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The Predictive Value of Median Household Income and Some College Education on the Seasonal Influenza Vaccination Rates of Counties in Ohio

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Scholarship in Medicine Proposal

☐ **By checking this box, I indicate that my mentor has read and reviewed my draft proposal prior to submission**

Abstract

Objective: The objective of this study is to determine the relationship between flu vaccination rates and education level and income for counties in Ohio.

Methods: Data was obtained from countyhealthrankings.org in the categories of flu vaccination rates among medicare enrollees, percent of population with some college education, and average household income. The data was then analyzed using the program IBM SPSS statistics version 26. Descriptive statistics were obtained to determine the z-score for each county in each category, making note of counties that are outliers in either the positive or negative direction. A Pearson correlation was then used to quantify the correlation between some college education and flu vaccination rates. A correlation was also quantified for the relationship between some college and median household income. A step wise linear regression was used to determine how the factors of some college education and average household income could account for the variance in the flu vaccination rate in Ohio counties.

Results: In the 88 counties of Ohio, the mean vaccination rate for counties is 45.9% with a standard deviation of 4.2%. The correlation coefficient between the vaccination rate and percent of individuals with some college education in a given county was $r = 0.488$ ($p<0.01$). The correlation coefficient between the median household income and percent vaccinated was $r = 0.505$ ($p<0.01$). A stepwise linear regression showed that the median household income and education level in Ohio counties can predict 32% of the variance in flu vaccination rates by county.

Key Words: Influenza vaccination, public health, health disparities, income, education

Introduction/Literature Review

The seasonal flu is a cause of significant morbidity and mortality every year with the Centers for Disease Control estimating the 2018-2019 flu season to have caused 35.5 million illness, 16.5 million medical visits, 490,600 hospitalizations, and 34,200 deaths in the United States.[1] The CDC estimates an average of 4.8 million symptomatic flu illnesses prevented by the flu vaccination per year over the past 9 years.[2] The influenza vaccine also has demonstrated benefit in patients with comorbidities. It has been showed influenza vaccination can reduce hospitalization rates of patients with diabetes.[3] It has also been found that the flu vaccine can decrease the hospitalization of patients with chronic lung conditions.[4] The studied benefits of the flu vaccination has not translated to public vigor, however as the overall flu vaccination rate in Ohio in 2016 was 47% among medicare enrollees according to countyhealthrankings.org. This rate has room for improvement and potential to decrease the burden of the seasonal flu on the healthcare system.

Many possible predictors of whether or not a patient will receive the flu vaccine have been investigated. Some studies have suggested racial disparities as obstacles to getting the vaccination. Concern about contracting influenza is a strong predictor of whether an individual would be vaccinated.[5] However even for Latinos who are concerned about the influenza virus, their vaccination rate was only 54%, compared to 96% and 91% among Caucasians and African Americans concerned about an influenza infection, respectively.[5] Latinos are more likely to report access and cost barriers to vaccinations.[5] This shows that even when there is a desire to receive the vaccination, groups with financial barriers will have a lower vaccination rate.[5]

The CDC found that there is racial disparity in the vaccination rates of adults greater than 65.[6] The rates in 2002 were 47% for Hispanics over the age 65, 52% for African Americans over the age of 65, with an overall 65% for individuals over the age of 65.[6] This is a peculiar finding because the flu vaccination is covered by medicare enrollees, suggesting that barrier goes beyond the paying for the vaccination.

Another investigated aspect of influenza vaccination rates is the attitudes and beliefs of patients about the vaccine. 30% of individuals have a fear of contracting the flu from the vaccination and that 35% are concerned about the possible side effects of the flu.[7] African Americans are more likely to cite reasons of mistrust that the vaccination causes the flu.[5] Addressing concerns about the vaccination causing the flu with CDC information can lower concerns about this for patients.[8] Thus demonstrating that information can be helpful in quelling vaccine mistrust and has a role in potentially increasing vaccination rates.

