



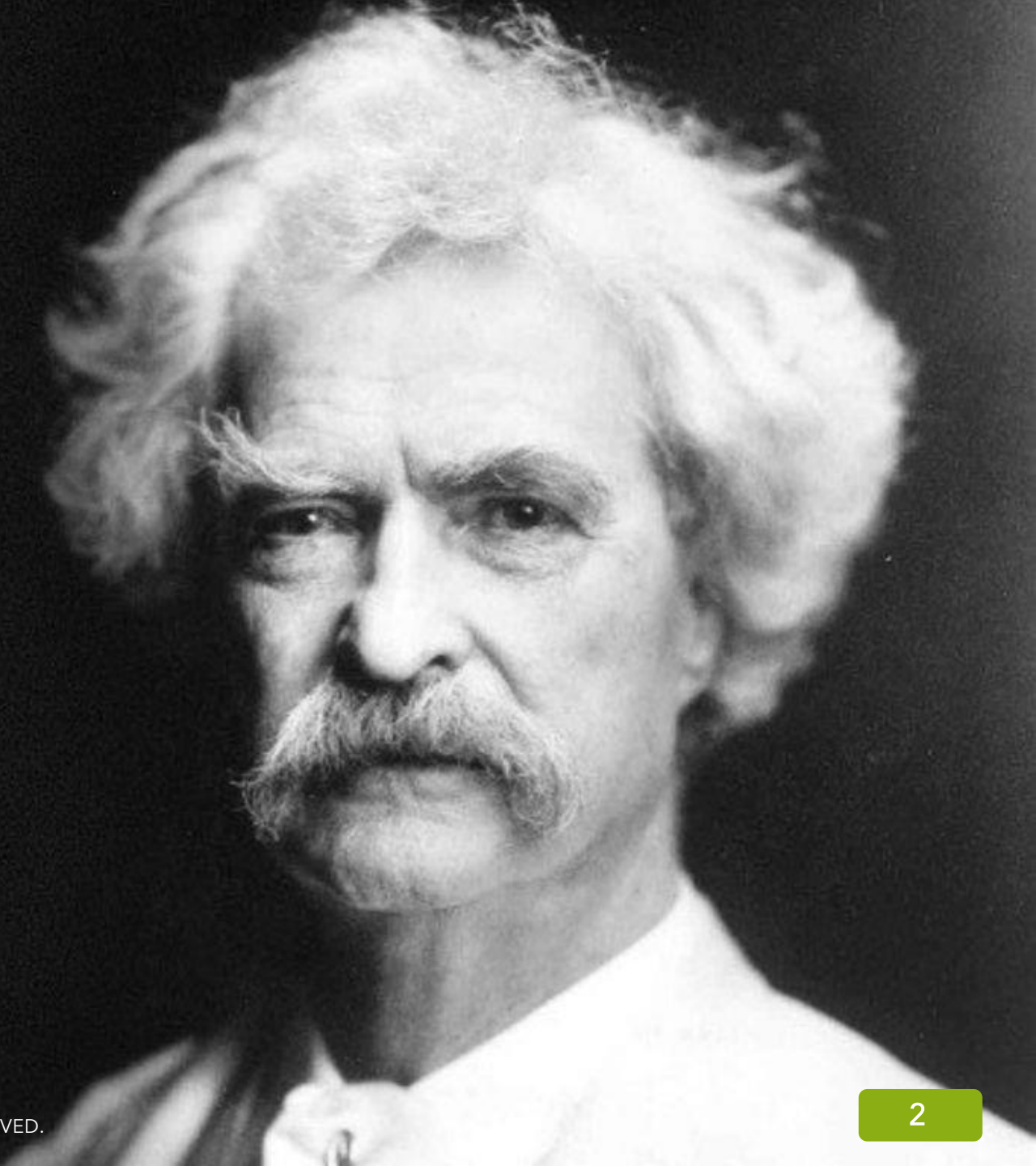
Lean Six Sigma - Statistical **Surprises** and **Absurdities**

By Thomas Pyzdek

“There are three kinds of lies:
lies, damned lies, and statistics.”

