Targeting Equity in COVID-19 Vaccinations Using the "Evaluating Vulnerability and Equity" (EVE) Model

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The COVID-19 pandemic has highlighted racial and ethnic disparities, most recently in vaccine administration. The EVE (Evaluating Vulnerability and Equity) Model combines a community's vulnerability with vaccination rates to enhance the equity of vaccine distribution in an intentional, targeted manner. When applied to Milwaukee County, Wisconsin, two extreme categories of vaccination status were identified to aid in resource allocation and messaging: populations with high vulnerability and low vaccination levels, and, conversely, those with low vulnerability and high vaccinations levels. (*Am J Public Health*. 2022;112(2):220–222. https://doi.org/10.2105/AJPH.2021.306585)

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As the landscape of the COVID-19 pandemic response has shifted to vaccination, inequities have persisted in the provision of this critical resource.[1] In particular, higher-vulnerability communities—including those of color, of lower income, and with less technological, health care, and transportation connectedness—have experienced a decreased ability to become vaccinated.

INTERVENTION

Building on the fundamental structure of the previous SAFER Model, the EVE (Evaluating Vulnerability and Equity) Model has been developed and implemented to understand the interconnectedness of vulnerability and vaccination rates.[2]

PLACE AND TIME

The EVE Model output presented here was based on an 86-day period (December 15, 2020–March 10, 2021) in the 296 census tracts of Milwaukee County, the largest county in Wisconsin. In practice, the model can be updated regularly to show dynamics in vaccination rates.

PERSON

The EVE Model was applied to residents of Milwaukee County. The county has a population of approximately 946 000, with a racial and ethnic breakdown of 50.6% White, 27.2% African American, 15.6% Hispanic, 4.7% Asian, 1.0% American Indian or Alaska Native, and 2.8% two or more races.[3] During the period evaluated, EVE Model calculations were based on approximately 146 466 individuals having received first doses of the vaccine—about 20% of the eligible population (aged ≥ 16 years).

PURPOSE

The EVE Model aims to provide a geographic understanding of inequities in vaccination rates in vulnerable communities. By targeting vaccine supply, messaging, and resource mobilization to communities with high vulnerability paired with low vaccination rates, disparities in vaccination can be directly addressed to enhance the equity of vaccine distribution in an intentional, targeted manner.

IMPLEMENTATION

The EVE Model (Figure 1) incorporates a four-quadrant design to categorize geographic areas based on two variables: vaccination rate and social vulnerability. This results in four categories: Low Vaccination/Low Vulnerability (LVa/LVu), Low Vaccination/High Vulnerability (LVa/HVu), High Vaccination/Low Vulnerability (HVa/LVu), and High Vaccination/High Vulnerability (HVa/HVu).

On each of the gradients composing the four-quadrant model, a midpoint divides the lesser from the greater quadrants, creating the general color categorization. Then, each quadrant is subcategorized into four further quadrants to provide 16 subgroupings for

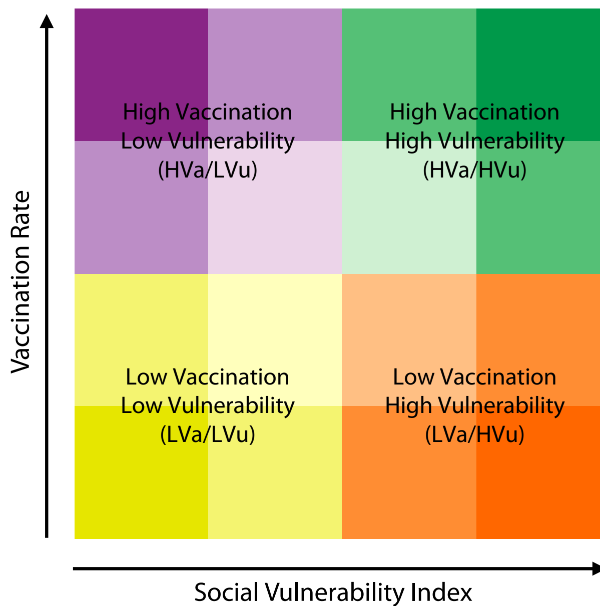

FIGURE 1— The EVE (Evaluating Vulnerability and Equity) Model for Understanding the Interconnectedness of Vulnerability and Vaccination Rates

the model overall to more clearly differentiate extremes in the variables.

Three classifications were developed for variable stratification. In all classifications, social vulnerability was stratified on the basis of the Centers for Disease Control and Prevention (CDC)-defined quartiles of the Social Vulnerability Index (SVI), with breakpoints at 0.25, 0.5, and 0.75.[4] This index is based on 15 census variables—such as poverty, housing, and transportation access—to assess the vulnerability of a community. The quartile breakpoint stratifications of the vaccination rate variable differed between classifications. The outlier classification ordered census tracts by vaccination rate, and the median value was used as a breakpoint to split the tracts into two groups (high or low). An outlier test (commonly called the "1.5 x IQR Rule") was then used to identify any tracts with particularly high or low vaccination rates, which were separated into the highest or lowest quartile categories. The quartile classification ordered tracts by vaccination rate and separated them into four groups containing an equal number of tracts (also known as quantiles). This classification forces half of the census tracts into the highest and lowest categories based on vaccination rate, which may make the values appear more extreme than they are relative to the rest of the county. The goal-oriented classification stratified tracts based on percentage of the population receiving at least one dose (0%–19%, 20%–49%, 50%–79%, and 80%–100% for each quartile).