It is therefore demonstrated that factors affecting influenza vaccination are access problems, cost barriers and misinformed beliefs about the vaccination (like that it causes influenza infection). It is not clear how these factors effect Ohio vaccination rates specifically. Cost

barriers and misinformation are arguably rooted in income level and education level.[5,8] Income level determines a patient's access to transportation to receive the vaccination, availability to take time off of work, ability to afford establishment at a doctor's office, and the time the patient might receive with a provider who would address concerns about the influenza vaccination. Education level could determine an individual's ability to overcome misconceptions through information, have a factually informed opinion about the vaccine, and be able to understand public health concepts that endorse receiving a vaccination. It is not known how income and education level influence whether or not an individual receives the flu vaccination in Ohio and it is the goal of this study to determine how they can predict vaccination rates throughout Ohio.

Hypothesis and Research Questions

It is hypothesized that regions in Ohio with a higher median household income and higher percentage of individuals with some college education will have higher corresponding influenza vaccination rates and that these will be positive predictive factors for whether or not an individual obtains a flu vaccination.

RQ1: How does flu vaccination rate, percent of population with some college education, and median household income vary among counties in Ohio?

RQ2: How does the percent of population with some college education in a given county correlate with flu vaccination rates in that county for 2016?

RQ3: How does median household income in a given county correlate with the flu vaccination rates in that county for 2016?

RQ4: How does the median household income of the population in a county and the percentage of the population with some college education collectively predict the vaccination rates for that county in 2016?

Methods

Context/Protocol

Publicly available data was collected of counties in Ohio from countyhealthrankings.org. It was first selected for Ohio's counties, then "measures" was selected. Under "health factors" then "clinical care" "flu vaccinations" was selected. This data was collected by including the percentage of Medicare FFS enrollees who received a flu vaccination. The numerator consists of Medicare beneficiaries enrolled in fee-for-service Medicare Part B for at least one month of 2016, and who received a flu vaccination in that year. The denominator consists of Medicare beneficiaries enrolled in fee-for-service Medicare part B for at least one month in 2016. This data was collected by the Centers for Medicare and Medicaid Services Office of Minority Health's Mapping Medicare Disparities Tool.

"Health factors" was again selected and "Social and Economic Factors" was selected then "Some College". This data was collected by the American Community Survey. This is a measurement of the percent of the population ages 25-44 with some post-secondary education, including people who pursued education after high school but did not receive a degree.

Then "Additional Measures", "Social and Economic Factors", and "Median household income" were selected. The Median household income is the income where half of the households in a county earn more and half of the household in the county earn less. It was measured as "the sum of the amounts reported separately for: wage or salary income; net self-

employment income; interest, dividends, or net rental or royalty income or income from estates and trusts; Social Security or Railroad Retirement income; Supplemental Security Income (SSI); public assistance or welfare payments; retirement, survivor, or disability pensions; and all other income." Capital gains, money from property sales, income from food stamps, public housing subsideies, medical carem employer contributions, withdrawal of bank deposits, money borrowed, tax refunds, exchange of money between relatives in the same household, gifts and lump sum inheritances, insurance payments, and other types of lump sum income. The Median Household Income was created using statistical modeling. The data was collected by the Small Area Income and Poverty Estimates program.

Data Collection

Data from counthealthrankings.org was collected from each of the counties in Ohio. Data in the following categories was collected: percentage of adults ages 25-44 with some post-secondary education in the years 2013-2017, the median household income in the year 2017, and the percentage of fee-for-service Medicare enrollees that had an annual flu vaccination in the year 2016. These years were all the most up to date data figures on countyhealthrankings.org and the statistics for these years were used for the 2019 rankings of Ohio's counties. All of the data collected was included in the Data Analysis.

Data Analysis

The program IBM SPSS statistics version 26 was used to analyze collected data. To answer RQ1 descriptive statistics were first used to determine how the categories of interest vary among the counties in Ohio by finding the z-score of each county. RQ2 and RQ3 were addressed numerical correlations were calculated using a Pearson correlation. The correlations were found

for the separate categories of percent with some college correlated to flu vaccination rates for RQ2 and the correlation between median household income and flu vaccination rates for RQ3. A stepwise linear regression was then used to address RQ4 and determine the additive effect of both some college education and median household income have on flu vaccination rates.

