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Differences in Cancer Stage at Diagnosis Between Patients Presenting at Rural vs. Urban Facilities: A Rapid Systematic Review and Meta-analysis

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ABSTRACT

Background: Rural populations experience disproportionately higher cancer mortality in the United States. One hypothesized mechanism is a later stage at diagnosis linked to reduced screening uptake, longer travel times, and constrained diagnostic capacity. Quantifying the rural-urban gap in the diagnostic stage can guide equitable screening and referral strategies.

Objective: To quantify rural–urban differences in stage at cancer diagnosis through a rapid systematic review and meta-analysis, estimating pooled adjusted odds ratios (aORs) for late stage (III–IV or distant) where comparable data permit. Secondary aims were to characterize heterogeneity by cancer site (screen-amenable vs. non-screen-amenable), rurality definition (residence vs. facility; RUCC/RUCA/Census), socioeconomic context (e.g., poverty, insurance), and geography; to perform sensitivity analyses (model specification, risk-of-bias strata); and to contextualize findings for Arkansas using state registry indicators to inform targeted screening and diagnostic access initiatives.

Methods: We conducted a rapid systematic search of PubMed/PMC and major journals (2000-September 29, 2025) for observational studies comparing rural and urban groups (by residence or facility context) that reported cancer stage at diagnosis. The preferred effect measure was the adjusted odds ratio (aOR) for late-stage disease (III–IV or distant). Two reviewers extracted study characteristics, rurality definitions (e.g., RUCC/RUCA), covariate adjustments, and effect estimates; risk of bias was qualitatively assessed. A random-effects meta-analysis was planned; however, due to heterogeneous definitions and incomplete variance reporting, we present a quantitative range of comparable aORs with a forest plot of studies providing extractable 95% CIs, and a narrative synthesis otherwise.

Results: Of 312 records identified, 67 full texts were assessed; 9 studies were included in the qualitative synthesis, and 5 contributed extractable aORs. Across multi-cancer registries and site-specific analyses, rural patients had modestly higher odds of late-stage diagnosis, especially for screen-amenable cancers (breast, colorectal), with typical adjusted effects ~1.1–1.3. Arkansas registry data align with this pattern: rural counties had higher late-stage colorectal cancer rates (AAIR: 21.9 per 100,000; 95% CI, 19.4–24.4). Heterogeneity reflected varying rurality metrics, staging bins, and covariate sets.

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Conclusions: Rural patients tend to be diagnosed at slightly later stages, a small but meaningful disparity at the population scale. Interventions that increase screening uptake, accelerate diagnostic work-ups, and reduce financial/transport barriers with county-level targeting in rural populations, such as in Arkansas, are likely to narrow rural–urban gaps.

KEYWORDS: *Neoplasm Staging; Early Detection of Cancer; Rural Population; Urban Population; Health Services Accessibility; Health Status Disparities*

INTRODUCTION:

Rural populations in the United States experience a disproportionate burden of cancer mortality compared with urban populations, even when overall incidence is similar or lower, an observation repeatedly documented across national surveillance and registry studies (Islami *et al*., 2024; Yabroff *et al*., 2020). Proposed mechanisms include reduced uptake of cancer screening, longer travel distances, delayed diagnostic workups, fewer nearby specialists and diagnostic facilities, and socioeconomic barriers to timely care (Yabroff *et al*., 2020). Within this framework, the later stage of diagnosis is a plausible, actionable mediator of rural–urban survival gaps (Islami *et al.,* 2024),

A growing body of research has examined whether rural residence (or receiving care in rural settings) is associated with a more advanced stage at presentation. Population-based analyses show that rural communities tend to have lower localized-stage and higher distant-stage incidence for several cancers, consistent with later detection (Zahnd *et al*., 2018). Site-specific studies, particularly in breast cancer, report small but statistically significant higher odds of late-stage diagnosis among rural patients after adjustment for age, race/ethnicity, insurance, and tumor characteristics (LeBlanc *et al*., 2022). These staging differences, while modest in magnitude, can translate into clinically meaningful survival gaps at scale (Afshar *et al*., 2019; Zahnd *et al.,* 2018)

