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Effective Use of Column Charts

Purpose	This tool provides guidelines and tips on how to effectively use column charts to communicate research findings.
Format	This tool provides guidance on column charts and their purposes, shows examples of preferred practices and practical tips for column charts, and provides cautions and examples of misuse and poor use of column charts and how to make corrections.
Audience	This tool is designed primarily for researchers from the Model Systems that are funded by the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR). The tool can be adapted by other NIDILRR-funded grantees and the general public.

Overview and Organization

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Overview

▶ Illustrations of types of column charts

▶ Guidance on the type of data and purposes for which column charts are well-suited

▶ Basic principles for presenting data visually using column charts

▶ Examples of preferred practices and practical tips for column charts

▶ Cautions and examples of misuse and poor use of column charts and how to correct such

▶ For some example charts, mock data was created to illustrate the concept and such mock examples should not be construed as real data

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Simple Column Chart – Categorical Comparisons

▶ Data values displayed as vertical columns.

▶ Magnitude of each data element is represented by the height of the column.

▶ Can be used to display values for categorical items (percent voting by race and gender, death rates by cause of death etc).

▶ Shows comparisons among the categorical groups on the measure.

▶ Categories displayed on the horizontal axis.

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Simple Column Chart – Categorical Comparisons

Age-Adjusted Death Rates Per 100,000 Standard Population, United States, 2012
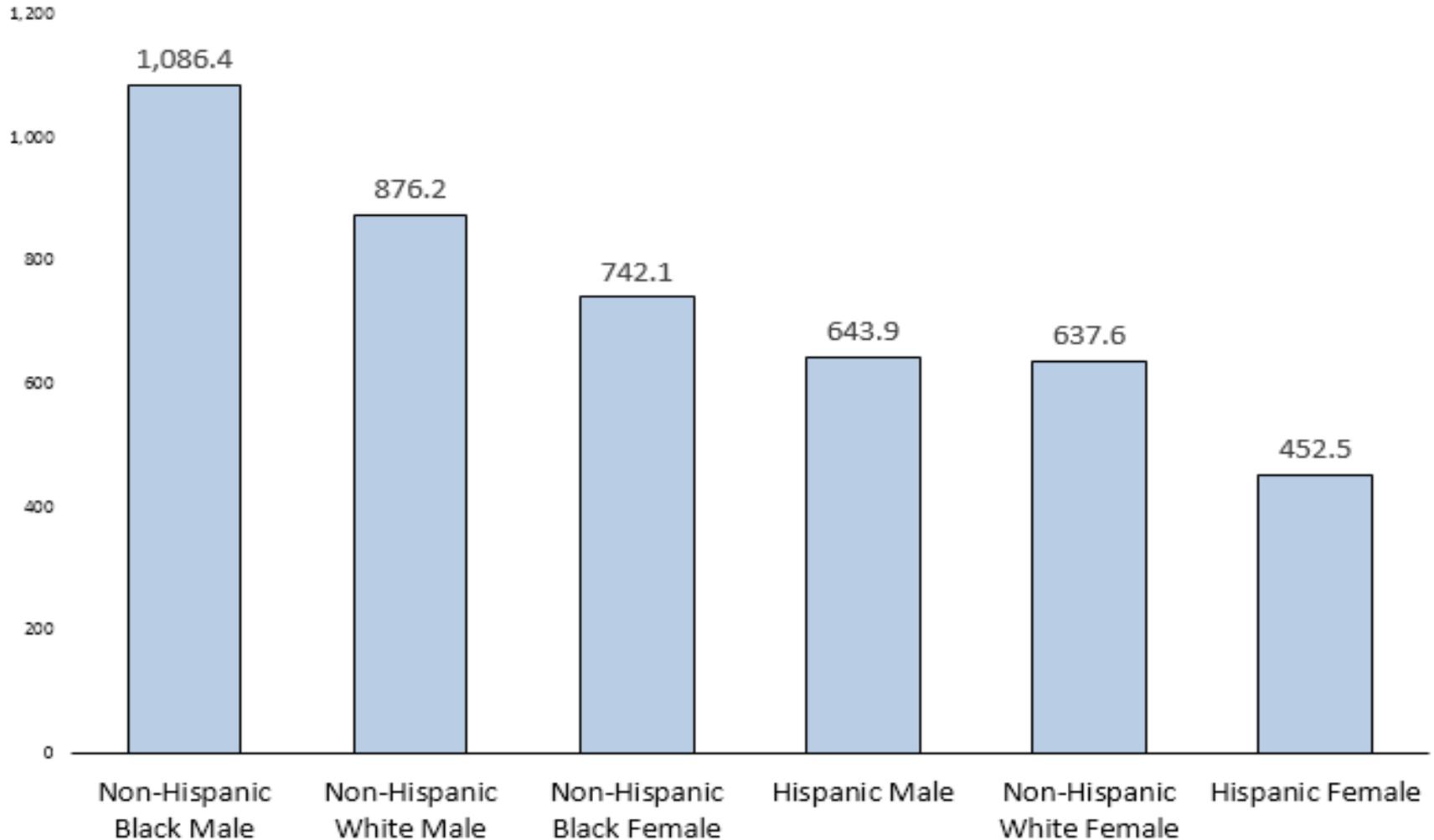
Source: CDC, National Vital Statistics System, Mortality   5

Simple Column Chart – Trends

▶ Data values displayed as vertical columns.

▶ Magnitude of each data element is represented by the height of the column.

▶ Columns can also be used to display values of some data series over time (clients served by quarter, percent of households that are wireless-only, etc).

▶ Shows trends over time on the measure.
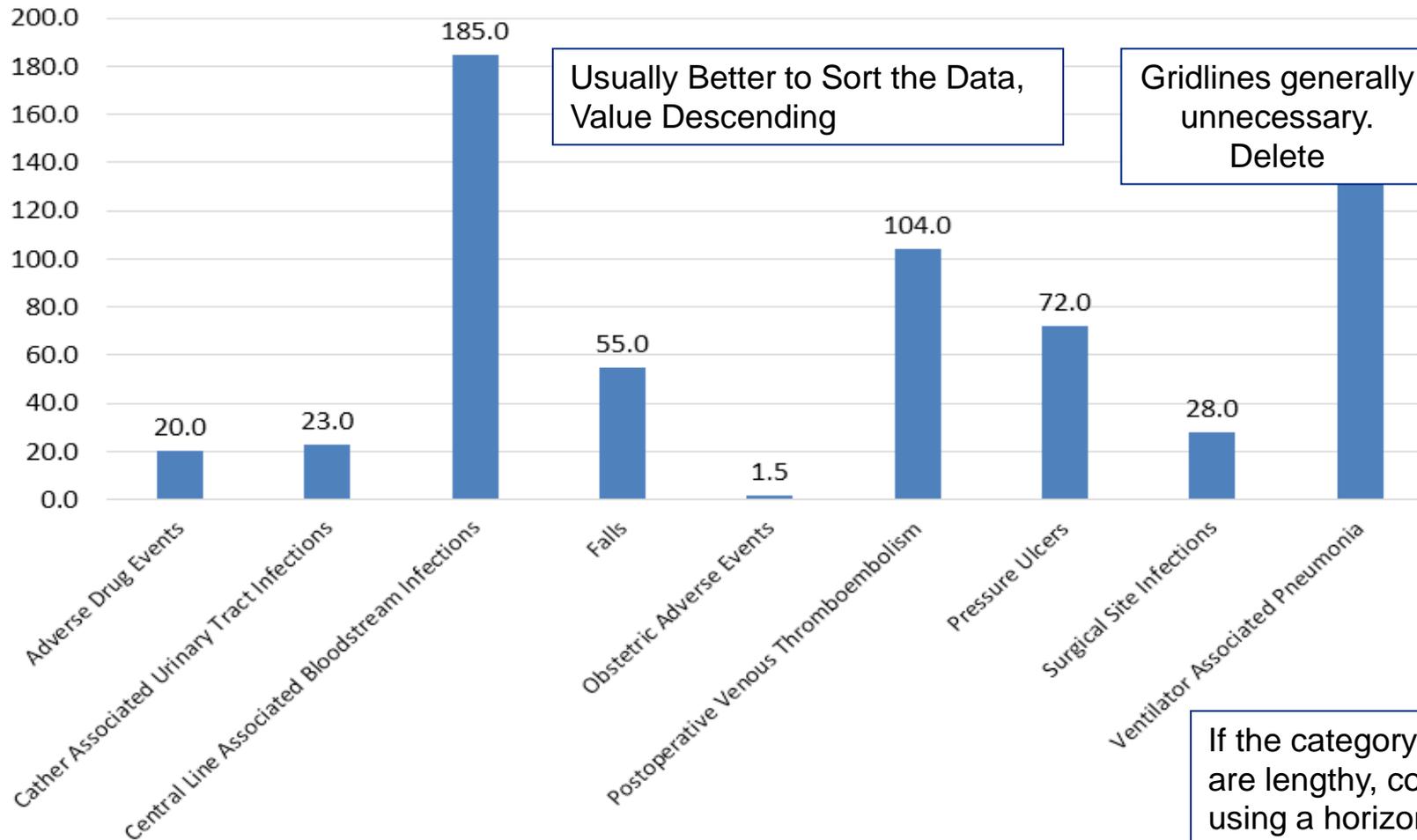
▶ Time displayed on the horizontal axis.

Simple Column Chart – Trends

Percent of Adults Living in Households that Do Not Have a Landline Telephone
But Have At Least One Wireless Telephone - Wireless-Only Households - US
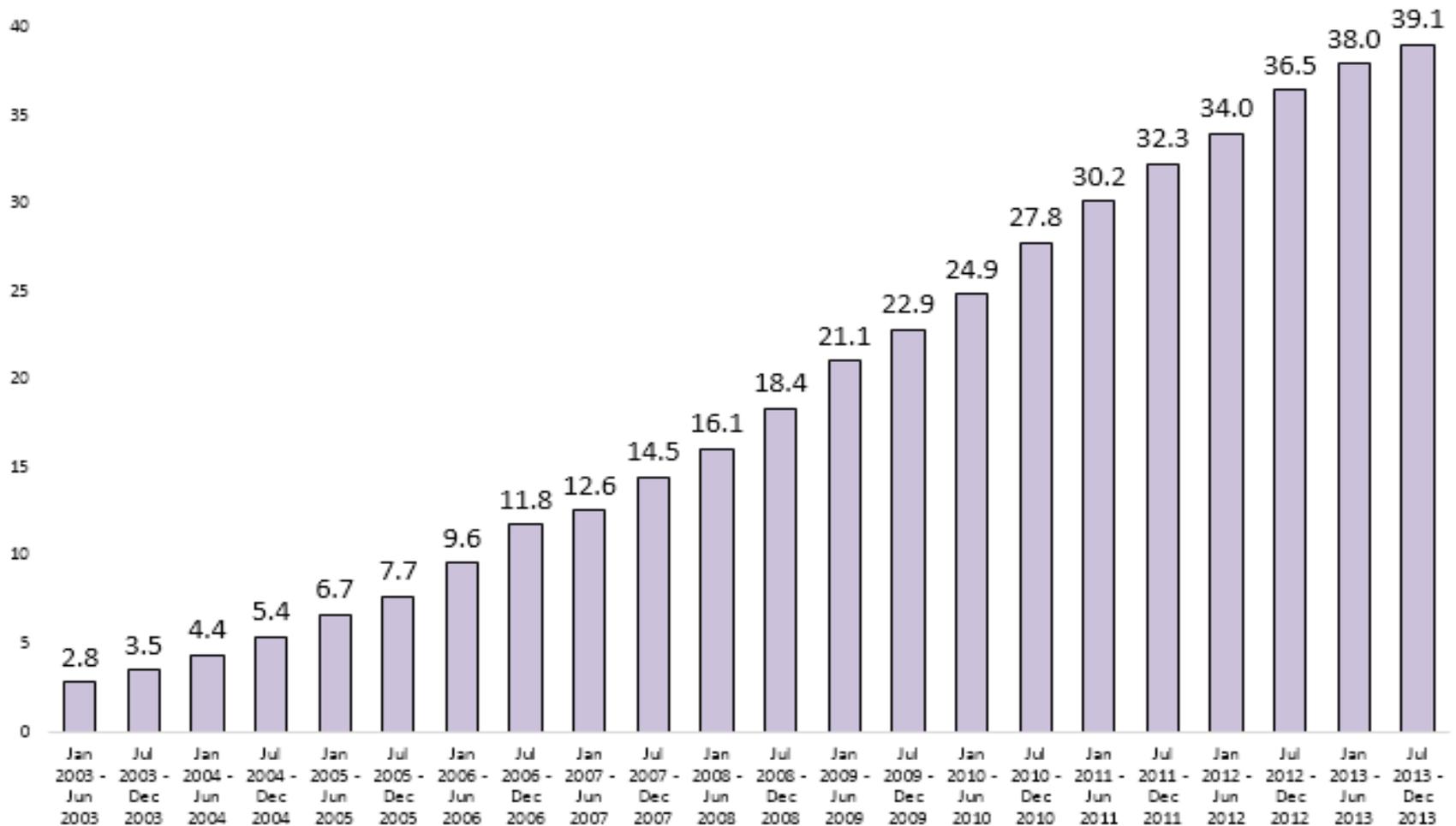
Source: National Health Interview Survey

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Simple Categorical Column Chart: Cautions, Misuse, and Poor Use

Unnecessary decimal detail on vertical axis.

Hospital Acquired Conditions [HAC] - Estimated Additional Inpatient Mortality Deaths Per 1000 Cases - Per HAC - US - 2011

Usually Better to Sort the Data, Value Descending

Gridlines generally unnecessary. Delete

Chart values:
- Adverse Drug Events: 20.0
- Cather Associated Urinary Tract Infections: 23.0
- Central Line Associated Bloodstream Infections: 185.0
- Falls: 55.0
- Obstetric Adverse Events: 1.5
- Postoperative Venous Thromboembolism: 104.0
- Pressure Ulcers: 72.0
- Surgical Site Infections: 28.0
- Ventilator Associated Pneumonia

If the category labels are lengthy, consider using a horizontal bar chart instead.

Do not angle the categorical labels on horizontal axis – difficult to read.

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Simple Categorical Column Chart - Sorted
Principles, Tips, Preferred Practices

Hospital Acquired Conditions [HAC] - Estimated Additional Inpatient Mortality
Deaths Per 1000 Cases - Per HAC - US - 2011

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Simple Bar Chart
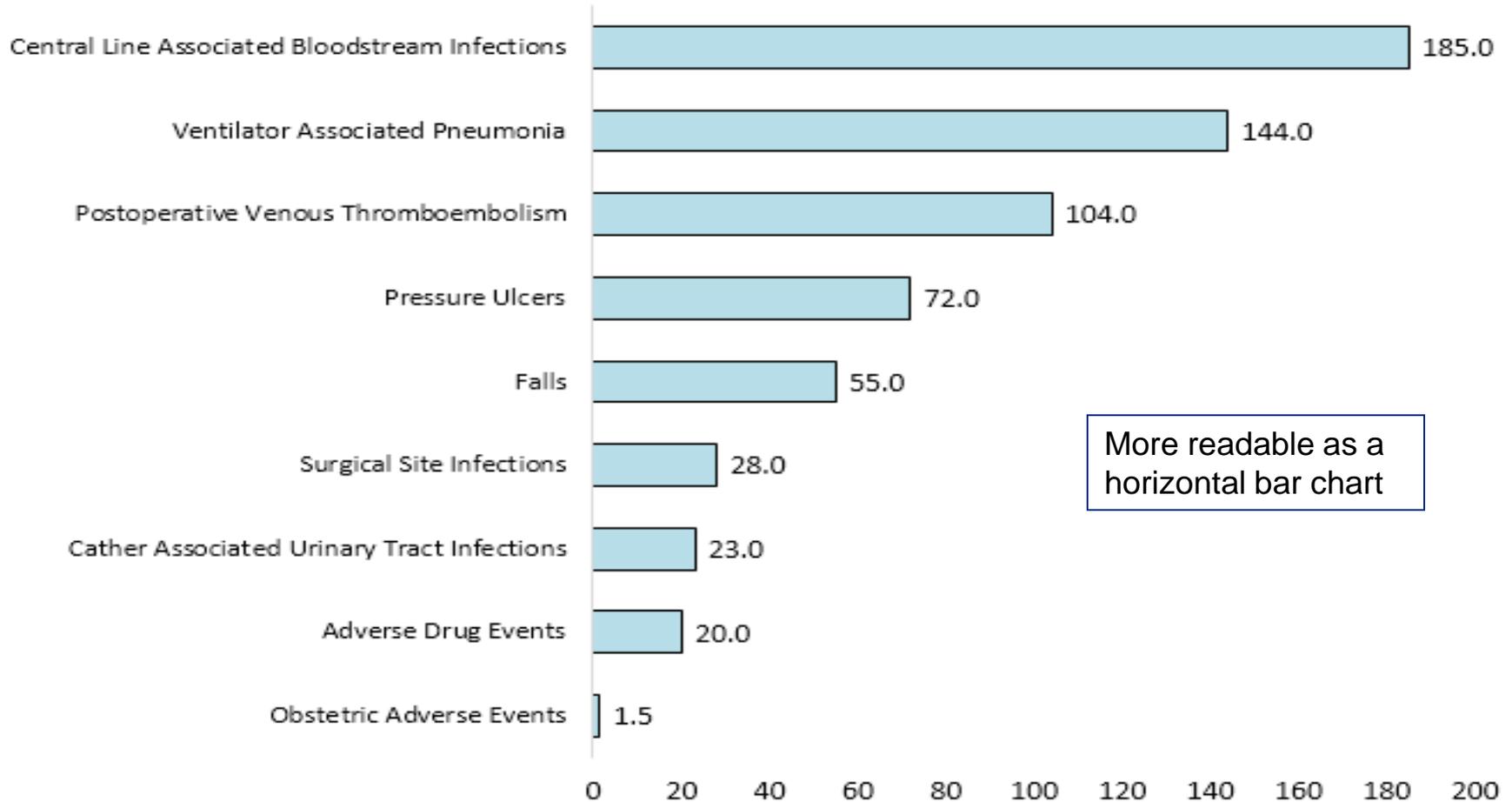## Principles, Tips, Preferred Practices