Results

Table 1: Descriptive statistics percent vaccination, some college, and median household income among counties in Ohio

	n	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Percent Vaccinated	88	31%	58%	45.9	4.21%
Some College	88	19%	84%	57.2	10.1%
Median Household Income	88	40900	107700	53751	11201

Figure 1. Flu vaccination rates among Ohio counties in 2016

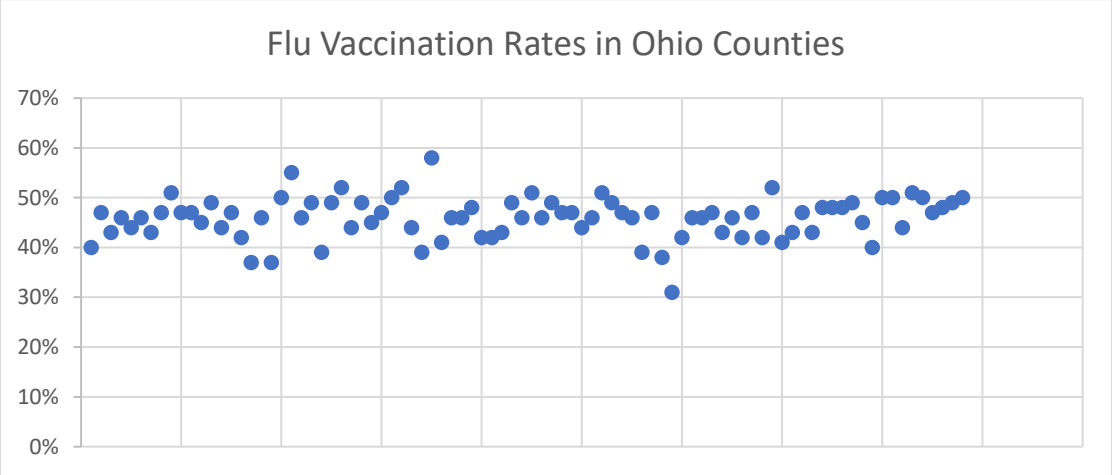


Figure 2. Median Household income in Ohio counties in 2016

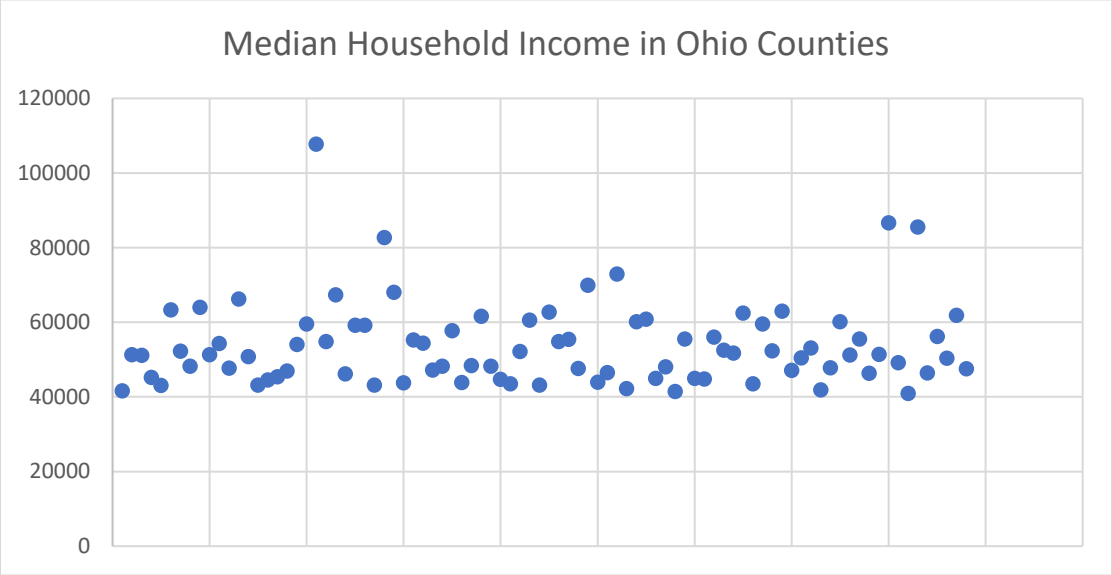
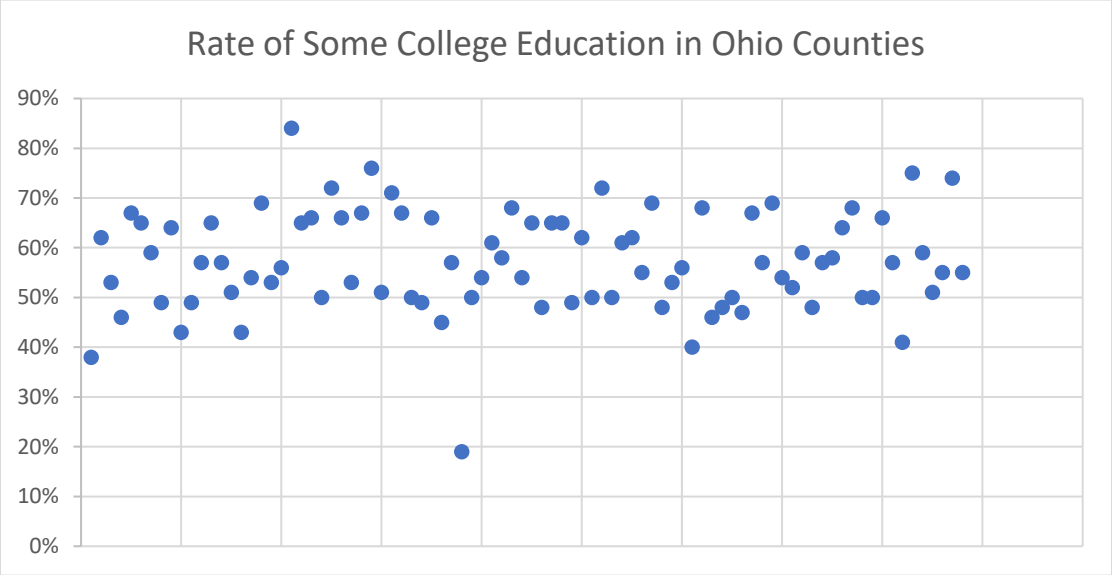


Figure 3. Rate of some college education among Ohio counties in 2016



(Q1) Figure 1, Figure 2, and Figure 3 demonstrate how the investigated health measures vary among the differing Ohio counties, while Table 1 shows the maximum, minimum, mean, and standard deviation of each category. There was relatively few outliers of data. When a county had a particularly highly negative or positive z-score in one county, it followed a similar trend in the other categories. Delaware county was a high outlier with a z-score of 2.16, 2.65, and 4.81 for percent vaccinated, some college, and median household income respectively. Morrow county had the lowest vaccination rate at 31%, while Henry county had the highest rate at 58%. Holmes county had the lowest percent of people with some college education at 19% while Delaware county had the highest at 84%. Vinton county had the lowest median household income at $40900 while Delaware county had the highest at $107700. Actual values and associated z-scores for the variables for each county are listed in Supplemental Table 1.

(RQ2 and 3) The results of the Pearson correlation for both variables showed moderate correlation. Some college had a correlation coefficient with the flu vaccination rate of 0.488 ($p<0.001$) and median household income had a coefficient of 0.505 ($p<0.001$) correlation with

flu vaccination rates. Figure 3 and Figure 4 showed the correlation of vaccination rates with percent with some college education and median household income, respectively.

Figure 3. Rate of vaccination per county correlated with percent of county with some college education.

