Lecture 4: Risk to Individuals: Perception and Reality

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Here we discuss "risks" in the everyday sense of "dangers", and one might start by distinguishing two classes.

1: Risks incidental to ordinary life.

- health, life (illness, injury)
- emotion, happiness (regret choice of Major, romantic disappointment)
- money, property (fire, theft)

2: Specific voluntary activities perceived as risky.

So these are rather distinct from
3: "Calculated risks" as part of a business or individual career
(setting out to be an entrepreneur, pursuing dream of becoming rock star, financial speculation (Lecture 2)).

Topics of this lecture:

- interpreting data about specific risks
- psychology – how we perceive different risks
- public policy (regulation)
- communicating data on risks to the public

The 2011 book *Risk: A Very Short Introduction* by Baruck Fischhoff and John Kadvany gives a brief overview of more topics.

I sometimes get emails like this

[show bing-travel-email]

These questions don't really make sense – most depend on whether you choose to do specific things.

Risks of dying from different causes.

This context has particular features, not necessarily present for other types of risk (e.g. injury).

- it's a yes/no event.
- we have comparatively good data on ages and (proximate) causes of death.
- there are large industries (life insurance directly, health care indirectly) associated with this particular risk.
- news media, television in particular, devote a lot of time to risks to life and health (often, as described later, disproportionate to the size of risk).

So keep in mind that "risks of death" are in many ways quite atypical amongst all the risks we face.

A particular example where we have very good data is "deaths from lightning".

[show page]

With a U.S. population around 320 million this suggests

- your chance of dying by lightning per year $\approx 26/(320 \text{ million}) \approx 1$ in 12 million.
- your chance of dying sometime by lightning $\approx 60/(12 \text{ million}) \approx 1$ in 200,000.

These are what I will call **population statistics** (or "statistical probabilities") and only a very rough indication of the probability for **you** in particular. That probability depends mostly on what **you** choose to do.

Typing `life expectancy age 63 male` into WolframAlpha, the output suggests that I have a 57% chance to reach my 80th birthday and a 21% chance to reach my 90th.
Is this reliable?

- It uses population statistics as probabilities for an individual – because WolframAlpha doesn't know anything about me as an individual but is just using the percentages from historical data for the entire U.S. male population.
- It assumes that the future will statistically resemble the past.

The second assumption seems reasonable in this particular setting, though the corresponding "age 1" is surely less reasonable – who knows what might happen to human lifespan over the next 80 years).
Population statistics are rarely numerically reliable as probabilities for a particular individual, which ideally should be based on everything relevant we know about that individual – current health and medical history, genetics as indicated by parental lifespans, etc. For instance WolframAlpha also suggests – from population statistics – that my chance of dying in the next 12 months is around 1.4%, but that is clearly unreliable, because those statistics include people already in poor health – my actual chance is considerably smaller.

Returning to the lightning example, our second assertion

Population statistics suggest

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involves

- assume that the future will statistically resemble the past.

This seems plausible – lightning is an iconic “random” event in the everyday sense of *random* – but is is true?

[show link historical data]

Regardless of the fact that population statistics shouldn't be interpreted as "risk to you", it is still worthwhile to know the data, in particular in the context of specific activities which might be considered risky. One can find such data online, or in books such as *The Book of Odds* by Amram Shapiro.

Note first that saying "the chance of dying in a skiing accident is 1 in XXXXXXX" is meaningless – does this mean per day or per year or per lifetime?

Also, describing chances of dying from particular causes in the "1 in XXXXXXX" format is not so helpful, partly because it's hard to visualize and compare very small numbers like "1 in 500,000" and "1 in 50 million".

More useful are the concepts of **micromort** and **microlife**.

A useful way of comparing risks of death from specific maybe-risky activities is via the concept of a **micromort**, defined as a 1 in a million chance of death. Here again we are mis-using “chance” to mean population statistics for people doing this particular activity.

