Innovating Care for Underserved Populations: AI-Driven Insights with the Community Vulnerability Compass (CVC)



Topics of Dis

About PCCI

PCCI Overview

CVC

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NMDoH Insights at Scale: The Community Vulnerability Compass overview and applications

AI Applications

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Leadership in AI and NMDoH to improve efficiency, access, outcomes, and cost

Opportunities

Opportunities for Collaboration and next steps





About PCCI

Pioneering New Ways to Health

PCCI is a non-profit innovation and research institute for Advanced Data Science and NMDoH Innovation. PCCI aspires to be a leader in Innovation and build scalable solutions focusing on responsible applications of AI-in-Medical Care for Underserved Populations.

PCCI Improves Community Health Through AI and NMDOH Analytics

PCCI is one of only a few organizations with over a decade of experience researching, testing, and using AI, non-medical drivers of health (NMDoH) and connected communities of care exclusively to improve the health and well-being of underserved populations. From the creation of responsible AI-in-Medicine for Underserved Populations (AIM-UP), to designing and deploying at scale of NMDoH technology such as IRIS[™], one of the first U.S. case management and closed-loop referral platforms with an awarded patent, to building and implementing the Community Vulnerability Compass for measuring social vulnerability at scale, PCCI continues to pioneer AI innovations and NMDoH analytics and advancing personalized health for the most marginalized community members.

To fuel broader innovation and share the unique experience of advancing these innovations for underserved populations, we regularly collaborate with diverse organizations through national AI collaboratives (Health AI Partnership, National Academy of Medicine AI Adoption and Code of Conduct Committee), grant activities (CMS AHC, Kaiser AIM-HI), and presentations and publications (Connected Community of Care Playbook, Pediatric Asthma Surveillance System).



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Al for Clinical Decision Support

Powered by PCCI's AIM-UP, our clinical decision support AI/ML predictive models are designed to empower healthcare teams by providing augmented intelligence and insights to generate early-warnings for clinical deterioration and enhance their point-of-care decision-making and intervene earlier and with more precision. (e.g., trauma, sepsis, or acute interventions).

Al for Population Health

Our population health AI/ML predictive models help health systems and their community partners identify rising risk for clinical deterioration and access barriers to enable earlier and more targeted interventions. The goal is to move care and prevention upstream and proactively engage individuals in hyper-personalized ways to improve their health and avoid emergency room visits and hospitalizations. (e.g., maternal health, pediatric asthma).

Al for Operational and Process Optimization

Utilizing advanced predictive analytics, our models optimize healthcare operations by forecasting resource needs, streamlining eligibility determinations, and enhancing capacity management. These tools empower teams to address demands like financial assistance eligibility and bed availability with precision and efficiency.(e.g., financial assistance eligibility, bed availability).

Al for Care Continuity and Engagement

Designed to enhance care continuity, our solution ensures proactive follow-up and prevents care gaps for patients in surveillance programs. By identifying risks like loss to follow-up or missed imaging appointments, it empowers healthcare teams to intervene early and maintain seamless patient management. (e.g., lost to care, missed appointments for imaging surveillance).

NMDoH Analytics and Resource Planning

Leveraging geographically detailed, population-level SDOH insights, our platform empowers organizations to build advanced predictive models, design precise outreach strategies, inform programmatic planning, and optimize resource allocation. This comprehensive approach enables data-driven decision-making to address vulnerabilities and maximize community impact.

Integrated Digital Data and Analytics Ecosystem

A cutting-edge, cloud-agnostic platform featuring advanced AI tools for secure data governance and AI model lifecycle management. It includes the Isthmus Digital Data Environment for data modeling and AI automation, an AI Model Monitoring Dashboard for performance tracking, and the Islet Visualization Tool for intuitive exploration of predictive outputs.

