Evidence from a Pandemic

The Importance of Helping Students Make Comparisons of Relative Size

The COViD-TASER Team

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A family story

TV announcer in March, 2020: 10% of people over 70 with a confirmed COVID-19 case died of it.

My mother in law: Is 10% a big risk?

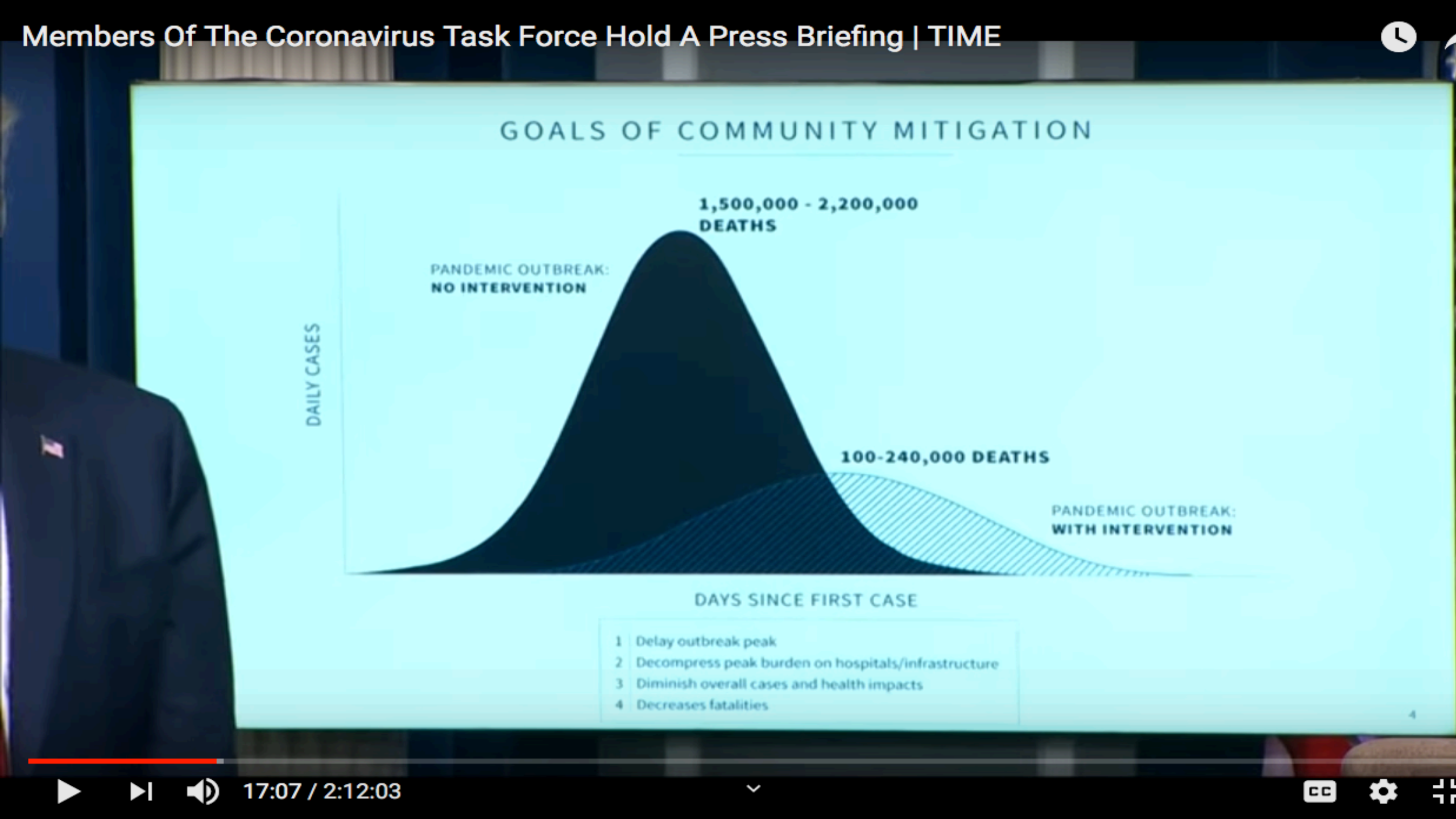
Me: 10% is a 1 in 10 chance. What is something you do 10 times a day?

