

# Mapping Civic Inequality in Texas: Gardens and Deserts of Democratic Engagement

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## Introduction

Throughout the past century, rights related to civic participation in the United States have generally expanded; the actual practice of democratic engagement remains uneven. Some communities sustain strong voter turnout. Others do not. Some have more stable educational systems, and more favorable health conditions, while others do not. These differences accumulate, shaping civic life. In this report, we have developed a framework to discuss communities with robust participation and supportive institutions as *civic gardens*, and to those with weak engagement and limited opportunity as *civic deserts*.

This project builds on the *civic desert* framework introduced by Tufts University's CIRCLE, which describes places with few opportunities for political or civic involvement and limited institutional support for engagement. We extend that idea by arguing that civic inequality cannot be understood through political participation alone. Instead, civic life operates as an interconnected ecosystem. Education, health, and participation reinforce one another. Weakness in any one element can undermine the whole system.

The Civic Triangle: Education, Health, and Voter Turnout

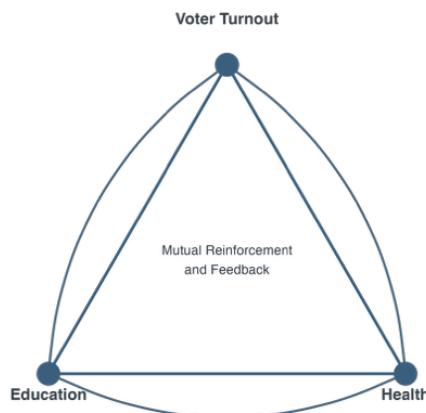


Figure 1

Our claim is that these three domains form what we call a *Civic Triangle* (Figure 1). Education shapes political knowledge, civic skills, and lifelong engagement. Health influences an individual's ability or desire, since poor physical or mental health limits civic activity. Political

participation, in turn, directly affects the allocation of resources toward schools, health systems, and other public goods. These relationships form feedback loops, creating conditions for communities to either sustain civic vitality or fall into patterns of persistent disadvantage.

Despite research linking each pair of these factors, it is unclear if there are any studies examining them as a single, interactive system. In Texas, where demographic diversity and geographic disparities are exaggerated, the interaction of these variables offers a valuable case for understanding how civic inequality develops and persists. County-level variation should provide insight into the interaction of these factors.

To analyze these patterns, we introduce the Civic Garden Index (CGI), a composite measure that integrates normalized indicators of voter turnout, education, and health. The index provides a single metric to classify counties as civic gardens to civic deserts. This approach allowed us to capture the structure in a way that any single variable cannot. Relying on data visualization including choropleth maps, regression plots and other tools, we have revealed the patterns in the interaction of these three important factors.

By treating education, health, and civic participation as a linked system, this project aims to clarify how civic gardens grow, why civic deserts persist, and what levers would be most effective in improving participation.

## The Civic Triangle

This table (*Table 1*) captures the core ideas: each domain influences the others. Education shapes political participation and long-term health. Health affects a person's ability to learn and to take part in civic life. Participation feeds back into the policy environment, shaping the resources available for both schools and public health. When these relationships reinforce one another in positive ways, communities sustain what we call *civic gardens*. When they reinforce one another in negative ways, they form *civic deserts*.

In this framework, no single dimension stands alone. A county with strong schools but weak health outcomes may struggle to translate educational advantages into civic engagement. A place with high turnout but poor educational or health conditions may not sustain civic participation over time. The triangle works as a system, not a set of isolated factors.

This integrated view guides the construction of the Civic Garden Index. By measuring education, health, and turnout together, we could observe whether counties exhibited balance across the triangle or showed strains along one or more of its sides. The framework helped interpret the visualizations that follow, especially when we identified counties that performed well in one dimension but lagged in others. In that sense, the Civic Triangle provided the conceptual structure for both the index and the empirical analysis that underpinned the rest of this report.

	Expected Relationship
<b>Education → Voting</b>	Education increases political involvement, civic knowledge, and voter participation.
<b>Health → Voting</b>	Healthier individuals are more likely to vote and engage. Poor health reduces civic participation.
<b>Education → Health</b>	Education predicts life expectancy, preventive care use, and health literacy.
<b>Voting → Health Policy</b>	Communities with higher turnout have more influence on health and education policy outcomes.
<b>Health → Education</b>	Healthy people perform better academically; adult wellness supports lifelong learning.
<b>Voting → Education</b>	Participatory democracies sustain educational investment; educated voters support public health policy.

Table 1

## Data and Methodology

This project drew on county-level data from three primary sources: the American Community Survey (Schroeder et al. 2025), the CDC PLACES health indicators (Centers for Disease Control and Prevention [CDC] 2022), and administrative election records from the Texas Secretary of State (Texas Secretary of State 2024). Together, these datasets provided measures of education, health, and voter participation for all 254 counties in Texas.

### American Community Survey (ACS)

Educational attainment data come from the ACS 5-year estimates, specifically Table B15003, which reported detailed categories for education among adults aged 25 and older. The table included 25 distinct levels of schooling, ranging from no formal education to doctoral degrees. These categories served as the basis for the Education Index.

### CDC PLACES Health Indicators

County health conditions were measured using the CDC PLACES dataset, which provided estimates for key indicators of physical, mental, and general health. We used the 2022 GIS-Friendly health dataset since it involves measurements taken in 2020. We selected eight variables

of the most salient variables for the analysis, which are outlined and described in *Appendix A*. Overall, these variables were self-reported, and subject to all the normal biases.

### Election Data

Voter participation was measured using official county-level results from the Texas Secretary of State. Two figures were used: the number of registered voters and the total ballots cast in the 2020 general election. These values were used to calculate turnout as the share of registered voters who cast a ballot. Turnout serves as the primary behavioral indicator of civic participation.

The counties with the highest turnouts were King County (86.9%), Borden County (83.3%), Glasscock County (81.6%), Roberts County (80.9%), and Blanco County (79.6%).

Blanco County has the highest turnout out of counties with 1000+ registered voters. Kendall County has the highest turnout rate when considering only counties with 10000+ registered voters (78.1%), and Williamson County has the highest turnout rate when only examining counties with 100000+ registered voters (76.9%).

The counties with the lowest turnouts were Willacy County (43.3%), Brooks County (45.0%), Presidio County (46.3%), Maverick County (46.4%), and Zapata County (46.9%). Webb County has the lowest turnout rate out of counties with 100000+ registered voters (49.6%).

### Data Harmonization and Cleaning

The data used in this project came from separate sources with different structures, naming conventions, and measurement scales. This section summarizes the steps in that process.