NMDoH Insights at Scale: The Community Vulnerability Compass





Background



2019 and 2022 Dallas County, Community Health

Needs Assessment highlighted:

- Geographic gaps in mortality and morbidity rates in Dallas County.
- Healthcare deserts in the southeastern sector of the county.



Limited access to local data.

- Non- Medical Drivers of Health.
- Community profiles beyond ZIP Codes.



Lack of integration of public health data and primary care data.





Implementation Plan Strategy





The Solution

Single Source of Truth and Actionable Data beyond ZIP Codes





Non-Medical Drivers of Health

The conditions in which people are born, grow, work, live, and age



What are non-medical drivers of health?

- Non-medical drivers of health (NMDOH) refer to the various conditions in the settings where individuals are born, reside, receive education, work, engage in recreational activities, worship, and grow older. These conditions significantly influence a broad spectrum of health, functional capabilities, and overall quality of life, as well as associated risks.
- According to Health People 2030 NMDOH can be grouped into 5 domains:
 - Economic Stability
 - Education Access and Quality
 - Health Care Access and Quality
 - Neighborhood and Build Environment
 - Social and Community Context

https://www.driversofhealthtx.org/



Whole Body Health and NMDOH

Healthy People 2030 NMDOH Domains

Economic Stability

Job Opportunities, Income, Food Insecurity, Paycheck Predictability

Health Care Access and Quality

Screenings, Vaccinations, Treatments, Health Literacy, Health Insurance

Neighborhood and Build Environment

Safe Housing, Transportation, Air Quality, Access to Nutritious Foods

https://health.gov/healthypeople/priority-areas/social-determinants-health

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Social and Community Context

Racism, Discrimination, Incarceration, Voter turnout

Education Access and Quality

Educational Attainment, Literacy, Language Skills

"Medical care only accounts for around 20 percent of the variation in health outcomes for a population whereas the 80 percent can be traced back to the NMDOH." Hood et al.

Hood CM, Gennuso KP, Swain GR, Catlin BB. County Health Rankings: Relationships Between Determinant Factors and Health Outcomes. Am J Prev Med. 2016;50(2):129-135. doi:10.1016/j.amepre.2015.08.024



Warner's Determinants of Health and Happiness

Understanding the Hierarchy of Determinants, Risk Factors, and Needs



Social Determinants

Love-Inbound/Outbound, Family/Friend Closeness, Connection Frequency/Quality, Social Participation, Past Times, Spirituality, Altruism, Growth



Personal Determinants

Literacy, Education Level, Learning Orientation, Quality/Stability of Work, Self-Esteem, Confidence Level, Cognitive Mindset, Civic Participation



Physical Determinants

Gender, Genetics, Sexual Orientation, Personal Health/Disabilities, Addictions, Diet and Exercise Regime, Sleep Quality, Levels of Stress



Local Living Determinants

Home Conditions, Power, Temperature Control, Internet Access, Exposure to Toxins, Access to Open Spaces, Levels of Debt, Dependency Level



Environmental Determinants

Location, Housing Type, Economics, Access to Transportation, Food Access, Safety/Security, Access to Services, Air/Noise Quality

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https://optimaljon.medium.com/can-innovation-and-or-technology-helpwith-social-determinants-of-health-627769470237



Health Related Social Needs

Prevalence of High Health-Related Social Needs (HRSNs).

Majority of individuals have *more than one HRSN*

- Out of nine possible HRSNs, 76% of respondents reported at least one, with over 25% reporting three or more, indicating a significant prevalence of high HRSNs.
- Also, for our AHC program, Out of 12,369 Unique Individuals Screened through AHC Model, 61% of individuals have 2 or more needs.

https://catalyst.nejm.org/doi/abs/10.1056/CAT.22.0149 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10728312/



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Community Vulnerability Compass

PCCI's propriety vulnerability index driven by NMDOH

Household Essentials

A critical measure of home stability and resources, reflecting the direct impact on residents' health and prosperity.

