How Safe Is It To Fly?

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Question:

How risky is travel on scheduled passenger flights, in the United States and elsewhere?

An e-mail message:

"My name is L.S. I would like to know if you, as an expert in aviation safety, fly regularly."

"You see, I stopped flying about a year ago and this has affected my life in a significant matter. Just one last question: what are the odds of me dying in a plane crash?"

Given that a passenger's greatest fear is of being killed in a plane crash, there is a natural interest in statistics about the likelihood of that outcome.

But which statistics are the most informative?

One statistic frequently used by the National Transportation Safety Board is **fatal accidents per 100,000 flight hours**.

But both the numerator and denominator of the ratio "fatal accidents per 100,000 flight hours" are problematic.

- The generic term **"fatal accident"** blurs the distinction between a crash that kills one passenger out of 300 and another that kills 300 out of 300.

- Measuring activity by **"flying hours"** misses the point that most accidents occur on landing or takeoff.

Why not use the simple ratio of passengers killed to passengers carried?

There might be a reason.

When a Boeing 737 hits a mountain killing all passengers, the implications about safety are the same whether it is full or only 1/3 full. Yet the number of passengers killed is 150 in one case and only 50 in the other. Thus, the "passengers killed" statistic treats the two events very differently, for no good reason.

A crash that kills 28 passengers out of 28 has a very different survival rate than another that kills 28 out of 280. Yet the statistic "number killed" treats the two events the same way, which is unfortunate.

Measure of Safety Performance Over a Past Period:

Death Risk Per Randomly Chosen Flight

Question:

   If a person chose a flight **at random** from among those of interest (e.g. Brazilian domestic flights over the period 1990-99), what is the probability that he would **not** survive it?

This death risk per flight statistic has some **conceptual advantages** compared to other statistics about passenger mortality risk.

What Conceptual Advantages?

- **Ignores length and duration of flight, which are virtually unrelated to mortality risk**

- **Weights each crash by the percentage of passengers killed**

- **Easy to calculate and understand**

Death Risk per Flight, Worldwide Scheduled Service 2000-07

1 in 3.0 million

But, much as the center of mass of a doughnut is the center of the hole, **where there is no mass**:

There were few if any nations around the world where the death risk per flight was 1 in 3 million.

Key Question:

How might we model the diversity of aviation death risk across nations in a **simple yet defensible** way?

We could summarize 2000-07 passenger mortality risk with a three-population model:

Region	Death Risk per Flight
• Traditional First World	1 in 10 million
• Advancing Nations	1 in 2 million
• Less Advanced Developing World	1 in 800,000

But What About the Last 7.4 Years, 1/1/2008 to 5/27/15?

2008-15 Data:

Group	Flights	Fatal Crashes	Passengers	Deaths
First W	137 (mill)	9	11.0 (bill)	566
Adv	51	14	5.7	859
Least	29	54	2.2	2174

Death Risk Per Flight 2008-15

Group	Death Risk	Change Since 2000-07
First World	1 in 22 mill	Better by 55%
Advancing	1 in 5 mill	Better by 60%
Less Developed	1 in 700,000	Worse by 14%
Whole World	1 in 3.5 mill	Better by 14%

In the First World, an Air Traveler Is:

- More likely to win the jackpot in the lottery **than to perish on next flight.**

- More likely to be elected Chief Executive **than to perish on next flight.**

Also:

- Could take one flight a day an average of **60,000 years** before perishing in an aviation accident

- For every hour saved by flying rather than driving, there is a bonus: a **78-second increase in life expectancy** tied to choosing the safer mode of travel

Death Risk per Flight, First-World Passenger Services, 1960-2015

Period	Death Risk per Flight
1960-69	1 in 400,000
1970-79	1 in 1 million
1980-89	1 in 4 million
1990-99	1 in 6 million
2000-07	1 in 10 million
2008-15	1 in 22 million

Rule of Thumb:

- **First World Death Risk per Flight has dropped by about a factor of two every decade in the jet age.**

 That pattern is striking because, the safer air travel gets, the harder it would seem to cut the remaining risk in half.

Do the Differences in Passenger Death Risk per Flight Between the First World and the Rest of the World Mean that, Given a Choice, One Should Opt for a First-World Airline?

Well, have you heard of the Ecological Fallacy?

Death Risk per Flight **Between** Traditional First World Cities and Cities in Other Nations, 2000-15:

First World Carriers: **1 in 2 million**

Other Carriers: **1 in 2.5 million**

Rule of Thumb:

When two airlines compete on a given route, **very rarely is there a reason related to safety to prefer one to the other.**

(For example, **Low-Cost Carriers** do not underperform established ones.)

However, the safety metric we have been using may suffer a weakness.

A Problem With "Death Risk per (Randomly Chosen) Flight" as a Risk Metric Is:

- **Passengers do not choose flights completely at random: the average A-380 carries far more passengers than the average Embraer-120.**

- **If there is any correlation between size of aircraft and risk of crashing, then death risk per flight might offer a biased estimate of the risk for a passenger selected at random.**

To avoid that potential bias, we might return **to passengers killed divided by passengers carried.**

- Or equivalently:

If we choose one boarding pass at random from all those used by the passengers of interest (e.g. Brazilian domestic air travelers over 1990-99), what is the probability that its owner did not survive her flight?

What Happens When We Compute Death Risk per Boarding?

Death Risk per Boarding, 2008-15

- Group   Death Risk per Boarding

- **First World**   **1 in 20 million**

- **Advancing**   **1 in 7 million**

- **Less Developed**   **1 in 1 million**

But what can be said of passenger safety for US airlines **on their own**?

In the late 1990's, FAA set the goal of **cutting the fatality rate** on scheduled US passenger flights by **80%** by 2007 compared to the 1994-96 rate.

How did things work out?

Passenger Death Risk , US airlines

- *Death Risk per Flight:*

- 1994-96: **1 in 2.9 million**

- 2007-15: **1 in 56.1 million**   **Down by 95%!!**

- *Death Risk per Boarding:*

- 1994-96: **1 in 2.2 million**

- 2007-15:   **1 in 127.2 million**   **Down by 98%!!**

Mission **truly** accomplished!!

Indeed, is the US safety record even better than that of its First World counterparts?

Death Risk per Flight, US vs. Rest of First World

- Period   Outcome

- 1960's   **US lower (better)**
- 1970's   **US lower**
- 1980's   **US lower**
- 1990's   **US higher (worse)**
- 2000-07   **US higher**
- 2008-15   **US lower**

It is safer to describe the US as a **member in very good standing** in the First World group than to assert outright superiority.

A Final Message to FAA:

Thank you!

for two reasons, in increasing order of importance.