

Research basics
Numbers in research
Steven Woloshin

Medicine & the Media
The Challenge of Reporting on Medical Research

How big? Numbers in research

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Everyone

Understanding numbers and basic research principles makes you less vulnerable to distortions

report their exaggerations

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Research basics
Generic research principles

1. Introduction: exposure, outcome, effect size
2. Numbers in research
 - How outcomes are counted
 - How effect size is calculated

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Generic Medical Research Question

Does exposure to _____ lead to the outcome of _____?

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Does exposure to _____ lead to the outcome of _____?

Exposure	→	Outcome
Asbestos	→	Mesothelioma
Radon	→	Lung cancer

When most of us hear the word "exposure", we think about something bad.

But in medical research an "exposure" is not necessarily bad, it may also be something good.

Aspirin	→	Less Heart attack
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An exposure is simply something that is associated with a change in outcome -- either for better or for worse.

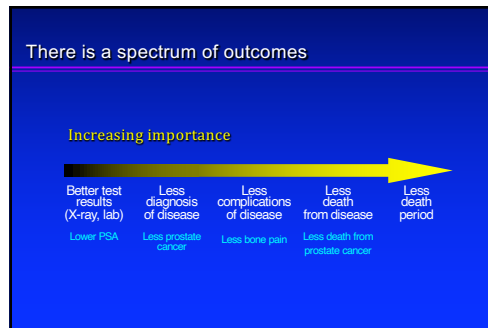
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Basic study design

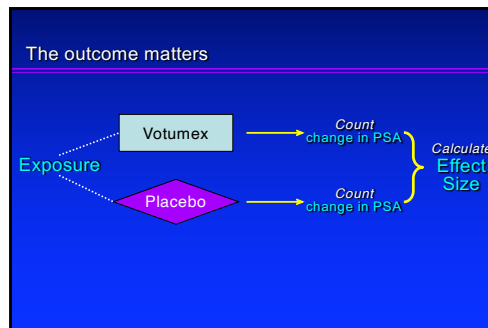
```
graph LR; Exposure --> Exposed; Exposure --> Control; Exposed --> CountOutcome1[Count Outcome]; Control --> CountOutcome2[Count Outcome]; CountOutcome1 --- EffectSize[Calculate Effect Size]; CountOutcome2 --- EffectSize;
```

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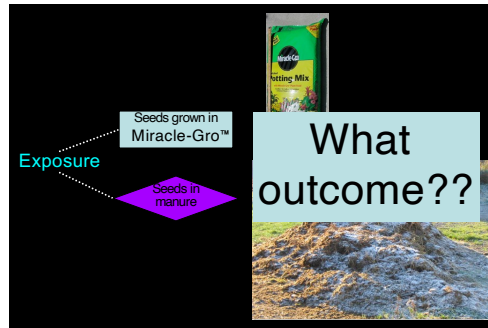


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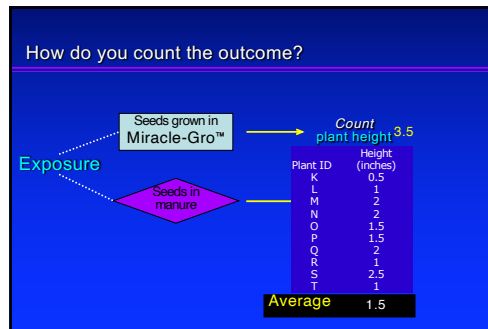
- How Big?*
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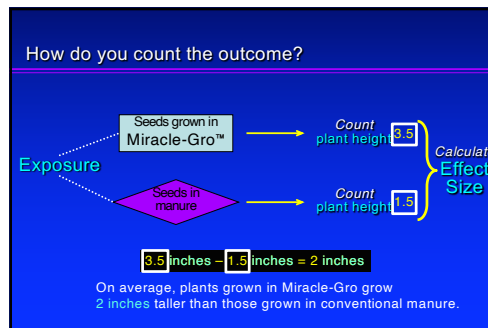
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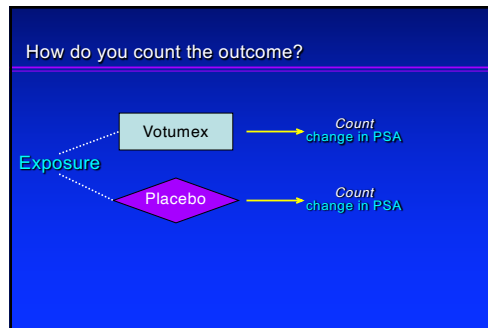


