Life expectancy disparities in Florida: a quantitative analysis of two counties

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ABSTRACT
Objectives. Despite substantial healthcare spending in the United States, health outcomes for low socioeconomic status populations remain less than the general population. This disparity is significantly influenced by social determinants of health (SDOH), such as income, education, and environment. This study delved into the influence of SDOH on the life expectancy gap between two Florida counties, Collier (with high life expectancy) and Marion (with low life expectancy). Examining these two contrasting counties aims to identify how SDOH contributed to this disparity. Methods. This comprehensive quantitative analysis considered three key areas: demographics, SDOH, and the influence of SDOH on internal and external factors of death and longevity. Demographic data for Collier and Marion counties and the Florida average were collected and converted to z scores. Linear regression was deployed to understand the relationship between these demographic variables. The z scores from the latest internal and external death data from Florida Health Charts (n.d.) were used in a linear regression to determine how the SDOH from each county influences years of potential life lost (YPLL). This comprehensive approach aimed to reveal how demographic characteristics and SDOH contributed to the life expectancy gap between the two counties. Survey population. Results. The regression analysis revealed a robust correlation between SDOH and internal causes of death (chronic diseases), which significantly impact life expectancy. SDOH factors explain a substantial portion of the variation in YPLL in both counties. However, the association between SDOH and external causes of death requires further investigation. While a positive correlation existed, it lacks statistical significance, suggesting the involvement of other factors. These findings underscore the importance of addressing SDOH in healthcare policies and practices to reduce the life expectancy gap. Conclusions. The analysis revealed a clear association between SDOH and life expectancy. Collier County has a higher median income, diverse population, excellent working-age demographics, and higher life expectancy. Conversely, Marion County, with lower income, less diversity, and younger populations with more children, has a higher risk of chronic diseases and lower life expectancy. The findings highlighted the importance of SDOH in understanding life expectancy variations and emphasized the need for targeted interventions to address social determinants and improve health outcomes across communities.

Keywords: Social Determinants, Life Expectancy, Lifespan, Health Inequities, Health Disparities, Population Health, Socioeconomic Factors, Public Health, Evidence-Informed Policymaking, Health Equity, Genetics.
1 INTRODUCTION

The United States spends more on healthcare than any other nation. Poor health-related quality of life outcomes is associated with lower socioeconomic status (SES). The US health system’s inequalities currently cost approximately $320 billion and could surpass $1 trillion by 2040.\(^1\) This increase represents a substantive increase in outcomes associated with SES.

This quantitative comparative analysis examines the reasons behind this disparity in Florida. It focuses on two counties: Collier (high life expectancy) and Marion (low life expectancy). It explores how social determinants of health (SDOH) influence the life expectancy gap between Collier and Marion counties (8.5 years). These counties have similar population sizes but significantly different life expectancies. Understanding how SDOH contributes to this disparity can inform strategies to improve health outcomes across Florida.

2 BACKGROUND

Human death takes place both within the body (internal death) and outside the body (external death). Genetics and SDOH interact with each other and with individual behaviors to influence health outcomes. The influence of SDOH on chronic diseases is found in the symptom experience of patients with a chronic condition. Chronic diseases caused by SDOH or genetics can further limit a person's ability to manage their health and environment, increasing vulnerability to external death sources.\(^2\) SDOH can influence how genes are expressed, making some individuals susceptible to chronic diseases even with the same genetic predisposition.

3 SES AND SDOH

Many SDOH factors are interconnected. Evidence shows a negative association between SDOH and exposure to environmental risks that harm human health, such as hazardous waste, air pollutants, inadequate housing, poor water quality, noise exposure, COVID-19, and the threat of violence.\(^3,4\) These types of connections complicate understanding the influence of SDOH on longevity. Understanding cause-and-effect relationships between SDOHs is critical in enhancing public health.

Several variables beyond a healthy lifestyle are known to influence longevity. The sum of exposure to different xenobiotics (substances that are foreign to the body) and stress factors in the living and working environment accumulated during the individual lifespan, known as the exposome, affects both quality of
life and longevity\(^5\). For example, high consumption of alcohol, drugs, and tobacco are some of the lifestyle variables known to have toxic consequences on organs and increase the risk of serious diseases.

Early life experiences can shape a person’s life from childhood through adulthood. These factors include childhood poverty, adverse childhood experiences (ACEs), educational opportunities, and early childhood development programs. Early deprivation and trauma can have lasting negative impacts on physical and mental health, increasing risks for chronic diseases and shortening lifespans\(^6\). Quality early education promotes healthy development, fosters resilience, and improves future health outcomes, contributing to longer lives\(^7\). Quality education can help shape a child with greater resilience, improved health outcomes, and a stronger foundation for success.

