SUICIDE CLUSTERING AND OUTBREAKS IN SPACE AND TIME IN THE UNITED STATES, 1999-2020

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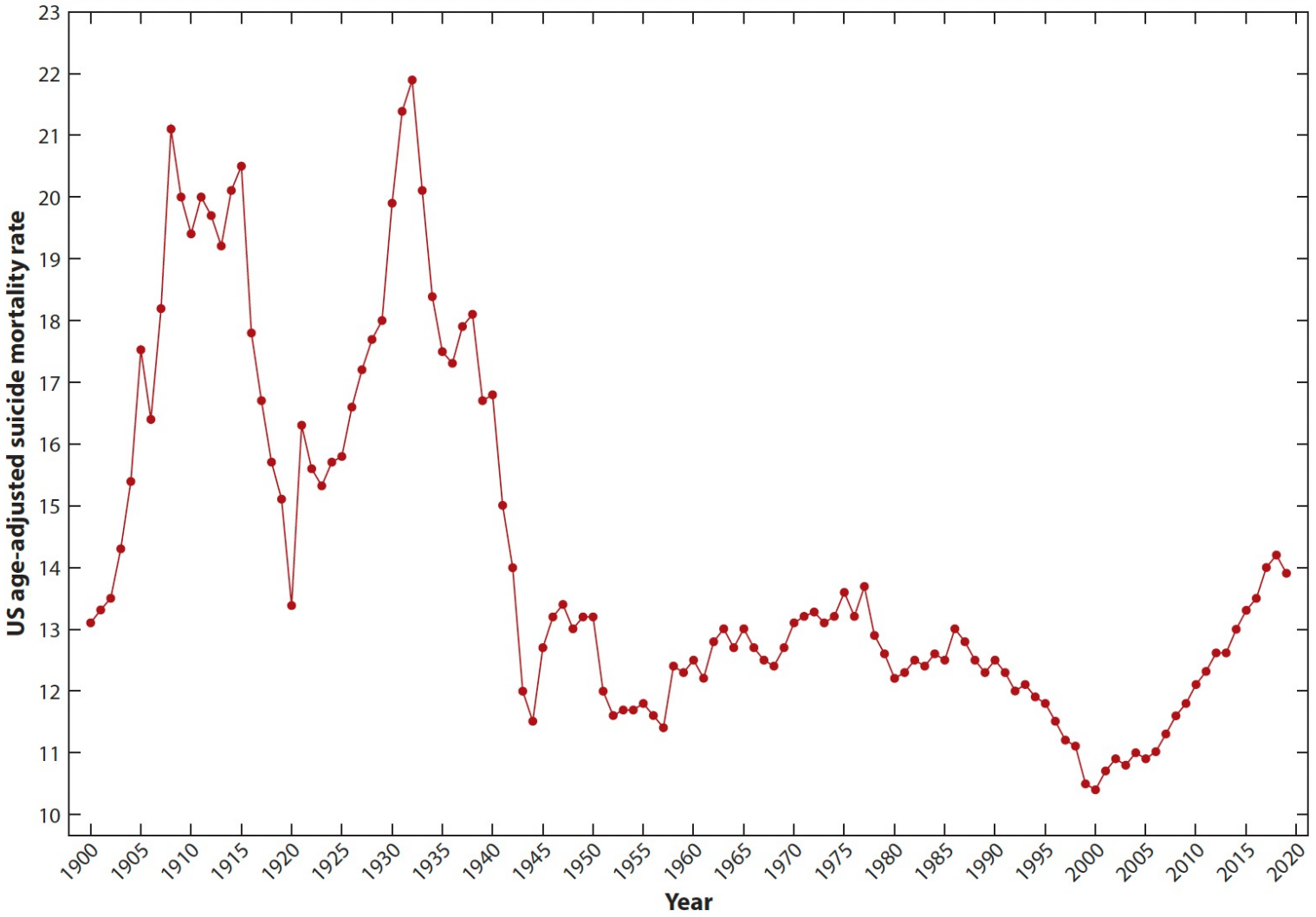
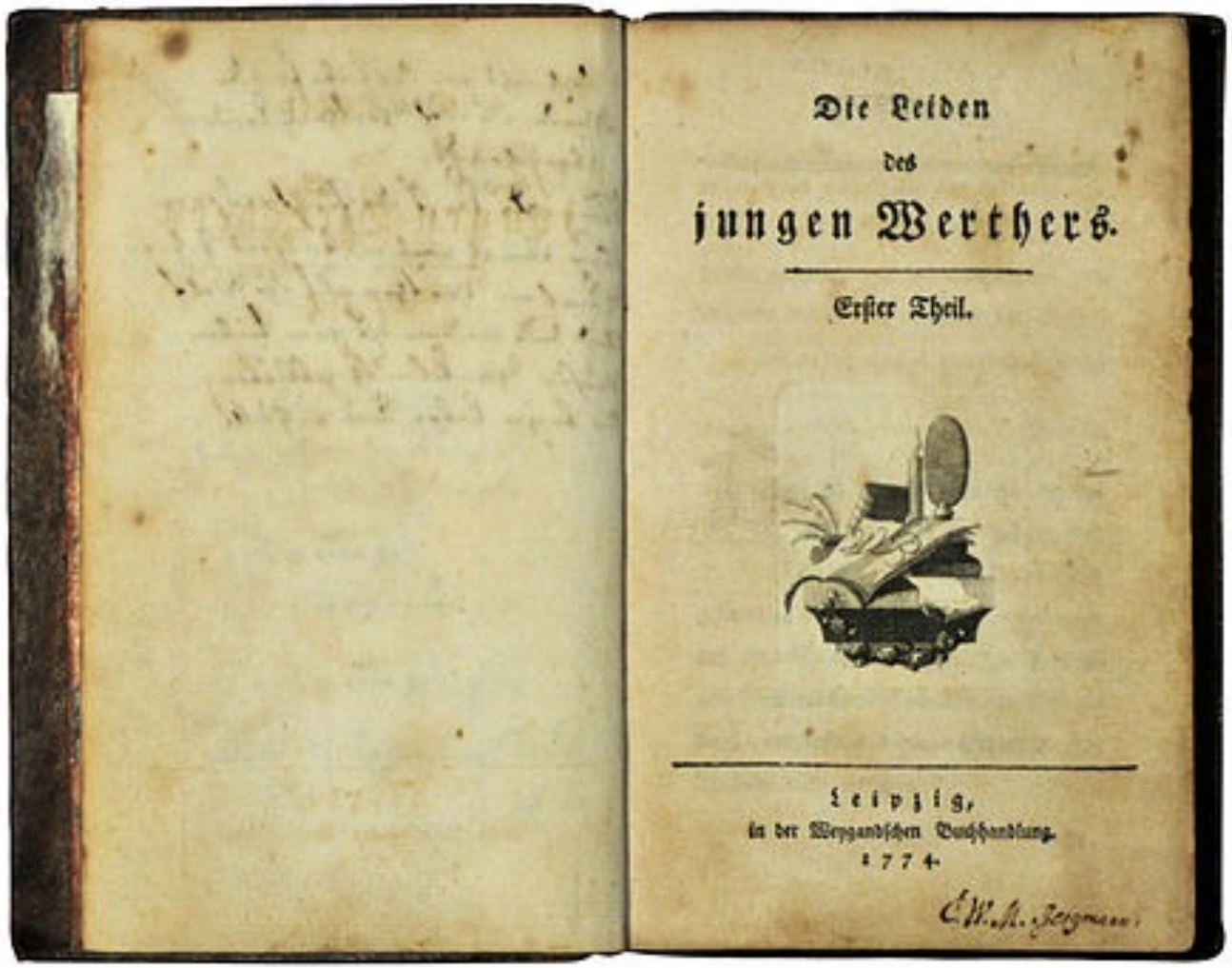
US recorded suicide mortality trends between 1900 and 2019, age adjusted to the 2000 US population



Martinez-Ales G, Jiang T, Keyes KM, Gradus J. 2022. The recent rise in suicide in the United States. *Annual Reviews of Public Health*.