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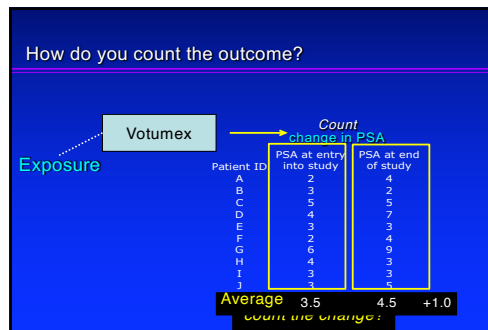


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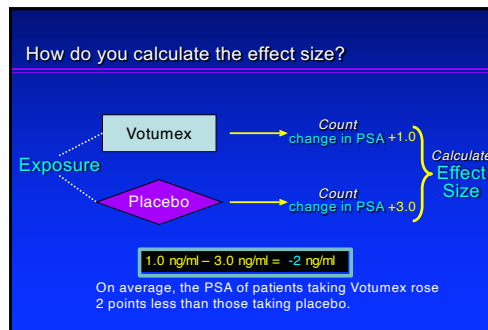
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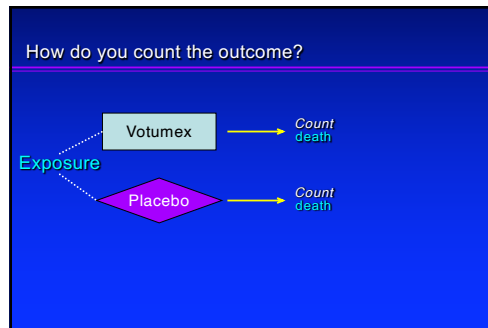


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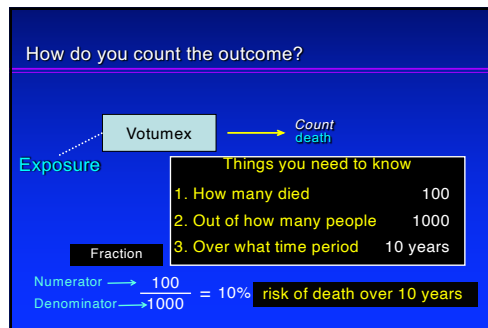


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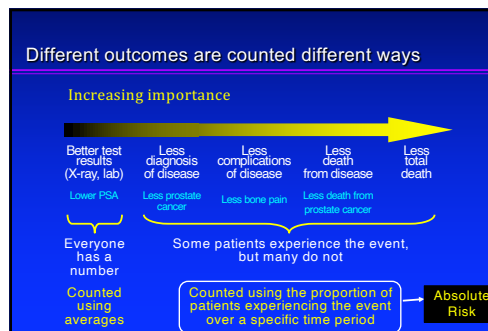
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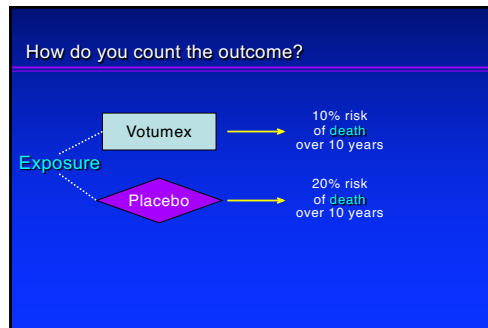


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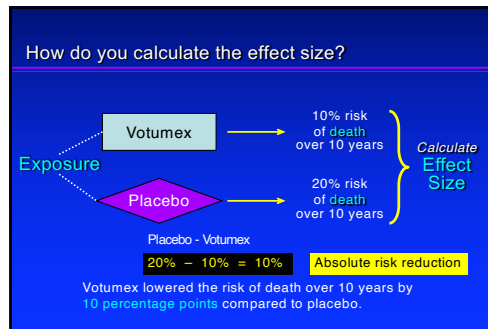


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Calculating Absolute Risks
A Primer

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The spectrum of presentation formats for 178,480
139,655,712

$0.001278 = 127.8$ per 100,000

$0.001278 = 12.8$ per 10,000

$0.001278 = 1.3$ per 1000

$0.001278 = 0.13$ per 100 **or 0.13%**

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Another way to calculate the effect size

Often investigators calculate a ratio of the two risks

$$\frac{10\%}{20\%} = 0.5$$

Relative Risk

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Calculating Relative Risk (RR)

