Selection in infant mortality

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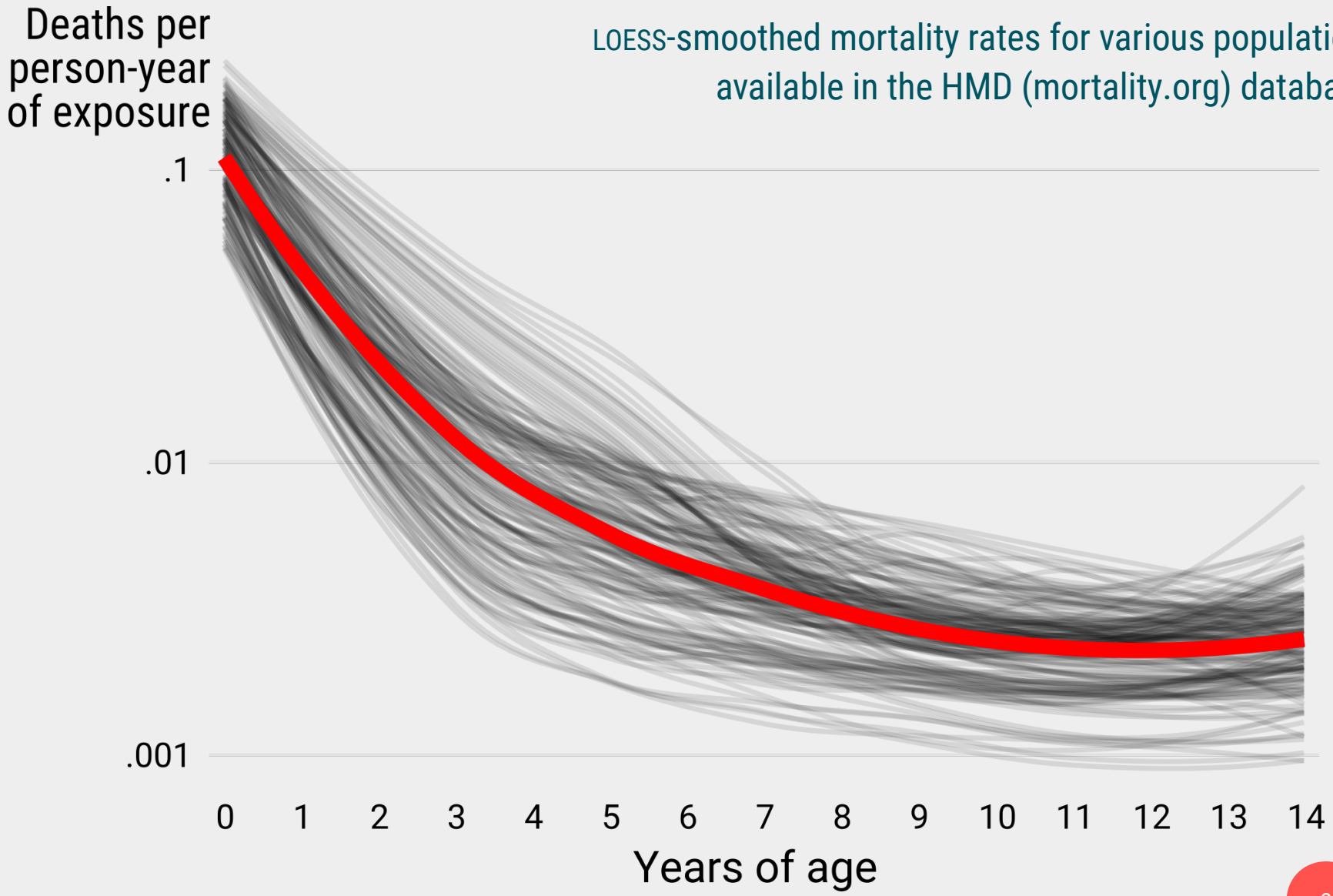
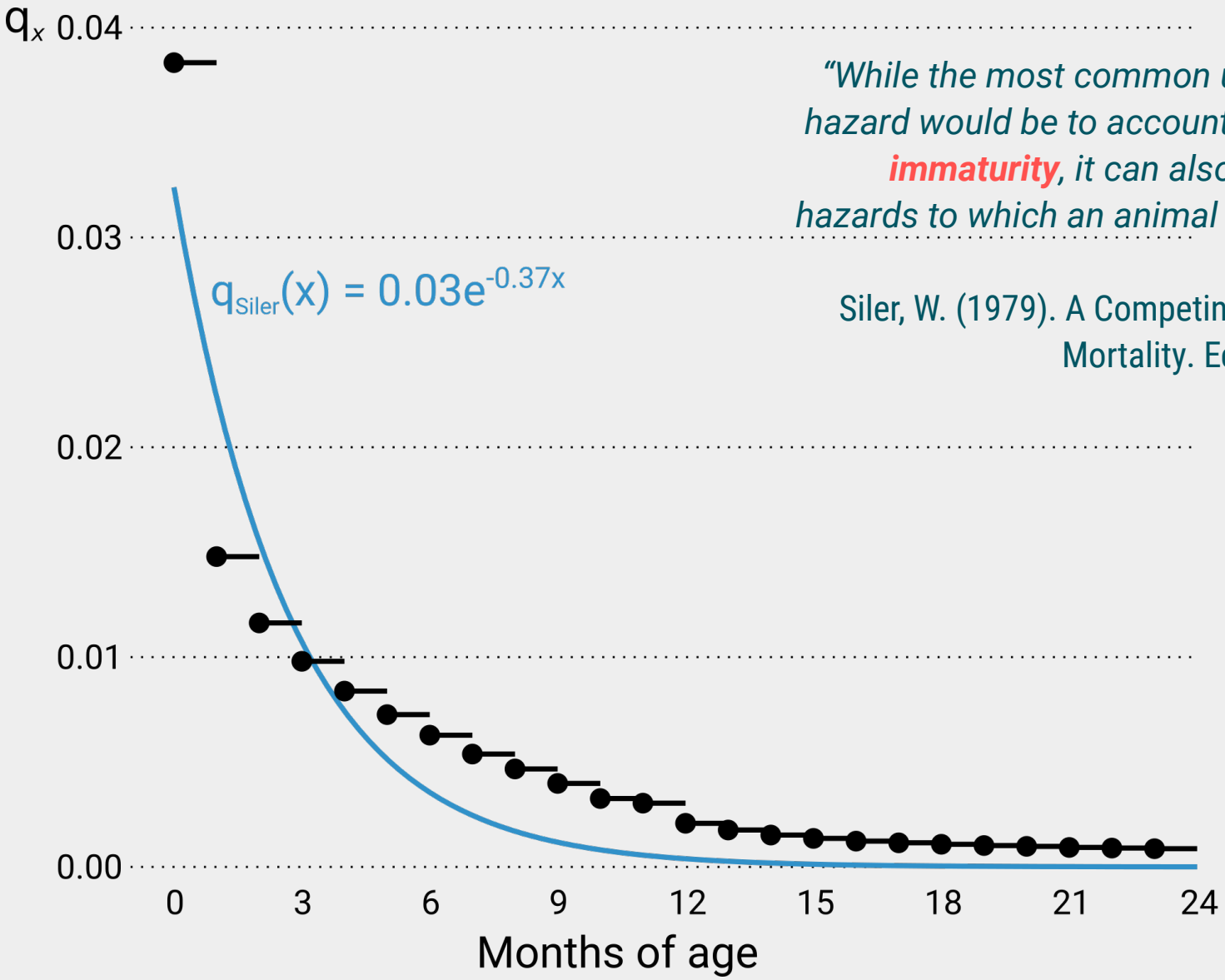
The age pattern of early life mortality



LOESS-smoothed mortality rates for various populations available in the HMD (mortality.org) database.