“When in doubt, tell the truth.”

- Mark Twain (1835-1910)



Surprises and Absurdities



- Surprise
 - A legitimate result that contradicts our expectation.
- Absurdity
 - An unexpected result that leads to a conclusion that isn't true.
- Lying with statistics
 - A statement which uses statistics to convey a misleading result.

Sample Bias



- The average salary of our graduates is \$100,000 per year... or not
 - Whose address or phone number is the school likely to have: Alumni club members? Or homeless graduates?
 - Who is most likely to respond: successful alumni or unsuccessful alumni?
 - Which is more likely: respondents who overstate their income, or who understate their income?
 - Accurate responses don't affect the bias.
- Discussion: can you think of other sources of sample bias?

Averages, Averages



Salaries:

- \$50,000
- \$50,000
- \$70,000
- \$500,000

Which statement is correct?

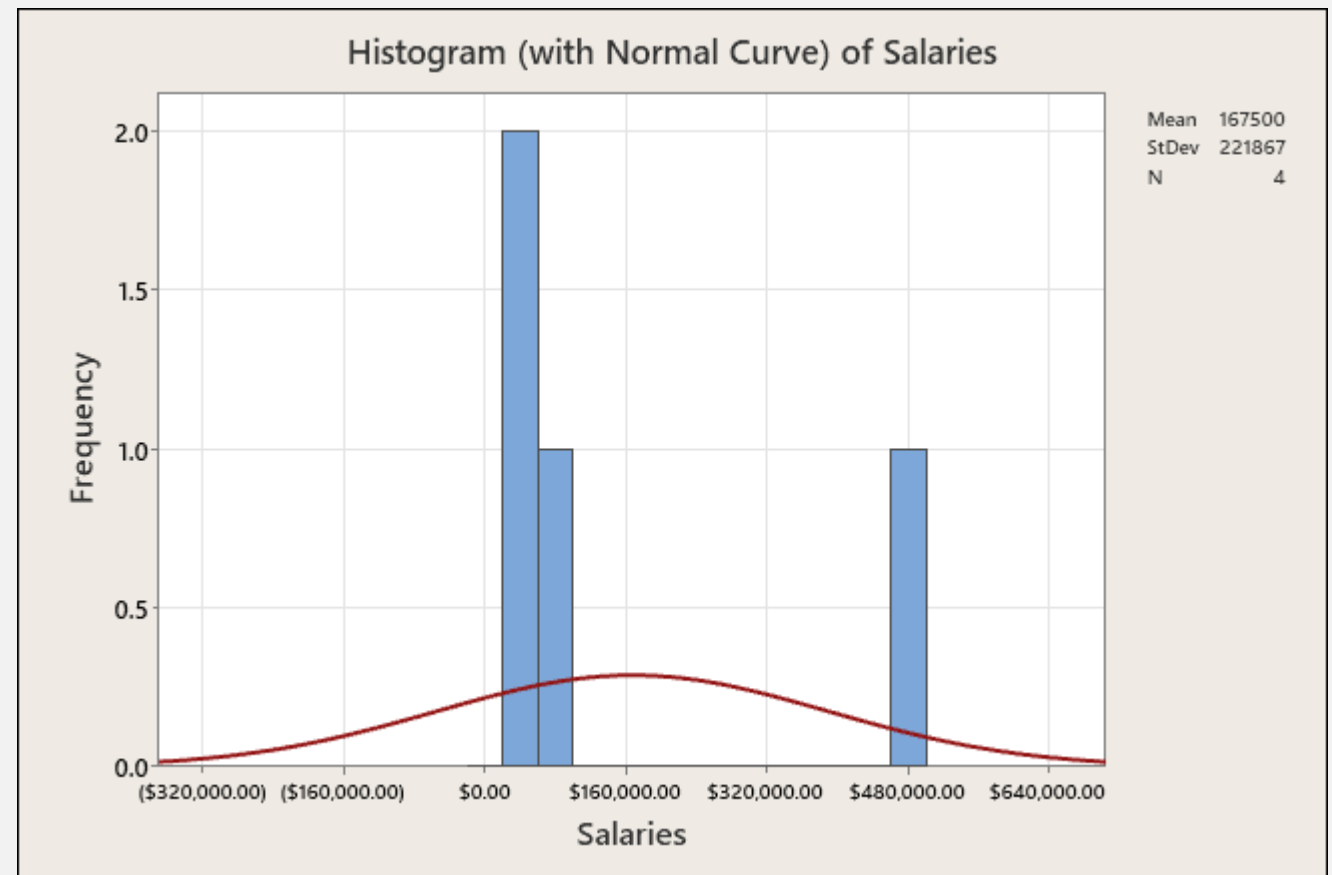
- A. Average salary \$ 50,000
- B. Average salary \$167,500
- C. Average salary \$ 60,000