Here are some typical values from the Wikipedia page Micromort.

scuba diving: 5 per dive
running a marathon: 7 per run
traveling by car: 0.4 per 100 miles
traveling by motor bike: 16 per 100 miles
traveling by passenger jet: 0.1 per 100 miles

But many issues to consider in making comparisons.

- population averages not accurate for individuals
- injuries more common than death?

To quantify long-term risks associated with ongoing activities, it is more useful to consider the effect on life expectancy. This leads to the concept of a **microlife**, defined as an increase in life expectancy of half an hour. This particular time duration was chosen because one million half-hours is about 57 years, a typical life span as an adult. Here are some typical values from the Wikipedia page Microlife. Note that negative numbers indicate decrease in life expectancy, i.e. risk, whereas positive numbers indicate benefit.

smoking 20 cigarettes: -10
1 alcoholic drink: $+1$
subsequent drinks (same day): - $1/2$
20 minutes moderate exercise: $+2$
40 extra minutes exercise (same day): $+1$
overweight: -1 per 10 pounds (per day)

The "moderate alcohol consumption is beneficial" assertion is somewhat controversial – **course project** look at discussion of this issue and read some of the actual papers describing studies.

In addition to the previous issues (population averages; other health effects short of death) we have at least two others:

- **Correlation is not causation** [show xkcd] – very hard to separate one specific factor from all other lifestyle/genetic factors.
- For mortality risk there is not necessarily a linear response to exposure to a risk factor.
- Effects of different factors may not be linear.

As example of recent study of the last issue see the paper *The combined effect on survival of four main behavioural risk factors for non-communicable diseases* by Martin-Diener et al. (surveying scientific literature could be a **course project**).

Digression: future impact of Big Data. People sometimes ask, as rhetorical humor

> *what risky/unhealthy pleasures would you give up today, at age 20, in order to live 2 extra years in a nursing home at age 90?*

You students, today, can justify (to yourself) ignoring this issue, because the risk estimates are very imprecise. But for **your children at age 20**, likely we will have much better estimates of individual risk.

You can read much more about the concepts we've discussed in recent books such as

- Blastland - Spiegelhalter *The Norm Chronicles: Stories and Numbers About Danger*
- Gigerenzer *Risk Savvy: How to Make Good Decisions*.

The older book Ropeik and Gray *Risk. A practical guide for deciding what's really safe and what's really dangerous in the world around you* consists of short sections on each of 48 risks (e.g. indoor air pollution; pesticides; firearms; X-rays; caffeine; breast implants) containing data and the relevant scientific knowledge, summarized by two scales of "likelihood of being affected" and "seriousness of being affected".

Course project: Write a report, in the style of the Ropeik-Gray Risk book, on some particular risk.

One second topic today is **perception of risks**.
In class in 2011 I asked my students

> *If your roommate said "I am going to . . . . . .", would the thought* risky *immediately come to mind?*

Here are the percentages saying *risky*.

5%: learn to target shoot at a gun club
25%: learn to ride a horse
25%: take cross-country road trip with parents
40%: walk across campus alone at midnight
50%: learn downhill skiing
70%: try online dating
80%: buy motor bike for commute
95%: try ecstasy.

Note these percentages are mostly not near 0% or 100%; perceptions of risk vary widely between individuals. Trying to compare these particular answers to some objective measure of actual risk for these particular activities is surprisingly hard – **project**.

In general people tend to perceive risks as greater or lesser than they really are, in somewhat predictable ways. As today's "anchor", here is some famous old data.

[show fig 16.5.gif]

[How can you tell this is old?]

In this data, people tend to

- overestimate risks that are very small, underestimate major risks.
- overestimate risks of accidents, underestimate risks of (major) diseases.

Ropeik, in the book *How Risky is it Really?*, lists the following psychological factors which can make a risk seem more threatening or less threatening than it really is. (In each case the direction of the effect is intuitively clear).

