COUNTY-LEVEL SOCIOECONOMIC DEPRIVATION, DEMOGRAPHICS, AND ULTRA-EARLY MORTALITY IN ADULT ACUTE LYMPHOBLASTIC LEUKAEMIA: A SEER-17 ANALYSIS

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Introduction

Adult acute lymphoblastic leukemia (ALL) is uncommon but carries substantial mortality in adults despite therapeutic advances, including broader adoption of pediatric-inspired regimens. Ultra-early death (≤30/90 days) is a sensitive safety and equity metric, yet its social determinants are under-characterized in national data. County-level socioeconomic deprivation is linked to worse cancer outcomes and may shape early ALL mortality.

Aim

To quantify the independent effects of age, sex, race/ethnicity, and 2023-adjusted county income on 30- and 90-day mortality after adult ALL diagnosis in SEER-17 (2000–2022).

Objectives

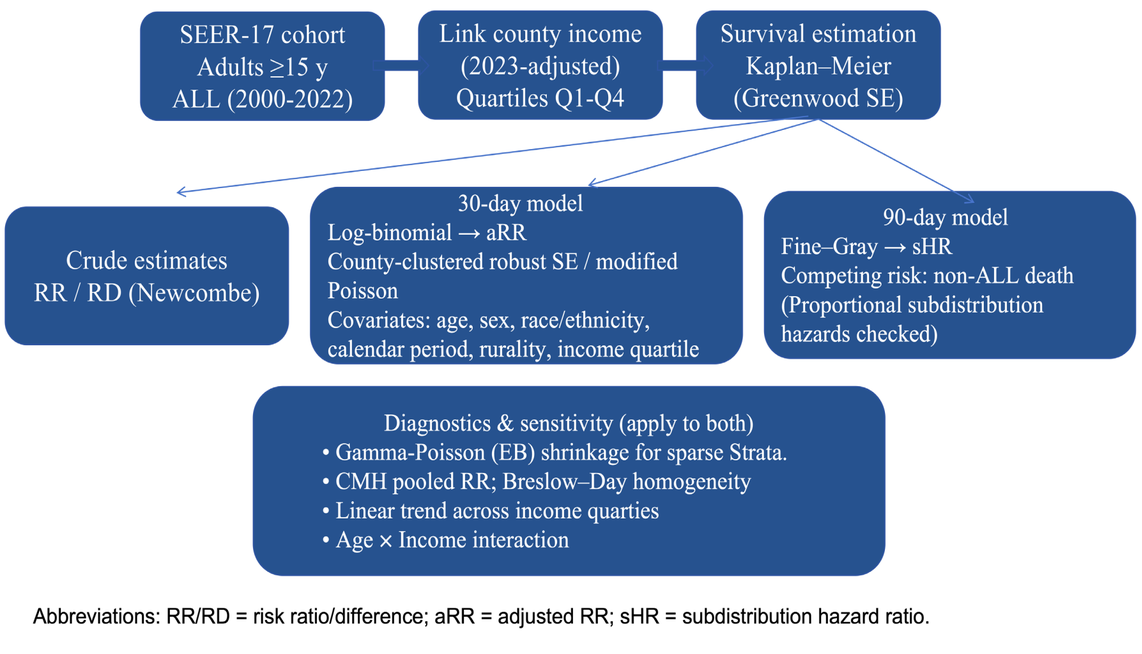
(1) Estimate 30/90-day mortality by age, sex, race/ethnicity, and income quartile.

(2) Compare crude vs adjusted risks using log-binomial (30 d) and Fine-Gray competing-risk models (90 d).

(3) Test linear trend across income quartiles and age × income interaction.
(4) Translate findings into equity-focused interventions.