Hospital Acquired Conditions [HAC] - Estimated Additional Inpatient Mortality
Deaths Per 1000 Cases - Per HAC - US - 2011

Condition	Value
Central Line Associated Bloodstream Infections	185.0
Ventilator Associated Pneumonia	144.0
Postoperative Venous Thromboembolism	104.0
Pressure Ulcers	72.0
Falls	55.0
Surgical Site Infections	28.0
Cather Associated Urinary Tract Infections	23.0
Adverse Drug Events	20.0
Obstetric Adverse Events	1.5

Axis: 0 20 40 60 80 100 120 140 160 180 200

More readable as a horizontal bar chart
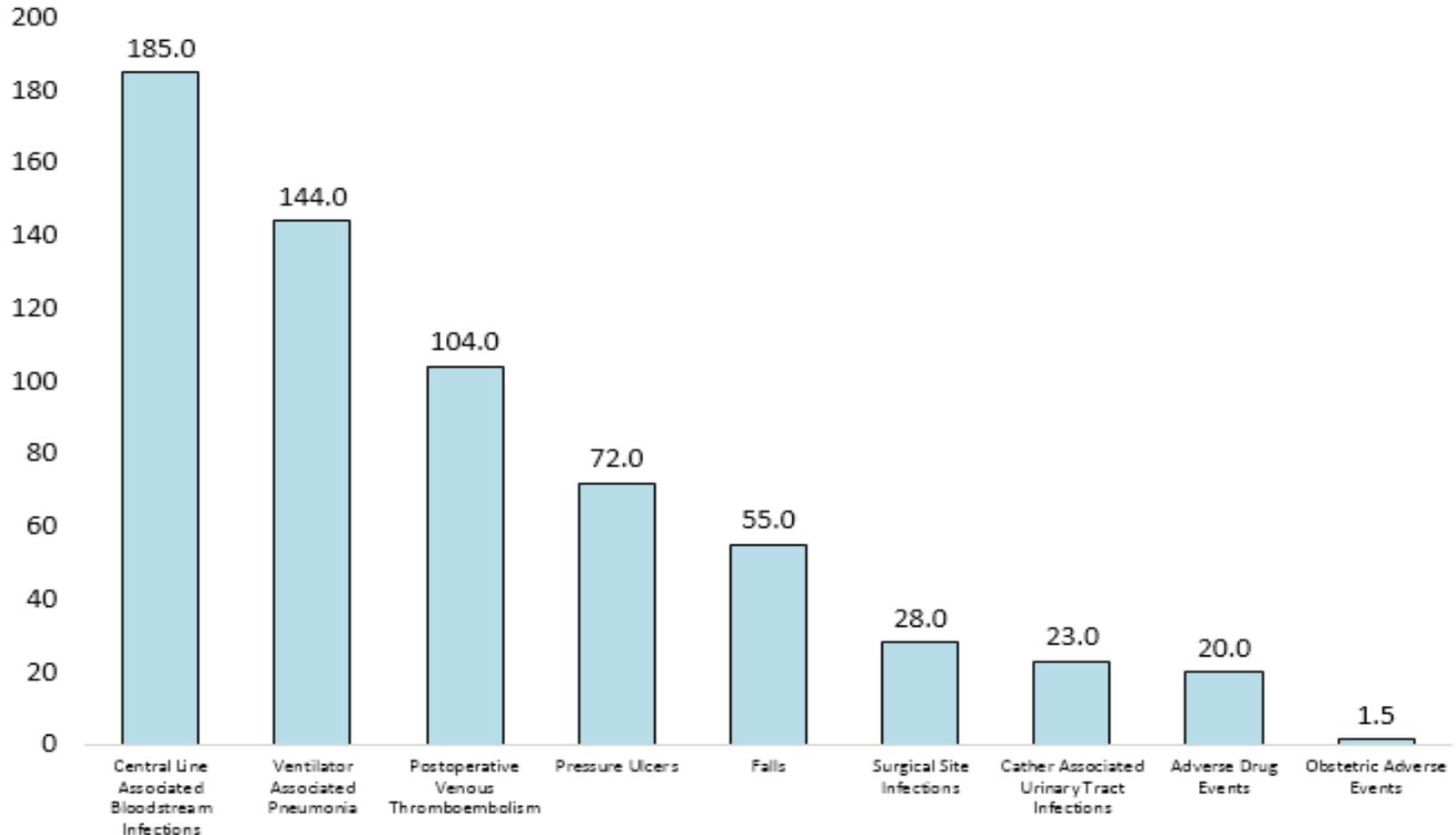
Source: CDC NCHS | <<Including source info is always helpful

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Simple Categorical Column Chart:
Cautions, Misuse, and Poor Use

City Proper - Population Estimate - 2014
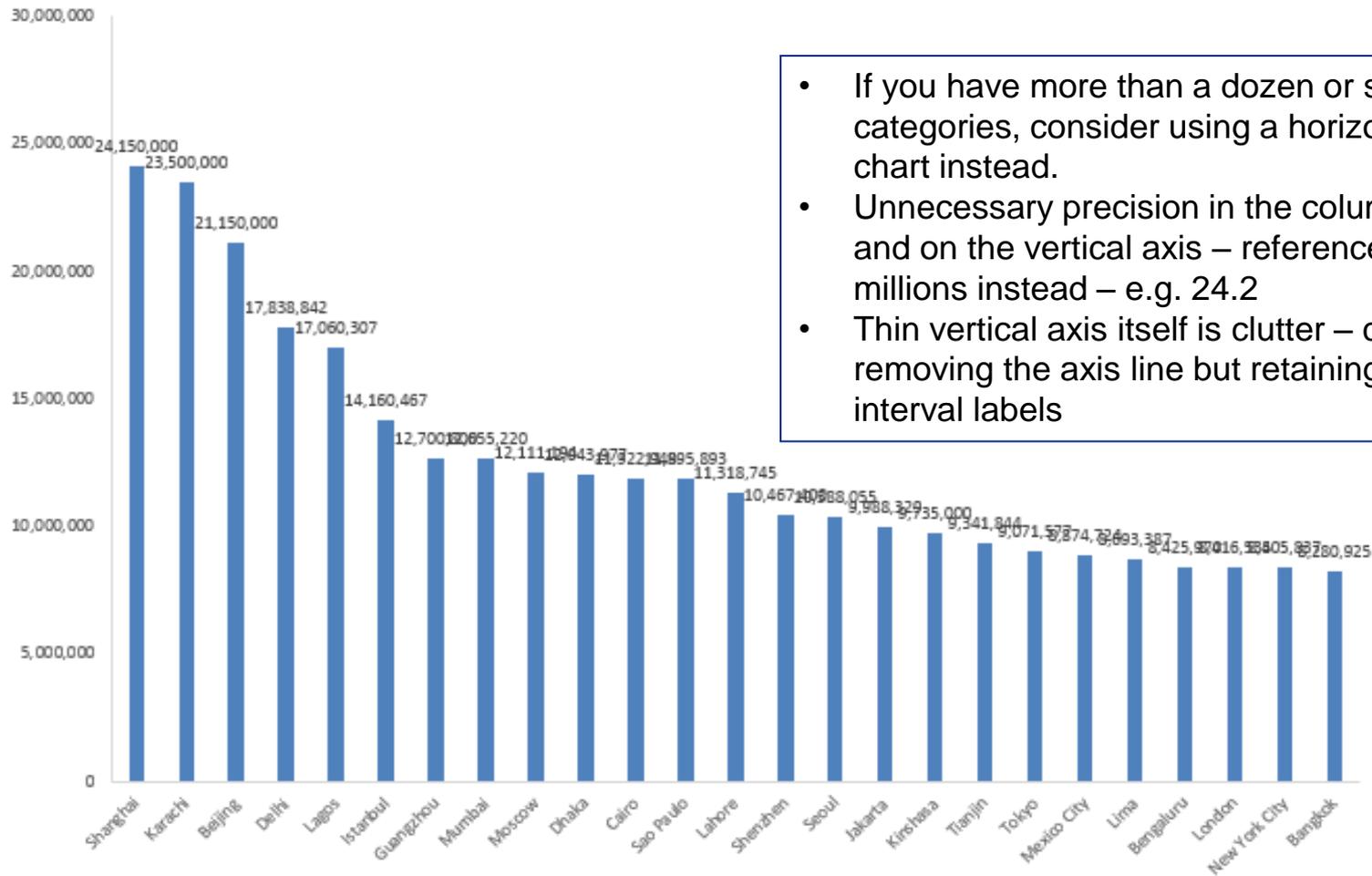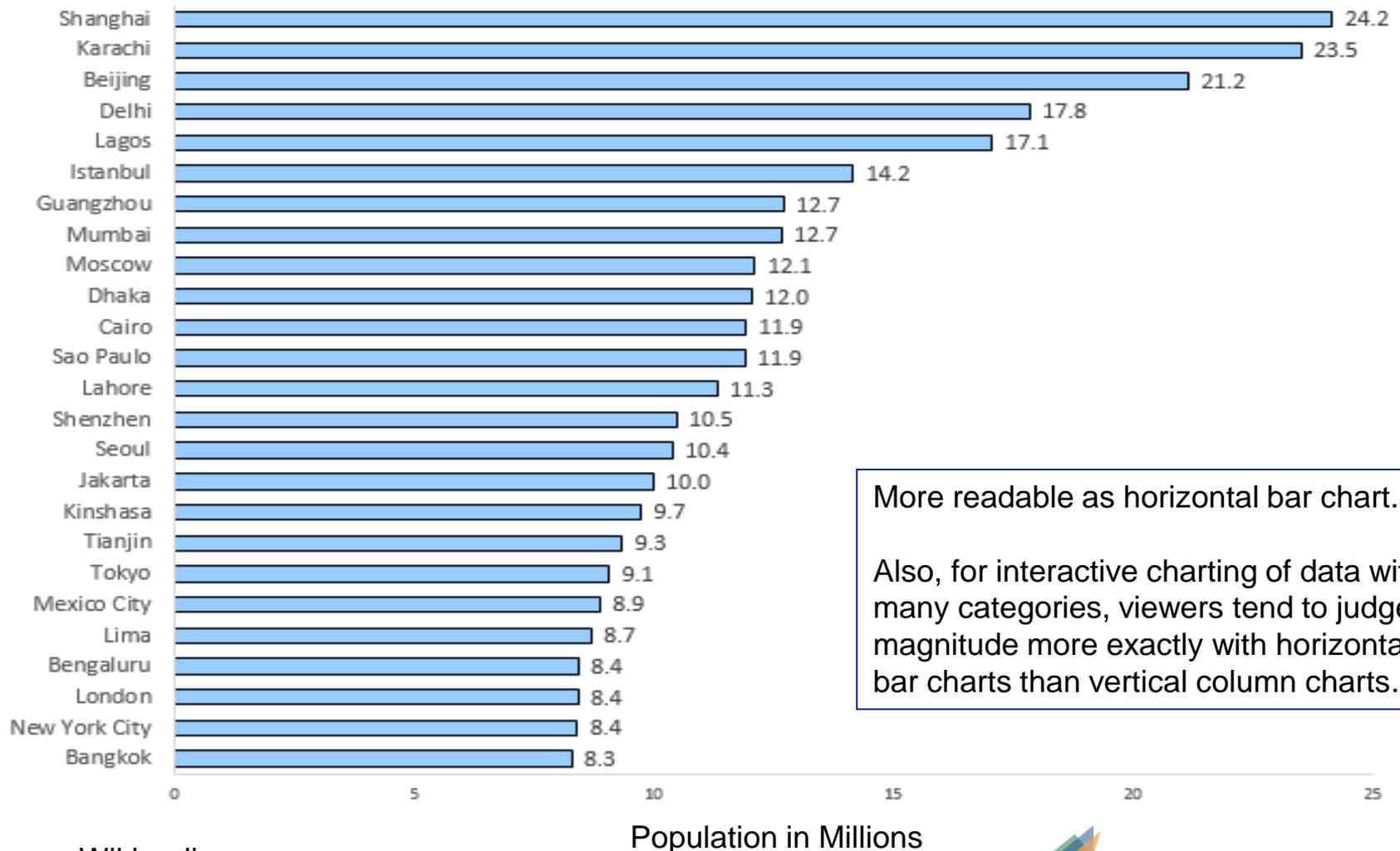
- If you have more than a dozen or so categories, consider using a horizontal bar chart instead.
- Unnecessary precision in the column labels and on the vertical axis – reference in millions instead – e.g. 24.2
- Thin vertical axis itself is clutter – consider removing the axis line but retaining the axis interval labels

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Simple Bar Chart
Principles, Tips, Preferred Practices

City Proper - Population Estimate - 2014

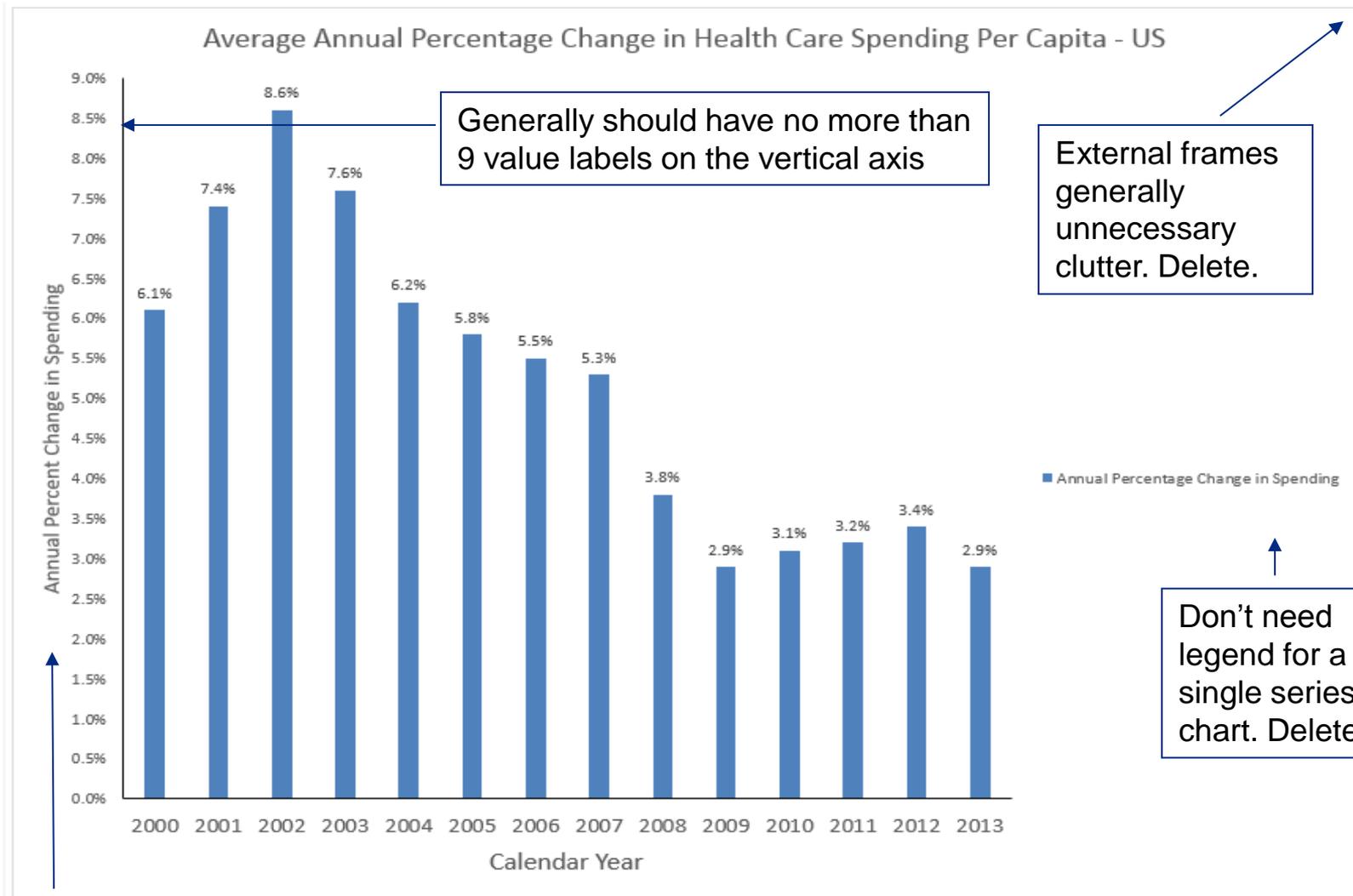| City	Population
Shanghai	24.2
Karachi	23.5
Beijing	21.2
Delhi	17.8
Lagos	17.1
Istanbul	14.2
Guangzhou	12.7
Mumbai	12.7
Moscow	12.1
Dhaka	12.0
Cairo	11.9
Sao Paulo	11.9
Lahore	11.3
Shenzhen	10.5
Seoul	10.4
Jakarta	10.0
Kinshasa	9.7
Tianjin	9.3
Tokyo	9.1
Mexico City	8.9
Lima	8.7
Bengaluru	8.4
London	8.4
New York City	8.4
Bangkok	8.3

Population in Millions

More readable as horizontal bar chart.