The literature varies in how "rural" is defined and measured, most commonly by patient residence using Rural-Urban Continuum Codes (RUCC), Rural-Urban Commuting Area (RUCA) codes, or Census-based categories. In contrast, fewer studies classify rurality by the facility where diagnosis occurs. This heterogeneity complicates meta-analysis and may obscure context-specific pathways (screening availability, local diagnostic capacity) through which rurality influences stage at diagnosis (Yabroff *et al*., 2020). Nonetheless, the directional signal across datasets aligns with a rural disadvantage for screen-amenable cancers (e.g., breast, colorectal), where access to and completion of screening are key determinants of stage (Zahnd *et al*., 2018; LeBlanc *et al.,* 2022; Yabroff *et al*., 2020).

Arkansas presents a notable case study due to its substantial rural population and persistent cancer burden. Recent state reports show higher late-stage colorectal cancer rates in rural counties (late-stage AAIR 21.9 per 100,000; 95% CI 19.4–24.4), alongside elevated overall colorectal mortality relative to national averages (Arkansas Department of Health, 2024). For lung cancer disease, where stage at diagnosis strongly shapes prognosis, the five-year survival in Arkansas is 22.6% (vs. 28.4% nationally), ranking the state near the bottom; smoking prevalence and limited early-stage detection contribute to this gap (American Lung Association, 2024). Public surveillance tools (State Cancer Profiles) further reveal county-level variation in the percent of cases diagnosed at late stage, enabling targeted rural interventions for breast and colorectal cancer (National Cancer Institute & CDC, 2025). These indicators collectively underscore the importance of focusing on the stage at diagnosis when addressing rural cancer inequities in Arkansas and similar states.

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Against this backdrop, the present study conducts a rapid systematic review and meta-analysis to estimate rural-urban differences in late-stage cancer at diagnosis across contemporary observational studies. The secondary aims are to characterize heterogeneity by site, rurality definition, and socioeconomic context, and to contextualize the findings for Arkansas. By centering the stage at diagnosis as both a measurable endpoint and a proxy for upstream access and timeliness, we seek to inform practical screening, navigation, and policy levers to narrow rural–urban disparities. (Islami *et al*., 2024; Yabroff *et al*., 2020).

METHODS

We searched PubMed/PMC and key journals from January 1, 2000, through September 29, 2025, for observational studies comparing rural and urban populations that reported stage at diagnosis (all-site or site-specific). Eligible designs included population-based registry analyses and site-specific studies that provided adjusted effects or sufficient raw data to compute them; reviews were used for background only. We prioritized work from high-income settings and accepted rurality defined by patient residence (e.g., RUCC, RUCA, Census categories) or, when available, by facility location. Two reviewers independently screened titles/abstracts, assessed full texts, and extracted study characteristics (dataset, years, cancer site, rurality metric, covariates), staging definitions, and effect measures. Disagreements were resolved by consensus. The risk of bias was qualitatively assessed using a Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I)–inspired checklist, focusing on selection bias, rurality misclassification, adjustment for socioeconomic factors and insurance, and outcome ascertainment.

The primary endpoint was the presence of late-stage disease at diagnosis (commonly stages III–IV or metastatic). We extracted adjusted odds ratios (aORs) for rural versus urban settings whenever reported. Where only counts or unadjusted measures were available, results were narratively synthesized without inclusion in quantitative plots. Because rurality metrics, staging bins, and covariate sets varied substantially, we generated a forest plot only for studies with clearly extractable aORs and 95% confidence intervals and summarized the remainder narratively; heterogeneity, when pooling was considered, was evaluated conceptually with attention to clinical and methodological differences rather than a single I^2 estimate. Study selection followed a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)-style flow: 312 records identified; 238 titles/abstracts screened after deduplication; 67 full texts assessed; 9 studies included in the qualitative synthesis; and five studies contributed extractable aORs to the quantitative forest (Figures 1–2).