The Sorrows of Young Werther
Johann Wolfgang von Goethe, 1774

Association between suicide reporting in the media and suicide: systematic review and meta-analysis

OPEN ACCESS

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professor[5 6], Ulrich S Tran *senior lecturer*[2 7], Martin Vorac
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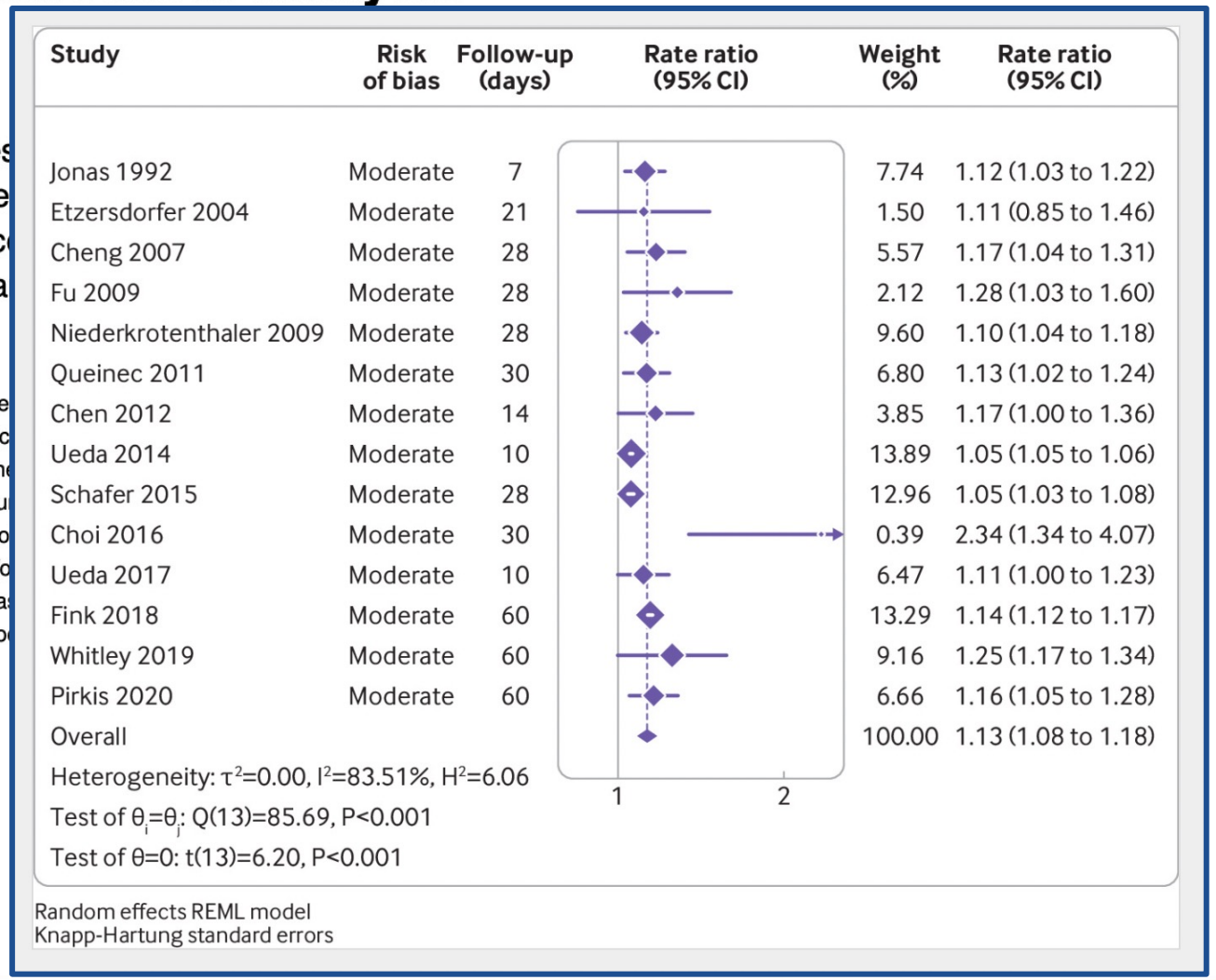
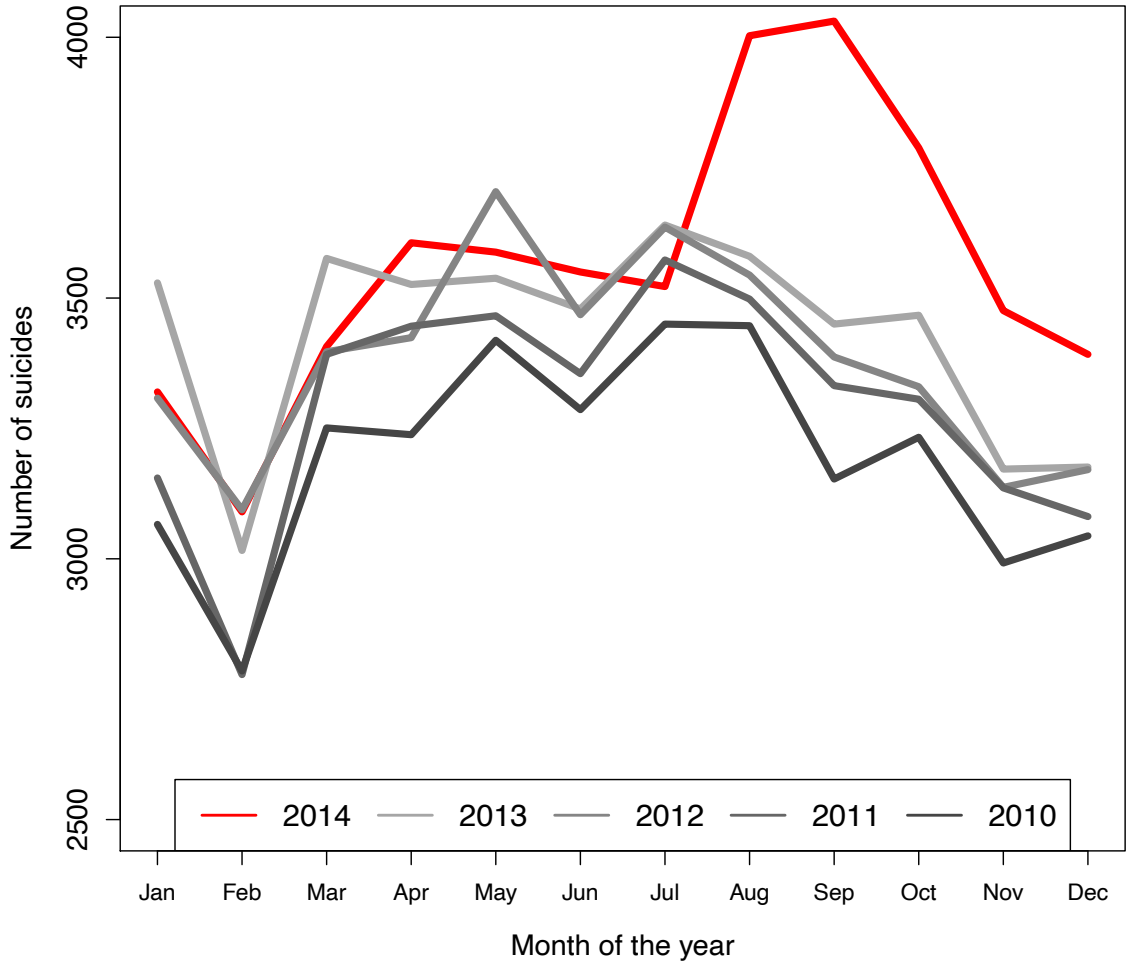
[11]Centre for Suicide Research and Prevention, and Department of Social Work and So
China



