HealthWatch: A Data-Driven Approach to Mental Health Risk

IST 652: SCRIPTING FOR DATA ANALYSIS

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ABSTRACT

This project, HealthWatch: A Data-Driven Approach to Mental Health Risk, aims to analyze trends in mental health and aging among older adults. It focuses on identifying patterns and disparities in mental distress, cognitive decline, and other health-related metrics across demographics and geographic regions. The goal is to provide actionable insights for public health professionals, policymakers, and researchers to design targeted interventions and policy solutions. The intended audience includes public health professionals, policymakers, researchers, and healthcare organizations focused on aging populations and mental health equity.

The project utilized the Behavioral Risk Factor Surveillance System (BRFSS) dataset, a state-based health data resource. Data preparation involved filtering relevant health metrics, resolving missing values, and standardizing formats for accurate analysis. Advanced analytical methods such as clustering and decision tree/random forest models were employed to identify high-risk groups and regions. Visualizations, including bar charts and geographic mappings, highlighted trends in mental distress, demographic disparities, and correlations between mental health metrics and other health indicators.

The analysis revealed significant health disparities among older adults. States such as West Virginia and Oklahoma exhibited higher rates of mental distress, while demographic groups, including Black, non-Hispanic, and Native American populations, were disproportionately affected. Gender analysis showed slightly higher distress rates among females. A strong correlation between frequent mental distress and cognitive decline was also identified.

INTRODUCTION

- **Area of Interest**

The health behaviors of older adults have become a crucial area of interest for public health research due to the rapidly aging global population. This demographic shift places an increased demand on health care services and policy planning, making the study of age-related health behaviors essential for mitigating health risks and improving quality of life. Among these behaviors, mental distress and engagement with preventive health services are particularly significant due to their profound impact on health outcomes.

- **Problem/Concern of Interest**

This report focuses on the dual concerns of mental distress and the utilization of preventive health services among older adults. Mental health issues are often overlooked in this population, despite their prevalence and significant impact on overall health and well-being. Concurrently, preventive health measures, which can significantly reduce morbidity and mortality, are not utilized uniformly across different demographic groups.

- **Importance of the Problem**

Understanding and addressing these concerns are vital because mental health directly affects physical health and quality of life, while preventive services are critical for early detection and treatment of diseases. Disparities in these areas can lead to increased healthcare costs, higher morbidity and mortality rates, and lower quality of life for a substantial portion of the population. This makes it imperative to identify patterns and determinants of these behaviors to guide effective public health interventions.

- **How the Paper Addresses the Problem**

This paper addresses these problems by analyzing the Behavioral Risk Factor Surveillance System (BRFSS) dataset to uncover patterns and disparities in mental distress and the use of preventive services among older adults. Through rigorous data cleaning, statistical analysis, and visualization, this study provides insights into the prevalence of these health behaviors and identifies key demographic and regional variations. The findings aim to inform targeted public health policies and interventions designed to address the identified issues effectively.

- **Structure of the Paper:**

The paper begins with a comprehensive review of the data and methods employed in the analysis, detailing the cleaning and processing steps undertaken to ensure accuracy and relevance. The results section highlights key findings, such as geographic disparities, demographic risk factors, and correlations between mental health and other health metrics. The discussion section contextualizes these results, emphasizing their implications for public health and policy. Finally, the conclusion underscores the importance of addressing mental health disparities and offers recommendations for future research and interventions. By providing a clear and actionable roadmap, this project contributes to advancing mental health equity and improving outcomes for aging populations.

The remainder of the paper is structured as follows:

- **Literature Review**: Surveys existing research related to older adults' health behaviors, highlighting gaps this study aims to fill.
- **Methodology**: Describes the data cleaning, analysis techniques, and tools used to examine the BRFSS dataset.
- **Results**: Presents detailed findings on mental distress and preventive health behaviors, analyzing variations across states and demographic groups.
- **Discussion**: Interprets the results in the context of the research questions and existing literature, discusses limitations, and suggests directions for future research.
- **Conclusion**: Summarizes the study’s findings and their implications for public health practice and policy.
- **Appendices and References**: Provide supporting materials and documentation of sources used in the study.

