

Risk



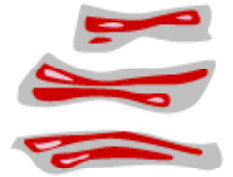
"Only those who will risk going too far can possibly find out how far they can go"

T S Eliot
(1885-1965)

Stephanie Budgett
Department of Statistics
University of Auckland

Some true headlines

"Bacon increases your risk of colorectal cancer by **20%**"



"One extra unit a day increases a woman's risk of breast cancer by **12%**"

"Two units a day reduce the risk of heart disease by about **17%**"



What do we mean by 'risk'?

- To do with situations where 'bad' (or 'good') things may happen
- Mainly use our 'gut feelings' to deal with these situations and to make decisions
- These feelings can be influenced by experience, emotion, media coverage, etc.

What do we mean by 'risk'?

- 2 main brain systems for decision making
 1. **Instinctive (i.e. gut feelings, driven by emotions, lower than level of conscious control)**
 2. **Conscious/rational**
 - 1. Instinctive – fast and effective (e.g. instantaneous integration of complex information, carrying out well-practiced actions)
 - 2. Conscious/rational – more useful in novel situations (eg. situations requiring deliberative analysis)
- SOMETIMES 1 KICKS IN WHEN 2 MAY BE BEST**

What do we mean by 'risk'?

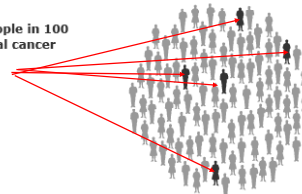
- Gut feelings can be unreliable, especially when
 - We are being manipulated
 - The reasoning is complex
 - Much depends on our decisions
- Question: A bat and a ball cost \$1.10. The bat costs \$1 more than the ball. How much is the ball?
 - ~3500 US university students
 - < 50% gave the correct answer
 - Intuition suggests 10c. Rational system does little to correct unless conscious effort intervenes

5c

"Bacon increases your risk of colorectal cancer by 20%"

"Bacon increases your risk of colorectal cancer by 20%"

About five people in 100 have colorectal cancer in a lifetime



"Bacon increases your risk of colorectal cancer by 20%"

About five people in 100 have colorectal cancer in a lifetime

If all 100 eat three extra rashers of bacon every day...

...that rises to about six



"One extra unit of alcohol a day increases a woman's risk of breast cancer by 12%"

But how bad is that?

"One extra unit of alcohol a day increases a woman's risk of breast cancer by 12%"

About 10 in every 100 women have breast cancer in a lifetime



"One extra unit of alcohol a day increases a woman's risk of breast cancer by 12%"

About 10 in every 100 women have breast cancer in a lifetime

If all 100 drink an extra unit of alcohol every day...

...that rises to about 11



"One extra unit of alcohol a day increases a woman's risk of breast cancer by 12%"

is the same as saying

about one extra case in every 100 women



"Two units of alcohol a day reduce the risk of heart disease by about 17%"

But how good is that?

"Two units of alcohol a day reduce the risk of heart disease by about 17%"

About 32 in every 100 women have coronary heart disease in a lifetime



"Two units of alcohol a day reduce the risk of heart disease by about 17%"

About 32 in every 100 women have coronary heart disease in a lifetime

If all 100 drink roughly two units of alcohol every day...

...that falls to about 27



"Two units of alcohol a day reduce the risk of heart disease by about 17%"

is the same as saying

about five fewer cases in every 100 women



So....

- Depending on the story
 - 20% or 12% can equal **one** person while
 - 17% can be the equivalent of **five** people
- Don't think percentages, think REAL PEOPLE!



Risk – some quotes from the media

- One of the largest studies of the impact of food and drink on mental decline has found a Mediterranean diet **cuts the risk** of Alzheimer's disease by **up to 40%**. (NZ Herald, April, 2006)
- WHO found that circumcised men in South Africa were **65% less likely** to become infected with HIV. (NZ Herald, 12/7/6)
- People who live alone are **twice as likely** to have serious heart disease as those who live with a partner. (NZ Herald, 17/7/6)

Thought question:

- Suppose a newspaper article claimed that drinking coffee **doubled your risk** of developing a certain disease.
- Assume that the statistic was based on legitimate, well-conducted research.
- What additional information would you want about this risk before deciding whether to quit drinking coffee?



