

Selection in infant mortality

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Max-Planck Odense Center on the
Biodemography of Aging

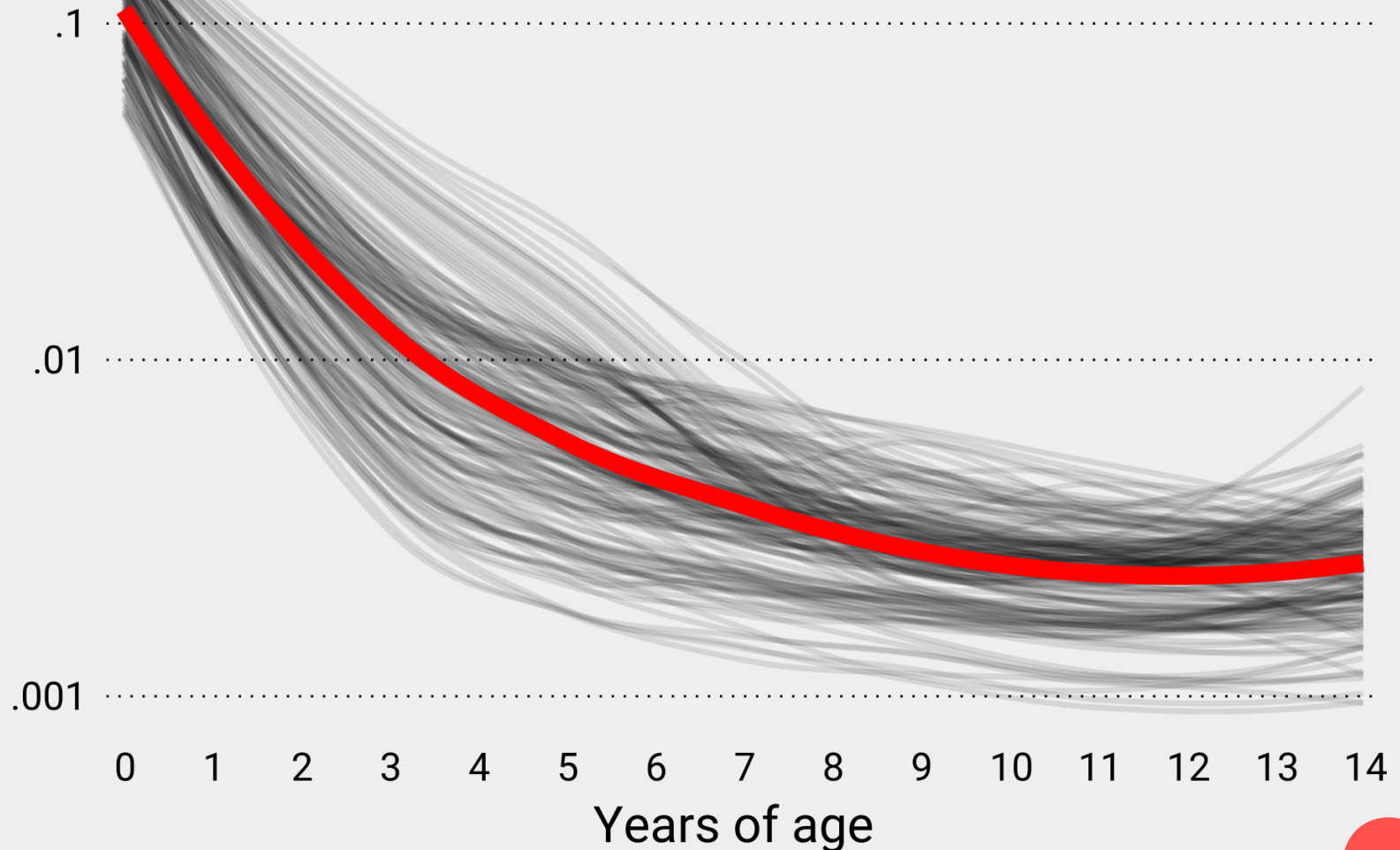


Department of Public Health
University of Southern Denmark

The age pattern of early life mortality

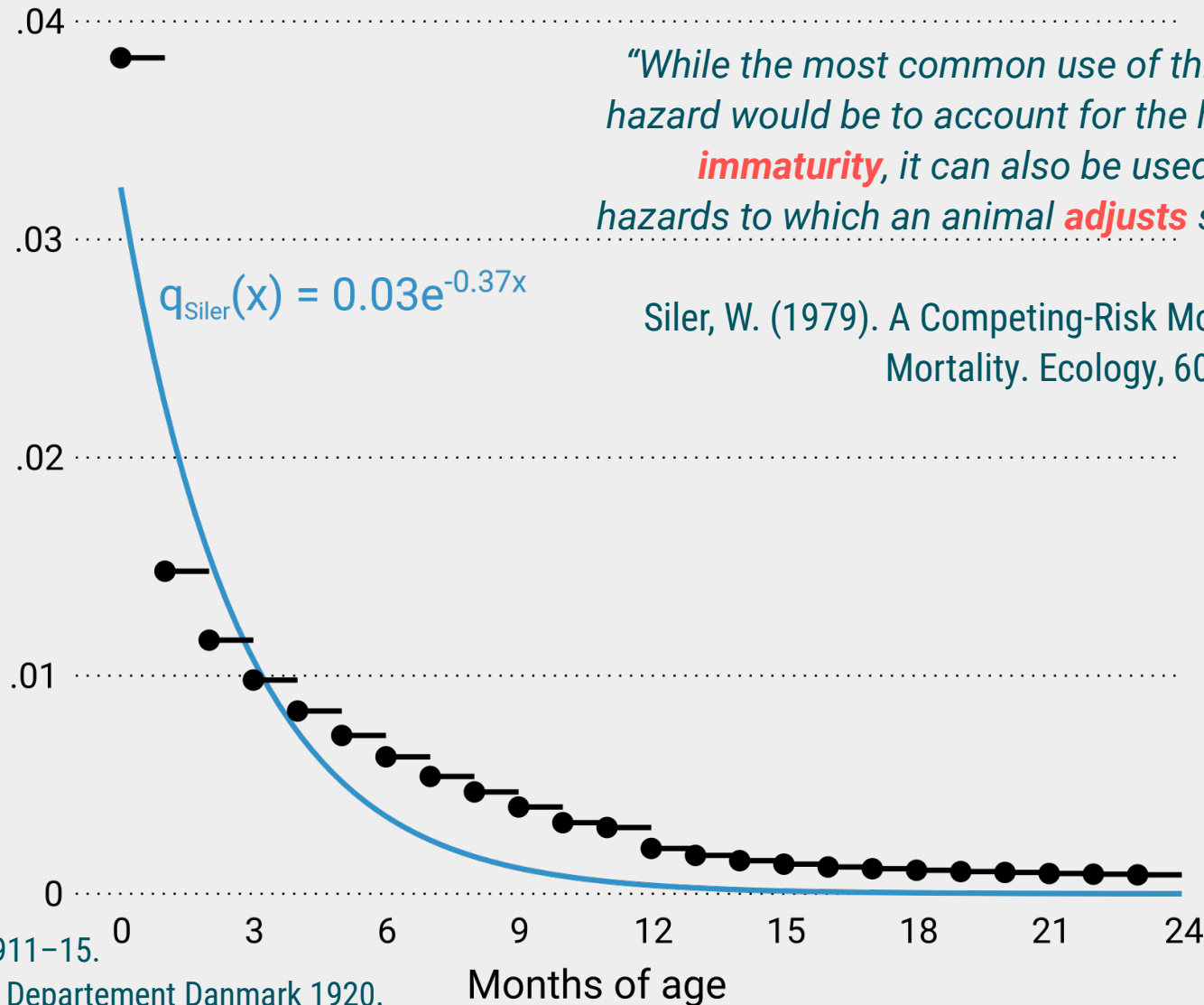
Deaths per
person-year
of exposure