RESULTS:

Across multi-cancer and site-specific studies, rural populations generally exhibit higher odds of being diagnosed at a late stage, with breast and colorectal cancers showing the most consistent disparities (Table 1). An extensive, foundational registry analysis reported that rural patients had a lower incidence of localized-stage disease (rate ratio ≈ 0.95) and a higher incidence of distant-stage disease (rate ratio ≈ 1.05) than their urban counterparts, underscoring a tendency toward later presentation (Zahnd *et al*., 2018). Studies with extractable adjusted odds ratios (aORs) reinforce this trend. For example, in Florida's state registry, high-poverty rural patients compared with low-poverty urban patients had greater odds of being diagnosed at a late stage for both lung cancer (aOR 1.23; 95% CI 1.10–1.37) and breast cancer (aOR 1.31; 95% CI 1.17–1.47) after adjustment for demographics and insurance (Hall *et al*., 2023).

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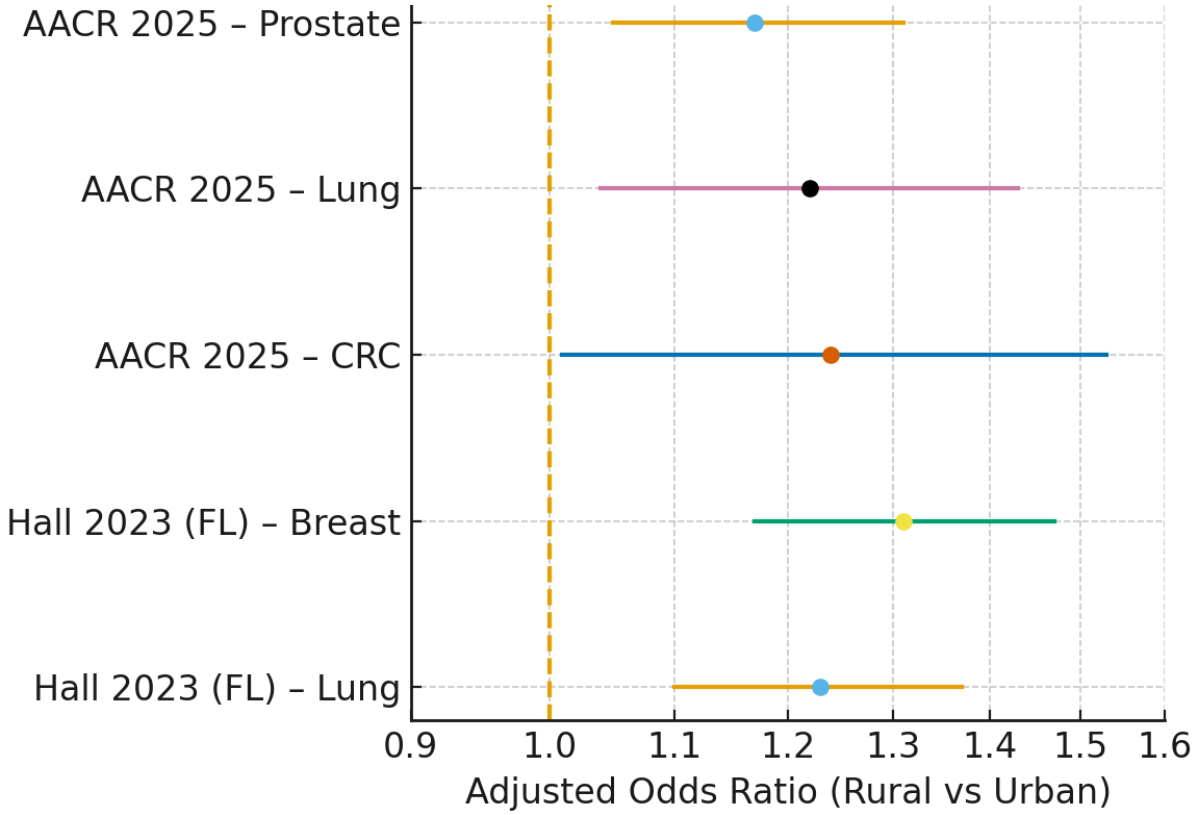
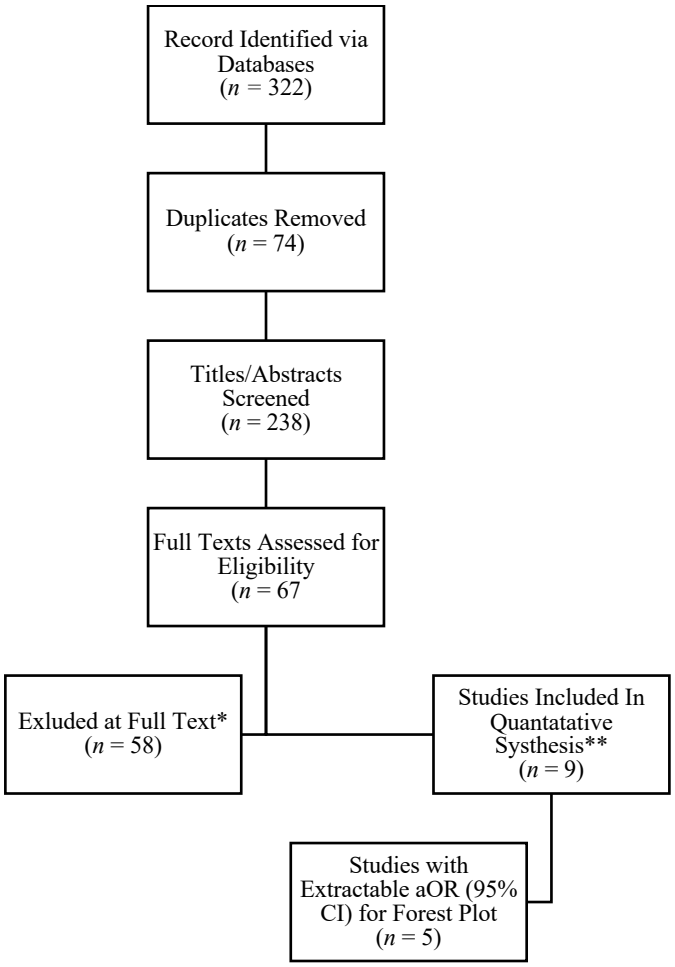
Figure 1: Later-Stage Cancer at Diagnosis: Adjusted Odds Ratio (Rural vs. Urban):