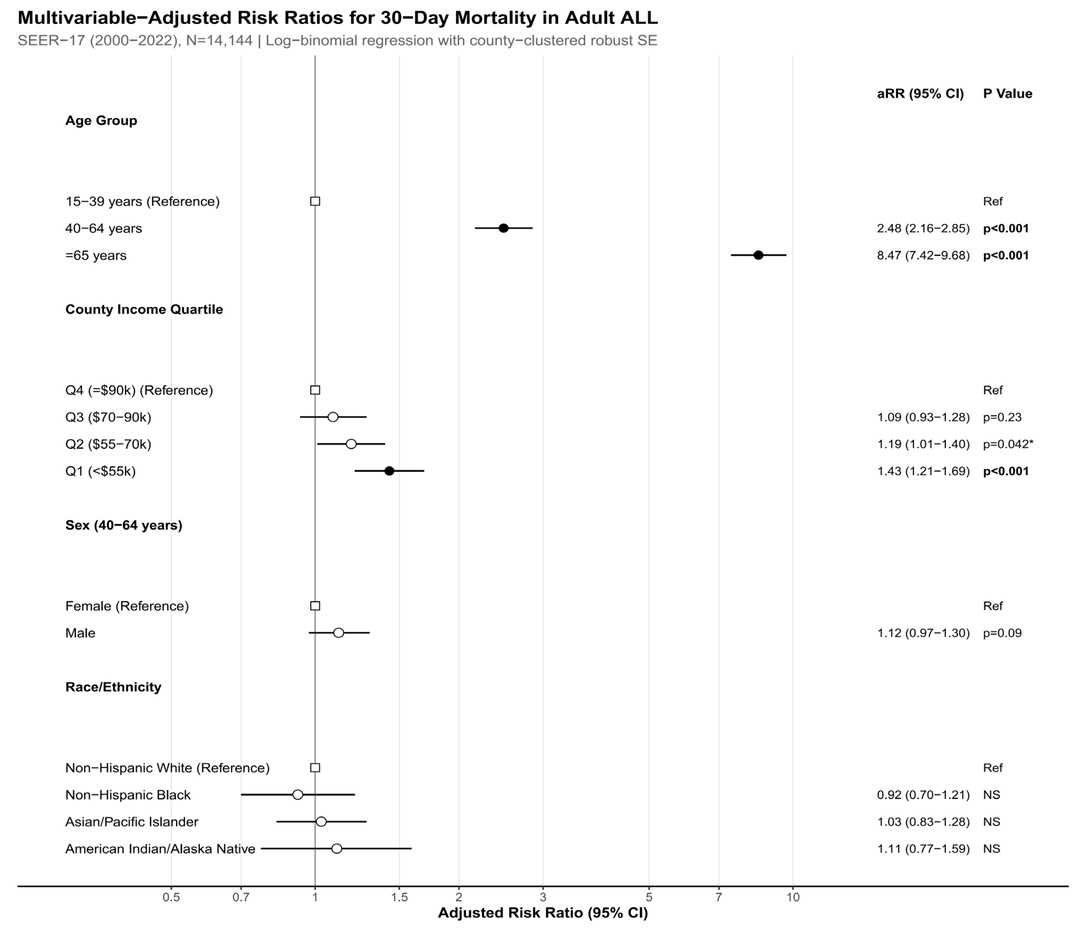
Methods

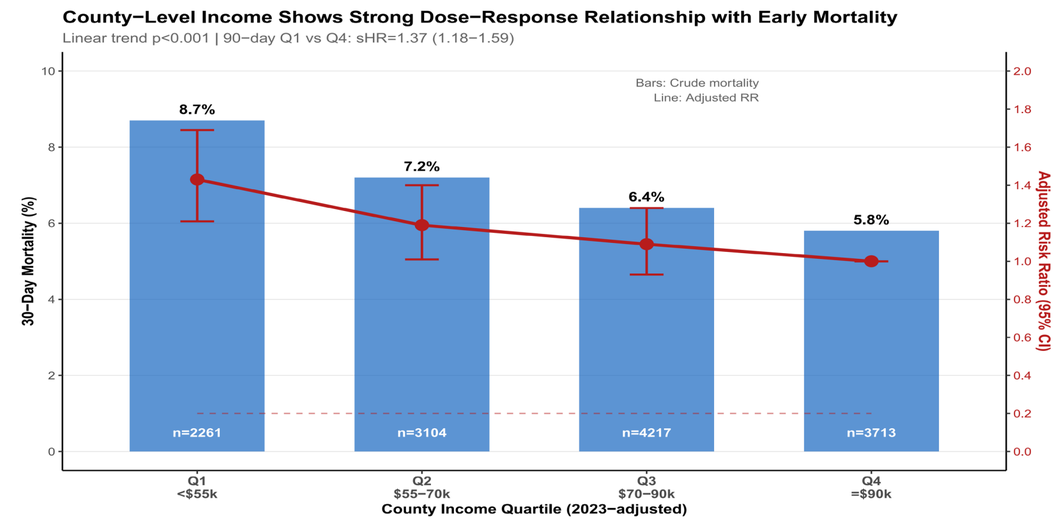
- Data & cohort: Surveillance, Epidemiology, and End Results (SEER) Program 17 registries, 2000–2022; adults ≥15 y, first-primary ALL; N=14,144 after standard exclusions.
- SES exposure: County median household income (2023-adjusted), quartiles Q1 < $55k … Q4 ≥ $90k.
- Endpoints: 30- and 90-day all-cause mortality.
- Estimation: Kaplan–Meier with Greenwood SE; crude RR/RD via Newcombe score intervals.
- Adjusted models: Log-binomial (30 d) reporting aRR with county-clustered robust SE; Fine–Gray (90 d) subdistribution hazards with non-ALL death as competing risk; proportionality checked.
- Covariates: Age 15–39/40–64/≥65, sex, race/ethnicity, calendar period, rurality, income quartile.
- Small-n handling & checks: Gamma-Poisson (empirical-Bayes) shrinkage for sparse strata; CMH pooled RRs / Breslow – Day homogeneity as sensitivity.
- Ethics: De-identified registry analysis under data-use agreement; IRB waiver/as applicable.