Mother in law: Well, I go to the bathroom about 10 times a day.

Me: What if you died one of those times you went into the bathroom?

Mother in law: Well, I'd never go in there again!

Members Of The Coronavirus Task Force Hold A Press Briefing | TIME



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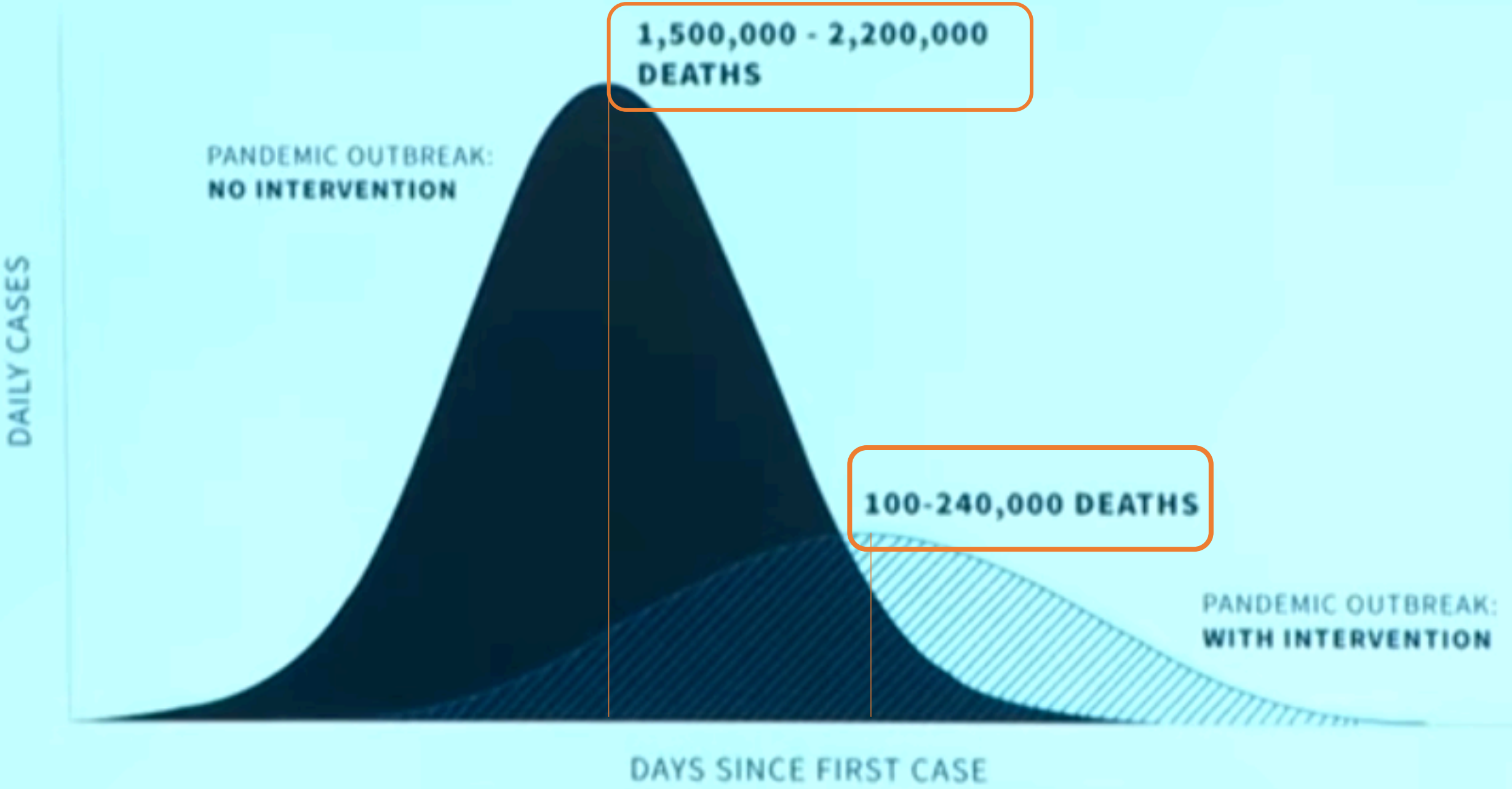
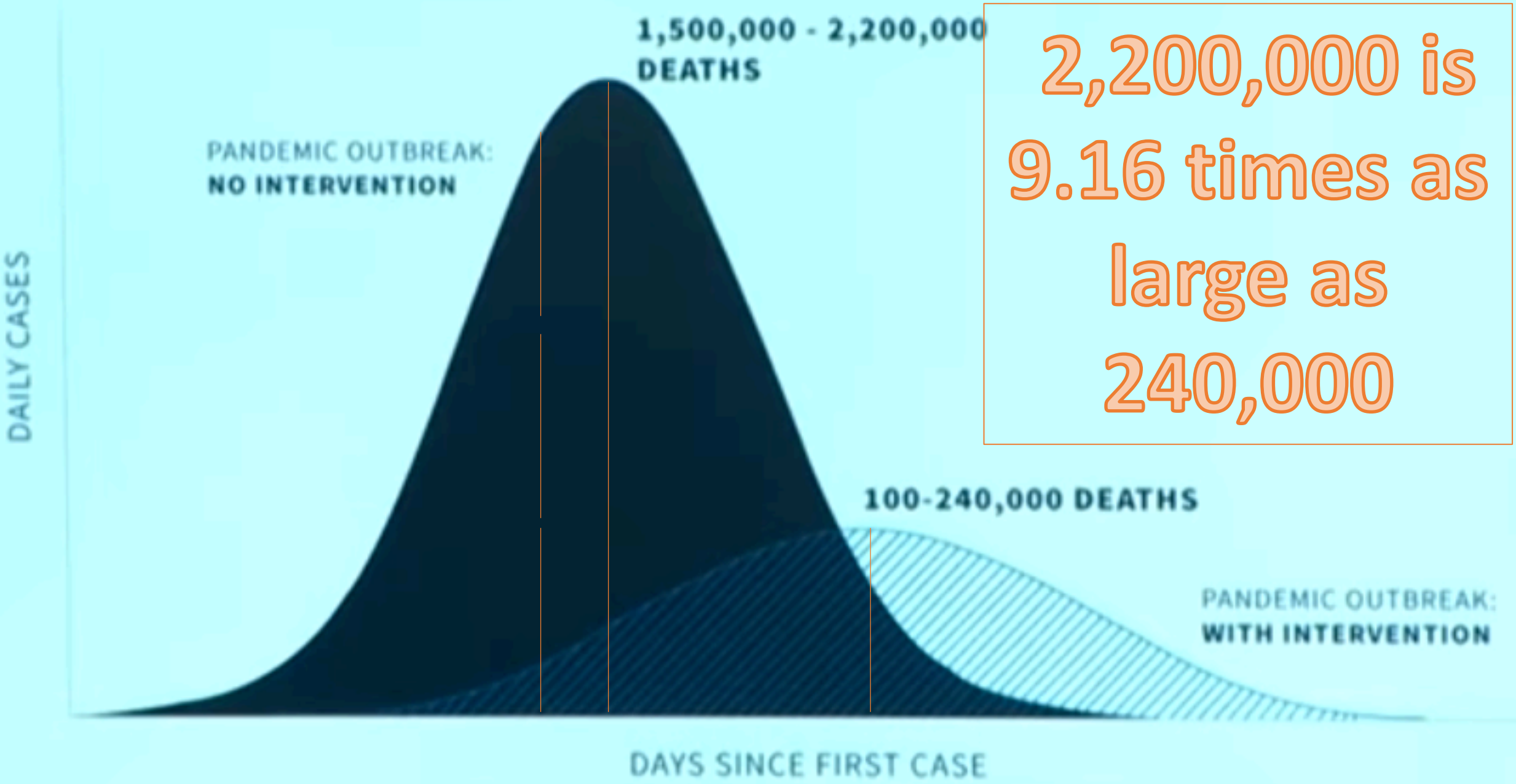
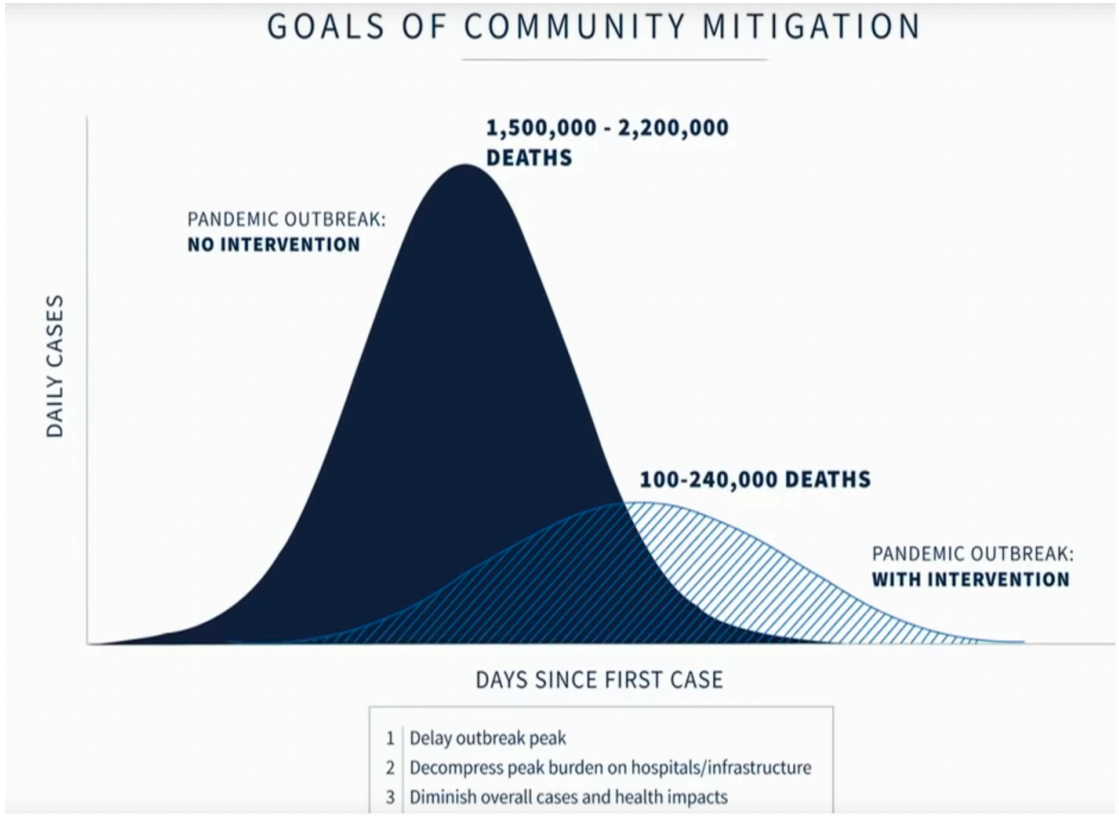
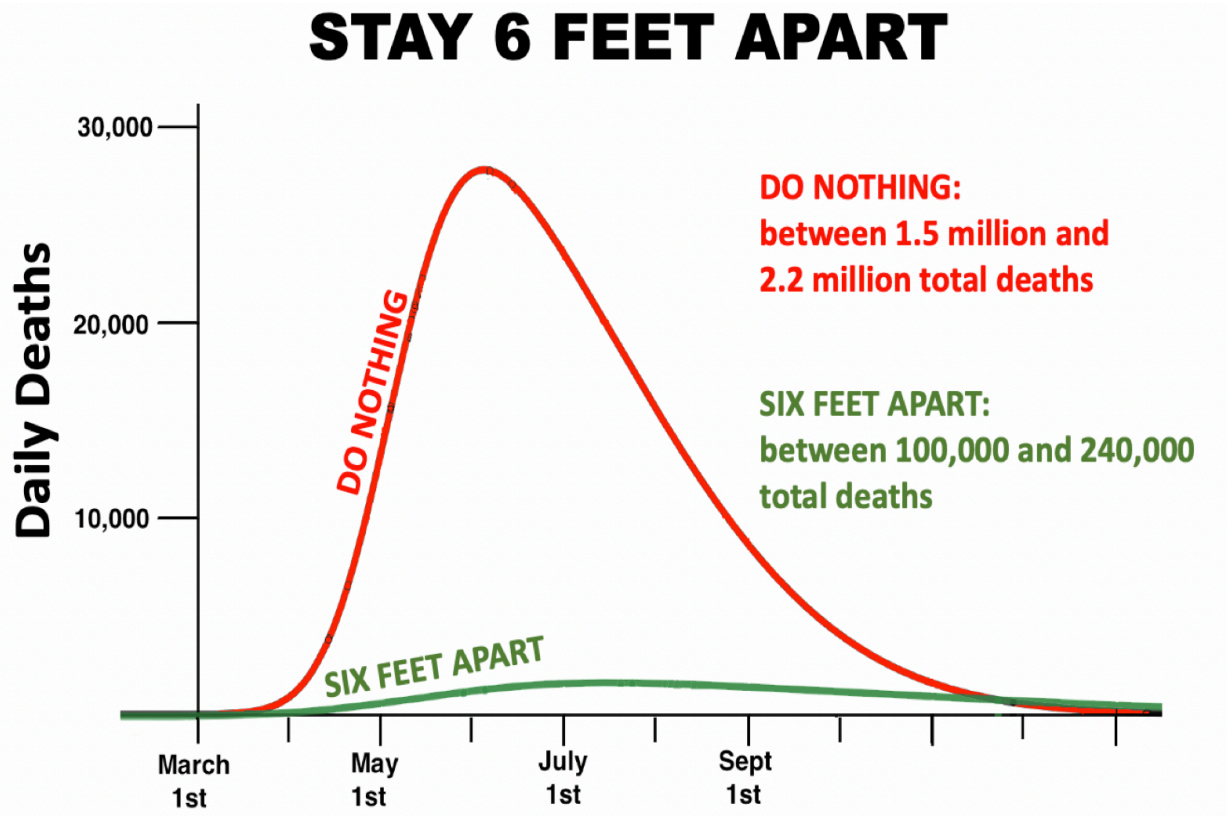