**County Name Alignment:** County identifiers appear in different formats across the ACS, CDC PLACES, and Texas election data, which required standard practices to ensure data alignment. This produced a uniform county identifier used throughout the analysis. Since we are only working in Texas and counties are uniquely named, county names were used as the key identifiers.

**Geospatial Standardization:** Texas county geometries were imported from the TIGER/Line. All boundaries were projected into a consistent coordinate system and

checked for geometric validity. A simplified layer was generated for visualization, while full-detail geometries were retained for spatial analysis.

**Missing Values:** Some counties lack complete estimates in the CDC PLACES dataset, largely due to small sample sizes. Rather than discard these counties, missing values were excluded. For each index, only the available elements were averaged, with the denominator adjusted accordingly.

**Normalization:** To place education and health measures on a common scale, each index was normalized to the unit interval. This allows direct comparison across counties and simplifies the construction of composite measures.

**Education:** The Education Index was constructed from a population-weighted years-of-schooling variable. This value was then normalized as indicated above.

**Health:** The Health Index is the mean of these eight variables indicated in Appendix A, which were then normalized. The Health Index was often inverted to have better outcomes be larger so that it paralleled the Education Index and Voter Turnout.

**Turnout:** Turnout is computed from the Secretary of State's data as the total ballots divided by the number of registered voters.

**Civic Vitality Index:** This is a composite of the average of the normalized indexes from turnout, health and education.

## Analytic Approach

The analysis had three stages. First, the county-level data was cleaned and harmonized to ensure that education, health, and turnout measures operate on comparable scales as noted above. This step also prepared each dataset for integration with Texas county geometries. Next, the results were visualized through a set of maps and graphics that revealed both expected and surprising patterns in civic vitality. Finally, each theoretical relationship within the Civic Triangle was evaluated via a combination of visual analysis, correlation analysis, partial regression, and spatial diagnostics.

We began by standardizing the components that form the Civic Vitality Index. A simple mean of the three components. This index served as a compact summary of civic conditions across Texas. With these analyses completed, we examined how each component related to the others.

Various plots such as scatterplots with fitted lines, choropleth maps, and partial regression plots tested the interactions between the three points of the triangle. A correlation matrix, ridge plots, slopegraphs, and other plots further analyzed the patterns. Together, these procedures provided a structured assessment of how civic conditions varied across Texas.

Table: An overview of counties with the highest and lowest percentages in each health variable component. Our explorer further details these variables with choropleth maps. Counties with the highest and lowest percentages in each value. As there would often be several counties with similar percentages, the second and third-most high/low counties were also listed.

## Results & Visualizations

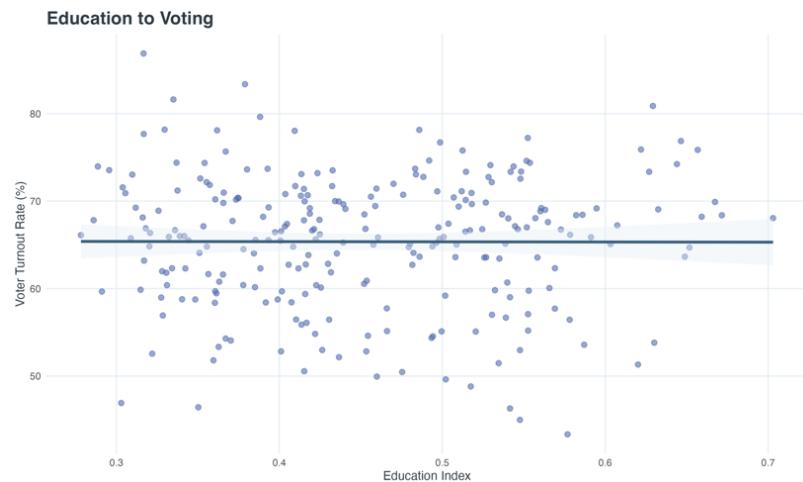
For an interactive presentation of this data, use our explorer at:

<https://john-glendenning.shinyapps.io/FinalReportGraphics/>

### Education Surprise

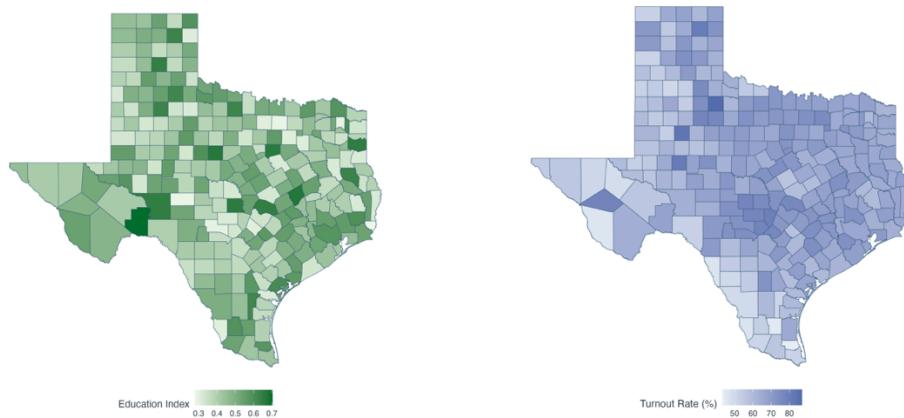
In our visual analysis, the first thing that we noticed was the relationship between education and voter turnout. Often, research identifies education as one of the strongest predictors of political participation, which meant we expected a clear positive relationship between education and voter turnout.

The data revealed otherwise. The correlation between our education index and voter turnout was nearly zero, indicating no linear relationship. The scatter plot (*Figure 2*) had a flat regression line with points widely dispersed across the entire range of education values.



*Figure 2*

Figure 3



The spatial distributions supported this disconnect (Figure 3). The education map had higher values concentrated in major metropolitan areas and their suburbs with lower values in rural areas throughout the state. The turnout map, by contrast, displayed a distinctly different geographic pattern. If education strongly predicted turnout, these maps would appear similar. Instead, the spatial patterns are disjointed and the expected correspondence between education and turnout did not appear.

## Health is Key

Contrasting education, the health index showed the expected strong relationship with voter turnout. The correlation between the health index and turnout is significant (Figure 4), indicating that healthier counties consistently demonstrated higher voter participation.

