

## Smoothing 3D mortality rates due to drug overdose and displaying death patterns with SAS/JMP software

Nancy Han MS. and Rong Wei PhD.

National Center for Health Statistics/CDC

### ABSTRACT

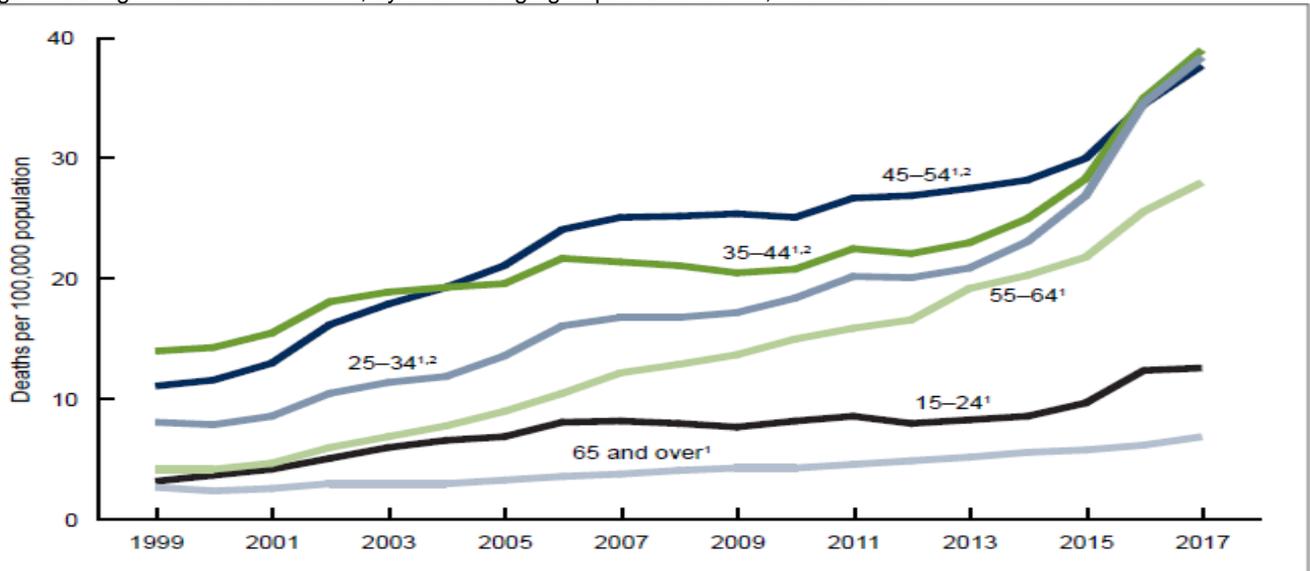
Many data presentation methods used to examine the trending behavior of drug overdose death rates by age over time rely on two-dimensional line graphs with age defined as a categorical variable. With the use of SAS/JMP procedures, visual graphic methods can be used to explore patterns and relationships between age and year of death on death rates with three dimensional (3D) plots. The drug overdose death rates were calculated using mortality data from the National Vital Statistics System public use multiple cause-of-death files. The SAS/JMP 3D plot software displays the changing death rates by age over the trending period when age is treated as a continuous variable rather than a grouped variable. Analysis is further enhanced, by the capability of the software to view the graphics from different angles. In addition to 3D data plots, locally smoothed 3D plots can be produced by SAS procedures prior to JMP plotting. SAS/TSPPINE is used to produce the examples.

**Keywords:** SAS, JMP, 3D

### INTRODUCTION

- Investigating trends in population health is an important part of epidemiology<sup>1</sup>.
- Many data presentation methods show trends in drug overdose death rates by age over time.
- Traditionally, these methods have relied on two-dimensional line graphs with age defined as a categorical variable.

Figure 1. Drug overdose death rates, by selected age group: United States, 1999-2017



Note how trends over time are presented for collapsed age groups, masking any changes that might be occurring within the defined collapsed groups.

### OBJECTIVE

To explore epidemiologic changes in drug overdose death rates over time by single years of age (instead of collapsed age groups) using SAS and JMP procedures.