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



Mortality decline as growth and adaptation

Probability to die
within 30 days
 ${}_1q_x$



*“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.”*

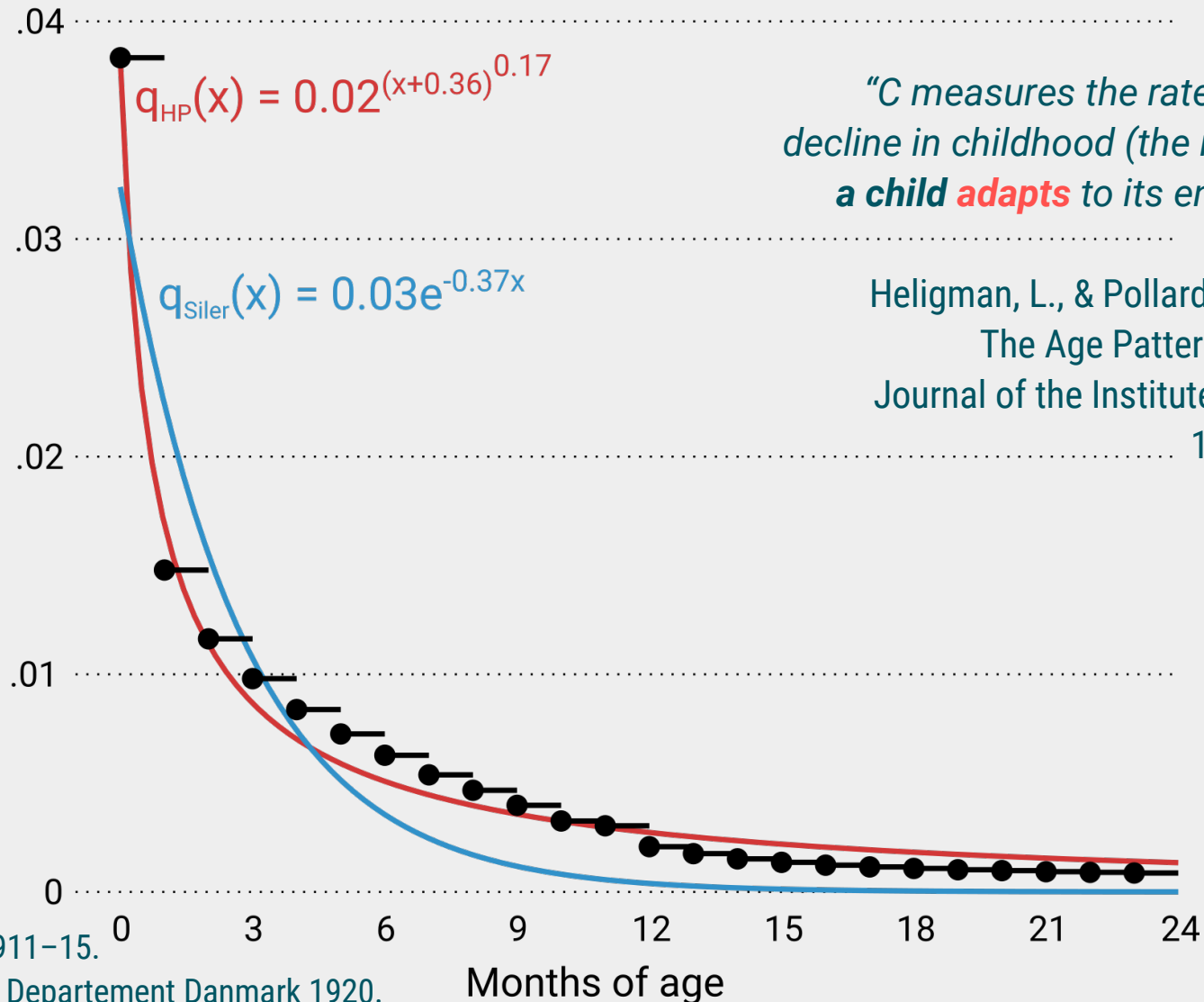
Siler, W. (1979). A Competing-Risk Model for Animal Mortality. *Ecology*, 60(4), 750–757.

Danish males born 1911–15.

Raw data: Statistiske Departement Danmark 1920.