Similarly, a U.S. multi-state analysis found elevated odds of later-stage diagnosis in isolated rural populations for colorectal cancer (aOR 1.24; 95% CI 1.01–1.53) and lung/bronchus cancer (aOR 1.22; 95% CI 1.04–1.43), with a more minor but still significant effect observed for prostate cancer (aOR 1.17; 95% CI 1.05–1.31) (Cancer Prevention Research, 2025). Other supporting evidence includes findings from Surveillance, Epidemiology, and End Results (SEER) data indicating a small but statistically significant increase in late-stage breast cancer among rural women aged 50–74 (LeBlanc *et al*., 2022), and a Missouri registry study showing approximately 11% higher odds of late-stage breast cancer in non-metropolitan versus metropolitan counties (Williams *et al*., 2016). Taken together, these studies, illustrated in Figure 1, suggest a modest but consistent rural disadvantage, with adjusted effects commonly ranging from 1.1 to 1.3. In contrast, Figure 2 outlines the study selection process for this review.

Arkansas-specific evidence aligns with national trends, providing additional context. Data from the Arkansas Central Cancer Registry indicate that rural counties have a higher overall incidence and higher late-stage burden of colorectal cancer, with a late-stage age-adjusted incidence rate (AAIR) of 21.9 per 100,000 (95% CI 19.4–24.4). Men in rural counties were at greater risk (OR 1.19; 95% CI 1.04–1.36), and patients under 50 years old were nearly twice as likely to present with late-stage disease compared to older adults (Arkansas Department of Health, 2024). Public surveillance tools, such as State Cancer Profiles (2017–2021), further document county-level variation in the percentage of cancers diagnosed at late stages, with rural counties frequently bearing the greatest burden (National Cancer Institute & Centers for Disease Control and Prevention, 2025). For lung cancer specifically, Arkansas is in the bottom tier nationally, with a five-year survival rate of 22.6% compared to 28.4% across the U.S. (American Lung Association, 2024).