Several broad SDOHs significantly impact life expectancy, acting as primary influences. These include SES, social and community context, and access to quality healthcare. Examples of underlying drivers of declining life expectancy include:

- the economic circumstances of low-income individuals. Wages for workers at the median of the earnings distribution have not kept pace with inflation or economic growth. Income has seldom been used to study social differences in disability-free life expectancy\(^8\);
- decreases in job opportunities have made it difficult for many individuals to ascend the economic ladder. Well-paying manufacturing jobs, held primarily by those without four-year college degrees, have disappeared due to automation and competition from non-US manufacturing. Laborers and those in craft and repair occupations had 10.9 years and 8.6 years lower life expectancy at age 18 than those with professional and managerial occupations\(^9\);
- the social safety net has become increasingly unable to support the growing numbers of needy people. An increased understanding of SDOH could better connect patients with relevant social services in clinical contexts. It could also target vulnerable populations with health-improving social policies and programs while addressing affordability\(^10\).

Each of these trends has been linked to increased mortality rates among less-educated, lower-income, working-age adults, most notably from drug overdose and suicide.

### 4 GENETICS

Genetics influence both internal and external life expectancy. Complex interactions between genes and the environment, wherein the environment epigenetically modulates genes, affect gene expression\(^5\). It is estimated that about 25 percent of the variation in human life span is determined by genetics\(^11\). Genetics also influence an individual’s life span. Studies suggest genetics contribute 20-40% of the
variation in human lifespan\textsuperscript{12,13, 14}. Some individuals may have a genetic predisposition to certain chronic diseases, making them more susceptible despite similar lifestyle choices compared to others.

Heredity can influence longevity. Longevity studies suggest genetics are more important in families with a long-life history, while environment plays a bigger role in individual cases\textsuperscript{15}. People with centenarian parents are less likely at age 70 to have the age-related diseases common among older adults\textsuperscript{16}. The brothers and sisters of centenarians typically have long lives. If they develop age-related diseases such as high blood pressure, heart disease, cancer, or Type 2 diabetes, these diseases appear later than they do in the general population\textsuperscript{17}. These facts suggest that shared genetics, lifestyle, or both play an essential role in determining longevity.

Epigenetic factors explain how environmental factors influence gene expression without changing the underlying DNA sequence. SDOH can influence how genes are expressed, making some individuals susceptible to chronic diseases even with the same genetic predisposition. For example:

- chronic stress exposure can activate epigenetic modifications that silence genes involved in critical cellular functions like DNA repair and immune response. This can increase susceptibility to various chronic diseases\textsuperscript{18};
- poor nutrition can lead to epigenetic changes affecting gene expression related to metabolism, inflammation, and even brain development\textsuperscript{19};
- exposure to environmental toxins like air pollution or certain chemicals can also trigger epigenetic changes linked to increased disease risk\textsuperscript{20};
- children exposed to stressful environments like poverty, neglect, or abuse can experience epigenetic changes that influence their stress response system and increase their risk of developing mental health issues or chronic diseases later in life\textsuperscript{22};
- smoking during pregnancy can lead to epigenetic changes in the developing baby's genes, potentially influencing their health outcomes in adulthood\textsuperscript{23}.

Epigenetic changes are reversible. Addressing SDOH and adopting healthy behaviors can potentially mitigate the negative impact of these changes on health.

This study aims to explore the influence of the SDOH on the life expectancy between two Florida counties — one with the highest life expectancy (Collier County = 86.1 years) and another with a low life expectancy (Marion County = 77.6 years) – a difference of 8.5 years\textsuperscript{23}. Out of 67 counties in Florida, Collier County has the highest life expectancy, and Marion County is in the bottom 25%. These counties were selected because they represent stark differences in life expectancy, have about the same population size, and have significant differences in socioeconomic indicators (e.g., income levels, poverty rates, and educational attainment).
5 RESEARCH QUESTIONS

After reviewing information on the SDOH and life expectancy, two research questions emerged:

RQ 1: How do the SDOH factors differ between the two Florida counties – Collier and Marion?

RQ 2: How much do the SDOH factors influence both counties’ internal and external life expectancy outcomes?

Insights into these research questions could provide public health and healthcare officials with a method to compare significant variables between two populations. Doing so can offer a different lens when evaluating SDOH and longevity.