- Food Insecurity
- Health Insurance Coverage
- Household Structure
- Median Household Income
- Paycheck Predictability

Equitable Communities

A measure of community health equity, spotlighting environmental and safety factors that foster inclusivity.

- Affordable Housing
- Clean Air
- Green Space Access
- Neighborhood Safety
- Neighborhood Stability
- Unemployment



Empowered People

An index gauging individual readiness for success through educational and digital empowerment.

- Connectivity
- Educational Attainment
- Households without Vehicles
- Literacy
- Walkability

Good Health

A vital index of community health, tracking chronic disease prevalence and life expectancy to underscore the value of health support systems.

- Alcohol Abuse
- Cancer
- Chronic Disease Burden: Asthma, Chronic Obstructive Pulmonary Disease, Coronary Heart Disease, Diabetes, High Blood Pressure and Obesity
- Disease Burden
- Life Expectancy
- Mental Health



Geographical Breakouts

Comprehending geographical subdivisions ranging from county to block group levels

County

A geographical and political subdivision within a state, typically larger than a city or town and smaller than a state.



ZIP Code Tabulation Area

A system of postal codes used by the United States Postal Service (USPS), with each code representing a specific geographic area.



Census Tract

A division of a county, typically containing between 1,200 to 8,000 people, used for statistical and demographic analysis.



Block Group

A division of a census tract, typically containing between 600 and 3,000 people, used for collecting and presenting census data.





Needs Title

Needs subtitle





CVC Reveals Individual's NMDOH

Comparison of CVC and ADI NMDOH Classification Against Individual-Level Z-code Documentation: Comparing Recall Rates.

Z-Code Recall Analyses:

- We compared ADI and CVI for individual level Z-Codes from ~158k patients from Parkland Health.
- CVI has up to 75% higher recall rate for identifying individual level Z-Codes.

| | Recall Rates (%) | | | |
|----------------------|------------------------|-------------|-------------|--|
| | CVI (Dallas County) | CVI (Texas) | ADI (Texas) | |
| All Z-Codes | 67.7 | 65 | 39 | |
| Empowered People | 64.6 | 56.5 | 37.3 | |
| Z-Codes | | | | |
| Equitable Community | 75.1 | 82.9 | 28.4 | |
| Z-Codes | | | | |
| Good Health Z-Codes | 60.6 | 55.5 | 43.9 | |
| Household Essentials | 62.1 | 59.9 | 42.6 | |
| Z-Codes | | | | |



Better Understanding

Analyzing patients' environmental NMDOH factors to inform strategic funding decisions regarding allocation and specific initiatives

Count

Literacy



Targeted Resource Allocation

Ability to prioritize zip codes and accurately allocate limited resources down to a block group level for higher impact.



Root Cause Analysis

Utility to identify areas of vulnerable populations and what determinants are contributing to overall vulnerability.



Interconnection of NMDOH

Capacity to understand how each of the NMDOH are intricately interwoven.



Proxy NMDOH

Capability to utilize patient address to connect to block group level NMDOH as a proxy for missing individual level NMDOH.



Solution Application





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Community Profile

Prioritize Sites for Service Deployment

Public Health Campaigns

Integration of Public Health & Primary Care Data

Pediatric Asthma Surveillance System





0.5M

Hispanic or Not Hispanic o Latino Latino

Black or Native Native Two or White or

Mobility Data

Cell phone ping data helps identify mobility patterns, such as where people travel daily or how far they go to access key services like clinics, grocery stores, or shelters — revealing actual utilization versus proximity alone.

NAICS codes classify business types and public service locations (e.g., pharmacies, food banks, dialysis centers), enabling us to map and quantify the availability and geographic distribution of vital services.

CVC vulnerability data adds critical context by highlighting populations at higher risk due to socioeconomic, health, and environmental challenges, pinpointing where unmet needs are likely to be concentrated.

