# Module 8, Capstone, Option 1: Youth Suicide and Population Factors

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**Abstract**

This study used the latest publicly available health and economic county-level data to find correlations between key health and economic measures and the percentage of Colorado youth who seriously considered suicide. Median home, median household income, and percent of housing units with more than one person per room were moderately negatively correlated. The percent of related children (5-17 years old) in poverty and the percent of children (< 18 years old) below poverty level were weakly positively correlated. Conversely, rates of poverty and deep poverty were not significantly correlated. Several health factors were moderately positively correlated, including markers of poor health among adults (rates of diabetes, obesity, inactivity, self-identified fair or poor health, and hospitalization due to stroke), poor health among high school students (rates of obesity and asthma), the percentage of high school students who had extended periods of sadness, and the percentage of high school students who had had sexual intercourse. Perhaps surprisingly, this study found that the percentage of adults who reported recent binge drinking and the percent of adults who used marijuana recently were moderately negatively correlated, while the percent of high schoolers who used marijuana recently was weakly negatively correlated. Finally, the percentage of students who ate several fruits and vegetables each day and the percent of active adults were both moderately negatively correlated. No significant correlations were found for rates of high schoolers' physical activity or current cigarette smoking or for adults' current asthma diagnoses.

# Youth Suicide and Population Factors

## Introduction

Suicide is the leading cause of death for Coloradans aged between 10 and 24 years (PCMH, n.d.). To address this crisis, it is vital to understand the public health factors that may help to identify vulnerable youth populations. That understanding may also point towards additional avenues of research in terms of designing targeted population-level interventions.

## Objectives

This exploratory study looked for correlations between high school students who have seriously considered suicide and a variety of health and economic factors. It compares Colorado counties across a variety of health and economic measures using public data provided by the Colorado and United States governments.

## Overview of Study

This study used public health and economic data to identify several health and economic factors that are correlated with the percent of high school students who seriously considered suicide. Factors examined were selected based on preliminary data exploration as well as insights gleaned from the literature review.

## Literature Review

Youth suicide has received substantial focus in the literature. Grimmond, Kornhaber, Visentin, and Cleary (2019) performed a qualitative systematic review focused on youth suicide and found that “thwarted belongingness,” “perceived burdensomeness” (often related to strained family relationships and poverty), and “the capability for suicide” (p. 19) were important factors. As well, they noted that drug and alcohol use was a common risk factor or trigger for youth

suicide (Grimmond et al., 2019). Border, Corley, Brown, Hewitt, Hopfer, McWilliams, Rhea, Shriver, Stallings, Wall, Woodward, and Rhee (2018) studied youth with conduct and substance use disorders and found that such youth and their siblings face an elevated risk for premature death. Moreover, substance use severity was not a good predictor of mortality, while conduct disorder was a robust predictor (Border et al., 2018). Crepeau-Hobson and Estes (2019) found that removing financial and social barriers to access to treatment for youth at risk of suicide led to a reduction in suicidal thoughts and behaviors. O'Keefe, Haroz, Goklish, Ivanich, Cwik, Barlow, and the Celebrating Life Team (2019) researched the impact of culturally-specific risk and protective factor interventions for Native American youth. They found it vital to provide individualized interventions using Native American support personnel for that population.

## Research Hypotheses

Previous researchers have found several factors that are correlated with youth suicide. Those studies were typically performed qualitatively, investigating the personal attributes for individuals. This study will leverage their findings using county-level measures to determine whether community attributes are similarly correlated with youth suicide rates. It will study the percentage of high school students who seriously considered attempting suicide during the previous 12 months (dated 2015). It will look at potential correlations with measures of poverty, alcohol and marijuana use, adult physical health, and youth health and behavior factors. See Appendix A for detailed questions and hypotheses.

## Research Design

### Methodology

This research study investigates health and economic factors that have been shown to

correlate with youth suicide risk on a personal level and determines whether they correlate at a population level when compared across counties in Colorado. It uses publicly available datasets provided by Colorado and United States government sources.

**Methods**

The Colorado Department of Public Health and Environment (CDPHE) county-level Colorado Health Indicators dataset ("CO Health") provides data for all 64 Colorado counties across a range of domains, including health, economics, and demographics. Its data appears as headcounts, percentages, and rates (such as per 100,000 population). The US Department of Health and Human Services, Health Resources and Services Administration (2019) Area Health Resources Files (AHRF) dataset contains descriptive information about United States counties, as well as the health services available. Data from both the CDPHE and AHRF datasets were used in this study. See Appendix B for detailed information about the datasets. The data underwent preliminary analysis using GoogleSheets (Google, n.d.) and RapidMiner Studio (RapidMiner, 2018). SAS® Studio was used to perform statistical analysis to test the hypotheses stated in Appendix A. All three named tools were used to extract and merge datasets.

**Limitations**

This paper explores correlations between the percent of high school students who have seriously considered suicide and a variety of factors. Correlations can not be assumed to imply causation. Moreover, when several correlations are explored, mere chance is expected to produce some correlations. Consequently, this exploratory work may provide insight for future research, but its findings should be taken with consideration of the number of correlations explored. As well, rates for people who have attempted suicide are known to differ from those who completed

suicide (Shain, 2016). For reasons explained in "Ethical Considerations," actual youth suicide numbers were not available for this study. Consequently, the percentages of youth who considered suicide were used instead. Finally, Colorado was the focus of this study. Similar questions asked in different regions (nationally and globally) could yield different results.

**Ethical Considerations**

The Center for Disease Control and Prevention (CDC) provides tallies for suicides by age groups within its CDC Wonder database. However, numbers lower than ten are suppressed to preserve anonymity. While that suppression is vital for privacy, it results in many Colorado counties with suppressed tallies for youth suicide. For example, if the CDC Wonder database is queried for county-level tallies for people aged 5-14 and 15-24 for the number of reported suicides in the most recent three years (2016-2018), no counties report numbers for 5-14 year olds and only 11 of 64 counties (17%) report numbers for 15-24 year olds. For that reason, the percent of high school students who have seriously considered suicide (data from CO Health) was used instead of actual youth suicide rates. Unfortunately, as noted, attempted suicides and completed suicides are not interchangeable numbers. Shain (2016) explained that, among adolescents (15 to 19 years old), boys complete suicide at triple the rate of girls, while girls attempt suicide at double the rate of boys. Shain noted that the different rates correlate with girls choosing less-lethal methods (2016). That difference in methods could point to differences in access (such as to firearms) or differences in intent.

## Findings

This research paper stipulated that a p-value $< 0.05$ indicates a significant finding. The strength of rho was estimated following Dancey and Reidy's categorization for psychology

(Akoglu, 2018). Rho absolute values between 0.1 and 0.3 are characterized as "weak," 0.4 and 0.6 as "moderate," and 0.7 and 0.9 as "strong" (Akoglu, 2018). See Appendix B. "Understanding the Strength of the Relationship" for different approaches to categorization. Since correlations are assessed for the percentage of high school students who have seriously considered suicide, that percentage was first inspected for normalcy (see Figure 1 in Appendix C). Since the measure does not appear to reflect a normal distribution, nonparametric analyses were used throughout the study. Key visualizations of significant correlations are represented in figures in Appendix C. Comprehensive correlation results and scatterplot matrices are represented in Appendix D.

**Economic Factors**

The CO Health and AHRF datasets contained several variables that reflect economic factors. A few key economic measures were tested using Spearman correlation coefficients against the percent of high school students who seriously considered suicide. Three measures were significantly, negatively correlated with the percentage of high schoolers who seriously considered suicide (see Figure 2 in Appendix C):

- Median home value for owner-occupied homes (Rho= -0.51000, p=<.0001)
- Percent of housing units with more than one person per room (Rho= -0.38591, p=0.0023)
- Median household income (-0.33612, 0.0086)

Two measures were positively correlated with the percentage of high school students who seriously considered suicide:

- Percent of related children (5-17 years old) in poverty, 2017 (Rho=0.33604, p=0.0087)
- Percent of children (< 18 years old) below poverty level, 2015 (Rho=0.26179, p=0.0433)

Among these five measures, "percent of housing units with more than one person per room" was

not related with the remaining four. However, the remaining four were all strongly correlated with each other (see Table 3 in Appendix D). Several economic factors showed no significant correlation: the percent of people below poverty (p=0.1100), the percent of households that received food stamps that had children (p=0.1720), the rural-urban continuum code (p=0.6530), and the percent of persons in deep poverty (p=0.6723) did not show significant correlation with the percentage of high school students who considered suicide.

**Health and Behavioral Factors**

This study considered the correlation between health factors for children, high school students, and adults and the percent of high school students who seriously considered suicide. First, correlations were explored with positive health factors. The percent of high school students who ate substantial amounts of produce (Rho= -0.45824, p=0.0002) and the percent of physically active adults (Rho= -0.46014, p=0.0005) were moderately negatively correlated with high schooler's serious thoughts of suicide. They were moderately positively correlated with each other (Rho=0.50661, p=0.0001). There was no significant correlation for the percent of physically active high school students (p=0.0967) with those who considered suicide. Unfortunately, there was very little data for the percent of children aged 5-14 years who (a) were physically active or (b) ate substantial produce (only 11 of 64 counties reported numbers), and no significance could be determined (p=0.2939 and p=0.8192, respectively).