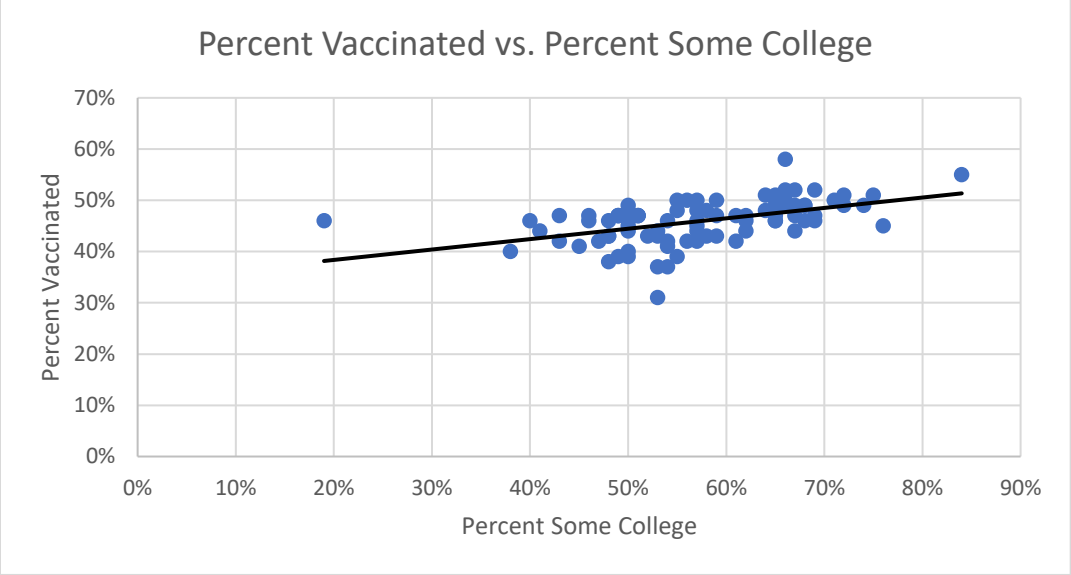
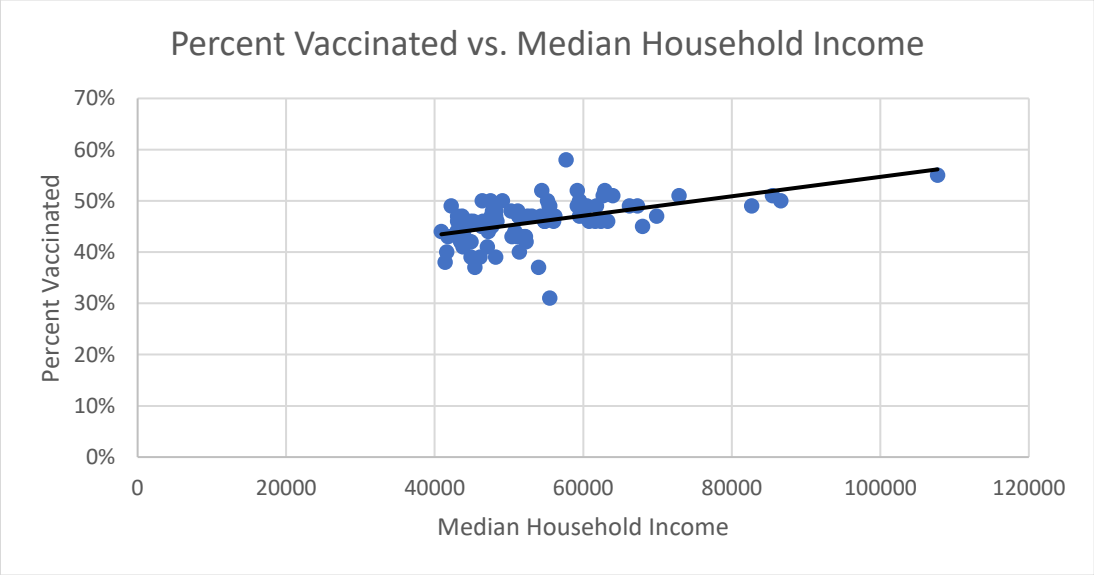


Figure 4. Rate of flu vaccination correlate with median household income among Ohio counties.