**DATA SOURCES:**

U.S. National Vital Statistics System, 2007 to 2017 (11 years)

Drug overdose deaths were identified using ICD-10 mortality codes: X40 – X44, X60 – X64, X85, and Y10 – Y14

Age range 15 to 85+ years in single year intervals.

U.S. Census Population data, 2007-2017, Denominators for death rates.

**ANALYSIS**

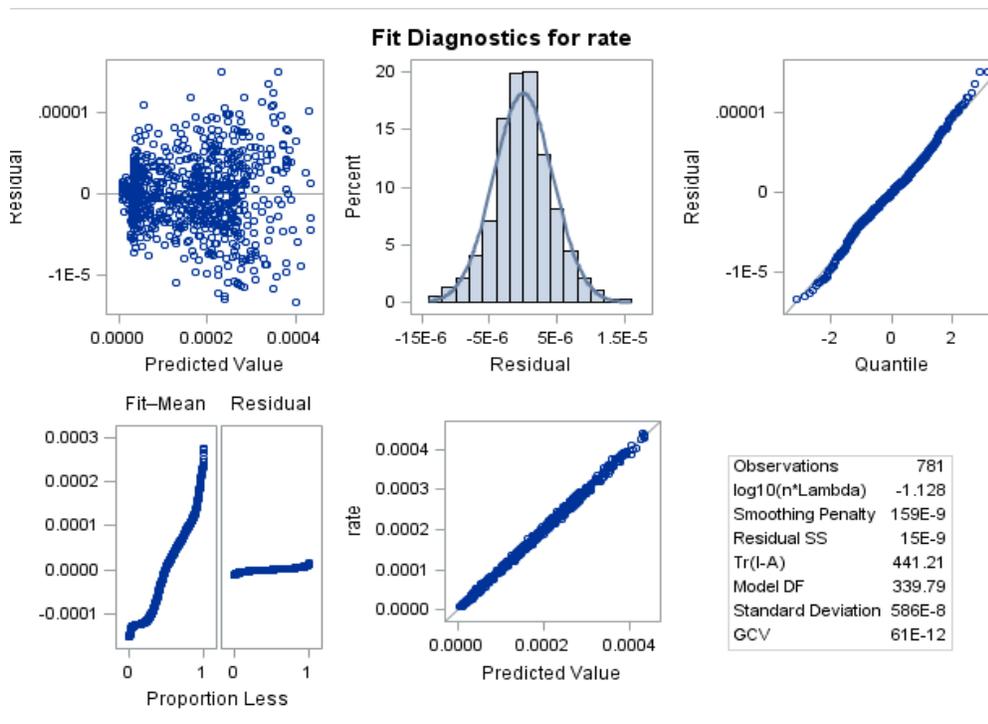
Drug overdose death rates were computed as death counts divided by populations in single year of age and calendar year, from 15 to 85+ years, from 2007 through 2017.

SAS/TPSPLINE procedures were used to smooth death rates at both age and year dimensions<sup>2,4</sup>. The core codes for the smoothing are