Next, correlations were explored with health factors associated with alcohol and marijuana. The percent of adults who reported binge drinking in the past 30 days (Rho= -0.44126, p=0.0009) and the percent of adults who reported taking marijuana in the last 30 days (Rho= -0.37357, p=0.0148) were moderately negatively correlated with the percent of high

school students who considered suicide. The percent of high school students who used marijuana in the past 30 days was weakly negatively correlated with those who have had suicidal thoughts (Rho= -0.27588, p=0.0329). The percent of adults who binge drink and those who recently took marijuana were moderately correlated (Rho=0.43238, p=0.0027) (see Figure 4 in Appendix C). However, the percent of high school students who recently took marijuana was not significantly correlated with rates of adults who recently took marijuana (p=0.0565) or adults who binge drink (p=0.2549). No significant correlations were found between thoughts of suicide and percent of high school students who drank five or more drinks in a couple of hours (p=0.0589) or the percent of high school students who reported driving while drinking alcohol (p=0.6756).

Finally, correlations were explored with health factors associated with additional issues related to health and behavior. The percent of high school students who are obese (Rho=0.51689, p<0.0001) and those who were ever diagnosed with asthma (Rho=0.50963, p<.0001) were both moderately correlated with rates of serious thoughts of suicide among high school students. Those factors showed no significant correlation with each other (p=0.2209). See Figure 5 in Appendix C. The percent of high school students who currently use cigarettes was not correlated with rates of youth suicidal ideation (p=0.0671), Several adult factors were moderately correlated with high school students who seriously considered suicide: the percent of adults with diabetes (Rho=0.59350, p<0.0001), the percent of obese adults (Rho=0.54391, p<0.0001), the age-adjusted rate of hospitalizations due to stroke (Rho=0.46718, p=0.0002), the percent of adults who reported fair or poor health (Rho=0.41712, p=0.0017), and the percent of inactive adults (Rho=0.41910, p=0.0018) were significantly, moderately positively correlated. See Figure 6 in Appendix C. Those significant factors are all also moderately correlated with each other (see

Table 8 in Appendix D). No significant correlations were found between high school students' thoughts of suicide and adults with asthma (p=0.2705).

Lastly, the percent of high school students who felt sad or hopeless almost every day for two or more consecutive weeks, interfering with usual activities during the past 12 months (Rho=0.47048, p=0.0001) and the percent of high school students who have ever had sexual intercourse (Rho=0.41905, p=0.0009) were both moderately positively correlated with rates of high school students who seriously considered suicide. They were not correlated with each other (p=0.1581). See Figure 7 in Appendix C.

## Conclusion

While youth suicide has been linked with poverty, this study found that, when looking at a population level, it is important to consider which measures of poverty to use. The county-level median home and median household income and the percent of units with more than one percent per room were moderately, negatively correlated with youth thoughts of suicide, and the county-level percent of children in poverty and the percent of related children living together in poverty were moderately positively correlated. However, the percent of people overall in poverty and deep poverty were not significantly correlated with high school suicidal ideation rates. This study identified several county-level health factors among adults (including rates of obesity, inactivity, diabetes, and hospitalization due to stroke) that were positively correlated with the percentage of high school students who considered suicide. As well, it identified correlations between high school student health factors (obesity and diagnoses of asthma) and thoughts of suicide. Surprisingly, the percentage of adults who reported recent binge drinking and the percent of high school students who took marijuana recently were negatively correlated with the

percent of high school students having thoughts of suicide. No significant correlations were found between rates of high schooler's thoughts of suicide and rates of adults with asthma, binge drinking among high school students, cigarette smoking among high schooolers, or driving while drinking alcohol among high school students. Finally, the percent of high school students who ate substantial produce and the percent of active adults were moderately negatively correlated with suicide considerations.

## Recommendations

It may be useful to explore these findings using a larger dataset in order to determine whether the correlations are reflected in data representing regions beyond Colorado. As well, this study identified several county-level health factors among adults that were positively correlated with the percentage of high school students who considered suicide, including the percent of adults with diabetes, the rate of hospitalizations due to stroke, the percent of adults who are obese, the percent of adults who reported being in fair or poor health, and the percent of inactive adults were all significantly correlated with youth thoughts of suicide. These factors are also correlated with each other. Consequently, it may be helpful to explore these factors further to determine which have the best predictive value - as well as whether any represent causal factors in youth suicides. Several Colorado counties do not currently track key metrics such as adults who regularly use marijuana or several children's health factors. Colorado may be better able to understand how those factors impact youth suicide, given additional data.

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# Appendix A

## Hypotheses

Previous researchers have found several elements that are correlated with youth suicide. Those studies were typically performed qualitatively, investigating the personal attributes for individuals. This study will study their results using county-level numbers to determine whether community attributes are similarly correlated with youth suicide.

### Poverty and Substance Abuse

Grimmond, Kornhaber, Visentin, and Cleary found links between youth suicide and "thwarted belongingness," "perceived burdensomeness" (often related to strained family relationships and poverty), and "the capability for suicide" (2019, p. 19). They also noted that drug and alcohol use was a common risk factor or trigger for youth suicide. This study will ask whether there are correlations at the county-level for rates of poverty and substance abuse and youth suicide.

Question 1: Is there a link at the county-level between poverty and attempted youth suicide (such as measured with median home value and rates of children in poverty)?

H0: The percentage of suicide attempts by high school students is not correlated with poverty.

H1: The percentage of suicide attempts by high school students is positively correlated with poverty.

Question 2: Is there a link at the county-level between rates of substance abuse and attempted youth suicide?

H0: The percentage of suicide attempts by high school students is not correlated with the

use of alcohol, cigarettes, or other drugs.

H1: The percentage of suicide attempts by high school students is correlated with the use of alcohol, cigarettes, or other drugs.

**Health-Related Hypotheses**

O'Keefe, Haroz, Goklish, Ivanich, Cwik, Barlow, and the Celebrating Life Team (2019) noted that suicide rates vary across racial and ethnic groups. Because their study was consistent with other studies, and because the comparison is at the same broad-level view as the current study, there is no need to repeat this question in the current study.

New questions were suggested by this study's preliminary exploration.

Question 3: Is there a link at the county-level between poor adult health and the rate of attempted youth suicide?

H0: The percentage of suicide attempts by high school students is not correlated with adult health.

H1: The percentage of suicide attempts by high school students is correlated with poor adult health.

Question 4: Is there a link at the county-level between the rate of high schoolers with health issues and the rate of attempted youth suicide (such as measured with obesity and asthma)? (Note that this question is similar to Question 2, in that both look at high school students' negative health attributes).

H0: The percentage of suicide attempts by high school students is not correlated with the percentage of high schoolers with health issues.

H1: The percentage of suicide attempts by high school students is positively correlated

with the percentage of high schoolers with health issues.

Question 5: Is there a link at the county-level between the rate of high schoolers with good health habits and the rate of attempted youth suicide (such as measured with eating fruits and vegetables and being active)?

H0: The percentage of suicide attempts by high school students is not correlated with the percentage of high schoolers with good health habits.

H1: The percentage of suicide attempts by high school students is correlated with the percentage of high schoolers with good health habits.

Question 6: Is there a link at the county-level between the rate of high schoolers who report two or more week periods of sadness and the rate of attempted youth suicide (such as measured with eating fruits and vegetables and being active)?

H0: The percentage of suicide attempts by high school students is not correlated with the percentage of high schoolers who report two or more week periods of sadness.

H1: The percentage of suicide attempts by high school students is correlated with the percentage of high schoolers who report two or more week periods of sadness.

Question 7: Is there a link at the county-level between the rate of high schoolers who have ever had sexual intercourse and the rate of attempted youth suicide?

H0: The percentage of suicide attempts by high school students is not correlated with the percentage of high schoolers who have ever had sexual intercourse.

H1: The percentage of suicide attempts by high school students is correlated with the percentage of high schoolers who have ever had sexual intercourse.

## Mental Health Resources

Originally, mental health resources were going to be explored because the literature review found that using mental health resources is correlated with reduced suicidal ideation. The AHRF database contains several county-level fields related to child psychologists:

- All non-federal child psychologists in 2010, 2015, and 2017
- All non-federal child psychologists who saw patients in 2010, 2015, and 2017
- The number of hospitals providing (a) short-term and (b) long-term children's psychology services in 2017
- The number of inpatient days in (a) short-term and (b) long-term children's psychology hospitals in 2017

However, a review of the data showed that children's mental health was quite limited in Colorado. The AHRF database identified no Colorado counties with hospitals providing short- or long-term children's psychology services in 2017. Consequently, there were also no inpatient days. As well, there were 45 Colorado counties (70% of all Colorado counties) with no non-federal child psychologists throughout the time period studied. There were an additional four counties that had a non-practicing child psychologist in 2010, but not in 2015 or 2017. Consequently, of Colorado's 64 counties, only 15 counties (23.4%) had practicing non-federal child psychologists in 2017. This low number is, in itself, concerning. It is also likely too small to be useful in correlational analysis.

Appendix B

Datasets and Data Tools

## Datasets

The Colorado Department of Public Health and Environment (CDPHE) county-level "Colorado Health Indicators" ("CO Health") provides data for all 64 Colorado Counties across a range of domains, including health, economics, and demographics. Its data appears as headcounts, percentages, and rates (such as per 100,000 population). The US Department of Health and Human Services, Health Resources and Services Administration (2019) Area Health Resources Files (AHRF) dataset contains descriptive information about United States counties, as well as the health services available. It also provides comprehensive information about the medical and mental health services that are available in each county. In addition, it provides finely tuned information about county demographics. Since the original AHRF dataset contained several thousand columns as well as rows for all US states, a subset of the data was extracted for the study (using SAS Studio). Only Colorado data was included, and roughly 200 columns were extracted for this study.