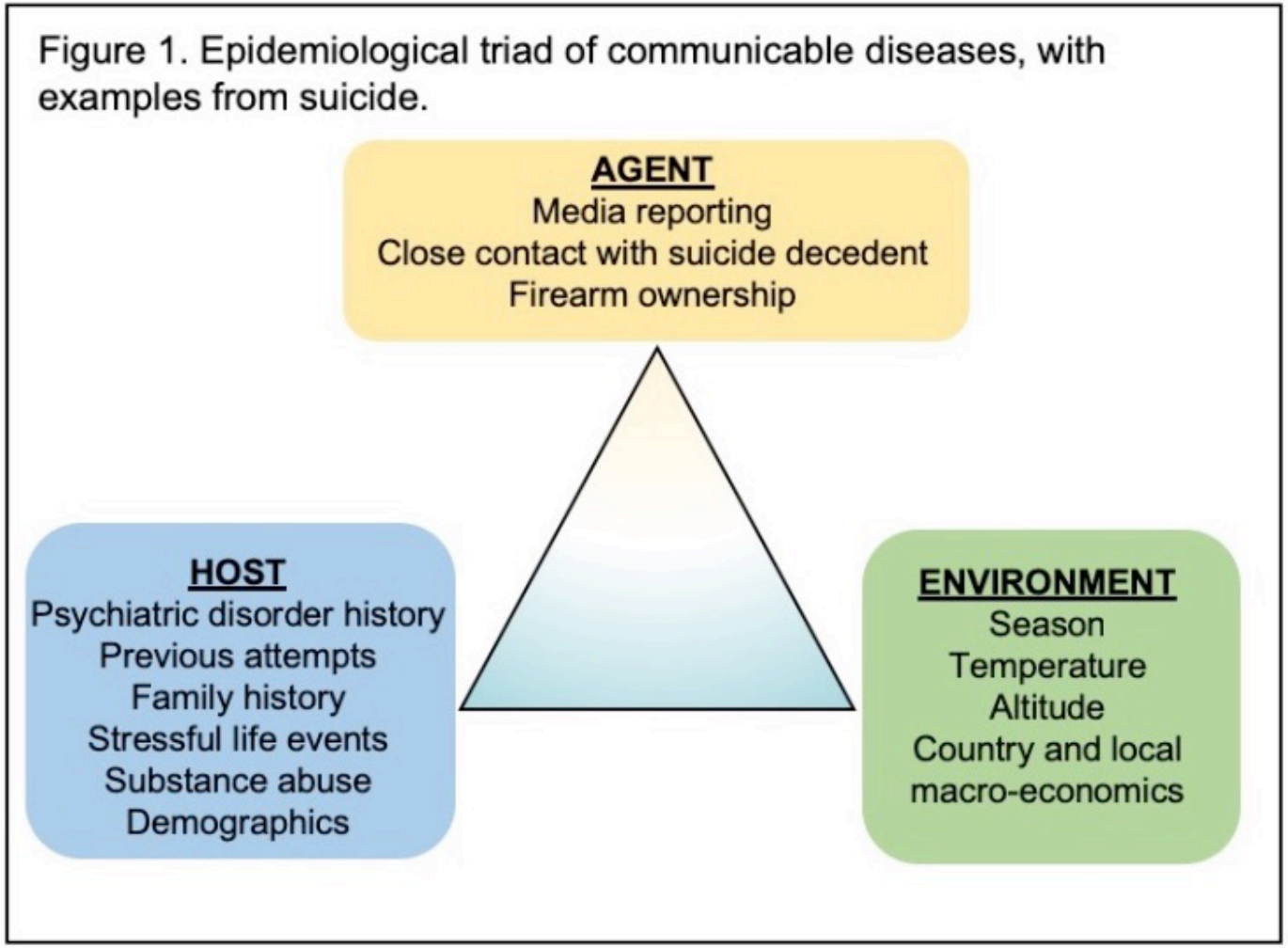
Monthly number of suicides in the United States (total population), 2011-2015



An excess of 1,841 cases (9.85% increase) potentially attributable to media reporting of the Robin Williams death

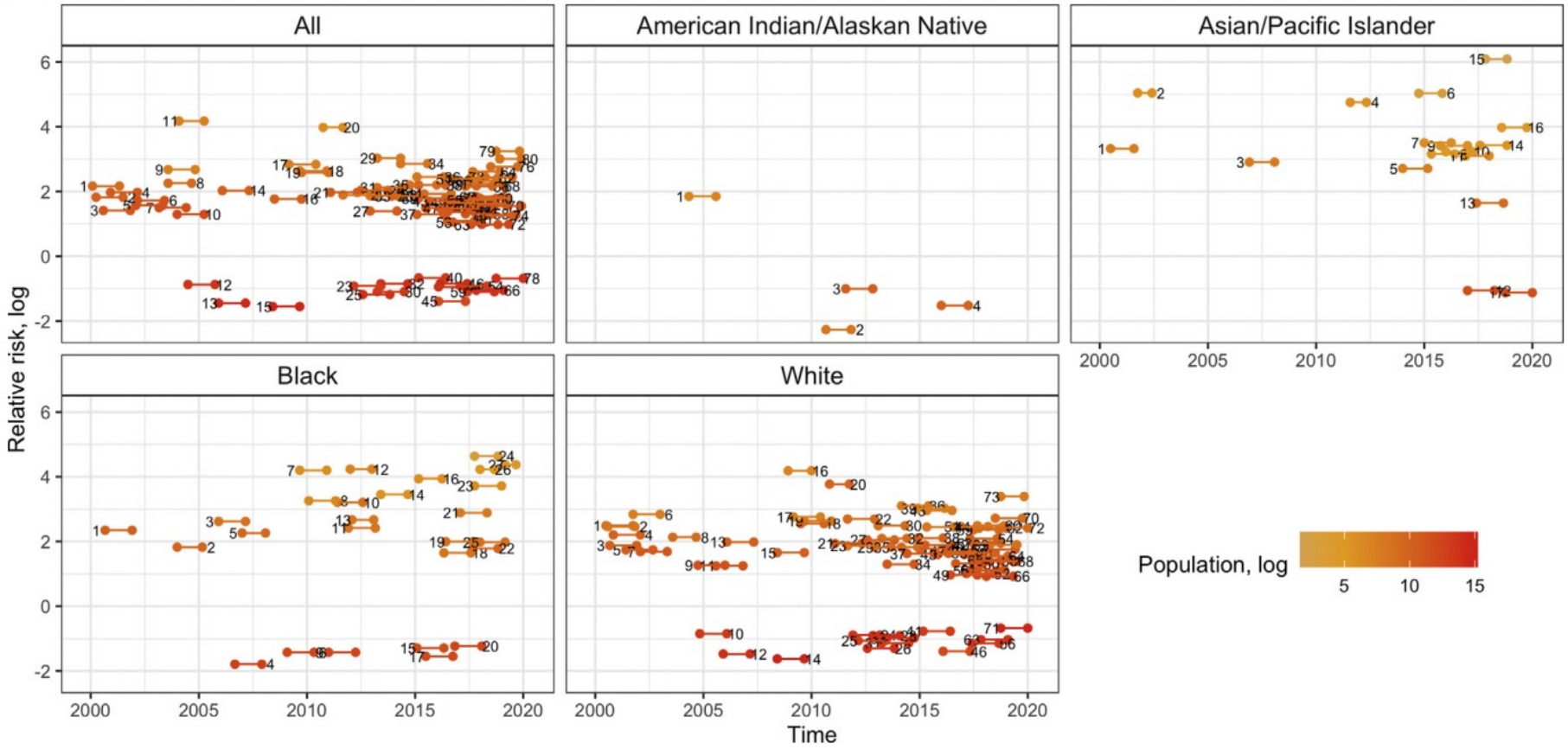
Fink DS, Santaella-Tenorio J, Keyes KM. Increase in Suicides the Months After the Death of Robin Williams in the U.S. 2018, Plos One.