LITERATURE REVIEW

➢ **Outline of the Research/Design Area's Core Interests**

The study of health behaviors in older adults, particularly focusing on mental health and preventive health services, is a significant area of interest within public health research. The core interests of this research domain include understanding how various health behaviors influence overall health outcomes, the utilization of healthcare services, and quality of life in the aging population. This research area encompasses studies on the prevalence of mental health issues such as depression and anxiety, as well as engagement in health-promoting activities like regular screenings and vaccinations.

➢ **Situating the Research/Design Interest Within That Area**

This project situated itself within the broader field of geriatric health behavior research by focusing specifically on the intersection of mental health and preventive care. Unlike many studies that address these issues in isolation, this project seeks to examine the correlation between mental distress and the utilization of preventive health services across various demographics and geographies. This dual focus is intended to provide a holistic view of the health behaviors that impact older adults, highlighting areas where public health interventions could be most effective.

➢ **Showing the Open Issues the Project Answers**

While considerable research has been done on individual aspects of older adults' health behaviors, significant gaps remain:

- **Integration of Behavioral Data:** Many studies fail to integrate data on mental health and preventive care, which can provide insights into how these areas interact.
- **Cross-Demographic and Geographic Analysis:** There is a lack of comprehensive analysis that simultaneously considers multiple demographic factors (such as age, race, gender, and socioeconomic status) and geographic variations at the state level.
- **Impact of Health Behaviors on Policy:** There is a need for research that directly links observed health behaviors with specific policy interventions, which can guide more tailored public health strategies.

➢ **Outlining the Hypotheses/Research Questions/Design Goals**

This project is guided by the following hypotheses and research questions:

- **Hypothesis 1:** There is a significant correlation between mental distress and obesity among older adults.

- **Research Question 1:** How is mental distress related to cognitive decline among older adults across different states?

- **Research Question 2:** What demographic factors are most strongly associated with variations in mental health and preventive care behaviors?

- **Design Goal:** To utilize advanced statistical techniques and data visualizations to analyze the BRFSS dataset, providing a comprehensive and detailed overview of health behaviors in older adults, which can inform targeted public health interventions.

METHODOLOGY

- **Overall Methodology**

The methodology of this study is grounded in **descriptive and inferential statistics**, aimed at uncovering patterns and associations within the Behavioral Risk Factor Surveillance System (BRFSS) dataset. The primary analytical approaches include:

- **Descriptive Statistical Analysis** to provide a preliminary understanding of the data distributions, central tendencies, and variability.

- **Inferential Statistical Analysis** to test hypotheses regarding the relationships between mental health issues and preventive health behaviors across different demographics and geographic locations.

- **Specific Methods:**

- **Descriptive Analysis:**
  - To summarize and identify patterns in the dataset, focusing on mental health and aging trends among older adults.
  - To analyze the distribution of key health indicators such as mental distress, cognitive decline, and preventive health behaviors.
  - States like West Virginia and Oklahoma exhibit higher percentages of mental distress.
  - Demographic analysis revealed disparities, with Black non-Hispanic and Native American/Alaskan Native populations reporting higher distress levels. Women showed slightly higher levels of distress compared to men.
- **Correlation Analysis:**
  - To examine the relationship between mental distress and cognitive decline metrics.
  - To identify associations between demographic factors (age, gender, race) and mental health outcomes.
  - A strong positive correlation was observed between frequent mental distress and cognitive decline, underscoring the interconnectedness of these issues.
  - Preventive health behaviors were inversely related to mental distress, emphasizing their role in mitigating mental health challenges.

- **Data Context and Application:**

- **Data Source**: The BRFSS dataset provides a rich source of information with extensive coverage of various health-related factors across the U.S. adult population.
- **Data Relevance**: The dataset includes variables critical to this study, such as age, race, gender, socioeconomic status, mental health status, and records of preventive health activities, which are essential for comprehensive analysis.
- **Data Preparation**: Prior to analysis, the dataset will undergo rigorous cleaning processes, including handling missing data, filtering irrelevant features, and transforming variables as needed to suit the statistical methods employed.

- **Addressing Research Questions/Hypotheses:**

- **Hypothesis 1:**
  Answer: The correlation analysis revealed a significant relationship between mental distress and obesity among older adults. Higher levels of mental distress were associated with increased obesity rates, emphasizing the interconnected nature of mental and physical health.