Mortality decline as growth and adaptation

Probability to die
within 30 days
 ${}_1q_x$



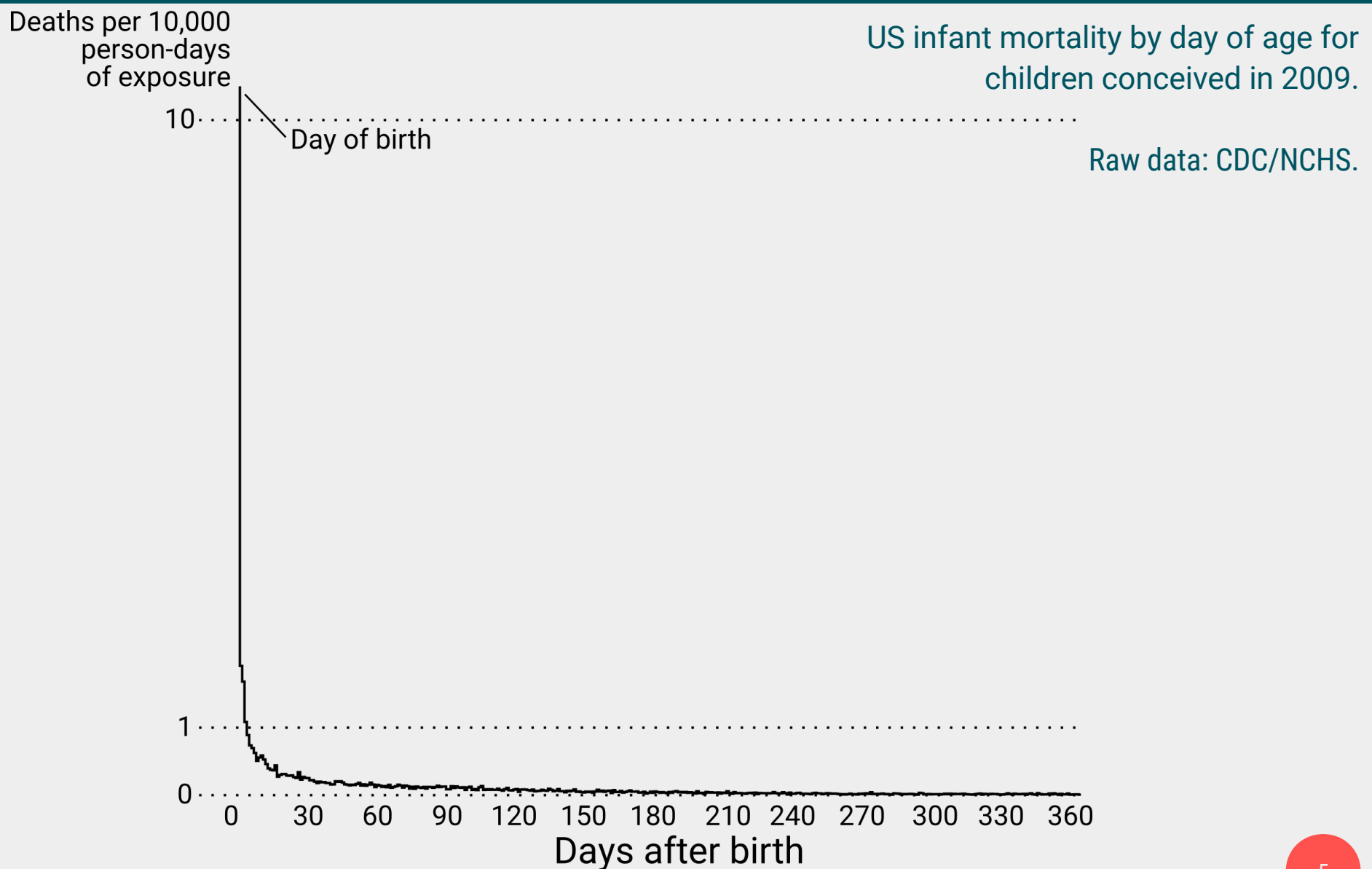
"C measures the rate of mortality decline in childhood (the rate at which a child adapts to its environment)."

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

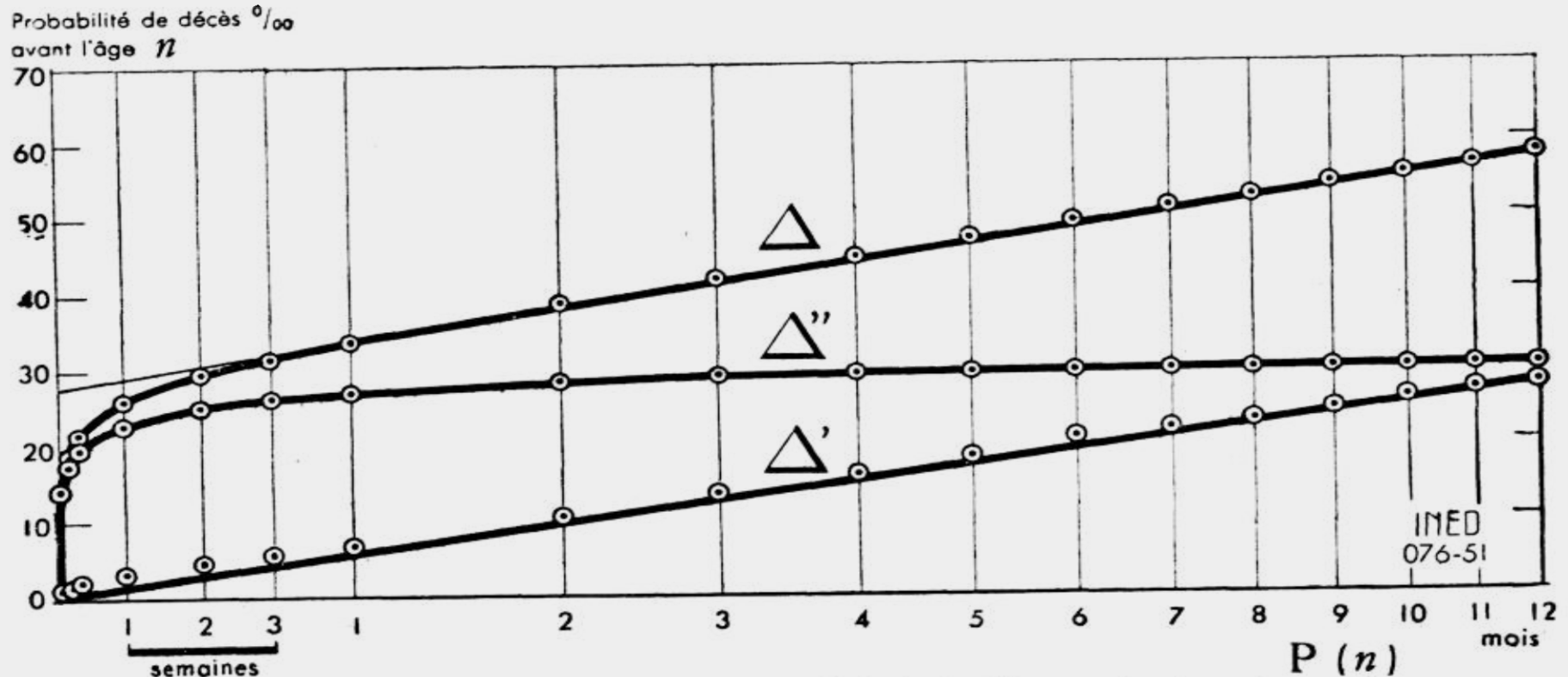
Danish males born 1911–15.

