Sustainable Living: The Impacts of Social Determinants on Health Outcomes

Shubham Vyas
Santa Clara University
ssvyas@scu.edu

Jinish Shah
Santa Clara University
Jshah6@scu.edu

Tania Ortiz-Rosales
Santa Clara University
tortizrosales@scu.edu

Abstract

This research investigates the impact of social determinants—income, education, and housing quality—on health outcomes in California communities. Using data from the Census Bureau, CDC, and Data.gov, we employ interactive visualizations, including geospatial maps, hexbin plots, and bar charts, to uncover patterns and correlations between these factors and health metrics such as chronic diseases and obesity. Our findings reveal significant associations, such as higher rates of health issues in regions with lower income levels and substandard housing. The study underscores the importance of addressing social determinants to improve public health and reduce disparities. The interactive web application, developed with Streamlit, provides a dynamic tool for policymakers and public health officials to explore these relationships and formulate targeted interventions for sustainable health improvements.

Introduction

This research project investigates how social determinants such as income, education, and housing influence health outcomes in various California communities. By focusing on these critical factors, the study aims to reveal patterns that can guide policy decisions and promote health equity. The disparities in health outcomes often correlate with socioeconomic status, with lower income, limited education, and substandard housing contributing to higher rates of chronic diseases and lower life expectancy. Understanding these relationships is essential for developing targeted interventions and equitable health policies.

The study uses comprehensive data collection and analysis methods, along with interactive visualizations, to explore the intricate connections between social determinants and health outcomes. The findings are intended to provide valuable insights for public health officials, policymakers, and community leaders, emphasizing the need for a holistic approach to health promotion and disease prevention. By highlighting these connections, the project underscores the importance of social investments in fostering sustainable health improvements and creating a healthier, more equitable society.

Motivation

Understanding the relationship between social determinants and health outcomes is crucial for creating equitable health policies and improving public health. Social determinants such as income, education, and housing significantly impact individuals' health status. For instance, lower income can limit access to nutritious food, healthcare, and safe living environments, leading to poorer health outcomes. Education affects

health literacy and the ability to make informed health decisions, while housing quality influences exposure to environmental hazards and access to community resources.

In California, significant health disparities exist across different communities, often rooted in socioeconomic inequalities. By investigating these disparities, this research aims to provide actionable insights that can help bridge the gap in health outcomes between different demographic groups. Highlighting the connections between social determinants and health outcomes will support the development of targeted interventions and policies that address the root causes of health inequities.

This research is motivated by the potential to contribute to a more equitable and sustainable healthcare system. By demonstrating how improvements in social determinants can lead to better health outcomes, the project underscores the long-term benefits of investing in social infrastructure. Ultimately, the goal is to inform public health strategies that promote health equity and improve the overall well-being of all Californians, particularly those in disadvantaged communities.

Methodology for Visualizations and Website

This section outlines the methodology used to create the visualizations and the interactive site for analyzing the impact of social determinants on health outcomes. The methodology involves data preparation, visualization design, and the development of an interactive web application using Streamlit.

Data Preparation

1. Data Collection:

- **Social Determinants Data:** Collected from the Census Bureau, covering income, education, and housing statistics.
- **Health Outcomes Data:** Sourced from CDC and Data.gov datasets, focusing on metrics relevant to the chosen health outcomes.

2. Data Cleaning:

- Ensured datasets from the same time periods and geographic regions for consistency.
- Handled missing values and ensured uniform formats.
- Aggregated data at the county level to maintain granularity while ensuring comprehensive analysis.

Visualization Design

1. Interactive Maps:

- Developed using Plotly's scatter_mapbox to show geographical distributions of health outcomes and social determinants.
- Enabled users to select different health indicators and view corresponding data, providing a clear spatial understanding of the relationships.

2. Correlation Analysis:

- Created using hexbin plots to show the density of data points and highlight correlations between variables such as income and health outcomes.
- Allowed dynamic updates based on user selection of health indicators, making the analysis flexible and user-driven.

3. Bar Charts:

- Designed to compare health outcomes across different regions or demographics.
- Provided detailed insights into specific health challenges within selected regions, facilitating targeted analysis.

Development of Interactive Site

1. Site Structure:

- **Organized into sections:** Home, Income vs Health, Education vs Health and Housing vs Health.
- Included navigation links for easy access to each section, ensuring a seamless user experience.