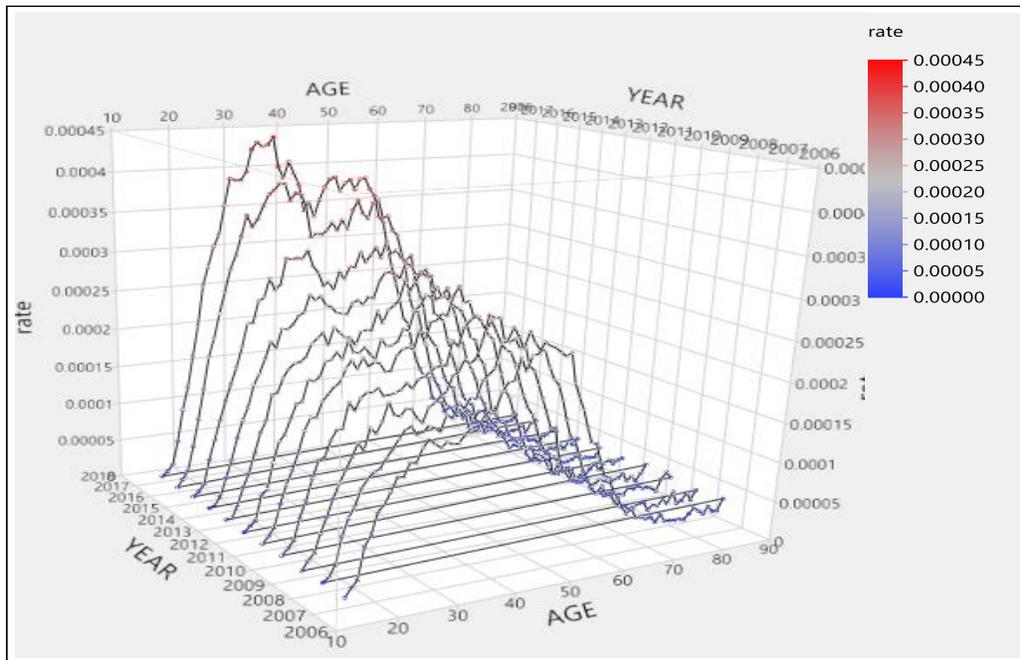
```
proc tpspline data= drugdeath;
ods select DiagnosticsPanel; title "drug abuse";
model rate = (age year);
score data=pred out=predy pred std uclm lclm;
run;
```

Smoothed data were plotted by using JMP/3D procedures<sup>3,4</sup> to display changing patterns of death rates in ages and years.

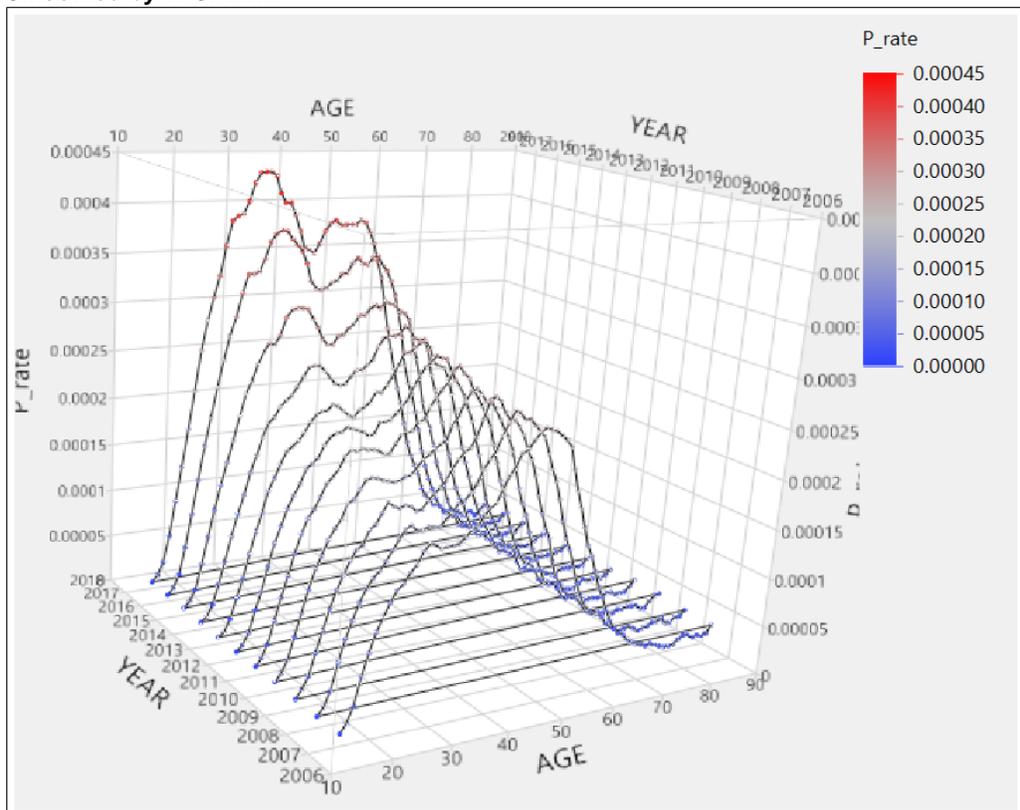
**FIGURE 2: TWO DIMENSIONAL (2D) SMOOTHING WITH SAS/TPSPLINE – DIAGNOSTIC 2D SMOOTHING MODEL**