Raw data: Statistiske Departement Danmark 1920.

Mortality decline as mortality selection



Mortality decline as mortality selection



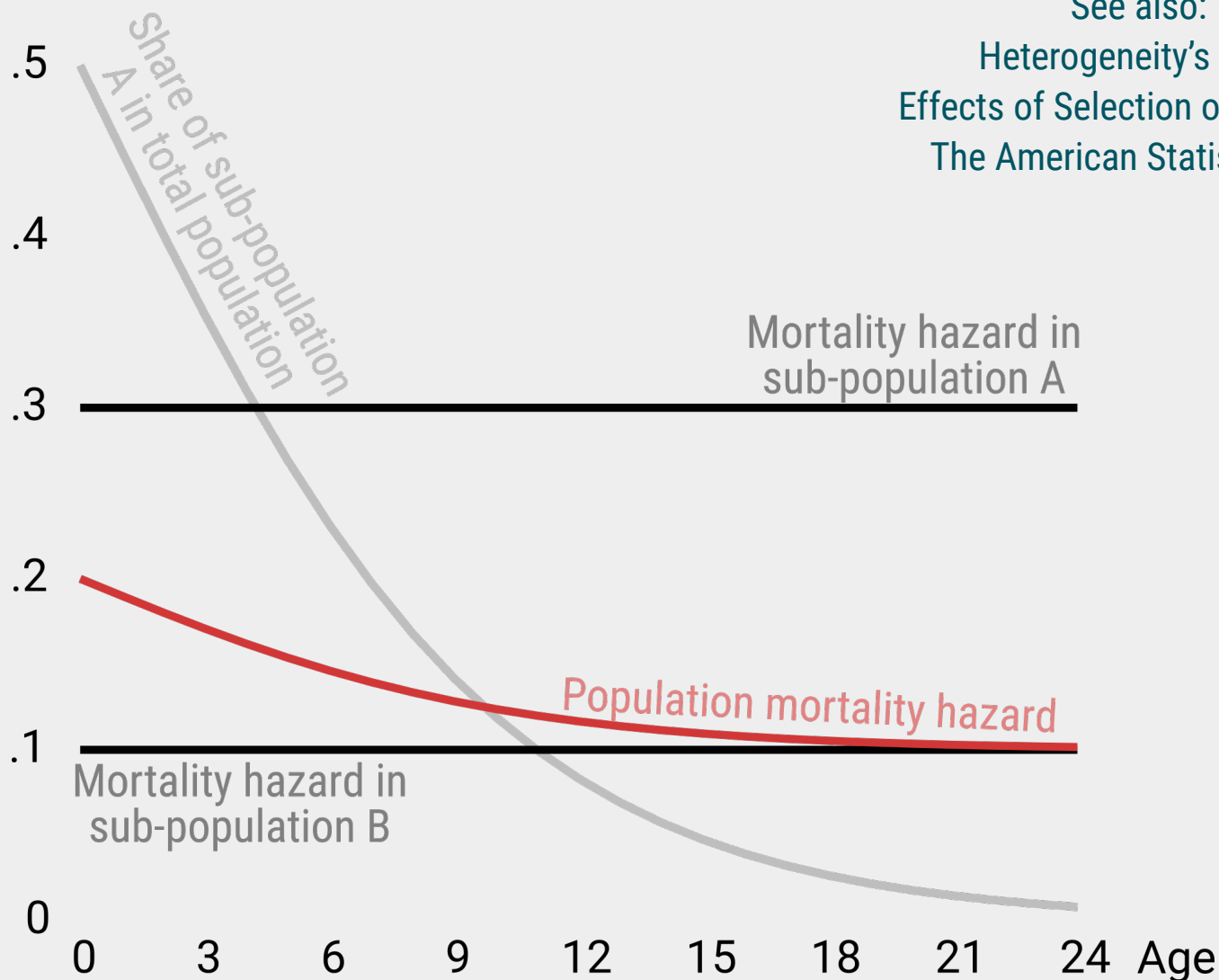
GRAPHIQUE n° 8. — Séparation des mortalités infantiles endogène et exogène.
(schéma observé aux États-Unis en 1932).

Bourgeois-Pichat, J. (1951). La mesure de la mortalité infantile.