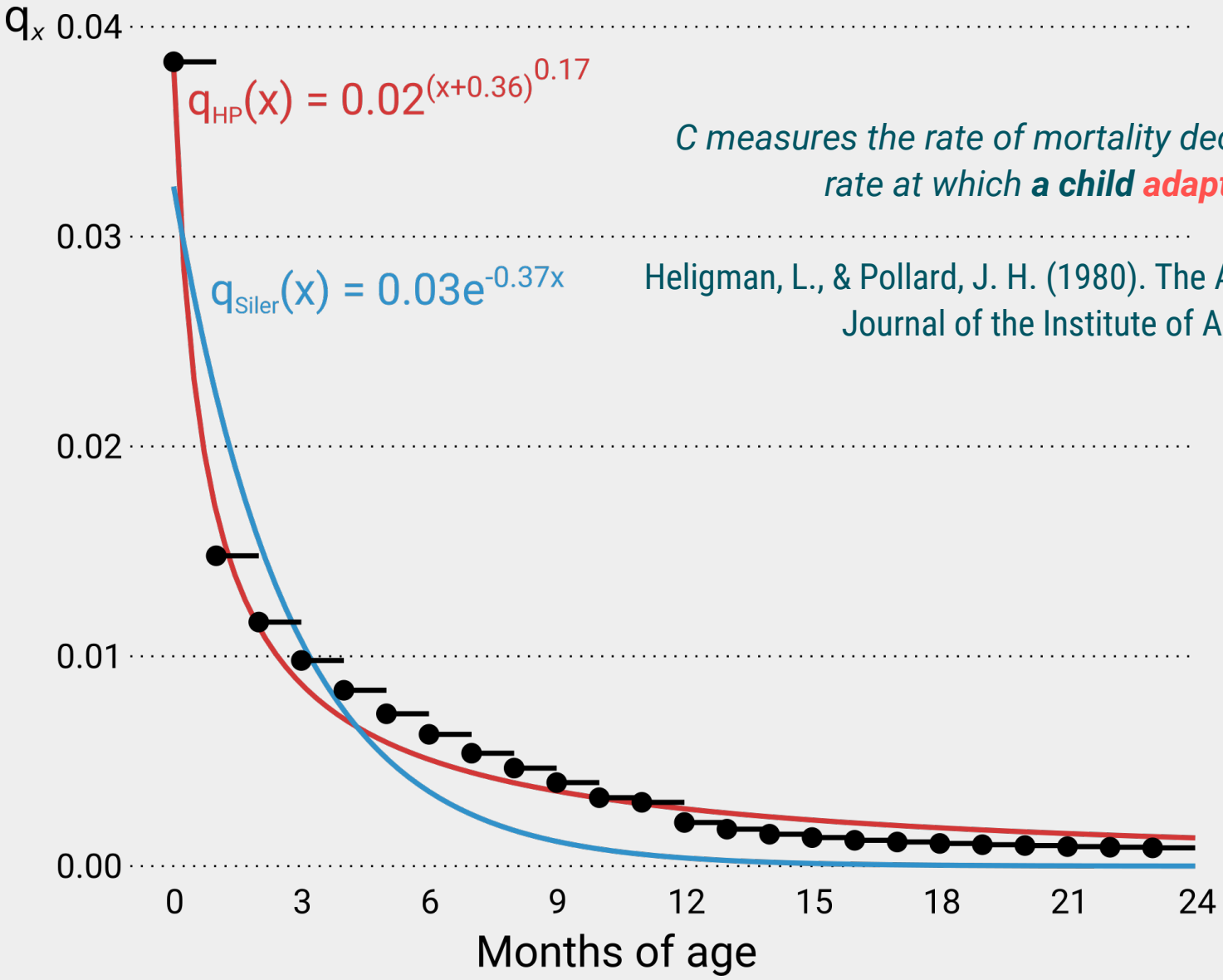
Mortality decline as growth and adaptation



*"While the most common use of this decreasing hazard would be to account for the hazard due to **immaturity**, it can also be used [...] for other hazards to which an animal **adjusts** successfully."*

Siler, W. (1979). A Competing-Risk Model for Animal Mortality. Ecology, 60(4), 750–757.

Mortality decline as growth and adaptation



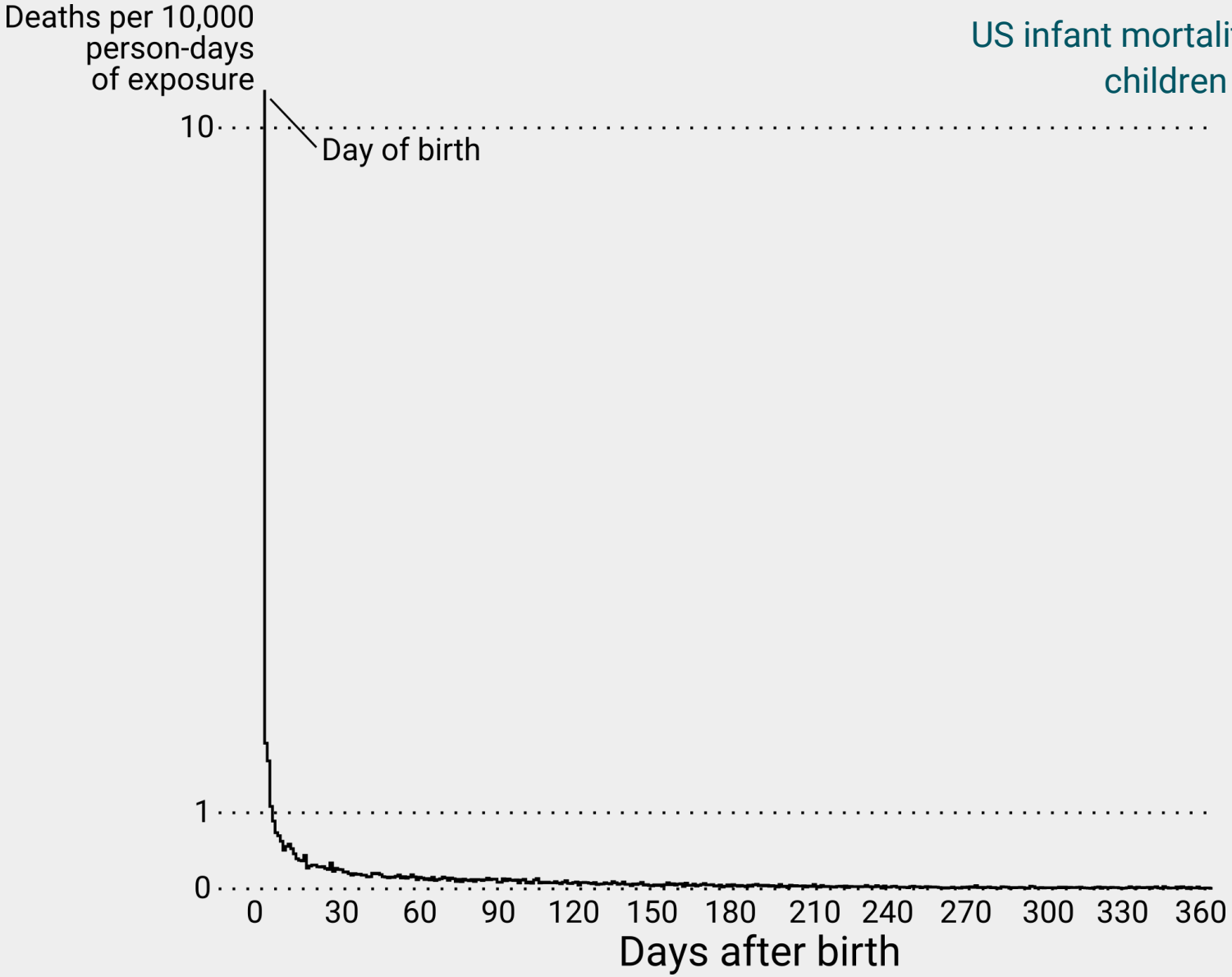
*C measures the rate of mortality decline in childhood (the rate at which **a child** **adapts** to its environment).*

Heligman, L., & Pollard, J. H. (1980). The Age Pattern of Mortality. Journal of the Institute of Actuaries, 107(1), 49–80.