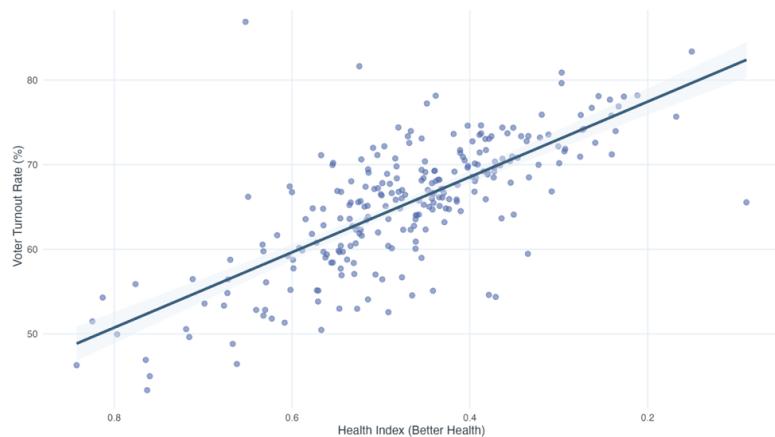
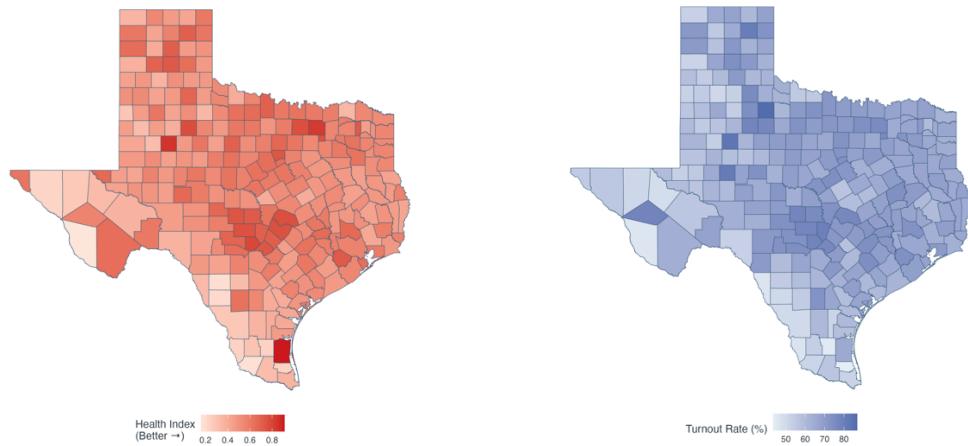


Figure 4

Figure 5



The scatter plot had a clear positive relationship. Counties with better health outcomes clustered in the upper-right quadrant with turnout rates reaching 75-80%, while counties with poorer health outcomes concentrated in the lower-left with turnout rates around 50-60%. The spatial distributions on the choropleth maps (Figure 5) confirmed this relationship so that health outcomes aligned with voter turnout.

## Interrelationships

The correlation matrix (Figure 6) reinforced the turnout-education-health interrelationships. Turnout has strong correlations with health, but no correlation with education. The near-zero education-turnout correlation meant that education contributed little to explaining civic vitality beyond what health already captured.

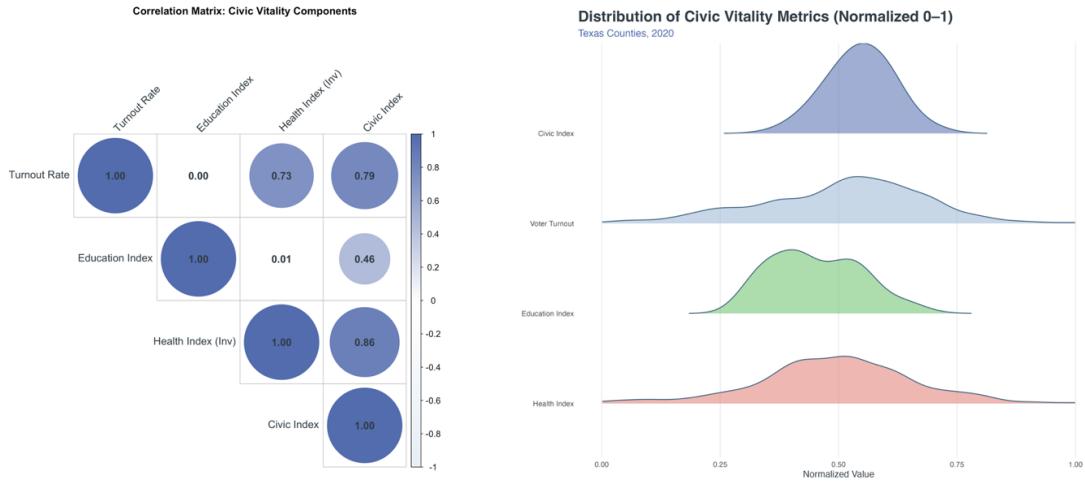
The distribution plots (Figure 6) showed differences in the variation of each index. Health displayed a relatively uniform distribution with substantial variation. Education showed a bimodal distribution, with most counties clustering somewhere near the middle. The distribution of voter turnout was unimodal with a low kurtosis that was clustered in the mid-to-high turnout range. The civic index appeared approximately normal, centered just above the middle. Nothing was extremely unusual.

## Geographic Patterns

The map of the civic vitality index map revealed geographic patterns across Texas (Figure 7). Counties were shaded on a diverging color scale, with blue indicating *civic gardens* and red

indicating *civic deserts*. These appeared to regionally cluster. Northeastern Texas showed a concentration of high-performing counties, which extended from the Oklahoma border southward. Major metropolitan areas and their surrounding counties, particularly around Dallas-Fort Worth, Houston, and Austin, showed higher civic vitality, and the Panhandle displayed scattered pockets of strong civic engagement.

Figure 6



Civic deserts were also clear. South Texas and West Texas, including much of the Rio Grande Valley, showed a low civic vitality. Central Texas showed more variation. The areas between civic gardens and deserts seemed to be associated with the transition boundaries from urban to rural areas but this pattern is not definitive. The highest value was Williamson county at 0.727, and the lowest value was Zapata county at 0.336.

## Quadrant Analysis

To better understand the grouping and trends in the data we selectively plotted voter turnout versus the civic index, and voter turnout versus education, using median values as the demarcation points. The civic index versus turnout plot (*Figure 8*) shows a strong linear relationship between the two. This is partly due to autocorrelation since the index includes voter turnout, but the effects of health on turnout are also a significant component.

The education-turnout quadrant analysis (*Figure 9*) is much different. Counties are scattered across all four quadrants with no clear pattern. Notable are the counties in the high-low, and low-high quadrants with outliers indicated in red. There are a significant number of counties that

deviate from the expected pattern. Counties like King, and Glasscock should be further examined since their voter rolls are very small and may not be representative.