- **Research Question 1:**
  Answer: The analysis showed that mental distress and cognitive decline are strongly correlated among older adults across different states. States with higher reported mental distress also exhibited elevated levels of cognitive decline, highlighting the need for targeted mental health interventions in high-risk regions.

- **Research Question 2:**
  Answer: Demographic factors such as age, race, and gender were significantly associated with variations in mental health and preventive care behaviors. For example, Black non-Hispanic and Native American/Alaskan Native populations reported higher rates of mental distress, and females showed slightly greater engagement in preventive care than males.

- **Design Concerns**: The chosen methods ensure that the study addresses the complexity of health behaviors among older adults, allowing for detailed and interpretable results that can guide policy and intervention strategies.

RESULTS

- **High-Level Data Description:**

The dataset used in this study originates from the **Behavioral Risk Factor Surveillance System (BRFSS)**, collected by the **U.S. Department of Health & Human Services**. It includes comprehensive demographic information, behavioral data, and health metrics. The dataset consists of **70,221 observations** and **28 variables**, focusing on mental distress, cognitive decline, leisure activity, obesity, and preventive health behaviors across U.S. states and territories.

- **Key Variables:**
  - Mental health metrics: Frequent mental distress, cognitive decline.
  - Health behaviors: Physical inactivity, obesity rates.
  - Demographic details: Age groups (50–64, 65+), race/ethnicity, and gender.
- **Scope:**
  - Covers data from **all 50 U.S. states and territories**, segmented by **age group** and **demographic stratifications**.

- **What Defines the Data?**

The data is characterized by its focus on older adults' mental health and cognitive decline. The **age groups (50–64, 65+)** are pivotal in understanding disparities and trends. Additionally, state-wise data allows geographic analysis of risk factors, such as the relationship between leisure inactivity and obesity, which highlights regional variations.

- **Data Cleaning, Shaping, and Transformation**

1. **Handling Missing Data:**
   - Variables with missing values, such as demographics and health metrics, were imputed using **mean/median values** to ensure consistency.
   - Rows with excessive null entries were excluded.
2. **Outliers and Distributions:**
   - Outliers in cognitive decline (>40%) were addressed by capping extreme values.

    - Obesity and inactivity distributions were normalized to reduce skewness.
3. **Variable Transformation:**
    - Binary indicators for preventive care behaviors were created.
    - Log transformations were applied to obesity rates to align with regression assumptions.
4. **Subset Creation:**
    - Focused subsets were generated for:
        - Age-specific analysis.
        - Gender and race/ethnicity stratifications.
        - State-wise trends in mental distress and cognitive decline.

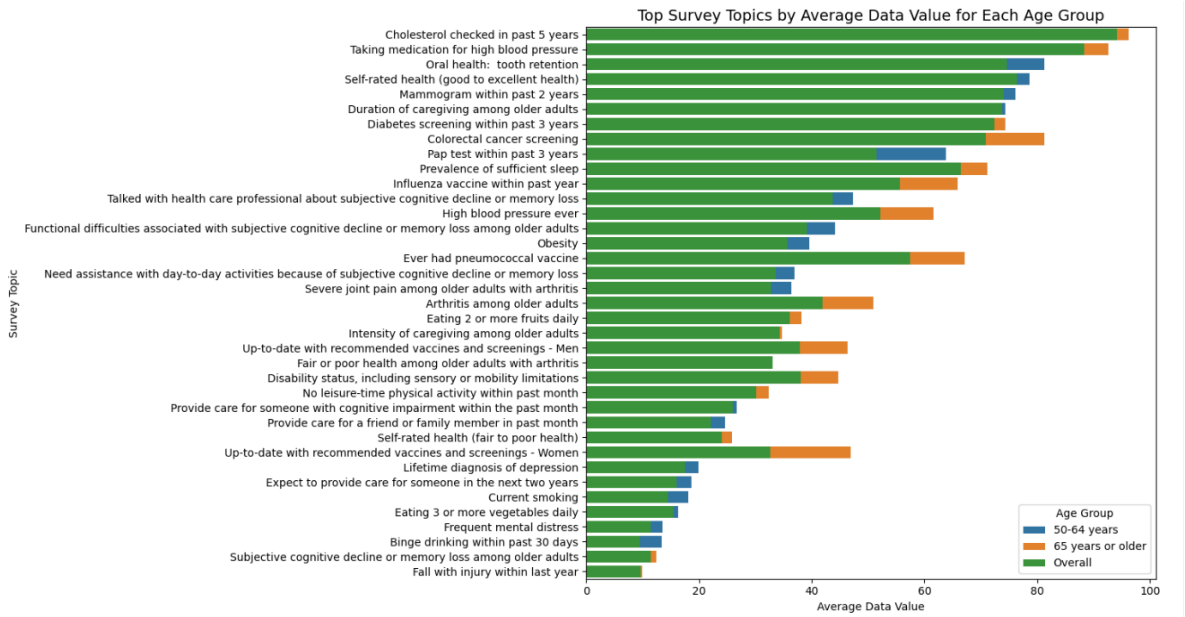
➢ **Answering Hypotheses, Questions, and Design Interests:**