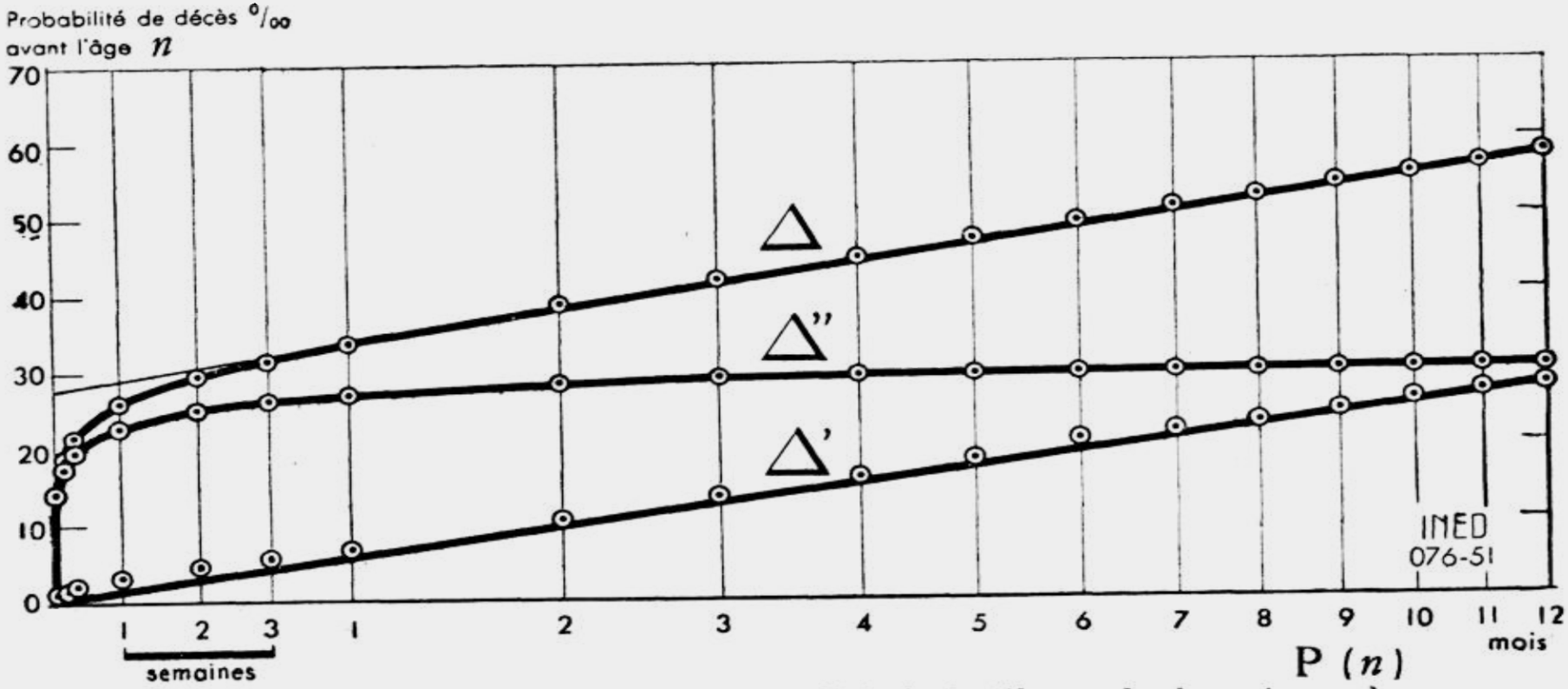
Mortality decline as mortality selection

US infant mortality by day of age for children conceived in 2009.

Raw data: CDC/NCHS



Mortality decline as mortality selection

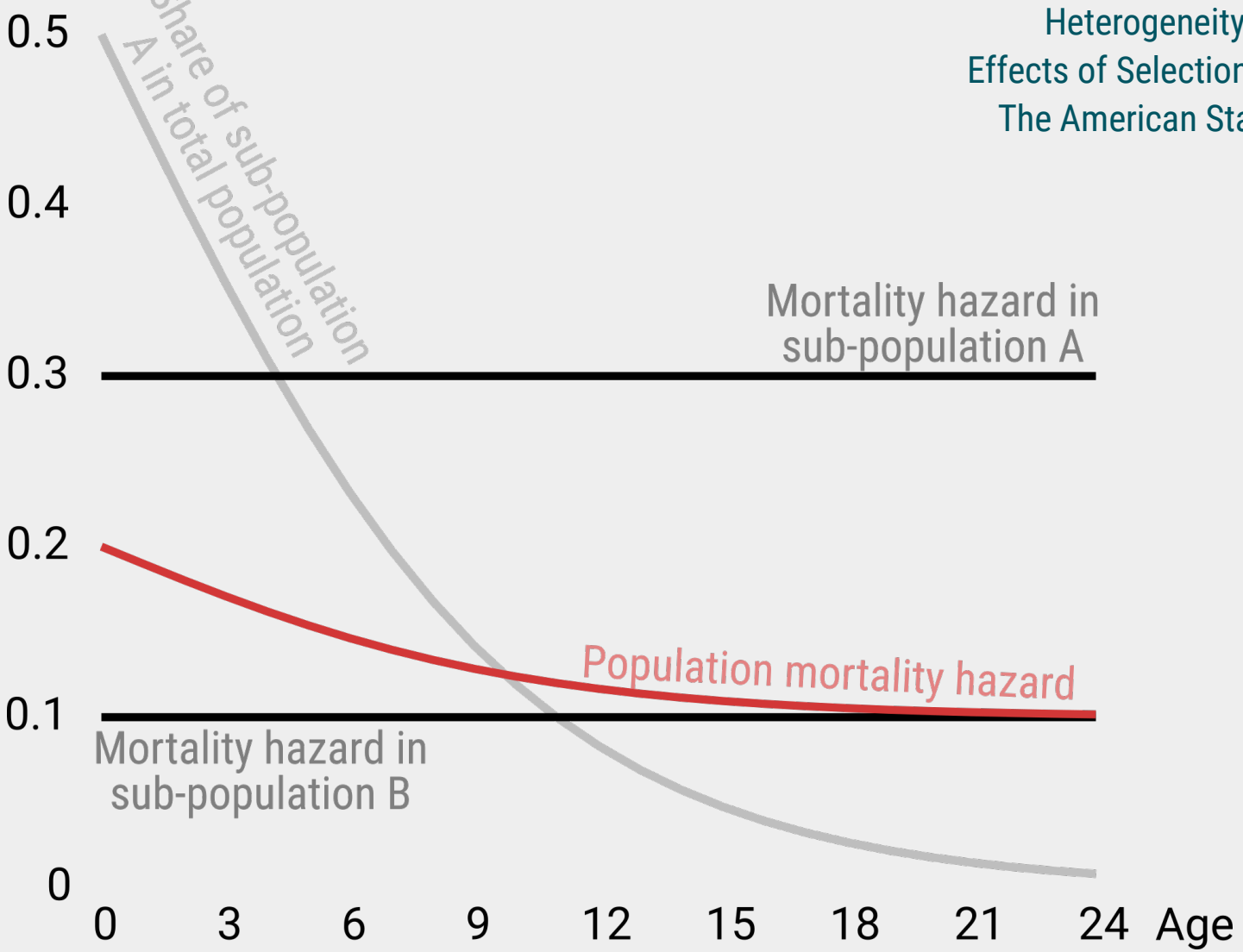


GRAPHIQUE nº 8. — Séparation des mortalités infantiles endogène et exogène. (schéma observé aux Etats-Unis en 1932).