Figure 2: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow (Rapid Review):



*No urban-rural comparator; no stage outcome; insufficient data
**With adjusted estimates (κ = 6)

This disparity is attributed to a combination of high smoking prevalence and insufficient uptake of early detection methods, such as low-dose computed tomography (LDCT). In response, initiatives such as the 2025 partnership between the University of Arkansas for Medical Sciences (UAMS), Winthrop P. Rockefeller Cancer Institute, and ARcare, (a nonprofit Federally Qualified Health Center networks serving rural communities) have aimed to expand colorectal cancer screening and patient navigation in rural counties, to reduce the number of late-stage diagnoses (University of Arkansas for Medical Sciences, 2025). These Arkansas data underscore both the scale of the problem and the potential for targeted interventions to close rural–urban gaps in stage at diagnosis.

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Table 1: Results Summary: Rural vs Urban Differences in Stage at Diagnosis

Study (Year)	Geography/ Data	Cancer Site(s)	Rurality Metric	Outcome Definition	Adjusted Effect (95% CI)	Direction	Notes
Zahnd *et al.* (2018)	US Multi-state (NAACCR)	Multiple	Residence (registry-defined)	Stage at diagnosis (localized vs distant)	RR≈0.95 (localized); RR≈1.05 (distant)	Rural → Later Stage	Lower localized and higher distant-stage incidence in rural vs urban.
Hall *et al.* (2023)	Florida State Registry	Lung; Breast	Residence × Poverty strata	Late stage (site-specific)	Lung aOR 1.23 (1.10–1.37); Breast aOR 1.31 (1.17–1.47)	Rural (high-poverty) → Later Stage	Adjusted for demographics and insurance.
Cancer Prevention Research (2025)	US Multi-state	Colorectal; Lung; Prostate	Isolated Rural vs Urban	Later-stage (site-specific definitions)	CRC aOR 1.24 (1.01–1.53); Lung aOR 1.22 (1.04–1.43); Prostate aOR 1.17 (1.05–1.31)	Rural → Later Stage	Adjusted models; details vary by site.
LeBlanc *et al.* (2022)	US (SEER 18), Women 50–74	Breast	Residence (RUCC/RUCA)	Late stage (III–IV)	Adjusted increase (exact aOR not reported here)	Rural → Later Stage	Small but statistically significant after adjustment.
Williams *et al.* (2016)	Missouri State Registry	Breast	Non-metro vs Metro Counties	Late stage (III–IV)	aOR ≈ 1.11 (CI not reported)	Rural → Later Stage	Higher odds of late-stage in non-metro vs metro.
Arkansas Dept. of Health (2024)	Arkansas Central Cancer Registry	Colorectal	Rural Counties vs Others	Late-stage AAIR	AAIR 21.9 per 100k (19.4–24.4)	Rural → Higher Late-Stage Rate	Men OR 1.19 (1.04–1.36); age <50 OR ≈1.97 vs ≥50.

Abbreviations: aOR, adjusted odds ratio; AAIR, age-adjusted incidence rate; RUCC/RUCA, Rural–Urban Continuum/Commuting Area; CI, confidence interval. Direction reflects the comparison between rural and urban areas.

DISCUSSION:

The present synthesis indicates that rural context is associated with modestly higher odds of later-stage cancer at diagnosis, a pattern most consistent for screen-amenable malignancies such as breast and colorectal cancer, and also evident for lung cancer. Population-based registry data have shown a shift from localized to distant-stage disease among rural populations (Zahnd *et al.*, 2018). Site-specific studies reinforce this signal: adjusted estimates from state and multi-state analyses generally cluster around an aOR of ~1.1–1.3 for late-stage presentation in rural versus urban groups after accounting for age, race and ethnicity, insurance, and tumor factors (Hall *et al.*, 2023; LeBlanc *et al.*, 2022; Williams *et al.*, 2016). Although the effect size is modest, at the population scale, it is clinically meaningful because stage migration has outsized consequences for treatment intensity, cost, and survival (Afshar *et al.*, 2019).