Figure 7

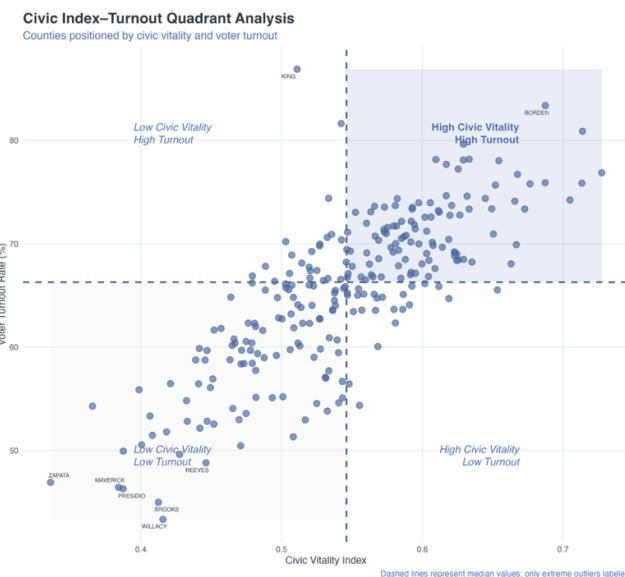
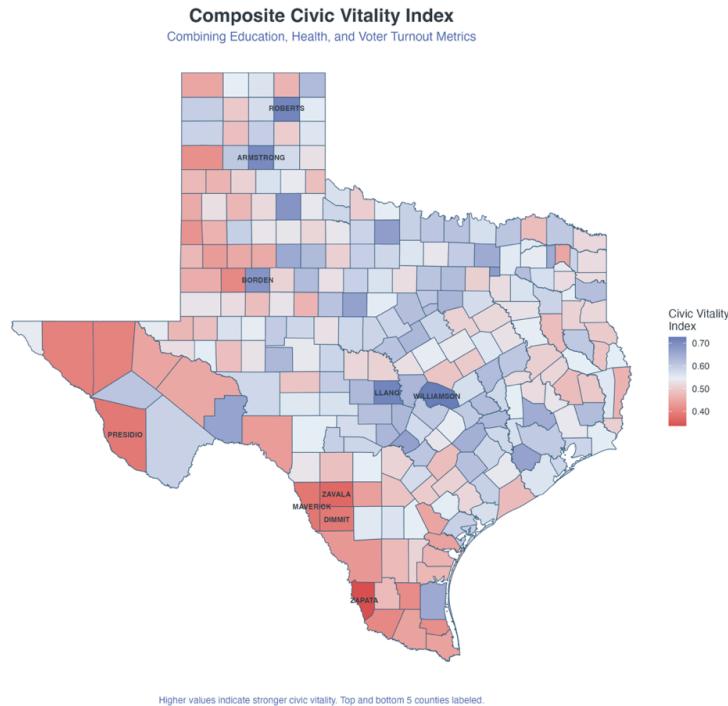


Figure 8

### Counties That Break the Education Hypothesis

Education should → higher turnout. These counties violate that expectation.