## Data Analysis Tools

The data underwent preliminary analysis using GoogleSheets (Google, n.d.) and RapidMiner Studio (RapidMiner, 2018). First, several columns were inspected visually using GoogleSheets pivot tables and charts. Potential relationships among variables were noted. Next, the CDPHE Colorado Health Indicators and AHRF dataset were merged using RapidMiner Studio. The merged dataset was explored using RapidMiner to assess how counties clustered. A k-means cluster tree identified clusters using economic variables. One cluster contained a high

percentage of single-person housing, and the two other clusters were distinguished from each other using a combination of comparisons for three fields: the median home value for owner-occupied housing, the number of children in poverty, and the percent of related children (5-17 years old) living together in poverty.

While the data contained a column showing the percentage of high school students who seriously considered attempting suicide during the previous 12 months (dated 2015), referred to below as "Percent HS Students Considering Suicide"), it was not possible to run RapidMiner predictive analysis on that variable because there were only 64 rows of data (one for each Colorado county). Instead, correlations between "Percent HS Students Considering Suicide" and other fields were explored. Not surprisingly, the strongest correlation was with "Percent of high school students who felt sad or hopeless almost every day for two or more weeks in a row so that they stopped doing some usual activities during the past 12 months, 2015" (0.634). As well, RapidMiner identified several positive correlations between "Percent HS Students Considering Suicide" and several variables indicating poor adult health. There were also correlations with measures for high school students related to risky and healthy behaviors as well as physical health. Finally, there was a correlation with the rate of mental health hospitalizations. RapidMiner identified two notable negative correlations: the median home value for owner-occupied housing units and the percent of high school students who ate two or more fruits and three or more vegetables per day in the previous seven days.

SAS Studio will be used to perform statistical analysis to test the stated hypotheses. RapidMiner may also be used to perform more exploratory analysis. Charts and graphs may be generated by SAS Studio or GoogleSheets, depending on needs. As previously noted, all three

named tools were used to extract and merge datasets.

## Understanding the Strength of the Relationship

This study explores correlations using Spearman's rho ($r_s$) to represent the strength of the relationship between variables. Akoglu (2018) explained that the meaning of correlation coefficient values varies by discipline. He provided a table with contrasting interpretations (see Table 1). For this study, Dancey and Reidy's categories for psychology will be used for this study.

**Table 1**
**Interpretation of Pearson's and Spearman's correlation coefficients.**

| Correlation Coefficient | | Dancey & Reidy (Psychology) | Quinnipiac University (Politics) | Chan YH (Medicine) |
|---|---|---|---|---|
| +1 | −1 | Perfect | Perfect | Perfect |
| +0.9 | −0.9 | Strong | Very Strong | Very Strong |
| +0.8 | −0.8 | Strong | Very Strong | Very Strong |
| +0.7 | −0.7 | Strong | Very Strong | Moderate |
| +0.6 | −0.6 | Moderate | Strong | Moderate |
| +0.5 | −0.5 | Moderate | Strong | Fair |
| +0.4 | −0.4 | Moderate | Strong | Fair |
| +0.3 | −0.3 | Weak | Moderate | Fair |
| +0.2 | −0.2 | Weak | Weak | Poor |
| +0.1 | −0.1 | Weak | Negligible | Poor |
| 0iu | 0 | Zero | None | None |

Note: Reproduced from Akoglu (2018, p. 92).

# Appendix C

## Key Figures

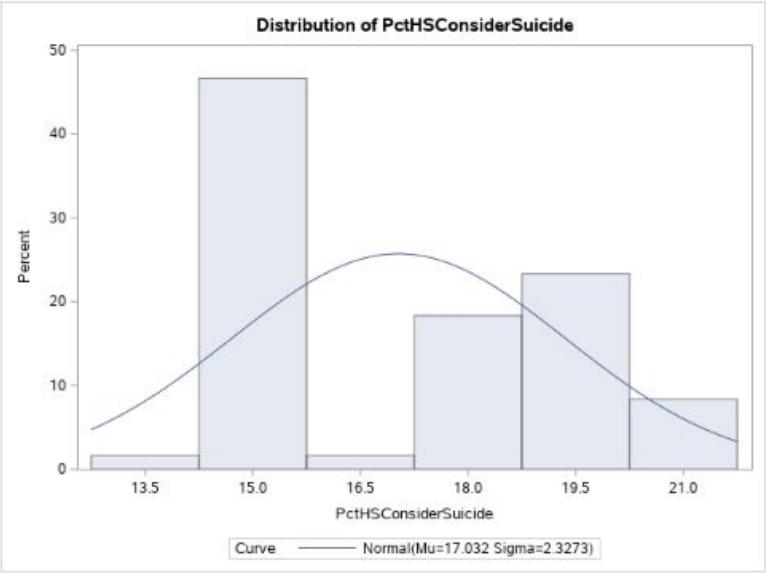


*Figure 1*. The histogram of county-level percentages of high school students in Colorado who seriously considered suicide in the previous year does not appear to have a normal distribution.

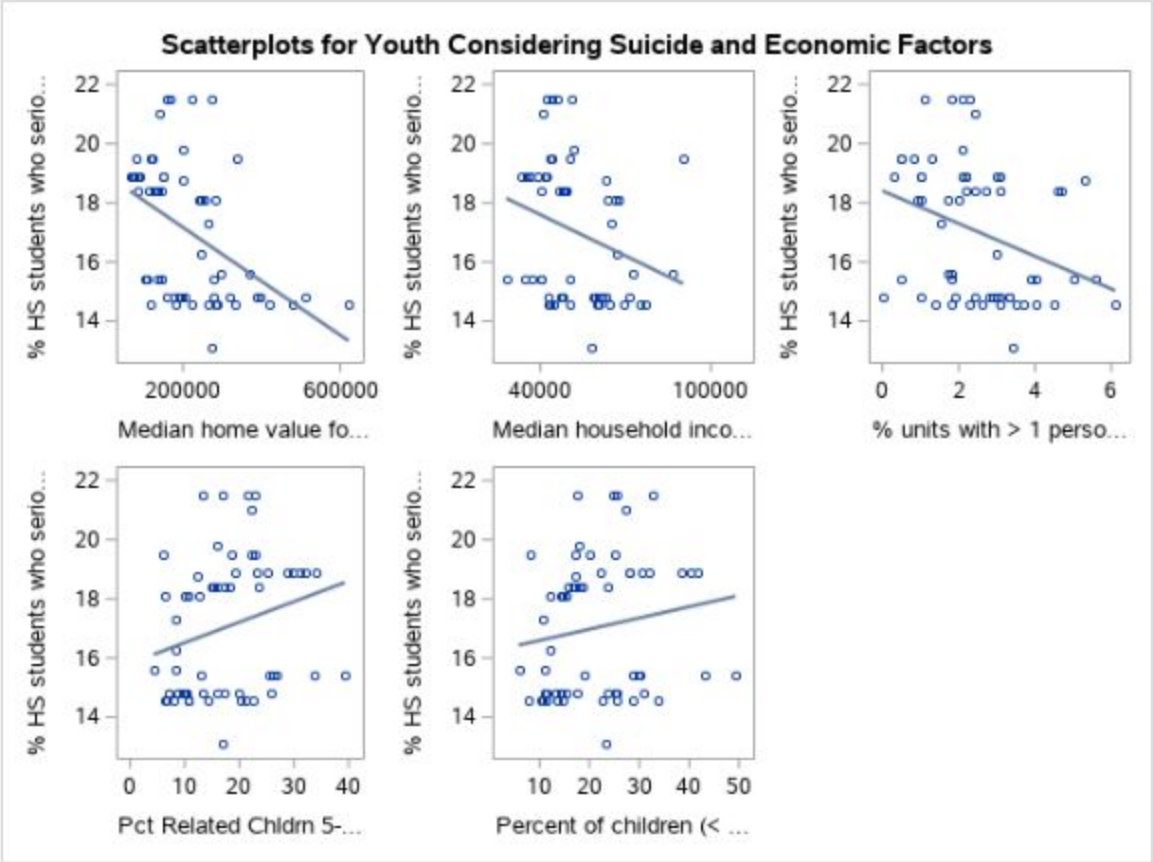


*Figure 2*. "Percent of high school students who seriously considered attempting suicide during the past 12 months, 2015" (CO Health, 2019) is shown on each vertical axis. Shown along the horizontal axes: "Median home value in US dollars for owner-occupied housing units, 2011-2015" (CO Health, 2019), "Median household income (US dollars), 2015"(CO Health, 2019), "% units w/more than 1 person/rm (2013)" (AHRF), " Pct Related Chldrn 5-17 in Pov, 2013-2017" (AHRF), and "Percent of children (< 18 years old) below poverty level, 2015" (CO Health).