2. Dynamic Content:

- Built using Streamlit's interactive widgets, allowing users to choose different health indicators and social determinants.
- Visualizations updated dynamically based on user input, making the site highly interactive and user-friendly.

3. User Interaction:

- Enabled users to hover over map markers to view detailed data for each specific region.
- Allowed selection of different variables for correlation analysis and viewing bar charts, enhancing user engagement and data exploration.

Ensuring Accuracy and Usability

This methodology ensures that the visualizations are accurate, informative, and user-friendly. The interactive site, built with Streamlit, provides a dynamic platform for data analysis and visualizations, enabling users to explore the relationship between social determinants and health outcomes effectively. By incorporating interactive elements and intuitive design, the site facilitates a deeper understanding of how socioeconomic factors impact health, ultimately supporting data-driven decision-making for public health strategies.

Visualization Design and Analysis

This section is divided into three key areas, each focusing on the relationship between health outcomes and a specific social determinant: income, education, and housing. Each section uses interactive and insightful visualizations to explore these relationships. Below is the detailed explanation for each section with examples to illustrate their effectiveness.

Health vs Income

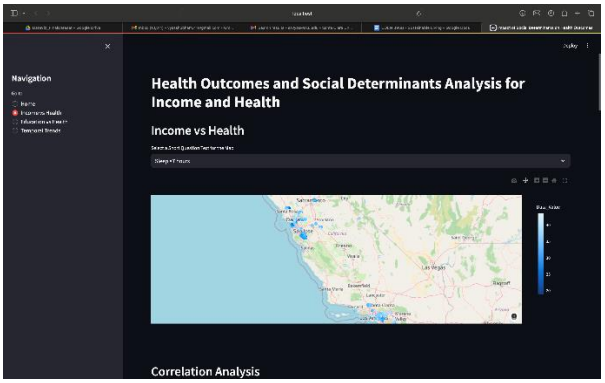
Objective

Explore how income levels impact various health outcomes using different visualization techniques. All visualizations are dynamic, allowing users to select multiple health issues and visualize the median income and health data values for those specific issues.

Visualizations

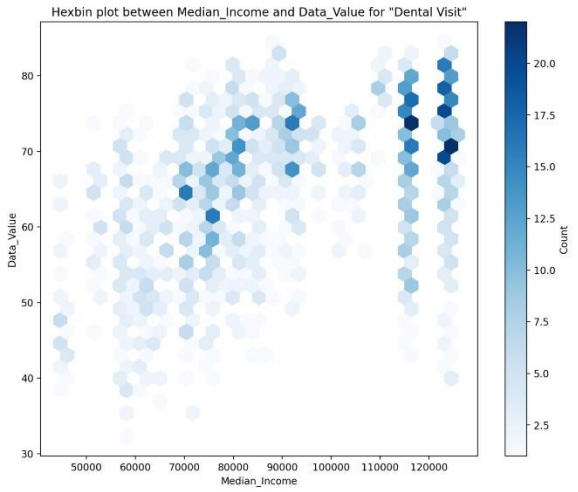
Interactive Map

- **Purpose:** Provides a geographical distribution of health outcomes, highlighting areas with significant income-related health issues.
- **Example:** For the question "Sleep <7 hours," the map shows regions with higher rates of insufficient sleep often correlated with lower median income.



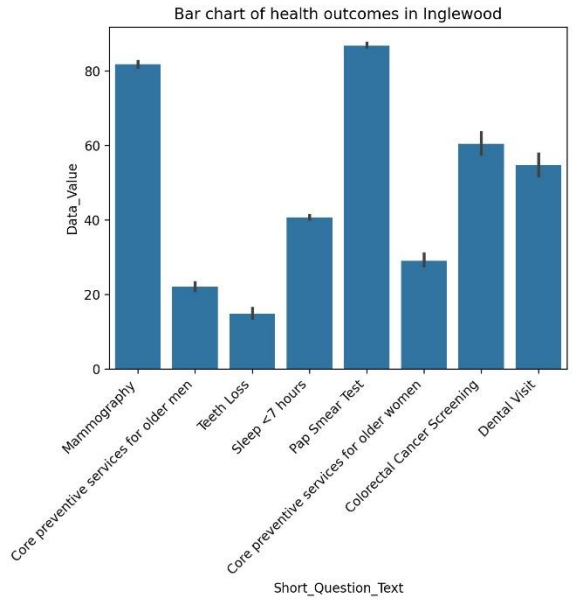
Correlation Analysis (Hexbin Plot)

- **Purpose:** Shows the density of data points, highlighting the correlation between income and health outcomes.
- **Example:** For "Dental Visit," the hexbin plot reveals that higher income groups visit the dentist more frequently, indicating better access to dental care.



