Evaluating an Artificial Intelligence Powered Medication Adherence Program's Targeting by Patients' Social Vulnerability.

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BACKGROUND

Improving a population's adherence to medications is a complex topic that involves using a variety of medication adherence intervention messages and channels of communication. With the wide variety of intervention opportunities, to achieve high levels of medication adherence across a population requires targeting certain patients to receive specific interventions. While historically intervention targeting has involved a series of rules often with complex interactions, increasingly companies have turned to Artificial Intelligence (AI) programs in an effort to more effectively target interventions to specific patients.

To help optimize total population's adherence, AI programs use machine learning or other techniques to make predictions about specific patients' future medication adherence behavior and how individual patients may react to interventions. However, because AI programs make predictions, it is possible that disadvantaged groups could be deprioritized if interventions are predicted to have more impact for non-disadvantaged groups. To assure health equity, it is prudent to evaluate AI programs for unintended bias. Some AI models used in other areas of healthcare have been shown to cause bias against providing services to socially vulnerable populations.[1]It is important to provide the reader with some additional background information on the Center for Disease Control (CDC)'s Social Vulnerability Index (SVI), which is referred to throughout this study. The CDC's SVI scores US census tracts based on overall Social Vulnerability and across four themes: socioeconomic status, household composition & disability, minority status & language, and housing type & transportation.[2]

- **The Socioeconomic Status theme – combines variables for income, poverty, employment, and education.**
- **The Household Composition & Disability theme – combines variables for age, disability, and single parenting.**
- **The Minority Status & Language theme – combines variables for race/ethnicity and English language proficiency**
- **The Housing and Transportation theme – combines variables for vehicle ownership, housing type (e.g. mobile homes, group centers), density of units per building, and density of individuals per room.**
- **Total Social Vulnerability – Combines variables of each of the four themes.**

US census tracts are regions that are designed to be demographically homogenous and are small subdivisions of counties.[3]
The CDC SVI dataset is updated every year, and the most recent version available at the time of this study was the 2018 dataset.

For all of 2020, Walgreens, a national retail pharmacy chain used an Artificial Intelligence (AI) powered program provided by AllazoHealth to target in-person, telephonic, SMS, and email interventions to patients with the goal of improving the population's adherence rate to diabetes, hypertension, and statin medications. The AI program did not explicitly attempt to provide more or less support to patients based on their SVI score.

OBJECTIVE

The objective was to determine whether patients classified as more socially vulnerable were more or less likely to be targeted by the AI program for adherence-improving interventions.

METHODS

This retrospective study used the 2018 SVI dataset and prescription, intervention, and AI targeting data between 1/1/2020 and 12/24/2020 from Walgreens pharmacy and AllazoHealth, a digital healthcare AI company.

Patients who were within the population assigned to AllazoHealth for AI targeting and who qualified for CMS specified hypertension, diabetes, or statin adherence measures based on their prescription fill data at Walgreens were included in the study.

Two-proportion z-tests were performed comparing the proportion of patients in the Lowest Vulnerability group that were targeted for medication adherence interventions compared to the proportion of patients in each of the other groups that were targeted for medication adherence interventions. In addition, two-proportion z-tests were performed comparing the proportion of Highest Vulnerability patients to the proportion of Less Vulnerable patients (patients in groups Lowest through Medium-High) that were targeted for medication adherence interventions. Each of these z-tests were repeated for Diabetes, Hypertension, and Statin patients.

For each of the four CDC social vulnerability themes, as well as for CDC's overall social vulnerability score, the CDC SVI provides the percentile ranking of each census tract compared to all other US Census tracts. Patients living in the census tracts ranked 80th percentile or higher on the SVI were classified as Highest Vulnerability; additional groups were classified according to *Table 1*, displayed to the right.

CDC Ranking of census tracts on social vulnerability themes or overall social vulnerability score	Vulnerability groups used for this study for patients living in respective census tracts	Additional vulnerability groups used for this study
80th percentile or higher	Highest	Highest Vulnerability
60-80th percentile	Medium-High	Less Vulnerable
40-60th percentile	Medium	
20-40th percentile	Low-Medium	
20th percentile or lower	Lowest	

Table 1.

Results

Population Distribution

Within all of the CDC's Social Vulnerability themes, between 15.1% and 26.3% of the Diabetes, Hypertension, and Statin populations was classified into each of the five levels of vulnerability as can be seen in Figures 1-5., which show the fraction of patients classified info each level of vulnerability.

Due to differences in the distribution of the study population compared to the total US population, it is not expected that patients would be equally distributed across each of the five levels of vulnerability.

Sample sizes for the study included patients qualified for the CMS specified adherence metrics and numbered 349,514 patients for Diabetes, 1,044,568 patients for Hypertension, and 1,174,871 patients for Statins.

Socioeconomic

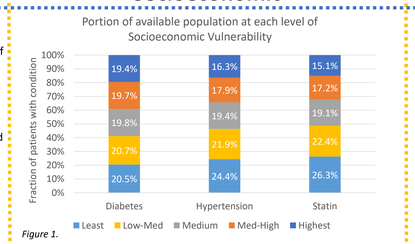

Figure 1.

Household Composition & Disability

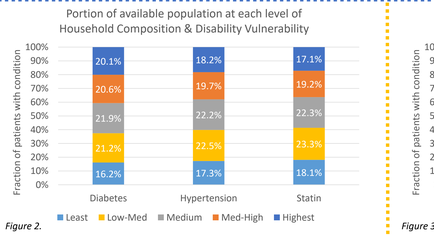

Figure 2.