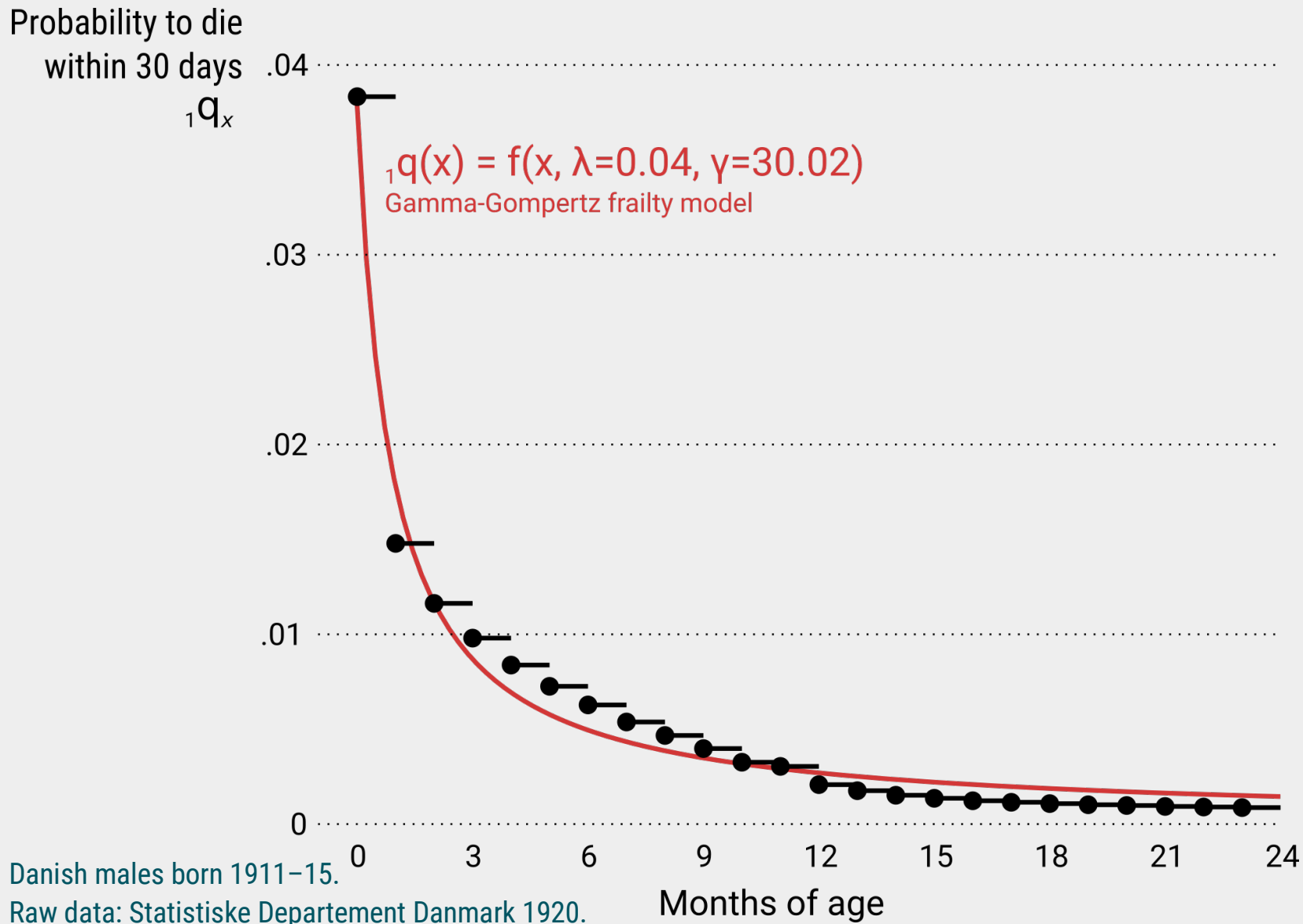
II. Les causes de décès. Population, 6(3), 459-480.

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



1. *Journal of the American Medical Association*, 1997; 278: 1039-1044.

TYPEPRINT IN PERMANENT BLACK INK FOR INSTRUCTIONS. SEE OTHER SIDE AND BACKSIDE.

NAME OF DECEDENT: For use by physician or institution

SEE INSTRUCTIONS ON OTHER SIDE

SEE DEFINITION ON OTHER SIDE

REGISTER

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE

CERTIFICATE OF DEATH

STATE FILE NUMBER _____

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) <input type="checkbox"/> HOSPITAL <input type="checkbox"/> Inpatient <input type="checkbox"/> Outpatient <input type="checkbox"/> DDA <input type="checkbox"/> OTHER <input type="checkbox"/> Nursing Home <input type="checkbox"/> Residence <input type="checkbox"/> 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
13a. INSIDE CITY	13c. ZIP CODE	14. WAS DECEDENT OF HISPANIC ORIGIN? (Specify No or Yes—if yes, specify Cuban, Mexican, Puerto Rican, etc.) <input type="checkbox"/> No <input type="checkbox"/> Yes (Specify)	15. RACE—American Indian, Black, White, etc. (Specify)
16. DECEDENT'S EDUCATION (Specify only highest grade completed) (Elementary/Secondary 8-12) College (1-4 or 5+)			
17. FATHER'S NAME (First, Middle, Last)		18. MOTHER'S NAME (First, Middle, Maiden Surname)	
19a. INFORMANT'S NAME (Type/Print)		19b. MAILING ADDRESS (Street and Number or Rural Route Number, City or Town, State, Zip Code)	
20a. METHOD OF DISPOSITION <input type="checkbox"/> Burial <input type="checkbox"/> Cremation <input type="checkbox"/> Removal from State <input type="checkbox"/> Donation <input type="checkbox"/> 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 (If Licensed)	22. NAME AND ADDRESS OF FACILITY	
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)
24. TIME OF DEATH	25. DATE PRONOUNCED DEAD (Month, Day, Year)	26. WAS CASE REFERRED TO MEDICAL EXAMINER/CORONER? (Yes or no)	

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.

<p>IMMEDIATE CAUSE (Final disease or condition resulting in death)</p> <p>a. _____</p> <p>b. _____</p> <p>c. _____</p> <p>d. _____</p>	<p>Approximate Interval Between Onset and Death</p>
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28. 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)
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29. MANNER OF DEATH <input type="checkbox"/> Natural <input type="checkbox"/> Pending Investigation <input type="checkbox"/> Accident <input type="checkbox"/> Could not be Determined <input type="checkbox"/> Suicide <input type="checkbox"/> Homicide	30a. DATE OF BLUJRY (Month, Day, Year)	30b. TIME OF BLUJRY _____	30c. BLUJRY AT WORK? (Yes or no)	30d. DESCRIBE HOW BLUJRY OCCURRED
30a. PLACE OF BLUJRY—At home, farm, street, factory, office, building, etc. (Specify)	30d. LOCATION (Street and Number or Rural Route Number, City or Town, State)			

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 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)		34. DATE FILED (Month, Day, Year)