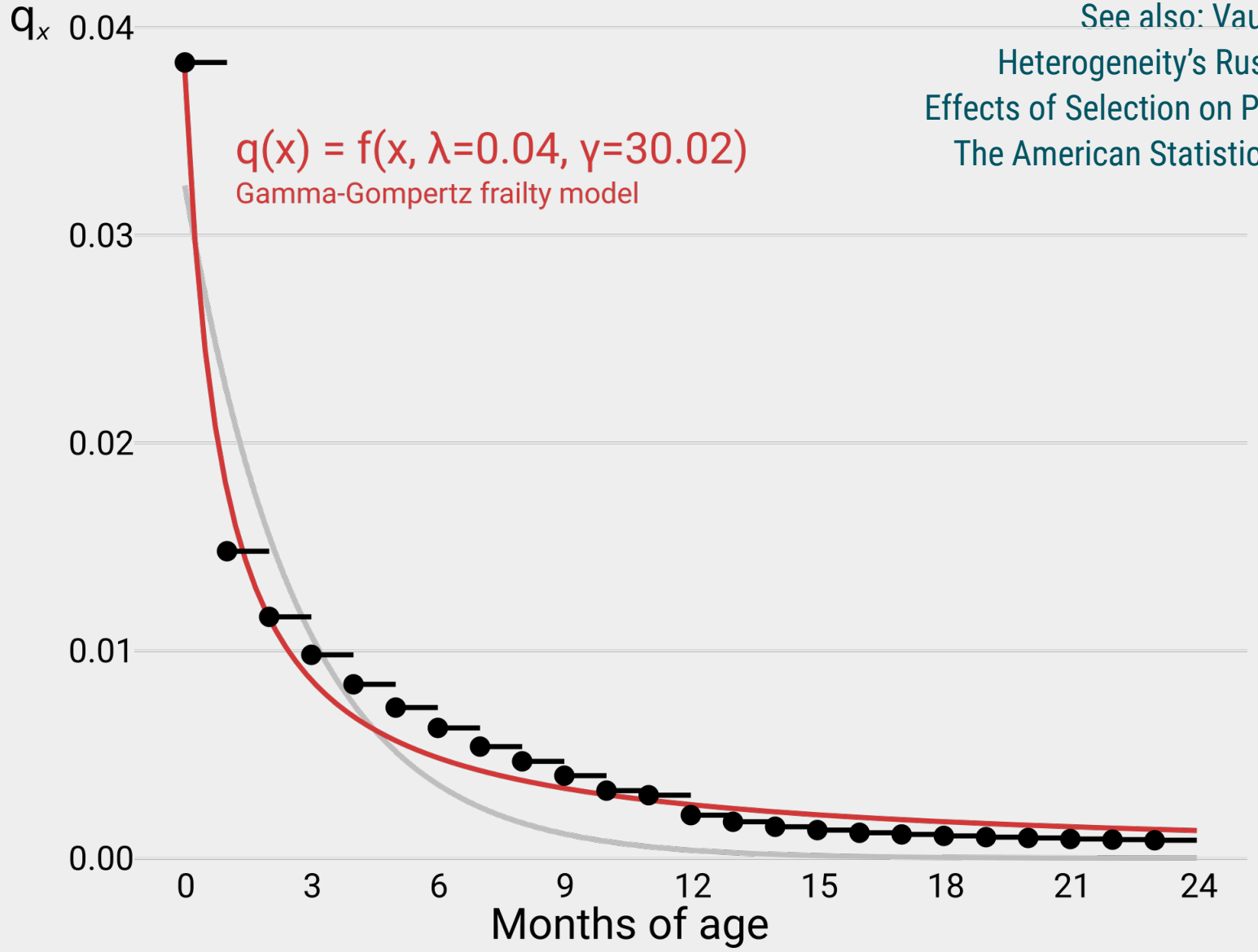
Bourgeois-Pichat, J. (1951). La mesure de la mortalité infantile. II. Les causes de décès. Population, 6(3), 459–480.

Mortality decline as mortality selection

See also: Vaupel & Yashin (1985). Heterogeneity's Ruses: Some Surprising Effects of Selection on Population Dynamics. The American Statistician, 39(3), 176–185.

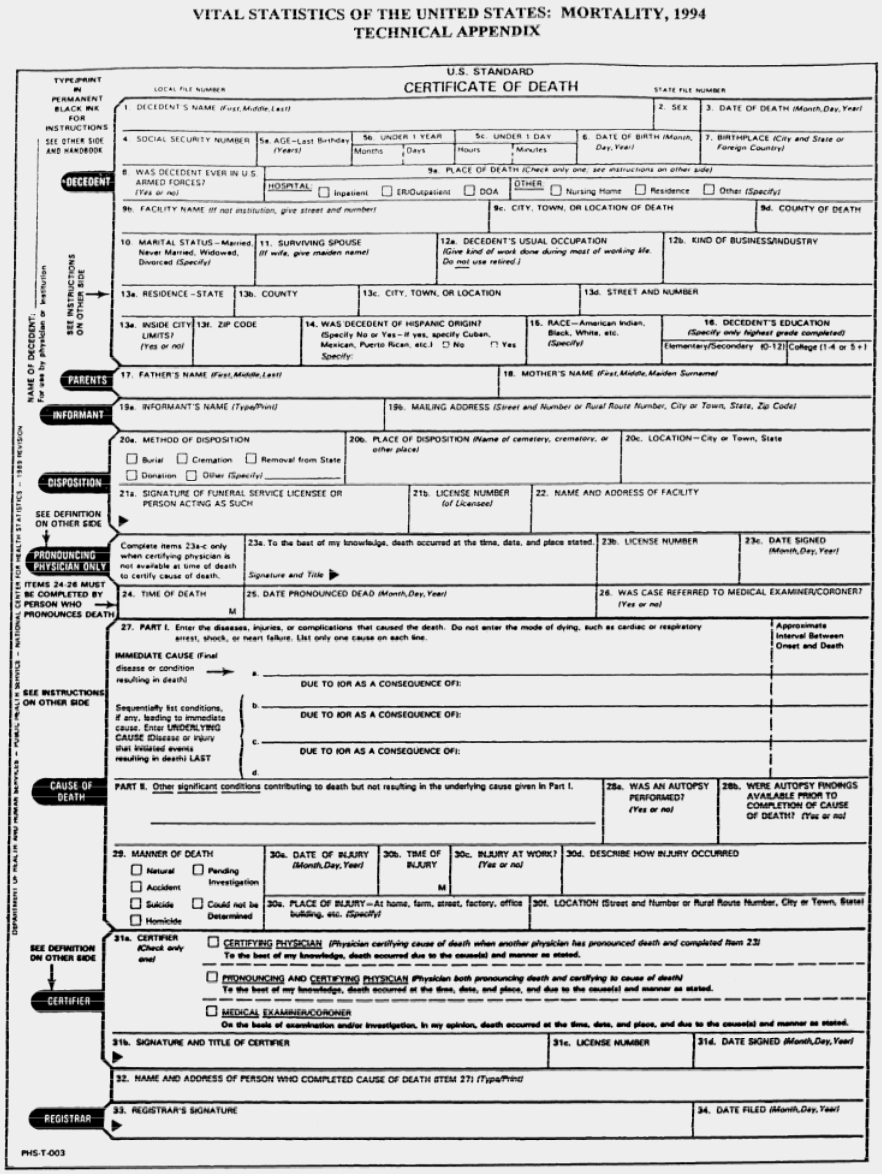


Mortality decline as mortality selection



See also: Vaupel & Yashin (1985). Heterogeneity's Ruses: Some Surprising Effects of Selection on Population Dynamics. The American Statistician, 39(3), 176–185.