The psychology of risk

1. Trust. Do you trust the organization assesing the level of risk? The book contrasts the top-down selection in the U.S. of the Yucca Mountain nuclear waste repository with the extensive public involvement in the selection of the Finnish equivalent, the Onkalo waste repository.
2. Risk vs benefit. Instead of comparing risks and benefits in the way one might compare income and expenses, when we perceive a benefit we tend to downplay the risk level. If I ask my grad students what their biggest expense is, they both know it intellectually (rent or tuition) and feel it ("I wish it wasn't so expensive"). If I ask what is their biggest risk to health in the short term they know it intellectually (auto accident) but they don't feel it - no-one answers the question "what is the most dangerous thing you've ever done" by saying they once drove across the U.S. with their parents.

3. Control. We feel less threatened when we perceive we have control over our response to a risk – when we hear there is plenty of influenza vaccine available, for instance.

4. Choice. Risk from purely voluntary activities such as horseback riding are perceived as less threatening.

5. Natural vs human-made. Almost no Americans die each year from human-made radiation, but around 5,000 die from the consequences (skin cancer) of natural solar radiation.

6. Pain and suffering. Cancer is often perceived as more of a threat than heart disease, partly because it is viewed as the iconic "likely to be fatal" condition and associated with suffering, even though it causes fewer deaths than heart disease.

7. Uncertainty. Where the extent of risk is uncertain or controversial (e.g. cell phone use) the uncertainty itself becomes perceived as a threat.

8. Catastrophic vs chronic. A plane crash with a hundred deaths attracts much more attention than tens of thousands of automobile deaths happening one or two at a time.
9. Can it happen to me? Most of us don't worry about the possibility of our house being caught in a firestorm, but if a neighborhood similar to ours is destroyed then we suddenly switch this possibility into the "it could happen to me" category.
10. New vs familiar? Ropeik relates the case of West Nile virus, which attracted attention disproportionate to its seriousness because of headlines *never (before) diagnosed in the Western Hemisphere*.
11. Risks to children. As illustrated by contemporary fears of online sex solicitation, we have an emotion reaction to risks to children.
12. Personification. Stories about individuals carry more emotional weight than statistics.
13. Fairness. If risks are borne by one group of people while benefits go to a different group we naturally regard the risk as unfair.

Of course these factors overlap, and any particular risk involves several factors that may act in opposite directions. Moreover because "increased perception of threat" attracts our attention, these factors influence the extent of media coverage of different risks - in particular for local TV news.

Course projects:

- Take some risks that are currently in the news, see how well they fit the 13 psychological factors listed above, and how this relates to extent of news coverage.
- Write a report on statistical studies of the relationships between people's perception of the relative size of different risks, and their actual size.

Here is a different angle, from Wikipedia *Cultural cognition*.

The cultural cognition hypothesis holds that individuals are motivated by a variety of psychological processes to form beliefs about putatively dangerous activities that match their cultural evaluations of them.

- Persons who subscribe to relatively individualistic values, for example, tend to value commerce and industry and are inclined to disbelieve that such activities pose serious environmental risks.
- Persons who subscribe to relatively egalitarian and communitarian values, in contrast, readily credit claims of environmental risks, consistent with their moral suspicion of commerce and industry as sources of inequality and symbols of excessive self-seeking.

In brief this is saying that (one aspect of) political views affect risk assessment – the current controversy over GMOs being a prominent example.

Third topic today: **Public policy – regulation etc**

Consider government regulation of business for health and safety reasons, e.g. coal mining, auto safety, unhealthy pollution, restaurant health code. In practice regulations emerge from the political system of a given country, but what's a rational way to think about it?

Typically there's a **cost** to business, which can be measured in dollars, and a **benefit** to workers or consumers or general public. The benefit is improved health/safety, not directly measured in dollars. I'll ignore other costs and benefits.

Often the people who benefit are different from the people who pay the cost (e.g. local pollution). Such cases inevitably involve notions of *fairness* – political philosophy outside my scope! I will instead discuss the "easy case" where the benefits go to those paying the costs (e.g. auto safety bags). Material based on paper *The Value of a Statistical Life: Some Clarifications and Puzzles* by Cass Sunstein.