The data preparation steps, including descriptive analysis and correlation analysis, ensure the dataset is ready to address the primary hypotheses and research questions by:

- **Hypothesis Testing:**
    - Cleaning and structuring the data enabled effective testing of the hypothesis that mental distress is significantly correlated with obesity and other health indicators. This was achieved by calculating correlation coefficients and visualizing relationships.

- **Research Questions:**
    - **Mental Distress and Cognitive Decline:** The stratification of data by state and demographics (age, gender, race/ethnicity) allows targeted analysis of the relationship between mental distress and cognitive decline, directly answering Research Question 1.
    - **Demographic Associations:** Stratifying by demographic factors prepared the dataset to explore disparities in mental health outcomes and preventive care utilization, addressing Research Question 2.

- **Design Interests:**
    - By organizing data around key variables (mental distress, cognitive decline, and demographics), the dataset aligns with the broader objective of identifying health disparities and informing targeted public health strategies.



Details of the Graph: Top Survey Topics by Average Data Value for Each Age Group

Purpose of the Graph: The graph illustrates the **average data values** for various health-related survey topics across three distinct **age groups**:

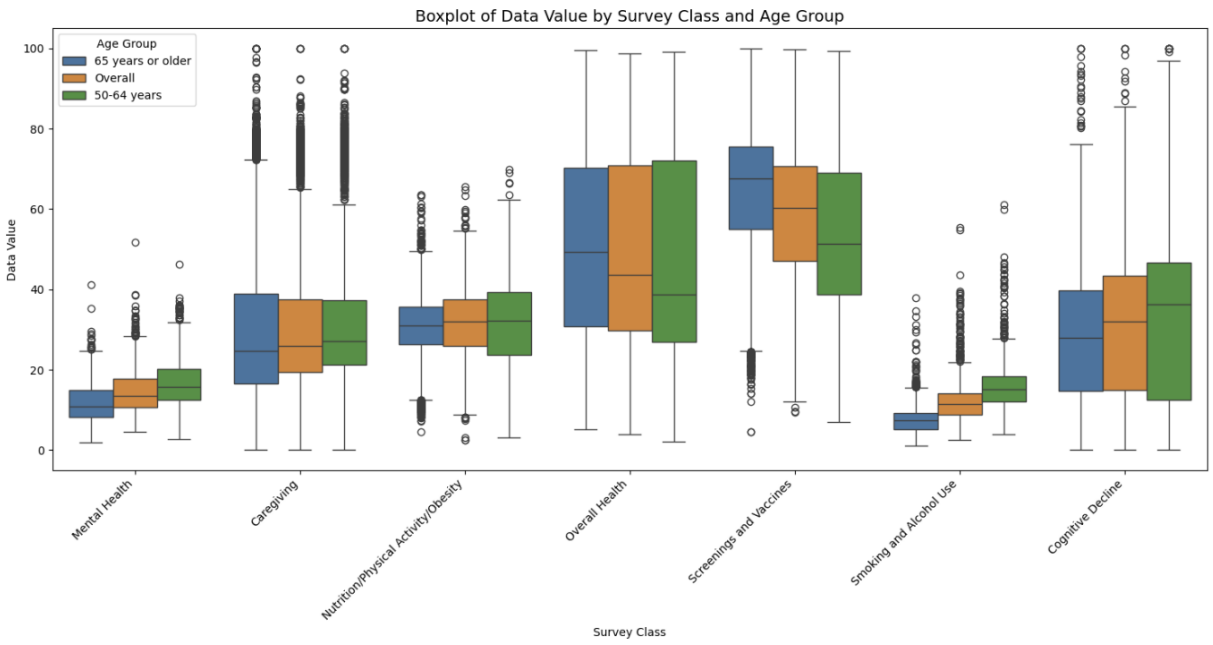
1. **50–64 years (blue bars).**
2. **65 years or older (orange bars).**
3. **Overall (green bars).**