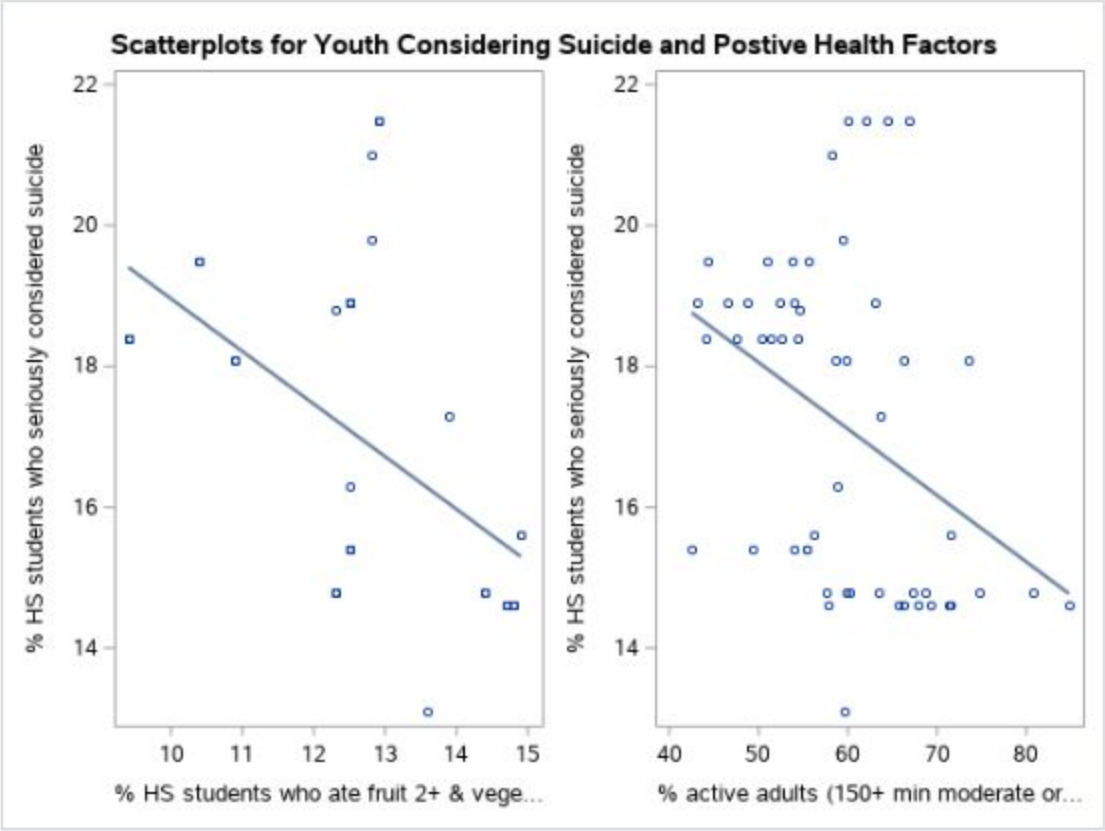


*Figure 3*. "Percent of high school students who seriously considered attempting suicide during the past 12 months, 2015" (CO Health, 2019) is shown on each vertical axis. Shown along the horizontal axes: "Percent of adults aged 18+ years who participated in 150+ minutes of moderate or 75+ minutes of vigorous aerobic physical activity per week, 2011, 2013, 2015" (CO Health, 2019) and "Percent of high school students who ate fruit 2+ and vegetables 3+ times per day during the past 7 days, 2015"(CO Health, 2019).

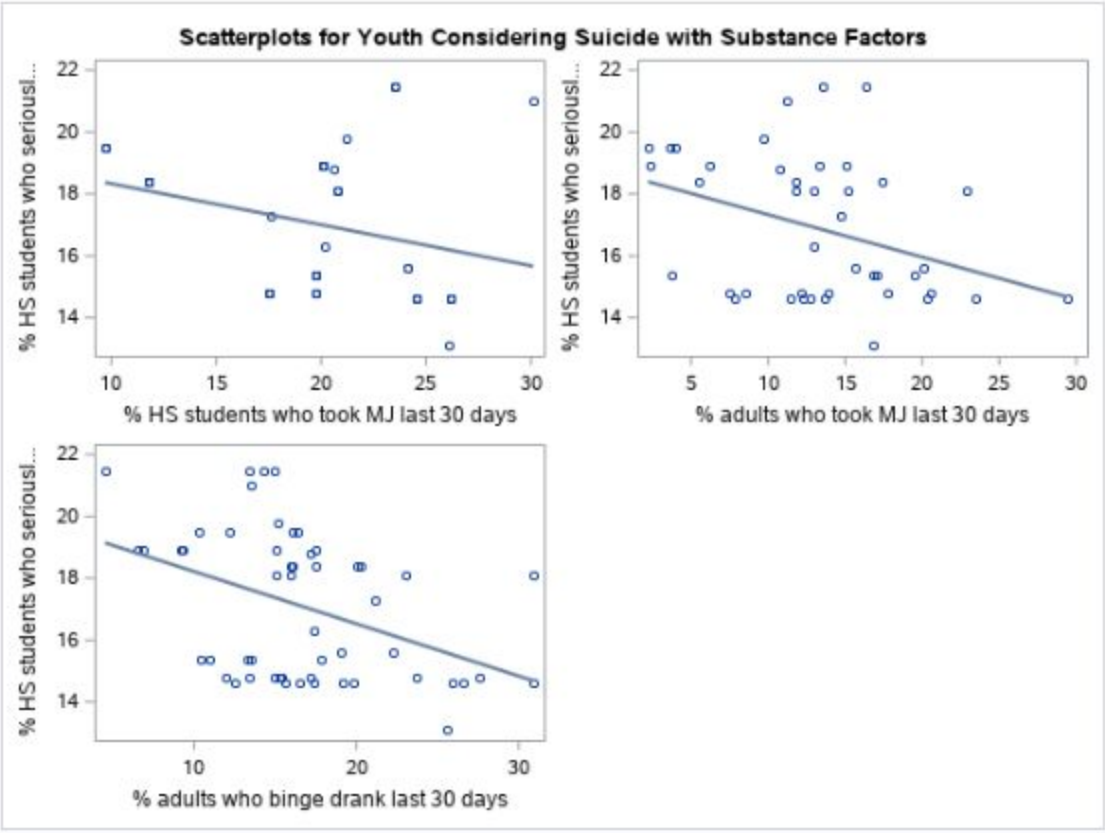


*Figure 4*. "Percent of high school students who seriously considered attempting suicide during the past 12 months, 2015" (CO Health, 2019) is shown on each vertical axis. Shown along the horizontal axes: "Percent of adults aged 18+ years who reported binge drinking in past 30 days, 2013-2015" (CO Health, 2019), "Percent of adults aged 18+ years who used marijuana one or more days during the past 30 days, 2014-2015" (CO Health, 2019), and "Percent of high school students who used marijuana one or more times during the past 30 days, 2015" (CO Health, 2019). Among Colorado counties, seven did not report rates for adults who binge drink, and 18 did not report adults who recently used marijuana.

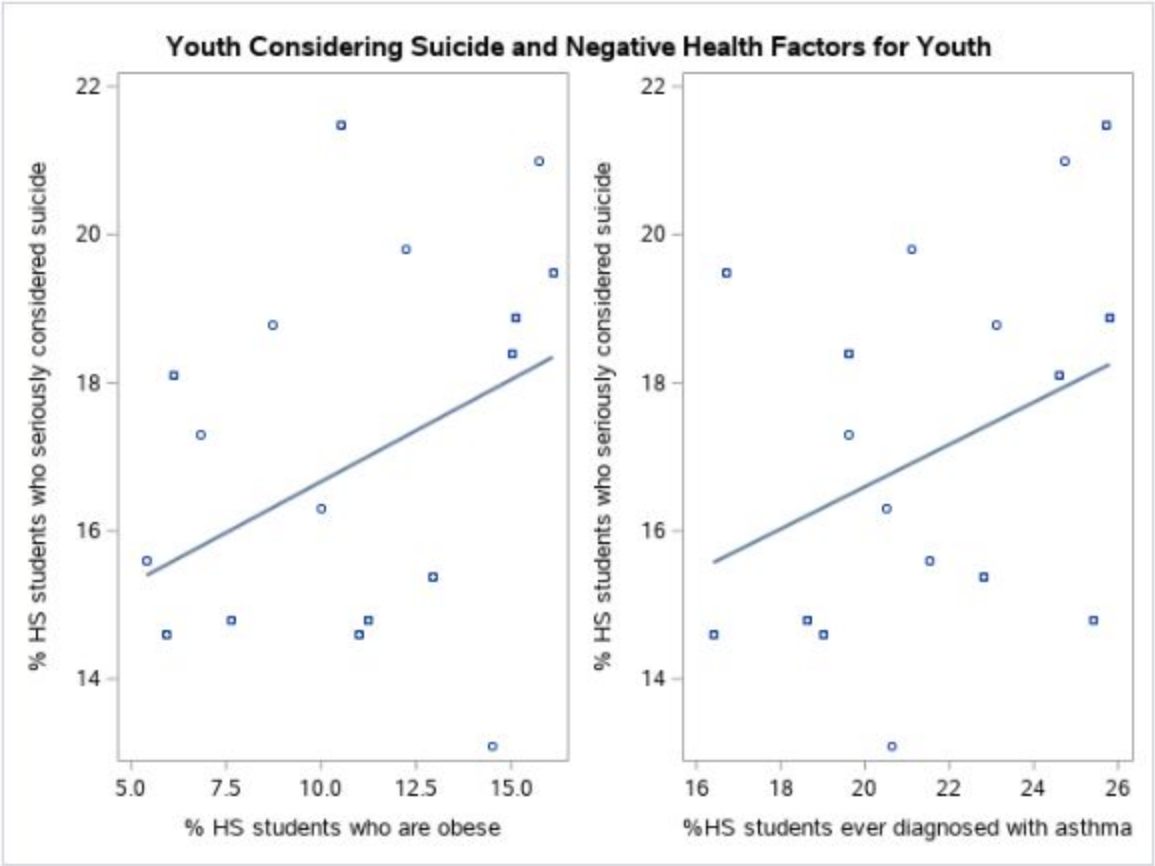


*Figure 5*. "Percent of high school students who seriously considered attempting suicide during the past 12 months, 2015" (CO Health, 2019) is shown on each vertical axis. Shown along the horizontal axes: "Percent of high school students who are obese, 2015" (CO Health, 2019) and "Percent of high school students ever told they had asthma, 2015" (CO Health, 2019).