Also, for interactive charting of data with many categories, viewers tend to judge magnitude more exactly with horizontal bar charts than vertical column charts.
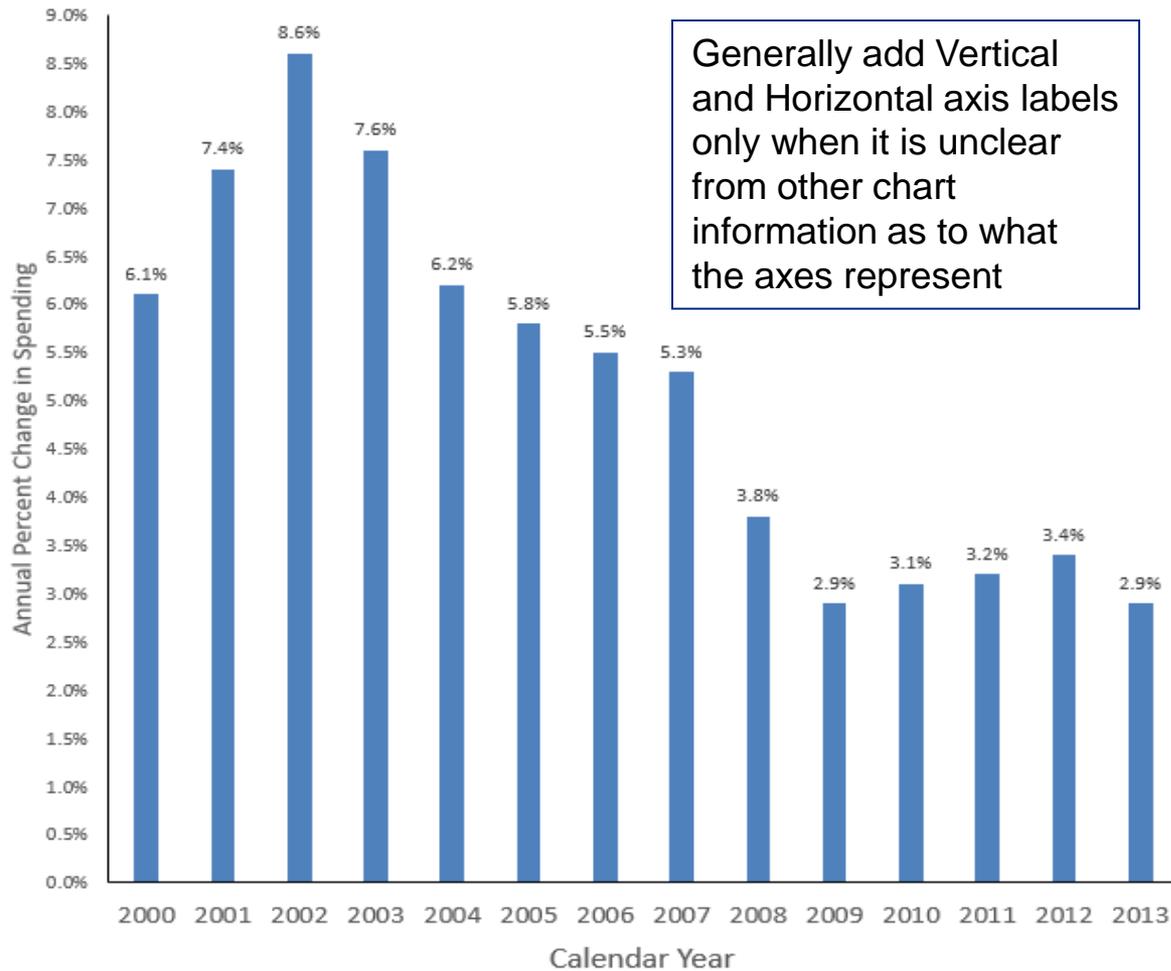
Source: Wikipedia.
Note: Legal political city boundaries. Does not << Notes add useful info
include suburbs.

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Simple Categorical Column Chart: Cautions, Misuse, and Poor Use

Average Annual Percentage Change in Health Care Spending Per Capita - US

Generally should have no more than 9 value labels on the vertical axis

External frames generally unnecessary clutter. Delete.

Don't need legend for a single series chart. Delete.

Don't need to repeat Axis Label if obvious or if addressed in title.

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Average Annual Percentage Change in Health Care Spending Per Capita - US

Annual Percent Change in Spending

Year	Value
2000	6.1%
2001	7.4%
2002	8.6%
2003	7.6%
2004	6.2%
2005	5.8%
2006	5.5%
2007	5.3%
2008	3.8%
2009	2.9%
2010	3.1%
2011	3.2%
2012	3.4%
2013	2.9%

Calendar Year

■ Annual Percentage Change in Spending

Generally add Vertical and Horizontal axis labels only when it is unclear from other chart information as to what the axes represent

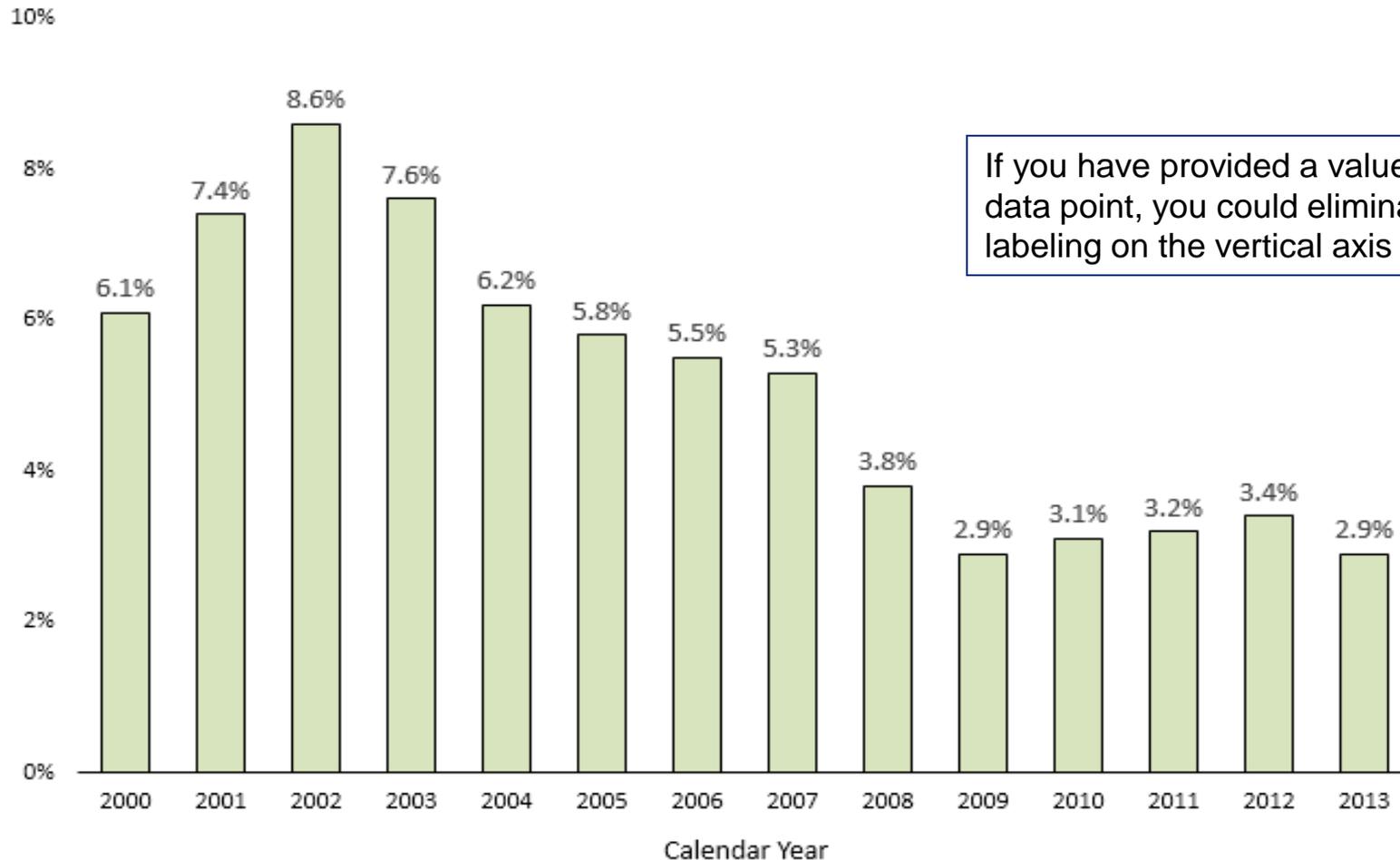Make vertical and horizontal axis labels as brief as possible

Horizontal axis label is useful in this example to differentiate CY FFY etc

Simple Column Chart - Trends
Principles, Tips, Preferred Practices

Average Annual Percentage Change in Health Care Spending Per Capita - US
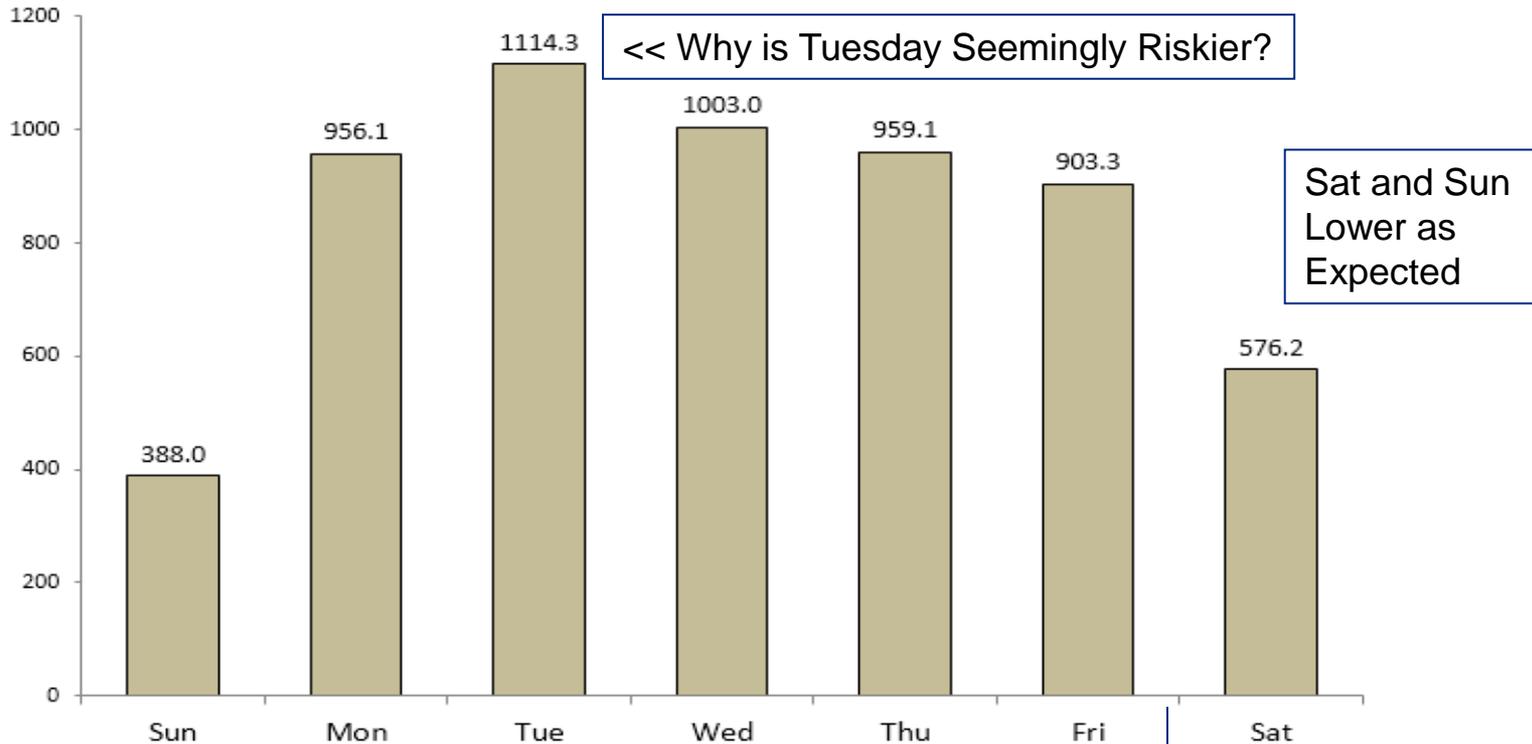

If you have provided a value for each data point, you could eliminate the labeling on the vertical axis entirely

Calendar Year

Source: CMS National Health Expenditures NHE

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Charting for Data Investigation

If using ticks on Quantitative axis, use Outside Ticks only. And no Minor Ticks

Total Fatal Occupational Injuries Per Day of Week of Incidence
Annual Average Per Day Across 20-Year Period - CY 1992 - CY 2011- US

<< Why is Tuesday Seemingly Riskier?

Sat and Sun Lower as Expected

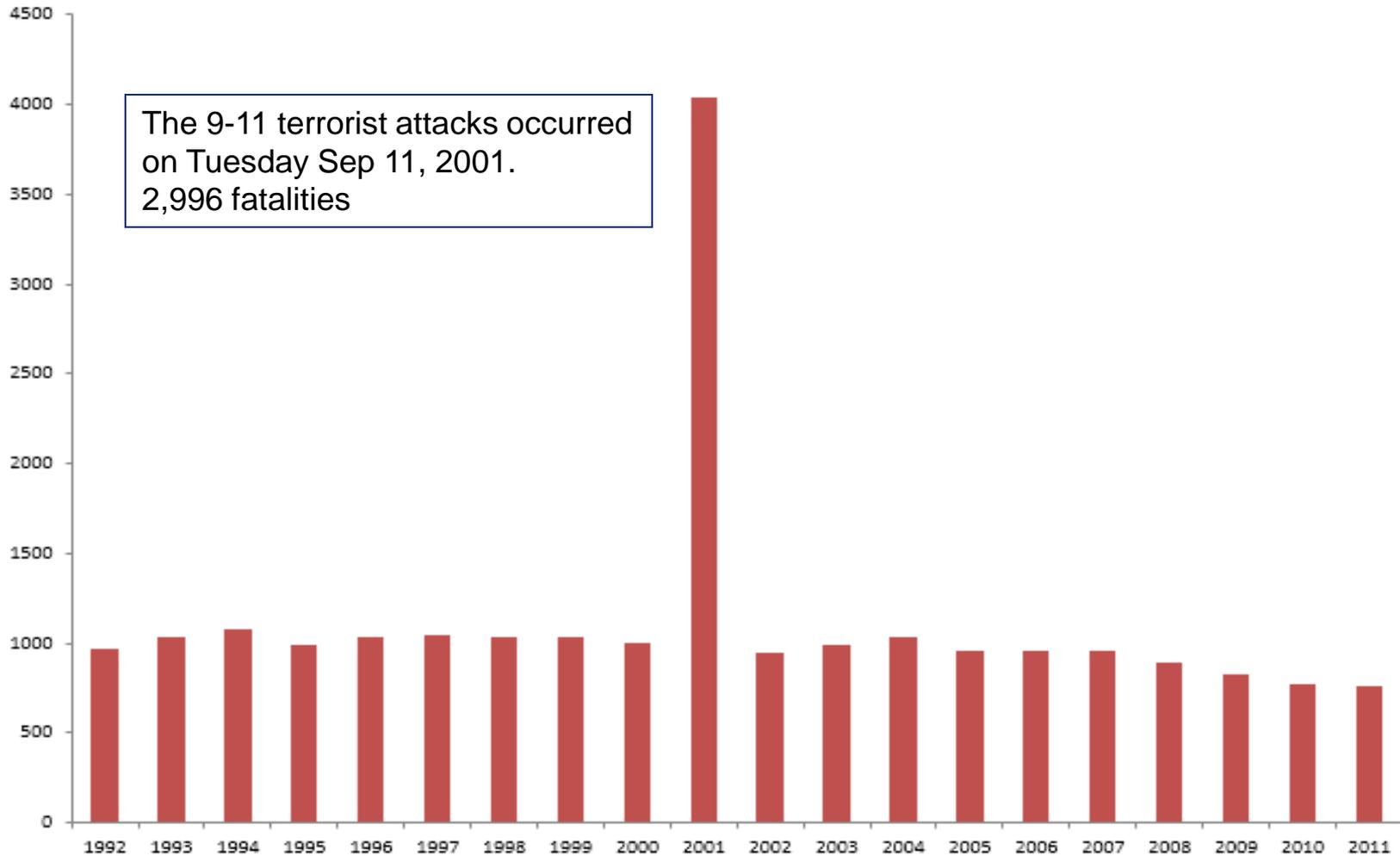| Day	Value
Sun	388.0
Mon	956.1
Tue	1114.3
Wed	1003.0
Thu	959.1
Fri	903.3
Sat	576.2

Intermediate tick marks not needed. Generally, do not use any ticks on Categorical axes.