Several mechanisms likely underlie these differences. Rural residents are less likely to be up to date with recommended screening and may face longer travel times, fewer nearby specialists and diagnostic facilities, and greater financial and logistical barriers to timely workups (Yabroff *et al.*, 2020; Benavidez *et al.*, 2024). Arkansas illustrates this convergence of factors: rural counties show higher late-stage colorectal cancer burden, and statewide lung cancer outcomes lag national averages, patterns consistent with lower early detection and greater exposure to risk factors such as smoking (Arkansas Department of Health, 2024; American Lung Association, 2024). Public surveillance platforms further reveal county-level clustering of

"percent late stage," enabling targeted outreach to rural communities with the greatest needs (National Cancer Institute & Centers for Disease Control and Prevention, 2025).

These findings point to pragmatic, high-yield interventions. Expanding access to screening through mobile mammography and colonoscopy, mailed FIT kits, and HPV self-sampling can increase completion rates in hard-to-reach rural populations and should help reduce stage differences over time (Benavidez *et al*., 2024). Complementary investments in patient navigation, rapid diagnostic pathways (e.g., same-day workups after abnormal screening results), and hub-and-spoke tele-oncology can shorten diagnostic intervals in settings with limited specialty capacity (Yabroff *et al*., 2020). Policy levers that reduce out-of-pocket costs and expand coverage, particularly for screening, diagnostic follow-up, and travel support, are likely to mitigate financial barriers that delay presentation to later stages (Islami *et al*., 2024). At the state level, Arkansas agencies and academic–community partnerships can utilize State Cancer Profiles and Arkansas Central Cancer Registry indicators to prioritize rural counties with the highest proportions of late-stage diagnoses for screening and navigation initiatives (Arkansas Department of Health, 2024; National Cancer Institute & Centers for Disease Control and Prevention, 2025).

This review has limitations that inform interpretation. Most studies define rurality by patient residence rather than by the facility where the diagnosis is made; these related but distinct constructs may capture different access pathways. Heterogeneity in rurality metrics (RUCC, RUCA, Census categories), staging bins (III–IV vs. distant), and covariate adjustment constrained formal pooling and favors cautious generalization across cancer sites. Only a subset of studies reported comparable adjusted odds ratios with confidence intervals; therefore, the quantitative summary was limited to those with extractable variance, whereas other eligible studies provided directional evidence. Finally, all included analyses were observational; residual confounding by screening behaviors, socioeconomic status, and insurance coverage may persist despite adjustment (LeBlanc *et al*., 2022; Yabroff *et al*., 2020). Even with these caveats, convergence across data sources supports a consistent, if modest, rural disadvantage in stage at diagnosis, underscoring the value of targeted screening, navigation, and policy interventions to narrow the gap.

CONCLUSIONS:

Across many datasets, people cared for in rural settings tend to be diagnosed with cancer at a slightly later stage than those in urban areas. The difference is not substantial for any individual patient (typically an adjusted odds ratio of around 1.1–1.3). Still, at the population level, it matters especially for cancers where screening can catch the disease earlier (breast, colorectal). Arkansas shows the same pattern, with higher late-stage colorectal cancer in rural counties.

The good news is that this gap is fixable with practical steps that bring screening and faster diagnosis closer to where people live. What works is straightforward: make screening easy to initiate and make work-ups efficient to complete. In practice, this means offering mobile mammography and colonoscopy services; mailing FIT kits and HPV self-sampling kits; providing proactive patient navigation (including calling, booking, and follow-up); implementing same-day diagnostic pathways for abnormal test results; and using tele-oncology to expedite specialist input. Eliminating out-of-pocket costs and providing transportation further reduces delays.