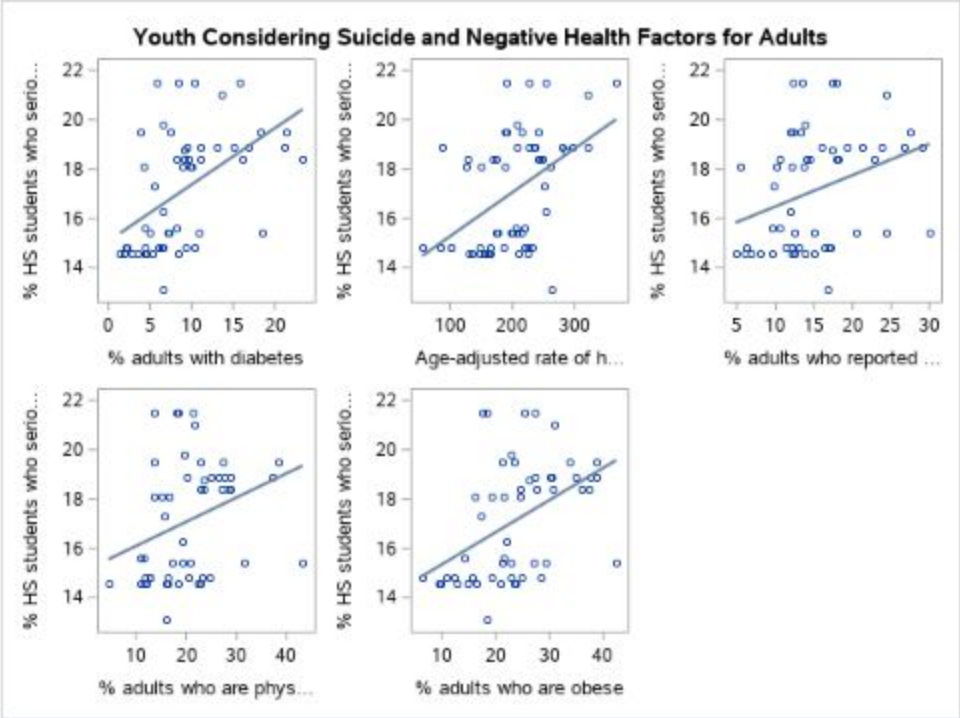


*Figure 6*. "Percent of high school students who seriously considered attempting suicide during the past 12 months, 2015" (CO Health, 2019) is shown on each vertical axis. Shown along the horizontal axes: "Percent of adults aged 18+ years with diabetes, 2013-2015" (CO Health, 2019), "Age-adjusted rate of hospitalizations due to stroke (per 100,000 population), 2013-2015," (CO Health, 2019), "Percent of adults aged 18+ years who are obese, 2013-2015," (CO Health, 2019), "Percent of adults aged 18+ years who reported that their general health was fair or poor, 2013-2015" (CO Health, 2019), and "Percent of adults aged 18+ years who are physically inactive, 2013-2015" (CO Health, 2019).

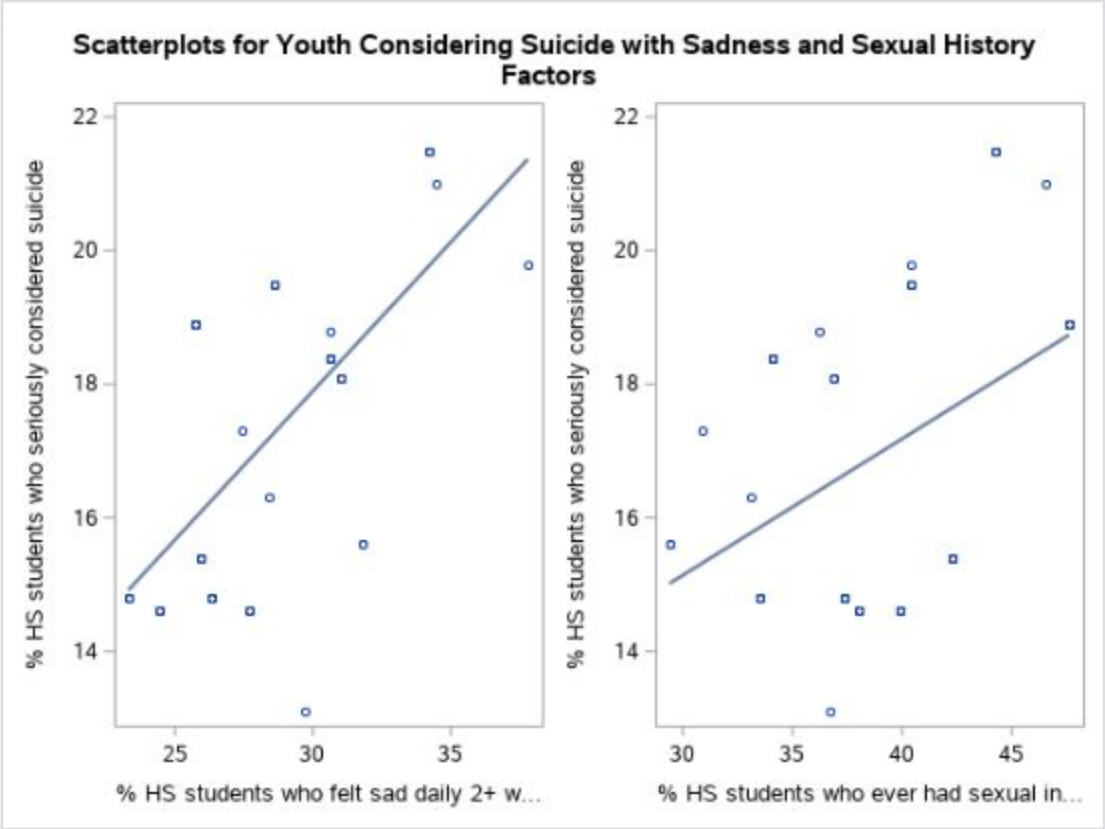


*Figure 7*. "Percent of high school students who seriously considered attempting suicide during the past 12 months, 2015" (CO Health, 2019) is shown on each vertical axis. Shown along the horizontal axes: "Percent of high school students who felt sad or hopeless almost every day for 2 or more weeks in a row so that they stopped doing some usual activities during the past 12 months, 2015"(CO Health, 2019) and "Percent of high school students who have ever had sexual intercourse, 2015" (CO Health, 2019).

Appendix D

Correlational Tables and Scatterplot Matrices from SAS ® Studio

**Poverty and High School Students who have Seriously Considered Suicide**

This appendix contains output from SAS® Studio. Tables have been adjusted to provide additional clarification regarding variables that reflect economic factors within counties. Scatterplot matrices are provided to provide additional insight into potential relationships among variables.

**Table 2**
**Spearman Correlation Coefficients for Poverty**

| | | **Percent of High School Students who Seriously Considered Suicide** | |
|---|---|---|---|
| **Measure** | **Source** | Meaning | Rho<br>P-value<br># Observations |
| **Median home value in US dollars for owner-occupied housing units, 2011-2015** | CO Health | Moderate, negative | -0.51000<br><.0001<br>60 |
| **Percent of housing units with more than 1 person per room 2013-17** | AHRF | Moderate, negative | -0.38591<br>0.0023<br>60 |
| **Median household income (US dollars), 2015** | CO Health | Weak, negative | -0.33612<br>0.0086<br>60 |
| **Percent of related children 5-17 years old in poverty 2017** | AHRF | Weak, positive | 0.33604<br>0.0087<br>60 |
| **Percent of children (< 18 years old) below poverty level, 2015** | CO Health | Weak, positive | 0.26179<br>0.0433<br>60 |
| **Percent of persons below poverty level 2013-17** | AHRF | Not significant | 0.20846<br>0.1100<br>60 |
| **Percent of households that received** | CO Health | Not significant | 0.18019 |

| | | | |
|---|---|---|---|
| **food stamps in the past 12 months with children less than 18 years old, 2011-2015** | | | 0.17205<br>9 |
| **# Households w/1 Persons 2010** | AHRF | Not significant | -0.12910<br>0.3256<br>60 |
| **Rural urban continuum code** | AHRF | Not significant | -0.05923<br>0.6530<br>60 |
| **Percent of persons in deep poverty 2013-17** | AHRF | Not significant | 0.05574<br>0.6723<br>60 |

Note: the fourth column contains three values: Rho (indicating the strength of the relationship), p-value (indicating the significance of the correlation, with $p<0.05$ indicating a significant correlation), and the number of observations.