Figure 1. Epidemiological triad of communicable diseases, with examples from suicide.



Keyes K, Kandula S, Olfson M, Gould M, Martinez-Alez G, Rutherford C, Shaman J. 2021. Suicide and the agent-host-environment triad: leveraging surveillance sources to inform prevention. Psychological Medicine.

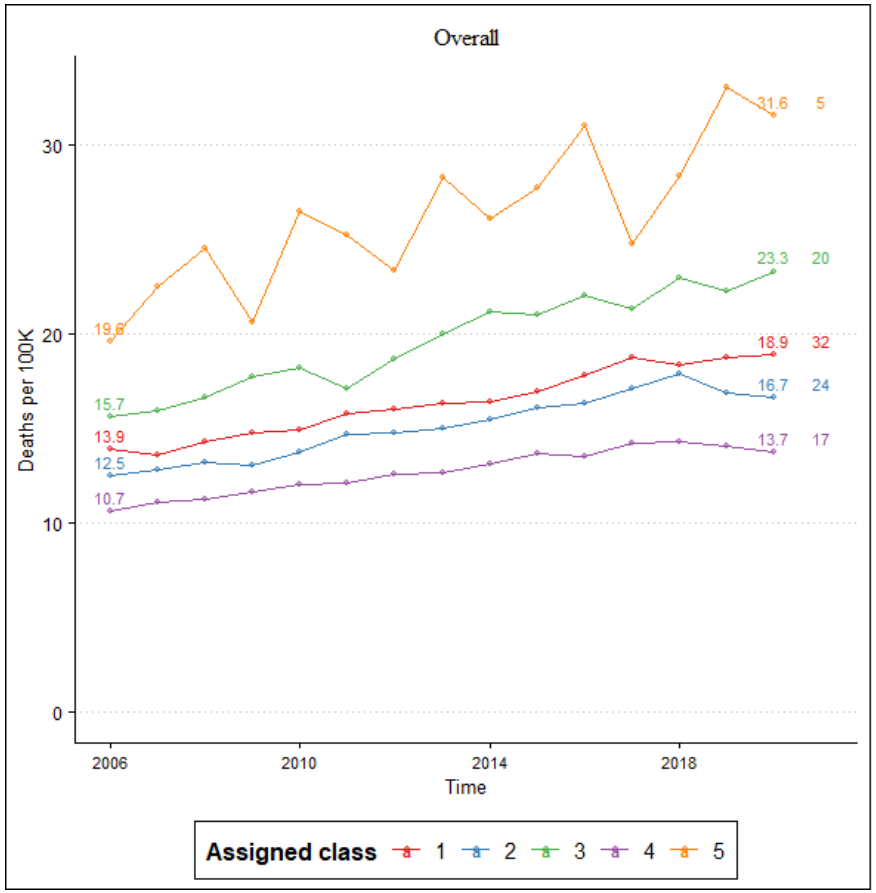
FIGURE 3 Temporal Clusters in Suicide Rates by Race, From 2000-2019, Among Persons Aged 5-25 Years

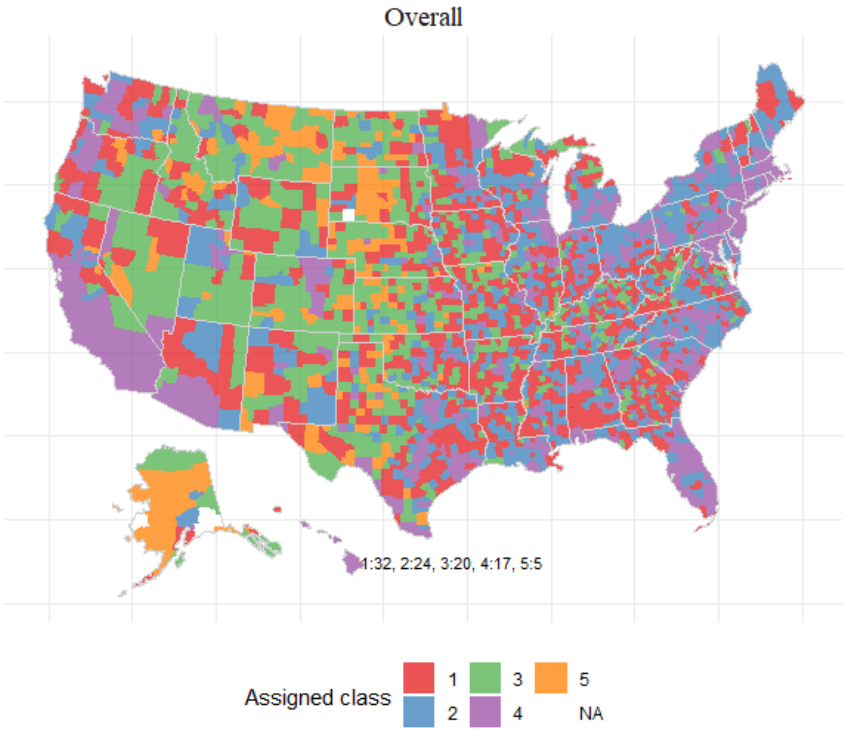


Note: *Spatiotemporal parameters are ≤150 km and ≤15 months.*

Platt JM, Pamplin JR, Gimbrone C, Rutherford C, Kandula S, Olfson M, Gould MS, Martinez-Alex G, Shaman J, Keyes K. Racial disparities in spatial and temporal youth suicide clusters. J Am Acad Child Asolesc Psychiatry, 2022.

Mean trajectories of posterior estimates of county suicide rates in the United States, 2006-2020, per the 5-class generalized mixed model





Keyes KM, Kandula S, Martinez-Ales G, Gimbrone C, Joseph V, Monnat S, Rutherford C, Olfson M, Gould M, Shaman J. Geographic Variation, Economic Activity, and Labor Market Characteristics in Trajectories of Suicide in the United States, 2008 to 2020. American Journal of Epidemiology, 2024.