Source: Bureau Labor Statistics.
Interpretative Statement: Approx 956 Fatal
Occupational Injuries Across all the Mondays in a Typical Year
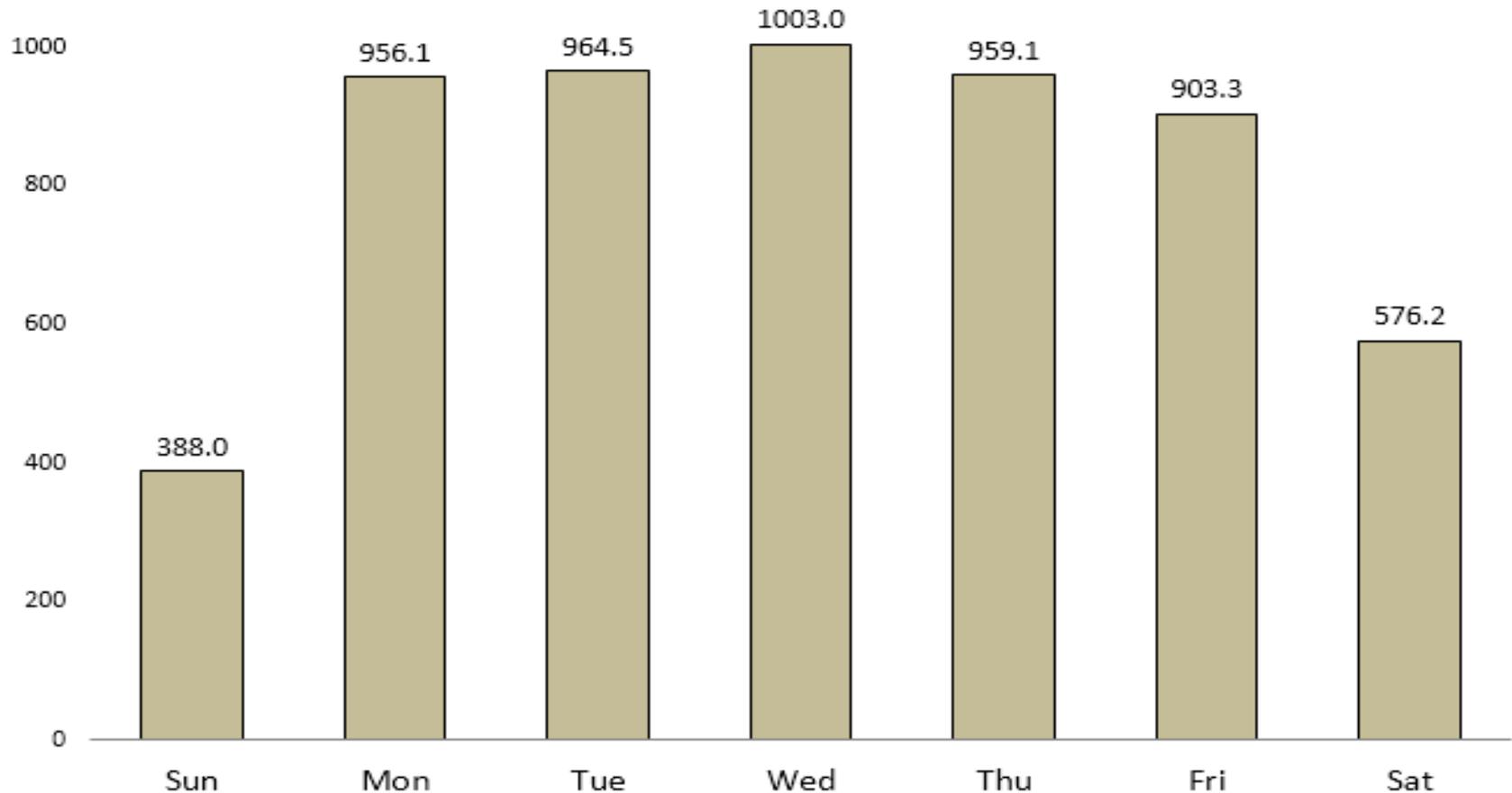
Interpretive Statements Helpful

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Charting for Data Investigation

Tuesday Fatal Occupational Injuries - By Year - US

The 9-11 terrorist attacks occurred on Tuesday Sep 11, 2001.
2,996 fatalities

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Charting for Data Investigation

Total Fatal Occupational Injuries Per Day of Week of Incidence
Annual Average Per Day Across 20-Year Period - CY 1992 - CY 2011- US


Source: Bureau Labor Statistics.
Interpretative Statement: Approx 956 Fatal Occupational Injuries Across all the Mondays in a Typical Year. Excludes the fatalities from the 9-11 terrorist attacks.

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Quick charts can often reveal anomalies, special cases, outlier data, as well as more prosaic data entry errors

Vertical Axis Manipulation
Cautions, Misuse, and Poor Use

Potentially Preventable Inpatient Hospital Readmissions Within 30 Days of Discharge

Percent of Persons With Selected Target Discharge Diagnoses Readmitted
Within 30 Days of Discharge - By Month of Discharge - Hospital System X [Mock Data]
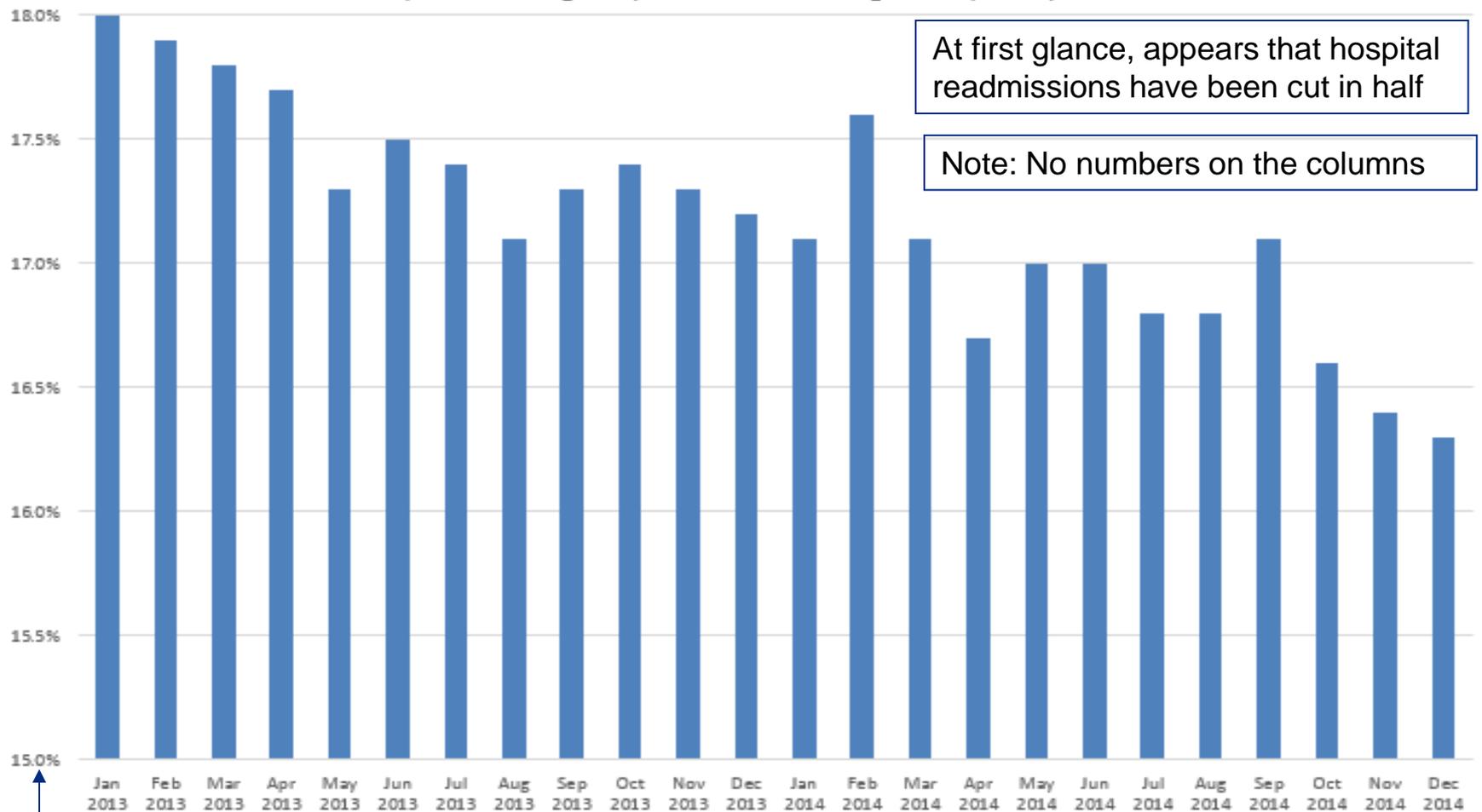
At first glance, appears that hospital readmissions have been cut in half
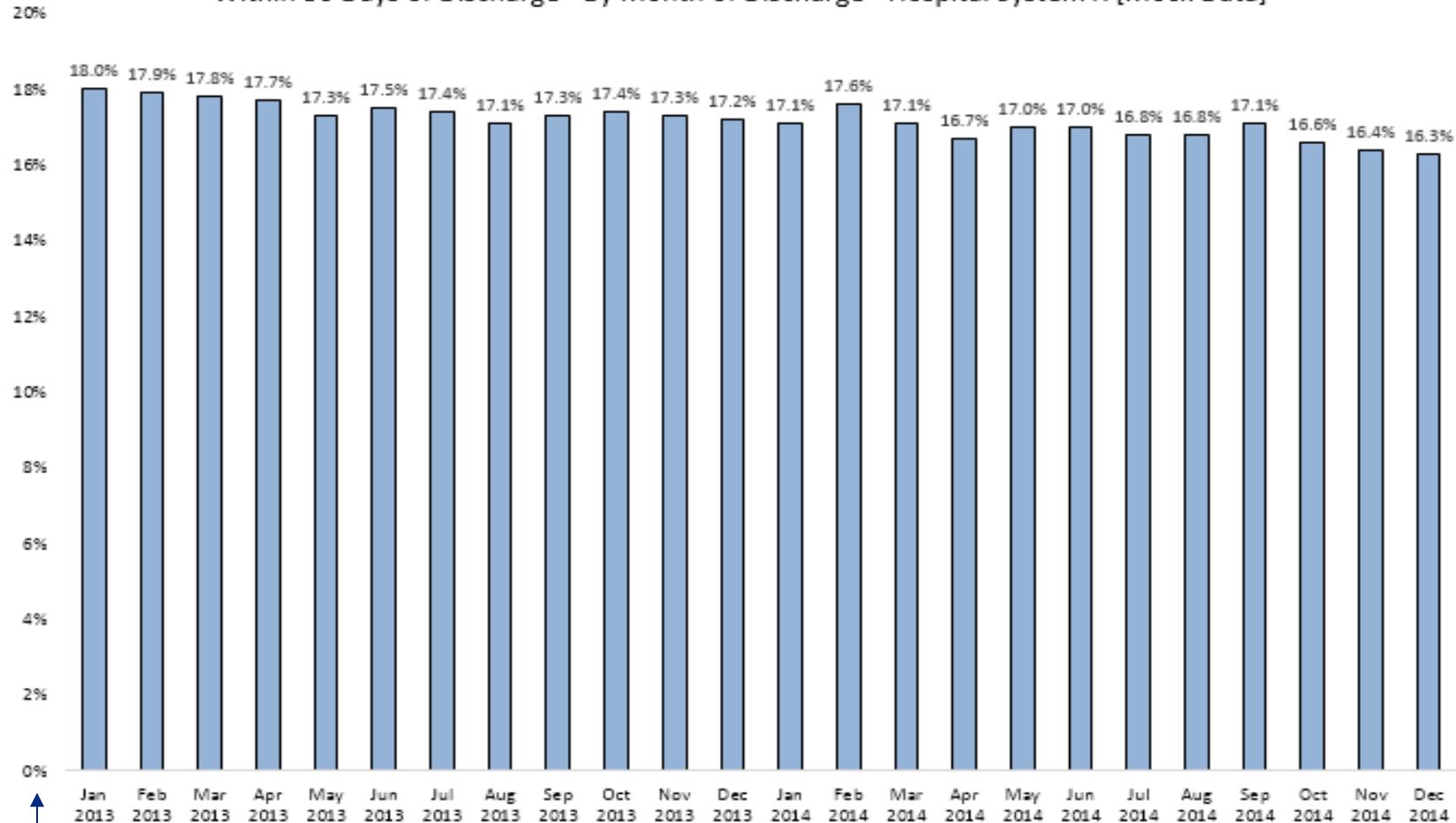
Note: No numbers on the columns

Did not start vertical axis at zero

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Vertical Axis Scaling
Principles, Tips, Preferred Practices

Potentially Preventable Inpatient Hospital Readmissions Within 30 Days of Discharge

Percent of Persons With Selected Target Discharge Diagnoses Readmitted
Within 30 Days of Discharge - By Month of Discharge - Hospital System X [Mock Data]

Started vertical axis at zero

Better representation of actual improvement
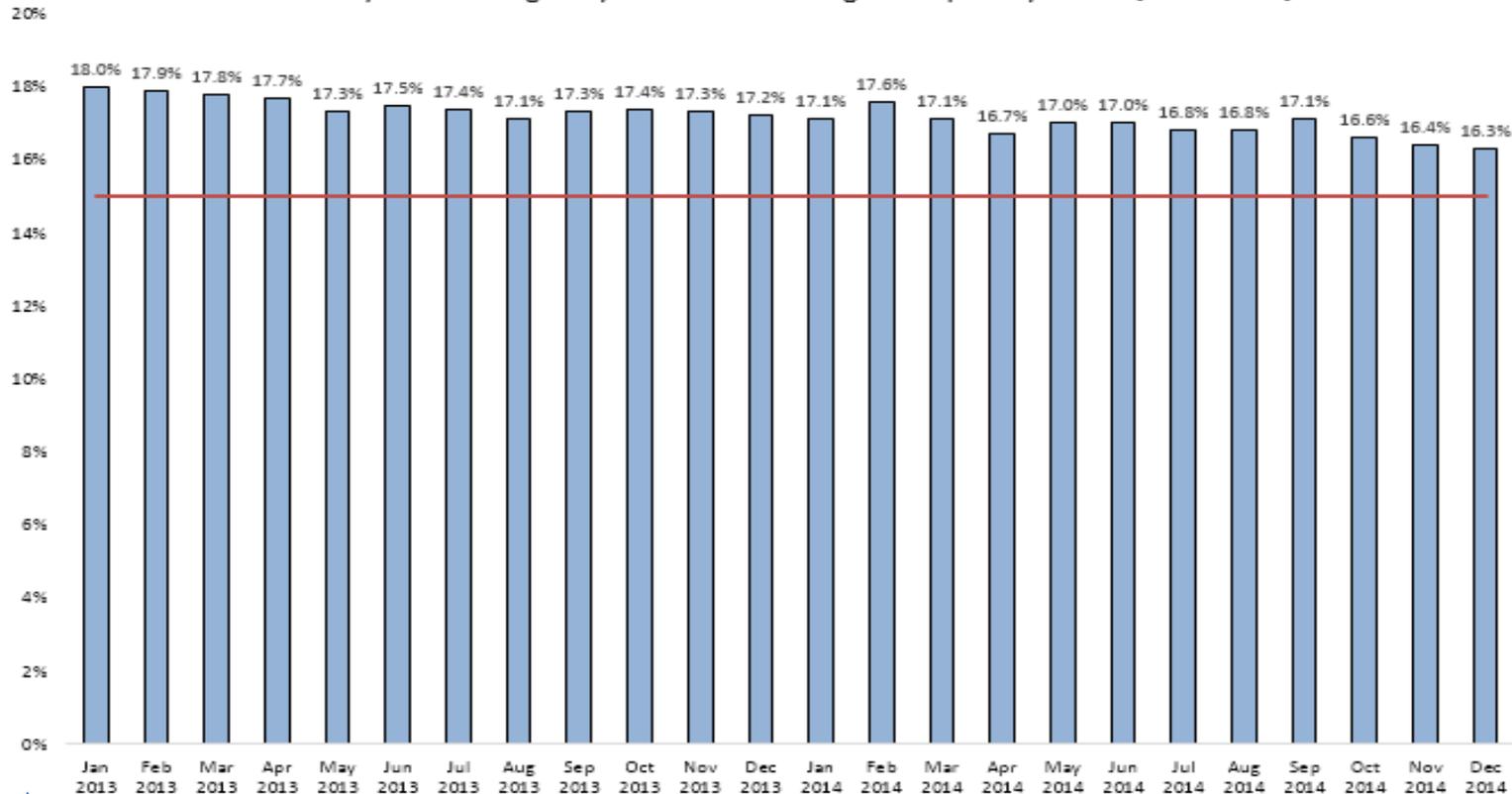Reduced readmissions from 18.0% to 16.3%

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Vertical Axis Scaling
Principles, Tips, Preferred Practices

Add Context. Goal was to reduce readmissions to below 15% by Dec 2014.