1,500,000 - 2,200,000
DEATHS
PANDEMIC OUTBREAK:
NO INTERVENTION
100-240,000 DEATHS
PANDEMIC OUTBREAK:
WITH INTERVENTION
DAILY CASES
DAYS SINCE FIRST CASE



2,200,000 is 9.16 times as large as 240,000





Research Questions

General: How do citizens' mathematics support them in assessing the severity of COVID-19?

For this talk: How do citizens make comparisons of relative sizes of quantities related to COVID-19? How do their comparisons of relative size help them make sense of the severity of COVID-19?

Study Design

We designed an interview protocol by collecting representations of COVID-19 data that we hypothesized would be interpreted differently by citizens with varying mathematical understandings.

We used zoom to conduct task-based clinical interview with 25 US citizens and 7 SK citizens between April 2nd, 2020 and May 11th, 2020 (Ginsburg, 1997; Goldin, 1997).

We analyzed participants' responses by transcribing and coding interviews using models of mathematical thinking as guidance.

Background Research:

Making comparisons of relative size is a challenge

Relative size item given to U.S. 12th graders

3% Correct

24% Partially Correct

In 1980 the populations of Towns A and B were 5000 and 6000, respectively. In 1990 the populations of Towns A and B were 8000 and 9000, respectively.

Brian claims that from 1980 to 1990 the two towns' populations grew by the same amount. Use mathematics to explain how Brian might have justified his answer.