Triangulation across the three sources enables us to detect service deserts (high vulnerability + limited mobility + few or no relevant services), evaluate service reach (how far vulnerable populations travel to access services), and prioritize interventions in areas where mobility and access gaps align with concentrated vulnerabilities.

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Extended Applications





care decisions

Current Updates



Access to Vital Services

- Adds services found within the community based on physical address, latitude and longitude.
- This enhancement supports smarter planning for collaborative opportunities within the community, helping ensure individuals with more than one health related social need can be referred as needed.



Trends and Forecasting Module

- Introduces time-series analysis and predictive modeling to visualize historical trends and anticipate future vulnerability shifts.
- Users can track how key indicators change over time and forecast emerging areas of concern, enabling proactive planning, program design, and resource allocation.



Congressional and ISD Boundary Overlays

- Enables users to view vulnerability data through the lens of congressional districts and independent school districts (ISDs).
- These overlays help align programs and funding requests with legislative and educational boundaries, improving advocacy, grant applications, and cross-sector coordination with schools and policymakers.



Project Overview

Purpose: Identify trends in social determinants that impact health outcomes and disparities between neighborhoods in Dallas County.



NMDOH Variables



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Non-Medical Drivers of Health (NMDOH)

| Food Insecurity | Paycheck Predictability | Household Structure | |
|---|--|---|--|
| Percentage of households receiving | Percentage of population working full- | Percentage of single parent | |
| SNAP in the past 12 months | time in the past 12 months | households | |
| Health Insurance Coverage Percentage of uninsured | Median Income Median household income in the past 12 months | Connectivity Percentage of households with no internet and no computer access | |
| Education Attainment | Households without Vehicles | Unemployment | |
| Percentage of population without high | Percentage of households without a | Percentage of unemployed individuals | |
| school degree | vehicle | out of the civilian labor force ages 16+ | |
| Neighborhood Stability | Neighborhood Safety | Green Space | |
| Percentage of housing units that are | Crime and violent crime rates per | Number of parks within zip code | |
| vacant | 1,000 residents in the past year | boundaries | |
| Alcohol Abuse | Cancer | Asthma | |
| Prevalence of binge drinking among | Prevalence of cancer among adults | Prevalence of asthma among adults | |
| adults ages 18+ | ages 18+ | ages 18+ | |
| Coronary Heart Disease Prevalence of coronary heart disease among adults ages 18+ | Diabetes Prevalence of diagnosed diabetes among adults ages 18+ | Mental Health Percentage of adults ages 18+ who stated that their mental health was not good for 14 or more of the past 30 days | |



Methodology

Linear Regression Models were Used to Analyze 2019-2022 Trends

Calculated:

- Intercept
- Slope
- R²
- P-Value

 $Zip Code = \frac{Zip Code Indicator Count}{Zip Code Population}$

County = $\frac{Sum \, of \, all \, (Zip \, Code \, Indicator \, Count)}{Dallas \, County \, Population}$

Example:



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Food Insecurity – Increasing Slope, Increasing Vulnerability **Median Income** – Increasing Slope, Decreasing Vulnerability

Good: If P-Value ≤ 0.05 & Decrease in Vulnerability Bad: If P-Value ≤ 0.05 & Increase in Vulnerability

Logic Used For Mapping:

• Neutral: If P-Value Not Significant

Example:



Good: Decrease Vulnerability



Bad: Increase Vulnerability



Neutral: No Change In Vulnerability



Zip Code Proportions of Trends

Denominator: Zip Code Population

Number (%) of Dallas County Zip Codes, out of 93, that show Increase, Decrease, or No Significant Linear Trend in Vulnerability from 2019 – 2022