Potentially Preventable Inpatient Hospital Readmissions Within 30 Days of Discharge

Percent of Persons With Selected Target Discharge Diagnoses Readmitted
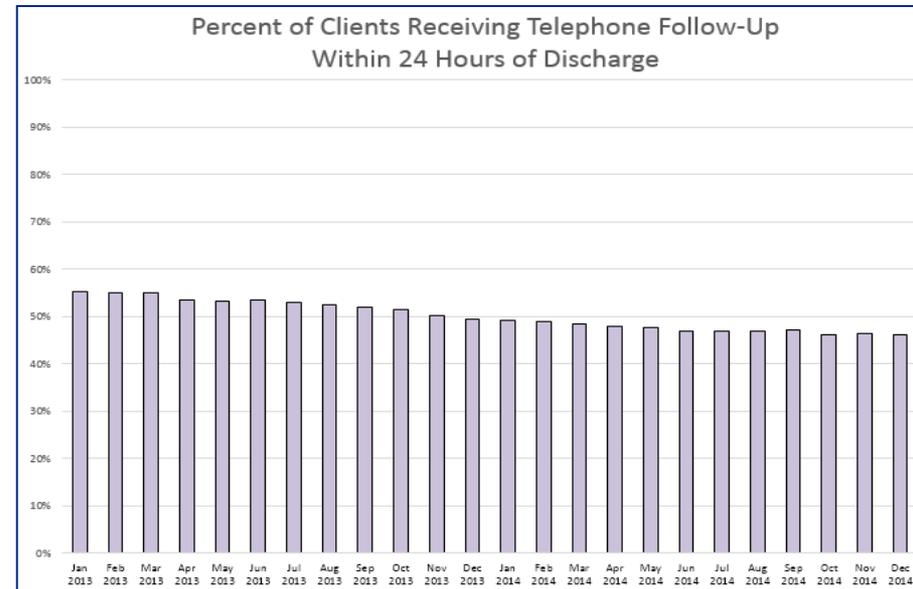Within 30 Days of Discharge - By Month of Discharge - Hospital System X [Mock Data]

Start vertical axis at zero

Best representation of actual improvement. Reduced readmissions from 18.0% to 16.3%. But have not yet achieved goal of Under 15%.

Context [in this case, goal red line at 15%] is always useful

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Vertical Axis Manipulation
Cautions, Misuse, and Poor Use
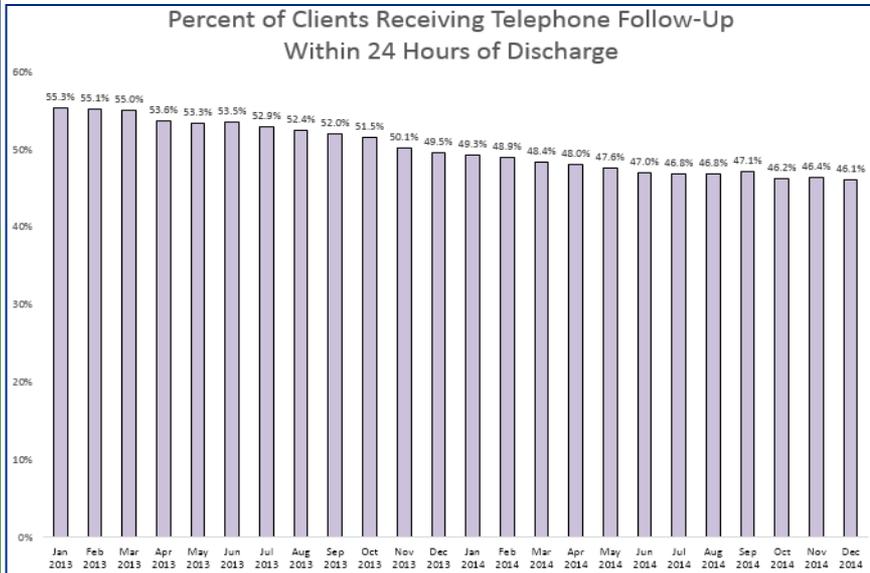
Conversely, you may have an indicator that is falling when it should be rising

Manipulating the top end of the vertical axis range partially disguises the magnitude of the drop.

Note that in some circumstances it is preferable to top out a percentage vertical axis at 100%. So you will need to use your judgment on appropriate vs misleading axis scaling

Contrast and Call Out

Median Visitors to Crabtree Mall - Evening Hours 6:00 PM Until Closing - By Day of Week
During Period 22 Aug 2014 thru 14 Nov 2014

High School Football Home Games Reduce Mall Traffic by Half of Expected Volume on Friday Evenings During High School Football Season
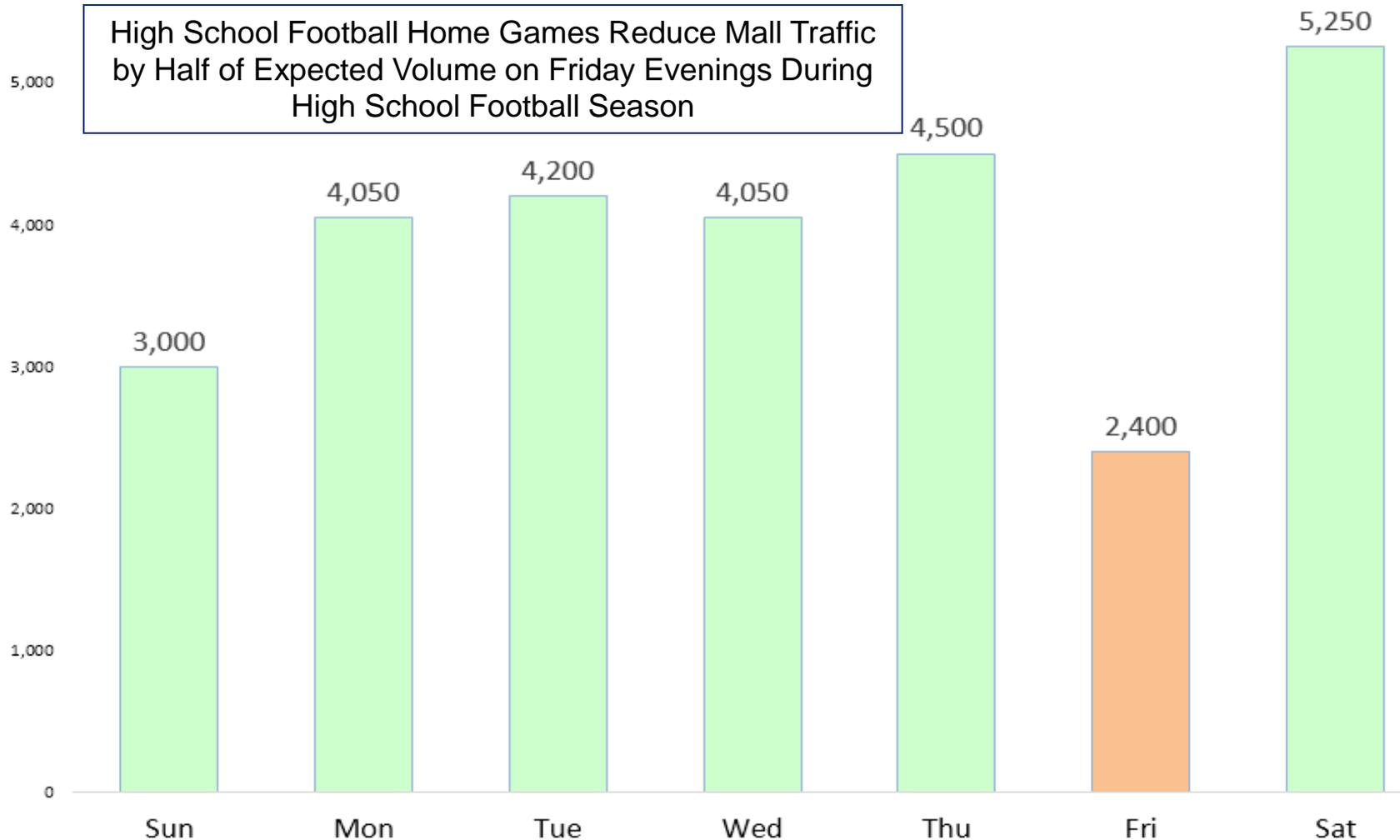
Color contrast and interpretive statements often helpful

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Charting for Data Investigation

Alcohol-Related Drivng Fatalities Among 18-20 Year Olds - Jurisdiction X

LDA 21   LDA 18   LDA 19   LDA 21   BAC 0.08
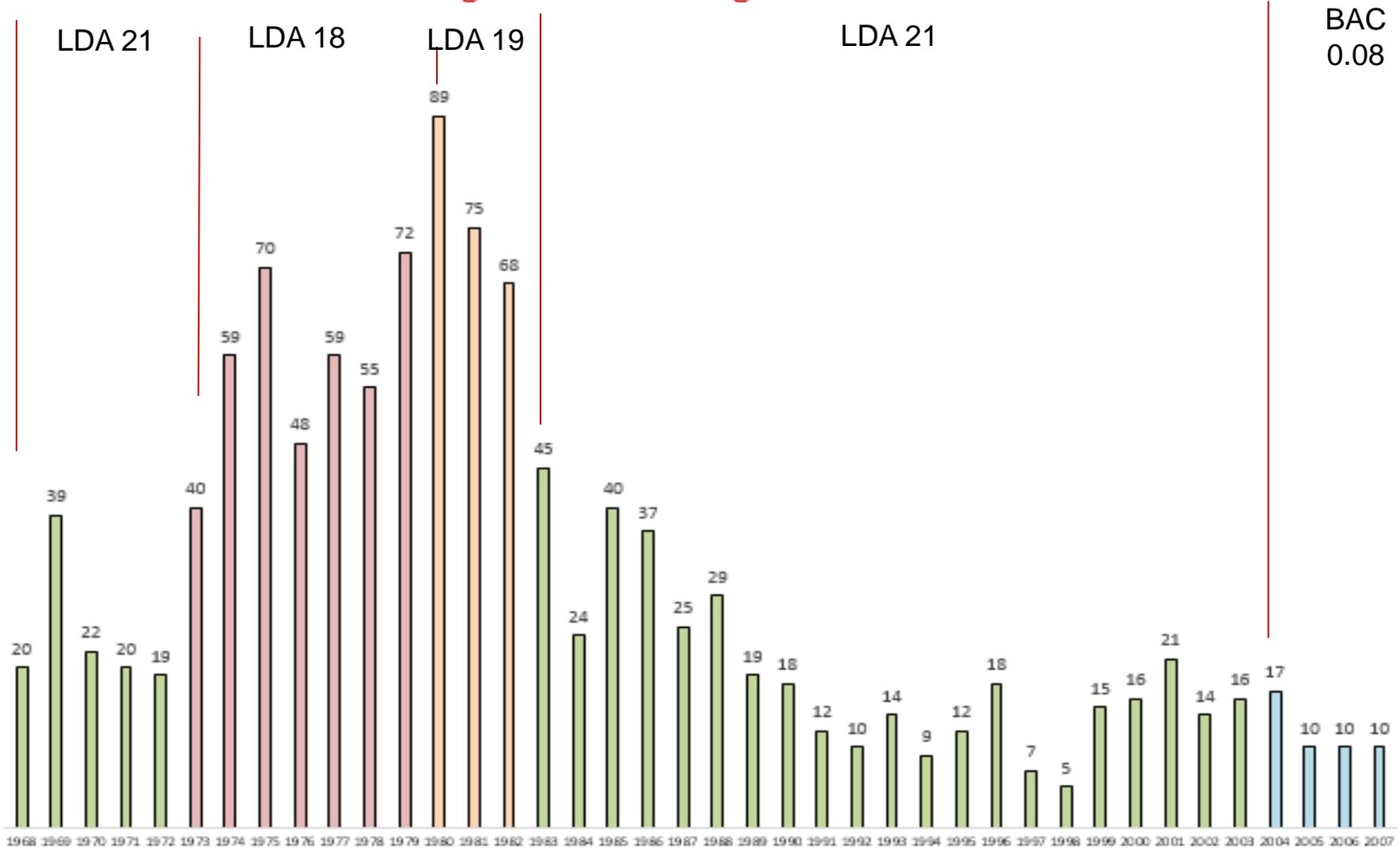
Column color and vertical separators help differentiate the impact of legislative changes in Legal Drinking Age and Blood Alcohol Content

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Column Charts – 3-D

▶ 3-D charts are generally a bad idea.

▶ The 3-D effect adds nothing, is more cluttered, creates confusion, and potentially obscures data.

▶ It's harder to judge relative column height with 3-D columns.

▶ Readers are often confused as to whether the front edge of the 3-D column or the back edge of the 3-D column represents the magnitude of the value.

▶ Intent of all charts should be quick comprehension. 3-D distracts from the central message and slows the processing of the intended information.

