

Principles of Analytic Graphics

Biostatistics 140.776

Principles of Analytic Graphics

Principle 1: Show comparisons

- ▶ Evidence for an hypothesis is always **relative** to another competing hypothesis
- ▶ Always ask “Compared to What?”

Show Comparisons

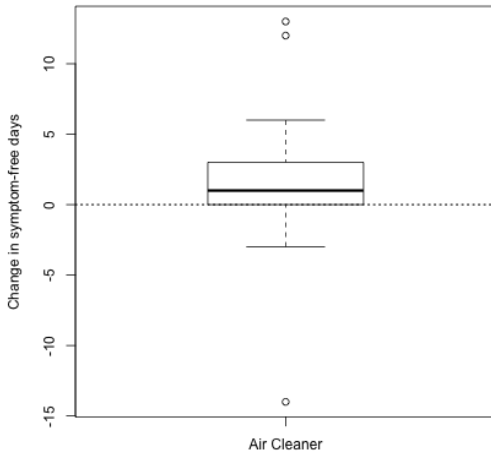


Figure 1: Show comparisons

Show Comparisons

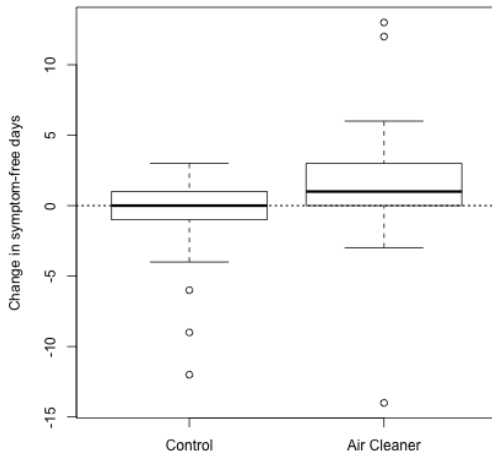


Figure 2: Show comparisons

Principles of Analytic Graphics

Principle 1: Show comparisons

- ▶ Evidence for an hypothesis is always **relative** to another competing hypothesis
- ▶ Always ask “Compared to What?”

Principle 2: Show causality, mechanism, explanation, systematic structure

- ▶ What is your causal framework for thinking about a question?