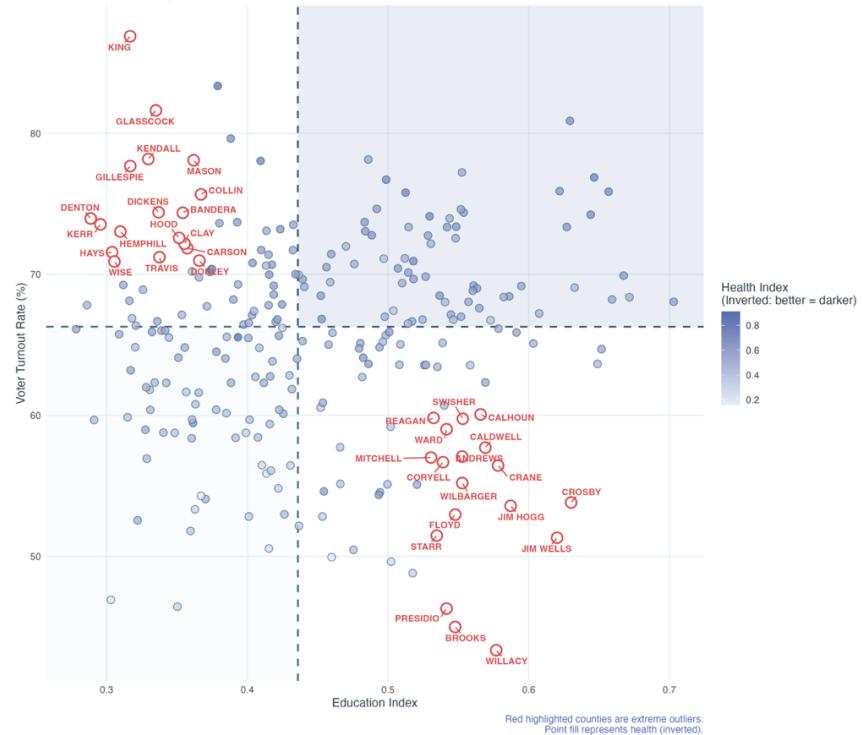


Figure 9

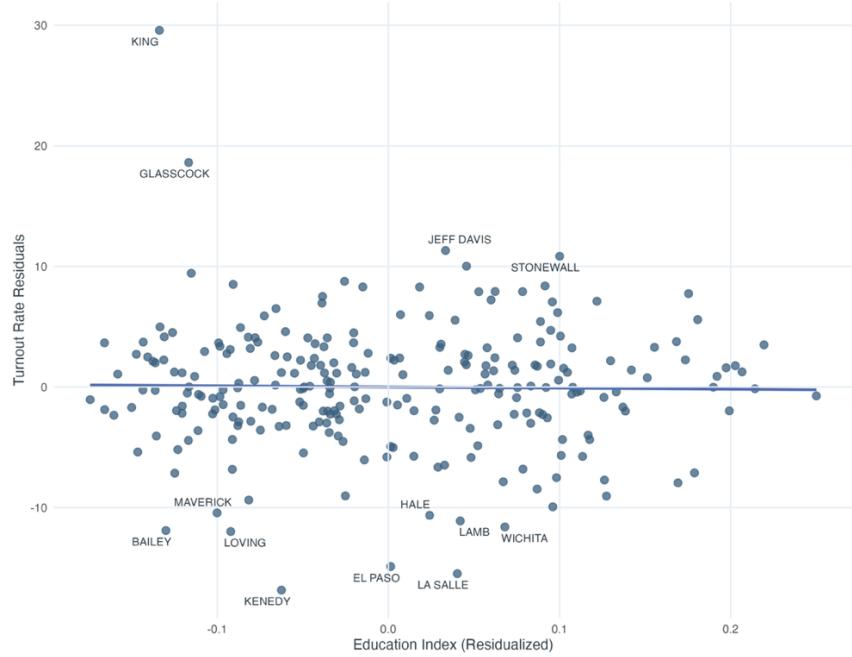


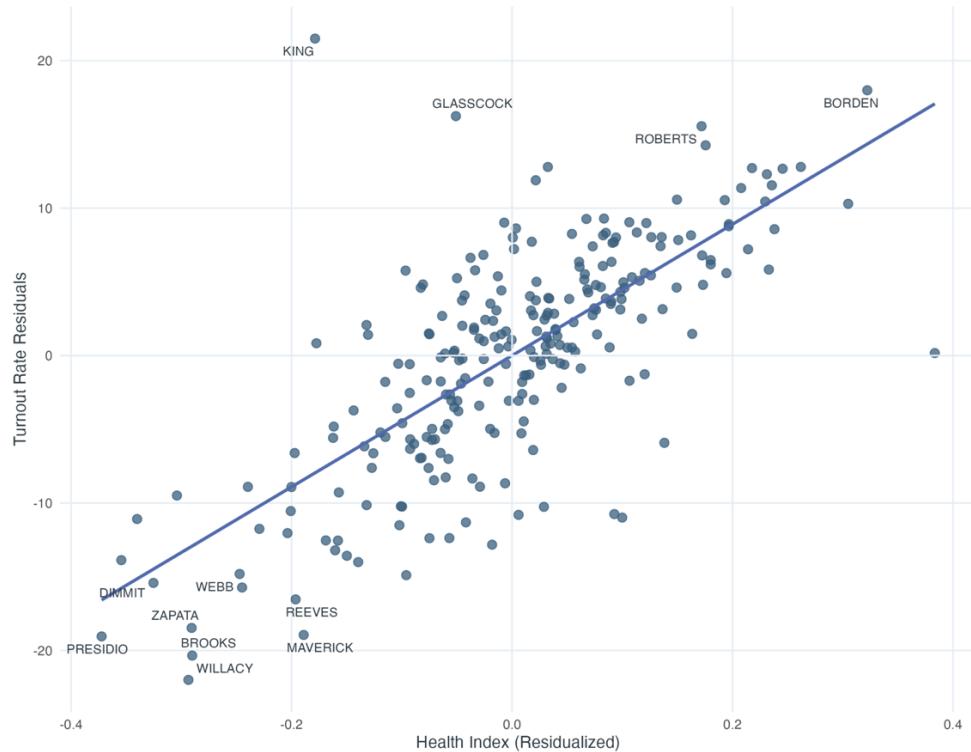
Figure 10

## Partial Regression

To understand whether education and health have independent effects on turnout, we produced a partial regression analysis, which residualized each predictor against the other, revealing any remaining relationship after accounting for their shared variance.

The relationship between education and turnout after removing the portion of each variable that can be explained by health is shown in *Figure 10*. The regression line is nearly flat, with a slight negative slope, and the scatter of points shows no discernible pattern, except for a few significant outliers. This confirmed education added essentially no explanatory power once health is controlled.

Performing the opposite analysis (*Figure 11*) showed a positive relationship between health and turnout. Counties with better health, after controlling for education, consistently showed higher turnout. The labeled counties represented outliers, but the overall pattern holds. Even after removing any shared variance with education, health maintained its strong predictive relationship with turnout, confirming that health is the primary driver.

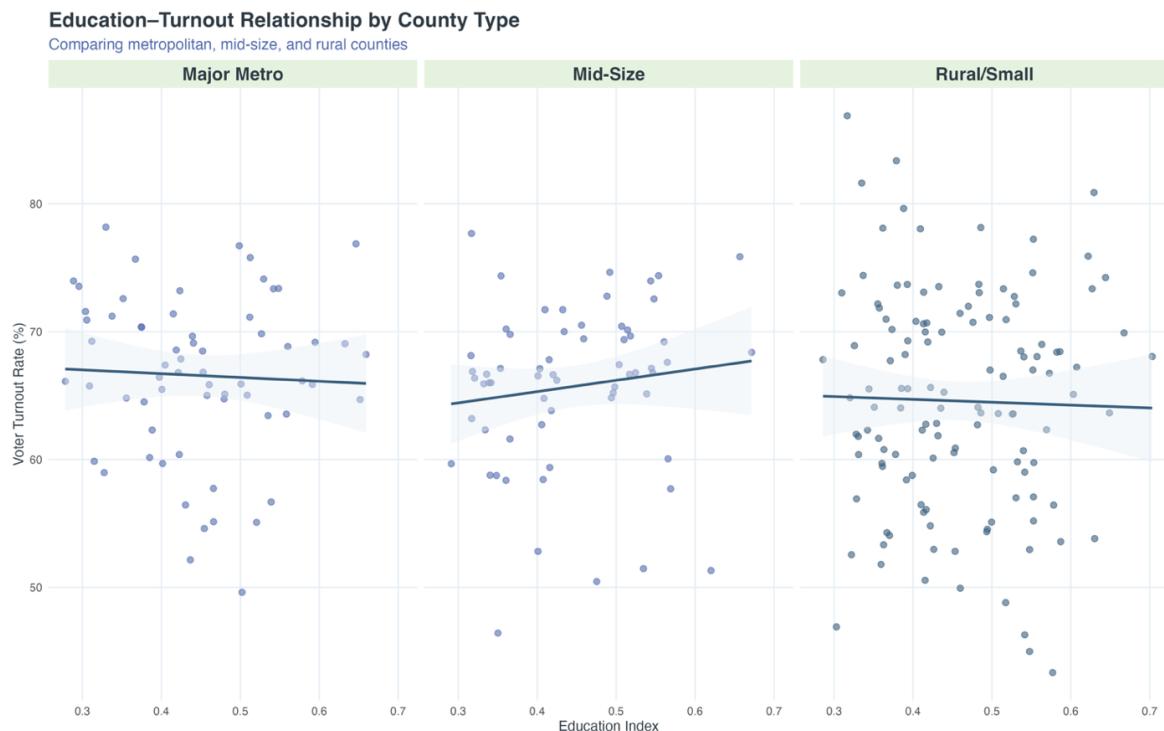


*Figure 11*

## County Size

To examine if there were any differences in the relationships that varied by county size, we grouped the counties into three categories: major metropolitan counties, mid-size counties, and rural/smaller counties.