Overcoming guesswork by using individual level data



VITAL STATISTICS OF THE UNITED STATES: MORTALITY, 1994
TECHNICAL APPENDIX

U.S. STANDARD
CERTIFICATE OF DEATH

TYPE/PRINT IN PERMANENT BLACK INK FOR INSTRUCTIONS SEE OTHER SIDE AND HANDBOOK

LOCAL FILE NUMBER — STATE FILE NUMBER

DECEDENT

1. DECEDENT'S NAME (First, Middle, Last) — 2. SEX — 3. DATE OF DEATH (Month, Day, Year)
4. SOCIAL SECURITY NUMBER — 5a. AGE–Last Birthday (Years) — 5b. UNDER 1 YEAR (Months, Days) — 5c. UNDER 1 DAY (Hours, Minutes) — 6. DATE OF BIRTH (Month, Day, Year) — 7. BIRTHPLACE (City and State or Foreign Country)
8. WAS DECEDENT EVER IN U.S. ARMED FORCES? (Yes or no)
9a. PLACE OF DEATH (Check only one; see instructions on other side)
HOSPITAL: ☐ Inpatient ☐ ER/Outpatient ☐ DOA — OTHER: ☐ Nursing Home ☐ Residence ☐ Other (Specify)
9b. FACILITY NAME (If not institution, give street and number) — 9c. CITY, TOWN, OR LOCATION OF DEATH — 9d. COUNTY OF DEATH
10. MARITAL STATUS–Married, Never Married, Widowed, Divorced (Specify) — 11. SURVIVING SPOUSE (If wife, give maiden name) — 12a. DECEDENT'S USUAL OCCUPATION (Give kind of work done during most of working life. Do not use retired.) — 12b. KIND OF BUSINESS/INDUSTRY
13a. RESIDENCE–STATE — 13b. COUNTY — 13c. CITY, TOWN, OR LOCATION — 13d. STREET AND NUMBER
13e. INSIDE CITY LIMITS? (Yes or no) — 13f. ZIP CODE — 14. WAS DECEDENT OF HISPANIC ORIGIN? (Specify No or Yes–If yes, specify Cuban, Mexican, Puerto Rican, etc.) ☐ No ☐ Yes Specify: — 15. RACE–American Indian, Black, White, etc. (Specify) — 16. DECEDENT'S EDUCATION (Specify only highest grade completed) Elementary/Secondary (0–12) — College (1–4 or 5+)

SEE INSTRUCTIONS ON OTHER SIDE

NAME OF DECEDENT: To be completed by physician or institution

PARENTS

17. FATHER'S NAME (First, Middle, Last) — 18. MOTHER'S NAME (First, Middle, Maiden Surname)

INFORMANT

19a. INFORMANT'S NAME (Type/Print) — 19b. MAILING ADDRESS (Street and Number or Rural Route Number, City or Town, State, Zip Code)

DISPOSITION

20a. METHOD OF DISPOSITION: ☐ Burial ☐ Cremation ☐ Removal from State ☐ Donation ☐ Other (Specify) — 20b. PLACE OF DISPOSITION (Name of cemetery, crematory, or other place) — 20c. LOCATION–City or Town, State
21a. SIGNATURE OF FUNERAL SERVICE LICENSEE OR PERSON ACTING AS SUCH — 21b. LICENSE NUMBER (of Licensee) — 22. NAME AND ADDRESS OF FACILITY

SEE DEFINITION ON OTHER SIDE

PRONOUNCING PHYSICIAN ONLY

Complete items 23a–c only when certifying physician is not available at time of death to certify cause of death.
23a. To the best of my knowledge, death occurred at the time, date, and place stated. Signature and Title — 23b. LICENSE NUMBER — 23c. DATE SIGNED (Month, Day, Year)

ITEMS 24–26 MUST BE COMPLETED BY PERSON WHO PRONOUNCES DEATH

24. TIME OF DEATH — 25. DATE PRONOUNCED DEAD (Month, Day, Year) — 26. WAS CASE REFERRED TO MEDICAL EXAMINER/CORONER? (Yes or no)

CAUSE OF DEATH

27. PART I. Enter the diseases, injuries, or complications that caused the death. Do not enter the mode of dying, such as cardiac or respiratory arrest, shock, or heart failure. List only one cause on each line. — Approximate Interval Between Onset and Death
IMMEDIATE CAUSE (Final disease or condition resulting in death) a. — DUE TO (OR AS A CONSEQUENCE OF):
Sequentially list conditions, if any, leading to immediate cause. Enter UNDERLYING CAUSE (Disease or injury that initiated events resulting in death) LAST
b. — DUE TO (OR AS A CONSEQUENCE OF):
c. — DUE TO (OR AS A CONSEQUENCE OF):
d.

SEE INSTRUCTIONS ON OTHER SIDE

PART II. Other significant conditions contributing to death but not resulting in the underlying cause given in Part I.
28a. WAS AN AUTOPSY PERFORMED? (Yes or no) — 28b. WERE AUTOPSY FINDINGS AVAILABLE PRIOR TO COMPLETION OF CAUSE OF DEATH? (Yes or no)

29. MANNER OF DEATH: ☐ Natural ☐ Accident ☐ Suicide ☐ Homicide ☐ Pending Investigation ☐ Could not be Determined
30a. DATE OF INJURY (Month, Day, Year) — 30b. TIME OF INJURY — 30c. INJURY AT WORK? (Yes or no) — 30d. DESCRIBE HOW INJURY OCCURRED
30e. PLACE OF INJURY–At home, farm, street, factory, office building, etc. (Specify) — 30f. LOCATION (Street and Number or Rural Route Number, City or Town, State)

SEE DEFINITION ON OTHER SIDE

CERTIFIER

31a. CERTIFIER (Check only one)
☐ CERTIFYING PHYSICIAN (Physician certifying cause of death when another physician has pronounced death and completed Item 23) To the best of my knowledge, death occurred due to the cause(s) and manner as stated.
☐ PRONOUNCING AND CERTIFYING PHYSICIAN (Physician both pronouncing death and certifying to cause of death) To the best of my knowledge, death occurred at the time, date, and place, and due to the cause(s) and manner as stated.
☐ MEDICAL EXAMINER/CORONER On the basis of examination and/or investigation, in my opinion, death occurred at the time, date, and place, and due to the cause(s) and manner as stated.
31b. SIGNATURE AND TITLE OF CERTIFIER — 31c. LICENSE NUMBER — 31d. DATE SIGNED (Month, Day, Year)