Show Causality, Mechanism

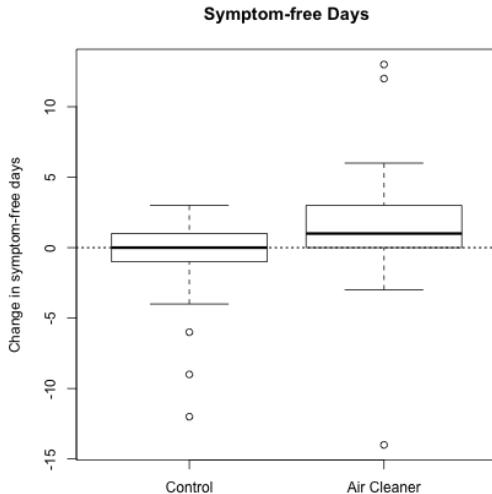


Figure 3: Show causality, mechanism

Show Causality, Mechanism

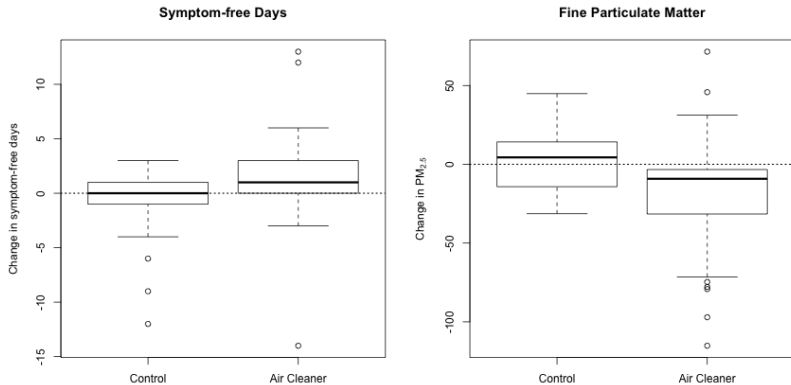


Figure 4: Show causality, mechanism

Reference: Butz AM, *et al.*, *JAMA Pediatrics*, 2011

Principles of Analytic Graphics

Principle 1: Show comparisons

- ▶ Evidence for an hypothesis is always **relative** to another competing hypothesis
- ▶ Always ask “Compared to What?”

Principle 2: Show causality, mechanism, explanation, systematic structure

- ▶ What is your causal framework for thinking about a question?

Principle 3: Show multivariate data

- ▶ Multivariate = more than 2 variables
- ▶ The real world is multivariate
- ▶ Need to “escape flatland”

Show Multivariate Data

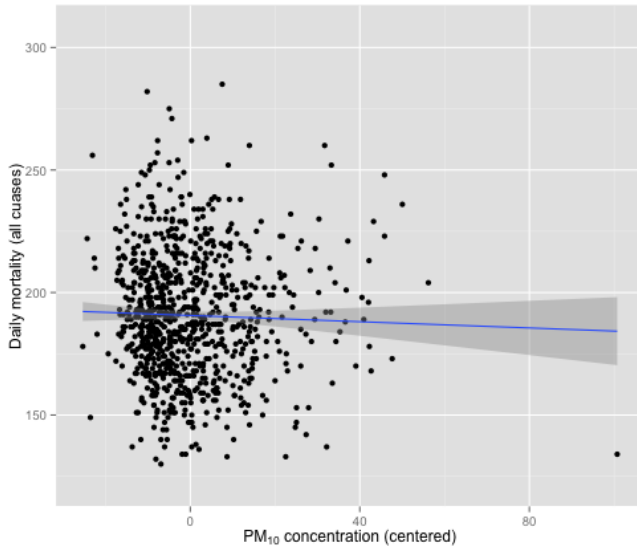


Figure 5: Two variables

Show Multivariate Data

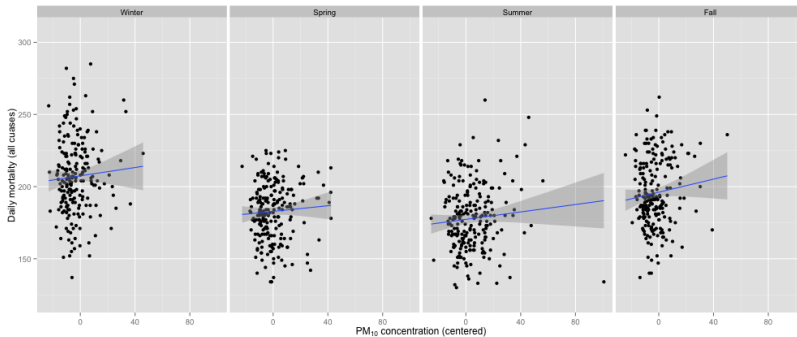


Figure 6: Three variables

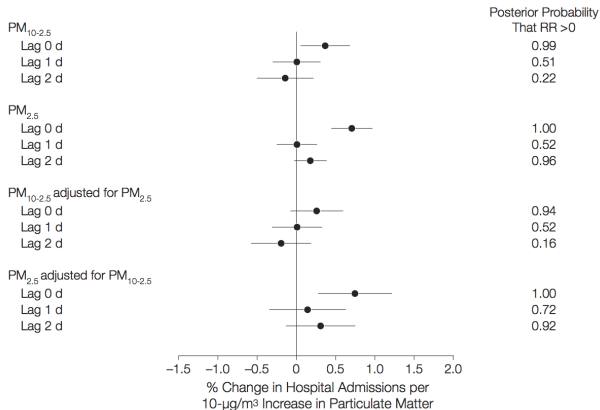
Principles of Analytic Graphics

Principle 4: Integrate Evidence

- ▶ Completely integrate words, numbers, images, diagrams
- ▶ Data graphics should make use of many modes of data presentation
- ▶ Don't let the tool drive the analysis