(RQ4) A stepwise linear regression showed an R squared value of 0.318. The B coefficient in this model was 0.000 for median household income and 0.126 for percent with some college education. The standardized Beta coefficient in the model was 0.339 for median household income and 0.302 for some college.

Discussion

(RQ1) It was hypothesized that the variation among counties in Ohio in the categories of Percentage of population with some college education, median household income, and flu vaccination rates would have relatively little variance. This was supported by the Z-score evaluations with few z-scores below -2 or greater than 2. Because of the interrelated nature of education, income, and access to health care it was also predicted that if a county was an outlier in one category, it would be likely they are similarly an outlier in other categories. When a population has a higher education level, they will have better paying job opportunities and can thus provide higher education for the younger individuals in their community. Although this study was focused specifically on counties in Ohio, these findings could have applications on a larger scale. These observations support the idea that from a population perspective, education and income both correlate with each other and with the access of population to healthcare.

(RQ2) It was indicated in the literature that concerns about contracting the flu from the flu vaccination and if the physician addresses these concerns, the patient is more likely to receive their flu vaccination.[7,8] Due to these findings, the ability to converse with the physician and address personal concerns will make a patient more likely to receive their vaccination. Therefore, a person with a higher level of education will be more able to engage in discussions addressing their worries over the vaccination. It was therefore hypothesis that the percent of the population with some college education would positively correlate with the flu vaccination rate in that

county was supported. The Pearson correlation of 0.488 ($p<0.001$) shows that a moderate correlation exists between the two categories. These findings are important because it demonstrates a significant relationship between education level and flu vaccination rates. From a population health perspective there can be two main interventions related to this concept. The first being increase access to higher education which will improve health outcomes in general population measures. Another intervention that could be more individualized would be to improve the informative materials about the flu vaccination so that it is accessible to patients with lower reading levels. Also, in patient-provider interactions reducing the medical jargon a provider uses while discussing flu vaccinations with their patient.

(RQ3) With patients citing financial barriers as obstacles to obtaining flu vaccination, it was hypothesized that the median household income would positively correlate with the flu vaccination rates in that county.[5] This hypothesis was supported with a Pearson correlation of 0.505 ($p<0.001$), indicating a moderate correlation between the two categories. This finding likely goes beyond actually paying for the vaccination because the value for vaccination rates was obtained from medicare enrollees who do not need to pay for the vaccination. This likely points to other obstacles these patients have to get access to healthcare, like transportation, time off work, and dispersion of information about how and where to receive a flu vaccination. Another possible factor that contributes to medicare enrollees of lower income brackets having a lower vaccination rate is the pattern they have developed from a life of less access to care. If a patient is used to not having a yearly wellness check that includes a flu vaccination when they are young and not benefitting from medicare, they are probably less likely to belief that a flu vaccination is important when they are older as well.

(RQ4) It was hypothesized that the percent of the population with some college education and the median household income for the population in a given county will collectively predict the flu vaccination rates in that county. This was supported with an R squared value of 0.312, signifying that 31% of variance in flu vaccination rates can be attributed to median household income in a county and percent of the county with some college education. This notion supports the fact that flu vaccination rates are multifactorial, as demonstrated in the literature that cites race, vaccination misinformation, and financial barriers. This value for R squared also indicates that while 31% of variance in vaccination rates are predicted by income level and education level, there are many other factors that come into play with a population's vaccination rate.

These finding support what was hypothesized to contribute to the flu vaccination rates in a given county. Since this study looks at the population of Medicare enrollees, the category of median household income likely manifests as obstacles to care more than the actual expense of the vaccination, which has been shown in previous studies to contribute to whether a patient will receive a flu vaccination.[5,6] Studies looking at mistrust around vaccinations and a patient's ability to engage in conversation with their provider to debunk myths support the findings that percent of the population with some education contributes to vaccination rates. [5,7,8]

Although studies have looked at what factors contribute to whether or not individual patients are vaccinated, this study shows how the vaccination rate in the population of Ohio is affected by these. The flu causes significant morbidity yearly and the flu vaccination has been shown efficacious at preventing both contracting influenza and hospitalization of patients.[2,3] It is thus important to understand the factors that affect the population of Ohio as whole so we know better what the needs are in the varying communities that surround Ohio practitioners.