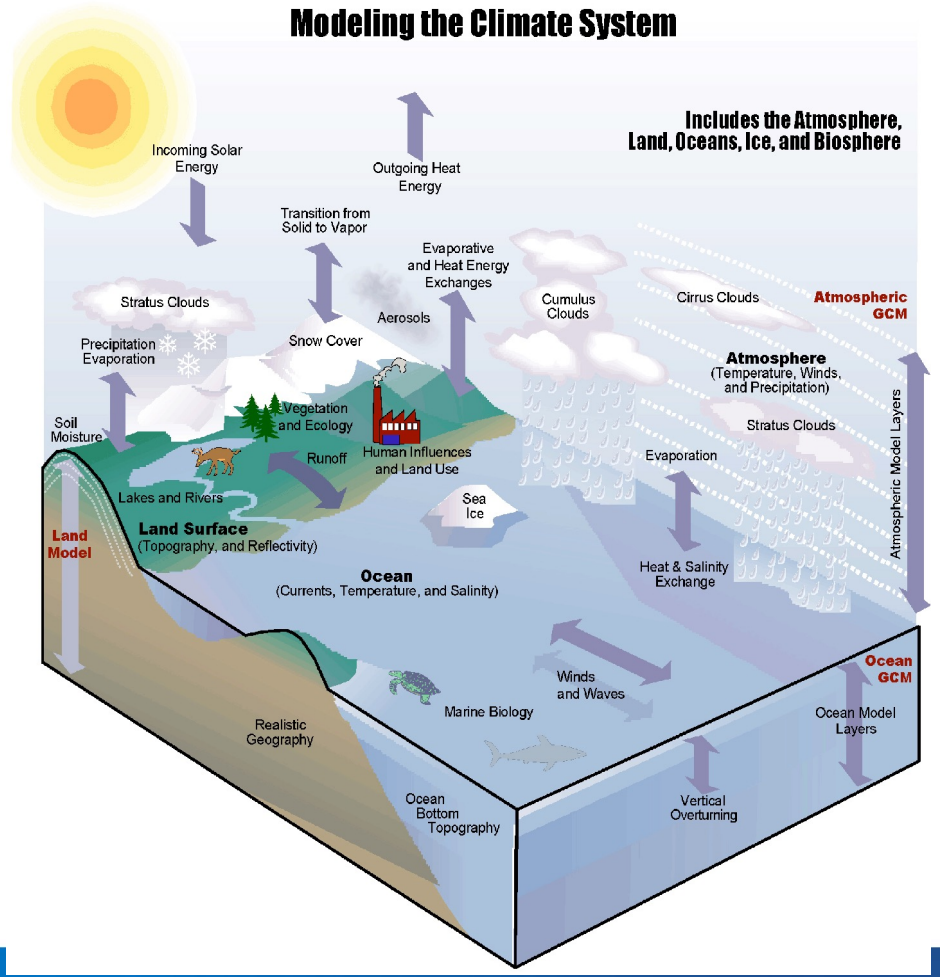
What is a Model?

Come in many shapes and sizes

Idealized or simplified representation of the real world

- Mental models
- Computational models

Take input information, process if according to some governing rules and produce an output

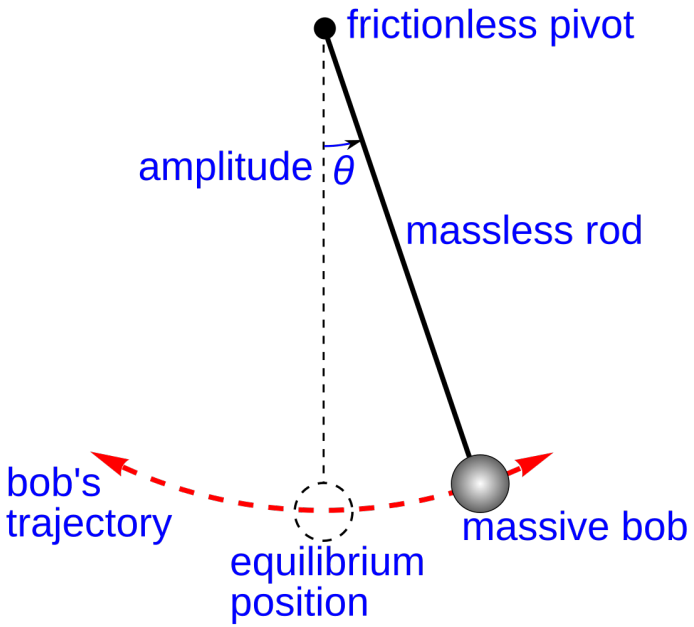


Dynamic Models

Process-based models that describe how system properties change through time

- Movement of a weight on the end of a spring
- Pendulum
- Numerical weather model

$$\frac{d^2\theta}{dt^2} + \frac{g}{l} sin\theta = 0$$

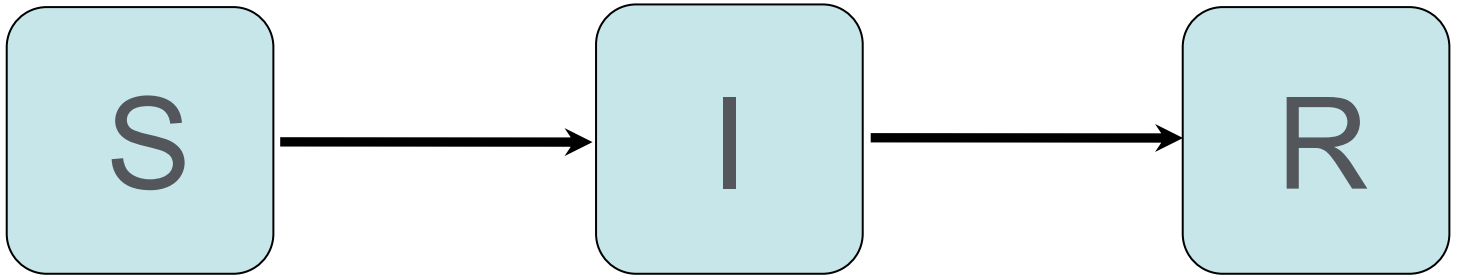


What do dynamic infectious disease models do?

Typically, provide limited, context specific information

Infectious disease models have 3 principal uses:

1. Simulation and inference — used to understand underlying processes of a disease
2. Forecast of future outcomes
3. Counterfactual simulation of alternate outcomes, e.g. interventions, control strategies, etc.



PUBLIC HEALTH

Quantifying suicide contagion at population scale

Jeffrey Shaman[1,2]*, Sasikiran Kandula[1], Sen Pei[1], Marta Galanti[1], Mark Olfson[3,4], Madelyn Gould[3,4], Katherine Keyes[3]

The spread of suicidal behavior among individuals is often described as a contagion; however, rigorous modeling of suicide as a dynamic, contagious process is minimal. Here, we develop and validate a model-inference system depicting suicide ideation and death and use it to quantify the contagion processes in the US associated with two prominent celebrity suicide events: Robin Williams during 2014 and Kate Spade and Anthony Bourdain, which occurred 3 days apart during 2018. We show that both events produced large transient increases of suicide contagion contact rates, i.e., the spread of suicidal thought and behavior, and a period of elevated suicidal ideation in the general population. Our modeling approach provides a framework for quantifying suicidal contagion and better understanding, preventing, and containing its spread.

Shaman *et al.*, *Sci. Adv.* **10**, eadq4074 (2024) 31 July 2024

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Suicide Contagion

Like an infectious agent, the spread of an idea or affect can be mathematically represented as a nonlinear function of the number of individuals capable of transmitting the contagion and the number of individuals susceptible to "infection."

Found only one example (Brady and Hardy, 1986) that used a dynamic model to depict suicide.

A Suicide Epidemic Model

Barry R. Davis and Robert J. Hardy

School of Public Health
University of Texas
Houston, Texas

Quantify Contagion

Quantifying suicide contagion rates at US national scales in response to two celebrity suicide events:

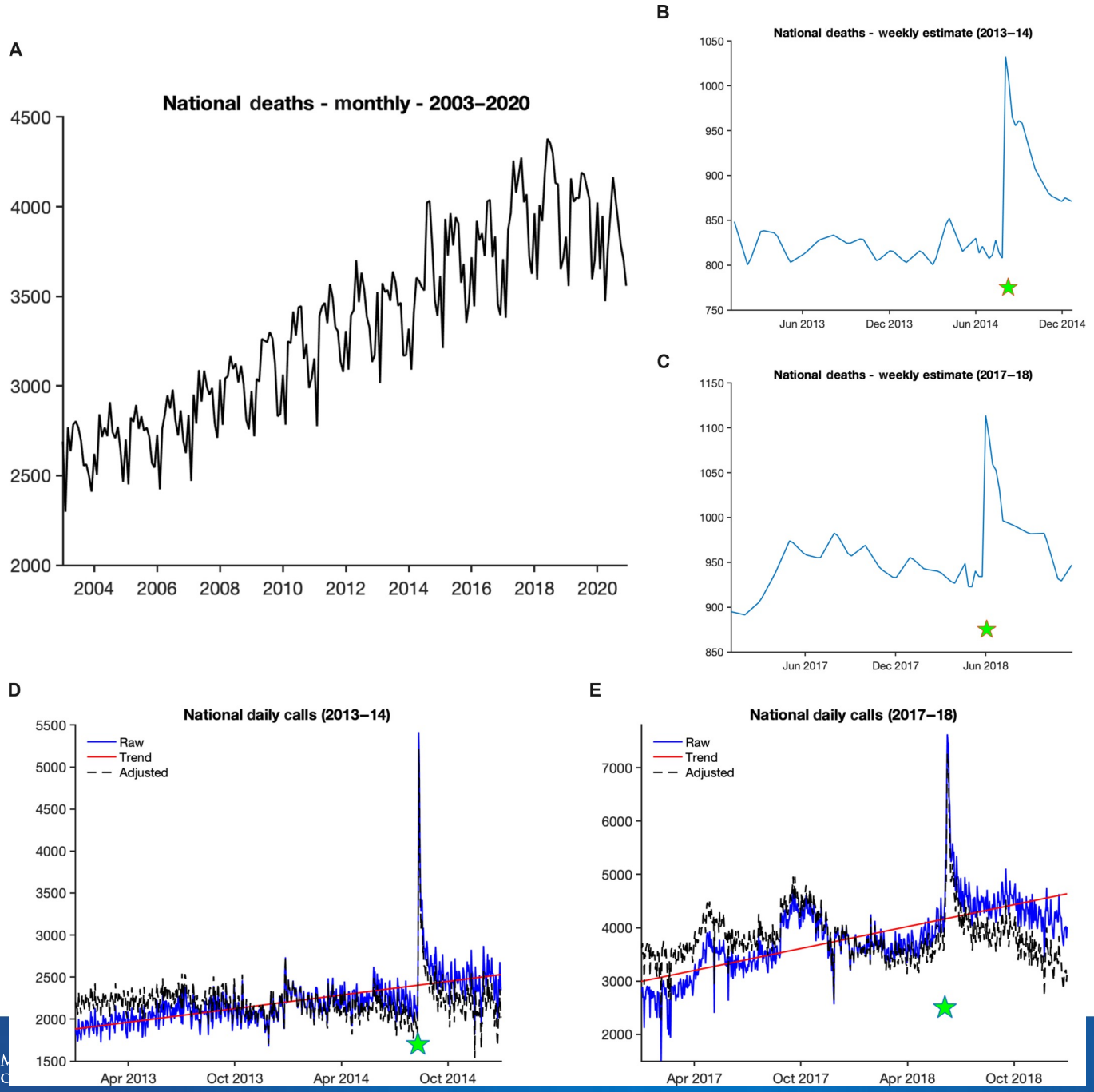
- Robin Williams in 2014
- Kate Spade and Anthony Bourdain, which occurred 3 days apart in 2018 and are here considered one event.

Robin Williams, Oscar-Winning Comedian, Dies at 63

Medical Examiner Says Kate Spade's Death Was a Suicide

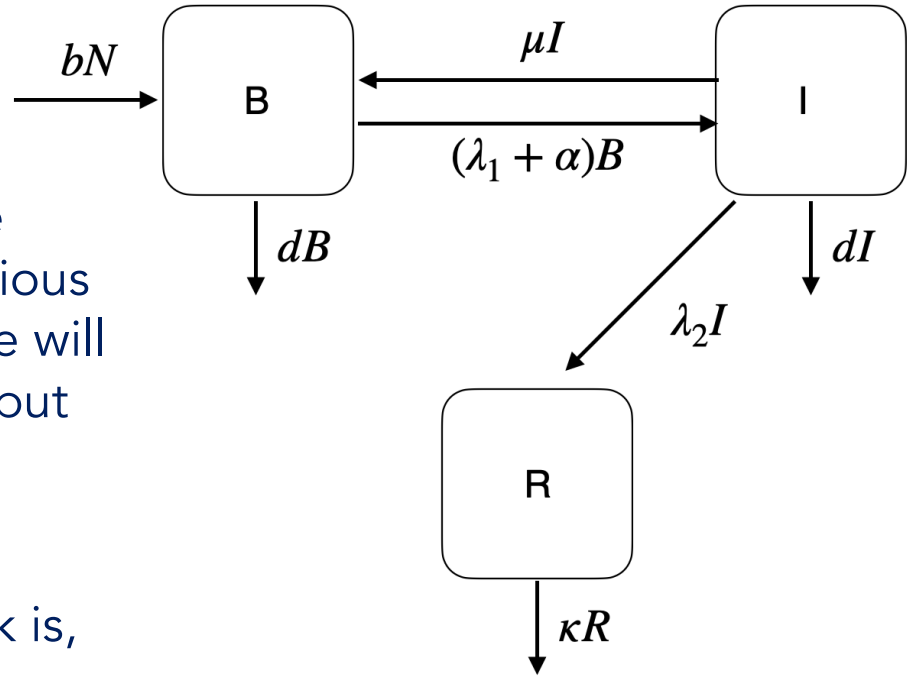
By Benjamin Mueller

Sorrow and Questions in a French Village After Anthony Bourdain's Suicide



Weekly interpolated estimates of suicide deaths with the seasonal cycle removed

Shaman et al. *Sci. Adv.* 2024



- *R* is the average awareness of people who have died by suicide. For a non-celebrity, the contagious impact of *knowing* that a person died by suicide will be acute for family, friends, and acquaintances but will wane over time
- Averaged over the entire population of the US, given how small most individual's social network is, the mean contagious effects on the entire US population, is small.
- This effect can be ***large,*** when general population knowledge of and affinity for that celebrity is great. In effect, the suicide of a more well-known individual who many in a population identify with and value can have a much greater contagion impact.