Risk

- Question: What does this mean?

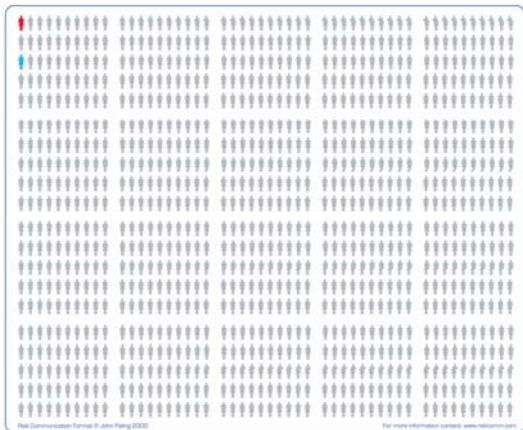
DOUBLED YOUR RISK

- Risk goes from 1 in 1,000 to 2 in 1,000?

One Thousand People – Pictures to Help You

See
Your
Odds

Risk of something BAD happening



Please Note:
We can only show
averages. It is
impossible to
predict whether
your results will be
positive or negative.

Background risk (no coffee)
Additional risk with coffee

Risk

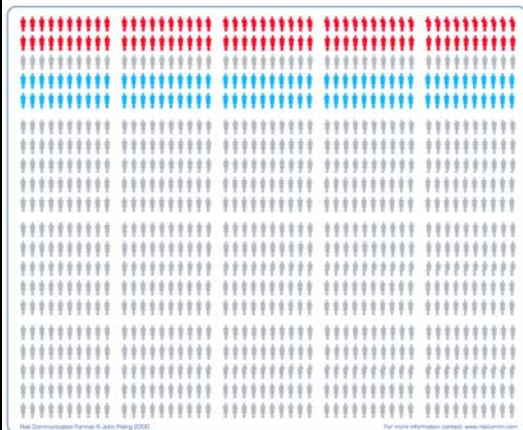
OR

– Risk goes from 1 in 10 to 2 in 10?

One Thousand People – Pictures to Help You

See
Your
Odds

Risk of something BAD happening



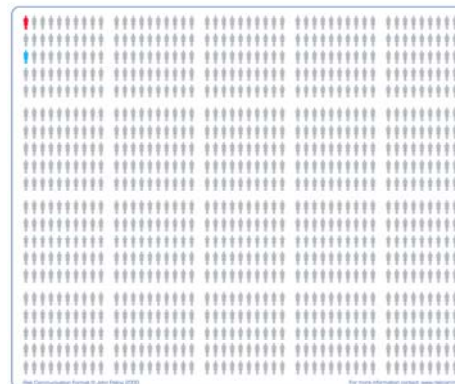
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See
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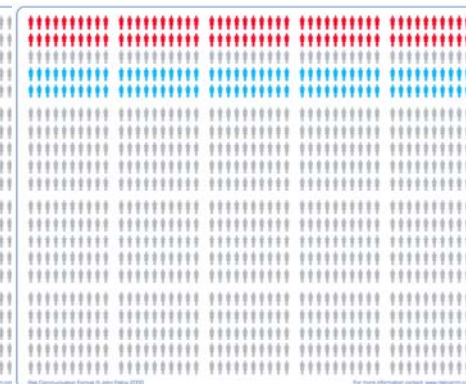
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Background risk (no coffee)
Additional risk with coffee