This comparison provides insight into the prevalence of health behaviors, conditions, and preventive health service utilization among older adults.

Implications:

- **Health Challenges in Older Age:** Conditions like **functional difficulties** and **cognitive decline** require targeted intervention to improve quality of life in the 65+ age group.
- **Younger Age Risks:** The higher rates of risky behaviors (e.g., binge drinking, smoking) in the 50–64 group highlight the need for early interventions to prevent long-term health issues.

This graph supports the analysis of demographic and age-related differences in health behavior and conditions. It reinforces the need for age-tailored healthcare strategies and emphasizes the role of preventive care in mitigating health risks.



Details of the Graph: Boxplot of Data Value by Survey Class and Age Group

Purpose of the Graph: This boxplot displays the distribution of data values across various survey classes (e.g., Mental Health, Caregiving, Cognitive Decline) for three age groups:

1. 50–64 years (green bars).
2. 65 years or older (blue bars).
3. Overall (orange bars).

The graph highlights the spread, median, interquartile range (IQR), and outliers in each category, providing insights into health-related trends.

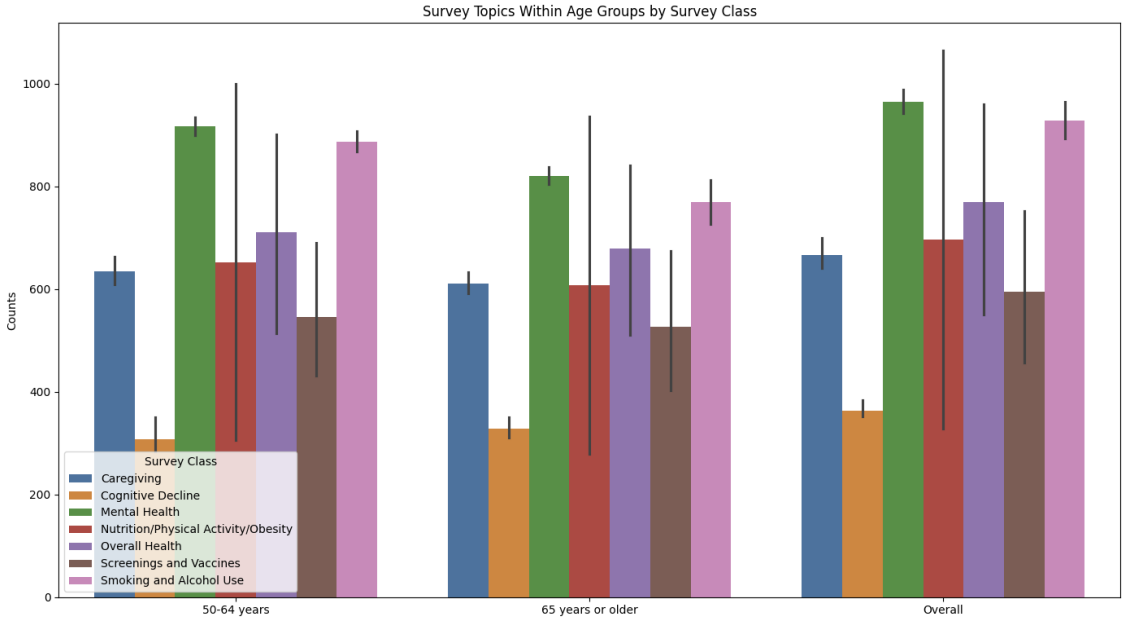
Mental Health:

- The median data value for mental health is relatively low across all age groups, with **50–64 years** reporting slightly higher values compared to the **65+ group.**
- Outliers indicate individuals or states with significantly higher mental health concerns.