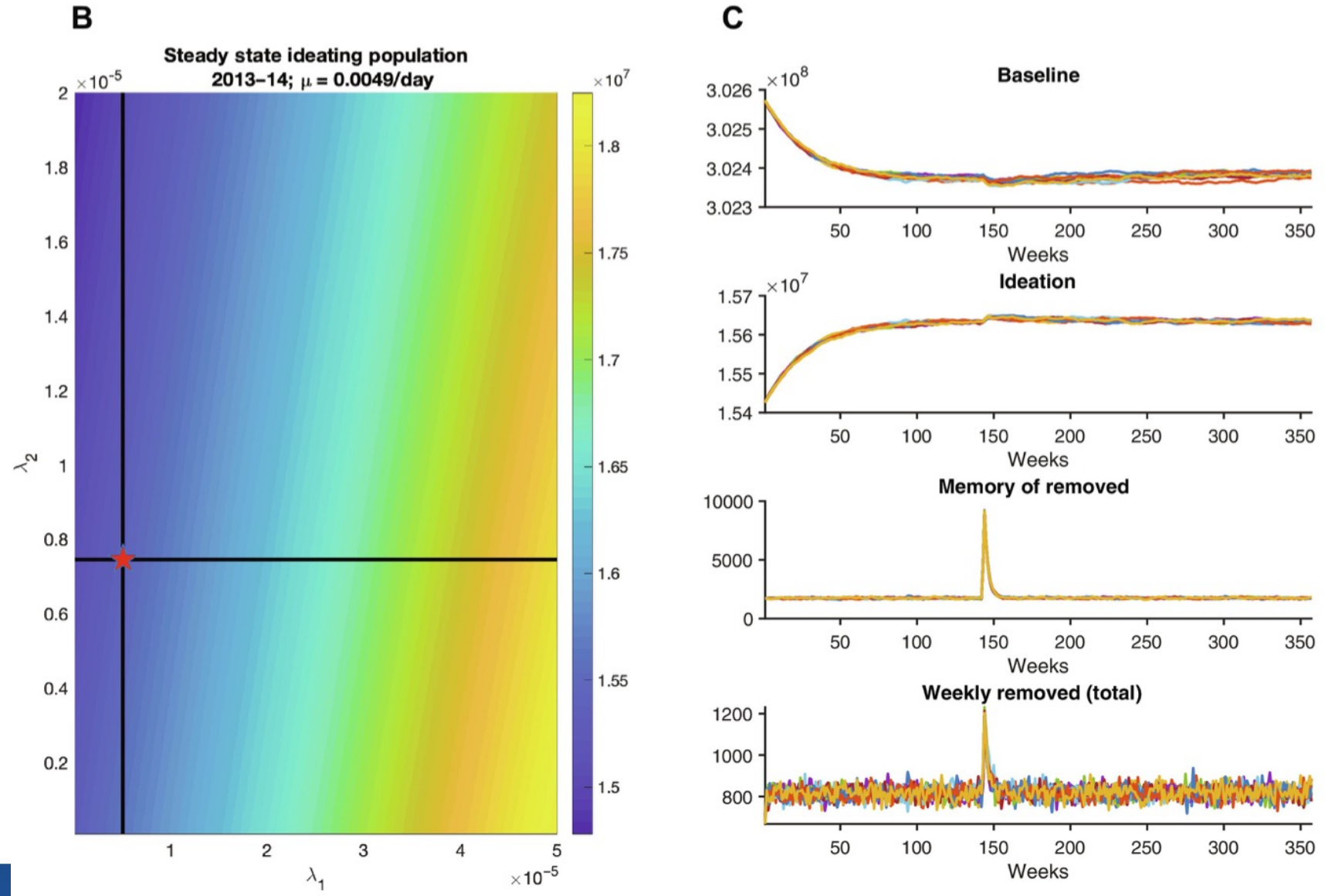
Shaman et al.
Sci. Adv. 2024

Steady Solution and Numerical Stability

Parameter	2013-2014 (Williams)	2017-2018 (Spade/Bourdain)	Source
Population ($N, people$)	318,000,000	327,000,000	Census Bureau
Ideators ($I_0, people$)	15,423,000	15,859,000	NHANES
Baseline Population ($B_0, people$)	303,577,000	303,141,000	Derived
Initial Awareness of Recent Suicides ($R_0, people$)	1724	1950	SI, Section 3
Birth Rate (b, day^{-1})	2.74×10^{-5}	2.74×10^{-5}	Census Bureau
Death Rate (d, day^{-1})	2.7×10^{-5}	2.7×10^{-5}	Census Bureau
Ideation Loss Rate (μ, day^{-1})	0.0049 (0.01)	0.0049 (0.01)	Zhang (2015)
Ideation Gain Rate (α, day^{-1})	0.00025 (0.00051)	0.00025 (0.00051)	Derived
Contact Rate of Non-Ideators with Ideators (β, day^{-1})	0.9423×10^{-4} (1.6131×10^{-4})	1.0207×10^{-4} (1.7517×10^{-4})	SI, Section 3
Contact Rate of Non-Ideators with Memory of Suicide Deaths (ϵ, day^{-1})	0.0937 (0.1603)	0.0916 (0.1583)	SI, Section 3
Contact Rate of Ideators with Memory of Suicide Deaths (τ, day^{-1})	0.1375	0.1375	SI, Section 3
Background Suicide Death Rate (γ, day^{-1})	6.71×10^{-6}	7.38×10^{-6}	SI, Section 3
Suicide Memory Loss Rate (κ, day^{-1})	0.0667	0.0667	SI, Section 3
Lifeline Call Rate (ρ, day^{-1})	1.42×10^{-4}	2.38×10^{-4}	Derived

