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Module 15 Project: Final Submission—Data Analysis Report

Topic: Analyzing Global Suicide Trends and Economic Factors

Previously research about this subject:
Considering that over 700,000 individuals die from suicide annually [1], understanding the patterns of this phenomenon is crucial. Previously, research has established that while the overall number of suicide deaths has risen globally, the age-standardized mortality rate from suicide has decreased [2], suggesting demographic changes influence global suicide trends. Additionally, studies, such as those examining the aftermath of the 2008 global economic crisis, have identified a correlation between economic downturns and increased suicide rates in some countries [3], highlighting the significant impact of economic factors on suicide trends.

Questions to answer (hypotheses):
The project will focus on answering three pivotal questions, each accompanied by a hypothesis rooted in the preliminary findings of previous studies and the dataset's potential to provide insights:

- **Economic Factors' Influence:** How do economic conditions, indicated by Gross Domestic Product (GDP) per capita, influence suicide rates across different countries?
  Hypothesis: There exists a nuanced, potentially inverse relationship between a nation's economic health (as measured by GDP per capita) and its suicide rates. This relationship is anticipated to vary across countries with differing economic statuses, providing insight into how financial prosperity or distress impacts mental well-being on a global scale.
- **Age-Specific Suicide Trends:** What patterns emerge in suicide rates when analyzed across different age groups globally?
  Hypothesis: Specific age groups are disproportionately affected by suicide, with the vulnerability of each group influenced by distinct socio-economic and psychological pressures. This project aims to delineate these age-specific trends to inform targeted prevention efforts.
- **Gender Disparities in Suicide Rates:** How do suicide rates differ between genders across various socioeconomic contexts, and what factors contribute to these disparities?
  Hypothesis: A "gender paradox" exists in suicide rates, with men exhibiting higher rates of suicide despite lower reported instances of depression compared to women. This disparity is hypothesized to stem from a complex interplay of cultural, societal, and economic factors.

Planned data:
The plan was to utilize a comprehensive dataset from Kaggle, specifically tailored for analyzing global suicide trends. This dataset was expected to include fields such as country, year, sex, age group, the count of suicides, and various socio-economic indicators like GDP and HDI.

Data actually explored, and how it differed from the planned data:
The actual dataset explored was the "Suicide Rates Overview 1985 to 2016" from Kaggle [4], which aligned well with the planned dataset. However, a significant deviation was the considerable number of missing entries in the 'HDI for year' column, affecting nearly 70% of the dataset. This limitation might have influenced the depth of analysis regarding the impact of human development on suicide trends.

Data source:
The data was obtained from Kaggle, an online platform that serves as a hub for data scientists and machine learning practitioners, offering a diverse range of datasets for various analytical projects.

Data metrics:
The dataset consists of 27,820 entries, organized into 12 distinct categories. These categories are:

- country (String): Represents the geographical area of the data.
- year (Integer): The period when the data was collected.
- sex (String): The gender of the individuals, male or female.
- age (String): Age groups classified into specific brackets.
- suicides_no (Integer): The total number of suicides recorded.
- population (Integer): The total number of people for each subgroup.
- suicides/100k pop (Float): The rate of suicides per 100,000 people.
- country-year (String): A unique identifier for each entry.
- HDI for year (Float): The Human Development Index for each given year.
- gdp_for_year ($) (String): The Gross Domestic Product of the country.
- gdp_per_capita ($) (Integer): GDP adjusted for population size.
- generation (String): Defined by the average age group of the population.

In terms of missing data, the 'HDI for year' category lacks entries for 19,456 data points, while all other categories are complete.

