Researchers reveal findings of nationwide study of the relationship between food environment and healthy eating

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An estimated 19 million people in the U.S. live in so-called food deserts, which have lower access to healthy and nutritious food. More than 32

million people live below the poverty line—limiting their options to the cheapest food regardless of proximity to potentially healthier options. Meanwhile, numerous studies have pointed to the role of diet in early mortality and the development of chronic diseases such as heart disease, type 2 diabetes and cancer.

Researchers are just beginning to understand how the complex interplay of individual and community characteristics influence diet and health. An interdisciplinary team of researchers from the University of Washington and Stanford University recently completed the largest nationwide study to date conducted in the U.S. on the relationship between food environment, demographics and dietary health with the help of a popular smartphone-based food journaling app. The results of that five-year effort, published Jan. 18 in *Nature Communications*, should give scientists, health care practitioners and policymakers plenty of food for thought.

"Our findings indicate that higher access to grocery stores, lower access to fast food, higher income and college education are independently associated with higher consumption of fresh fruits and vegetables, lower consumption of fast food and soda, and less likelihood of being classified as overweight or obese," explained lead author Tim Althoff, UW assistant professor in the Paul G. Allen School of Computer Science & Engineering.

"While these results probably come as no surprise," Althoff continued, "until now our ability to gauge the relationship between environment, socioeconomic factors and diet has been challenged by small sample sizes, single locations and non-uniform design across studies. Different from traditional epidemiological studies, our quasi-experimental methodology enabled us to explore the impact on a nationwide scale and identify which factors matter the most."

The study, which began when Althoff was a doctoral student at Stanford, analyzed data from more than 1.1 million users of the MyFitnessPal app—spanning roughly 2.3 billion food entries and encompassing more than 9,800 U.S. zip codes—to gain insights into how factors such as access to grocery stores and fast food, family income level, and educational attainment contribute to people's food consumption and overall dietary health.

The team measured the association of these variables, from data available by zip code, with each of four self-reported dietary outcomes logged between 2010 and 2016: fresh fruit and vegetable consumption, fast food consumption, soda consumption, and incidence of overweight or obese classified by body mass index.

To understand how each variable corresponded positively or negatively with those outcomes, the researchers employed a matching-based approach wherein they divided the available zip codes into treatment and control groups, split along the median for each input. This enabled them to compare app user logs in zip codes that were statistically above the median—for example, those with more than 20.3% of the population living within half a mile of the nearest grocery store—with those below the median.

Among the four inputs the team examined, higher educational attainment than the median, defined as 29.8% or more of the population with a college degree, was the greatest positive predictor of a healthier diet and BMI. All four inputs positively contributed to dietary outcomes, with one exception: high family income, defined as income at or above $70,241, was associated with a marginally higher percentage of people with a BMI qualifying as overweight or obese. But upon further investigation, these results only scratched the surface of what is a complex issue that varies from community to community.

"When we dug into the data further, we discovered that the population-level results masked significant differences in how the food environment and socioeconomic factors corresponded with dietary health across subpopulations," said co-author Hamed Nilforoshan, a doctoral student at Stanford.

As an example, Nilforoshan pointed to the notably higher association between above-median grocery store access and increased fruit and vegetable consumption in zip codes with a majority of Black residents, at a 10.2% difference, and with a majority of Hispanic residents, at a 7.4% difference, compared to zip codes with a majority of non-Hispanic, white residents, where the researchers found only a 1.7% difference in the association between increased fruit and vegetable consumption and access to grocery stores.

"People assume that if we eliminate food deserts, that will automatically lead to healthier eating, and that a higher income and a higher degree lead to a higher quality diet. These assumptions are, indeed, borne out by the data at the whole population level," said co-author Jenna Hua, a former postdoctoral fellow at Stanford University School of Medicine and founder and CEO of Million Marker Wellness, Inc. "But if you segment the data out, you see the impacts can vary significantly depending on the community. Diet is a complex issue!"

Hua continued: "While policies aimed at improving food access, economic opportunity and education can and do support healthy eating, our findings strongly suggest that we need to tailor interventions to communities rather than pursuing a one-size-fits-all approach."

Both the team's approach and its findings can guide future research on this complex topic that has implications for both individuals and entire communities, Althoff said.

"We hope that this study will impact public health and epidemiological research methods as well as policy research," said Althoff, who is also the director of the Behavioral Data Science Group. "Regarding the former, we demonstrated that the increasing volume and variety of consumer-reported health data being made available due to mobile devices and applications can be leveraged for public health research at unprecedented scale and granularity. For the latter, we see many opportunities for future research to investigate the mechanisms driving the disparate diet relationships across subpopulations in the U.S."

Jure Leskovec, an associate professor at Stanford, is the senior author on this paper.

More information: Tim Althoff, Large-scale diet tracking data reveal disparate associations between food environment and diet, *Nature Communications* (2022). DOI: 10.1038/s41467-021-27522-y. www.nature.com/articles/s41467-021-27522-y

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