Conclusion

One limitation of this study is that it looked only vaccination rate data from Medicare enrollees, so it cannot be applied to patients of different age groups. Another limit of this study is that the data is studied from 2016, and thus what the trend has been for the most recent years has not been evaluated.

Future directions for this study include looking at the most recent data for trends in these categories among counties in Ohio and up to date vaccination rates. Another direction would be to compare these factors in different states to explore how these factors affect the vaccination rates in other areas of the country.

In conclusion, flu vaccination rates can directly impact the overall health of a community, decreasing the influenza infection rates and hospitalization. In the measurement of a state's population, this can save healthcare dollars and prevent enormous summation of disease suffering. Looking at predictors for increasing vaccination rates is thus a relevant venture in population health. This study demonstrated two significant factors in predicting the flu vaccination rate of a population are the level of education and income level. Interventions based on these finding can include increasing access to vaccinations in the community and raising awareness about where to find them in poorer neighborhoods. It also points to the role of health literacy and the importance that patients have discussion with healthcare professional about flu vaccinations without medical jargon in an easily understood manner.

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Supplemental Materials

Supplemental table 1. Values and correlated Z-scores for percent vaccinated, some college, and median household income for different Ohio counties.

	Percent Vaccinated	z-score	Some College	z-score	Median Household Income	z-score
Adams	40%	-1.40699	38%	-1.89723	41600	-1.08481
Allen	47%	0.25655	62%	0.47375	51300	-0.21883
Ashland	43%	-0.69404	53%	-0.41537	51100	-0.23668
Ashtabula	46%	0.0189	46%	-1.1069	45200	-0.76342
Athens	44%	-0.45639	67%	0.9677	43000	-0.95982
Auglaize	46%	0.0189	65%	0.77012	63300	0.85249
Belmont	43%	-0.69404	59%	0.17737	52200	-0.13848
Brown	47%	0.25655	49%	-0.81053	48200	-0.49559
Butler	51%	1.20715	64%	0.67133	64000	0.91498
Carroll	47%	0.25655	43%	-1.40328	51300	-0.21883
Champaign	47%	0.25655	49%	-0.81053	54300	0.049
Clark	45%	-0.21875	57%	-0.02021	47700	-0.54022
Clermont	49%	0.73185	65%	0.77012	66200	1.11139
Clinton	44%	-0.45639	57%	-0.02021	50800	-0.26347
Columbiana	47%	0.25655	51%	-0.61295	43100	-0.9509
Coshocton	42%	-0.93169	43%	-1.40328	44500	-0.82591
Crawford	37%	-2.11994	54%	-0.31658	45400	-0.74556
Cuyahoga	46%	0.0189	69%	1.16528	46900	-0.61165
Darke	37%	-2.11994	53%	-0.41537	54000	0.02222
Defiance	50%	0.9695	56%	-0.119	59500	0.51324
Delaware	55%	2.15775	84%	2.64714	107700	4.81636
Erie	46%	0.0189	65%	0.77012	54800	0.09364
Fairfield	49%	0.73185	66%	0.86891	67300	1.20959
Fayette	39%	-1.64464	50%	-0.71174	46100	-0.68307
Franklin	49%	0.73185	72%	1.46165	59200	0.48646
Fulton	52%	1.4448	66%	0.86891	59200	0.48646
Gallia	44%	-0.45639	53%	-0.41537	43100	-0.9509
Geauga	49%	0.73185	67%	0.9677	82700	2.58445
Greene	45%	-0.21875	76%	1.85681	68000	1.27209
Guernsey	47%	0.25655	51%	-0.61295	43700	-0.89733
Hamilton	50%	0.9695	71%	1.36286	55200	0.12935
Hancock	52%	1.4448	67%	0.9677	54400	0.05793
Hardin	44%	-0.45639	50%	-0.71174	47200	-0.58486
Harrison	39%	-1.64464	49%	-0.81053	48200	-0.49559
Henry	58%	2.8707	66%	0.86891	57700	0.35254