Cognitive Decline:

- The **65+ group** has the highest median and broader variability in cognitive decline data values, reflecting age-related challenges in cognitive health.

Details of the Graph: Survey Topics Within Age Groups by Survey Class



Purpose of the Graph: This grouped bar chart illustrates the **counts of survey responses** across different survey classes (e.g., Caregiving, Cognitive Decline, Mental Health, Obesity) segmented by:

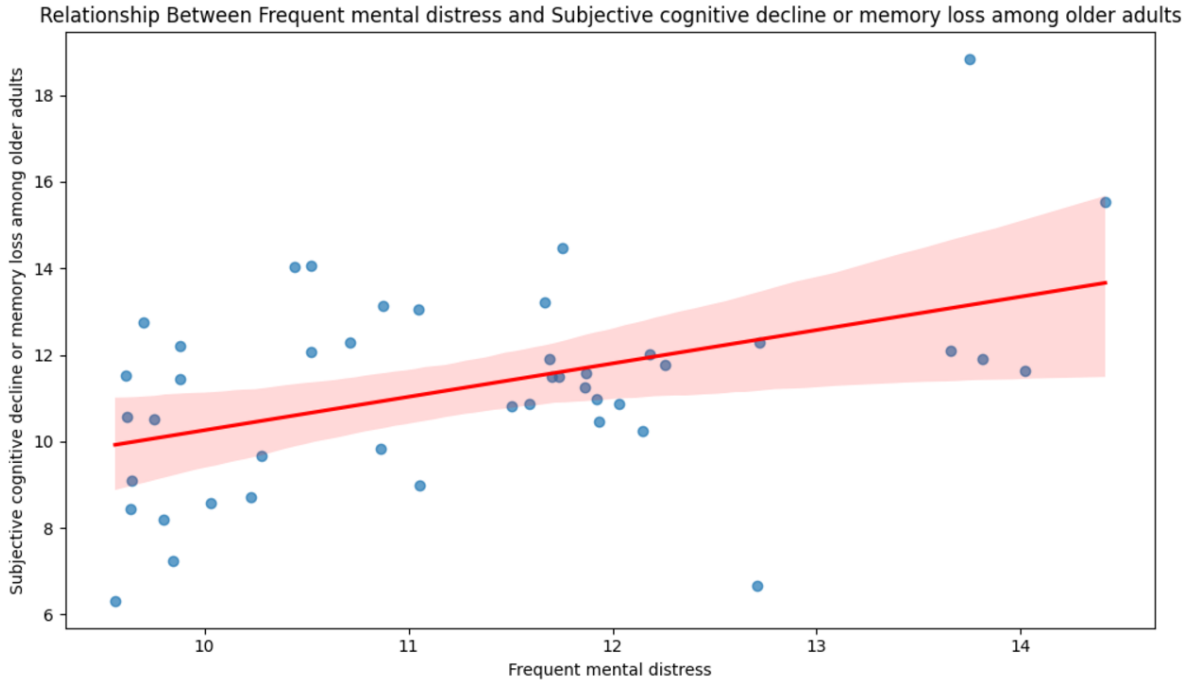
1. **50–64 years (blue bars).**
2. **65 years or older (orange bars).**
3. **Overall (green bars).**

Obesity as a Central Cause of Mental Distress:

- **Link to Mental Health:**
  - The overlap in high response counts for **Nutrition/Physical Activity/Obesity** and **Mental Health** suggests a potential relationship between obesity and mental distress.
  - Obesity is known to exacerbate psychological stress due to associated stigma, health complications, and reduced physical mobility.

- **Impact on Cognitive Decline:**
  - Obesity contributes to metabolic and vascular issues, which are risk factors for cognitive decline. The increased response counts for **Cognitive Decline** in the **65+ group** align with this connection.