Abbreviations: RR/RD = risk ratio/difference; aRR = adjusted RR; sHR = subdistribution hazard ratio.

Results





Income quartiles and 30-day mortality in adult ALL (SEER-17)

Income quartile	Cases (n)	Crude 30-d mortality	Age-, sex-adjusted RR (vs Q4)	Multivariable aRR
Q1 < $55k	2,261	8.70%	1.48 (1.28-1.71)	1.43 (1.21-1.69)
Q2 $55-69k	3,104	7.20%	1.23 (1.06-1.43)	1.19 (1.01-1.40)
Q3 $70-89k	4,217	6.40%	1.11 (0.95-1.29)	1.09 (0.93-1.28)
Q4 ≥ $90k	3,713	5.80%	reference	reference

Reference = Q4; aRR from log-binomial with county-clustered robust SE.
Linear trend across income quartiles: p<0.001.
At 90 days: Q1 vs Q4 Fine-Gray sHR 1.37 (1.18-1.59).

*30 / 90-d death **7.8 %** / 13.7 %*

Age *↑ 40-64 y aRR 2.5；≥65 y 8.5 (vs 15-39 y)*
Income *↑ Q1 crude 8.7 %→5.8 %；**aRR 1.43**(Q1)/1.19(Q2)，trend <0.001；90-d sHR 1.37*
Sex & race*: no sig. adjusted effect (all CIs span 1)*

Stats robust to CMH, Breslow-Day, γ-Poisson

Conclusion

- Age is the dominant driver of ultra-early mortality: aRR 2.48 (40–64 y) and 8.47 (≥65 y) vs 15–39 y, both p < 0.001.
- Structural deprivation: lowest-income counties (Q1 vs Q4) show ~43% higher 30-d risk (aRR 1.43, trend p < 0.001); at 90 d sHR 1.37.
- Sex & race/ethnicity: no statistically significant residual effects after adjustment (male aRR 1.12, p = 0.09; all racial 95% CIs include 1; pooled RR 0.88, p = 0.22).
- Implication: prioritize rapid-start induction, strengthened supportive-care/financial aid, and targeted trial access in low-income counties—especially for older adults.

References

1. Kaplan–Meier：Kaplan EL, Meier P. Nonparametric estimation from incomplete observations. *JASA*. 1958;53:457–481.
2. Greenwood M. *The Natural Duration of Cancer*. 1926.
3. Newcombe RG. Interval estimation for the difference between independent proportions. *Stat Med*. 1998;17:873–890.
4. Fine–Gray: Fine JP, Gray RJ. A proportional hazards model for the subdistribution of a competing risk. *J Am Stat Assoc*. 1999;94:496–509.
5. Zou G. A modified Poisson regression approach to prospective studies with binary data. *Am J Epidemiol*. 2004;159:702–706.
6. SEER Program. Suggested citations for SEER datasets and SEER*Stat.

Footnotes

1. Abbrev. CMH = Cochran–Mantel–Haenszel; KM = Kaplan–Meier; API = Asian/Pacific Islander; AI/AN = American Indian/Alaska Native; NH = non-Hispanic.
2. Data. SEER-17 adult (≥15 y) first-primary ALL, diagnoses 2000–2022; cite using the SEER*Stat "Suggested Citation" string from your exact database selection.
3. Income exposure. County median household income, inflation-adjusted to 2023 USD (CPI-U); quartiles: Q1 < $55k; Q2 $55–69k; Q3 $70–89k; Q4 ≥ $90k.
4. Outcomes. 30-/90-day all-cause mortality: 30 d via KM with Greenwood SE; 90 d via Fine–Gray subdistribution hazards with non-ALL death as competing risk.
5. Models. 30 d: log-binomial with county-clustered robust SE (modified Poisson fallback); crude binomial contrasts by Newcombe intervals; pooled RRs by CMH, homogeneity by Breslow–Day; 90 d: Fine–Gray.
6. Conventions. Two-sided α=0.05; 95% CI; reference categories = age 15–39 y, female, NH White, income Q4. Ethics. De-identified registry; SEER Data-Use Agreement; local IRB exempt/waived. Software. SEER*Stat (extraction); R (survival, cmprsk, robust/sandwich).