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3-D Column Chart
Cautions, Misuse, and Poor Use

LDL [Bad Cholesterol] Blood Level Among Men - By Level of Exercise - US
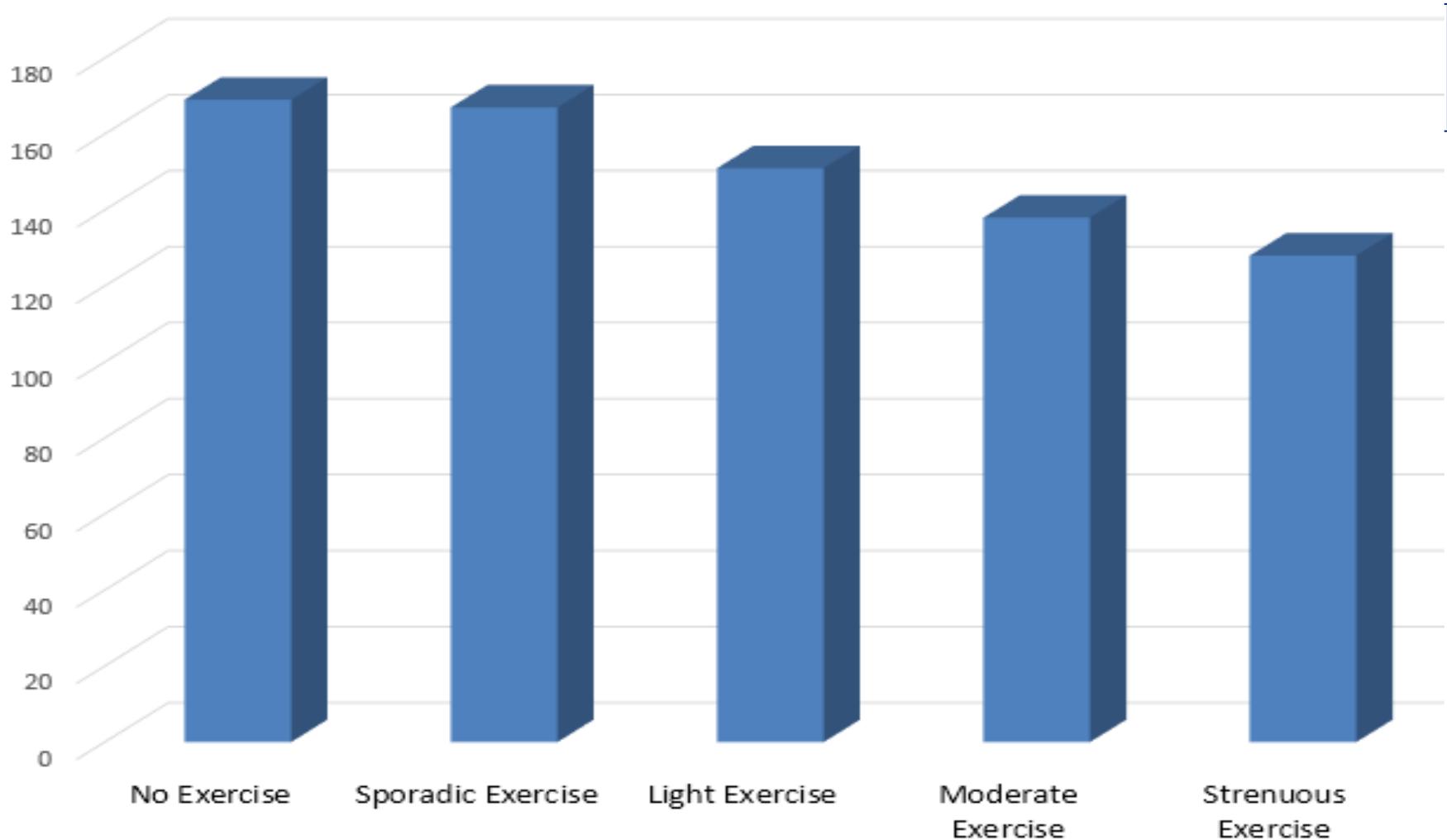
If "Below 130" is the Desirable Range for LDL, which exercise groups are below 130?

3-D Column Chart
Cautions, Misuse, and Poor Use

LDL [Bad Cholesterol] Blood Level Among Men - By Level of Exercise - US

Even when you add value labels to a 3-D chart, often both the front and back edge of the columns don't perceptually match the value

Source: Mock Data

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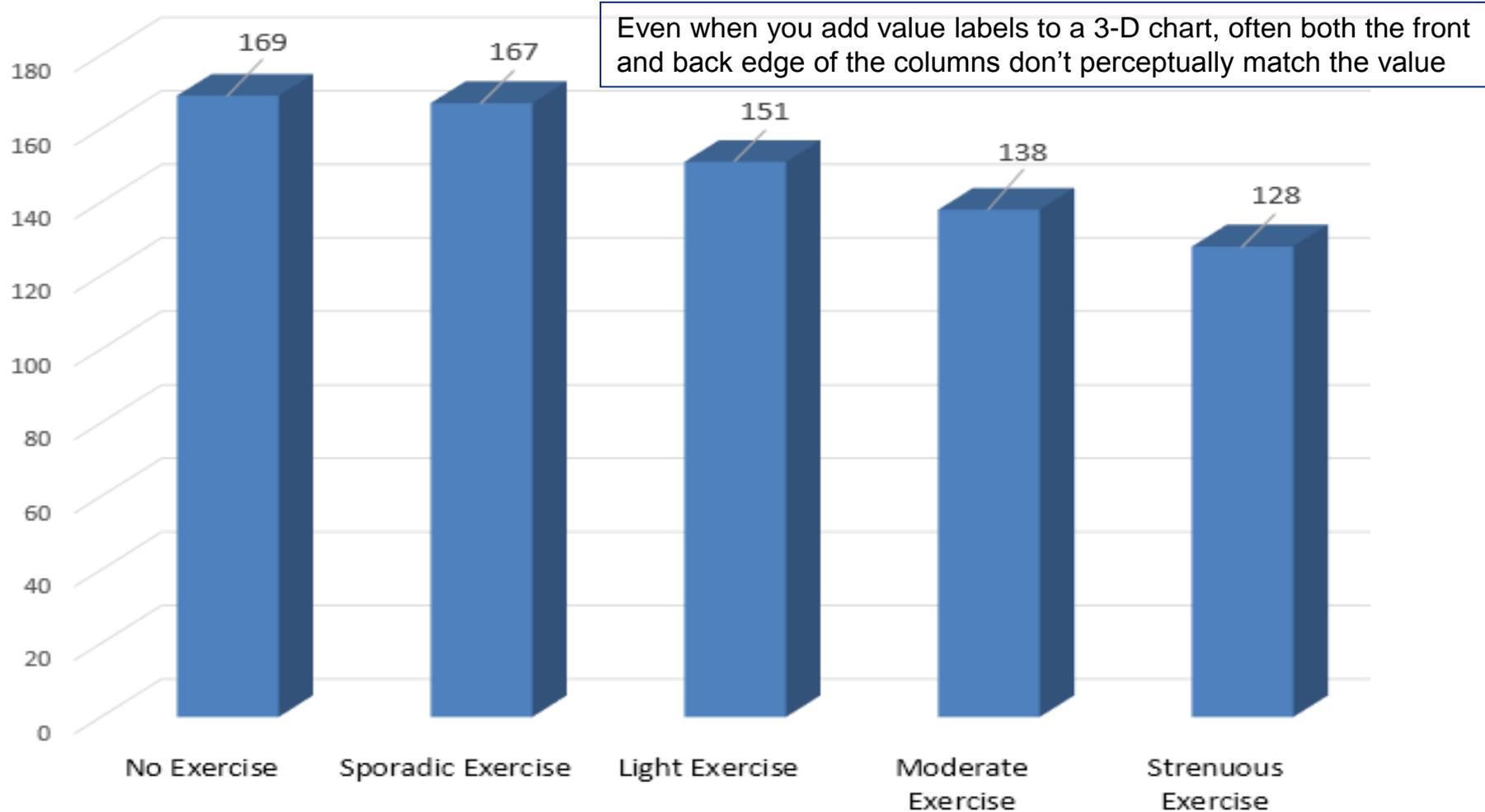
3-D Column Chart
Cautions, Misuse, and Poor Use
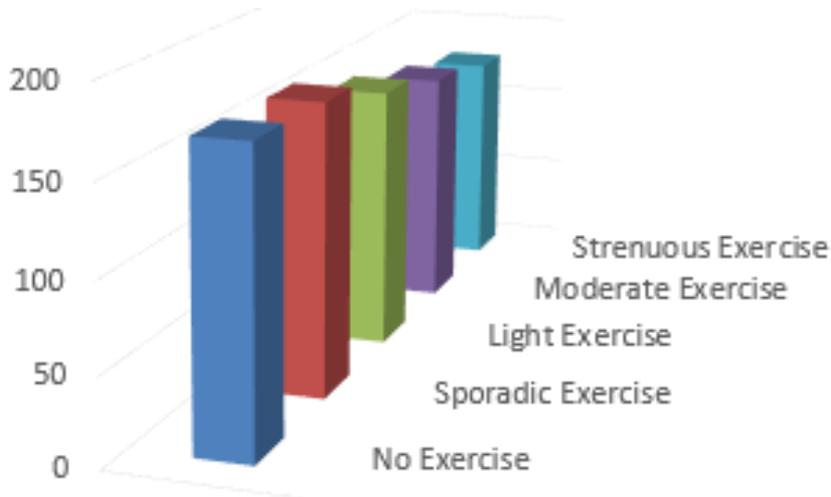
Adding skew to a 3-D chart further distorts the perception of the relative differences in the columns

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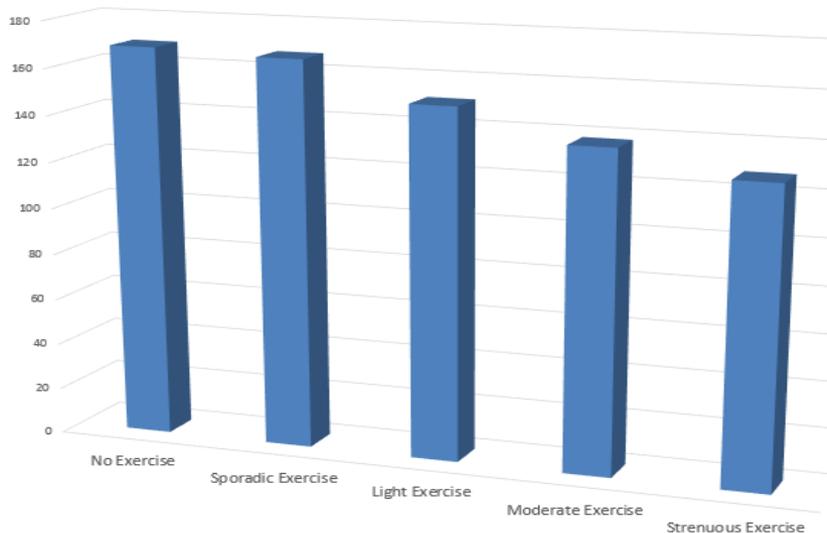
3-D Column Chart
Cautions, Misuse, and Poor Use
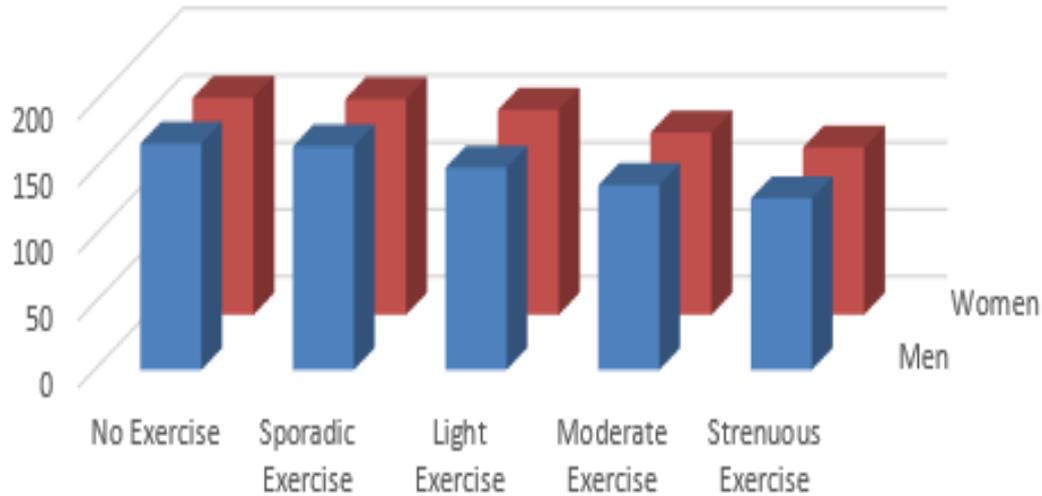
Without adding the value labels, can you tell if males or females have higher LDL levels and are there gender differences at various exercise levels?
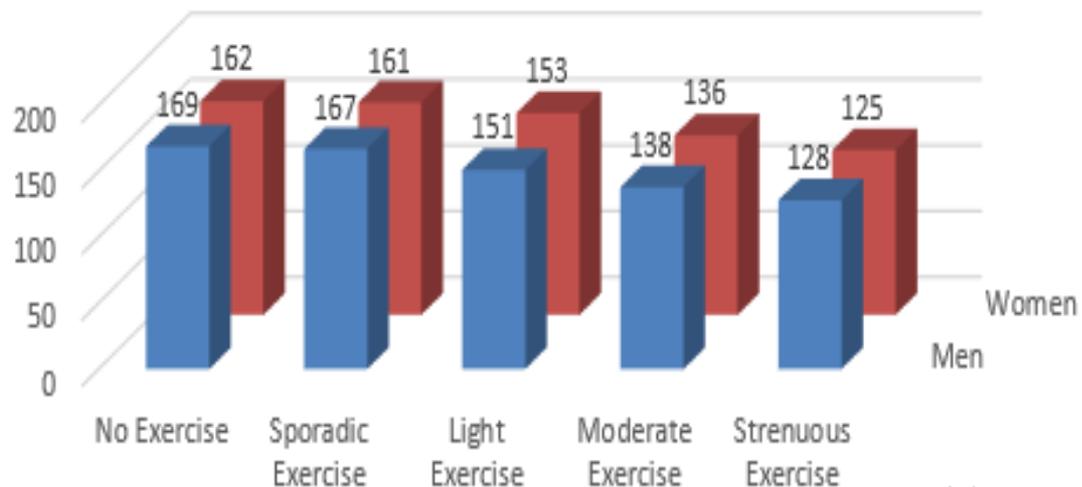
Males have higher LDL levels, except at the Light Exercise level

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3-D Column Chart
Cautions, Misuse, and Poor Use

LDL By Exercise Level and Race-Ethnicity

3-D columns have the potential to obscure other columns

Legend: ■ Hispanic ■ Black Non-Hispanic ■ White Non-Hispanic

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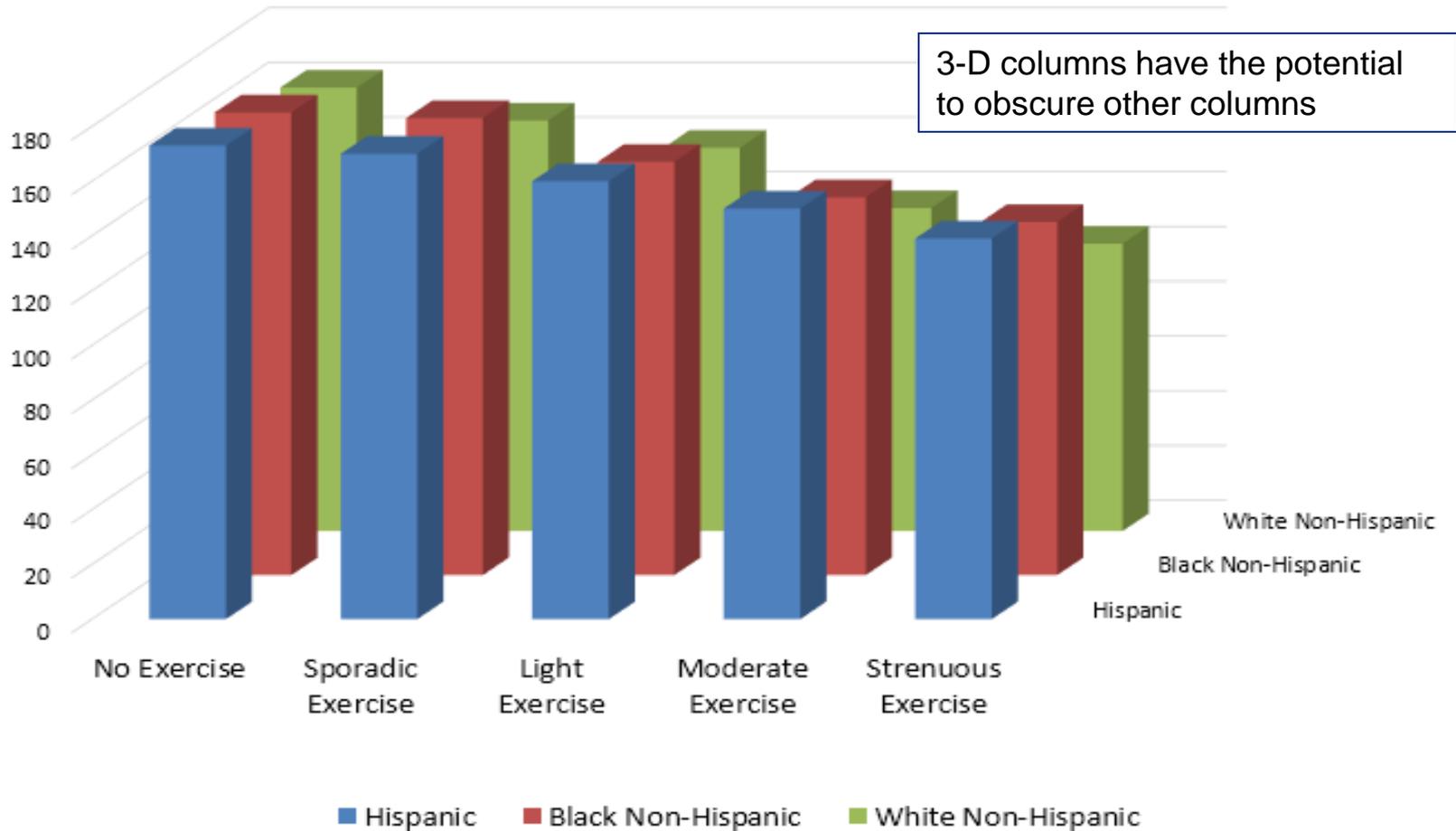
Clustered Column Charts