Which is right?

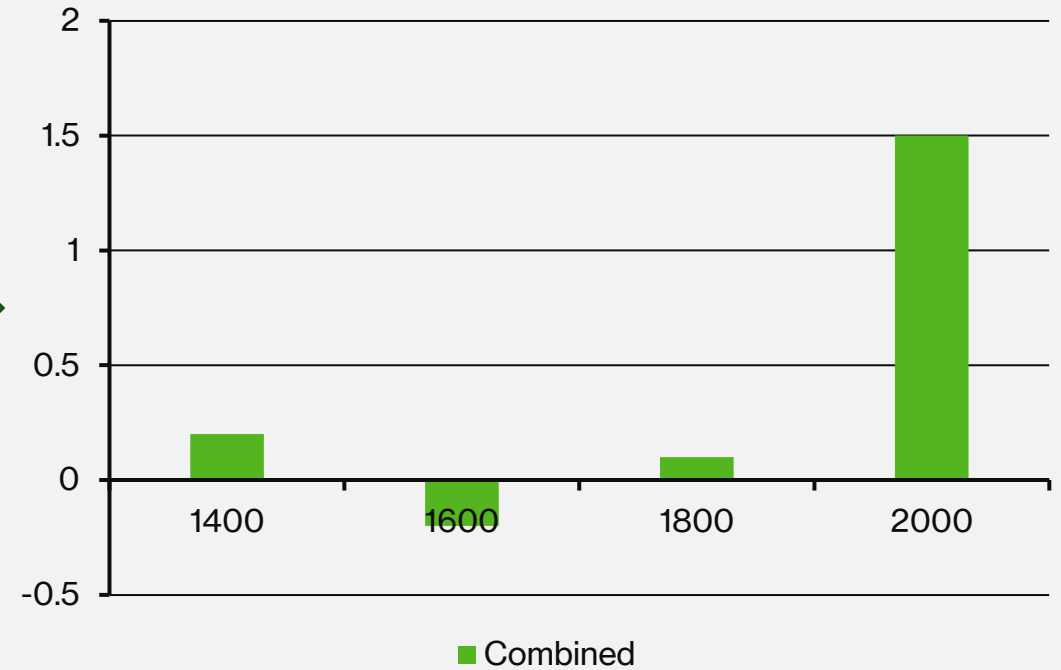
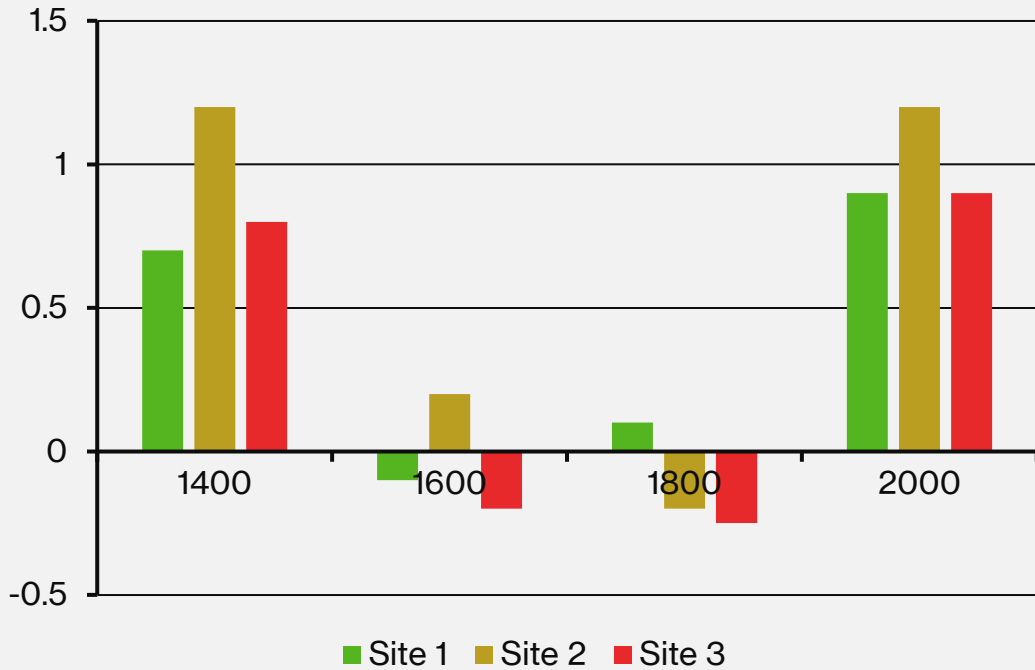
- D. All of the above
- A. mode
- B. arithmetic mean
- C. median

