022). These spatial measures were used to reveal issues of health inequity, such as exploring if socioeconomically deprived neighborhoods have a higher density of fast-food restaurants. However, the foremost issue in these spatial assessments is that human mobility is largely overlooked. After all, food activities are not simply confined by a static venue and can happen beyond the residential place in a chain of daily activities and movements. In addition, daily mobility has been considered the crucial driver of social differentiation and inequality (Kaufmann et al., 2004). Failing to consider human mobility could result in overlooking valuable food resources that are accessible outside of a residential community and could misrepresent the built environment in which people are influenced.

In this study, we examine food procurement activities, specifically restaurant visits, from a social vulnerability perspective. Specifically, we consider that a restaurant visit is a spatial interaction between food supply (e.g., restaurants) and demand (e.g., customers), and social vulnerability in both the places of supply and demand can shape such interaction. To substantiate this concept, we have conducted a case study using large-scale human mobility data about restaurant visits in Hartford, Connecticut. The mobility data, originally collected from the SafeGraph, contain over 66,605 restaurant visit records, where each record represents the total visits from customers' home census tract to a restaurant on a monthly basis in 2018–2019. As this study period was before the outbreak of the COVID-19 pandemic, the study result can well represent the mobility patterns of restaurant visits in a non-extreme context.

Operationalizing the concept cannot be achieved without exploring the social vulnerability variables. Specifically, we collected the social vulnerability index (SVI) data from the Centers for Disease Control and Prevention (CDC) (Agency for Toxic Substances and Disease Registry, 2022). The SVI is a widely used index representing the social vulnerability of communities on the census tract scale. The index is aggregated from fifteen sociodemographic factors, which are originally sourced from the 2014–2018 American Community Survey (ACS) 5-Year Estimates. In the study, we employed the overall percentile ranking of the SVI, which is an index ranging from 0 to 1 (1 means the most socially vulnerable census tract and 0 the least). Since our framework is focused on the demand and supply in restaurant visits, we aggregated the mobility data in two different ways: (1) by census tract where the restaurants are located,

representing food supply, and (2) by census tract where the customers originate (which is their home census tract per the SafeGraph definition), representing food demand.

After the mobility data were aggregated, we performed two tiers of analysis. The first analysis was an exploratory analysis focused on data visualization by using Geographic Information System (GIS). We visualized the human mobility patterns in spider diagrams based on (1) the overall SVI percentile ranking of the restaurant census tracts (see *Figure 1*) and (2) the overall SVI percentile ranking of the customers' home census tracts. The second analysis was an explanatory analysis using multivariate linear regression. Specifically, we examined how the demand-side mobility and supply-side mobility were correlated with restaurant characteristics (e.g., rating, price, log-transformed review counts, and restaurant category) and community characteristics (e.g., total population, overall SVI percentile ranking, food desert label, and urban status label).