<u>Global Suicide Trend</u>

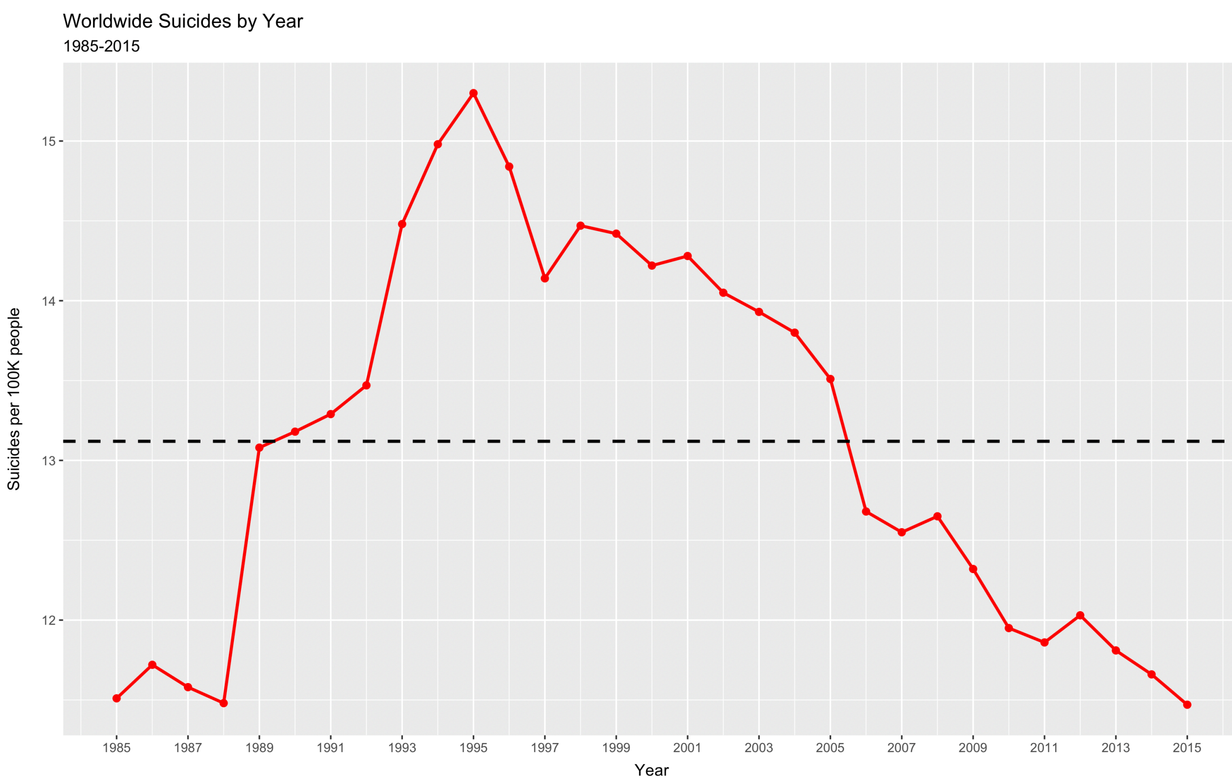
R Code:

```
# Import necessary libraries
library(dplyr)           # For data manipulation
library(countrycode)     # For country name conversion
library(tibble)          # For data frames as tibbles
library(ggplot2)         # For data visualization
library(viridis)         # For color scales in plots
library(sf)              # 'sf' for handling spatial data in simple features format
library(rnaturalearth)   # 'rnaturalearth' to access natural earth map data

# Load and clean the data
data <- read.csv("master.csv") %>%
  filter(year != 2016, # Remove data for 2016 and countries with 0 data
       country != 'Dominica', # Exclude data for Dominica
       country != 'Saint Kitts and Nevis') %>% # Exclude data for Saint Kitts and Nevis
  # Standardize country names to ensure consistency
  mutate(country = recode(country,
                    "Bahamas" = "The Bahamas",
                    "Cabo Verde" = "Cape Verde",
                    "Republic of Korea" = "South Korea",
                    "Russian Federation" = "Russia",
                    "Serbia" = "Republic of Serbia",
                    "United States" = "United States of America"))

# Reorder levels of the 'age' column for proper ordering in plots and analysis
data$age <- factor(data$age, levels = c("5-14 years", "15-24 years", "25-34 years", "35-54
years", "55-74 years", "75+ years"))

# Create a tibble summarizing yearly statistics on suicide rates
overall_tibble <- data %>%
  select(year, suicides_no, population) %>%
  group_by(year) %>%
  summarize(suicide_capita = round((sum(suicides_no) / sum(population)) * 100000, 2)) #
Calculate suicides per 100,000 people and round off

# Create a line plot to visualize the trend of suicide rates over years
global_average <- mean(overall_tibble$suicide_capita) # Calculate the global average suicide
rate

ggplot(overall_tibble, aes(x = year, y = suicide_capita)) +
  geom_line(color = "red", linewidth = 1) + # Red line for trend
```

```
geom_point(color = "red", size = 2) + # Red points for each year
geom_hline(yintercept = global_average, color = "black", linetype = "dashed", linewidth = 1) +
labs(
  title = "Worldwide Suicides by Year",
  subtitle = "1985-2015",
  x = "Year",
  y = "Suicides per 100K people"
) +
scale_x_continuous(breaks = seq(1985, 2015, 2)) +
scale_y_continuous(breaks = seq(10, 20))
```

Plot:

A line plot is ideal for showing continuous data over time, allowing for easy visualization of trends and patterns in suicide rates across multiple years.



Analysis:

- The peak global suicide rate was observed in 1995, reaching 15.3 deaths per 100,000 people.
- The average global suicide rate over the period from 1985 to 2015 was 13.15 deaths per 100,000 people annually, as indicated by the dashed line on the graph.

- After reaching its peak in 1995, the suicide rate has shown a steady decline, falling to 11.5 deaths per 100,000 people by 2015, marking a 25% reduction from the peak.
- This decreasing trend has returned the suicide rates to levels similar to those before the increase in the early 1990s.
- Data from the 1980s is less reliable and should be approached with caution, as it might not provide an accurate representation of the global situation during that era.