▶ Clustered Column charts – also known as side-by-side column charts

▶ Useful for comparing multiple data series on one chart

▶ Vertical axis is numeric data (counts, percents etc)

▶ Compares values for different categories

▶ Columns are clustered side-by-side along the horizontal axis

▶ Generally the columns are color-coded by category to allow quick visual comparison by category

▶ Horizontal axis can be time-based or category-based

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Clustered Column Charts – Two Series, Time-Based

Major National Newspaper Headlines Containing the Words:
"Thanksgiving" vs "Black Friday"

■ Thanksgiving ■ Black Friday

"Black Friday" headlines are now twice as common as "Thanksgiving" headlines during the month of November

Source: Google Trends

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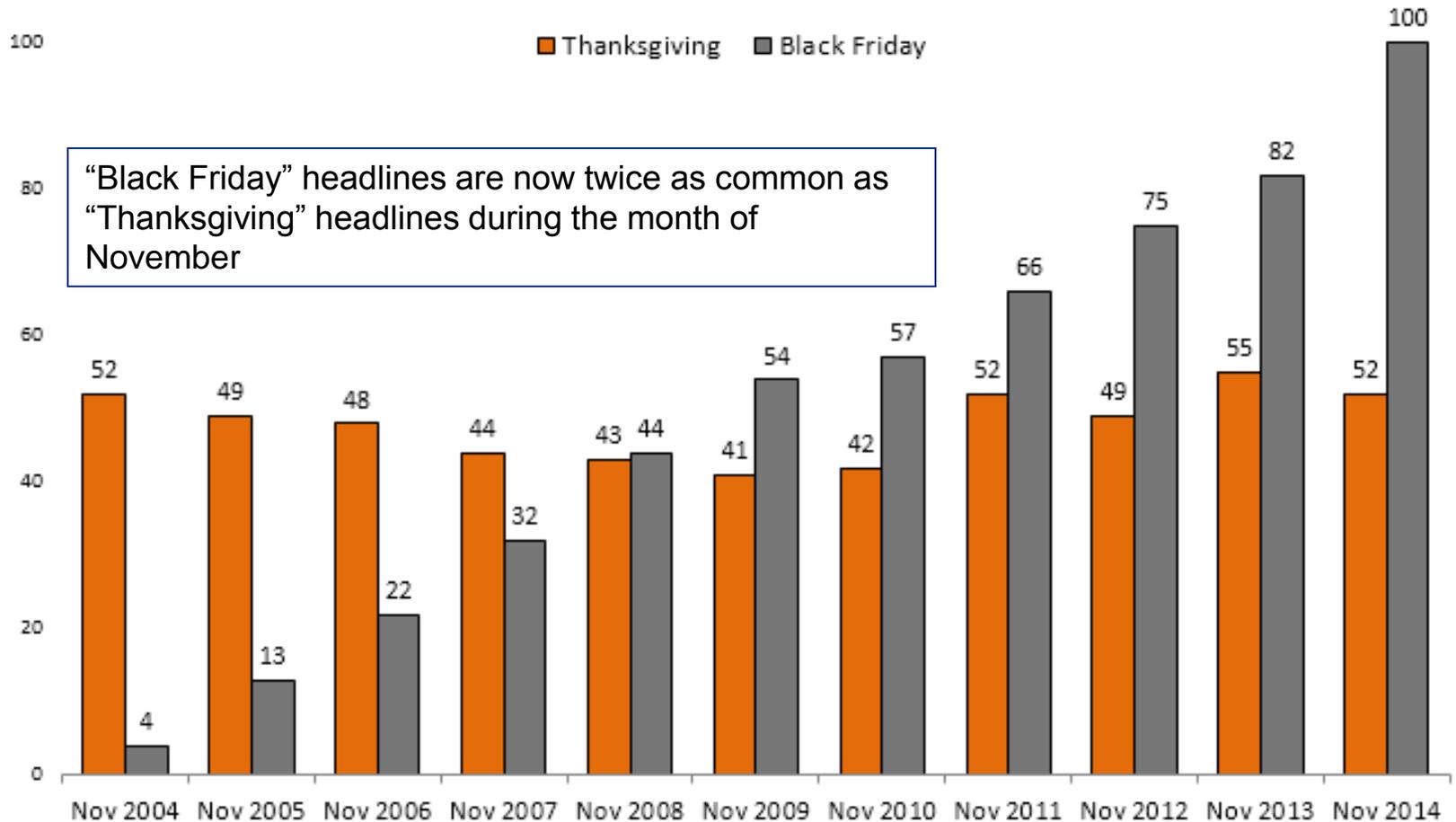
Clustered Column Charts – Legend Placement

Major National Newspaper Headlines Containing the Words:
"Thanksgiving" vs "Black Friday"

Place legends to maximize the image of the chart per se. Place legends within the chart plot if possible, or above the chart or below the chart. But don't place legend to the side [wastes chart space and throws off chart centering]

Legend: ■ Thanksgiving ■ Black Friday

	Nov 2004	Nov 2005	Nov 2006	Nov 2007	Nov 2008	Nov 2009	Nov 2010	Nov 2011	Nov 2012	Nov 2013	Nov 2014
Thanksgiving	52	49	48	44	43	41	42	52	49	55	52
Black Friday	4	13	22	32	44	54	57	66	75	82	100

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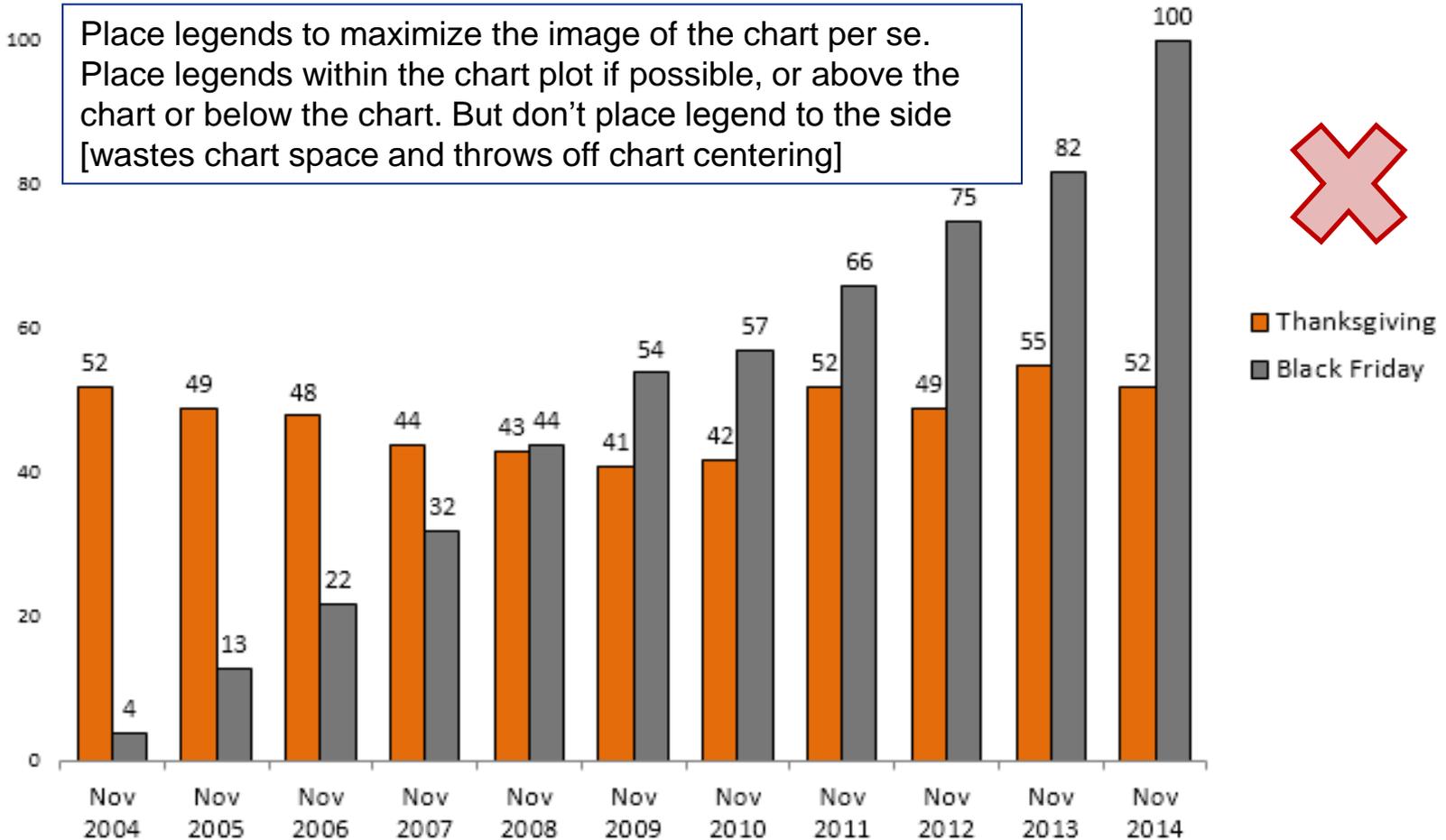
Clustered Column Charts – Background

Major National Newspaper Headlines Containing the Words:
"Thanksgiving" vs "Black Friday"
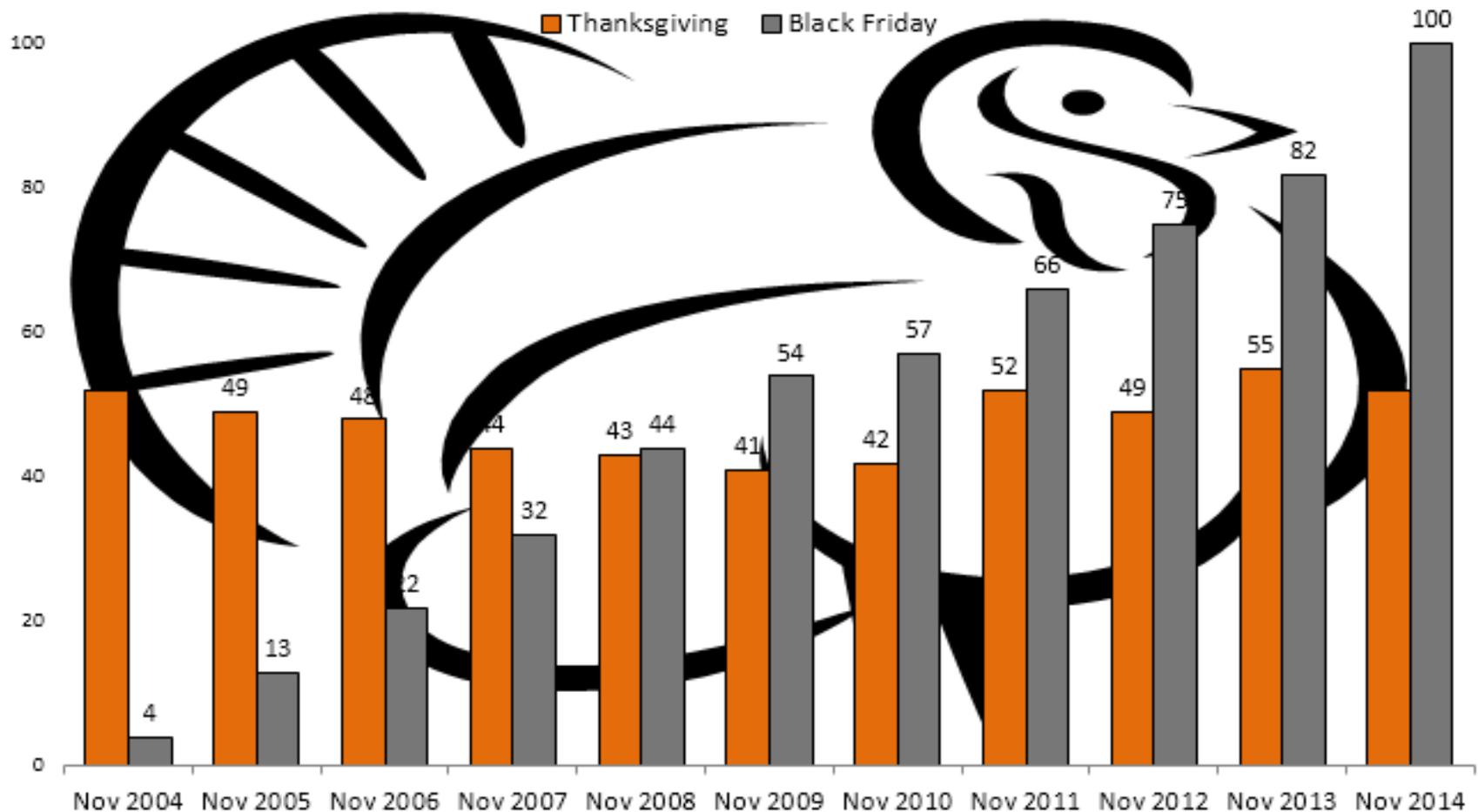
Generally, do not add unnecessary backgrounds to your charts – detracts from the message. Maximize message. Reduce noise.

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Clustered Column Charts – Prevalence, Two Factors

Percent of Persons with Depression Symptoms Who Sought Help From a Mental Health Professional in the Prior 12 Months

By Depressive Symptom Severity and Race-Ethnicity, Age 12 and Older, US, 2009-2012

■ Hispanic   ■ Black Non-Hispanic   ■ White Non-Hispanic

Across all Race-Ethnicity Groups, Persons with Increasingly Severe Symptoms Are More Likely to Seek Help

At Each Symptom Severity Level, White Non-Hispanics Are More Likely to Seek Help and Hispanics Are the Least Likely to Seek Help

Mild Depressive Symptoms: 9.1%, 11.6%, 13.9%
Moderate Depressive Symptoms: 17.1%, 19.2%, 20.9%
Severe Depressive Symptoms: 27.8%, 33.6%, 37.0%

Source: CDC NCHS

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Clustered Column Charts – Prevalence, Two Factors

Percent of Persons with Depression Symptoms Who Sought Help From a Mental Health Professional in the Prior 12 Months

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Mild Depressive Symptoms: 9.1%, 11.6%, 13.9%
Moderate Depressive Symptoms: 17.1%, 19.2%, 20.9%
Severe Depressive Symptoms: 27.8%, 33.6%, 37.0%

Tip: When you wish the reader to compare differences (such as the differences in help-seeking by race-ethnicity within each level of depression), place the columns close together.

Humans are better able to accurately judge and compare column heights when placed closer together.

Similarly, when visual separation is intended (such as among the three levels of depression, increase the gap width).