**Figure 3: Plot with JMP/3D scatter to compare smoothed & unsmoothed data Unsmoothed data**

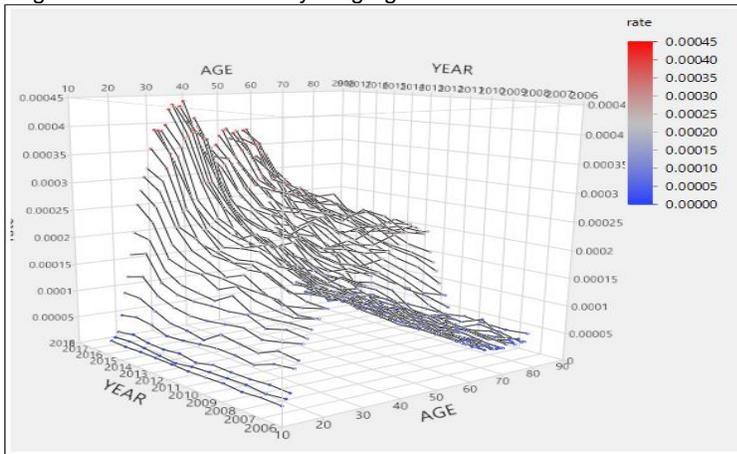


Smoothed by TPSPLINE

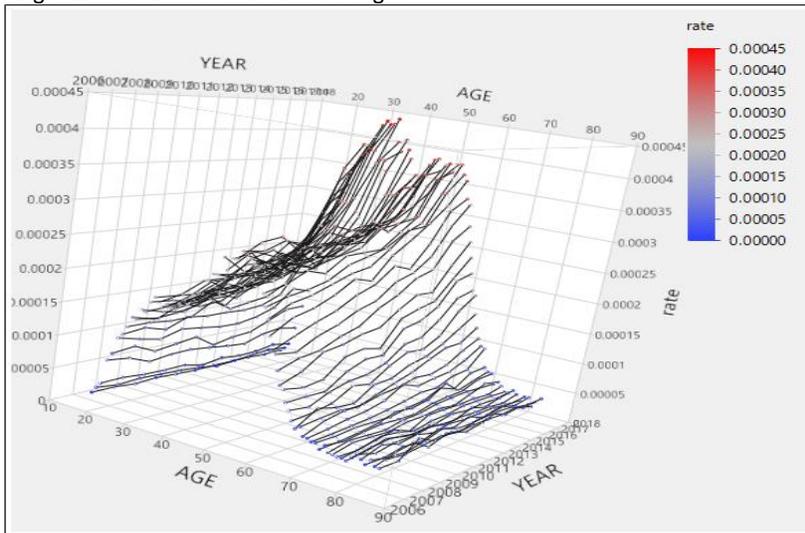


**FIGURE 4: VIEW THE PLOT FROM DIFFERENT ANGLES TO SEE TRENDS ACROSS YEARS FOR EACH AGE YEAR**

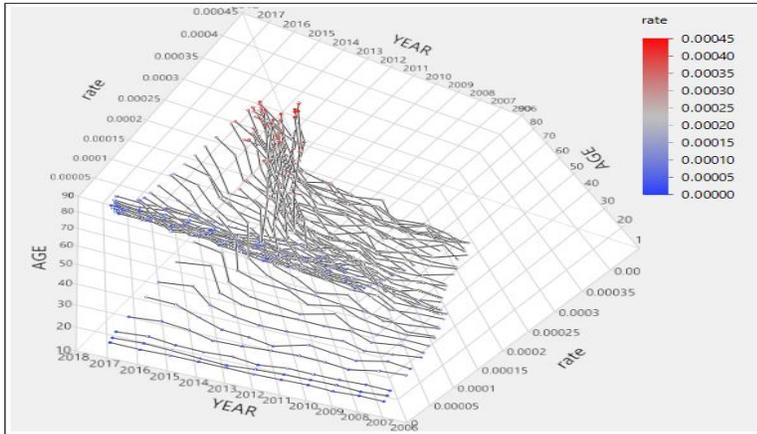