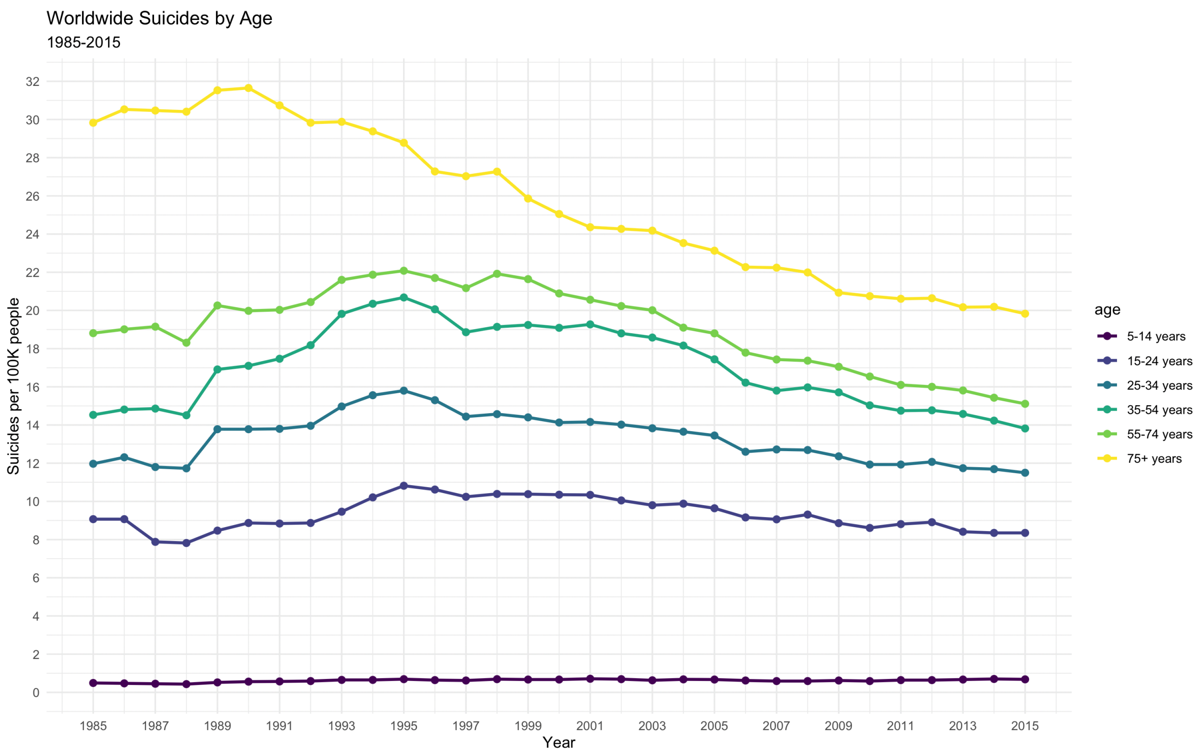
<u>Global Suicides by Age</u>

R Code:

```
# Select relevant columns and group data by year and age to calculate suicide rates per 100,000
individuals
age_tibble <- data %>%
  select(year, age, suicides_no, population) %>%
  group_by(year, age) %>%
  summarize(suicide_capita = round((sum(suicides_no) / sum(population)) * 100000, 2), .groups
= "drop") # Compute suicide rates

# Create a line plot
ggplot(age_tibble, aes(x = year, y = suicide_capita, color = age)) +
  geom_line(size = 1) +
  geom_point(size = 2) +
  labs(
    title = "Worldwide Suicides by Age",
    subtitle = "1985-2015",
    x = "Year",
    y = "Suicides per 100K people"
  ) +
  scale_color_viridis_d() +
  scale_x_continuous(breaks = seq(1985, 2015, 2)) +
  scale_y_continuous(breaks = seq(0, 40, 2)) +
  theme_minimal()
```

Plot:

Using a line plot helps track changes in suicide rates across different age groups over time, revealing potential age-related trends or shifts in the data.



Analysis:

- The analysis demonstrates a clear relationship between age and suicide rates globally, with older age groups generally showing higher rates of suicide.
- Since 1995, there has been a consistent downward trend in suicide rates among all age groups starting from age 15 and upwards.
- There has been a significant reduction in suicide rates among those aged 75 and older, with rates halving since 1990.
- The suicide rates for the youngest age group, those between 5 and 14 years old, have remained low and relatively stable, typically staying below 1 incident per 100,000 individuals annually.

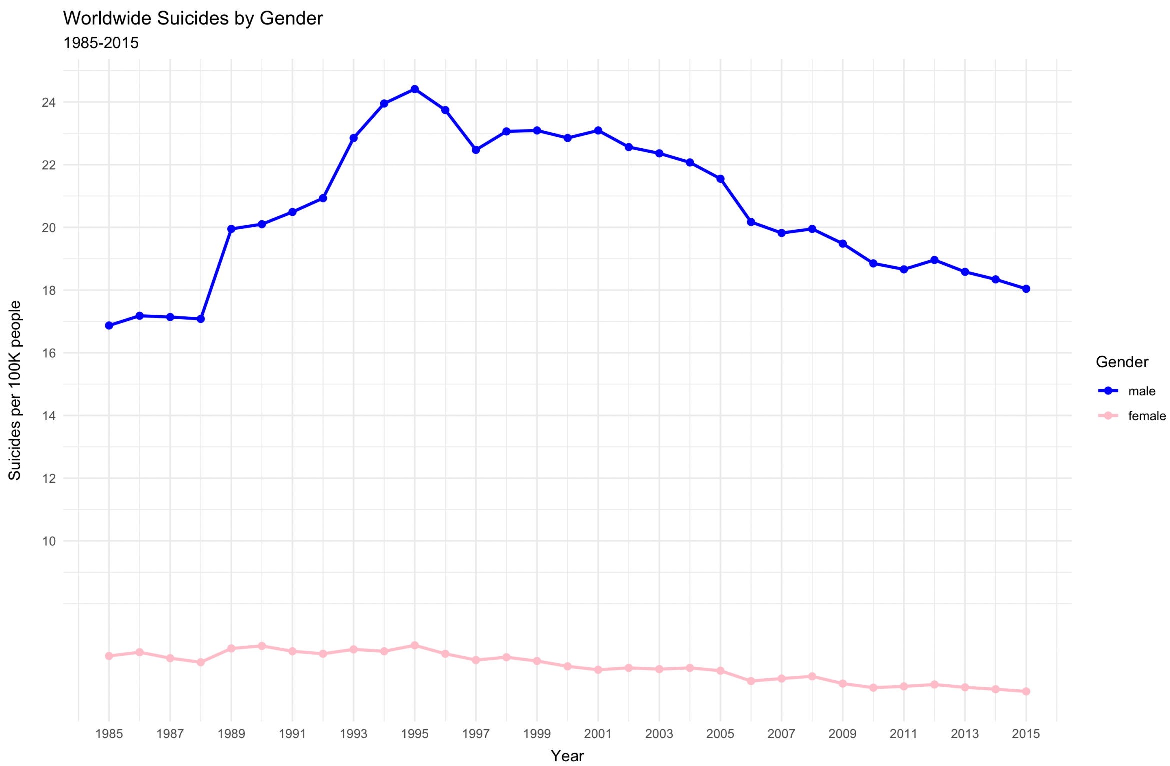
Global Suicides by Gender

R Code:

```
# Convert the 'sex' column to a factor with specified levels to ensure accurate categorization
data$sex <- factor(data$sex, levels = c("male", "female"))

# Select relevant columns and compute the suicide rate per 100,000 people grouped by year
and sex
sex_tibble <- data %>%
  select(year, sex, suicides_no, population) %>%
  group_by(year, sex) %>%
  summarize(suicide_capita = round((sum(suicides_no) / sum(population)) * 100000, 2), .groups
= "drop") # Calculate and round suicide rates

# Create a line plot with specific color settings to distinguish between genders
ggplot(sex_tibble, aes(x = year, y = suicide_capita, color = sex)) +
  geom_line(size = 1) +
  geom_point(size = 2) +
  labs(
    title = "Worldwide Suicides by Gender", # Main title of the plot
    subtitle = "1985-2015",
    x = "Year",
    y = "Suicides per 100K people",
    color = "Gender"
  ) +
  scale_color_manual(values = c("female" = "pink", "male" = "blue")) +
  scale_x_continuous(breaks = seq(1985, 2015, 2)) +
  scale_y_continuous(breaks = seq(10, 40, 2)) +
  theme_minimal()
```

Plot:

A Line plot is useful for observing how suicide rates may differ between genders over time, highlighting any persistent trends or changes in gender disparities.