Integrate Evidence

Figure 2. Percentage Change in Emergency Hospital Admissions Rate for Cardiovascular Diseases per a $10\text{-}\mu\text{g}/\text{m}^3$ Increase in Particulate Matter



Estimates are on average across 108 counties. $\text{PM}_{2.5}$ indicates particulate matter is $2.5\text{ }\mu\text{m}$ or less in aerodynamic diameter; PM_{10} , particulate matter is $10\text{ }\mu\text{m}$ or less in aerodynamic diameter; $\text{PM}_{10-2.5}$, particulate matter is greater than $2.5\text{ }\mu\text{m}$ and $10\text{ }\mu\text{m}$ or less in aerodynamic diameter; RR, relative risk. Error bars indicate 95% posterior intervals.

Figure 7: Using annotations on a figure

Integrate Evidence

MARRIAGES, MALE AND FEMALE

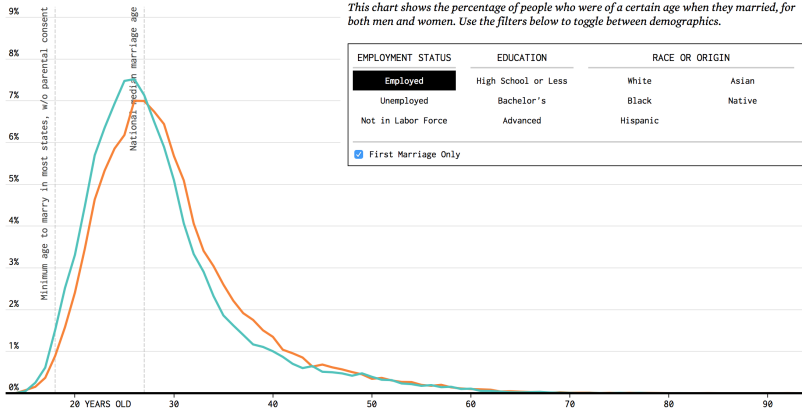


Figure 8: When do people get married?

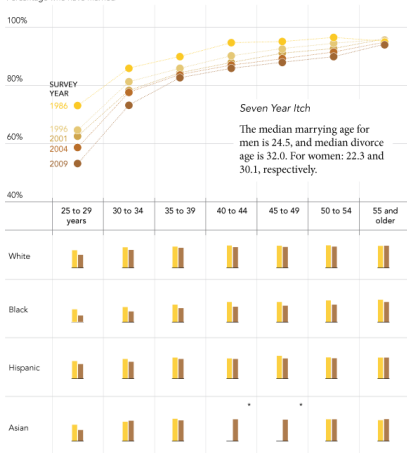
Source: <http://flowingdata.com/2016/03/03/marrying-age/>

Integrate Evidence

Getting Married Later

In 1986, nearly three-quarters of women from 25 to 29 years old had married at least once, while in 2009, only about half of women in the age group have married.

Percentage who have married

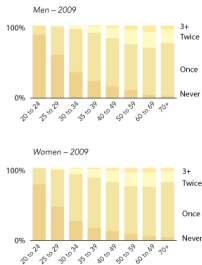


*No data available from 1986

Source: U.S. Census Bureau | Nathan Yau, <http://flowingdata.com>

More than Once

It's not incredibly uncommon for someone to be married more than once.



1986 vs. 2009, by race

In most age and race groups, a lower percentage of people were married in 2009 than in 1986. However, in some groups, such as those 55 years and older, a *higher* percentage of people were married in 2009 than in 1986, although the differences are quite small.