Statistics

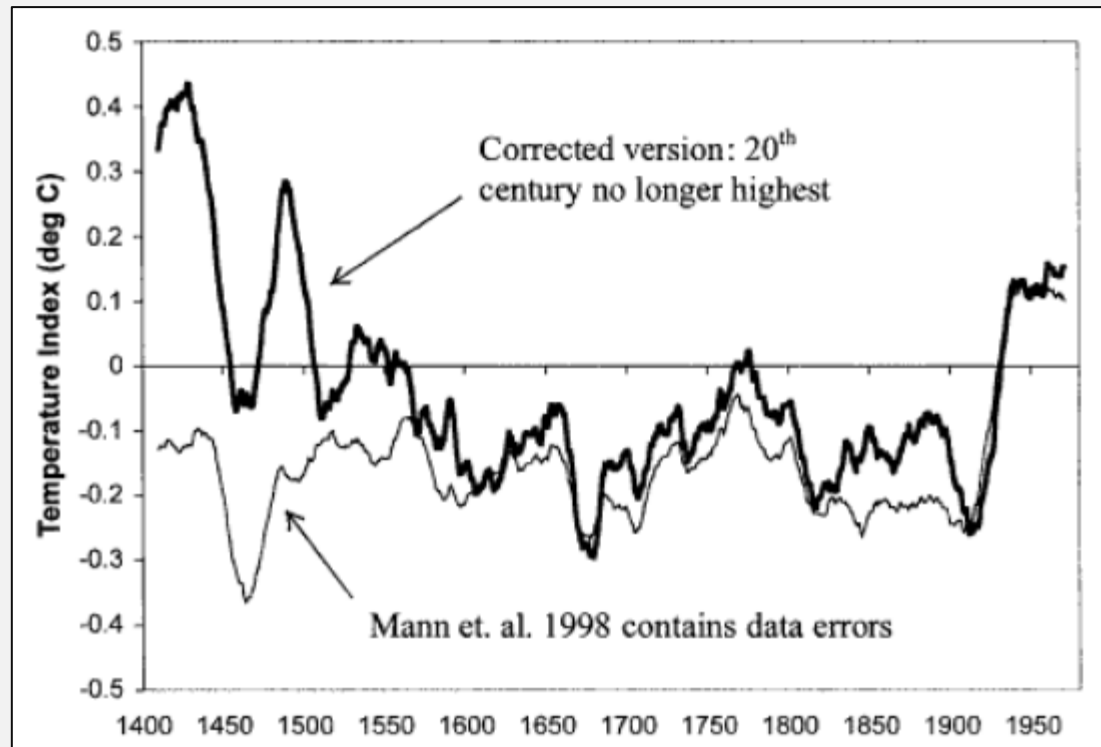
Variable	Mean	Median	Mode	N for Mode
Salaries	167500	60000	50000	2



Selective Data Weighting



Selective Data Weighting



McIntyre, S., McIntyre, S., & McKittrick, R. (2003). Figure 8 [Graph].
<http://www.jstor.org/stable/43734600>

Selective Reporting



- "8 out of 10 dentists prefer Smiley Toothpaste."
- Small sample sizes also a way to tell a lie.