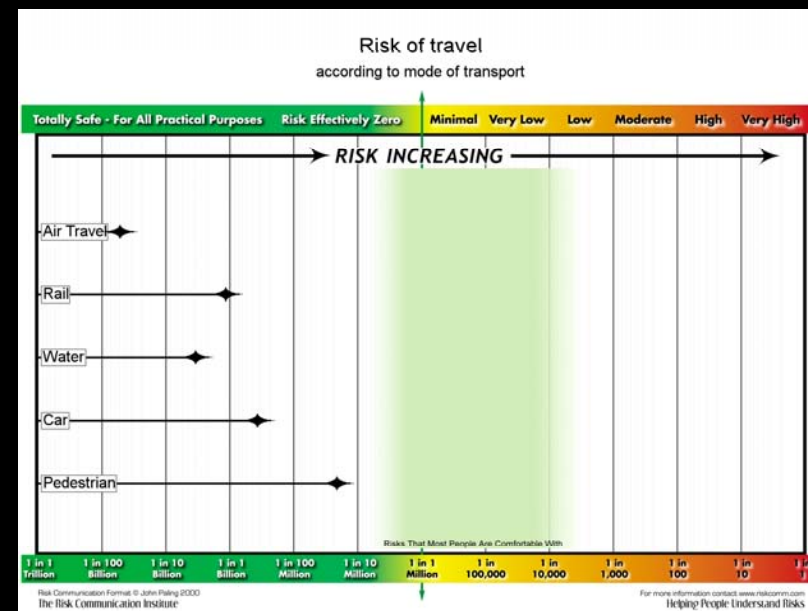
Public perceptions of health risks:

- Vaccines (MMR, meningitis, polio)
- BSE/vCJD (mad cow disease)
- Injury and death in road transport crashes

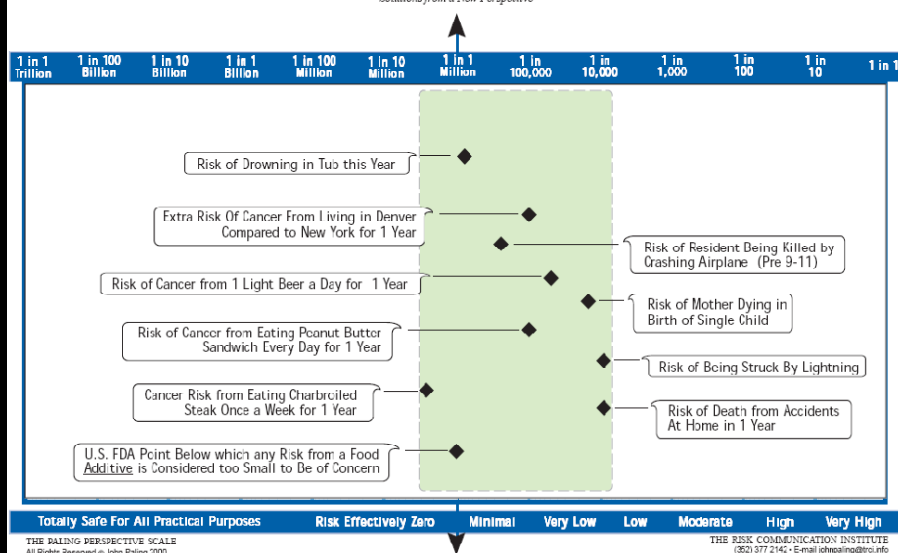


Risk by far the largest but still controversial

the fraud' - medical
world refusing
was an
Dr A
children
in the medical
the small size
the number of children receiving the MMR
lower (the anti-vaccine group) who
child is a
in Deer has accused Dr Wakefield of altering the
to have identified a new syndrome.
selected by an anti-vaccine campaign group, who he
of planned litigation.
were "previously normal," five had documented pre-existing



Risks With Which We Are "At Home" The Paling Perspective Scale®



Risk, reporting and media influence

- Media reporting of health-related news stories can be highly influential
 - priorities and decisions of policy-makers are often shaped by what they see on TV and read in the general and specialist press.
- Members of the public may alter their behaviour in ways that affect their health, at least partly as a result of information and advice they get from the media.