Figure 9: Getting married later

Integrate Evidence

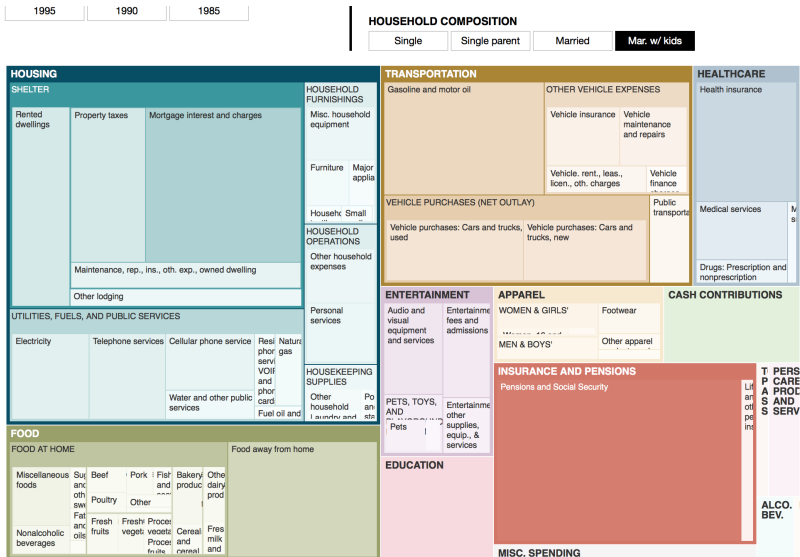


Figure 10: How we spend our money

Principles of Analytic Graphics

Principle 4: Integrate Evidence

- ▶ Completely integrate words, numbers, images, diagrams
- ▶ Data graphics should make use of many modes of data presentation
- ▶ Don't let the tool drive the analysis

Principle 5: Describe and document the evidence with appropriate labels, scales, sources, etc.

- ▶ A data graphic should tell a complete story that is credible
- ▶ Same is true for a slide in a presentation

Document the Evidence

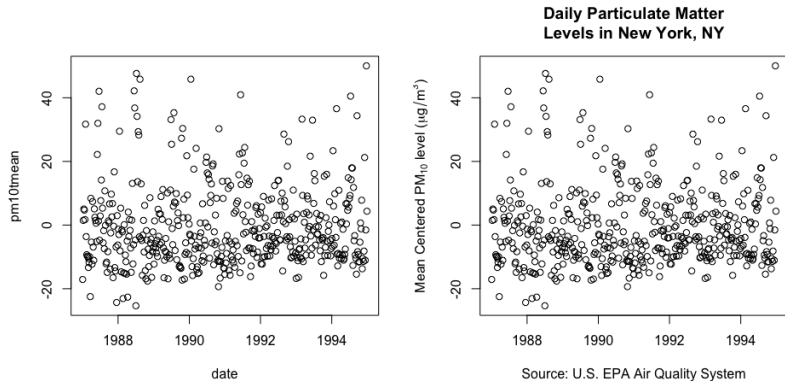


Figure 11: Unlabelled and labelled figure

Principles of Analytic Graphics

Principle 4: Integrate Evidence

- ▶ Completely integrate words, numbers, images, diagrams
- ▶ Data graphics should make use of many modes of data presentation
- ▶ Don't let the tool drive the analysis

Principle 5: Describe and document the evidence with appropriate labels, scales, sources, etc.

- ▶ A data graphic should tell a complete story that is credible
- ▶ Same is true for a slide in a presentation

Principle 6: Content is king

- ▶ Analytical presentations ultimately stand or fall depending on the *quality*, *relevance*, and *integrity* of their content

Summary

Principle 1: Show comparisons

Principle 2: Show causality, mechanism, explanation

Principle 3: Show multivariate data

Principle 4: Integrate multiple modes of evidence

Principle 5: Describe and document the evidence

Principle 6: Content is king

Reference

Edward Tufte (2006). Beautiful Evidence, Graphics Press LLC.
www.edwardtufte.com