Bar Charts

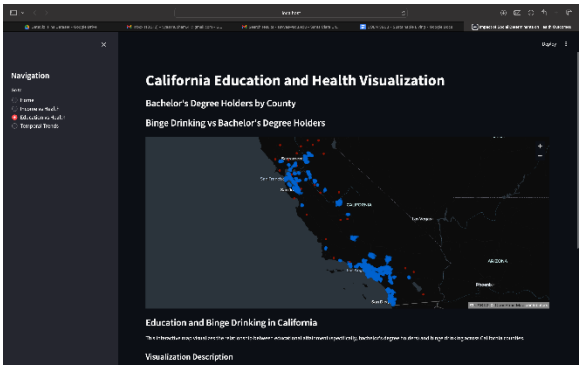
- **Purpose:** Compares health outcomes across different regions or demographics, providing detailed insights into regional health disparities.
- **Example:** For the city of Inglewood, the bar chart shows various health outcomes like mammography rates and dental visits, highlighting specific health challenges within the city.



Health vs Education

Objective: Examine how educational attainment levels, specifically the number of bachelor's degree holders, influence health outcomes such as binge drinking across California counties.

Interactive Map



Markers

- **Red Markers:** Represent the number of bachelor's degree holders in each county.
- **Blue Markers:** Represent the prevalence of binge drinking in each county.
- **Purpose:** Allows users to see the distribution and correlation between higher education levels and health behaviors, specifically binge drinking.

Key Insights

Education and Binge Drinking: There appears to be a correlation between the number of bachelor's degree holders and the prevalence of binge drinking. Urban areas, such as the San Francisco Bay Area and Los Angeles, with a higher concentration of bachelor's degree holders, also exhibit significant instances of binge drinking. This suggests that areas with more educated populations might also have higher social activity, potentially leading to higher rates of binge drinking.

Rural vs. Urban Trends: Rural areas in California, which typically have fewer bachelor's degree holders, also show fewer instances of binge drinking. This could be due to different lifestyle choices and less social activity compared

to urban areas. The visualization highlights the contrast in health behaviors between rural and urban populations, providing valuable insights for public health strategies.

Summary

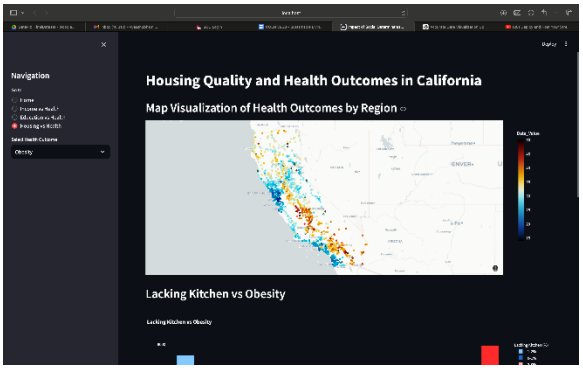
The "Health vs Education" section of the report uses interactive maps to reveal the relationship between educational attainment and health outcomes such as binge drinking. By visualizing this data, the report uncovers patterns and contrasts between rural and urban areas, providing actionable insights for policymakers and public health officials to address the specific health needs of different communities.

Health vs Housing

Objective: Investigate how housing quality affects health outcomes, focusing on indicators such as lacking plumbing and kitchen facilities, and their relationship with chronic diseases and obesity.

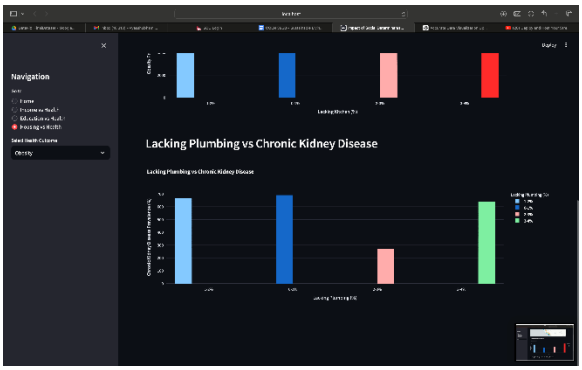
Interactive Map

- **Purpose:** Visualizes the relationship between housing quality indicators (e.g., lacking kitchen facilities) and health outcomes across California regions.
- **Example:** Shows regions with higher rates of obesity often correlated with higher percentages of lacking kitchen facilities.