Risk, reporting and media influence

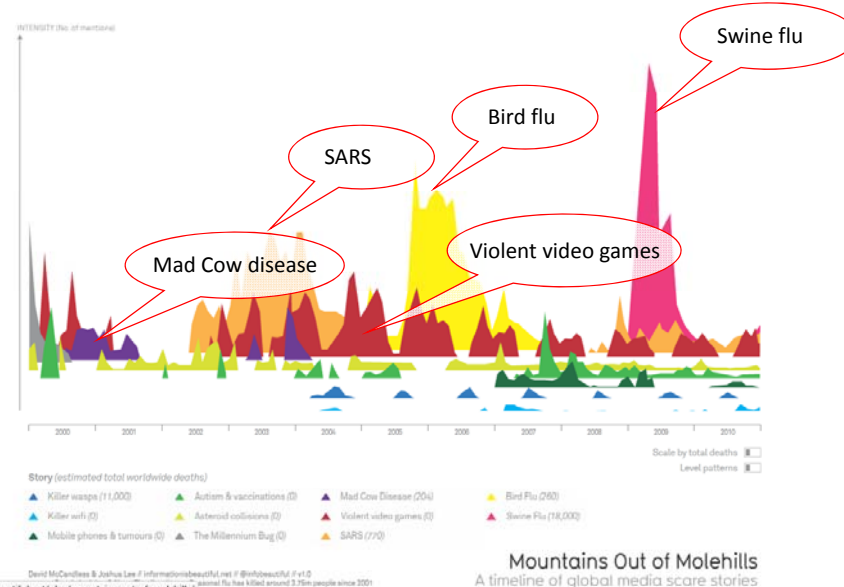
- The media is often uninterested in serious, proven health risks such as smoking, alcohol and obesity.
- More interested in 'crises' such as SARS, vCJD etc. which pose relatively little danger.
- Example: Study carried out in the UK found that **8,571** people died from smoking for each news story on the health risks of **smoking**, compared to **0.33** deaths for each news story on **vCJD**.

Information is Beautiful

Ideas, issues, knowledge, data - visualized!

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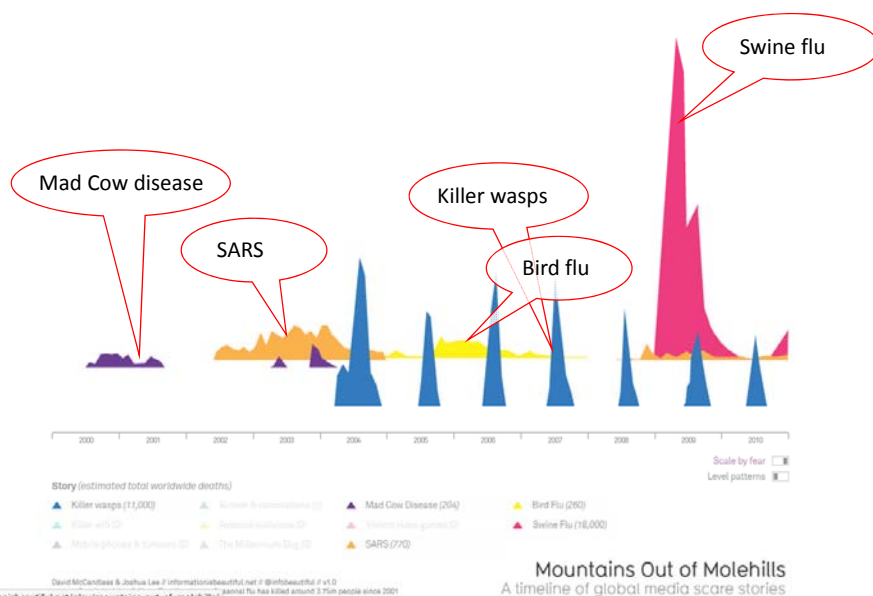


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"One extra unit of alcohol a day increases a woman's risk of breast cancer by **12%**"

But how bad is that?