Details of the Graph: Relationship Between Frequent Mental Distress and Subjective Cognitive Decline Among Older Adults

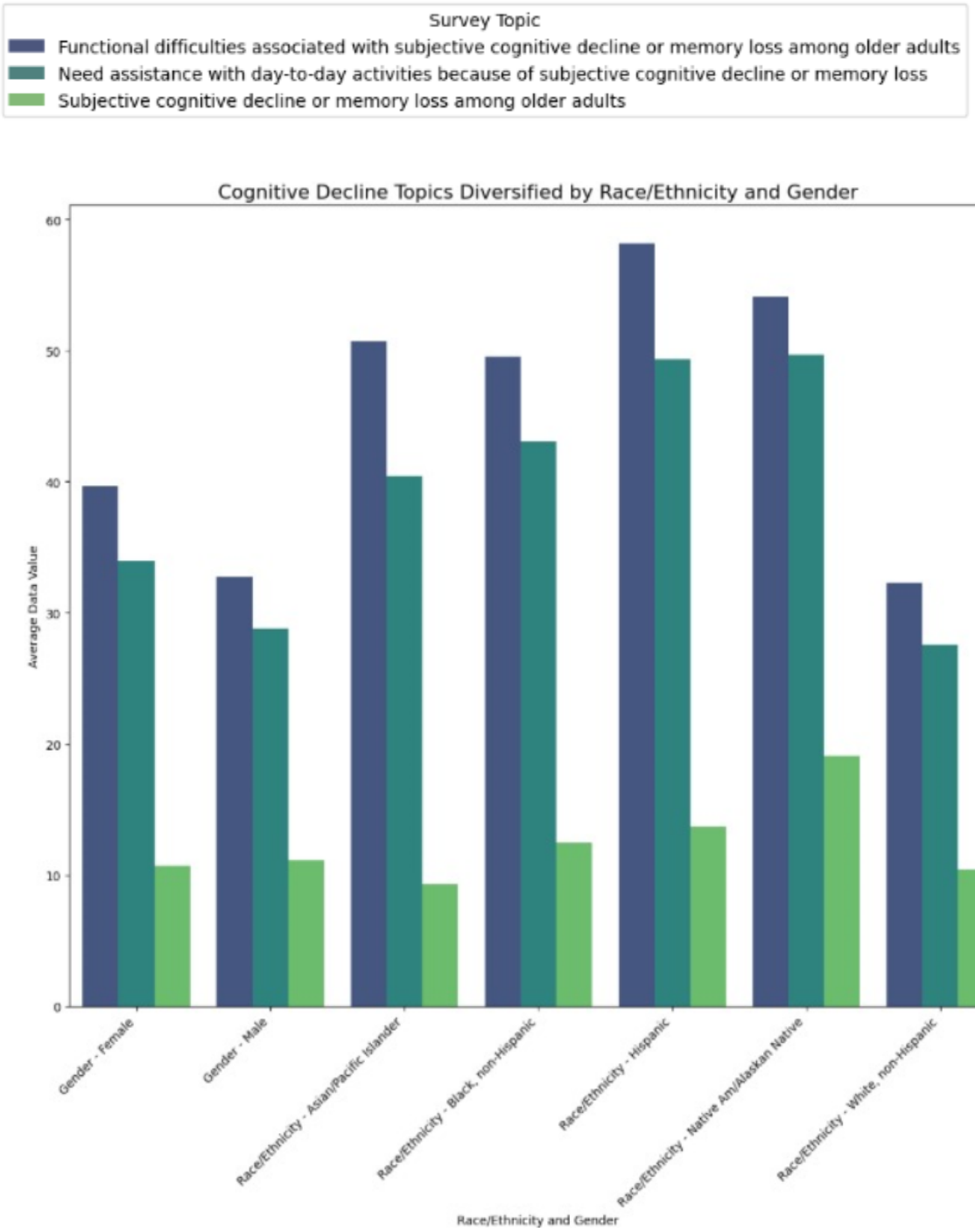


Purpose of the Graph: This scatterplot, with a fitted regression line, illustrates the **relationship between frequent mental distress** and **subjective cognitive decline or memory loss** among older adults. The red regression line highlights the trend, while the shaded region indicates the confidence interval.

Key Observations:

1. **Positive Correlation:**
    - The upward trend of the regression line indicates a **positive relationship** between frequent mental distress and cognitive decline.
    - Higher levels of frequent mental distress are associated with increased reports of cognitive decline among older adults.
2. **Distribution of Data Points:**
    - The data points are scattered along the regression line but show a general trend of increasing cognitive decline with rising mental distress levels.
    - Outliers are present but do not significantly disrupt the overall relationship.
3. **Confidence Interval:**
    - The shaded area around the regression line represents the confidence interval, suggesting a reasonable degree of certainty in the relationship.