Analysis:

- Globally, the suicide rate for men is notably higher, being roughly 3.5 times greater than that for women.
- The highest recorded suicide rates for both genders were in 1995, followed by a consistent decrease in the years thereafter.
- The ratio of male to female suicide rates has remained relatively stable at approximately 3.5 to 1 since the mid-1990s.
- In contrast, during the 1980s, this ratio was lower, approximately 2.7 to 1.
- Although women are statistically more prone to depression and more frequently consider suicide, men are more likely to complete the act. This discrepancy is known as the "gender paradox" in suicidal behavior [3], highlighting the complex relationship between mental health challenges and fatal outcomes across different genders.

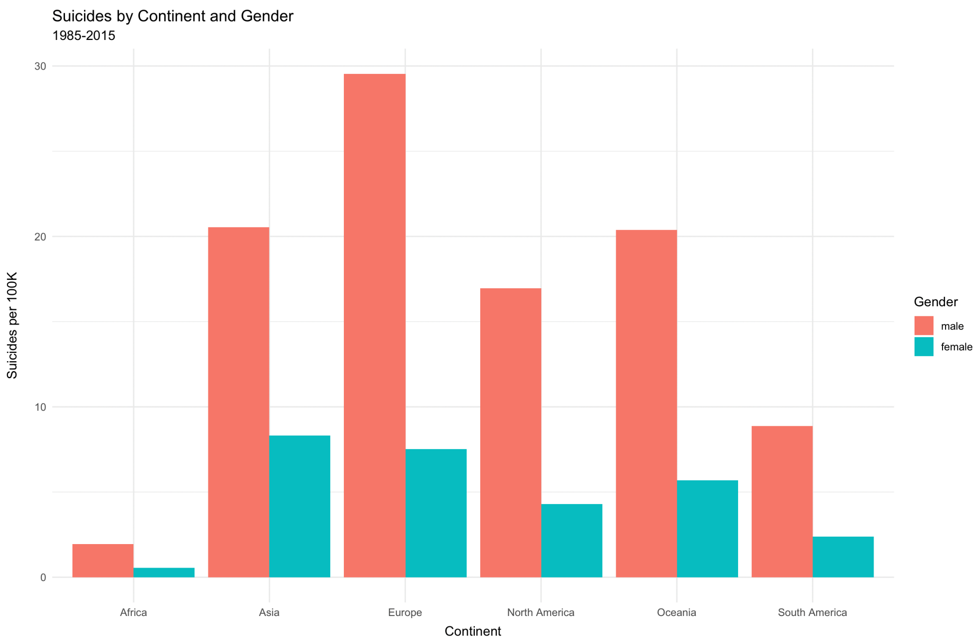
<u>Global Suicides by Continent</u>

R Code:

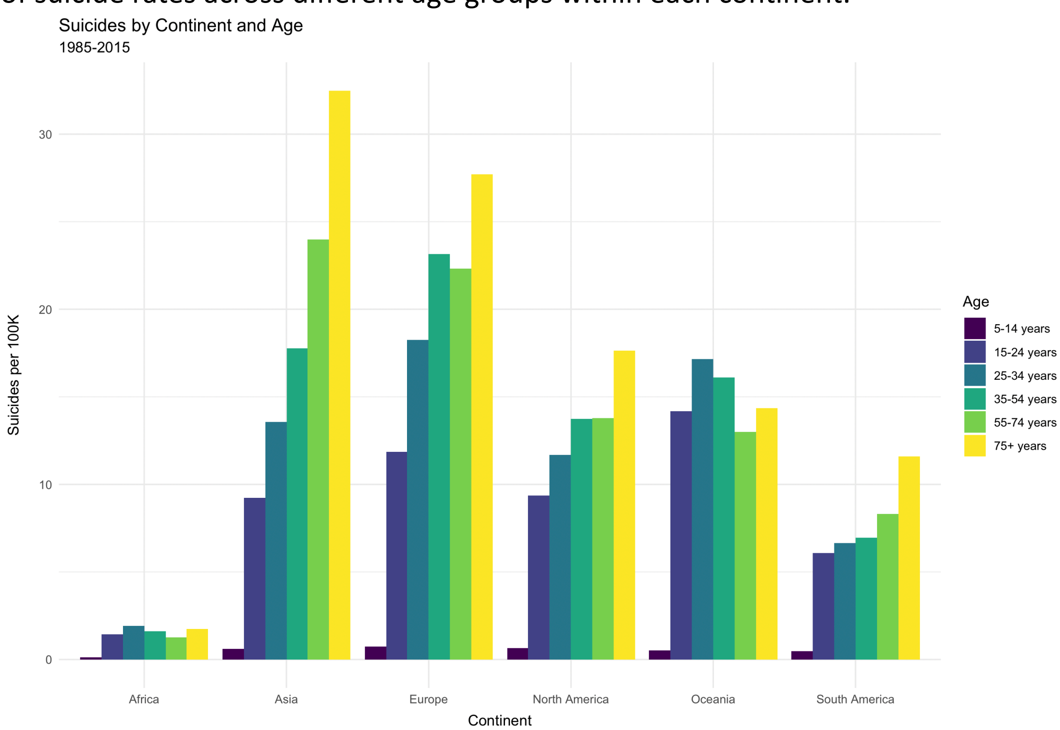
```r
# Convert country names to continent names using the 'countrycode' library
data$continent <- countrycode(data$country, "country.name", "continent")

# Reclassify 'Americas' into 'North America' and 'South America' based on specific countries
south_america <- c('Argentina', 'Brazil', 'Chile', 'Colombia', 'Ecuador', 'Guyana', 'Paraguay',
'Suriname', 'Uruguay')
data$continent[data$country %in% south_america] <- 'South America' # Assign South America
to specific countries
data$continent[data$continent == 'Americas'] <- 'North America' # Rename remaining
'Americas' to 'North America'

# Group data by continent and sex, then calculate the suicide rate per 100,000 population
continent_sex_tibble <- data %>%
  select(continent, sex, suicides_no, population) %>%
  group_by(continent, sex) %>%
  summarize(suicide_capita = round((sum(suicides_no)/sum(population)) * 100000, 2), .groups =
"drop")

# Group data by continent and age, then calculate the suicide rate per 100,000 population
continent_age_tibble <- data %>%
  select(continent, age, suicides_no, population) %>%
  group_by(continent, age) %>%
  summarize(suicide_capita = round((sum(suicides_no)/sum(population)) * 100000, 2), .groups =
"drop")

# Plot for suicides by continent and gender
ggplot(continent_sex_tibble, aes(x = continent, y = suicide_capita, fill = sex)) +
  geom_col(position = "dodge") +
  labs(title = "Suicides by Continent and Gender", subtitle = "1985-2015",
       x = "Continent", y = "Suicides per 100K", fill = "Gender") +
  theme_minimal()

# Plot for suicides by continent and age
ggplot(continent_age_tibble, aes(x = continent, y = suicide_capita, fill = age)) +
  geom_col(position = "dodge") +
  labs(title = "Suicides by Continent and Age", subtitle = "1985-2015",
       x = "Continent", y = "Suicides per 100K", fill = "Age") +
  scale_fill_viridis_d() +
  theme_minimal()
```