The plot of turnout versus education for county sizes (*Figure 12*) showed a slightly negative slope for both metropolitan and rural counties, but a slightly positive slope for the mid-sized counties. This is an interesting outcome and warrants further examination, since it is directly counter-intuitive. This also indicates that different county types appear to negate the effect of the others in the analysis.

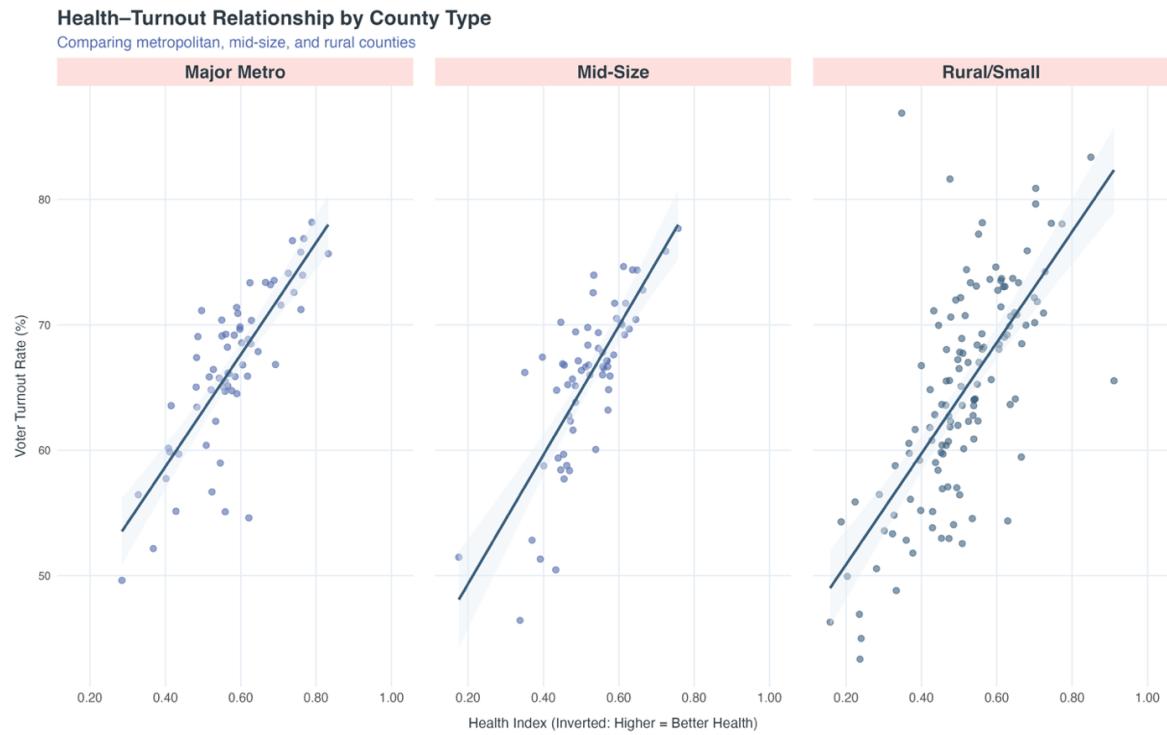


*Figure 12*

Variable	Highest	Lowest
Poor Physical Health	Presidio County (21.3%)	Collin County (7.9%)
Poor Mental Health	Gaines County (17.4%)	Kenedy County (9.5%)
Poor General Health	Presidio County (40.3%)	Collin County (11.1%)
No Health Insurance	Starr County (53.4%)	Collin County (18.3%)
Regular Checkups	Reeves County (34.1%)	Llano County (22.6%)
Poor Sleep	Jefferson County (39.6%)	Kenedy County (27%)
Low Physical Activity	Presidio County (47.2%)	Kenedy County (18.6%)
Obese	Zavala County (45.4%)	Collin County (28.6%)

*Table 2*

The health-turnout analysis (*Figure 13*) was uniformly consistent with previous analysis. There were clear positive relationships with steep regression lines and relatively tight clustering of points around the fitted line. The usual suspects were outliers in the rural plot. Again, health was a strong predictor of voter turnout. *Table 2* gives an overview of the counties with the highest and lowest percentages of each variable. It is interesting to note the number of repeated counties in each list.



*Figure 13*

## Regression Residuals

To understand where our predictors succeeded and failed, we mapped the regression residuals (*Figure 14*) in quintiles. This residual map showed which counties perform better or worse than their health and education characteristics would predict and revealed some unexplained geographic patterns.

This map indicated where some unknowns have created meaningful deviations from our predictions based solely on health and education. Texas border counties systematically underperformed. This does not appear to be scattered random, but more of a regional pattern. Areas of the Panhandle, and central and east Texas overperformed. Metropolitan areas generally met expectations.

Turnout vs Expected (Quintiles of Model Residuals)