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# Clustered Column Charts – Distribution, Two Factors

Distribution of Persons Receiving Social Security Disability by Type of Beneficiary and by Disability Diagnostic Group - US - December 2013

- ■ Musculo-Skeletal-Connective
- ■ Other Mental Disorders
- ■ Nervous System and Sense Organs
- ■ Circulatory System
- ■ Endocrine Nutritional Metabolic
- ■ Intellectual Disability
- ■ All Other Impairments
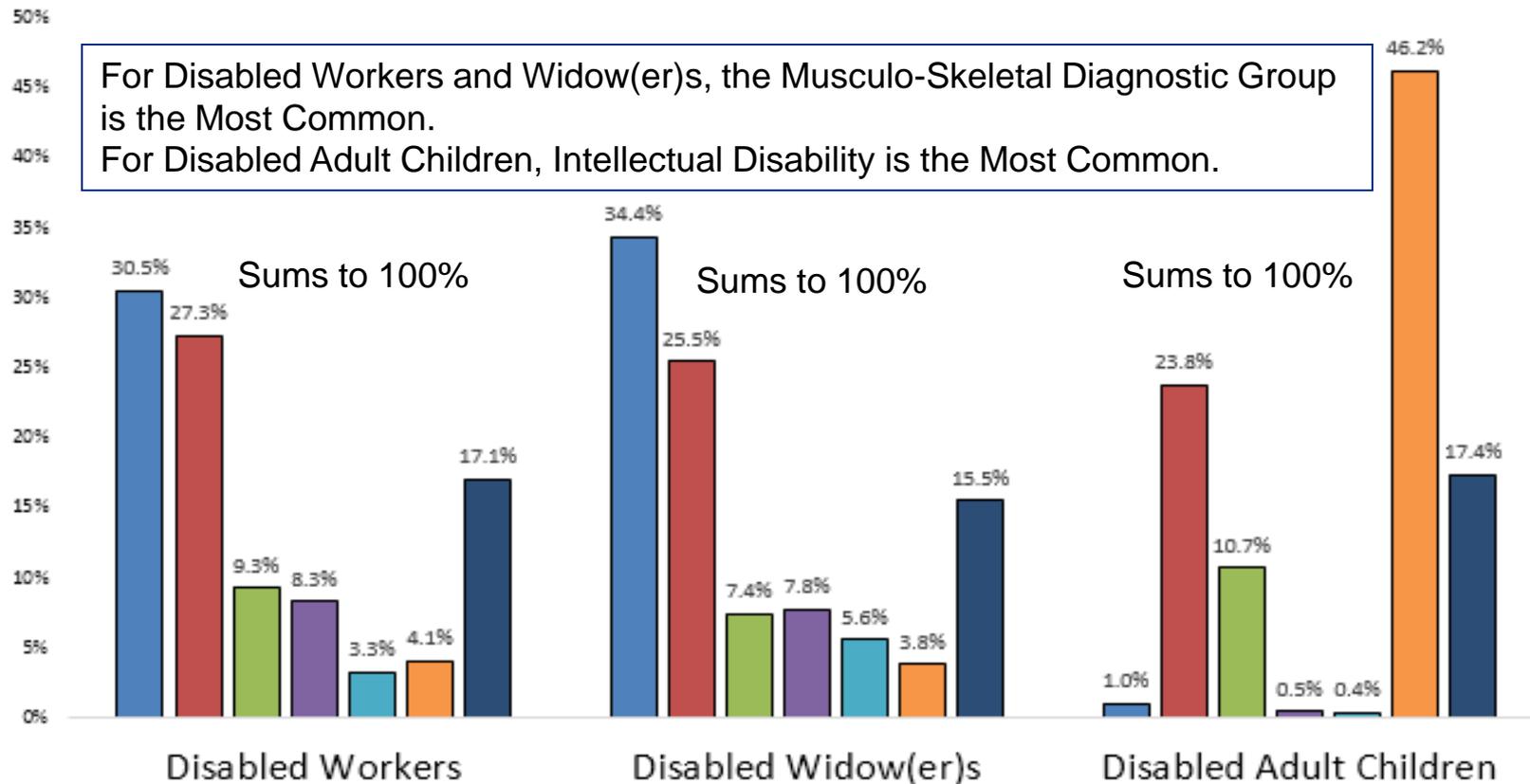
For Disabled Workers and Widow(er)s, the Musculo-Skeletal Diagnostic Group is the Most Common.
For Disabled Adult Children, Intellectual Disability is the Most Common.

Sums to 100%   Sums to 100%   Sums to 100%

Disabled Workers

- 30.5%
- 27.3%
- 9.3%
- 8.3%
- 3.3%
- 4.1%
- 17.1%

Disabled Widow(er)s

- 34.4%
- 25.5%
- 7.4%
- 7.8%
- 5.6%
- 3.8%
- 15.5%

Disabled Adult Children

- 1.0%
- 23.8%
- 10.7%
- 0.5%
- 0.4%
- 46.2%
- 17.4%

Generally, do not attempt to display more than 8 series in a clustered column chart

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Source: Social Security

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Stacked Column Charts

▶ Used to show relationship of components to the whole

▶ Vertical axis is numeric (counts, percents etc)

▶ Horizontal axis can be time-based or categorical (group-based)

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Stacked Column Chart – Time Based - Numeric

Guns Manufactured in US in Millions
By Type and Calendar Year

☐ Rifles   ☐ Pistols   ☐ Shotguns

Since 2000:
Shotguns have remained approx stable.
Rifles have almost doubled.
Pistols have almost quadrupled.
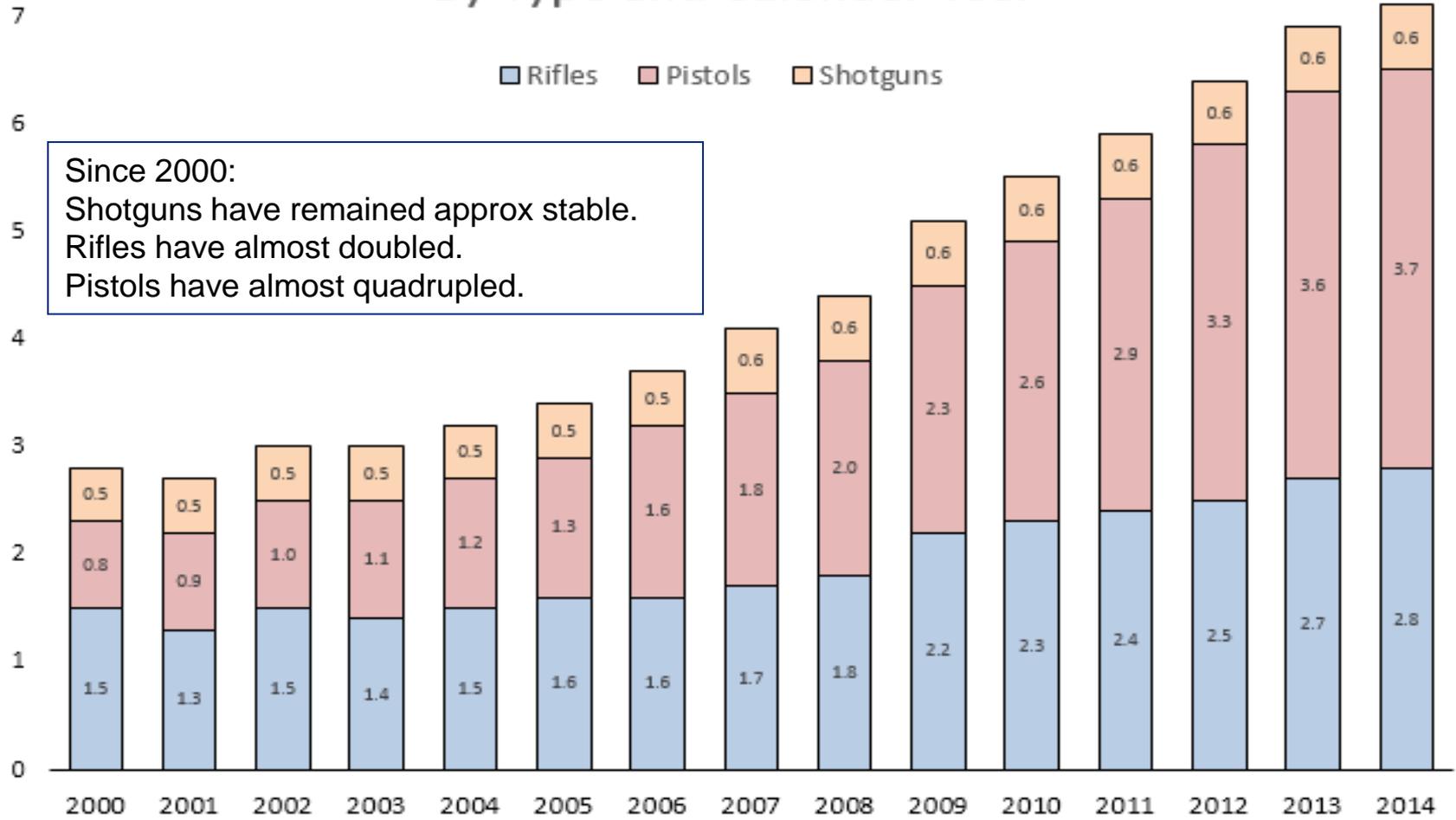
Stacked Column Chart – Time Based - Distribution

Now can see that rifles and shotguns have decreased as a proportion of total firearms

Percentage Distribution of Guns Manufactured in US
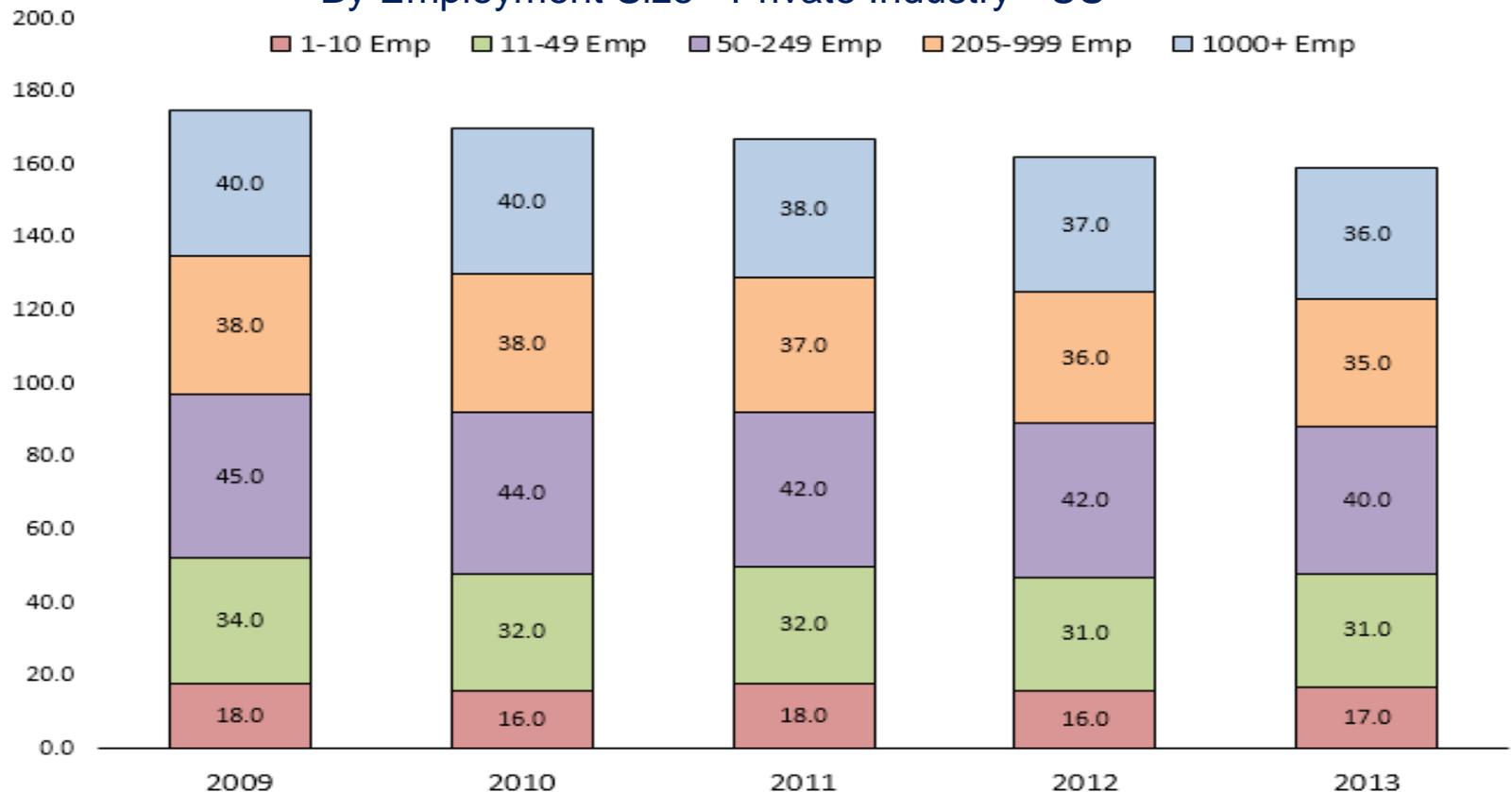By Type and Calendar Year

☐ Rifles   ☐ Pistols   ☐ Shotguns

Source: Mock Data

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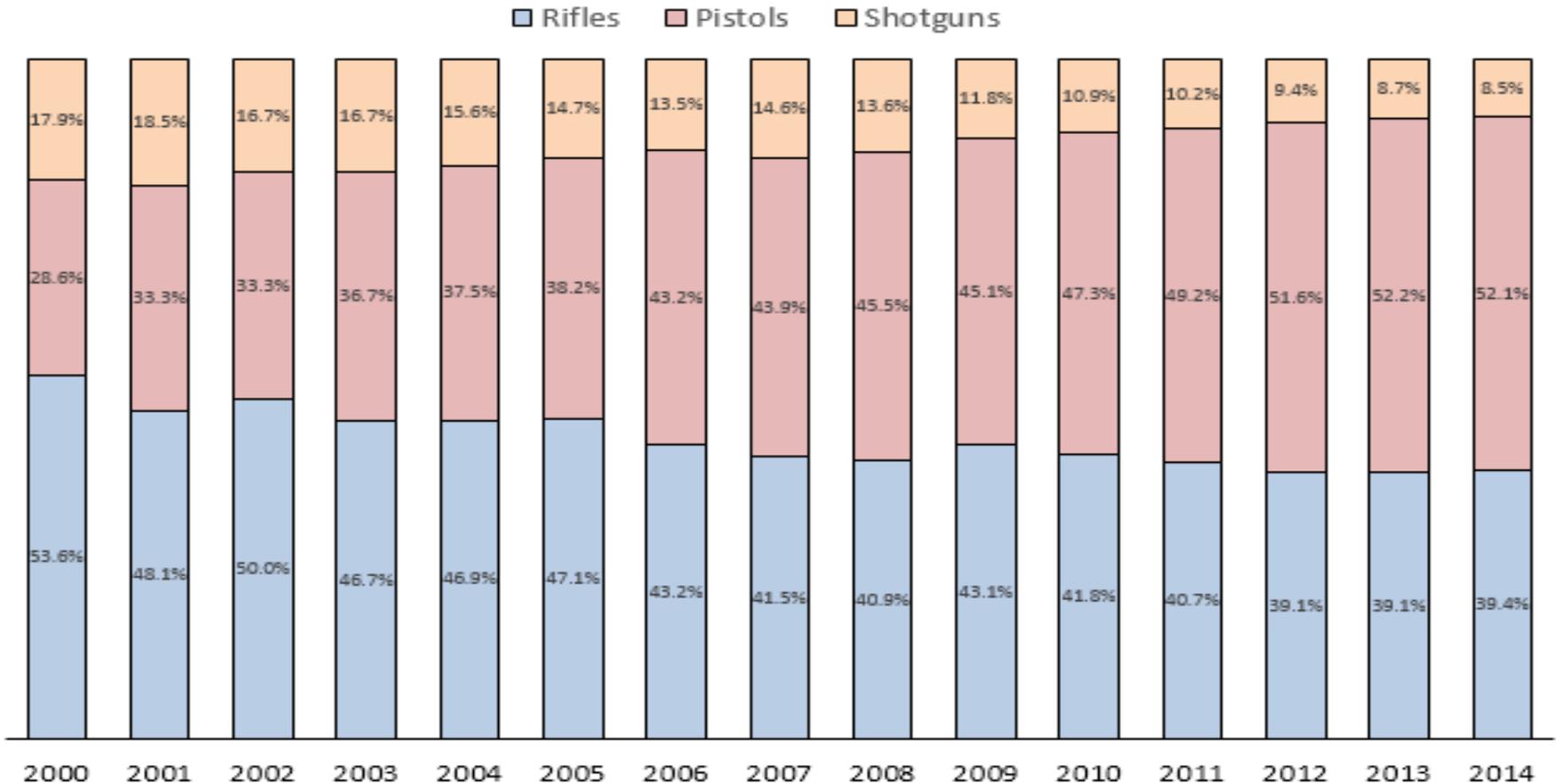
Stacked Column Chart – Time Based - Numeric

Total Recordable Non-Fatal Occupational Injury and Illness Rates
By Employment Size - Private Industry - US

Legend: ☐ 1-10 Emp ☐ 11-49 Emp ☐ 50-249 Emp ☐ 205-999 Emp ☐ 1000+ Emp

Year	1-10 Emp	11-49 Emp	50-249 Emp	205-999 Emp	1000+ Emp
2009	18.0	34.0	45.0	38.0	40.0
2010	16.0	32.0	44.0	38.0	40.0
2011	18.0	32.0	42.0	37.0	38.0
2012	16.0	31.0	42.0	36.0	37.0
2013	17.0	31.0	40.0	35.0	36.0

Often difficult to see relationships clearly in a stacked column chart. Bottom layer of a stacked column and the total overall trend are easily interpreted in a stacked column chart. But the true trend in the additional layered columns is often difficult to reliably discern in a stacked column chart.

Source: Bureau of Labor Statistics

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Stacked Column Chart – Category-Based - Distribution

Intendedness of Births at Conception
By Mother's Income as a Percent of Poverty

☐ Unwanted   ☐ Mistimed - Two Years or More Too Soon   ☐ Mistimed - Less Than Two Years Too Soon

Unwanted births and substantially mistimed births are relatively less common as income rises.

	0%-149%	150%-299%	300% or Higher
Mistimed - Less Than Two Years Too Soon	9.8%	9.5%	8.5%
Mistimed - Two Years or More Too Soon	15.6%	13.4%	4.6%
Unwanted	20.7%	11.7%	4.5%

Source: CDC NCHS, 2006-2010

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