**Table 3**
**Spearman Correlation Coefficients for Economic Factors that are Significantly Correlated with High School Students who have Seriously Considered Suicide**

| | **Median home value (owner-occupied)** | **% units with > 1 person per room** | **Median household income** | **% related children (5-17) in poverty** | **% children (<18) below poverty level** |
|---|---|---|---|---|---|
| **Median home value for owner-occupied housing** | 1.00000 | 0.04266<br>0.7379 | 0.80919<br><.0001 | -0.81996<br><.0001 | -0.70013<br><.0001 |
| **Percent units with > 1 person per room** | 0.04266<br>0.7379 | 1.00000 | -0.08901<br>0.4843 | 0.08135<br>0.5228 | 0.10286<br>0.4186 |
| **Median household income** | 0.80919<br><.0001 | -0.08901<br>0.4843 | 1.00000 | -0.94700<br><.0001 | -0.91476<br><.0001 |
| **Percent of related children 5-17 in poverty 2017** | -0.81996<br><.0001 | 0.08135<br>0.5228 | -0.94700<br><.0001 | 1.00000 | 0.93666<br><.0001 |
| **Percent of children (< 18 years old) below poverty level, 2015** | -0.70013<br><.0001 | 0.10286<br>0.4186 | -0.91476<br><.0001 | 0.93666<br><.0001 | 1.00000 |

Note: each column contains three values: Rho (indicating the strength of the relationship), p-value (indicating the significance of the correlation, with $p<0.05$ indicating a significant correlation), and the number of observations.

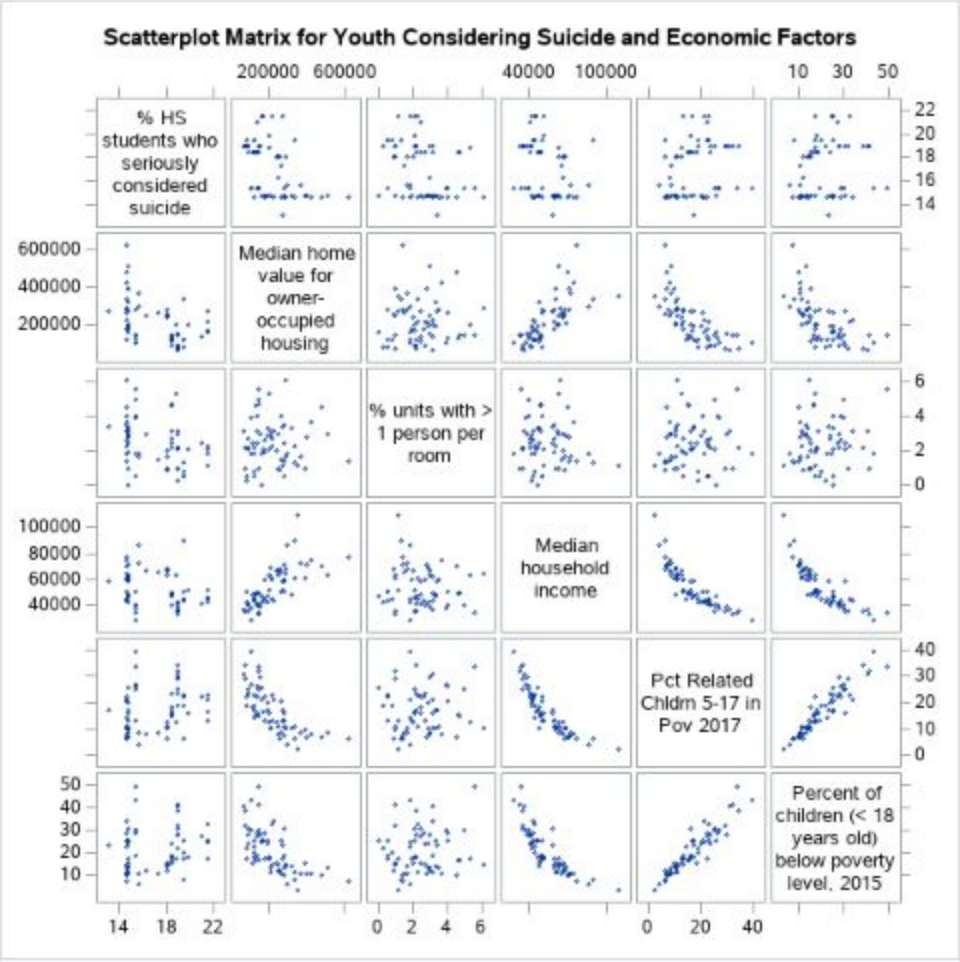


*Figure 8*. The scatterplot matrix between high school students who seriously considered suicide and attributes related to poverty shows a relationship between poverty and considerations for suicide.

**Health Factors and High School Students who have Seriously Considered Suicide**

This appendix contains output from SAS® Studio. Tables have been adjusted to provide additional clarification regarding variables that reflect health and behavioral factors within counties. Scatterplot matrices are provided to provide additional insight into potential relationships among variables.

| **Table 4**<br>**Spearman Correlation Coefficients for Positive Health-Related Factors** | | |
|---|---|---|
| | | **Percent of High School Students** |

| Measure | Source | who Seriously Considered Suicide | |
|---|---|---|---|
| | | Meaning | Rho<br>P-value<br># Observations |
| **Percent of high school students who ate fruit 2+ and vegetables 3+ times per day during the past 7 days, 2015** | CO Health | Moderate, negative | -0.45824<br>0.0002<br>60 |
| **Percent of adults aged 18+ years who participated in 150+ minutes of moderate or 75+ minutes of vigorous aerobic physical activity per week, 2011, 2013, 2015** | CO Health | Moderate, negative | -0.46014<br>0.0005<br>53 |
| **Percent of high school students who were physically active for a total of at least 60 minutes/day for the past 7 days, 2015** | CO Health | Not significant | 0.21645<br>0.0967<br>60 |
| **Percent of children aged 5-14 years who were physically active for at least 60 minutes/ day for the past 7 days, 2013-2015** | CO Health | Not significant | 0.46429<br>0.2939<br>7 |
| **Percent of children aged 1-14 years who ate fruit 2 or more times per day and vegetables 3 or more times per day, 2013-2015** | CO Health | Not significant | -0.10714<br>0.8192<br>7 |
| Note: the fourth column contains three values: Rho (indicating the strength of the relationship), p-value (indicating the significance of the correlation, with $p<0.05$ indicating a significant correlation), and the number of observations. | | | |

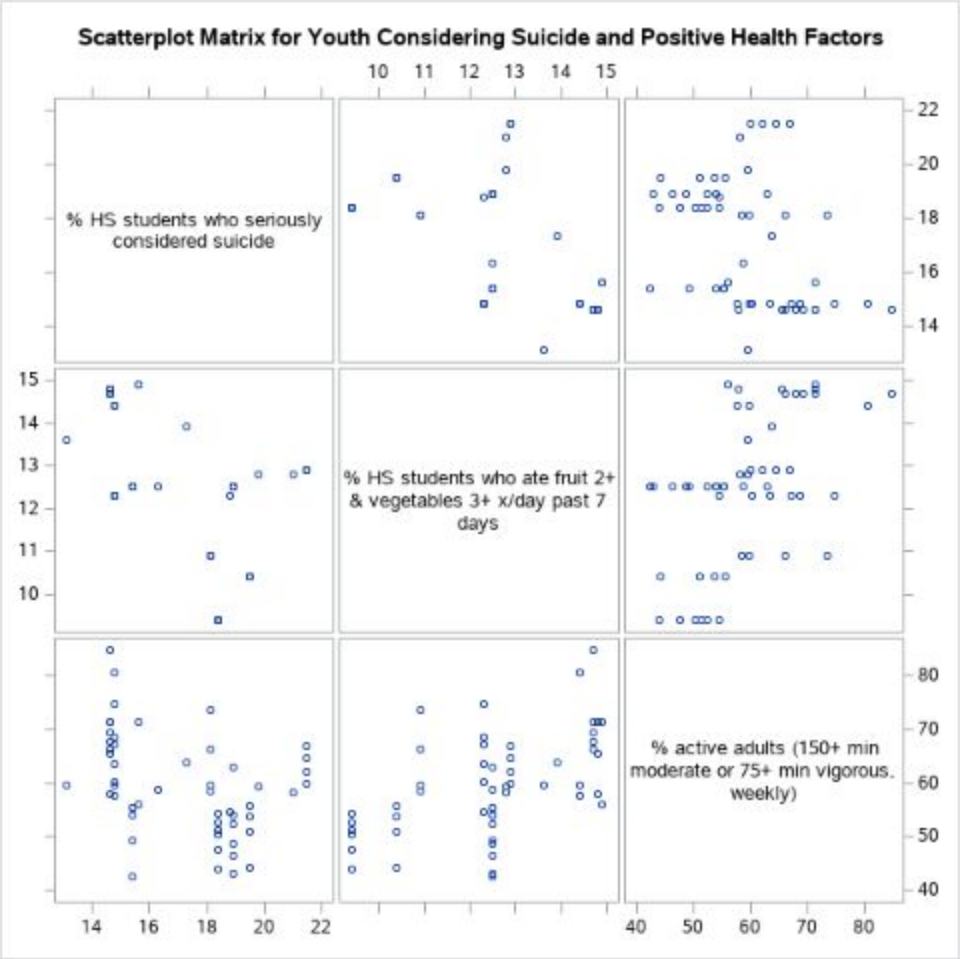


*Figure 9*. The scatterplot matrix between high school students who seriously considered suicide and attributes related to positive health factors.