EVALUATION

The maps and quartile (as well as subquartile) breakdowns of census tract distribution are shown in Figure A (available as a supplement to the online version of this article at https://www.ajph.org). The widest distribution of census tracts was found in the quartile classification, which had at least one census tract in each of the 16 subquartiles. The least distribution, in part due to the application of this model early in the vaccination effort, was with the goal-oriented classification. The outlier classification fell between these other two classifications, with few census tracts falling into the most extreme lowest and highest levels of vaccination stratification.

Overall, the outlier classification, used as our default view on the public facing dashboard, highlighted the disparities in the community, placing the majority of census tracts in either the HVa/LVu (purple, 110 tracts, 37.2%) or LVa/HVu (orange, 138 tracts, 46.6%) quadrants. This dichotomy in vaccine administration based on SVI demonstrated and geomapped the stark disparities in our community. Although the lowest vulnerability group had 91.7% (54/60) of census tracts above the median in vaccination rates, the highest vulnerability group had 90.2% (111/123) of census tracts below the median for vaccination rates.

ADVERSE EFFECTS

We are not aware of any adverse effects of this model. Rather than stigmatizing any communities, we hope that the EVE Model will bring further resources to vulnerable, underserved communities to enhance their overall health.

SUSTAINABILITY

The EVE Model may be fairly easily replicated by other communities of varying resources and sizes. As SVI is publicly available, provided a community has access to geographic-level vaccination

rates, simple calculation may be performed to replicate this model in regions of any size, from county to state and beyond.

PUBLIC HEALTH SIGNIFICANCE

The EVE Model provides a simple view for both decision-makers and the general public to understand disparities in COVID-19 vaccine distribution. The dichotomy of high versus low SVI, compared with high versus low vaccination rates, allows for the clear highlighting of communities most at risk: those with LVa/HVu. High-SVI communities, often composed of populations of color, are inherently more likely to be left behind by health care initiatives, and the coupling of this metric with low vaccination rates can help to further pinpoint areas of greatest need.

The three views of the EVE Model may be used for different community aims and decisions. The outlier classification is better suited to understanding vaccination efforts across the county as a whole, as well as identifying any extreme disparities in vaccination rates. The quartile classification may be useful in identifying tracts of interest when few outliers are present in the data. Finally, the goal-oriented classification was designed to monitor progress toward the goal of full vaccination for 80% of the currently eligible population.

Although the EVE Model in this situation is used for determination of vaccine equity, the four-quadrant design of geomapping a health variable with the SVI may have applications in other equity-focused campaigns to guide resource allocation and messaging. Examples may include rates of bystander cardiopulmonary resuscitation in cardiac arrests, traumatic injuries in a population, food deserts in a community, or other disease burdens that may not initially be considered related to social vulnerability. Indeed, the SVI has been linked to many adverse health conditions, including pediatric trauma, heat-related health outcomes, and obesity rates.[5–7]

When applied to Milwaukee County, the model demonstrated substantial inequities in vaccine distribution between the low- and high-vulnerability groups. Specifically targeting disparities in transportation availability, health care access, and health literacy, the county expanded the availability of vaccination clinics in the LVa/HVu communities while simultaneously launching a door-to-door campaign to provide information and vaccine access, thereby increasing vaccine uptake.

The EVE Model provides a clear geomapped view of disparities in vaccination rates when considering a community's vulnerability. This model provides a roadmap for targeting vaccination resources, interventions, and messaging to communities most in need. AJPH

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CONTRIBUTORS

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

HUMAN PARTICIPANT PROTECTION

This study was reviewed by the Medical College of Wisconsin institutional review board and determined to not be human participant research.

REFERENCES

1. Noguchi Y. Race versus time: targeting vaccine to the most vulnerable is no speedy task. *NPR*. February 23, 2021. Available at: https://www.npr.org/sections/health-shots/2021/02/23/969384904/race-versus-time-targeting-vaccine-to-the-most-vulnerable-is-no-speedy-task. Accessed March 23, 2021.
2. Weston BW, Swingen ZN, Gramann S, Pojar D. SAFER model: strategic allocation of fundamental epidemic resources. *J Public Health (Oxf)*. 2020;(November):fdaa179. https://doi.org/10.1093/pubmed/fdaa179
3. US Census Bureau. QuickFacts: Milwaukee County, Wisconsin. Available at: https://www.census.gov/quickfacts/milwaukeecountywisconsin#qf-flag-Z. Accessed June 24, 2020.
4. Agency for Toxic Substances and Disease Registry. CDC/ATSDR Social Vulnerability Index. Available at: https://svi.cdc.gov. September 5, 2018. Accessed June 24, 2020.
5. Morgan ME, Horst MA, Vernon TM, et al. An analysis of pediatric social vulnerability in the Pennsylvania trauma system. *J Pediatr Surg*. 2020;55(12):2746–2751. https://doi.org/10.1016/j.jpedsurg.2020.05.024
6. Lehnert EA, Wilt G, Flanagan B, Hallisey E. Spatial exploration of the CDC's Social Vulnerability Index and heat-related health outcomes in Georgia. *Int J Disaster Risk Reduct*. 2020;46:101517. https://doi.org/10.1016/j.ijdrr.2020.101517
7. An R, Xiang X. Social vulnerability and obesity among US adults. *Int J Health Sci*. 2015;3(3):7–21. https://doi.org/10.15640/ijhs.v3n3a2