Angle 1: Trends of rates for young ages



Angle 2: Trends of rates for older ages



Angle 3: Peak of rates for younger ages



Angle 4: Peak of rates for older ages

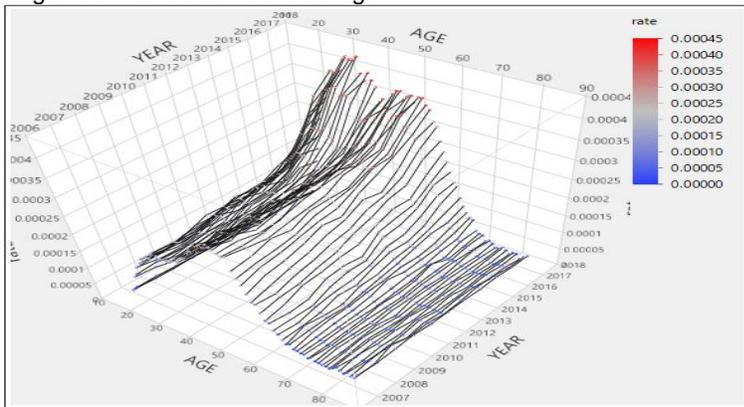
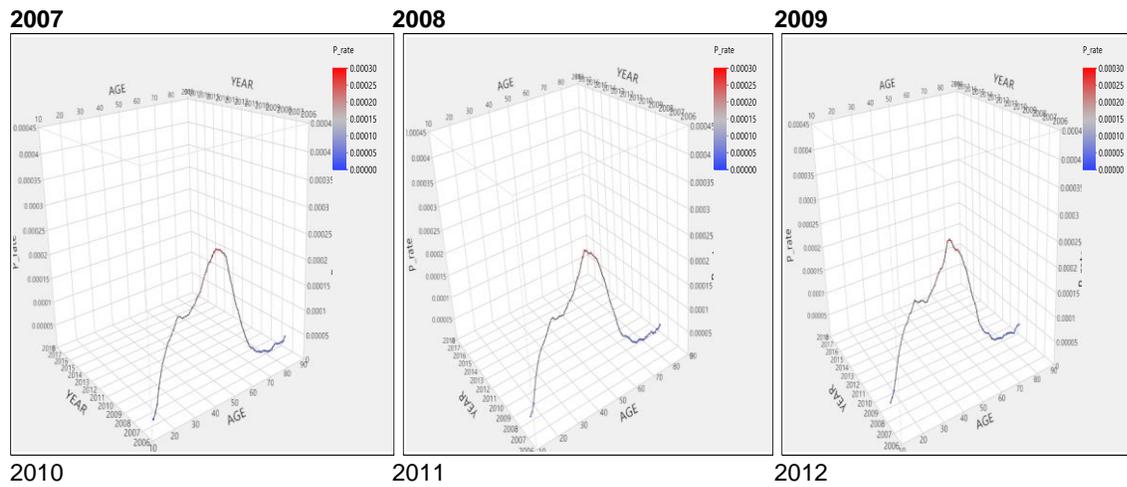
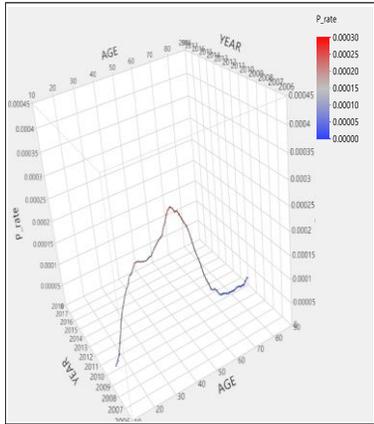
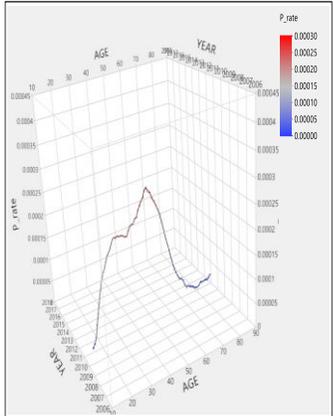


