

The project, led by Dr. Sophia Newcomer in the University of Montana's Center for Population Health Research, is the first spatial scan analysis to identify hotspots of undervaccinated children across Montana and evaluate whether they are due to social or geographic barriers.

CPHR is funded through the National Institutes of Health, and the analysis is part of a collaborative study with the Montana Department of Public Health and Human Services to help inform the state's public health measures.

Irish, a history and math major from Lewistown set to graduate from UM this fall, became involved in January after taking a statistics course with UM math Professor Jon Graham, who also is the Data and Modeling Core director of CPHR.

Irish said the project is the first to use data, rather than anecdotes from physicians, on why childhood undervaccination exists in the state.

"Montana is already undervaccinated, and this study overall is trying to find out why and where," Irish said.

The CDC's Advisory Committee on Immunization Practices recommends that by age 2, when they are most vulnerable, children receive the combined 7-[vaccine](#) series. These vaccines work against diphtheria, tetanus and pertussis; polio; measles, mumps and rubella; hepatitis B; varicella; Haemophilus influenzae type b; and pneumococcal disease.

According to the CPHR and Montana DPHHS study, published in the *American Journal of Preventive Medicine*, Montana lags behind the 2019 national childhood combined 7-series vaccination rate of 71%. Just 62% of the children studied completed the vaccine series, and only 38%

received them on time—fewer than two in five.

Partnering with DPHHS, the CPHR Data and Modeling Core analyzed immunization data on Montana children born between 2015 and 2017, which includes more than 30,000 kids. Newcomer, an assistant professor in UM's School of Public and Community Health Sciences, led the research effort as one of several projects ongoing in CPHR.

Irish and Graham then used biostatistical modeling and a spatial statistical technique known as spatial scan analysis to identify and create the maps of clusters of undervaccination.

"This technique takes measurements of some variable of interest on a landscape and identifies hotspots of unusual values," Graham said.

"Kayla and I read several papers on the spatial scan method, learned how to implement it in the R statistical software package and applied it to the vaccination data."

The research method considers hundreds of thousands of areas throughout the state to identify large and small geographic hotspots with the highest rates of childhood undervaccination of the combined 7-vaccine series. In addition to identifying the clusters, separate analyses identified groups where children may be undervaccinated due to access barriers such as geographic distances and those where parents are hesitant to vaccinate their children.

To identify patterns suggestive of parental hesitancy, the researchers looked for inconsistency in the number of vaccines children received in the series or vaccines spread out over multiple clinic visits.

"Say you have all the different vaccines in the combined 7-vaccine series," Irish said. "If five of them are perfectly on time and two of them aren't happening, that's a pretty clear sign of parents consciously electing

not to vaccinate with certain shots."

According to the spatial analysis, parental hesitancy on vaccination is concentrated in the western part of the state.

Structural or access barriers, in contrast, mainly show up on the eastern side. To determine potential structural barriers, the team looked at children missing final vaccine doses or receiving them late.

Irish said looking at the two factors helps researchers understand how to increase vaccination rates in certain areas. Interventions to structural barriers, for example, might include hiring more vaccine program providers or creating programs in nontraditional settings for areas where clinics may be inaccessible, while social media tools and physician-client discussions may aid in addressing parental hesitancy.

"I think it's really cool because the long-term objective of this study is to test and determine ways to intervene," she said. "This is an amazing and great map for that."

Rain Freeman, UM's epidemiology specialist and the project's data manager, analyst and programmer, said national Vaccines for Children Program data showed a substantial dip in routine, pediatric vaccine orders at the beginning of the pandemic. And Montana was not immune to that trend.

Although more recent CDC data shows an uptick in vaccine orders again, it is not enough to catch up on the missed doses. Freeman said making sure children are vaccinated on time is crucial to preventing diseases during COVID-19 like measles, which needs a 95% vaccination rate for herd immunity.

"The problem is if vaccination rates for these preventable diseases dip

too far below the estimated thresholds for herd immunity, we're worried that we could have multiple epidemics or outbreaks occurring as social interaction becomes a little more normal," she said.

As a history major, Irish is interested in predicting the next preventable disease outbreak. Promoting community health, helping write a scientific paper, and using and managing data while working on the CPHR project also has prepared her for grad school.

"I'm gaining the skills I'll be needing anyway," she said. "It's unbelievably useful to me. I cannot recommend undergrad research too much."

The CPHR team is currently drafting a paper on these analyses and will submit it for publication in the coming months.

"It's hard not to be excited," Irish said. "I feel so much satisfaction. In computer science, it feels like in everything you do, you write a little bit of code and it always fails, and when you see it actually works, it's so cool. And I have so many of those moments here."

More information: Sophia R. Newcomer et al, Timeliness of Early Childhood Vaccinations and Undervaccination Patterns in Montana, *American Journal of Preventive Medicine* (2021). [DOI: 10.1016/j.amepre.2021.01.038](https://doi.org/10.1016/j.amepre.2021.01.038)

Provided by University of Montana

Citation: Researchers analyze Montana childhood under vaccination (2021, June 22) retrieved 27 April 2024 from <https://medicalxpress.com/news/2021-06-montana-childhood-vaccination.html>

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