Darlene claims that from 1980 to 1990 the population of Town A had grown more. Use mathematics to explain how Darlene might have justified her answer. (NAEP M069601)

1996 NAEP item presented in Thompson & Saldanha (2003)

Project Aspire Quick Background

Project Aspire was a multi-year National Science Foundation funded assessment creation project let by Pat Thompson. (Thompson, 2016)

Pat, Hyunkyoung, Surani, other graduate students, and I created and validated a 43-item diagnostic assessment to model teachers' mathematical meanings for teaching.

We administered the assessment to 619 secondary mathematics teachers in the United States and Korea from various convenience samples.

See "Publications" on www.pat-thompson.net for details.

Relative size item given to U.S. and S.K. Secondary Mathematics Teachers

A container has a volume of m liters. One gallon is 189/50 times as large as one liter. What is the container's volume in gallons? Explain.

부피가 m 리터의 용기가 있다. 1 갤런은 1 리터의 $\frac{189}{50}$ 배 만큼 크다. 이 용기의 부피를 갤런으로 나타내고, 그 이유를 설명하시오.

The size of one gallon is larger than the size of one liter. The number of gallons in a container is smaller than the number of liters in the same container.

$$\frac{50}{189}m \ gallons$$

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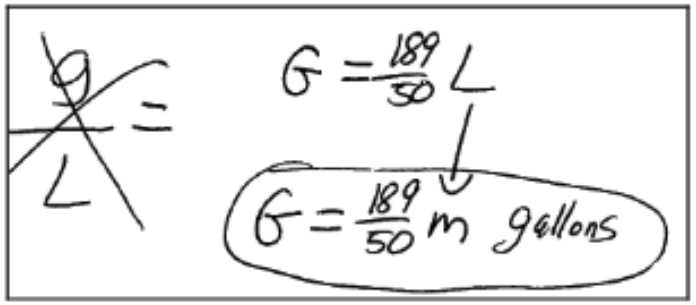


Response	Korean HS	Korean MS	US less than calc	US calc or above
Correct	64%	47%	32%	44%
Incorrect	36%	53%	68%	56%
Total	262 teachers	101 teachers	169 teachers	72 teachers

COVID-19 Interview Items and Results

Flu versus Covid-19 Rates Task (English)

Scientists (such as Wu and team) estimate the symptomatic fatality rate for COVID-19 is between 0.66 and 2.1%. The symptomatic fatality rate for the seasonal flu is usually about 0.1% in the U.S.

A. How should this data impact decision making about social distancing?

B. Suppose there are two hypothetical situations. In one situation 50 million people get the flu. In the other situation 50 million people get the coronavirus. Assuming the death rates of .1% and 2.1% how many times as many people will die from the coronavirus as the flu?

Flu versus Covid-19 Rates Task (Korean)

과학자들은COVID-19 치사율을 0.66에서 2.1%로 추정했다.
독감으로 인한 치사율은 미국에서 보통 0.1% 정도이다.

해당 데이터가 사회적 거리두기에 대한 의사결정에 어떻게 영향을 주어야한다고 생각합니까?

5천만 명의 사람들이 독감에 걸렸고, 5천만 명의 사람들이 코로나 바이러스에 걸렸다고 가정해보세요. 독감 치사율이 0.1%, 코로나 바이러스 치사율이 2.1% 라고 하면, 독감으로 사망하는 사람들에 비해 몇 배의 사람들이 코로나 바이러스로 사망하게 될까요?

Amelia: *The numbers – the 50 million, 50 million – doesn't matter. The um, you're comparing 0.1 to 2.1. You could be saying you are comparing 1 to 21. I guess we'll take 21 times. We'll take 21 times as many.*

Eunseok: *0.1% of 50 million is 1/1000 of 50 million. Then… isn't it 50,000? 1 million people would die when death rate of the coronavirus is 2.1% since it is like 2/100. Then isn't that 20 times more?*

silences were removed from all audio clips

Interviewer: *Because you said it was such a large range, can you just pick some number between 0.66% and 2.1%?*

Katie: *Uh….1.5?*

Interviewer: *[…]What does it mean to have a death rate of one point five percent?*