"One extra unit of alcohol a day increases a woman's risk of breast cancer by **12%**"

About 10 in every 100 women have breast cancer in a lifetime

"One extra unit of alcohol a day increases a woman's risk of breast cancer by **12%**"

About 10 in every 100 women have breast cancer in a lifetime

If all 100 drink an extra unit of alcohol every day...
...that rises to about 11

"One extra unit of alcohol a day increases a woman's risk of breast cancer by **12%**"

is the same as saying

about one extra case in every 100 women

The Breast Cancer Debate

- Breast cancer risk – top of national US health agenda
- Large activist movement
 - Emphasizing and exaggerating danger posed by breast cancer
- Heightened media attention
- Increased government funding

The Breast Cancer Debate

- Deaths from cancer in US in 1997:
 - 46,000 US women died of breast cancer
 - 38,000 US men died of prostate cancer
- Major media stories that year:
 - Breast cancer mentioned 5,800 times
 - Prostate cancer mentioned 150 times
- National Cancer Institute:
 - \$213m for breast cancer research
 - \$51m for prostate cancer research

~20% more

~230% more

~420% more

The Breast Cancer Debate

- In NZ, 1 in 9 women will develop breast cancer
- This is a lifetime risk – not the same as the risk women are exposed to at any given time

Age	Risk of BC within 10 years
40	1 in 63
50	1 in 41
60	1 in 28
70	1 in 24
80	1 in 29

Assuming live to 85



Conveying Risk

- Baseline risk
- Risk difference
- Relative risk
- Increased risk/Reduced risk
- Odds Ratio
- Attributable risk
- Number needed to treat

Conveying Risk

Baseline risk

- This is the risk without a specified treatment or behaviour.
 - If we want to find out if taking an aspirin helps prevent heart attacks, the baseline risk is...
the risk of having a heart attack without taking aspirin.
 - If we want to investigate the risk of smoking and getting lung cancer, the baseline risk is...
the risk of getting lung cancer without smoking.

Conveying Risk

Risk difference

- The difference in risk, for lung cancer say, associated with smoking, is simply
Risk for those exposed (smokers) – Baseline risk (non-smokers)
Risk for the exposed – Risk for the unexposed
(simple difference between the 2 probabilities)
Seldom used and quoted
 - because for small probabilities ratios tend to be much more stable measures of effect (from population to population) than differences

Conveying Risk

Relative risk

- The ratio of the risks for two groups

e.g. Relative risk of cancer due to smoking

$$= \frac{\text{Risk (prob) of Cancer for a smoker}}{\text{Risk (prob) Cancer for a nonsmoker}}$$

Conveying Risk

Relative risk

- The ratio of the risks for two groups
 - Group of interest on top line
 - Comparison (baseline) group on bottom line
- often expressed as a multiple
 - A relative risk of 3 means that the risk of developing a disease for the group of interest is three times the risk for the baseline group
 - A relative risk of 1 would mean that the risk is the same for both groups

Conveying Risk

•Relative risk

- It is useful to compare the risk of disease (e.g. heart attacks) for those **with** a certain characteristic (e.g. taking aspirin) to the baseline risk of that disease (e.g. heart attacks in those **not** taking aspirin).
- It doesn't usually matter which way round we calculate the ratio, but relative risks of greater than 1 are easier to interpret than those between 0 and 1.

Conveying Risk

Example:

Relative Risk of Developing Breast Cancer (*Utts, Seeing Through Statistics, p224*)

First Child at age 25 or older?	Breast Cancer	No Breast Cancer	Total
Yes	31	1597	1628
No	65	4475	4540
Total	96	6072	6168

Breast cancer risk for a woman

$$\text{having first child } \geq 25 = 31 / 1628 = 0.0190$$

$$\text{having first child } < 25 = 65 / 4540 = 0.0143$$

$$\text{Relative risk} = 0.0190 / 0.0143 = 1.33$$

Conveying Risk

In Words:

The risk of developing breast cancer is **1.33** times greater for women who had their first child at age 25 or older than for those who did not

OR the other way up

i.e. comparing "under 25" to "over 25"