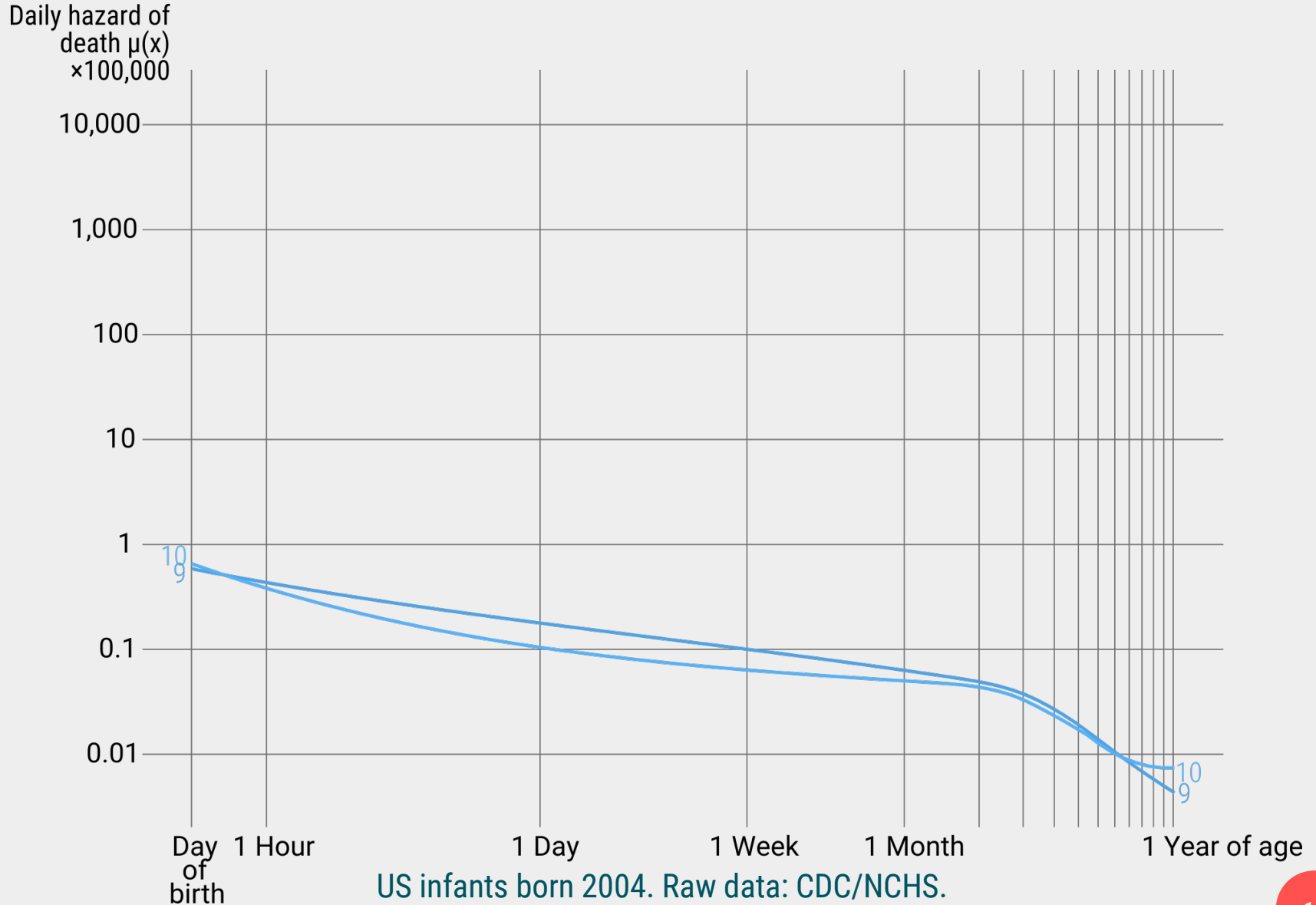
PHS-T-1003

birth certificates on

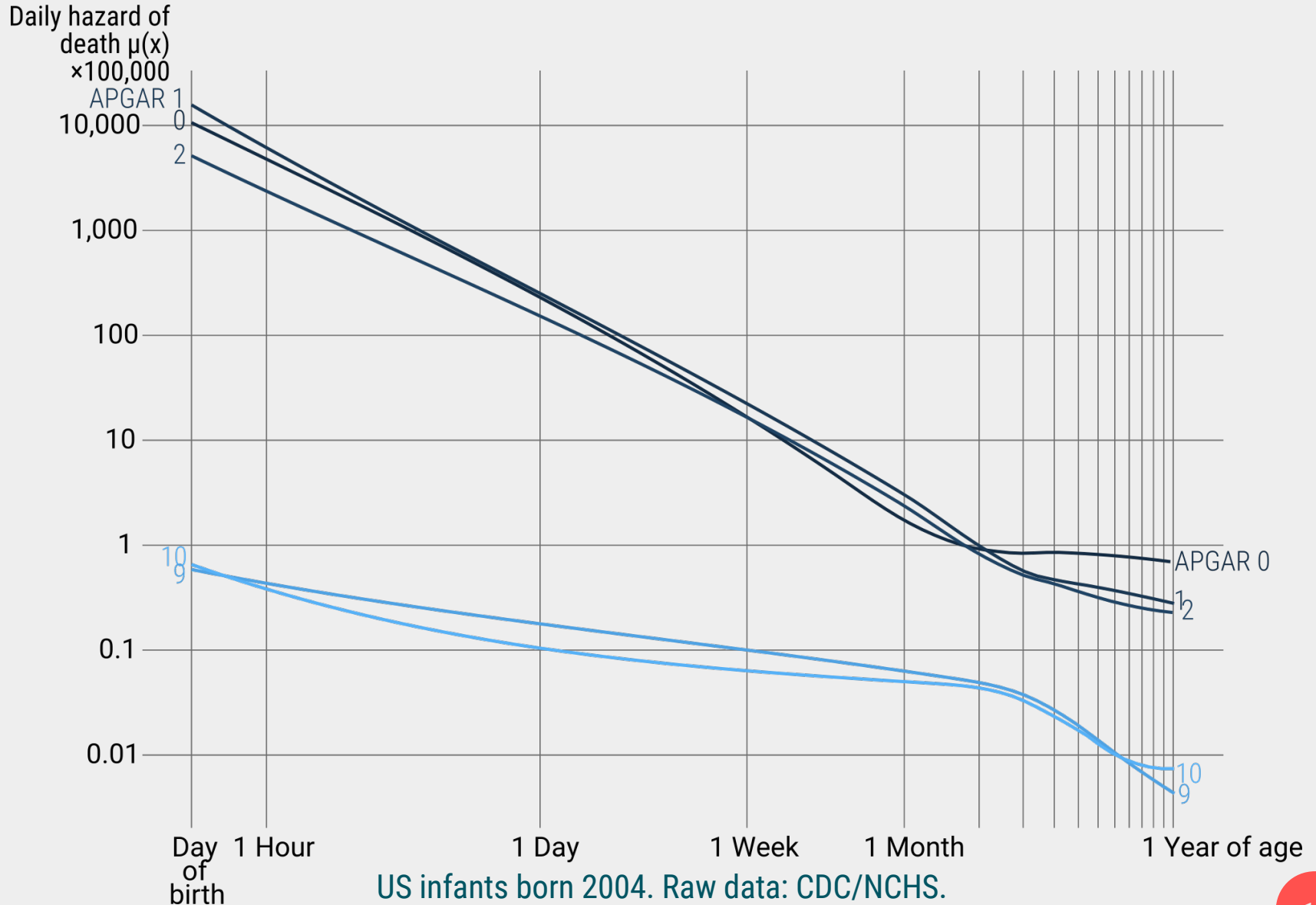
- birth certificates on **~70 million US births** over period 1995–2010
- death certificates on the 439,215 infant deaths during that time