32. NAME AND ADDRESS OF PERSON WHO COMPLETED CAUSE OF DEATH (ITEM 27) (Type/Print)

REGISTRAR

33. REGISTRAR'S SIGNATURE — 34. DATE FILED (Month, Day, Year)

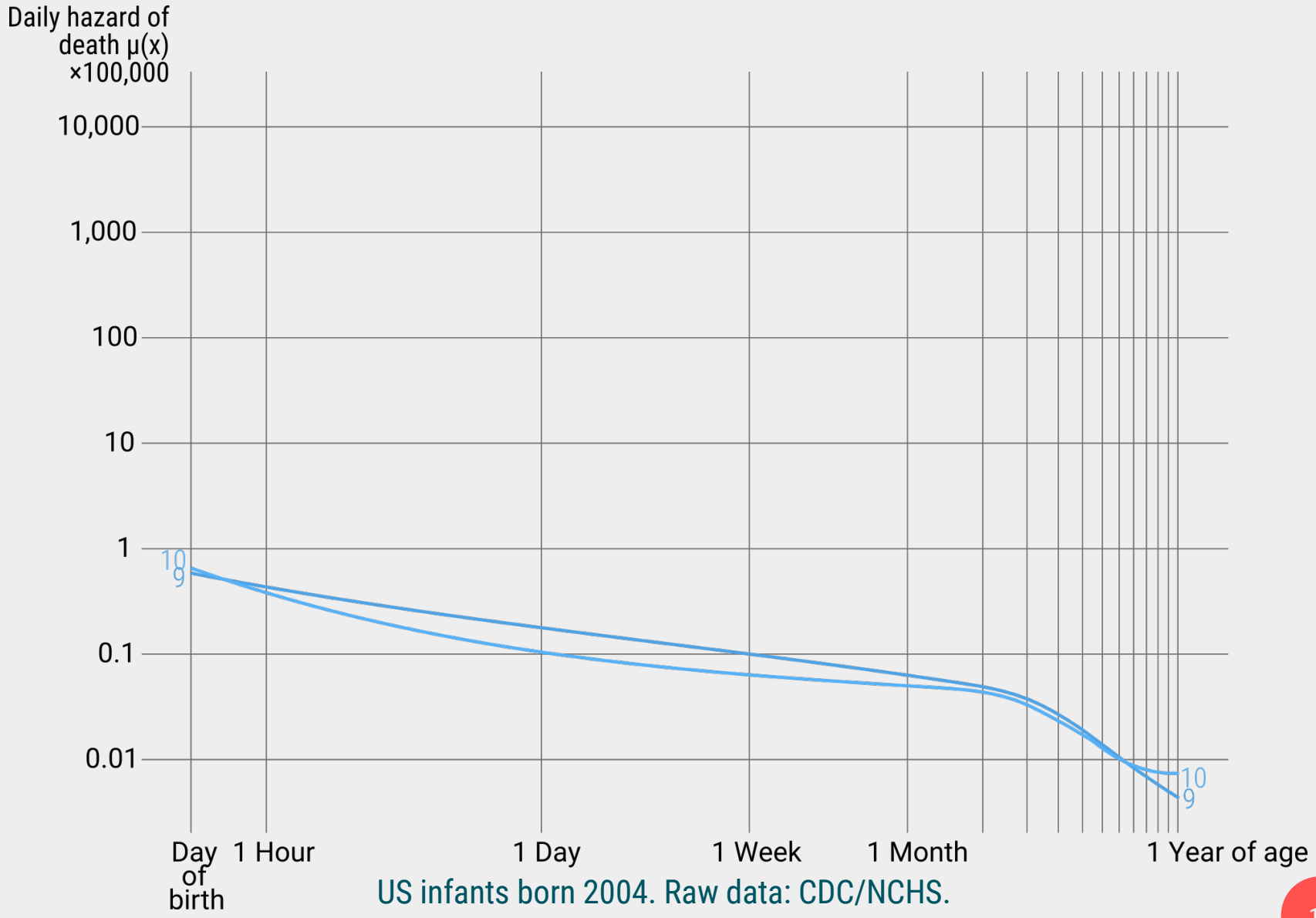
DEPARTMENT OF HEALTH AND HUMAN SERVICES – PUBLIC HEALTH SERVICE – NATIONAL CENTER FOR HEALTH STATISTICS – 1989 REVISION

PHS-T-003

The NCHS provides:

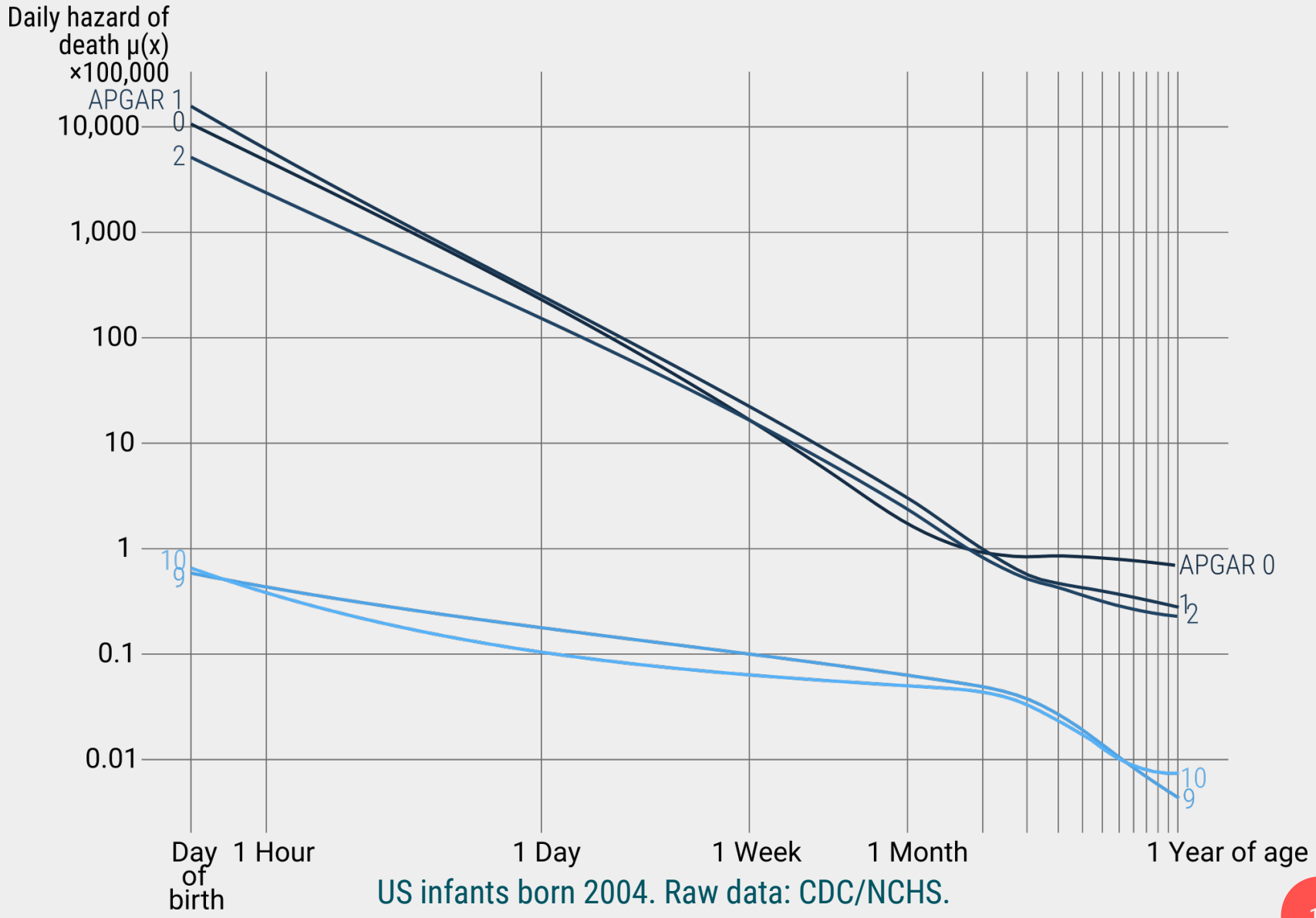
- birth certificates on **~70 million US births** over period 1995–2010
- death certificates on the 439,215 infant deaths during that time