6 CONCEPTUAL FRAMEWORK

Several models were considered for this study. The area deprivation index (ADI)\textsuperscript{24, 25} focused on socioeconomic disadvantage and the differing dimensions of poverty. The North Carolina Institute of Public Health and the Carolinas HealthCare System developed a conceptual model–driven SDOH index that includes additional dimensions of health-related social needs, such as food accessibility; however, this index has not yet been validated against actualized health outcomes\textsuperscript{10}. Selecting the most suitable model depends on its ability to comprehensively capture the range of SDOH factors influencing life expectancy disparities in Collier and Marion Counties. None of the preceding models meet this criterion.

Other conceptual frameworks incorporate indicators with various applications for data collection, clinical use, and research (e.g., the World Health Organization’s framework, the Rural Community Health & Well-Being Framework, the public health framework for reducing health inequities [Bay Area Regional Health Inequities Initiative], Healthy People 2020, Keiser Family Foundation, and the Yoder framework)\textsuperscript{26}. The proxies used to assess SDOH in the models remain varied and unstandardized and may obfuscate the underlying factors involved in differential health outcomes\textsuperscript{26}. Each framework focuses on the SDOH and does not attempt to connect life expectancy directly to the model. Because of the singularity of purpose in each model, a conceptual framework for this study was developed to guide this study. The framework in Figure 1 provides the basis for the factors used to identify the broad categories and components that influence life expectancy.

In 2022, 238,869 individuals died in Florida – 178,895 (74.9%) from internal causes and 59,974 (25.1%) from external causes\textsuperscript{23}. Natural death is caused solely by disease or natural processes inside the body, like chronic diseases\textsuperscript{28}. External death takes place outside the body, like accidents, violence, or suicide. Premature mortality is defined as death before the age of 75 years\textsuperscript{10}. Aging increases an individual’s risk of developing chronic diseases. Having a family history of certain chronic diseases can increase risk.
7 METHODS

No single analysis can sufficiently explain the reasons for differences in life expectancy. This study uses comparative and regression analysis to understand how SDOH impacts life expectancy. Combining these methods contributes to 1) identifying relationships between SDOH and life expectancy, 2) controlling for other factors, 3) measuring the strength of association, and 4) assessing statistical significance. This approach provides a more comprehensive picture than a single method.

8 DATA SOURCES

The study employed a multi-analytical approach of comparing descriptive statistics, regression analysis, and causal inference techniques. The data profile for Collier and Marion counties was built from the following publicly available data sources:

1. the 2022 County Health Rankings & Roadmaps;
2. Florida Health Charts;

The latest published community health needs assessments (CHNAs) from both counties were used to provide context.

9 DEMOGRAPHIC ANALYSIS

1. demographic data from the U.S. Census Bureau was collected for both counties and converted to z scores using Florida averages;
2. linear regression explored the relationship between demographics and life expectancy, identifying potential confounders.

10 SDOH ANALYSIS

3. SDOH data from the U.S. Census Bureau was collected, validated, and loaded into SPSS Version 29.
4. data was standardized to z scores with a mean of 0 and a standard deviation of 1;
5. according to established rankings, SDOH factors were weighted based on their impact on health;
6. a comparative analysis highlights key SDOH differences between the counties.
11 LIFE EXPECTANCY ANALYSIS

1. data on internal causes of death (chronic diseases) and external causes (accidents, etc.) is collected for both counties and Florida;
2. data is validated and converted to z scores based on YPLL;
3. multiple linear regression analyzed the influence of SDOH factors on internal and external YPLL (separate analyses for each county);
4. regression coefficients are compared across counties to identify factors with the most substantial impact on life expectancy gaps.

12 RESULTS

RQ 1: How do the SDOH and demographic factors differ between the two Florida counties – Collier and Marion?

The relationship between chronic disease risk (z score Florida) and demographic characteristics in two counties (Collier and Marion) with similar population sizes was analyzed. Demographics showed significant differences between the counties (Table 1). Collier County has a higher life expectancy, more working-age adults, a more diverse population, and higher income. Marion County has a younger population, lower income, and less diversity.

The data were analyzed using a linear regression model. The model explained a high proportion of the variation in chronic disease risk ($R^2 = .979$). The analysis suggests a strong positive association between chronic disease risk and demographics in both counties ($\beta$ coefficients for Collier and Marion are positive). Marion County's demographics have a statistically more significant association with chronic disease risk than Collier County's (higher t-score for Marion's z score). This implies that the demographic makeup of Marion County has a stronger influence on chronic disease risk compared to Collier County (Table 2).