Sample	Smiley	Other
1	2	8
2	4	6
3	6	4
4	5	5
5	8	2



Missing Information



- True perhaps, but most doctors don't smoke!
 - Was "I don't smoke" offered as a choice?
- On any list, *something* must be first.

According to repeated nationwide surveys,

More Doctors Smoke **CAMELS** than any other cigarette!

Doctors in every branch of medicine were asked, "What cigarette do you smoke?" The brand named most was Camel!

You'll enjoy Camels for the same reasons so many doctors enjoy them. Camels have cool, cool *mildness*, pack after pack, and a *flavor* unmatched by any other cigarette. Make this sensible test: Smoke only Camels for 30 days and see how well Camels please your taste, how well they suit *your* throat as your steady smoke. You'll see how enjoyable a cigarette can be!

THE DOCTORS' CHOICE IS AMERICA'S CHOICE!



MAUREN O'NEAL says: "I pick Camels. They agree with my throat and taste wonderful!"

DICK HAYNES states: "I get more pleasure from Camels than from any other brand!"

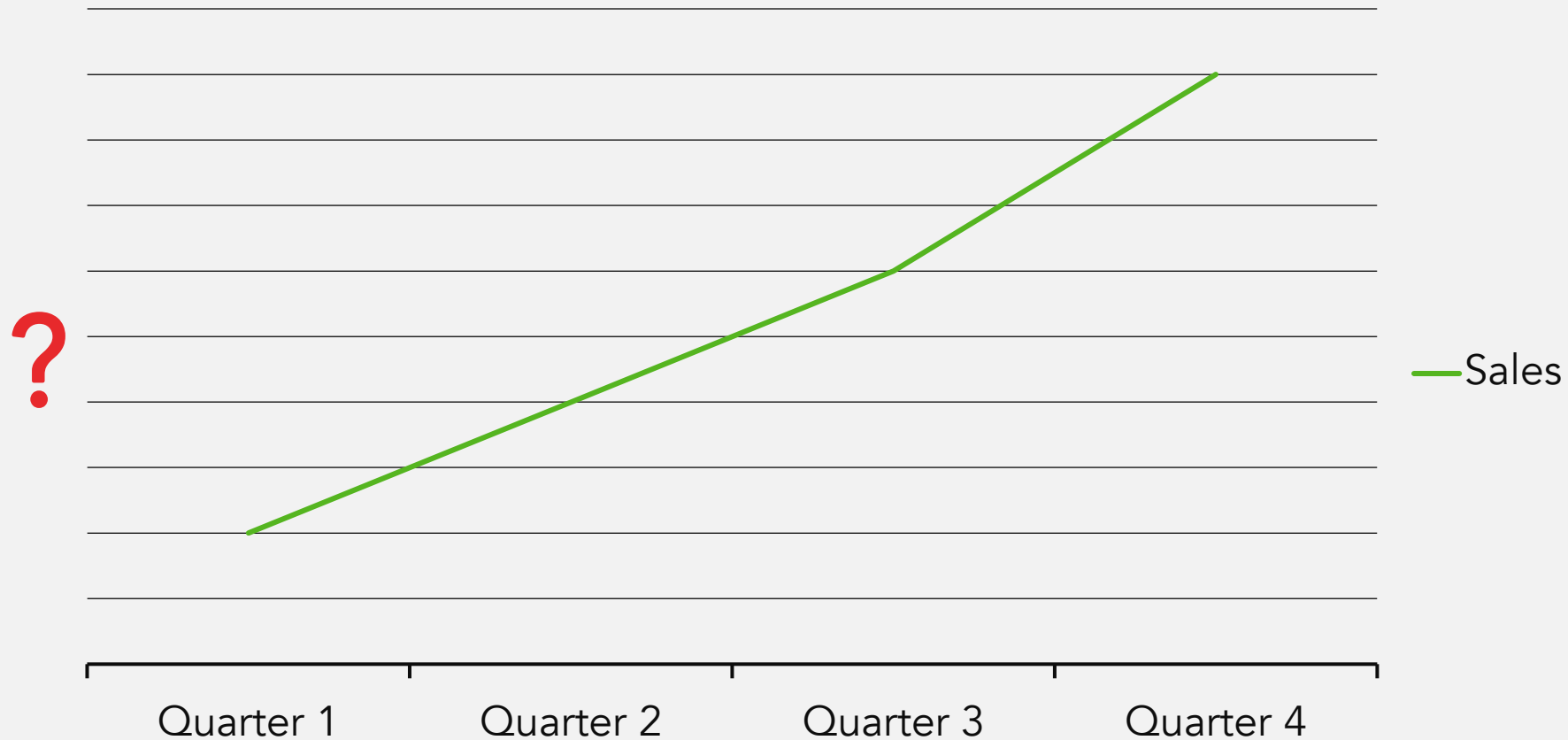
RALPH BELLAMY reports: "Camels suit my taste and throat. I've smoked 'em for years!"