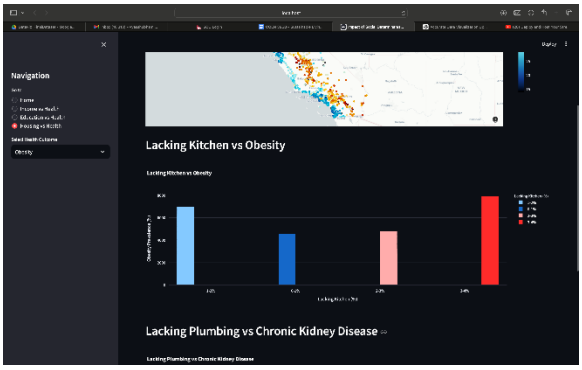
Correlation Analysis

- **Purpose:** Highlights the relationship between housing quality indicators and health outcomes.
- **Example:** For "Lacking Plumbing vs Chronic Kidney Disease," the analysis shows that regions with a higher percentage of lacking plumbing facilities tend to have higher prevalence rates of chronic kidney disease.



Bar Charts

- **Purpose:** Provides detailed insights into specific health challenges related to housing quality within selected regions.
- **Example:** Compares different regions' health outcomes, such as obesity rates and chronic kidney disease prevalence, highlighting areas with poor housing conditions.



Summary

Each section of the report uses interactive maps, correlation analyses, and bar charts to explore the relationships between health outcomes and social determinants (income, education, housing). These visualizations help uncover patterns and provide actionable insights, making the data more accessible and impactful.

Figures

1. Interactive Dashboard: Shows various health outcomes and their correlations with income, education, and housing quality.

2. Scatter Mapbox Visualizations: Displays geographical distributions of health outcomes and social determinants.

3. Hexbin Plot: Illustrates the density of data points and correlations between median income and health outcomes such as dental visits.

4. Bar Chart: Compares health outcomes like mammography rates and dental visits across different regions, exemplified by data from Inglewood.

5. Geospatial Analysis: Provides a map visualization of health outcomes by region, indicating lacking kitchen and plumbing facilities' impact on health metrics like obesity and chronic kidney disease.

This methodology ensures that the visualizations are accurate, informative, and user-friendly, enabling users to explore the relationship between social determinants and health outcomes effectively. The interactive site, built with Streamlit, provides a dynamic platform for data analysis and visualizations, fostering a deeper understanding of how socioeconomic factors impact health and supporting data-driven decision-making for public health strategies.

Sustainability Aspect

Addressing social determinants of health is crucial for achieving sustainable health improvements and equity. By focusing on the interplay between income, education, and housing quality, this research highlights the long-term benefits of social investments. Here are the key sustainability aspects:

Environmental Factors

Promoting sustainable environmental practices such as clean air and water policies, and access to green spaces can significantly improve community health. Clean environments reduce exposure to pollutants, leading to lower rates of respiratory and cardiovascular diseases. Ensuring access to natural resources like parks and recreational areas fosters physical activity, mental well-being, and overall health.

Healthcare Access and Quality

Universal healthcare access is fundamental for health equity and sustainability. A robust healthcare system that prioritizes preventive care can address social determinants and improve health literacy. By reducing barriers to healthcare, we can lower the incidence of preventable diseases, ultimately reducing healthcare costs and resource consumption. Investing in healthcare infrastructure is vital for creating a resilient and sustainable health system.

Policy and Governance

Strong government policies that promote social, economic, and environmental sustainability are essential. Policies that ensure universal healthcare, affordable housing, access to quality education, and nutritious food can create a more inclusive and healthy society. Effective governance can drive the implementation of these policies, fostering long-term health improvements and reducing disparities.

Importance of Addressing Social Determinants

Understanding and addressing social determinants of health is critical for several reasons:

1. Health Equity: Reducing disparities in health outcomes ensures that all individuals have the opportunity to achieve optimal health, regardless of their socioeconomic status.

2. Preventive Care: Addressing root causes of health issues through social determinants can

prevent the onset of diseases, reducing the burden on healthcare systems.

3. Economic Benefits: Improved health outcomes lead to a more productive workforce, lower healthcare costs, and economic growth.

4. Community Well-being: Enhancing social determinants improves overall quality of life, fostering healthier, more vibrant communities.