Plots:

A bar plot allows for clear visualization of how suicide rates compare between genders within each continent, facilitating an analysis of regional and gender-based differences.



A bar plot effectively displays categorical data, such as continent and age, enabling comparison of suicide rates across different age groups within each continent.



Analysis:

- Europe is observed to have the highest suicide rates among all continents.
- From 1985 to 2015, European males consistently displayed the highest suicide risk among all groups, with an annual rate of around 30 per 100,000.
- In Asia, the suicide rate for males was about 2.5 times higher than for females, marking the smallest gender difference in suicide rates among the regions studied.
- In contrast, the suicide rate for European males was nearly 3.9 times that of European females, showing a much larger gender gap in suicide rates.
- There is a notable trend across the Americas, Asia, and Europe, showing that suicide rates tend to rise with age.
- Conversely, in Oceania and Africa, the age group with the highest suicide rates is consistently the 25-34 age group.

Global Suicides by Country

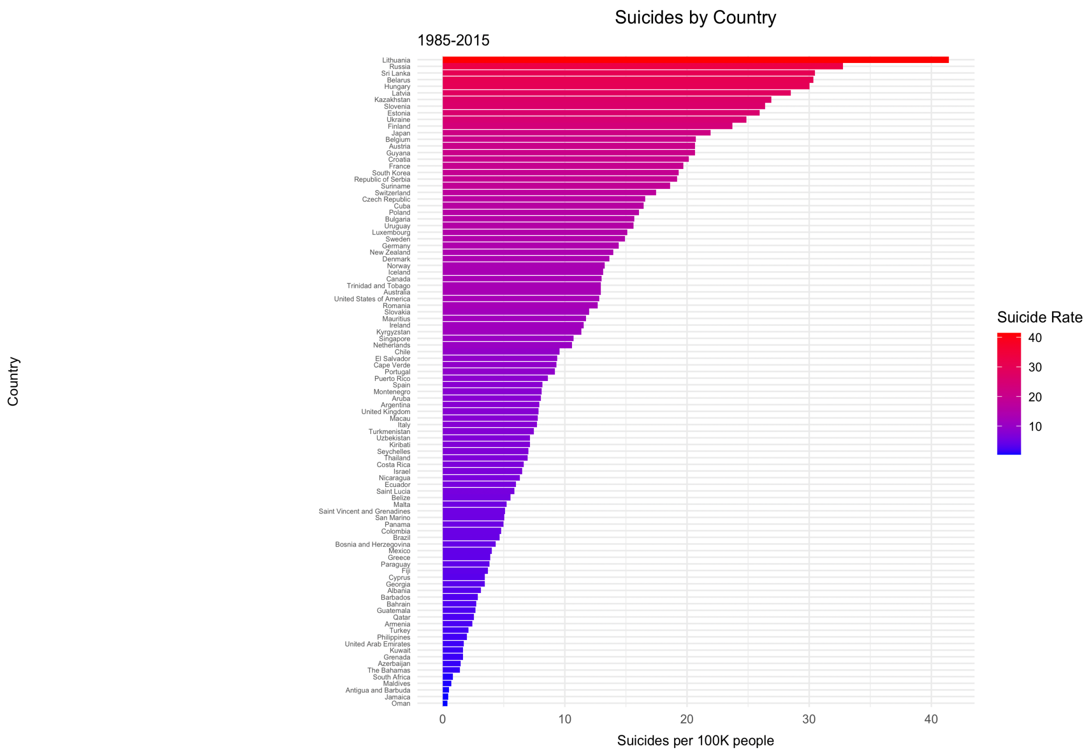
R Code:

```
# Group data by country and calculate suicide rate per 100k population
country_tibble <- data %>%
  select(country, suicides_no, population) %>%
  group_by(country) %>%
  summarize(suicide_capita = round((sum(suicides_no) / sum(population)) * 100000, 2)) %>%
  arrange(desc(suicide_capita))

ggplot(country_tibble, aes(x = reorder(country, suicide_capita), y = suicide_capita, fill =
suicide_capita)) +
  geom_col() +
  coord_flip() +
  labs(title = "Suicides by Country",
       subtitle = "1985-2015",
       x = "Country",
       y = "Suicides per 100K people",
       fill = "Suicide Rate") +
  theme_minimal() +
  theme(axis.text.y = element_text(size = 5, angle = 0),
        plot.title = element_text(hjust = 0.5),
        axis.title = element_text(size = 10)) +
  scale_fill_gradient(low = "blue", high = "red")

# Retrieve world geometry data
world <- ne_countries(scale = "medium", returnclass = "sf")
```