- Imagine you are working, doing an average job. There is another job opportunity, the same as your current job except it runs an extra risk of being killed, chance 1/10,000 per year. How much extra pay (per year) would you want, to be **willing to accept** this other job?
- Suppose you drive a car the average (in U.S.) amount, so your chance of being killed in an auto accident is about 1/10,000 per year. Suppose when buying a new car, some optional safety equipment is available, which will cut the chance of being killed by half. How much extra (assume you earn an average salary) would you be **willing to pay** for this equipment?

These questions illustrate the notions of
WTP – willingness to pay (for a decreased risk)
WTA – willingness to accept (an increased risk).
Suppose, in a particular context, people are WTA $900 for an increased risk 1/10,000 of death for, or WTP $450 for a decreased risk 1/20,000 of death. How to interpret/use these figures?

Suppose, in a particular context, people are (on average) WTA \$900 for an increased risk 1/10,000 of death for, or WTP \$450 for a decreased risk 1/20,000 of death. How to interpret/use these figures?

First let's pretend people were "rational" in the sense of Economics theory. Then their WTAs would be approximately linear for small risks; they should be WTA \$90 for an increased risk 1/100,000 of death, or WTA \$9,000 for an increased risk 1/1,000 of death. We can now extrapolate the risk in either direction. Extrapolating down to a 1/1,000,000 chance

(i) people are (on average) WTA \$9 per micromort.

In the other direction, obviously few people would accept \$9 million in exchange for a 100% chance of death. But economists have used this concept under the name VSL (**value of a statistical life**)

(ii) people assess (on average) the VSL in this WTA context at \$9 million.

Statements (i) and (ii) have exactly the same meaning.

[from hypothetical data]
(i) people are (on average) WTA \$9 per micromort.
(ii) people assess (on average) the VSL in this WTA context at \$9 million.

The particular phrase **value of a statistical life** is a terrible choice of phrase, when used in a public forum, because it invites the response "you can't put a value on human life", as discussed in *Euthanizing the Value of a Statistical Life* by Cameron. It would be better to use (i), because we are dealing only with *small* risks, and because \$9 is easier to visualize than \$9 million.

In our hypothetical data, people were (on average) WTP \$450 for a decreased risk 1/20,000 of death, and this would lead to the same figures for WTP as for WTA
(i) people are (on average) WTP \$9 per micromort.
(ii) people assess (on average) the VSL in this WTA context at \$9 million.

In reality it is very hard to find a definitive number for consensus VSL, for several reasons. If we use **stated preference** questions as above, then the difficulty is

- responses are very non-linear; averages for risks 1/1,000 and risks 1/10,000 differ by much less than a factor of 10.
- WTA amounts are much larger than WTP amounts (an example of the *endowment effect* in a later Lecture).

Another way is to look at actual wages and compare jobs that are similar in respects other than "risk".

Another way is to look at what consumers actually pay for optional safety devices, e.g. auto air bags/auto anti-lock brakes when first introduced as options.

Course project to survey academic literature.

Jumping to a bottom line, the U.S. Department of Transportation uses a VSL of $9.2 million in 2014.

[show page]

Why does the U.S. Department of Transportation need a VSL? Suppose you're deciding whether to build a new freeway. There are many costs and benefits that you can try to assign a dollar value to, in order to decide. One benefit is that freeways are safer than other roads. By including VSL in the calculation you make safety-improving projects more likely to be carried out.

In other words, a consequence of saying "you can't put a value on human life" is that your are implicitly treating the value as zero. Further discussion on the Wikipedia *Value of Life* page.

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Today's final topic is **communicating data on risks to the public**. This topic is discussed in the books mentioned earlier and the article Gigerenzer et al. *Helping Doctors and Patients Make Sense of Health Statistics*.

The web site `Understanding Uncertainty` is devoted to this and to more general statistics related to health – well worth browsing. In particular it has a valuable page *2845 ways to spin the risk* showing how data on risks

> *can be "spun" to look bigger or smaller . . . . . . by changing the words used, the way the numbers are expressed, and the particular graphics chosen.*

[show page]