Katie: *It is a very low death rate….It is very low. Especially, if you think about how many people there are in the world or how many people there are in the US. It is very, very low. I mean you look at rates of cancer, or heart disease, they are much, much higher. So, umm…I mean it is not a very high death rate. But there has also been a lot of discussion about how people that have the coronavirus have lung damage afterwards.*

Gertrude: *This, this if you look at this like I'm looking at 0.1 from the flu and 2.1- that's a big difference.*

Interviewer: *Okay how much bigger?*

G: *[laughs] Almost a hundred percent [laughs]…umm..*

I: *How many times bigger I guess is a better way to ask it.*

G: *I mean you're looking at point one to two point one that's like two times. two times…[pause for 6 seconds]I want to say two times but I know it's way more.*

I: *Yeah, it is bigger than two. I'll give you a second to think about it. This is a hard question.*

G: *I feel dumb for this now. I'm a [math] teacher.*

I: *I research how math teachers think about percents.*

G: *[laughs]*

[continued on next slide]

I: *I knew it was a hard question when I asked it because I've asked this question to lots of people. But um*

G: *So I'm not the only one. I feel… Because it's point one percent. [pauses to think] So that is…point zero one. [pause to write on scratch paper] Okay. I guess I want to say almost a 200 percent. [laughs]*

I: *You're laughing again! [laughs]*

G: *Oh my gosh.*

I: *You didn't sound sure so I was just, I was just doing wait time. Umm the way I've been thinking about it is that point one percent is a tenth of one percent. And so point one fits into one percent ten times. One percent is ten times as large as point one percent. Does that hint help you?*

G: *So point one is like oh!…[pauses and looks at scratch paper] So that's like 2,000 then that would be [pauses] point one to two point [pauses for 50 seconds to think] So two…so, uh the two, two hundred percent right?*

Mike: *Oh gosh you're gonna make me [Mike & Interviewer are joking]*

Interviewer: *This is one of the hardest questions [more joking]*

M: *So and then…at first I was going to do decimals […] so so that's point one percent and then [works in silence] wait did I do that right so that's ten percent one percent so that's ten percent, one percent. I oh gosh I'm embarrassed now.*

I: *You can use a calculator.*

M: *Oh gosh I thought - should have told me that before I uh*

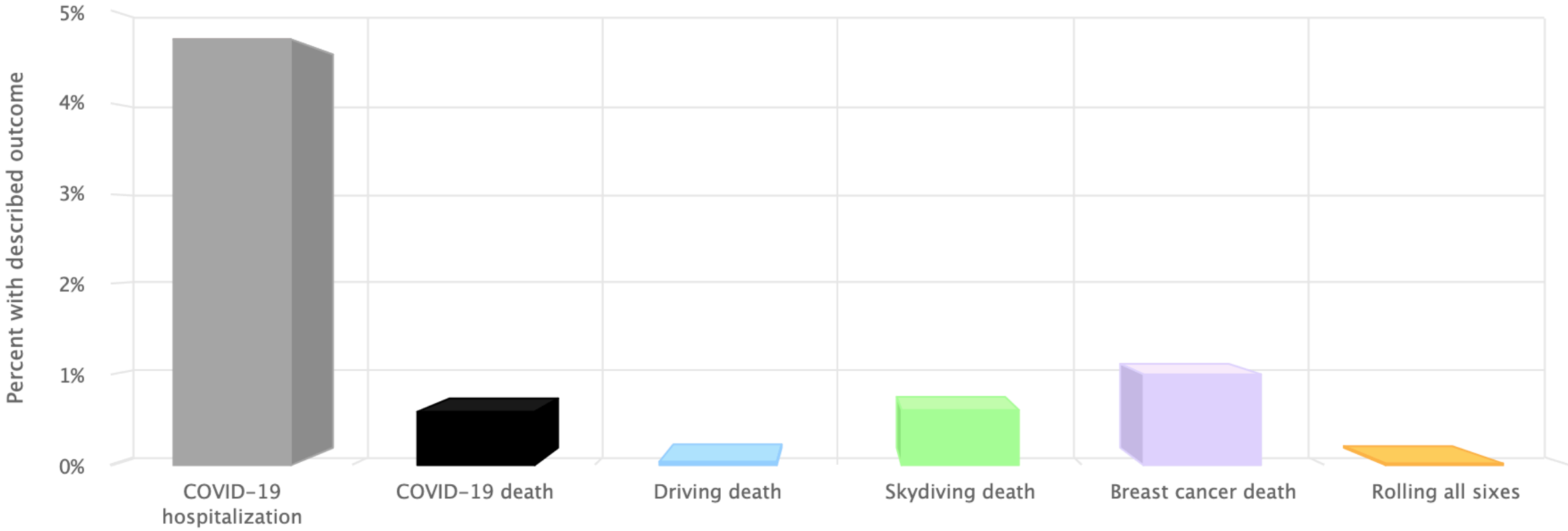
I: *No…this isn't about can you do math in your head. It's more to figure out this answer, not – we're not trying to take away your tools you would normally use in your normal life. Like I hope doctors [Mike is a doctor] use calculators when they compute my medicine they give me to double check if they need to do that.*