Based on the calculations from Table 2, Marion County has a higher premature death rate, poor physical and mental health days, lower birth rate, higher adult smoking and obesity rates, higher unemployment rate, and more injury deaths. These elements are linked by a complex web that can negatively impact a person's life expectancy. The interconnectedness between the significant SDOH shows a casual domino effect:

- low socioeconomic status (unemployment, low education). Limited access to healthy food and quality healthcare can lead to poor physical and mental health, manifesting as poor physical health days and poor mental health days;
poor physical and mental health. Chronic health conditions like obesity or mental health issues can make it difficult to maintain employment, creating a cycle of unemployment and financial strain;

financial strain. Financial stress can worsen mental health and limit access to healthy food and preventative healthcare. This, in turn, increases the risk of obesity, smoking, and poor physical health days;

poor health behaviors. Stress and financial strain can lead to unhealthy coping mechanisms like smoking or overeating, contributing to obesity and further health problems;

health consequences. Obesity, smoking, and poor overall health all increase the risk of chronic diseases, premature death, and injury deaths (accidents are more likely with certain health conditions);

low birthweight. Poor maternal health and nutrition can contribute to low birthweight babies. These babies are at a higher risk for chronic health issues later in life, potentially leading to poor physical health days and a higher risk of premature death. Each factor can worsen the others, creating a downward spiral. For example, unemployment can lead to poor mental health, which can lead to poor dietary choices and obesity, further impacting employability.

RQ 2: How much do the SDOH factors influence both counties' internal and external life expectancy outcomes?

SDOH factors influence both internal and external life expectancy outcomes. This question aims to understand how SDOH affects internal health and external deaths. Linear regression provides insights into this question. The analytic dashboard in Table 3 details how the data was used to reach the findings.

13 INTERNAL LIFE EXPECTANCY

Social determinants of health (SDOH) factors significantly impact life expectancy. Data from two counties was analyzed to understand the connection between SDOH and internal death factors (factors within a person affecting lifespan). The analysis focused on the top 26 internal factors and SDOH factors that together explained nearly 90% of premature deaths (under 75 years old) (see Table 4).

A regression analysis was used to assess how well SDOH factors explain variations in life expectancy due to internal causes. Collier County's model showed a stronger relationship (74% explained variability) than Marion County's (48% explained variability). This suggests that SDOH has a more substantial effect on life expectancy in Collier County. Despite some limitations, the analysis highlights the importance of SDOH in shaping health outcomes. Higher SDOH scores were linked to lower internal death factors, potentially impacting life expectancy.
Further investigation is needed to explore the specific SDOH variables influencing life expectancy and develop targeted solutions to address health disparities.

14 EXTERNAL LIFE EXPECTANCY

The analysis explores the relationship between social determinants of health (SDOH) and years of potential life lost (YPLL) from external deaths (unintentional injury, suicide, homicide, nutritional deficiencies, and medical and surgical care complications) (see Table 3). The R-squared values for Collier County (0.746) and Marion County (0.915) indicate a strong positive linear relationship between the predicted and observed values in the regression analysis. This means that the model's SDOH and external death variables can explain a substantial proportion of the variation in YPLL.

The SEE values (1.1262 for Collier County and 0.5912 for Marion County) suggest a moderate error between the predicted and actual YPLL values. However, the SEE is a small fraction of the overall data range for both counties, indicating that the prediction errors are relatively small. In Collier and Marion counties, the unexplained variance (residual sum of squares) is greater than zero, suggesting some unexplained variation in the data. This may be due to factors not included in the model. The F-statistic for Collier County is 2.942 with a p-value of 0.254, which is not statistically significant at the typical significance level (e.g., 0.05). This means that we cannot reject that there is no relationship between the independent and dependent variables in the model for Collier County.

The excerpt does not provide the F-statistic for Marion County, but the p-value (0.085) is marginally non-significant. This suggests that the model's explanatory power might not be statistically strong at a conventional significance level. The constant term (intercept) is statistically significant in both counties, indicating that it strongly influences the model even when both z scores are zero.

The coefficient for external deaths (z score 1) is marginally significant, with a positive beta in Collier County. This suggests a possible positive association between external deaths and YPLL, but more data or a stronger effect is needed for a definitive conclusion. In Marion County, the coefficient for external deaths is negative and marginally non-significant, suggesting a possible negative association, but again, more data or a stronger effect is needed. The coefficient for SDOH (z score 2) is not statistically significant in either county, and the beta values are relatively low. This suggests weak evidence for a relationship between SDOH and YPLL.