For 30 days, test Camels in your "T-Zone" (T for Throat, T for Taste).

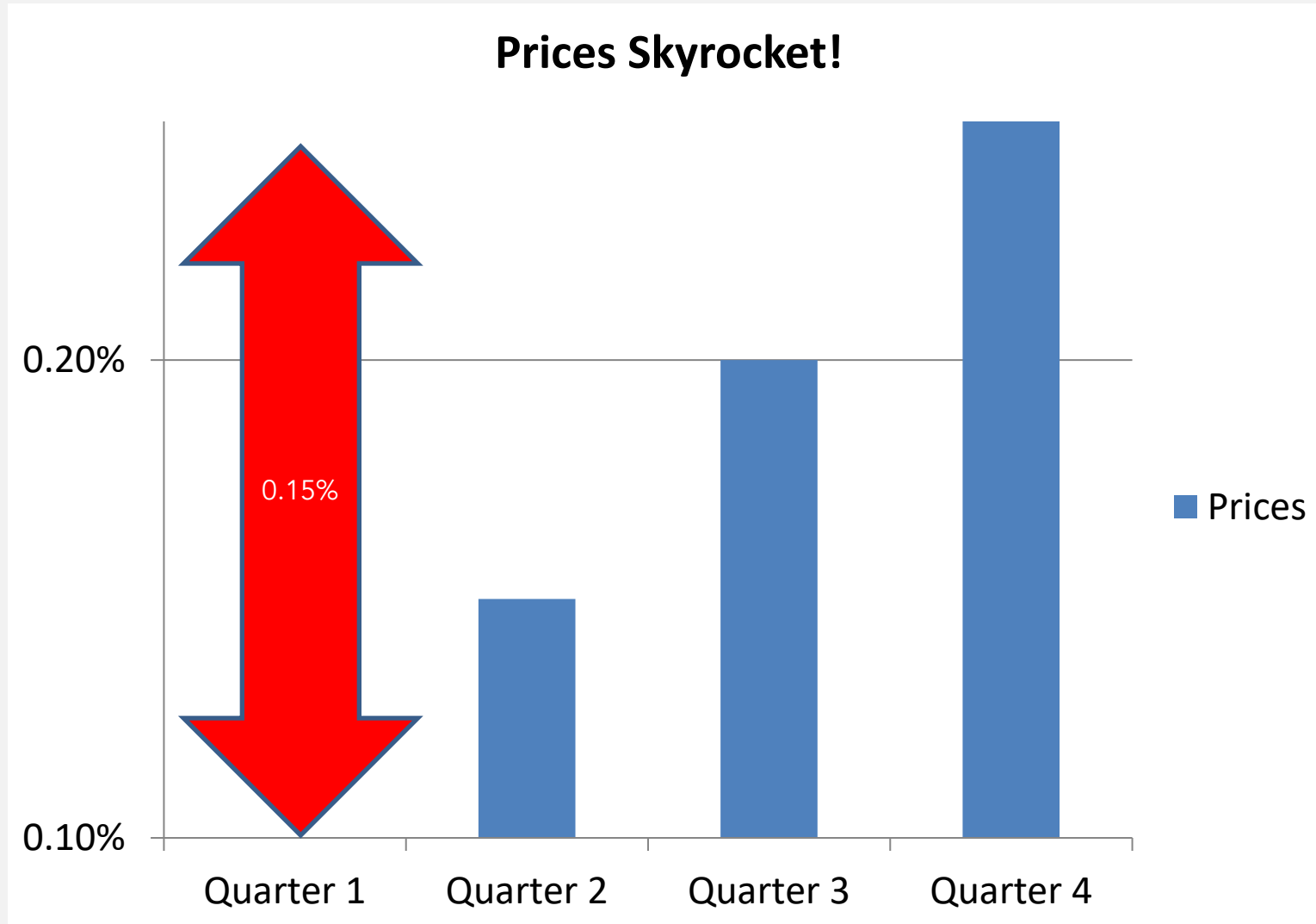
Missing Information-Graphics Version



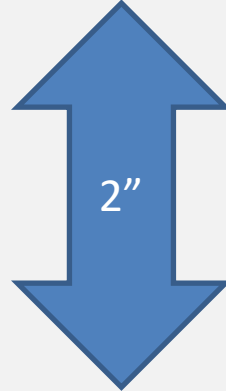
Sales Skyrocket!



Scale Distortion



3D Trickery



Beef Prices Double!
(But appear to quadruple)



“Say-What” and “So-What” Statistics



- The say-what? statistic
 - “Lean organizations are 20% more efficient!”
 - More efficient than ... ?
- The so-what statistic
 - “More Black Belts prefer Puffs facial tissue”
 - Who cares? Black Belts are no more qualified than anyone else to make this assessment.

Lurking Variables Can Make a Difference



Tough Program's Admission Data

Sex	Accept	Reject	Total	Rate
Male	40	160	200	20%
Female	200	600	800	25%
Total	240	760	1000	24%

Gender Bias in School Admissions!



Sex	Accept	Reject	Total	Rate
Male	700	300	1000	70%
Female	400	600	1000	40%
Total	1100	900	2000	55%



Easy Program's Admission Data

Sex	Accept	Reject	Total	Rate
Male	660	140	800	83%
Female	200	0	200	100%
Total	860	140	1000	86%



True But Misleading Risk Statements



- Let's assume the following is true:
 - For every 100,000 people who *don't* drink Yippee soda 99,999 will survive for the next year.
 - For every 100,000 Yippee soda drinkers 99,998 will survive for the next year.
- True statement

“Drinking Yippee Doubles your risk of dying”

- Medical researchers report the “relative risk”
 - Risk for non-Yippee drinkers: 1/100,000.
 - Risk for Yippee drinkers: 2/100,000
 - Relative Risk: **2**

Risk Reporting Example



MailOnline

Home U.K. Home News Sport U.S. Showbiz Femail **Health** Science Money RightM

[Health Home](#) | [Health Directory](#) | [Health Boards](#) | [Diets](#) | [MyDish Recipe Finder](#)

Taking painkillers long-term 'triples risk of kidney cancer'

By [CLAIRE BATES](#)

The overall risk of renal cell cancer remains small in comparison to that of other major diseases.

Only six per 100,000 people are expected to develop the condition.

Odds of **not** getting renal cell cancer:

No Painkillers: 99,998 in 100,000

Painkillers: 99,992 in 100,000




Lies, Damned Lies, and Medical Science

Much of what medical researchers conclude in their studies is misleading, exaggerated, or flat-out wrong. So why are doctors—to a striking extent—still drawing upon misinformation in their everyday practice? Dr. John Ioannidis has spent his career challenging his peers by exposing their bad science.