Non-disease-free equilibria

Steady Solution and Numerical Stability



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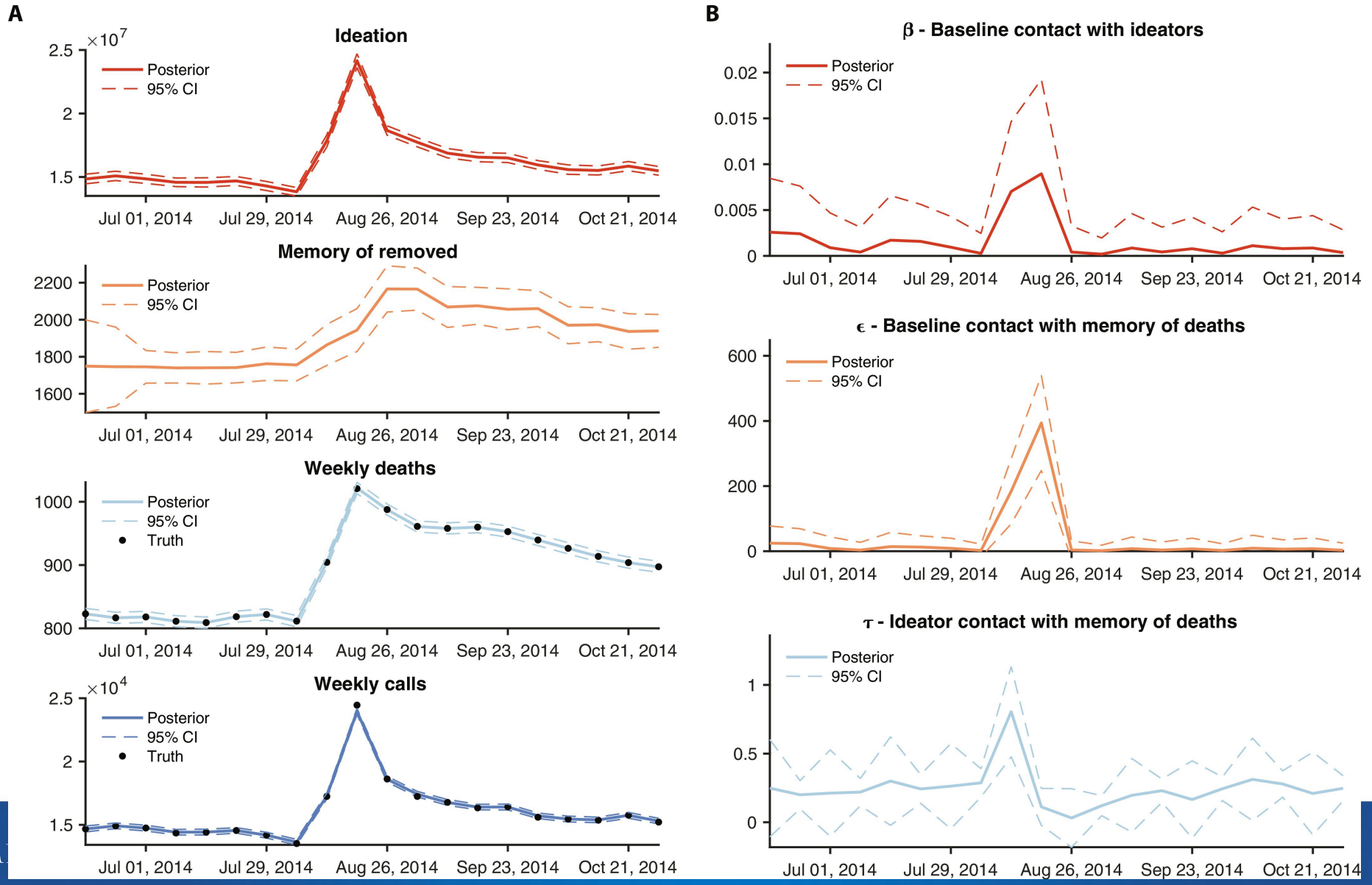
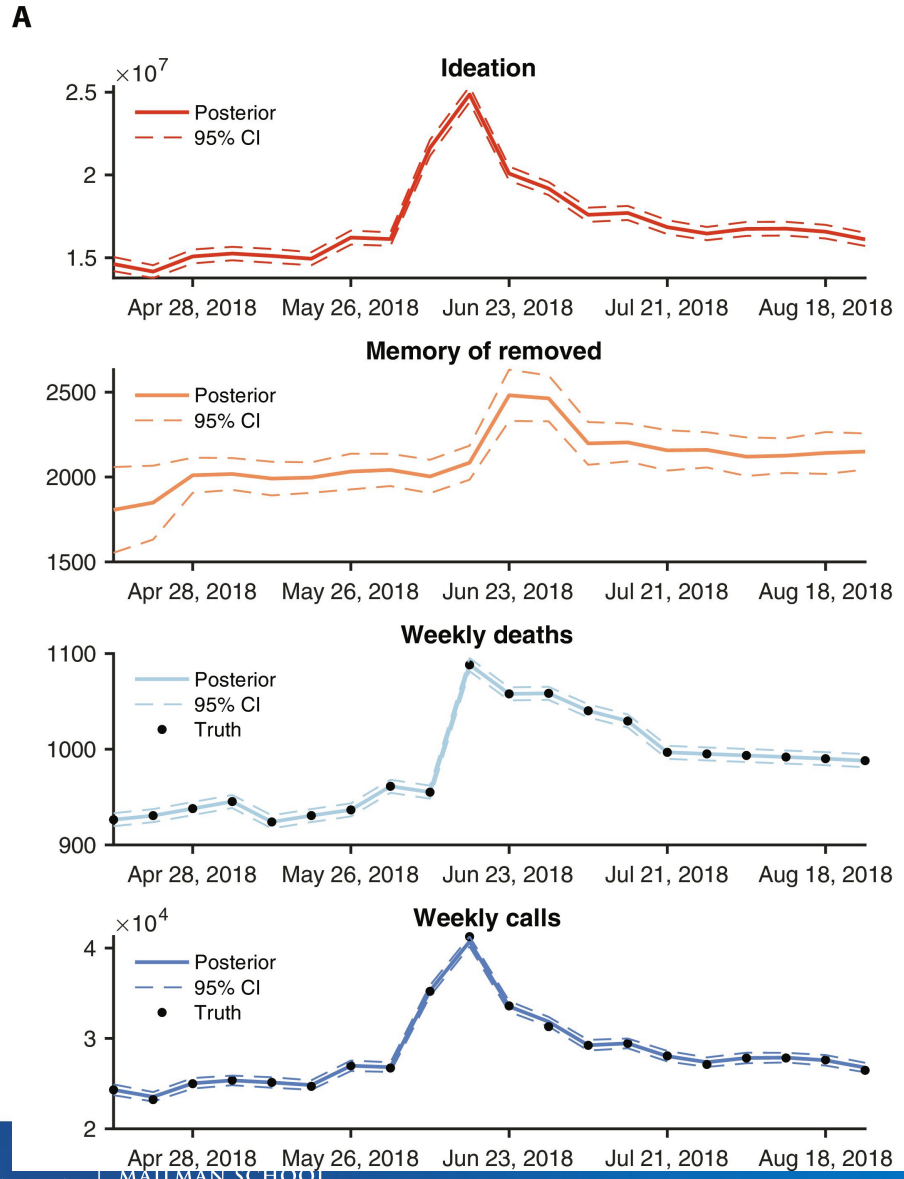
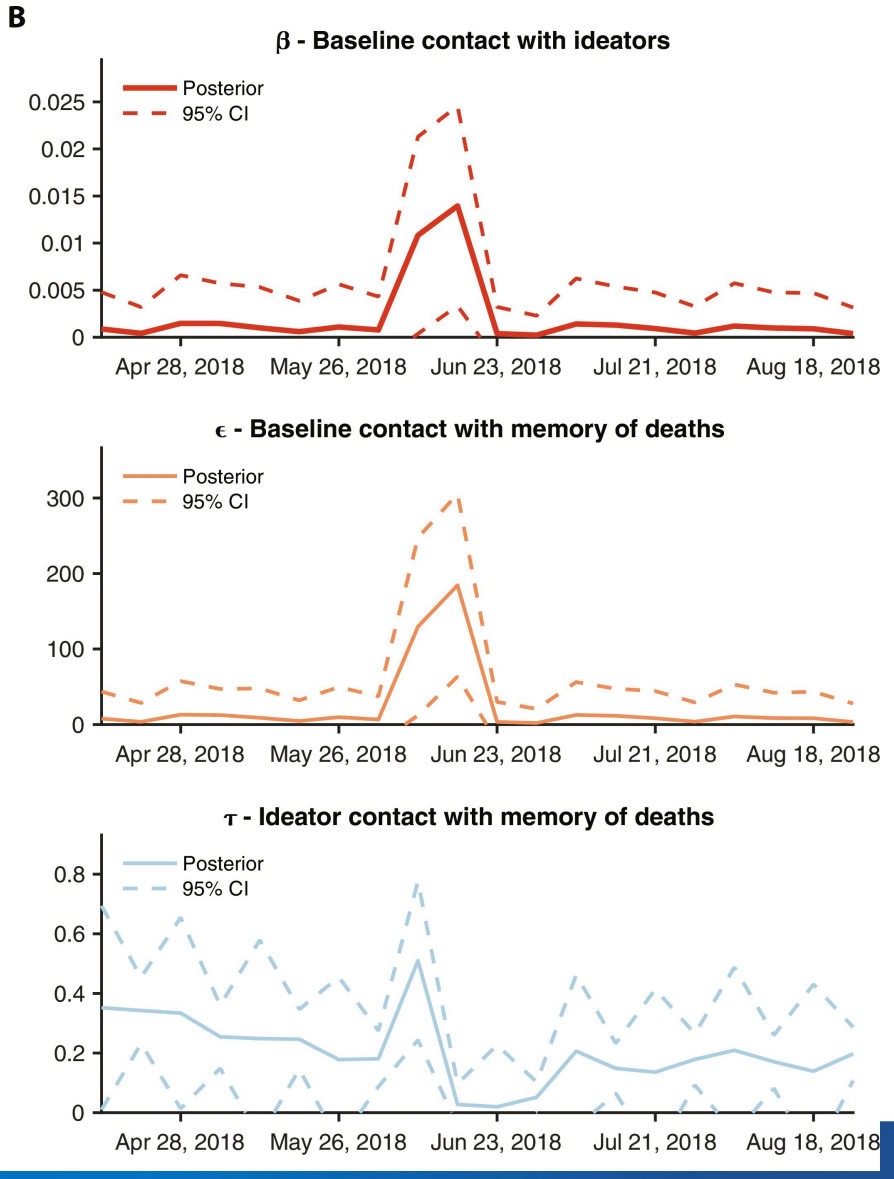
Application - Robin Williams



Application - Spade/Bourdain





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Findings

Infer a pronounced, rapid and transient increase of all three nonlinear parameters, indicating an increase in suicide contagion rates.

Mean estimates for the Robin Williams event show a tripling of τ, the contagion contact rate of the ideating population with the memory of person.

ϵ, the contagion contact rate of the population currently not ideating suicide with the memory of persons who have died by suicide, increases more than three orders of magnitude.

Among the two celebrity suicide events, the number of excess suicide deaths was approximately double following the 2014 Robin Williams event

Summary and future directions

- Suicide continues to be a national health crisis
- Suicide is spatially and temporally correlated pointing to the need to develop intervention and prevention efforts that attend to that correlation
- Suicide contagion can be modeled as a dynamic non-linear system and leveraged for understanding mechanisms, forecasting, and intervention modeling
- Rapid surveillance data resources are needed

Conclusion: Papageno in Mozart's the Magic Flute

THANK YOU

R01-MH-12140 (Co-PIs: Keyes & Shaman)

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