The analysis suggests a possible positive relationship between SDOH and YPLL from external deaths. However, more data or a more robust model might be needed for statistically significant results, especially for the SDOH variable. The findings regarding the relationship between external deaths and
YPLL are inconclusive. Further investigation is needed to clarify these relationships and identify other factors that may influence YPLL.

15 DISCUSSION

Although there is no single most important measure in a regression analysis, two key metrics stand out — $R^2$ and SEE. A higher $R^2$ suggests a better fit but does not necessarily mean a good model. However, $R^2$ does not tell the direction of the relationship (positive or negative). The SEE reflects the average difference between predicted and actual observed values. A lower SEE indicates a more precise model with predictions closer to the actual values. A high $R^2$ with a large SEE suggests that the model explains many variances, but the predictions might be far from the actual values. Conversely, a lower $R^2$ but a small SEE reflects that the model explains a smaller portion of the variance, but the predictions are likely more accurate.

Two additional factors were considered. First, the statistical significance of coefficients refers to the relationships between the independent and dependent variables that are statistically significant (usually measured by $p$-values). Second, does the model make sense conceptually, based on existing knowledge regarding longevity and age? By evaluating these factors, a better understanding of how well the model captures the relationship between the variables and its overall usefulness for prediction is achieved.

RQ 1: How do the SDOH factors differ between the two Florida counties – Collier and Marion?

Even though the population of both counties is about the same, there are differences within the data. Collier County has a higher life expectancy, a more significant population between 19 and 65 years of age, a more diverse population, and a higher median household income. Marion County has a lower life expectancy, a younger median age, more individuals under 19, fewer over 65, lower income, and a less diverse population.

The data suggests a strong link between demographics and chronic disease risk in the two Florida counties with similar populations. The linear regression indicates a good fit ($R^2 = .979$). This means the model explains most of the variation in chronic disease risk (dependent variable) based on demographics (independent variables). The z scores from Marion and Collier counties are positively associated with chronic disease risk, meaning higher scores correlate with higher risk. The z score Marion has a more substantial and statistically significant connection than the z score Collier. While both z scores show a positive association, the significance level for Collier County is borderline ($t = 2.042$). This means the Marion County demographics ($t = 2.467$) are more explicitly linked to chronic disease risk. Overall, the analysis highlights the importance of demographics in understanding chronic disease risk across these Florida counties.
RQ 2: How much do the SDOH factors influence both counties' internal and external life expectancy outcomes?

The first part of this research question examines how SDOH influences internal factors affecting life expectancy in the two counties. The analysis concentrates on the 26 most impactful internal factors (out of 300+) contributing to life expectancy reduction (measured in YPLL). These factors and SDOH explain nearly 89% of YPLL in both counties.

SDOH factors significantly influence internal causes of life expectancy disparities across both counties. The study provides valuable insights despite limitations in Marion County's model. Further analysis is recommended to explore the complete picture and develop solutions that address health issues rooted in social determinants of health. The study reveals a substantial link between SDOH and internal factors affecting life expectancy, emphasizing the importance of addressing social determinants to improve health outcomes. Collier County's model offers more substantial evidence, but both counties warrant further investigation for targeted solutions.

The second part of this research question examined how SDOH influences external factors affecting life expectancy in the two counties. There is a strong positive correlation between SDOH and YPLL in both counties. This means poorer social determinants are linked with higher YPLL from external causes. However, the Marion County model has a stronger correlation than Collier. The models predict YPLL reasonably well, but there is still some unexplained variation (error) between predicted and actual values.

While a positive association exists, the SDOH factor (z score 2) is not statistically significant in either county. This means other factors might affect the relationship between SDOH and YPLL. The study suggests a possible link between SDOH and YPLL, but more data or a more robust model might be needed to confirm a statistically significant cause-and-effect relationship. Overall, the study highlights a potential connection between social determinants of health and life expectancy lost to external causes. However, more research is needed to solidify this connection and explore the underlying mechanisms.

This research examined the life expectancy differences between Collier and Marion counties in Florida. The analysis highlights the role of social determinants of health (SDOH) in explaining this gap. The study's findings reconfirm that local data is crucial for understanding health disparities. SDOH significantly affects the life expectancy gap between Collier and Marion counties. The study acknowledges two limitations. First, the omission of confounding factors like genetics and lifestyle choices. Second, the use of linear regression may not fully capture complex relationships. Future research opportunities include analyzing a wider range of factors, especially SDOH, employing methods to account for confounding variables, and considering the non-linear relationships between variables. This study emphasizes the need for a comprehensive understanding of life expectancy variations. By addressing these limitations, policymakers can design better strategies to improve health equity and overall population health.
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