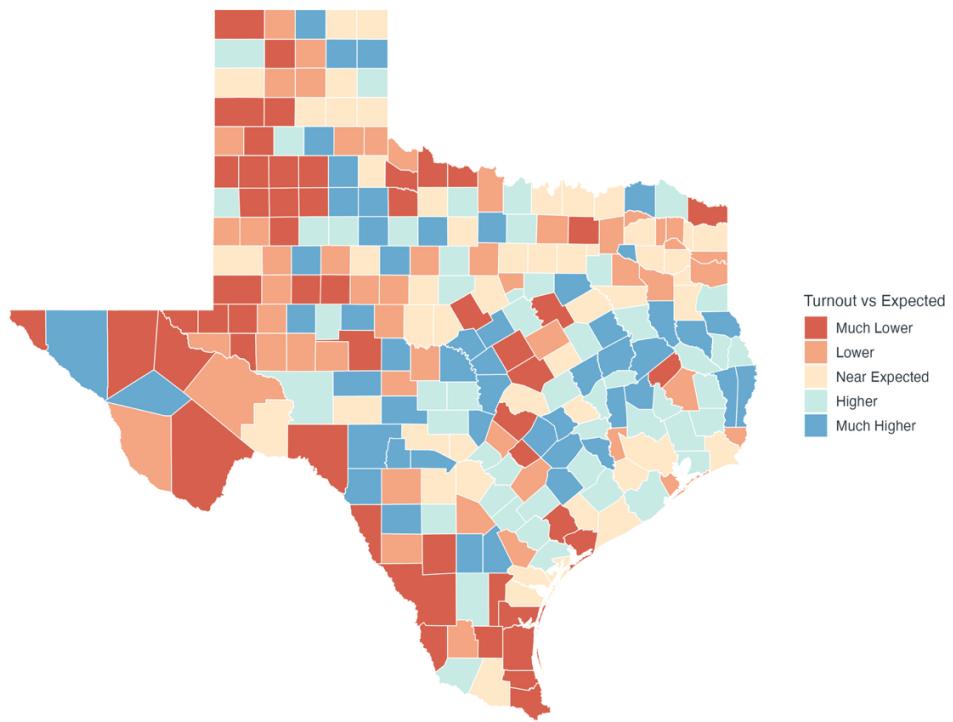


Figure 14

Regression Diagnostics: Health → Turnout Model

Adjusted  $R^2 = 0.531$  | Education excluded due to null relationship

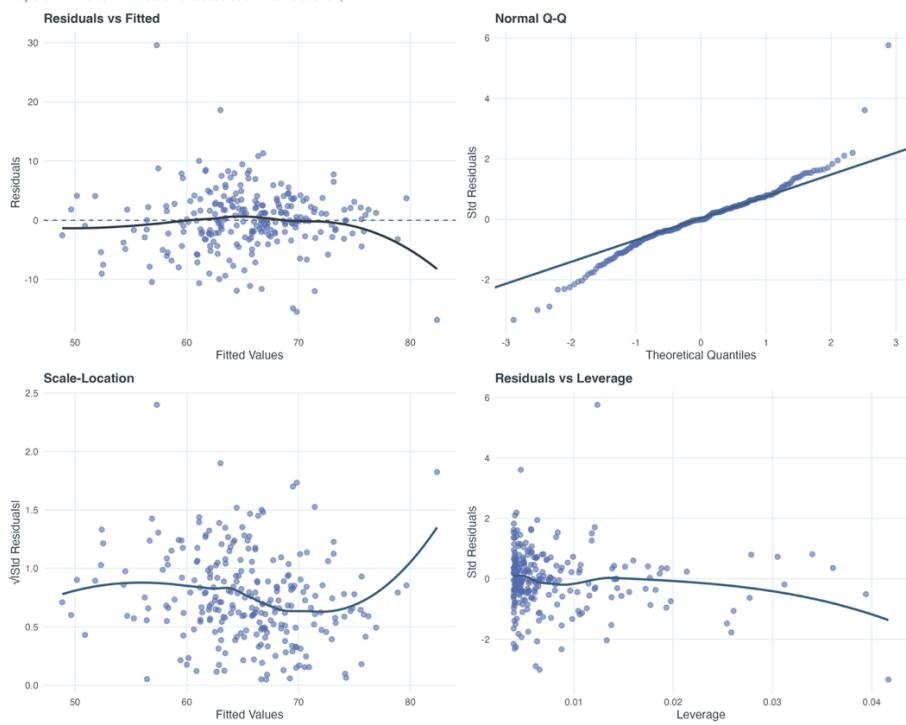


Figure 15

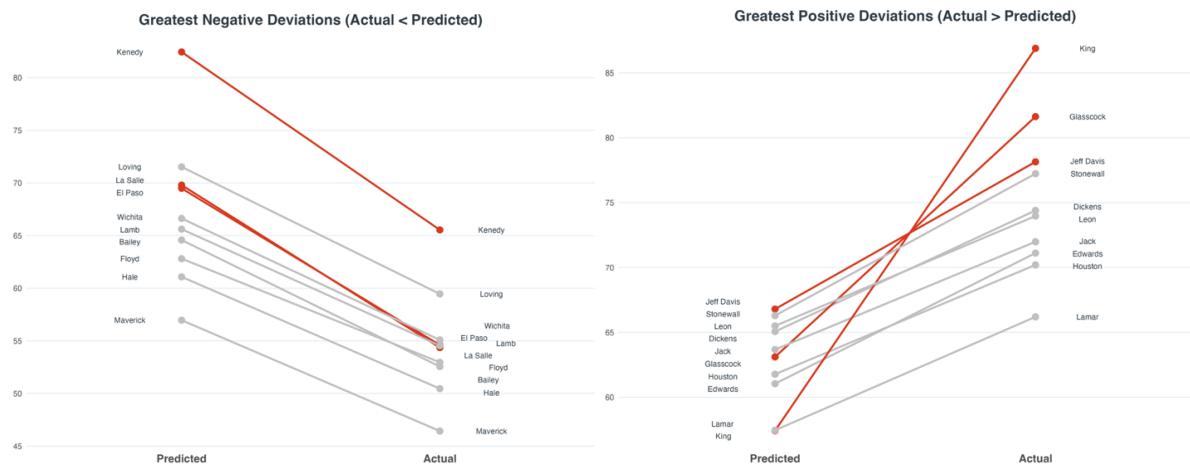
## Model Diagnostics

To understand if these results are valid, standard diagnostic plots were produced (*Figure 15*). In the plot of the residuals versus fitted, the residuals scattered around a horizontal line at zero with no clear pattern, indicating the linear model was appropriate. The Q-Q plot generally followed the reference line, deviating at the tails, but not enough to raise concerns. The plot of the square root of standardized residuals against fitted indicated variance at the extremes, but the pattern is not extreme and does not compromise the model. The standardized residuals plotted against leverage do not indicate that there were any points falling outside the Cook's distance contours which suggested that no individual county exerts undue influence on the regression estimates. Generally, the diagnostics showed that the model met the regression assumptions adequately.

## Model Deviations

To identify which specific counties deviated the most dramatically from predictions, we examined the largest positive and negative residuals. In *Figure 16*, the top 10 greatest negative deviations are shown. Kenedy, El Paso, and La Salle counties were significantly over predicted. Conversely *Figure 16* indicates that King, Glasscock, and Jeff Davis counties were under predicted. These are also some of the significant outliers throughout our analyses.

*Figure 16*



Since many of the greatest positive deviations were with the tiniest counties, the top 10 metropolitan counties were plotted in *Figure 17*. While seven of the ten were accurately predicted, three were not. El Paso County was extremely overpredicted, indicating that there

were significant factors that were not captured in the index. The other two, Travis and Collin Counties are in the Dallas-Fort Worth area, which raises additional questions about that area.