**Table 5**
**Spearman Correlation Coefficients for Factors Related to Alcohol and Marijuana**

| | | **Percent of High School Students who Seriously Considered Suicide** | |
|---|---|---|---|
| **Measure** | **Source** | Meaning | Rho<br>P-value<br># Observations |
| **Percent of adults aged 18+ years who reported binge drinking in past 30 days, 2013-2015** | CO Health | Moderate, negative | -0.44126<br>0.0009<br>53 |
| **Percent of adults aged 18+ years who used marijuana one or more days during the past 30 days, 2014-2015** | CO Health | Moderate, negative | -0.37357<br>0.0148<br>42 |

| | | | |
|---|---|---|---|
| **Percent of high school students who used marijuana one or more times during the past 30 days, 2015** | CO Health | Weak, negative | -0.27588<br>0.0329<br>60 |
| **Percent of high school students who had five or more drinks of alcohol within a couple of hours, 2015** | CO Health | Not significant | -0.24529<br>0.0589<br>60 |
| **Percent of high school students who reported driving a car or other vehicle when they had been drinking alcohol, 2015** | CO Health | Not significant | -0.05515<br>0.6756<br>60 |
| Note: the fourth column contains three values: Rho (indicating the strength of the relationship), p-value (indicating the significance of the correlation, with $p<0.05$ indicating a significant correlation), and the number of observations. | | | |

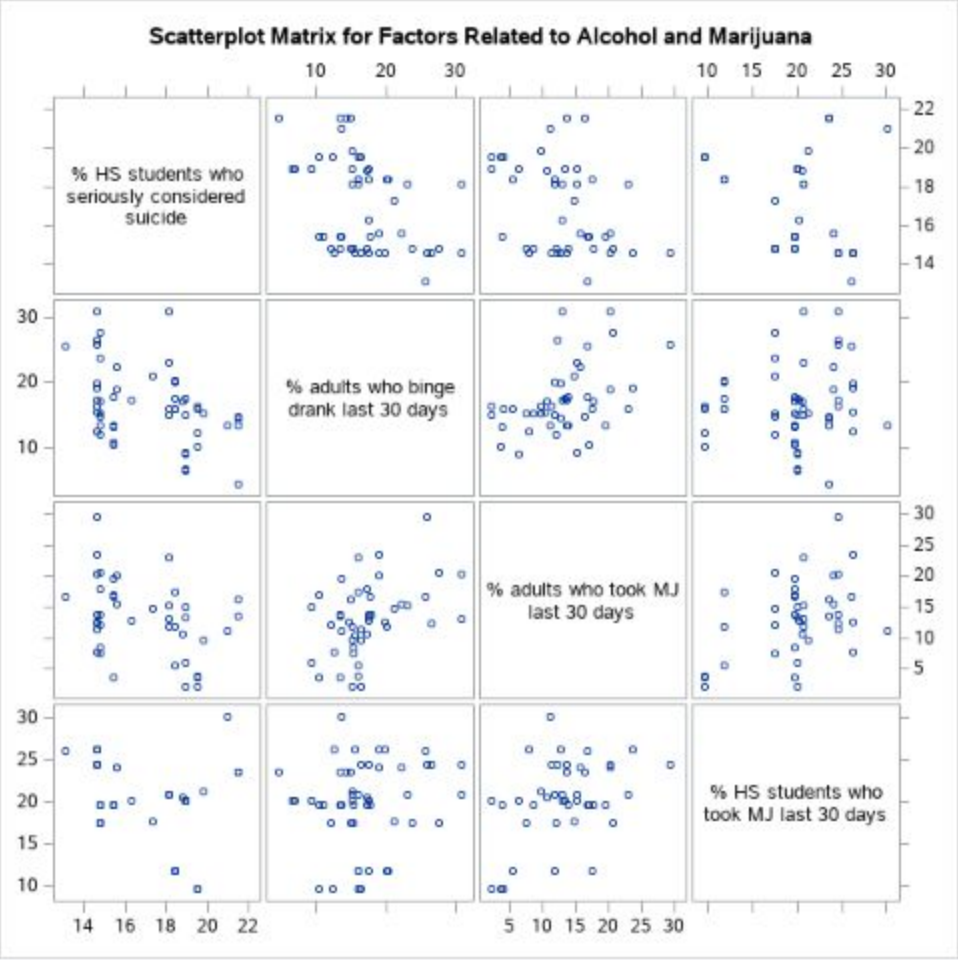


*Figure 10*. The scatterplot matrix between high school students who seriously considered suicide and attributes related to alcohol and marijuana.

**Table 6**
**Spearman Correlation Coefficients for Negative Youth Health-Related Factors**

| | | **Percent of High School Students who Seriously Considered Suicide** | |
|---|---|---|---|
| **Measure** | **Source** | Meaning | Rho<br>P-value<br># Observations |
| **Percent of high school students who are obese, 2015** | CO Health | Moderate, positive | 0.51689<br><.0001<br>60 |
| **Percent of high school students ever told they had asthma, 2015** | CO Health | Moderate, positive | 0.50963<br><.0001<br>60 |
| **Percent of high school students who currently use cigarettes, 2015** | CO Health | Not significant | 0.23797<br>0.0671<br>60 |

Note: the fourth column contains three values: Rho (indicating the strength of the relationship), p-value (indicating the significance of the correlation, with $p<0.05$ indicating a significant correlation), and the number of observations.

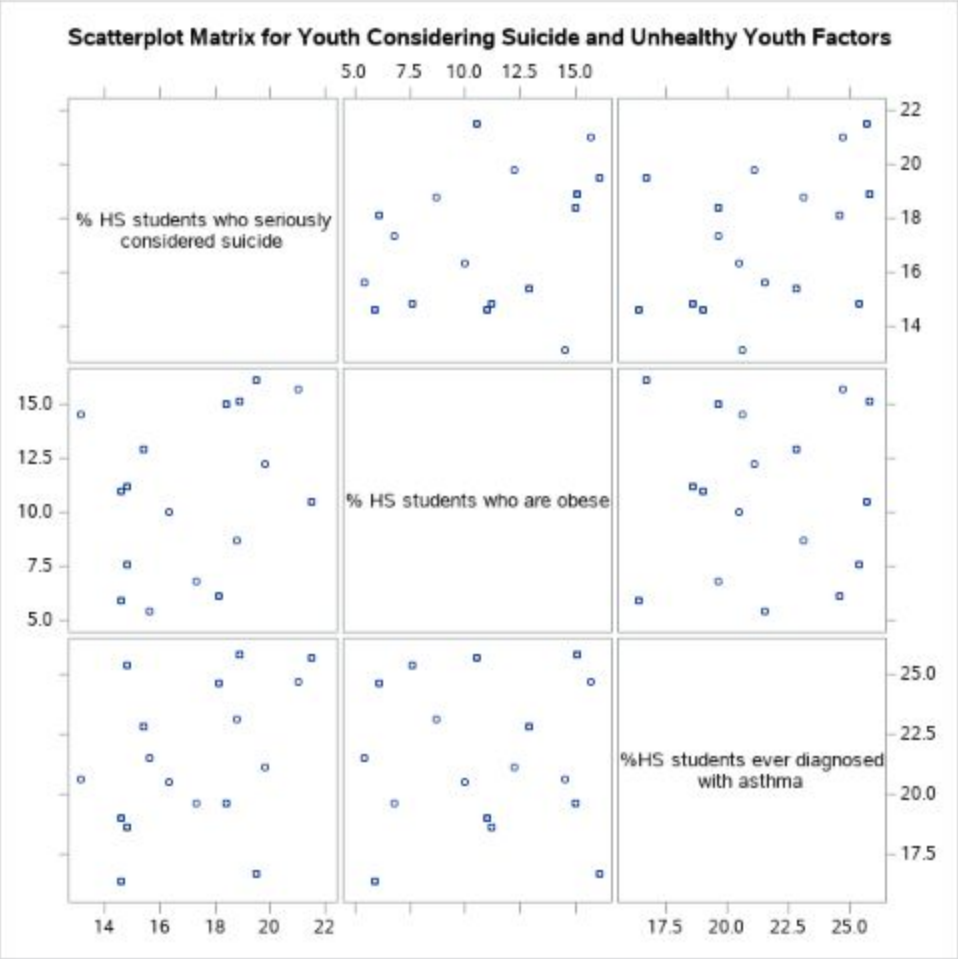


*Figure 11*. The scatterplot matrix between high school students who seriously considered suicide and attributes related to negative youth health status and behavior.