Figure 5: 2D smoothing with SAS/TPSPLINE. Dissect 3D plot into separate years

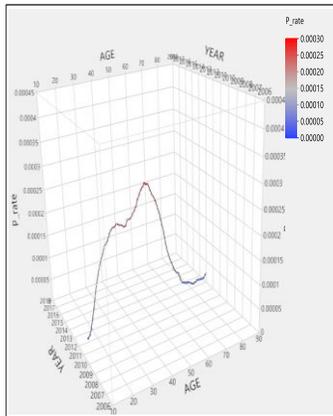




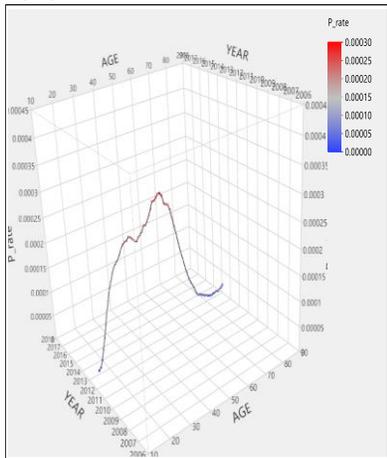
2013



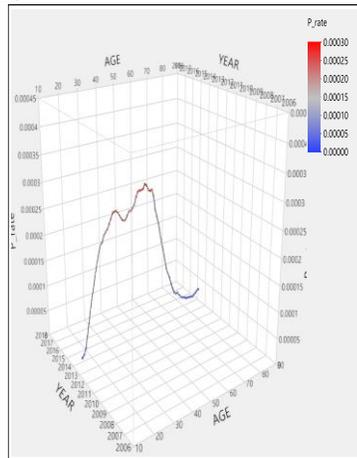
2014



2015



2016



2017

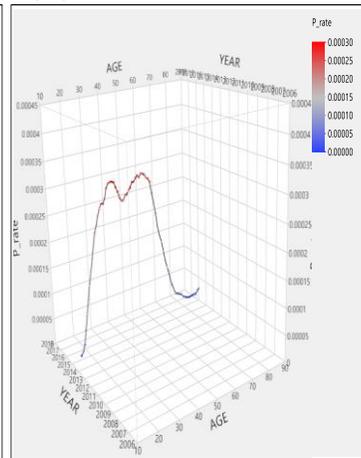
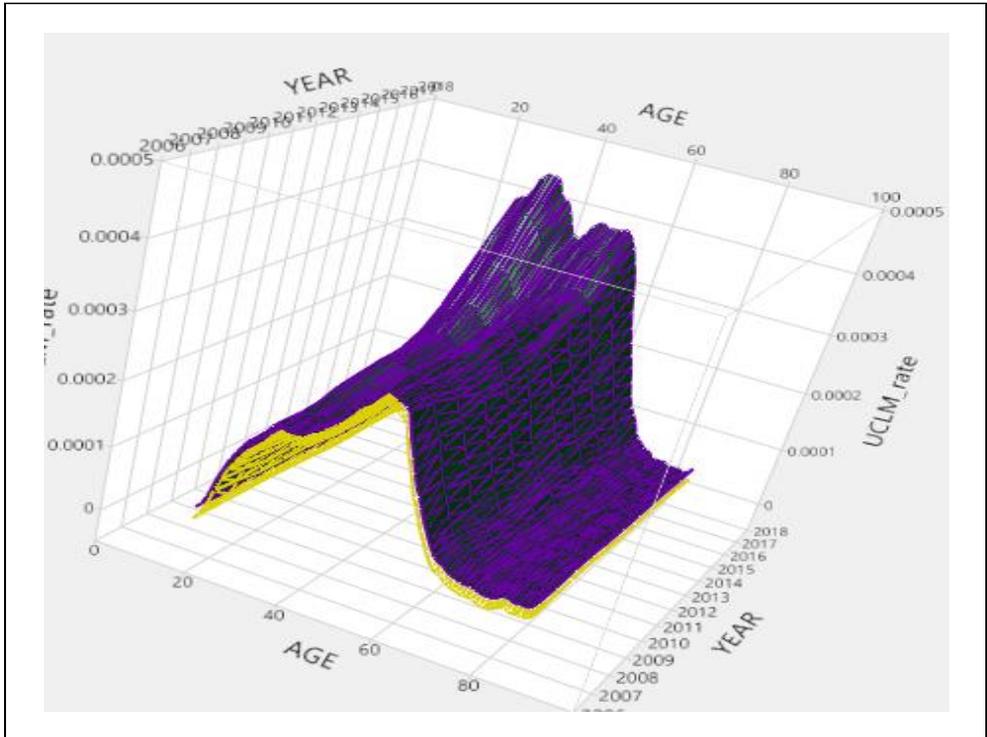
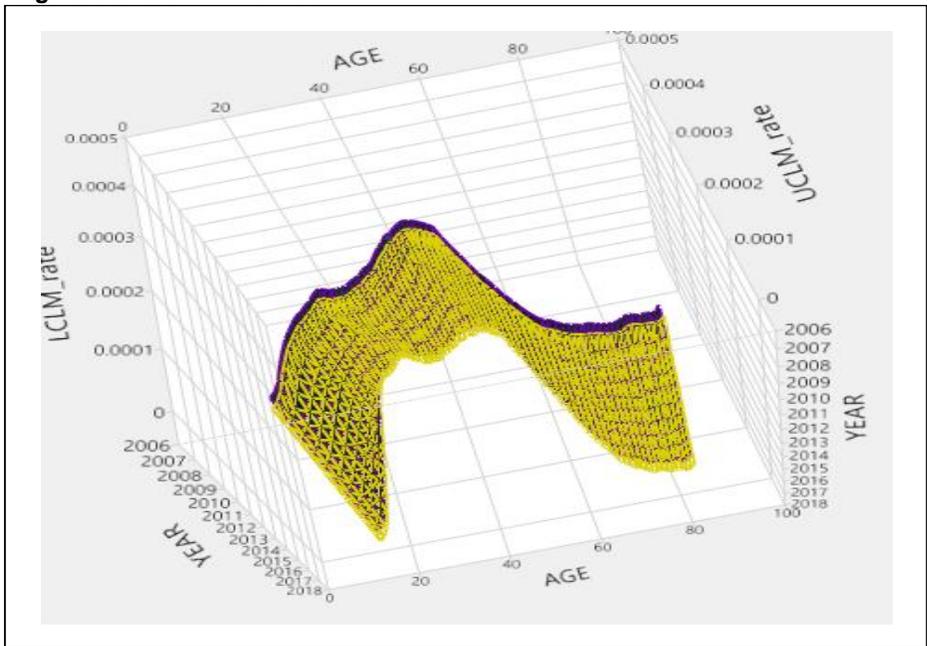


Figure 6: Check smoothing 95% confidence interval using overlapped 3D plots

Angle 1: Upper 95% CI surface



Angle 2 : Lower 95% CI surface



Green: smoothed death rate. Purple: Upper 95% CI. Yellow: Lower 95% CI.

## CONCLUSION

- In the 3D result, a gradually increasing peak for deaths between ages 30 and 40 can be seen from 2007 to 2017. By 2017, this peak was higher than the peak for deaths between ages 50 and 60.

- The age pattern changes displayed in the 3D plots could not be seen with conventional 2D plots. The 2D smoothing and 3D plotting helped extract information from data, providing insight into the epidemiology of drug overdose.
- JMP 3D plot procedures can explore data at greater granularity.
- SAS 2D smoothing is a useful tool for visual methods by simultaneously smoothing two variables, which minimizes overall errors in the smoothing procedure.
- These methods could be extended to other epidemiology fields and help to address public health issues.