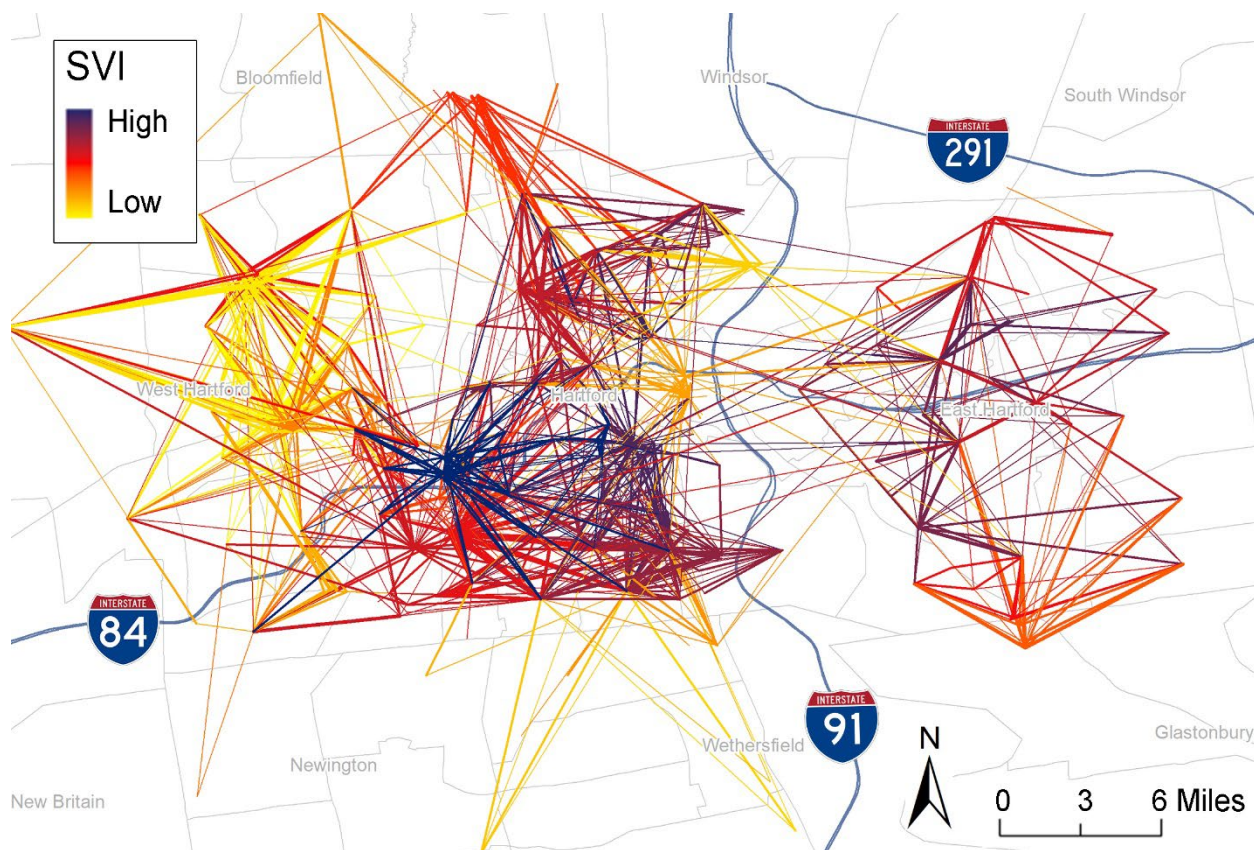


Figure 1. Human mobility patterns of restaurant visits in Hartford, Connecticut. The line color represents the percentile ranking of the SVI for the restaurant's census tract, where a darker color means higher social vulnerability. The figure is adapted from Jin et al. (2023).

The exploratory analysis reveals human mobility patterns in restaurant visits in the study area. It shows that only 8.4% (standard deviation [SD] = 5.8%) of the customers visited a restaurant within the census tract of their home address, and the majority of customers (43.5%, SD = 10.3%) traveled between 1 mile to 5 miles to visit a restaurant. The result implies that consumers were more likely to patronize restaurants beyond their immediate residential neighborhoods, which was considered the result of the selective daily mobility bias (Jin et al., 2023). The explanatory analysis further shows that selected restaurant characteristics and community characteristics were correlated with human mobility patterns. The supply side

analysis reveals that restaurants located in socially vulnerable neighborhoods attracted more customers who lived in the same neighborhoods, while restaurants in well-off neighborhoods attracted more customers who lived further away. In addition, the demand side analysis shows that customers from socially vulnerable areas traveled shorter distances and were more likely to visit restaurants located in socially vulnerable areas.

The case study on human mobility patterns in restaurant visits can have policy implications. It corroborates the spatial scope of individuals' food procurement practices, which are beyond their immediate neighborhoods and can be largely driven by an uneven socioeconomic landscape. Thus, urban planning initiatives and health interventions to improve the nutritional quality of restaurants and community members' diets should also consider human mobility, including the supply and demand of food activities. Only by contextualizing both sides of human mobility can these policy tools be rationalized.

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