- Relative risk = $0.0143 / 0.0190 = 0.75$

Conveying Risk

Increased/Decreased risk

- Sometimes the change in risk is expressed as a percentage increase (or decrease) instead of a multiple.

$$\text{Increased risk} = (\text{change in risk}) / (\text{baseline risk}) \times 100\%$$

Or

$$\text{Increased risk} = (\text{Relative risk} - 1.0) \times 100\%$$

Conveying Risk

Increased risk

The risk of developing breast cancer is **1.33** times greater for women who had their first child at age 25 or older than for those who did not. Thus

Increased Risk =

In words: There is an **increased** risk of **33%** of developing breast cancer for women who had their first child at age 25 or older compared to those who had their first child before the age of 25.

Conveying Risk

Decreased risk

For women who have their first child before the age of 25, the risk of developing breast cancer is **0.75** times that for women who had their first child after the age of 25. Thus

Decreased Risk =

In words: There is a **reduced** risk of **25%** of developing breast cancer for women who had their first child before the age of 25 compared to those who had their first child after the age of 25.

Conveying Risk

Odds Ratio



- Popular in epidemiology where comparative risk is presented as an odds ratio instead of a relative risk.
- Also popular in gambling!



Conveying Risk

•Odds Ratio

- Very common in technical reporting of risk
- **Idea** is more complicated **than that of “relative risk”**
- BUT **when we are comparing small probabilities**
 - **the Relative risk and odds ratio are numerically almost identical**

Conveying Risk

- Lots of important forms of statistical analysis naturally produce odds ratios
(e.g. logistic regression)

Relative risk of cancer due to smoking

$$= \frac{\text{Prob of Cancer for a smoker}}{\text{Prob of Cancer for a nonsmoker}}$$

Odds ratio

$$= \frac{\text{Odds of Cancer for a smoker}}{\text{Odds of Cancer for a nonsmoker}}$$

Odds Ratio

$$= \frac{\text{Odds of Cancer for a smoker}}{\text{Odds of Cancer for a nonsmoker}}$$

$$\text{Odds of Cancer} = \frac{\text{Prob of getting Cancer}}{\text{Prob of not getting cancer}}$$

First Child at age 25 or older?	Breast Cancer	No Breast Cancer	Total
Yes	31	1597	1628
No	65	4475	4540
Total	96	6072	6168

Odds of cancer risk for a woman

$$\text{having first child} \geq 25 = \frac{31 / 1628}{1597 / 4540} = \frac{31}{1597}$$

Odds Ratio

First Child at age 25 or older?	Breast Cancer	No Breast Cancer	Total
Yes	31	1597	1628
No	65	4475	4540
Total	96	6072	6168

Breast cancer odds for a woman

$$\text{having first child} < 25 = 31 / 1597 = 0.0194$$

$$\text{having first child} \geq 25 = 65 / 4475 = 0.0145$$

$$\text{Odds Ratio} = 0.0194 / 0.0145 = 1.34$$

(cf. RR=1.33)

Conveying Risk

•Odds

- If the risk of disease is small, the odds ratio and the relative risk will be approximately equal.
- Relative risk is more intuitive, but the odds ratio is easy to deal with statistically.

Conveying Risk

- Attributable Risk (risk difference)
 - The rate of disease in exposed individuals that can be attributed to the exposure. Obtained by subtracting the incidence rate in the non-exposed individuals from the corresponding rate among exposed individuals.
- Number Needed to Treat (NNT)
 - The number of patients that need to be treated to prevent one bad outcome. Calculated as the reciprocal of the attributable risk reduction ($1/ARR$).

Conveying Risk

- What is the benefit of a cholesterol-lowering drug on the *risk* of coronary heart disease?
- “People with high cholesterol can rapidly reduce...their risk of death by 22% by taking a widely prescribed drug.”
- What does this mean?

Conveying Risk

“22% risk reduction”

- Does it mean that out of 100 with high cholesterol, 22 can be prevented from becoming heart attack victims?

– No!