| TREND | Food Insecurity | Paycheck Predictability | Household Structure | Health Insurance Coverage | Median Income | Connectivity | Education Attainment | Households Without Vehicles | Unemployment |
|----------------------------|--------------------|----------------------------|------------------------|---------------------------------|-----------------------|-----------------------|-------------------------|-----------------------------------|--------------|
| Decreased Vulnerability | 15 (16%) | 10 (11%) | 5 (5%) | 4 (4%) | <mark>47 (51%)</mark> | <mark>44 (47%)</mark> | 18 (19%) | 8 (9%) | 4 (4%) |
| Neutral | 75 (81%) | 79 (85%) | 81 (87%) | 78 (84%) | 46 (49%) | 49 (53%) | 72 (77%) | 75 (81%) | 81 (87%) |
| Increased Vulnerability | 3 (3%) | 4 (4%) | 7 (8%) | 11 (12%) | 0 (0%) | 0 (0%) | 3 (3%) | 10 (11%) | 8 (9%) |

| TREND | Neighborhood Stability | Neighborhood Safety | Green Space | Alcohol Abuse | Cancer | Asthma | Coronary Heart Disease | Diabetes | Mental Health |
|----------------------------|---------------------------|------------------------|----------------|---------------|------------------------|----------|---------------------------|----------|-----------------------|
| Decreased Vulnerability | 13 (14%) | 1 (1%) | 3 (3%) | 6 (6%) | 0 (0%) | 0 (0%) | 0 (0%) | 4 (4%) | 0 (0%) |
| Neutral | 76 (82%) | 92 (99%) | 85 (91%) | 87 (94%) | <mark>93 (100%)</mark> | 86 (92%) | <mark>93 (100%)</mark> | 89 (96%) | 37 (40%) |
| Increased Vulnerability | 4 (4%) | 0 (0%) | 4 (4%) | 0 (0%) | 0 (0%) | 7 (8%) | 0 (0%) | 0 (0%) | <mark>56 (60%)</mark> |

- Median Income, Connectivity, and Mental Health have the greatest amount of Dallas county zip codes that show significant trends between 2019 and 2022
- Cancer and Coronary Heart Disease have **no** significant trends in Dallas county zip codes over the 4-year period



NMDOH Comparison Across Zip Codes

Zip Codes w/ Highest Count of Increased Vulnerability

- 75081 (4 NMDOH Features)
 - Education Attainment, <u>Household without Vehicle</u>, Unemployment, <u>Mental Health</u>
- 75236 (4 NMDOH Features)
 - Household Structure, <u>Household without Vehicle</u>, Green Space, <u>Mental Health</u>

CHNA Zip Codes

- 75210 (1 NMDOH Feature)
 - Food Insecurity
- 75211 (3 NMDOH Features)
 - Paycheck Predictability, Unemployment, Mental Health
- 75215 (1 NMDOH Features)
 - Green Space
- 75216 (0 NMDOH Features)
- 75217 (0 NMDOH Features)
- 75241 (0 NMDOH Features)

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Total Number of NMDOH Features w/ Increasing Vulnerability



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NMDOH Comparison Across Zip Codes

Zip Code w/ Highest Count of Decreased Vulnerability

- 75227 (6 NMDOH Features)
 - Median Income, Food Insecurity, Paycheck Predictability, Connectivity, Household without Vehicle, Neighborhood Stability

CHNA Zip Codes

- 75210 (2 NMDOH Feature)
 - Household without Vehicle, Alcohol Abuse
- 75211 (2 NMDOH Features)
 - Median Income, Education Attainment
- 75215 (3 NMDOH Features)
 - Connectivity, Neighborhood Stability, Diabetes
- 75216 (4 NMDOH Features)
 - Median Income, Connectivity, Neighborhood Stability, Diabetes
- 75217 (3 NMDOH Features)
 - Median Income, Food Insecurity, Connectivity
- 75241 (4 NMDOH Features)
 - Median Income, Connectivity, Neighborhood Safety, Diabetes

Total Number of NMDOH Features w/ Decreasing Vulnerability



Connectivity

Denominator: Zip Code Population

Definition: Maximum vulnerability coming from internet connectivity (% of households without an internet subscription and % of households without internet access) and access to devices (No computer access) to connect the internet