## REFERENCES

1. NCHS Data Brief, No. 329, November 2018. Holly H.MD, Arialdi M, MPH etc.
2. JMP essential graphing manual, version 14. SAS Campus Drive Cary NC 27513
3. SAS/STAT® 9.3 User's Guide, SAS Instituted Inc. 2011. Cary NC.
4. Wei, R. 2014. Smoothing US Cause-Specific Mortality Rates at the State Level: Identifying Patterns of Change from 1970 to 2010 with 3-D Plots. Unpublished.

## CONTACT INFORMATION

Your comments and questions are valued and encouraged. Contact the author at:

Nancy Han and Rong Wei  
National Center for Health Statistics /CDC  
3311 Toledo Road  
Hyattsville, MD 20872-2064  
Phone: (301)458-4735  
Email: ndh7@cdc.gov

## BASIC INSTRUCTIONS

### WRITING GUIDELINES

#### Trademarks and product names

To find correct SAS product names (including use of trademark symbols), if you are a SAS employee, see the [Master Name List](#). Otherwise, see [SAS Trademarks](#).

- Use superscripted trademark symbols in the first use in title, first use in abstract, and in graphics, charts, figures, and slides.
- Do not abbreviate product names. For example, you cannot use “EM” for SAS® Enterprise Miner™. After having introduced a SAS product name, you can occasionally omit “SAS” for certain products, provided that your editor agrees. For example, after you have introduced SAS® Simulation Studio, you can occasionally use “Simulation Studio.”

#### Writing style

- Use active voice. (Use passive voice only if the recipient of the action needs to be emphasized.) For example:  
The product creates reports. (active)  
Reports are created by the product. (passive)
- Use second person and present tense as much as possible. For example:  
You get accurate results from this product. (second person, present tense)  
The user will get accurate results from this product. (future tense)
- Run spellcheck, and fix errors in grammar and punctuation.

#### Citing references

All published work that is cited in your paper must be listed in the REFERENCES section.

If you include text or visuals that were written or developed by someone other than yourself, you must use the following guidelines to cite the sources:

- If you use material that is copyrighted, you must mention that you have permission from the copyright holder or the publisher, who might also require you to include a copyright notice. For example: “Reprinted with permission of SAS Institute Inc. from *SAS® Risk Dimensions®: Examples and Exercises*. Copyright 2004. SAS Institute Inc.”
- If you use information from a previously printed source from which you haven’t requested copyright permission, you must cite the source in parentheses after the paraphrased text. For example: “The minimum variance defines the distance between cluster (Ward 1984, p. 23)

#### TIPS FOR USING WORD

These instructions are written for MS Word 2007, MS Word 2010 and MS Word 2013. The steps are similar for MS Word 2003.

#### To select a paragraph style

1. Click the HOME tab. The most common styles in your document are displayed in the top right area of the Microsoft ribbon. If you don’t see a style that you want, click the slanted down arrow at the bottom right corner of the Styles area, and scroll through the list. The main styles for this template are headings 1 through 4, PaperBody, and Caption. Avoid using other styles.
2. To change a paragraph style, click the paragraph to which you want to apply a style, and then click the style that you want in the ribbon.
3. PaperBody (used for most text) is automatically applied when you press Enter at the end of any heading style or the Caption style.

#### To insert a caption

1. Click **REFERENCES** on the main Word menu.
2. Click **Insert Caption**.
3. Select the **Label** type that you want.
4. Click **OK**.

## To insert a cross-reference

1. Click **REFERENCES** on the main Word menu.
2. Click **Cross-reference**.
3. In the **Reference type** list box, select **Heading, Figure, Table, Display, or Output**.
4. For a heading:
  - a. In the **For which heading** list, select the heading that you want.
  - b. From the **Insert reference to** list, select **Heading text**.
5. For a figure, table, display, or output:
  - a. In the **For which caption** list, select the caption that you want.
  - b. From the **Insert reference to** list, select **Only label and number**.

## To insert a graphic from a file

1. Click **INSERT** on the main Word menu.
2. Click **Picture**.
3. In the Insert Picture dialog box, navigate to the file that you want to insert.
4. When the name of the file that you want to insert is displayed in the **File name** box, click **Insert**.