

Researchers find intriguing clues about obesity by counting steps via smartphones

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Credit: CC0 Public Domain

Stanford researchers using smartphones to track the activity levels of hundreds of thousands of people around the globe made an intriguing discovery: in countries with little obesity, people mostly walked a similar

amount per day. But big gaps between people who walked a lot and those who walked very little coincided with much higher levels of obesity.

Considering that an estimated 5.3 million people die from causes associated with physical inactivity every year, these researchers looked for a simple and convenient way to measure activity across millions of people to help figure out why [obesity](#) is a bigger problem in some countries than others.

The ground-breaking study, appearing in *Nature*, used data captured from smartphones to analyze the habits of 717,000 men and women from 111 countries, whose steps were studied for an average of 95 days.

The researchers, led by computer scientist Jure Leskovec and bioengineer Scott Delp, dubbed this phenomenon "activity inequality" to evoke the well-established concept of income inequality.

"If you think about some people in a country as 'activity rich' and others as 'activity poor,' the size of the gap between them is a strong indicator of obesity levels in that society," Delp said.

A related finding was the powerful role that gender played in country-to-country differences. Prior studies of [physical activity](#), done mainly in the United States, have shown that men walk more than women, and this was borne out in the global findings. What surprised researchers, however, was how greatly this gender step gap varied from country to country with negative consequences for women.

"When activity inequality is greatest, women's activity is reduced much more dramatically than men's activity, and thus the negative connections to obesity can affect women more greatly," Leskovec said.

The researchers, who are sharing their findings on an activity inequality

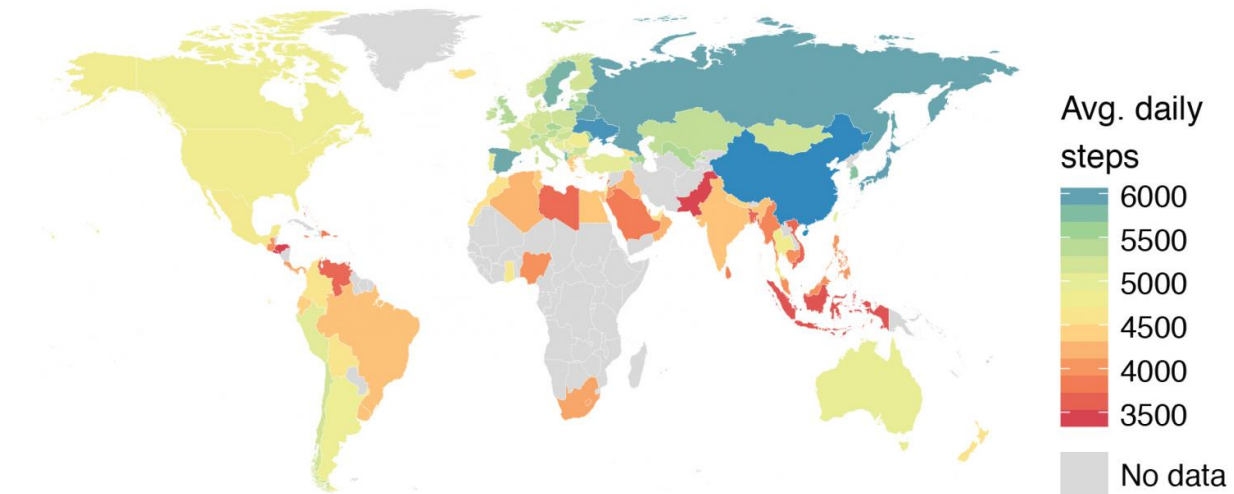
website, hope their work will help improve public health campaigns against obesity and support policies to make cities more "walkable."

Smartphones and steps

Smartphones are equipped with tiny sensors called accelerometers that can automatically record stepping motions. The researchers acquired the data for this study from the Azumio Argus app, which tracks physical activity and other health behaviors. Azumio anonymized the data but provided key health demographics: age, gender, height and weight. The last two data points enabled the researchers to calculate each person's body mass index.

The findings leaned most heavily on data from the 46 countries for which Azumio provided at least a thousand anonymized users, enough to form the basis for statistically valid inferences. The analysis disclosed strong correlations among activity inequality, the gender-activity gap, and obesity levels.

"For instance, Sweden had one of the smallest gaps between activity rich and activity poor, and the smallest disparity between male and female steps," said Tim Althoff, a doctoral candidate in computer science and first author on the *Nature* paper. "It also had one of the lowest rates of obesity."



Smartphone data from more than 68 million days of activity by 717,527 individuals across 111 countries reveal variability in physical activity around the world. Credit: T Althoff et al, Stanford University

Meanwhile, the United States ranked fourth from the bottom in overall activity inequality, indicating a large gap between activity rich and activity poor. It was fifth from the bottom in the gender step gap and it has high levels of obesity.

Walkable cities

To better understand the causes and consequences of activity inequality in urban settings, the researchers analyzed a large subset of data from the United States to investigate how the built environments of 69 cities related to activity, obesity and health.

Prior research had scored each city by how walkable and pedestrian-friendly it is, using factors such as ease of walking to shops, restaurants, parks and other destinations. The researchers then correlated this

walkability index to their smartphone activity data.

Team member Jennifer Hicks, director of data science for the Mobilize Center at Stanford, said the results make clear that city design has health impacts: the cities that were most conducive to walking had the lowest activity inequality.

"Looking at three California cities in close geographic proximity - San Francisco, San Jose and Fremont - we determined that San Francisco had both the highest walkability score and the lowest level of activity inequality," she said. "In cities that are more walkable everyone tends to take more daily steps, whether male or female, young or old, healthy weight or obese."

A new research instrument?

The technological star of the project was the increasingly ubiquitous smartphone. Nearly 70 percent of adults in developed countries now carry smartphones; in developing nations, the percentage is close to half.

"This opens the door to new ways of doing science at a much larger scale," Delp said.

But qualifying the smartphone as a tool for this type of research was no cakewalk.

"The methodology was so new that the reviewers were dubious at first," Leskovec said.

But strong data and rigorous computational methods ultimately proved the validity of this new approach. Now, having qualified the smartphone for research of this sort, the Stanford researchers are looking for new ways to leverage this tool.

"With the appropriate apps and sensors we can push this research in exciting directions," said team member Abby King, a professor of medicine and health research and policy. "We could better link activity within and across populations with food intake, or examine the ways activity and inactivity may affect stress or mental health, as well as investigating how best to fine-tune our environments to promote increased activity."

More information: Large-scale physical activity data reveal worldwide activity inequality, *Nature* (2017).
[nature.com/articles/doi:10.1038/nature23018](https://doi.org/10.1038/nature23018)

Provided by Stanford University

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