**Table 7**
**Spearman Correlation Coefficients for Negative Adult Health-Related Factors**

| | | **Percent of High School Students who Seriously Considered Suicide** | |
|---|---|---|---|
| **Measure** | **Source** | Meaning | Rho<br>P-value<br># Observations |
| **Percent of adults aged 18+ years with diabetes, 2013-2015** | CO Health | Moderate, positive | 0.59350<br><.0001<br>54 |
| **Percent of adults aged 18+ years who are obese, 2013-2015** | CO Health | Moderate, positive | 0.54391<br><.0001<br>53 |

| | | | |
|---|---|---|---|
| **Age-adjusted rate of hospitalizations due to stroke (per 100,000 population), 2013-2015** | CO Health | Moderate, positive | 0.46718<br>0.0002<br>59 |
| **Percent of adults aged 18+ years who reported that their general health was fair or poor, 2013-2015** | CO Health | Moderate, positive | 0.41712<br>0.0017<br>54 |
| **Percent of adults aged 18+ years who are physically inactive, 2013-2015** | CO Health | Moderate, positive | 0.41910<br>0.0018<br>53 |
| **Percent of adults aged 18+ years that currently have asthma, 2013-2015** | CO Health | No significance | 0.15265<br>0.2705<br>54 |
| Note: the fourth column contains three values: Rho (indicating the strength of the relationship), p-value (indicating the significance of the correlation, with $p<0.05$ indicating a significant correlation), and the number of observations. | | | |

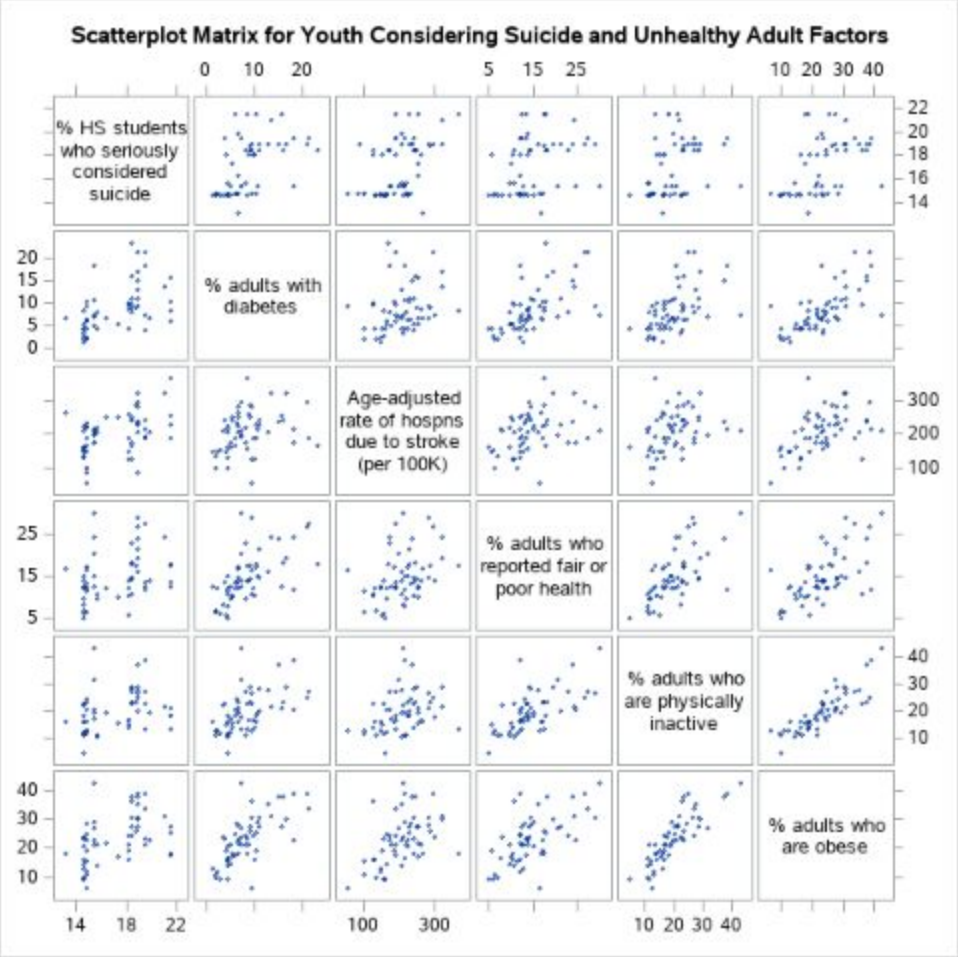


*Figure 12*. The scatterplot matrix between high school students who seriously considered suicide

and attributes related to adult poor health.

**Table 8**
**Spearman Correlation Coefficients for Adult Negative Health-Related Factors that are Significantly Correlated with High School Students who have Seriously Considered Suicide**

| | % HS Students Considering Suicide | % Adults with Diabetes | Rate Hospitalization d/t Stroke | % Adults Reporting Fair or Poor Health | % Inactive Adults |
|---|---|---|---|---|---|
| **% HS Students Considering Suicide** | 1.00000<br><br>60 | 0.59350<br><.0001<br>54 | 0.46718<br>0.0002<br>59 | 0.41712<br>0.0017<br>54 | 0.41910<br>0.0018<br>53 |
| **% Adults with Diabetes** | 0.59350<br><.0001<br>54 | 1.00000<br><br>58 | 0.36481<br>0.0049<br>58 | 0.66373<br><.0001<br>58 | 0.57951<br><.0001<br>57 |
| **Rate Hospitalization d/t Stroke** | 0.46718<br>0.0002<br>59 | 0.36481<br>0.0049<br>58 | 1.00000<br><br>63 | 0.43563<br>0.0006<br>58 | 0.40859<br>0.0016<br>57 |
| **% Adults Reporting Fair or Poor Health** | 0.41712<br>0.0017<br>54 | 0.66373<br><.0001<br>58 | 0.43563<br>0.0006<br>58 | 1.00000<br><br>58 | 0.66494<br><.0001<br>57 |
| **% Inactive Adults** | 0.41910<br>0.0018<br>53 | 0.57951<br><.0001<br>57 | 0.40859<br>0.0016<br>57 | 0.66494<br><.0001<br>57 | 1.00000<br><br>57 |

Note: each column contains three values: Rho (indicating the strength of the relationship), p-value (indicating the significance of the correlation, with $p<0.05$ indicating a significant correlation), and the number of observations.

**Table 9**
**Spearman Correlation Coefficients for Sexual History and Feelings of Sadness**

| | | Percent of High School Students who Seriously Considered Suicide | |
|---|---|---|---|
| **Measure** | **Source** | Meaning | Rho<br>P-value<br># Observations |
| **Percent of high school students who** | CO Health | Moderate, | 0.47048 |

| | | | |
|---|---|---|---|
| **felt sad or hopeless almost every day for 2 or more weeks in a row so that they stopped doing some usual activities during the past 12 months, 2015** | | positive | 0.0001<br>60 |
| **Percent of high school students who have ever had sexual intercourse, 2015** | CO Health | Moderate, positive | 0.41905<br>0.0009<br>60 |
| Note: the fourth column contains three values: Rho (indicating the strength of the relationship), p-value (indicating the significance of the correlation, with $p<0.05$ indicating a significant correlation), and the number of observations. | | | |

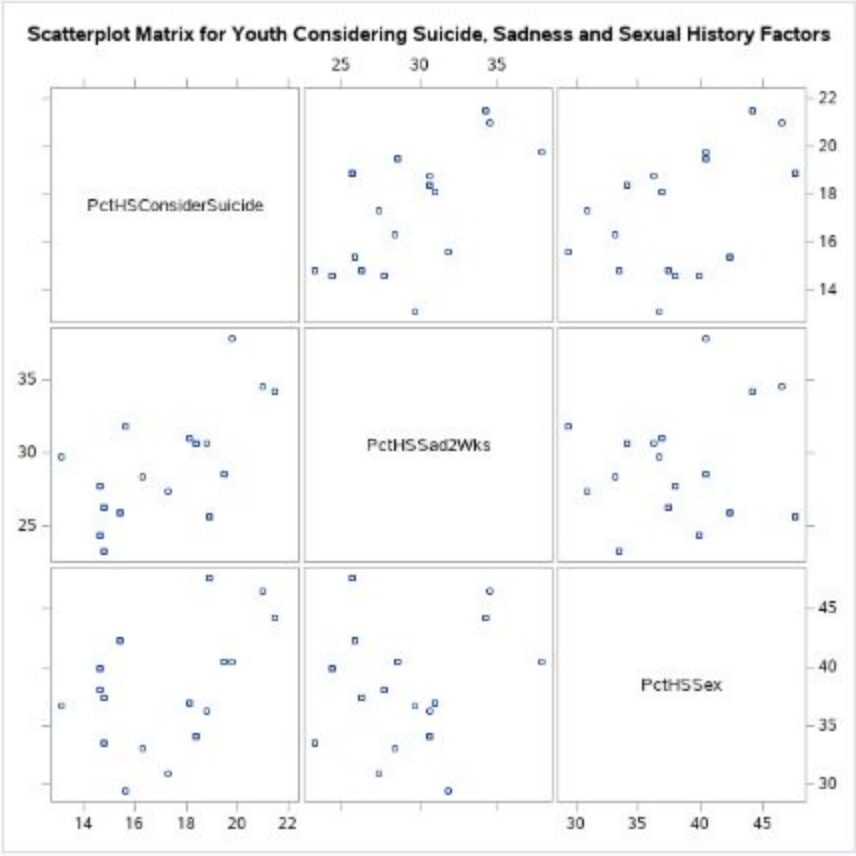


*Figure 13*. The scatterplot matrix between high school students who seriously considered suicide, high school students who felt sad or hopeless almost every day for two or more weeks in a row, and high school students who have ever had sexual intercourse.