- Freedman, D. H. (2010, October 4). *Dr. John Ioannidis Exposes the Bad Science of Colleagues*. The Atlantic; The Atlantic. <https://www.theatlantic.com/magazine/archive/2010/11/lies-damned-lies-and-medical-science/308269/>

Example of Problems



 News Events Video Support Services Health Advice ▾ Champions

HEART AND LUNGS

Heart risk of painkillers examined

A painkiller taken by millions can increase the risk of heart attack and stroke by 40%, the *Daily Mail* has today reported. The newspaper says that researchers are calling for the drug, called diclofenac, to be available on prescription only.

The news is based on a large review that looked at the cardiovascular risks associated with a class of widely used painkillers called non-steroidal anti-inflammatory drugs (NSAIDs). NSAIDs in high-dose formulations are usually only available on prescription, but some low-dose NSAIDs, including ibuprofen, naproxen and diclofenac, can be bought over the counter.

■
■
■

Where did the story come from?

The study was carried out by researchers affiliated with Hull York Medical School, the Institute for Clinical Evaluative Sciences, the University of Toronto in Canada and the University of Newcastle in Australia. It received no external funding. The study was published in the [peer-reviewed](#) journal *PLoS Medicine*.

PLOS MEDICINE

Why Most Published Research Findings Are False

John P. A. Ioannidis

Published: August 30, 2005 • <https://doi.org/10.1371/journal.pmed.0020124>

Article	Authors	Metrics	Comments	Media Coverage
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Correction

Abstract

Modeling the Framework for False Positive Findings

Bias

Testing by Several Independent Teams

Corollaries

Most Research Findings Are False for Most Research Designs and for Most Fields

Claimed Research Findings May Often Be Simply Accurate Measures of the Prevailing Bias

How Can We Improve the Situation?

References

Correction

25 Aug 2022: Ioannidis JPA (2022) Correction: Why Most Published Research Findings Are False. *PLOS Medicine* 19(8): e1004085. <https://doi.org/10.1371/journal.pmed.1004085> | [View correction](#)

Abstract

Summary

There is increasing concern that most current published research findings are false. The probability that a research claim is true may depend on study power and bias, the number of other studies on the same question, and, importantly, the ratio of true to no relationships among the relationships probed in each scientific field. In this framework, a research finding is less likely to be true when the studies conducted in a field are smaller; when effect sizes are smaller; when there is a greater number and lesser preselection of tested relationships; where there is greater flexibility in designs, definitions, outcomes, and analytical modes; when there is greater financial and other interest and prejudice; and when more teams are involved in a scientific field in chase of statistical significance. Simulations show that for most study designs and settings, it is more likely for a research claim to be false than true. Moreover, for many current scientific fields, claimed research findings may often be simply accurate measures of the prevailing bias. In this essay, I discuss the implications of these problems for the conduct and interpretation of research.



Conclusion

This large review has published some important information on the cardiovascular risks associated with NSAIDs, including the risk associated with different doses and in populations at both high and low risk of cardiovascular events. It raises concerns about some of these risks, in particular the risk associated with the widely used non-prescription drug diclofenac.

As its authors point out, it had some limitations.

- It had to rely on observational studies (rather than randomised controlled trials), which are subject to bias, especially in terms of other factors (**confounders**) that might influence results. However, the researchers did take steps to minimise this risk.
- The data in the studies mainly came from large administrative databases and electronic health records, and may not have been comprehensive, especially concerning key information such as use of non-prescription NSAIDs and aspirin, or information about people's risk of heart problems.
- The review suffered from 'heterogeneity'. This means that many of the studies varied in their design, their methods and how they analysed results. Heterogeneity makes it harder to combine the results of different studies accurately and can, therefore, throw doubt on the findings of systematic reviews.

Patients using NSAIDs who are worried about side effects should not stop taking them, but instead consult their doctor.

Source Studies had weak designs to begin with.

Lurking Variables

Confounders

Mixed apples and oranges

Be careful! Don't let this happen to you!