[illegible]

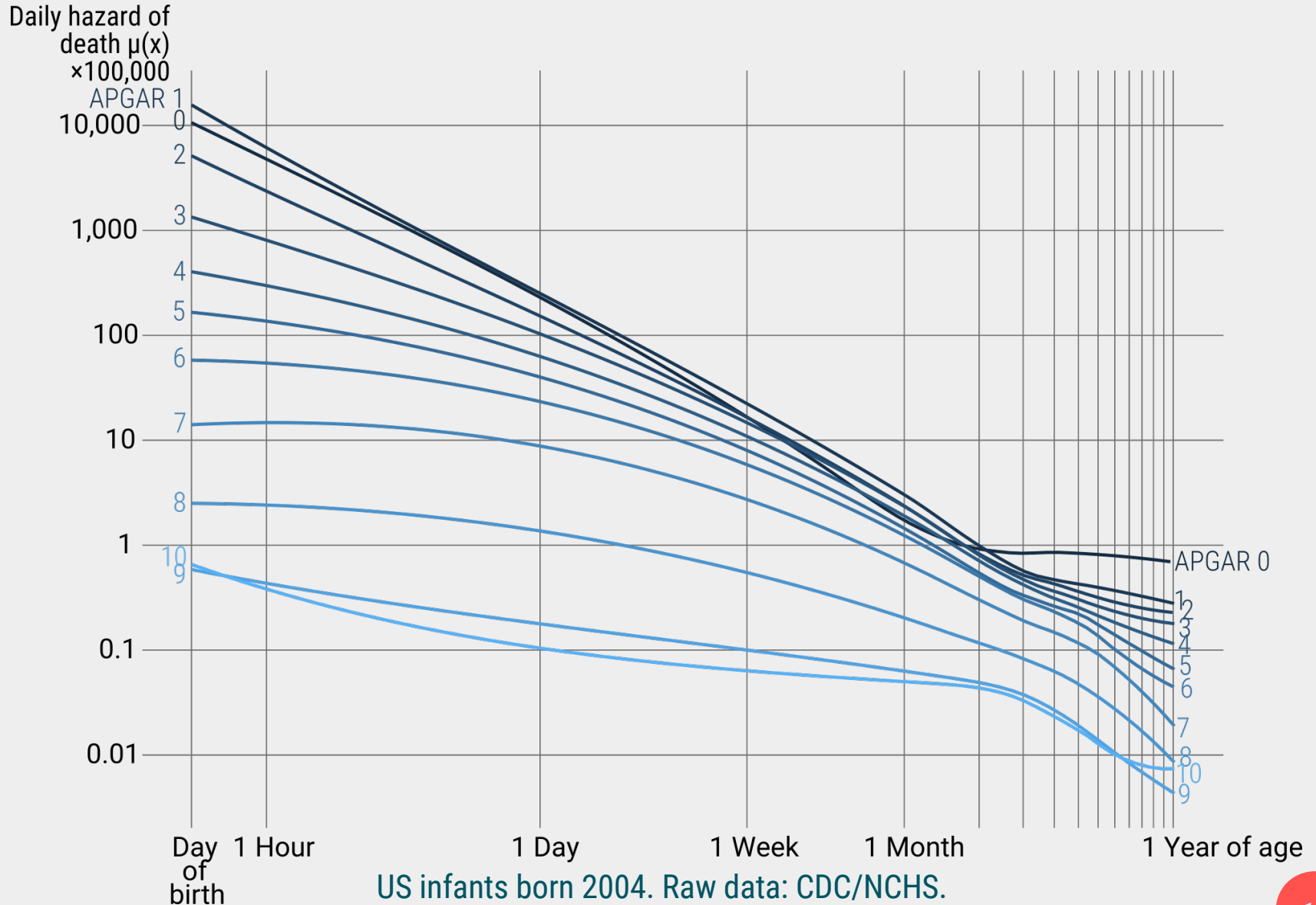
A demonstration of mortality selection



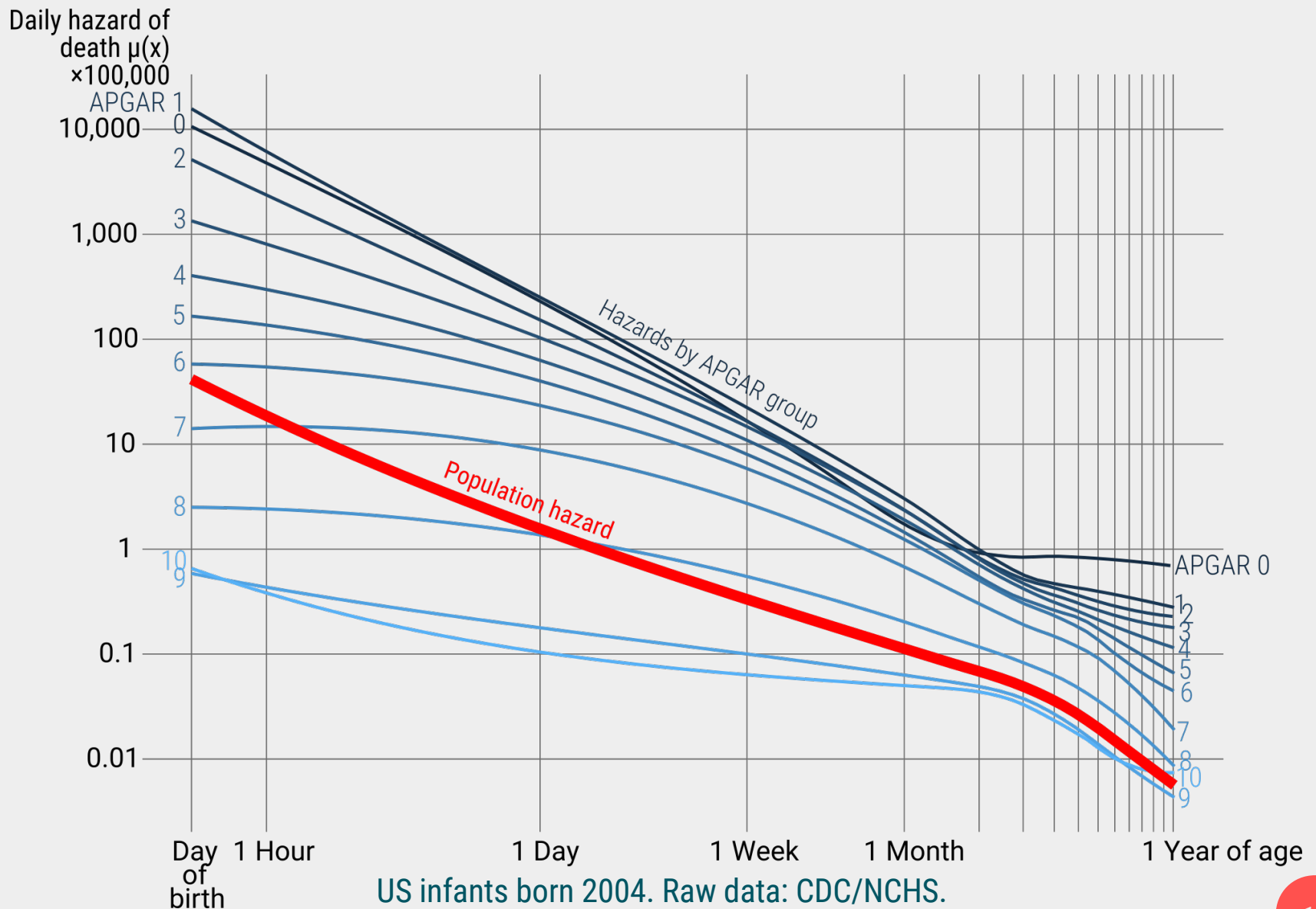
A demonstration of mortality selection



A demonstration of mortality selection



A demonstration of mortality selection



Decomposition methods

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

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.

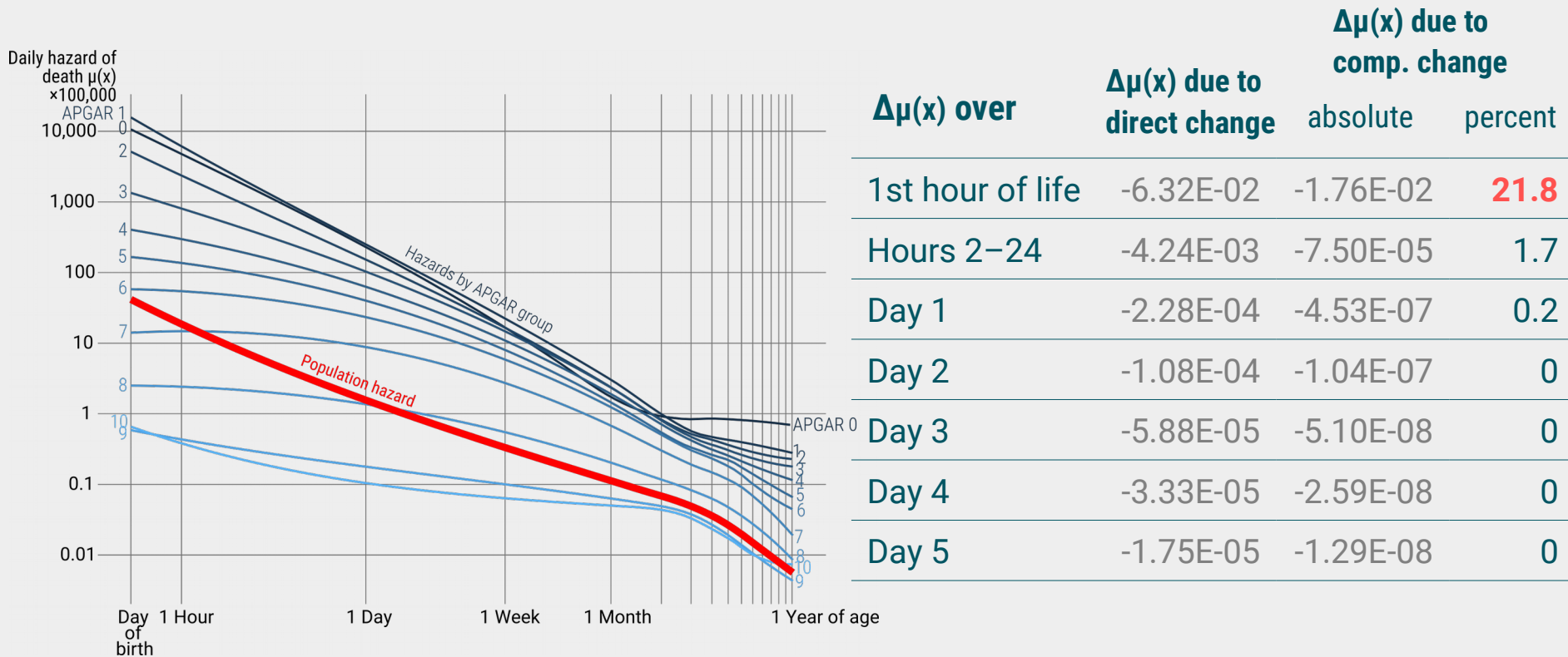
$$\underbrace{Y(A)|X_A - Y(B)|X_B}_{\text{Total difference in outcome between groups A and B}} = \underbrace{(A-B)}_{\text{Difference due to group effect}} + \underbrace{(X_A - X_B)}_{\text{Difference due to group composition}}$$

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



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

$\Delta\mu(x)$ over	total $\Delta\mu(x)$	% $\Delta\mu(x)$ due to	
		direct change	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

$\Delta\mu(x)$ over	total $\Delta\mu(x)$	% $\Delta\mu(x)$ due to		share on compositional change				
		direct change	compos. change	sex	birth-weight	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

$\Delta\mu(x)$ over	total $\Delta\mu(x)$	% $\Delta\mu(x)$ due to		share on compositional change				
		direct change	compos. change	sex	birth-weight	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,

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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