44 (47%) out of 93 Dallas county zip codes have a decreasing vulnerability in connectivity in the 4-year period

- 4 of these negative trends are in CHNA zip codes
 - Decreased Vulnerability: 75215 (-12.2%), 75216 (-9.4%), 75217 (-10.9%), 75241 (-12.7%)

Vulnerability of no internet nor computer access is decreasing as the world is becoming more connected

| Min | Мах | Median | Mean |
|-----|-------|--------|------|
| 0.0 | 100.0 | 19.8 | 24.3 |

* Combined Data 2019-2022 **PCCI AI** | Texas Demographics Center



Connectivity Vulnerability



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Connectivity: Trends vs CVC



Dallas Zip Code Trend

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Dallas CVC Vulnerability



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Diabetes

Dallas County Zip Codes Trend

Definition: Prevalence of diagnosed diabetes among adults ages 18 years and older

4 (4%) out of 93 Dallas county zip codes have a decreasing vulnerability in diabetes in the 4-year period

- 3 of these decreasing vulnerabilities are in CHNA zip codes
 - Decreased Vulnerability: 75215 (-0.65), 75216 (-0.77), 75241 (-0.77)
 - For these CHNA zip codes, the prevalence of diabetes is decreasing at an average rate of 0.65%, 0.77%, and 0.77%

Prevalence of diabetes has been **decreasing** from 2019 to 2022 in vulnerable populations

| Min | Max | Median | Mean |
|------|-------|--------|-------|
| 4.00 | 23.00 | 11.05 | 11.47 |

* Combined Data 2019-2022



Diabetes: Trend vs CVC

Dallas Zip Code Trend



Dallas CVC Vulnerability



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Mental Health

Dallas County Zip Codes Trend

Definition: Percentage of adults 18 years and older who stated that their mental health, which includes stress, depression, and problems with emotions, was not good for 14 or more of the past 30 days

56 (60%) out of 93 Dallas county zip codes have an increasing trend in poor mental health in the 4-year period

- 1 of these increasing vulnerabilities are in CHNA zip codes
 - Increased Vulnerability: 75211 (+1.20)
 - Poor mental health has increased on an average rate of 1.2% per year

Prevalence of poor mental health has been *increasing* from 2019 to 2022 for *over half* of the zip codes in Dallas county

| Min | Max | Median | Mean |
|------|-------|--------|-------|
| 8.90 | 23.60 | 16.30 | 16.30 |

* Combined Data 2019-2022



Mental Health: Trend vs CVC

Dallas Zip Code Trend



Dallas CVC Vulnerability





Total Population Count

Dallas County Zip Codes Trend

Definition: Total Population Count

11 (12%) out of 93 Dallas county zip codes have a significant *increase* in total population count from 2019 to 2024

78 (84%) out of 93 Dallas county zip codes have **no** significant change in total population and the counts stayed roughly the same from 2019 through 2024



As a County, the population count in Dallas County has remained roughly the same with no significant changes from 2019-2022

- R² = 0.15
- P = 0.613



Population Count Trend

Increasing No Change Decreasing



Closing Remark

Unlocking New Possibilities with CVC

The Community Vulnerability Compass (CVC) equips organizations with hyperlocal, actionable data to strengthen Community Health Needs Assessments (CHNAs) and guide strategic planning. From identifying high-need areas to informing clinic placement, outreach efforts, and funding strategies, CVC turns complex data into clear direction.

Looking forward, CVC data can power advanced AI applications—serving as a foundation for predictive models that forecast emerging vulnerabilities, simulate intervention scenarios, and optimize resource distribution. By combining CVC's rich datasets with AI, organizations can move from static assessments to dynamic, forward-looking health strategies.

CVC bridges data and decision-making—helping you act faster, smarter, and more equitably.