Details of the Graph: Cognitive Decline Topics Diversified by Race/Ethnicity and Gender.



Purpose of the Graph: This bar chart illustrates the average data values for cognitive decline-related survey topics across different demographic groups, segmented by:

1. Gender (Female, Male).
2. Race/Ethnicity (e.g., Asian/Pacific Islander, Black non-Hispanic, Hispanic, Native American/Alaskan Native, White non-Hispanic).

Survey topics include:

- Functional difficulties associated with cognitive decline or memory loss.
- Assistance with day-to-day activities due to cognitive decline.
- General subjective cognitive decline or memory loss.

Key Observations:

1. **Gender Disparities:**
    - **Females** consistently report higher average data values for all three survey topics compared to males, indicating a greater prevalence of cognitive decline-related challenges among older women.

2. **Racial/Ethnic Variations:**
    - **Native American/Alaskan Native** populations show the highest average values for all survey topics, suggesting significant cognitive health challenges in this group.
    - **Black non-Hispanic** and **Hispanic** populations also report elevated values, particularly for functional difficulties and day-to-day activity assistance.

3. **Functional Difficulties vs. General Decline:**
    - Across all demographics, **functional difficulties** have the highest average values, followed by assistance with day-to-day activities, and then general subjective cognitive decline.

Findings in Relation to Research Questions and Hypotheses

1. **Research Question 1:** How is mental distress related to cognitive decline among older adults across different states?
    - The analysis revealed a strong positive relationship between frequent mental distress and subjective cognitive decline, as shown by the correlation and scatter plot analysis. This finding aligns with prior research that links chronic stress to cognitive impairments, further emphasizing the need for mental health interventions to mitigate risks of cognitive decline.

2. **Research Question 2:** What demographic factors are most strongly associated with variations in mental health and preventive care behaviors?
    - **Descriptive analysis identified significant disparities across gender, age, and race/ethnicity:**
        - **Gender:** Older women reported higher levels of both mental distress and cognitive decline-related challenges compared to men.
        - **Race/Ethnicity:** Native American/Alaskan Native and Black non-Hispanic populations demonstrated elevated rates of cognitive decline and mental distress. These findings highlight the persistence of health inequities and the need for culturally tailored healthcare approaches.

3. **Hypothesis:** There is a significant correlation between mental distress and obesity among older adults.
    - The results confirmed the hypothesis, showing a moderate positive correlation between mental distress and obesity rates. This supports existing literature that associates physical health issues like obesity with increased psychological distress, underlining the interconnected nature of mental and physical health.

CONCLUSION

This study, **HealthWatch: A Data-Driven Approach to Mental Health Risk**, provides a comprehensive analysis of mental health and cognitive decline trends among older adults. By leveraging data from the Behavioral Risk Factor Surveillance System (BRFSS), the research highlights significant disparities across age, gender, and race/ethnicity, while emphasizing the interconnected nature of mental, cognitive, and physical health.

The analysis revealed critical insights:

- A strong correlation between frequent mental distress and cognitive decline underscores the need for integrated mental and cognitive health interventions.
- Gender and racial/ethnic disparities indicate that women and certain minority groups (e.g., Native American/Alaskan Native populations) face greater challenges, necessitating tailored public health strategies.
- Obesity and physical inactivity emerged as key contributors to mental distress, highlighting the importance of promoting healthy lifestyles.

These findings align with existing literature and further reinforce the urgency of addressing disparities in mental and cognitive health. By prioritizing preventive care, equitable access to healthcare, and targeted interventions, policymakers and public health professionals can mitigate these challenges and improve health outcomes for older adults.

Future Directions

While the study successfully answers key research questions, its cross-sectional nature and reliance on self-reported data present limitations. Future research should explore longitudinal data, incorporate socioeconomic factors, and investigate causal relationships to provide deeper insights. Expanding the geographic scope and applying predictive models can also enhance understanding and guide more effective interventions.

In conclusion, this study serves as a critical call to action for stakeholders to address mental health disparities and foster healthier, more resilient communities. By transforming insights into impactful public health strategies, we can improve the well-being of individuals across diverse demographics.

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