M: *[works in silence] Okay I had it right on the first one…Okay, so, it would be twenty-one times more people died if there was a 2.1 percent mortality rate with 50 million people infected.*

"Flu vs. COVID-19 rates"						
	Approximately correct multiplicative comparison.	Incorrect multiplicative comparison.	Asked to make multiplicative comparison but citizen didn't respond	Said 2% of a large number is very large.	Said 2.1% and 0.1% are both small so COVID-19 is not too serious	Said scientists incorrectly estimated infection fatality rates for COVID-19.
Flu is more severe than COVID-19	1	1	2	3 incl. Katie	1 incl. Katie	2
COVID-19 is more severe than flu	12 incl. Eunseok and Amelia and Mike	9 Incl. Gertrude	1	12 incl. Eunseok and Amelia	1	0
Unsure if flu or COVID-19 is worse	0	0	1	2	0	0
Subtotal	13	10	4	17	2	2

Interactive COVID-19 Risk Comparison Tool

Adjust sliders to compare your risk of COVID-19 to other situations. Hover over bars for full description



Final Thoughts

Making fluent comparisons of relative size helps citizens evaluate personal and community risk in a pandemic.

Making comparisons of relative size is difficult, even for highly educated, successful professionals that deal with mathematics frequently.

We need to emphasize comparisons of relative size in K-16 education.

Send Questions or Thoughts to: cbyerley@uga.edu

References

Byerley, C., & Thompson, P. W. (2017). Secondary mathematics teachers' meanings for measure, slope, and rate of change. *The Journal of Mathematical Behavior*, *48*, 168-193.
Byerley, C., & Thompson, P. W. (2014). Secondary Teachers' Relative Size Schemes. *North American Chapter of the International Group for the Psychology of Mathematics Education*.
Ginsburg, H. (1997). *Entering the child's mind: The clinical interview in psychological research and practice*: Cambridge University Press.
Goldin, G. A. (1997). Chapter 4: Observing mathematical problem solving through task-based interviews. *Journal for Research in Mathematics Education. Monograph*, 40-177.
Thompson, P. W., & Saldanha, L. A. (2003). Fractions and multiplicative reasoning. *Research companion to the principles and standards for school mathematics*, 95-113.
Yoon, H., Byerley, C., & Thompson, P. W. (2015). Teachers' meanings for average rate of change in USA and Korea. In *Proceedings of the 18th Annual Conference on Research in Undergraduate Mathematics Education*.

Project Context

National Science Foundation RAPID grant (DUE- 2032688) focuses on applying STEM Education research to investigate how United States (US) and South Korea (SK) citizens understand media-used COVID-19 quantitative data representations QDRs.

- Characterize the extent particular meanings are productive for understanding pandemic QDRs.
- Extend constructs developed in our and colleagues' research programs to explain individuals' meanings for pandemic QDRs.

- Characterize the extent particular meanings are productive for understanding pandemic QDRs.

- Create QDRs that better support individuals in understanding the COVID-19 pandemic including its health risks.