By integrating sustainability into public health strategies, we can create a more equitable and healthier society. This research underscores the necessity of a holistic approach to health promotion, where social, economic, and environmental factors are interwoven to achieve lasting health benefits for all.

Evaluation Plan

The evaluation of this project will focus on assessing the accuracy, usability, and impact of the visualizations and the interactive web application. To ensure data quality, we will cross-verify data from different sources and use statistical methods to handle any inconsistencies. The data cleaning process will be carefully reviewed to address missing values and formatting issues.

To evaluate the effectiveness of the visualizations, user testing sessions will be conducted to gather feedback on their clarity and informativeness. Engagement metrics, such as the number of visualizations explored and the time spent on the platform, will help assess user interaction and identify areas for improvement.

Usability and user experience will be assessed through usability testing, focusing on navigation and overall user satisfaction. The web application will also be evaluated for accessibility to ensure it meets web accessibility standards.

Finally, feedback from users will be continuously collected to improve the platform. This will include regular updates and enhancements based on user input and emerging data, ensuring the project remains effective and relevant.

Discussion and Future Work

This report provides a foundational overview of social determinants of health (SDOH) and their effects on individuals' health within various California communities. While the current analysis offers valuable insights, there is significant potential for further research and expansion.

Expanding Determinant Analysis

The study could be enhanced by expanding the range of social determinants analyzed. Currently, we focus on income, education, and housing quality. Future work should include additional factors such as access to public transportation, crime rates, and environmental conditions. Including these factors will provide a more comprehensive understanding of how various elements interact to influence health outcomes. Broader data fields will allow for more nuanced analyses and the development of targeted interventions.

Advanced Analytics and Techniques

Given more time and resources, the study can incorporate more sophisticated data models and machine learning techniques. Advanced analytics, such as time-series analysis and clustering, could forecast health outcomes based on dynamic socio-economic data. Machine learning models could identify complex patterns and interactions that may not be apparent through traditional analysis methods. This approach would create a more robust and predictive framework for understanding the impacts of SDOH on health outcomes.

Inter-related Data Values

The current datasets contain numerous data values that are inter-related. While this report has focused on extracting the most apparent relationships, there remains significant scope for

discovering more intricate connections and addressing additional issues. Future research can delve deeper into these interrelations, uncovering hidden patterns and providing a more holistic view of how various social determinants collectively influence health outcomes.

Geographic Expansion

The current analysis is limited to communities within California. Future research should broaden the geographical scope to include a nationwide analysis. By comparing health outcomes across different states, we can gain insights into how local policies and socio-economic conditions influence health. A nationwide study would allow for a thorough comparison of state-level health outcomes and the effectiveness of various health policies. This broader perspective would enhance the generalizability of the findings and provide a basis for national health policy recommendations.

Continuous Improvement and Feedback

To ensure the relevance and effectiveness of the project, continuous feedback from users and stakeholders should be integrated. Regular updates and enhancements based on user input and emerging data will keep the platform current and useful. Future iterations of the project could include more interactive features and real-time data updates, further increasing the utility and impact of the visualizations.

Conclusion

This project has provided a foundational analysis of the impact of social determinants such as income, education, and housing quality on health outcomes within various California communities. Through interactive visualizations and comprehensive data analysis, we have highlighted significant correlations that underline the importance of addressing these social determinants to improve public health.

Our findings demonstrate that lower income levels, limited educational attainment, and substandard housing conditions are closely linked to poorer health outcomes, such as higher rates of chronic diseases and reduced access to healthcare services. These insights are crucial for informing public health strategies and policies aimed at reducing health disparities and promoting health equity.

While this report offers valuable initial insights, there is considerable scope for further research and expansion. Future studies should explore additional social determinants, employ advanced analytical techniques, and broaden the geographic scope to include a nationwide analysis. Additionally, the current datasets contain many inter-related values, suggesting potential for uncovering more intricate connections and addressing further issues through deeper analysis.

The development of an interactive web application using Streamlit has made these insights accessible and user-friendly, empowering policymakers, public health officials, and community leaders with the tools to make informed decisions. Continuous feedback and iterative improvements will ensure that the platform remains relevant and effective.

In conclusion, this project underscores the critical role of social determinants in shaping health outcomes and the necessity of a holistic approach to health promotion. By investing in social infrastructure and addressing these determinants, we can foster sustainable health improvements and create a healthier, more equitable society. The ongoing enhancement and expansion of this research will continue to provide valuable insights, driving positive change in public health practices and policies.

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