A demonstration of mortality selection



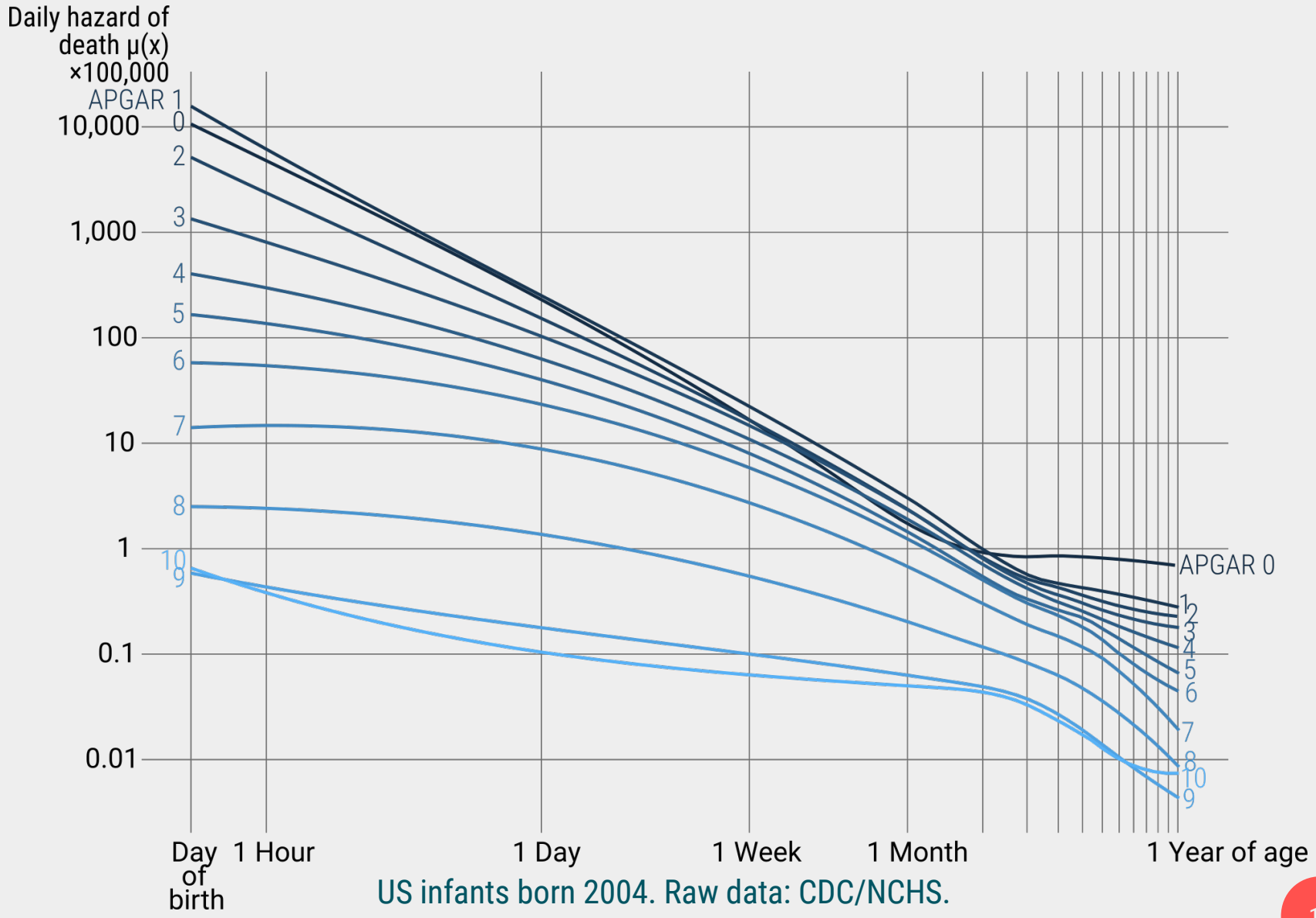
US infants born 2004. Raw data: CDC/NCHS.

A demonstration of mortality selection



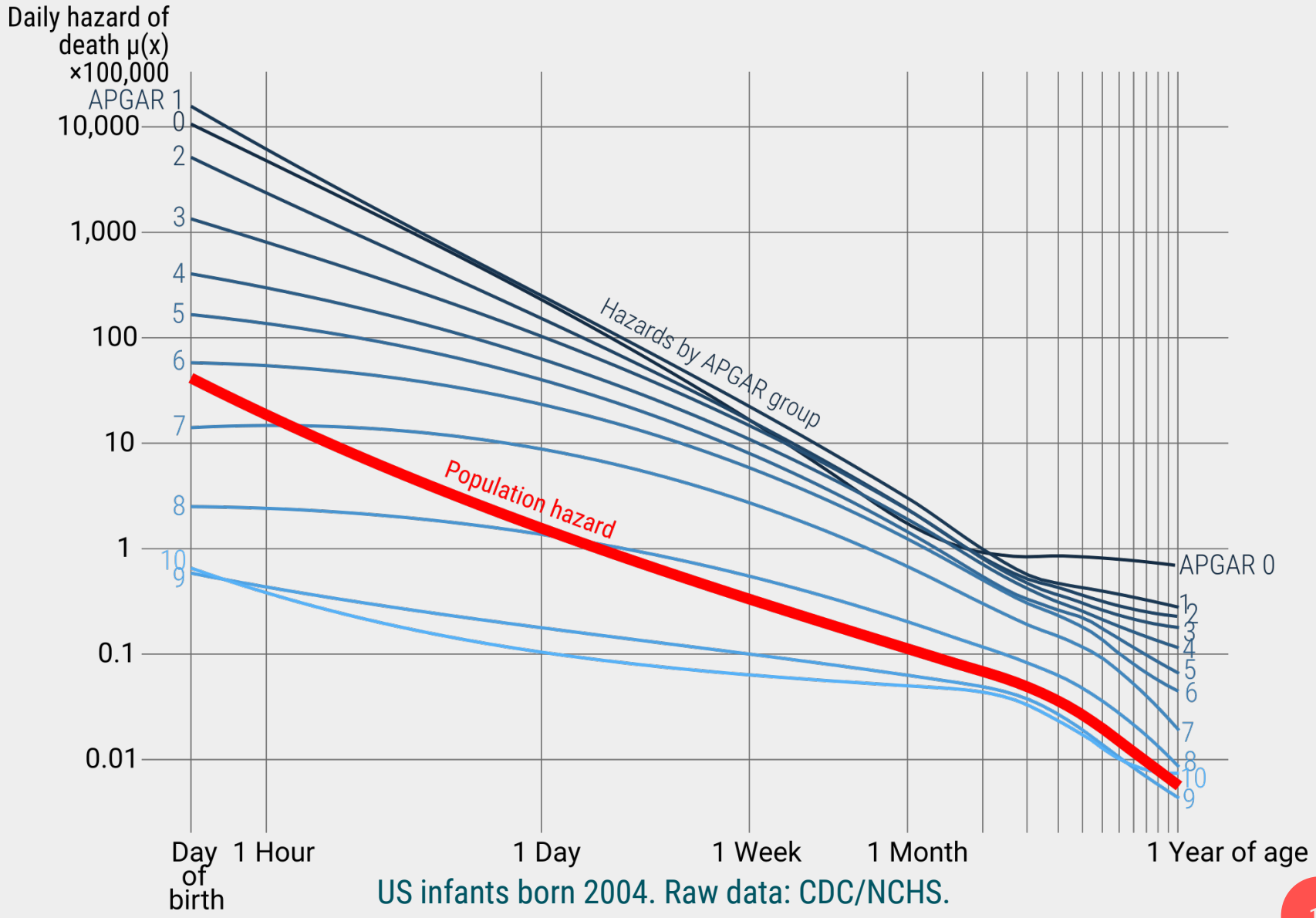
US infants born 2004. Raw data: CDC/NCHS.