A ratio of two risks $\frac{\text{Risk in exposed}}{\text{Risk in control}}$

← Absolute risk

← Absolute risk

$\frac{\text{Risk in intervention}}{\text{Risk in control}}$	$\frac{\text{Risk in drug group}}{\text{Risk in placebo group}}$	$\frac{\text{Risk in those exposed to toxin}}{\text{Risk in those not exposed}}$	$\frac{\text{Risk with new therapy}}{\text{Risk with standard therapy}}$
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Calculating RRs
now you try:

16% develop heart disease following new therapy vs. 20% in controls.	$\frac{16\%}{20\%} = 0.8$
10% of smokers develop lung cancer vs. 1% in non-smokers.	$\frac{10\%}{1\%} = 10$
10% of patients taking placebo have a stroke vs. 4% taking new drug.	$\frac{4\%}{10\%} = 0.4$

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Interpreting a relative risk

	$\frac{\text{Risk in exposed}}{\text{Risk in control}}$
Relative Risk	Effect of exposure (intervention, toxin, etc.)
Less than 1	Exposure decreases the chance of the outcome.
Equals 1	Exposure is not related to the outcome.
Greater than 1	Exposure increases the chance of the outcome.

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Interpreting RRs
now you try:

*Pick one:
 increases or decreases*

RR = 0.8 for heart disease following new therapy vs. controls.	New therapy decreases the risk of heart disease
RR = 10 for lung cancer in smokers vs. non-smokers	Smoking increases the risk of lung cancer
RR = 0.4 for stroke in patients taking new drug vs. placebo	New drug decreases the risk of stroke

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Interpreting RRs in words
now you try:

Think "times the risk"

RR = 0.8 for heart disease following new therapy vs. controls.

Patients taking new therapy have 0.8 times the risk of heart disease as controls

RR = 10 for lung cancer in smokers vs. non-smokers

Smokers have 10 times the risk of lung cancer as non-smokers

RR = 0.4 for stroke in patients taking new drug vs. placebo

Patients taking new drug have 0.4 times the risk of stroke as those taking placebo

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Calculating % increase

An RR of 1.5 would equal 150%

But that doesn't mean 150% increase, it means 150% of the risk in the comparison group - which is a 50% increase.

The calculation:

RR - 1, then convert to %

If the RR = 1.60

1.60 - 1 = 0.60 or a 60% increase

If the RR = 2.60

2.60 - 1 = 1.60 or a 160% increase

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Writing about a relative risk (RR) greater than 1

Approach 1 Say the relative risk ("times the risk")

RR = 1.5 "1.5 times the risk"

RR = 3 "3 times the risk"

RR = 4.5 "4.5 times the risk" or "over 4 times the risk"

RR = 9 "9 times the risk"

Approach 2 Use percent increase (= RR - 1, then convert to %)

RR = 1.5 "50% increase in risk"

RR = 1.75 "75% increase in risk"

RR = 1.3 "30% increase in risk"

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Writing about a relative risk (RR) less than 1

Approach 1 Say the relative risk ("times the risk" or "of the risk")

RR = 0.25 "0.25 times the risk"
 RR = 0.33 "0.33 of the risk"
 RR = 0.50 "0.5 of the risk" or "halves the risk"

Approach 2 Relative risk reduction = 1 - RR, then convert to %

RR = 0.80 "20% decrease in risk"
 RR = 0.67 "33% decrease in risk"
 RR = 0.10 "90% decrease in risk"

RR = 0.80
 1 - 0.80 = 0.20
 or a 20% decrease

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Shopping (\$) **Medicine** (%) **percentage points**

Sale reduces the "price of ties" → DRUG reduces "risk of death"

The Sale: 20% off → Relative risk reduction Drug reduces risk by 20%

Regular price	Sales price	PLACEBO Group absolute risk	DRUG Group absolute risk
\$20	\$16	20%	16%

20% decrease in price. → 20% decrease in risk.

Savings = \$20 - \$16 = \$4 → Absolute risk reduction = 20% - 16% = 4%
 "4 percentage points"

$\frac{\text{Sales price}}{\text{Regular price}} = \frac{16\%}{20\%} = 0.8$ → Relative risk = $\frac{16\%}{20\%} = 0.8 = 80\%$

The sales price is 80% of the regular price. → The risk of death with the DRUG is 0.8 times that of PLACEBO.

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Fundamental question

Should I believe the reported relationship between exposure and outcome?

This question is about study design.

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