Figure 17



Figure 17 shows all the counties, grouped by color into top, middle, and bottom in the Civic Vitality Index. There are two things to note in this visualization. The first is that the deviations in education were obvious, and the second is that the other three indices were consistent and thus are a good visual summary of all the previous findings and analyses.

## Discussion

The absence of a county-level education-turnout relationship raises some questions about civic engagement research. It is likely that education is distinctly individual. Information processing, political knowledge, civic skills, etc. may not aggregate to county-level participation. A county with many educated residents is not equivalent to an educated county. Education's correlation with health infrastructure suggests that it matters for civic life primarily through the community resources that educated populations support, but not through individual enlightenment.

The strong health-turnout relationship may reflect community infrastructure more than individual wellness. Our health index which combines insurance coverage, preventive care access, and health behaviors can be interpreted as proxies for overall community resources. Counties with accessible healthcare can also have better transportation, more civic organizations, and stronger mobilization networks. King and Glasscock counties, with poor health but high turnout, support this interpretation: where local political culture and mobilization are strong, individual health

limitations matter less. Health outcomes serve as an indicator of collective resources that enable democratic participation.

These findings demonstrate how individual-level and aggregate-level relationships can diverge. Variables predicting individual behavior through personal attributes may not predict grouped outcomes, while variables reflecting collective resources show stronger relationships even when mechanisms are less direct. Civic participation may be less about individual decisions collective ability through community infrastructure.

This was a very limited analysis of voting behaviors, and we used only the 2020 election. Since this was during the pandemic, there are some fundamental questions about the ability to generalize. Normal election years, if such a thing exists, may differ. In addition, our county-level analysis masks within-county variation that may reveal different patterns. This is especially true in larger, urban counties. The regional residuals (South Texas underperforming, Panhandle overperforming) indicate structural variables which may miss important cultural and historical factors that have created conditions that have not been addressed in the analysis. Our health measures emphasize access and utilization over underlying health status, possibly conflating infrastructure with outcomes.

The civic triangle framework assumes mutually reinforcing relationships among education, health, and participation. At the county level, this triangle seemingly collapses. Health infrastructure predicts turnout while education adds minimal explanatory power after controlling for health. This requires reconceptualizing civic participation not as an individual choice but as a collective endeavor. Where communities have infrastructure such as healthcare, transportation, information networks, participation seems to follow. Where infrastructure is weak, even individually advantaged residents may not participate at high rates. Democratic engagement could be more a community-level phenomenon shaped by local resources.

## Conclusion

When examining Texas counties with the Civic Triangle in mind, the relationship between health and voter turnout is strong, but the relationships between education and turnout, and between health and education are not. Many counties break the education hypothesis, with numerous examples of high turnout and low education, or high education and low turnout.

Meanwhile, good health consistently predicts higher turnout. Only King and Glasscock counties stand out as exceptions with poor health and high turnout. As noted earlier, King County has the highest turnout rate of registered voters of any Texas county but only has less than 200 registered voters, and Glasscock has the third-highest turnout, but about 800 registered voters. While health is a strong predictor of voter turnout, these examples show that other variables, need to be considered as well.

When examining Texas counties for civic 'gardens' and 'deserts', the highest civic vitality values appear in northeastern Texas, particularly around major metropolitan areas. The lowest values cluster in southwestern Texas, including South Texas, West Texas, and the Rio Grande Valley. The regression residuals reveal that South Texas systematically underperforms relative to predictions while the Panhandle overperforms, suggesting local or unaccounted for factors.

For future studies, we recommend examining how additional health variables, particularly healthcare infrastructure, access to facilities, and mental health services, relate to voter turnout. Our variables focused largely on self-evaluation of health and healthy behaviors; other health system measures should be studied. Additionally, examining turnout in comparison to these factors in other election years aside from 2020 could improve understanding of these relationships and distinguish 2020-specific patterns from more structural relationships.

Our policy recommendations for improving voter turnout are to invest in community health infrastructure as a pathway to democratic participation and to target health disparities in underperforming regions, particularly South and West Texas. School-based education interventions are unlikely to boost turnout, as education's effect appears to operate primarily through its correlation with health infrastructure.

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## AI Disclosure

Portions of this work, including code development, analytical procedures, and report structure, were generated with the assistance of AI language models. Any AI-generated content was reviewed, verified, and edited by the authors to ensure accuracy and appropriateness.

## Appendix A – List of Variables

### From ACS

Table 9: Educational Attainment for the Population 25 Years and Over

Universe: Population 25 years and over

Source code: B15003

NHGIS code: AMRZ

AMRZM001: Total

AMRZM002: No schooling completed

AMRZM003: Nursery school

AMRZM004: Kindergarten

AMRZM005: 1st grade

AMRZM006: 2nd grade

AMRZM007: 3rd grade

AMRZM008: 4th grade

AMRZM009: 5th grade

AMRZM010: 6th grade

AMRZM011: 7th grade

AMRZM012: 8th grade

AMRZM013: 9th grade

AMRZM014: 10th grade

AMRZM015: 11th grade

AMRZM016: 12th grade, no diploma

AMRZM017: Regular high school diploma

AMRZM018: GED or alternative credential

AMRZM019: Some college, less than 1 year

AMRZM020: Some college, 1 or more years, no degree

AMRZM021: Associate's degree

AMRZM022: Bachelor's degree

AMRZM023: Master's degree

AMRZM024: Professional school degree

AMRZM025: Doctorate degree

### From CDC Places:

GHLTH\_CrudePrev

General Health

Percentage of adults reporting fair or poor general health.

MHLTH\_CrudePrev

Poor Mental Health

Percentage of adults reporting 14 or more days of poor mental health in the past 30 days.

ACCESS2\_CrudePrev

**Lack of Health Insurance**

Percentage of adults aged 18–64 without health insurance coverage.

**PHLTH\_CrudePrev**

**Poor Physical Health**

Percentage of adults reporting 14 or more days of poor physical health in the past 30 days.

**OBESITY\_CrudePrev**

**Obesity**

Percentage of adults aged 18 years and older who have a body mass index (BMI) of 30.0 or higher.

**CHECKUP\_CrudePrev**

**Annual Checkup**

Percentage of adults aged 18 years and older who report having had a routine checkup in the past year.

**SLEEP\_CrudePrev**

**Insufficient Sleep**

Percentage of adults who report sleeping fewer than 7 hours on average in a 24-hour period.

**LPA\_CrudePrev**

**Physical Inactivity**

Percentage of adults who report no leisure-time physical activity.

**From Texas Secretary of State**

Total Votes Cast by county 2024

Registered Voters by county 2024