Highland	41%	-1.16934	45%	-1.20569	43800	-0.8884
Hocking	46%	0.0189	57%	-0.02021	48400	-0.47773
Holmes	46%	0.0189	19%	-3.77425	61600	0.70072
Huron	48%	0.4942	50%	-0.71174	48200	-0.49559
Jackson	42%	-0.93169	54%	-0.31658	44700	-0.80805
Jefferson	42%	-0.93169	61%	0.37496	43500	-0.91519
Knox	43%	-0.69404	58%	0.07858	52100	-0.14741
Lake	49%	0.73185	68%	1.06649	60500	0.60251
Lawrence	46%	0.0189	54%	-0.31658	43100	-0.9509
Licking	51%	1.20715	65%	0.77012	62700	0.79892
Logan	46%	0.0189	48%	-0.90932	54800	0.09364
Lorain	49%	0.73185	65%	0.77012	55400	0.1472
Lucas	47%	0.25655	65%	0.77012	47600	-0.54915
Madison	47%	0.25655	49%	-0.81053	69900	1.44171
Mahoning	44%	-0.45639	62%	0.47375	43900	-0.87947
Marion	46%	0.0189	50%	-0.71174	46500	-0.64736
Medina	51%	1.20715	72%	1.46165	72900	1.70954
Meigs	49%	0.73185	50%	-0.71174	42200	-1.03124
Mercer	47%	0.25655	61%	0.37496	60100	0.5668
Miami	46%	0.0189	62%	0.47375	60800	0.6293
Monroe	39%	-1.64464	55%	-0.21779	44900	-0.7902
Montgomery	47%	0.25655	69%	1.16528	48000	-0.51344
Morgan	38%	-1.88229	48%	-0.90932	41400	-1.10267
Morrow	31%	-3.54584	53%	-0.41537	55500	0.15613
Muskingum	42%	-0.93169	56%	-0.119	44900	-0.7902
Noble	46%	0.0189	40%	-1.69965	44800	-0.79913
Ottawa	46%	0.0189	68%	1.06649	56000	0.20077
Paulding	47%	0.25655	46%	-1.1069	52500	-0.1117
Perry	43%	-0.69404	48%	-0.90932	51700	-0.18312
Pickaway	46%	0.0189	50%	-0.71174	62400	0.77214
Pike	42%	-0.93169	47%	-1.00811	43500	-0.91519
Portage	47%	0.25655	67%	0.9677	59500	0.51324
Preble	42%	-0.93169	57%	-0.02021	52300	-0.12955
Putnam	52%	1.4448	69%	1.16528	62900	0.81678
Richland	41%	-1.16934	54%	-0.31658	47100	-0.59379
Ross	43%	-0.69404	52%	-0.51416	50400	-0.29918
Sandusky	47%	0.25655	59%	0.17737	53100	-0.05813
Scioto	43%	-0.69404	48%	-0.90932	41800	-1.06696
Seneca	48%	0.4942	57%	-0.02021	47800	-0.5313
Shelby	48%	0.4942	58%	0.07858	60100	0.5668
Stark	48%	0.4942	64%	0.67133	51200	-0.22776
Summit	49%	0.73185	68%	1.06649	55500	0.15613
Trumbull	45%	-0.21875	50%	-0.71174	46300	-0.66521
Tuscarawas	40%	-1.40699	50%	-0.71174	51400	-0.2099

Union	50%	0.9695	66%	0.86891	86600	2.93263
Van Wert	50%	0.9695	57%	-0.02021	49100	-0.41524
Vinton	44%	-0.45639	41%	-1.60086	40900	-1.1473
Warren	51%	1.20715	75%	1.75802	85500	2.83443
Washington	50%	0.9695	59%	0.17737	46400	-0.65628
Wayne	47%	0.25655	51%	-0.61295	56200	0.21863
Williams	48%	0.4942	55%	-0.21779	50300	-0.30811
Wood	49%	0.73185	74%	1.65923	61800	0.71857
Wyandot	50%	0.9695	55%	-0.21779	47500	-0.55808