A demonstration of mortality selection



US infants born 2004. Raw data: CDC/NCHS.

A demonstration of mortality selection



US infants born 2004. Raw data: CDC/NCHS.

Decomposition methods

$$\underbrace{Y(A)|X_A - Y(B)|X_B}_{\text{Total difference in outcome between groups A and B}} = \underbrace{(A\text{-}B)}_{\text{Difference due to group effect}} + \underbrace{(X_A\text{-}X_B)}_{\text{Difference due to group composition}}$$

Decomposition methods

Vaupel, J. W., & Zhang, Z. (2010). **Attrition in heterogeneous cohorts**. Demographic Research, 23(26), 737–748.

Oaxaca, R. (1973). "**Male-Female Wage Differentials in Urban Labor Markets**". International Economic Review. 14 (3): 693–709.

Price, G. R. (1970). **Selection and covariance**. Nature, 227(5257), 520–1.

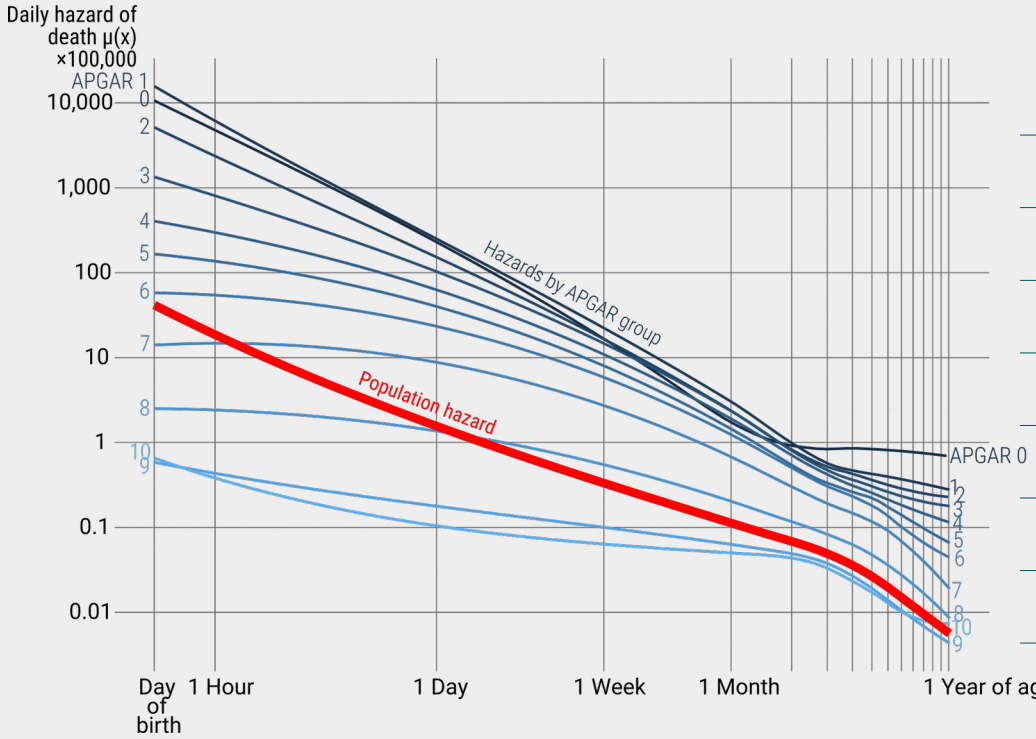
$$\underbrace{Y(A)|X_A - Y(B)|X_B}_{\text{Total difference in outcome between groups A and B}} = \underbrace{(A\text{-}B)}_{\text{Difference due to group effect}} + \underbrace{(X_A\text{-}X_B)}_{\text{Difference due to group composition}}$$

Powers, D. A., Yoshioka, H., & Yun, M.-S. (2011). **mvdcmp: Multivariate decomposition for nonlinear response models.** The Stata Journal, 11(4), 556–576.

Preston, S.H., Himes, C.L., and Eggers, M. (1989). **Demographic conditions responsible for population aging**. Demography 26(4): 691–704.

Vaupel, J.W. and Canudas-Romo, V. (2002). **Decomposing demographic change into direct vs. compositional components**. Demographic Research 7(1): 1–14.

Decomposing the infant mortality age decline



Δμ(x) over	Δμ(x) due to direct change	Δμ(x) due to comp. change	
		absolute	percent
1st hour of life	-6.32E-02	-1.76E-02	**21.8**
Hours 2–24	-4.24E-03	-7.50E-05	1.7
Day 1	-2.28E-04	-4.53E-07	0.2
Day 2	-1.08E-04	-1.04E-07	0
Day 3	-5.88E-05	-5.10E-08	0
Day 4	-3.33E-05	-2.59E-08	0
Day 5	-1.75E-05	-1.29E-08	0

Method: Vaupel, J.W. and Canudas-Romo, V. (2002). Decomposing demographic change into direct vs. compositional components. Demographic Research 7(1): 1–14.

Data: US infants born 2005-10. CDC/NCHS,

Decomposing the infant mortality age decline

Δμ(x) over	total Δμ(x)	% Δμ(x) due to direct change	% Δμ(x) due to compos. change
hour 0 to 24	2.86E-03	39.4	60.6

Method: Poisson regression on infant death counts decomposed using Powers, D. A., Yoshioka, H., & Yun, M.-S. (2011). mvdcmp: Multivariate decomposition for nonlinear response models. The Stata Journal, 11(4), 556–576.

Data: US infants born 2004. CDC/NCHS,

Decomposing the infant mortality age decline

		% Δμ(x) due to		share on compositional change				
Δμ(x) over	**total Δμ(x)**	direct change	compos. change	sex	birth-weigh	birth defect	5 min APGAR	Mother
hour 0 to 24	2.86E-03	39.4	**60.6**	0.00	**0.16**	0.04	**0.80**	0.00

Method: Poisson regression on infant death counts decomposed using Powers, D. A., Yoshioka, H., & Yun, M.-S. (2011). mvdcmp: Multivariate decomposition for nonlinear response models. The Stata Journal, 11(4), 556–576.

Data: US infants born 2004. CDC/NCHS,

Decomposing the infant mortality age decline

Δμ(x) over	total Δμ(x)	% Δμ(x) due to		share on compositional change				
		direct change	compos. change	sex	birth-weigh	birth defect	5 min APGAR	Mother
hour 0 to 24	2.86E-03	39.4	**60.6**	0.00	0.16	0.04	0.80	0.00
Day 2 to 7	7.84E-06	85.5	14.5	0.00	0.27	0.13	0.59	0.01
Week 2 to 4	1.72E-06	91.7	8.3	0.00	0.25	0.24	0.49	0.02
Month 2 to 12	1.69E-06	93.7	6.3	0.00	0.52	0.20	0.28	0.00

Method: Poisson regression on infant death counts decomposed using Powers, D. A., Yoshioka, H., & Yun, M.-S. (2011). mvdcmp: Multivariate decomposition for nonlinear response models. The Stata Journal, 11(4), 556–576.

Data: US infants born 2004. CDC/NCHS,

Conclusion

Mortality selection drives the mortality decline immediately after birth

Still, most of the infant mortality decline over age is due to individual level effects.

More on this project

github.com/jschoeley/imort_select

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