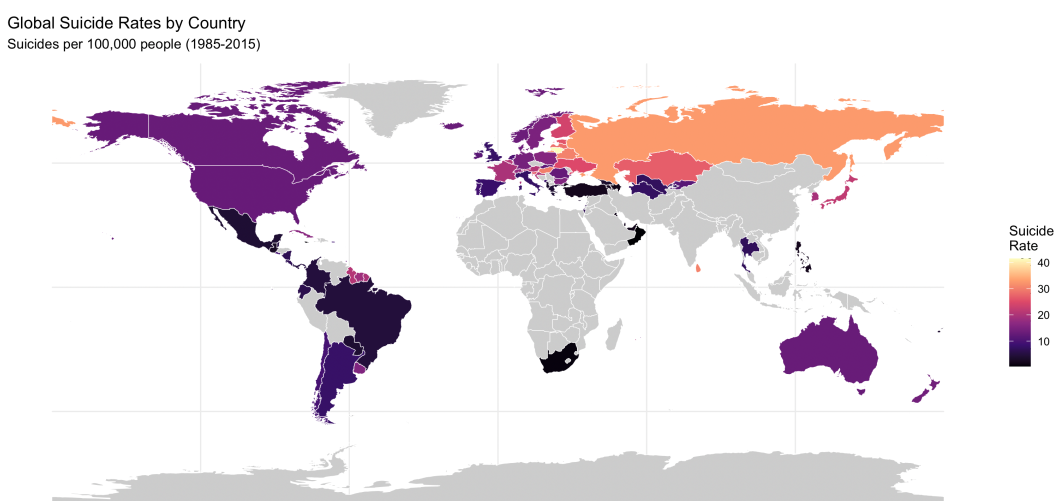
```
# Group data by country, calculate the suicide rate per 100,000 people
suicide_data <- data %>%
  group_by(country) %>%
  summarize(suicide_capita = round((sum(suicides_no) / sum(population)) * 100000, 2), .groups
= 'drop')

# Join suicide rates with world geometrical data
world_suicide <- world %>%
  left_join(suicide_data, by = c("name" = "country"))

# Create and plot the choropleth map
ggplot(data = world_suicide) +
  geom_sf(aes(fill = suicide_capita), color = "white", size = 0.2) +
  scale_fill_viridis_c(option = "magma", na.value = "grey80", label = scales::comma) +
  labs(
    title = "Global Suicide Rates by Country",
    subtitle = "Suicides per 100,000 people (1985-2015)",
    fill = "Suicide\nRate"
  ) +
  theme_minimal() +
  theme(legend.position = "right")
```

Plots:

Bar plots provide a straightforward way to compare suicide rates across different countries, making it easier to identify countries with higher or lower rates.



A choropleth map visually represents variations in suicide rates across different geographical areas, providing a global perspective and highlighting regional trends.



Analysis:

- Lithuania records the highest annual suicide rate, surpassing 41 deaths per 100,000 people.
- European nations predominantly occupy the higher tiers of suicide rates, with fewer countries positioned at the lower end.
- The spatial distribution of countries on the map reveals regional trends, hinting at cultural, economic, or policy factors that might impact suicide rates.
- The choropleth map visualizes suicide rates throughout the study period, emphasizing regions with limited data, particularly in Africa and Asia. Notably, data from seven countries were excluded due to their incompleteness.

Global Suicides by GDP

R Code:

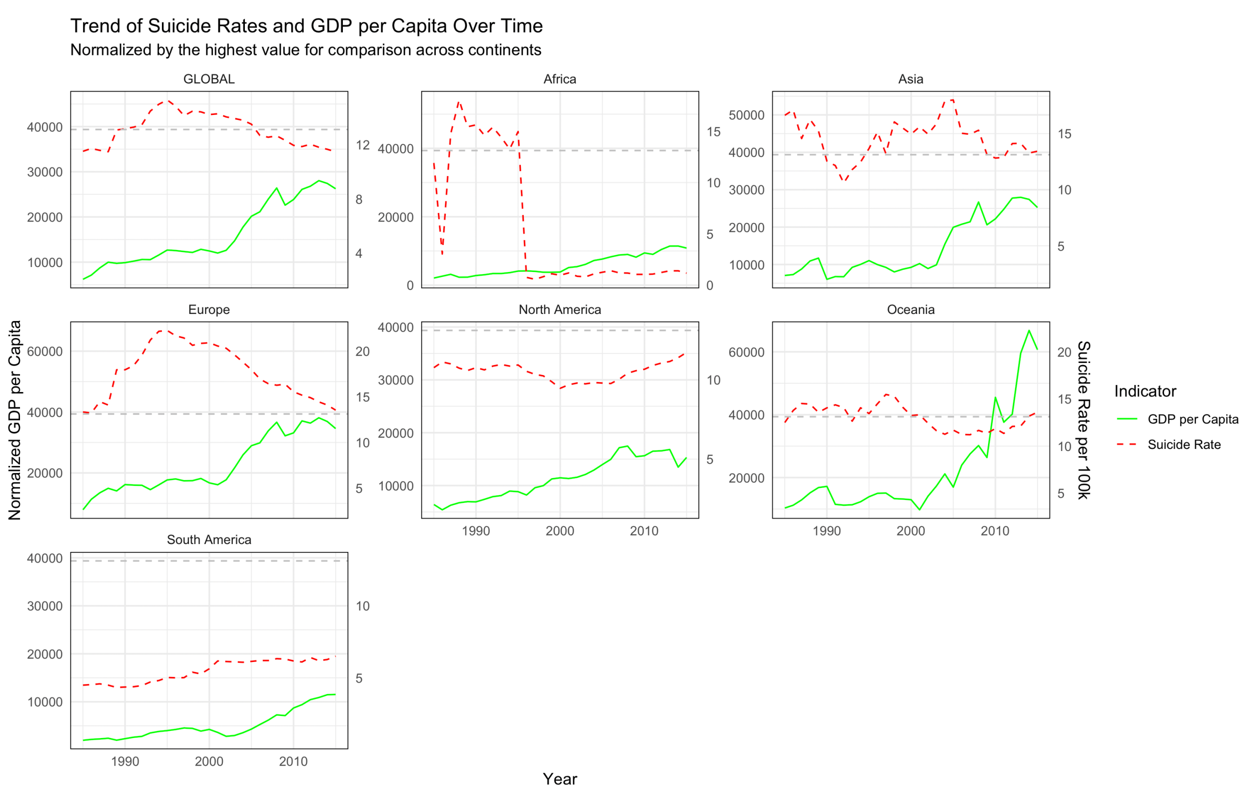
```
# Renaming the column with trailing dots to 'gdp_per_capita'
data <- data %>%
  rename(gdp_per_capita = `gdp_per_capita....`)

# Calculate Suicide Rates and Average GDP by Country and Year
country_summary <- data %>%
  group_by(country, year) %>%
  summarize(
    suicide_capita = round((sum(suicides_no) / sum(population)) * 100000, 2),  # Calculate
suicide rates per 100,000 people
    avg_gdp_per_capita = mean(gdp_per_capita, na.rm = TRUE),  # Calculate average GDP per
capita, ignoring NA values
    .groups = 'drop'
  )

# Calculate Global Suicide Rates and Average GDP by Year
global_stats <- data %>%
  group_by(year) %>%
  summarize(
    suicide_rate = round((sum(suicides_no) / sum(population)) * 100000, 2),  # Aggregate and
calculate global suicide rates
    avg_gdp_per_capita = mean(gdp_per_capita, na.rm = TRUE),  # Average GDP per capita at the
global level
    .groups = 'drop'
  ) %>%
  mutate(continent = 'GLOBAL')  # Add a 'GLOBAL' identifier for these entries for easy reference
in plots
```

```
# Calculate Continent-wise Suicide Rates and Average GDP by Year
continent_stats <- data %>%
  group_by(year, continent) %>%
  summarize(
    suicide_rate = round((sum(suicides_no) / sum(population)) * 100000, 2),  # Calculate suicide
rates by continent
    avg_gdp_per_capita = mean(gdp_per_capita, na.rm = TRUE),  # Average GDP per capita by
continent
    .groups = 'drop'
  )

# Combine Global and Continent Data for comparative analysis
combined_stats <- bind_rows(global_stats, continent_stats) %>%
  mutate(continent = factor(continent, levels = c('GLOBAL', unique(continent[continent !=
'GLOBAL']))))  # Ensure 'GLOBAL' appears first in plots

# Calculate scaling factors for plotting normalized data to compare GDP and suicide rates
directly
max_gdp <- max(combined_stats$avg_gdp_per_capita, na.rm = TRUE)
max_suicide_rate <- max(combined_stats$suicide_rate, na.rm = TRUE)
scaling_factor <- max_suicide_rate / max_gdp  # Scaling factor to normalize suicide rates against
GDP values

# Create line plots showing trends of suicide rates and GDP per Capita over time across
continents
ggplot(combined_stats, aes(x = year)) +
  geom_line(aes(y = avg_gdp_per_capita, color = "GDP per Capita"), linetype = 1) +  # Plot GDP
trends
  geom_line(aes(y = suicide_rate / scaling_factor, color = "Suicide Rate"), linetype = 2) +  # Plot
normalized suicide rates
  geom_hline(yintercept = mean(global_stats$suicide_rate) / scaling_factor, linetype = "dashed",
color = "grey") +  # Global average line for reference
  labs(
    title = "Trend of Suicide Rates and GDP per Capita Over Time",
    subtitle = "Normalized by the highest value for comparison across continents",
    x = "Year",
    y = "Normalized GDP per Capita",
    color = "Indicator"
  ) +
  scale_y_continuous(sec.axis = sec_axis(~ . * scaling_factor, name = "Suicide Rate per 100k")) +
  facet_wrap(~ continent, scales = 'free_y') +
  theme_minimal() +
  theme(panel.border = element_rect(color = "black", fill = NA, linewidth = 0.5)) +
```

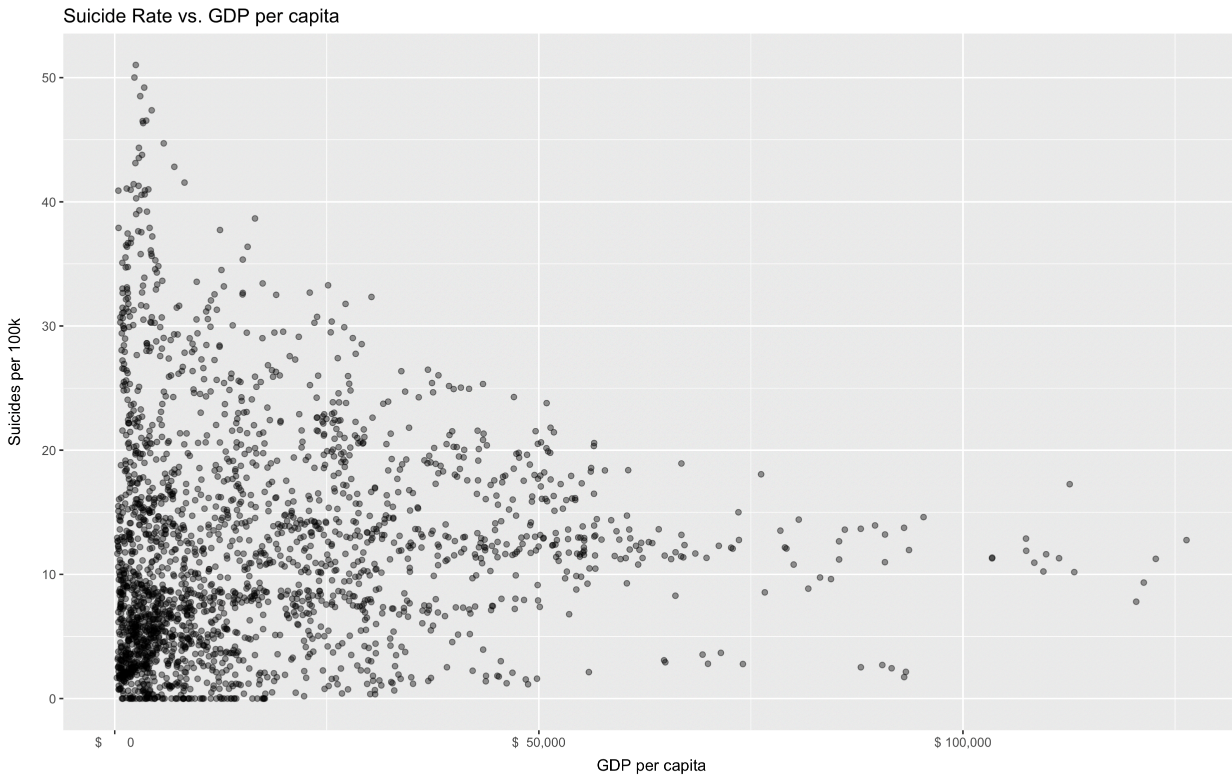
```r
  scale_color_manual(values = c("darkblue", "orange"))

# Create a scatter plot comparing suicide rate against GDP per capita
suicide_rate_plot <- data %>%
  group_by(country, gdp_per_capita) %>%
  summarize(suicide_rate = round((sum(suicides_no) / sum(population)) * 100000, 2), .groups = 
'drop') %>%
  ggplot(aes(x = gdp_per_capita, y = suicide_rate)) +
  geom_point(alpha = 0.4) +
  scale_x_continuous(labels = function(x) paste("$", format(x, big.mark = ",", scientific = FALSE))) 
+
  labs(
    title = "Suicide Rate vs. GDP per capita",
    x = "GDP per capita",
    y = "Suicides per 100k"
  )
plot(suicide_rate_plot)
```