- Here are some results from the trial:

Treatment	Deaths (per 1,000 with high cholesterol)
Active drug	32
Placebo	41

$$RR = 32/41 = 0.78$$

(22% reduction)

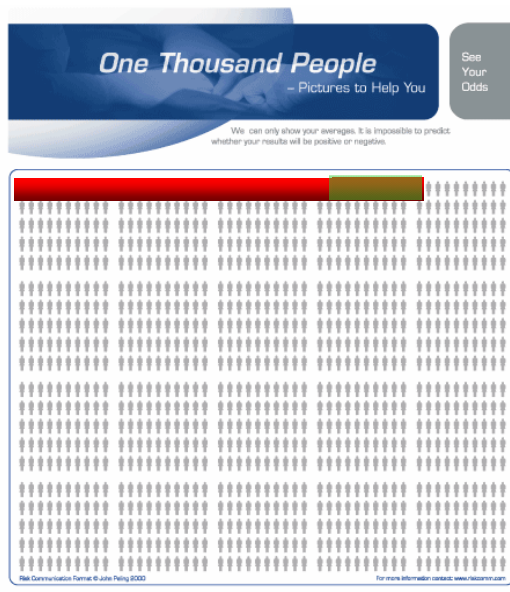
Conveying Risk

Other ways of making sense of the numbers

Treatment	Deaths (per 1,000 with high cholesterol)
Active drug	32
Placebo	41

Absolute Risk (Reduction) (ARR):

- “What is the effect of treatment?”
 - If we treat 1000 people (on average and taking everything at face value)
 - instead 41 dying (as would if untreated) we’d have 32 die
 - a saving of $41-32 = 9$ lives per 1000 people treated
 - (0.9%)



Actually, shading a random 41 people
Then removing a random 9 of them...

Conveying Risk

Other ways of making sense of the numbers

Treatment	Deaths (per 1,000 with high cholesterol)
Active drug	32
Placebo	41

Number needed to treat (NNT):

- “How many people do we need to treat to prevent one death?” (on average and taking everything at face value)

9 deaths per 1,000 treated are prevented by the drug

so on average etc, we need to treat

1000/9 = 111 people to prevent one death
(this is also $1/ARR = 1/0.009 = 111$)

Physicians' Study



For those in the aspirin group:
The proportion who had a heart attack =

Treatment	Heart attack	No heart attack	Total
Aspirin	104	10 933	11 037
Placebo	189	10 845	11 034
Total	293	21 778	22 071

Physicians' Study



For those in the aspirin group:
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Total	293	21 778	22 071

Physicians' Study



For those in the aspirin group:
The proportion who had a heart attack =
The probability that a randomly selected
participant had a heart attack =
The percentage who had a heart attack =

Treatment	Heart attack	No heart attack	Total
Aspirin	104	10 933	11 037
Placebo	189	10 845	11 034
Total	293	21 778	22 071

Physicians' Study



For those in the aspirin group:
The risk of having a heart attack =
As a rate per 1000 participants
As a rate per 10 000 participants

Treatment	Heart attack	No heart attack	Total
Aspirin	104	10 933	11 037
Placebo	189	10 845	11 034
Total	293	21 778	22 071

Physicians' Study



For those in the placebo group:
The risk of having a heart attack =

Treatment	Heart attack	No heart attack	Total
Aspirin	104	10 933	11 037
Placebo	189	10 845	11 034
Total	293	21 778	22 071

Physicians' Study



For those in the placebo group:

The risk of having a heart attack =

As a rate per 1000 participants

As a rate per 10 000 participants

Treatment	Heart attack	No heart attack	Total
Aspirin	104	10 933	11 037
Placebo	189	10 845	11 034
Total	293	21 778	22 071

Physicians' Study



Aspirin group: Risk of heart attack = 0.00942

Placebo group: Risk of heart attack = 0.01713

Relative risk

Using the placebo group as the baseline group:

Relative risk of aspirin group =

Using the aspirin group as the baseline group:

Relative risk of placebo group =

Physicians' Study



Aspirin group: Risk of heart attack = 0.00942

Placebo group: Risk of heart attack = 0.01713

Increased/decreased risk

Using the placebo group as the baseline group:

Percentage change in risk =



nzherald.co.nz

Study links older fathers to autism

By Jeremy Laurance

Men over 40 are more than five times more likely to father a child with autism than their younger peers, a study has found.