Minority Status & Language

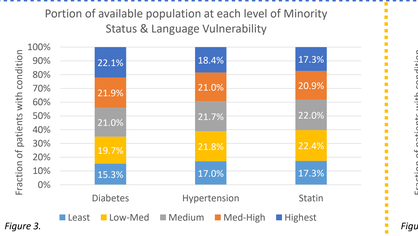

Figure 3.

Housing & Transportation

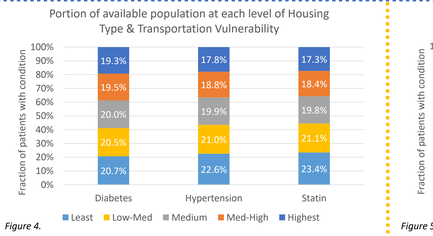

Figure 4.

Total Social Vulnerability

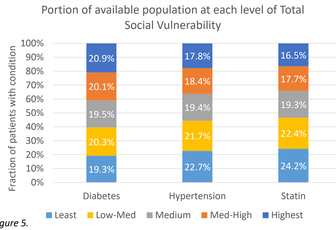

Figure 5.

Evaluation of Potential AI Bias

The AI program did not explicitly attempt to provide more or less support to patients based on their level of vulnerability. Figures 6-10 compares the fraction of patients who were targeted for interventions in the Lowest Vulnerability group. The Lowest Vulnerability group shows 100% on each graph because it is being compared to itself.

Across all conditions and vulnerability themes, as a patient's vulnerability increased, the AI was more likely to target that patient for medication adherence interventions.

Further analysis was also completed and this compared the proportion of patients targeted for medication adherence interventions within the Highest Vulnerability population to all other groups combined. (refer to bottom row of Table 2)

Socioeconomic

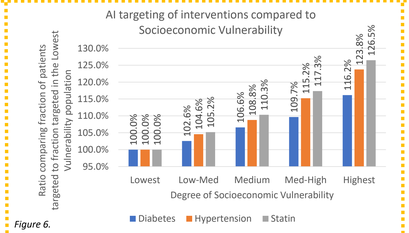

Figure 6.

Household Composition & Disability

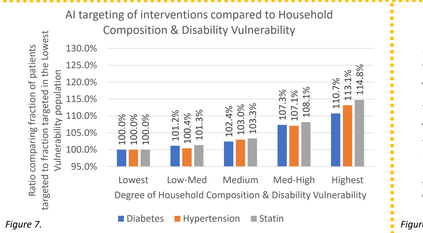

Figure 7.

Minority Status & Language

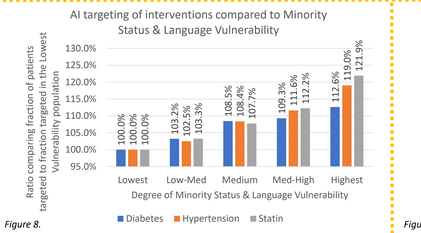

Figure 8.

Housing & Transportation

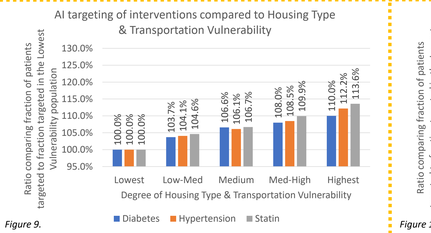

Figure 9.

Total Social Vulnerability

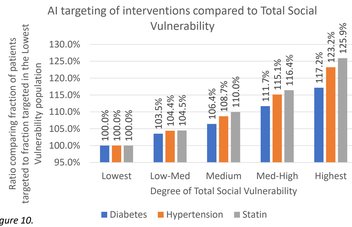

Figure 10.

Table 2	Diabetes	Hypertension	Statins	Diabetes	Hypertension	Statins	Diabetes	Hypertension	Statins	Diabetes	Hypertension	Statins	Diabetes	Hypertension	Statins
Increase in proportion of the patients in the Highest Vulnerability group targeted for interventions compared to the Lowest Vulnerability group. All p-values (P<0.00001). Figures 6-10	16.2%	23.8%	26.5%	10.7%	13.1%	14.8%	12.6%	19.0%	21.9%	10.0%	12.2%	13.6%	17.2%	23.2%	25.9%
Increase in percentage that Highest Vulnerability patients were more likely than Less Vulnerable patients to be targeted by the AI for interventions. All p-values (P<0.00001).	11.0%	16.2%	18.0%	7.6%	10.3%	11.3%	6.5%	12.4%	15.0%	5.3%	7.4%	8.2%	11.1%	15.6%	17.7%

- *The AI did not intentionally provide more or less support to patients based on their level of Social Vulnerability.*
- *The evaluation showed that the AI was not biased against supporting socially vulnerable patients.*
- *The AI provided more support to patients that were more socially vulnerable, promoting health equity.*

CONCLUSIONS

Although the AI program was not specifically attempting to target those patients who were more socially vulnerable, this study shows that by looking at a combination of patient behavior and patient response to interventions, an AI program can provide additional support to socially vulnerable patients. As shown in the results, across every dimension of the Social Vulnerability Index, the AI program targeted the Highest Vulnerability patients substantially more than the Less Vulnerable patients. Additionally, as CDC SVI rankings increase, the amount of AI targeting also increases, indicating that the AI program predicts that providing greater support to the more vulnerable results in a higher proportion of the entire population achieving adherence.

REFERENCES

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SPONSORSHIP

AllazoHealth*

Walgreens Boots Alliance†

This study was conducted in compliance with HIPAA's Privacy Rule regarding research.