Plots:

Line plots allow for simultaneous tracking of two continuous variables (suicide rates and GDP per capita), showing how economic factors might correlate with suicide rates across different continents over time.



A scatter plot is ideal for examining relationships between two quantitative variables, in this case to explore potential correlations or patterns between GDP per capita and suicide rates.



Analysis:

- Economic Influence on Mental Health: While a general pattern emerges showing GDP per capita growth coinciding with decreasing suicide rates, this relationship is not consistent across all regions. This inconsistency points to the influence of additional factors beyond just economic growth.
- Variability in Economic Impact: At lower GDP per capita levels, there is a notable spread in suicide rates, indicating that economic conditions might affect suicide rates differently in less affluent countries.
- Trend of Economic Prosperity and Lower Suicide Rates: In regions with higher GDP per capita, there tends to be a grouping of lower suicide rates. This observation supports the idea of a negative correlation between economic prosperity and suicide rates, particularly visible in higher economic brackets. For instance, Oceania, has high GDP with lower suicide rates.
- Economic Challenges and Higher Suicide Rates: Africa often displays lower GDP per capita coupled with higher suicide rates, contrasting with other regions.
- Economic and Suicide Rate Distribution in Asia: Asia displays a wide range across various GDP levels but generally maintain lower suicide rates, especially at higher economic levels.

- Limits of Economic Benefits on Mental Health: The data suggests a threshold beyond which further economic gains do not correlate with reductions in suicide rates, suggesting a plateau effect where additional wealth may not translate into further improvements in mental health.
- Significance of Outliers: Outliers—those with high suicide rates despite high GDP—highlight that economic prosperity alone is not a definitive predictor of mental health outcomes. Cultural and systemic factors may also play critical roles.
- Concluding Thoughts on GDP and Suicide Rates: Although there is some correlation between GDP per capita and suicide rates, the relationship is complex, layered, and non-linear. This analysis emphasizes the need to look beyond economic metrics to fully understand the factors influencing mental health and to comprehensively address the diverse causes of suicide globally.

Conclusions:

The comprehensive analysis of global suicide trends over the last three decades has provided profound insights into how suicide rates vary among different demographic groups and how they have evolved. The findings demonstrate a notable global decline in suicide rates, particularly among older populations, yet reveal a consistent higher prevalence of suicide among males.

- Economic Influence on Suicide Rates: A significant relationship was identified between the economic status of a region and its suicide rates. While there is a general trend of decreasing suicide rates alongside improved economic conditions, the relationship is not straightforward, suggesting that economic factors alone do not entirely explain the variations in suicide rates.
- Impact of Age and Gender on Suicide Rates: The study highlights distinct differences in suicide rates based on age and gender. Significant reductions in suicide rates have been observed in older age groups. However, the higher incidence of suicide among males compared to females—often referred to as the "gender paradox"—points to the need for targeted mental health interventions.
- Variations Across Regions and Continents: There are notable differences in suicide trends across various regions. Europe, for instance, has experienced substantial declines in suicide rates, whereas the trends in Oceania and the Americas warrant further investigation. These discrepancies underscore the influence of cultural, economic, and policy factors on regional suicide rates.
- Implications and Directions for Future Research: The results reveal a complex interplay of economic, social, and psychological factors impacting suicide rates. This complexity underscores the importance of developing multifaceted suicide prevention strategies that address these varied influences. Future research should explore these relationships more deeply, particularly in regions where data are currently limited.

In summary, although there has been progress in reducing global suicide rates, the persistent and complex nature of suicide necessitates ongoing research, dedicated efforts, and adaptive policy measures to effectively address and mitigate this public health issue.

List of future studies and recommendations:

- Expanding Socioeconomic and Demographic Variable: Further studies could enrich the analysis by integrating a wider array of socioeconomic and demographic details like Human Development Index (HDI), differences between generations, levels of education, and employment status to uncover complex interactions affecting suicide rates.
- In-Depth Regional Analysis: Future research could focus on detailed examinations at the regional or national levels to pinpoint specific local causes and trends influencing suicide rates, considering the unique cultural, economic, and policy factors in each area.
- Data Update and Time Extension: Extending the existing dataset to include the most recent years up to 2023 would help researchers understand ongoing trends and the impacts of recent global events, such as the COVID-19 pandemic, on suicide statistics.
- Predictive Simulations Using Agent-Based Models: Employing agent-based modeling [6] for simulating and forecasting the diverse factors that influence suicide could provide insights into how individual actions and societal conditions converge to affect suicide rates.
- Real-Time Monitoring and Digital Phenotyping for Suicide Risk: Utilizing real-time monitoring and digital phenotyping [7] to assess suicide risk could deliver immediate and detailed insights into individual mental states, enabling prompt and tailored interventions.
- Predictive Modeling of Suicide Rates Using Machine Learning: Leveraging machine learning to forecast suicide rates from demographic, socioeconomic, and health-related data could help in crafting targeted and effective prevention measures.

References:

[1] World Health Organization Fact Sheet, https://www.who.int/news-room/fact-sheets/detail/suicide
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