Research involving more than 130,000 children has revealed that the risk of autism rises steadily with advancing paternal age.

But there was no link with increasing maternal age, say the researchers, who included a team from the Institute of Psychiatry at King's College, London.

The finding suggests men have their own biological clock, which affects their capacity to produce healthy offspring as they age, in a similar way to women.

The risk of birth abnormalities such as spina bifida increases sharply with advancing age in mothers but is popularly thought to be unaffected by the age of the father.

But experts say this may be because fathers have not been studied as closely.



Justin Hoffman (right, played by Cruise's autistic brother in Rain Man).

Autism Study



Fathers aged 15 – 29: Risk of autism =

Fathers aged 30 – 39: Risk of autism =

Fathers aged ≥ 40 : Risk of autism =

Father's age group	Autism	No autism	Total
15 – 29	34	60 654	60 688
30 – 39	62	67 211	67 273
≥ 40	14	4 296	4 310
Total	110	132 161	132 271

Autism Study



15 – 29 age group: Risk of autism = 0.00056

30 – 39 age group: Risk of autism = 0.00092

≥ 40 age group: Risk of autism = 0.00325

Relative risks

Using the 15 – 29 age group as the baseline group:

Relative risk for 30 – 39 group =

Relative risk for ≥ 40 group =

Autism Study



15 – 29 age group: Risk of autism = 0.00056

30 – 39 age group: Risk of autism = 0.00092

≥ 40 age group: Risk of autism = 0.00324

Increased/decreased risk

Using the 15 – 29 age group as the baseline group:

Percentage change in risk for ≥ 40 group



MailOnline

Autism risk rises 50% for older mothers, say scientists

By Jenny Hope

Last updated at 2:12 AM on 15th February 2010

Like

Women who delay pregnancy are more likely to have a child with autism, a major study suggests.

The research found the risk to be 50 per cent higher for a woman of 40 than it is for a woman in her late 20s.

A number of studies have made a similar link but it had been unclear whether the age of the mother or the father was the more important.



Autism Study



Mothers aged < 25: Risk of autism =

Mothers aged 25 – 29: Risk of autism =

Mothers aged ≥ 40: Risk of autism =

Mother's age group	Autism	No autism	Total
< 25	2 689	1 713 971	1 716 660
25 – 29	3 304	1 406 234	1 409 538
30 – 34	3 576	1 161 890	1 165 466
35 – 39	2 089	541 102	543 191
≥ 40	501	112 579	113 080
Total	12 159	4 935 776	4 947 935

Autism Study



< 25 age group: Risk of autism = 0.00157

25 – 29 age group: Risk of autism = 0.002344

≥ 40 age group: Risk of autism = 0.00443

Relative risks

Using the 25-29 age group as the baseline group:

Relative risk for < 25 age group =

Relative risk for ≥ 40 group =

Autism Study



< 25 age group: Risk of autism = 0.00157

25 – 29 age group: Risk of autism = 0.002344

≥ 40 age group: Risk of autism = 0.00443

Increased/decreased risk

Using the 25 – 29 age group as the baseline group:

Percentage change in risk for ≥ 40 group

The screenshot shows the BBC Lab UK website. The header includes the University of Auckland Department of Statistics logo and the BBC Lab UK logo. The main content area is titled "BBC - Lab UK - About the Big Risk Test". It features a quote from Professor David Spiegelhalter and Dr Mike Ashken about the complexity of risk. The text explains that the Big Risk Test aims to be the biggest study of risk ever undertaken. A sidebar on the right contains links to "More on the Big Risk Test", "The Big Risk Test FAQ", and "Experiment credits".