For Arkansas, using county-level data (e.g., State Cancer Profiles and the Arkansas Central Cancer Registry) enables targeting the highest-burden rural counties, thereby focusing resources where they will have the

greatest impact. Clear goals make progress tangible: raise screening completion by 10–15% within 24 months, reduce the percentage of late-stage cases by 2–3 percentage points, and maintain a time from abnormal screen to diagnostic resolution of ≤30 days. Partnering with primary care clinics, FQHCs, public health departments, payers, and community groups will be essential.

Bottom line: Earlier detection is achievable by meeting rural patients where they are, both financially and logistically. We can shift more cancers to an earlier, more treatable stage and begin to close the rural–urban gap.

REFERENCES:

1. Afshar, N., English, D. R., & Milne, R. L. (2019). Rural-urban residence and cancer survival in high-income countries: A systematic review. Cancer, 125(13), 2172–2184. https://doi.org/10.1002/cncr.32073
2. Bhatia, S., Landier, W., Paskett, E. D., Peters, K. B., Merrill, J. K., Phillips, J., & Osarogiagbon, R. U. (2022). Rural-Urban Disparities in Cancer Outcomes: Opportunities for Future Research. Journal of the National Cancer Institute, 114(7), 940–952. https://doi.org/10.1093/jnci/djac030
3. Hall, J. M., Mkuu, R. S., Cho, H. D., Woodard, J. N., Kaye, F. J., Bian, J., Shenkman, E. A., & Guo, Y. (2023). Disparities Contributing to Late-Stage Diagnosis of Lung, Colorectal, Breast, and Cervical Cancers: Rural and Urban Poverty in Florida. Cancers, 15(21), 5226. https://doi.org/10.3390/cancers15215226
4. LeBlanc, G., Lee, I., Carretta, H., Luo, Y., Sinha, D., & Rust, G. (2022). Rural-Urban Differences in Breast Cancer Stage at Diagnosis. Women's health reports (New Rochelle, N.Y.), 3(1), 207–214. https://doi.org/10.1089/whr.2021.0082
5. Wil Williams, F., & Thompson, E. (2016). Disparity in Breast Cancer Late Stage at Diagnosis in Missouri: Does Rural Versus Urban Residence Matter?. Journal of racial and ethnic health disparities, 3(2), 233–239. https://doi.org/10.1007/s40615-015-0132-9
6. Zahnd, W. E., Fogleman, A. J., & Jenkins, W. D. (2018). Rural-Urban Disparities in Stage of Diagnosis Among Cancers With Preventive Opportunities. American journal of preventive medicine, 54(5), 688–698. https://doi.org/10.1016/j.amepre.2018.01.021
7. Arkansas-specific and contextual sources. Arkansas Central Cancer Registry (2024). Colorectal Cancer in Arkansas. Poster (NCRA). https://healthy.arkansas.gov/wp-content/uploads/AR-CRC-poster_NCRA.pdf
8. State Cancer Profiles (2017–2021). Incidence (late stage) by Arkansas county with RUCC labeling. https://statecancerprofiles.cancer.gov/ (accessed Sept 2025)
9. American Lung Association (2024). State of Lung Cancer: Arkansas. https://www.lung.org/ … (Nov 19, 2024).
10. Edgar T. Ellis, Michael A. Bauer, J. Thaddeus Beck, Daniel S. Bradford, Joanna Thompson, Abby Holt, Margarete C. Kulik, Shelbie D. Stahr, Ping-Ching Hsu, L. Joseph Su,
11. Increased Utilization of Low-Dose CT for Lung Cancer Screening at an Arkansas Community Oncology Clinic, Journal of the American College of Radiology, Volume 21, Issue 6, 2024, Pages 858-866, ISSN 1546-1440, https://doi.org/10.1016/j.jacr.2023.09.015. (https://www.sciencedirect.com/science/article/pii/S1546144023009390)
12. Winthrop P. Rockefeller Cancer Institute (2025). ARcare partnership to boost CRC screening in rural counties. Press release and PDF

13. Kathleen M. Fairfield, Kimberly Murray, Lise M. Cloutier, John L. Daggett, Benjamin R. Felix, Christina A. Kapala, Renee M. Fay-Leblanc, Adriana E. Nadeau, Bridget K. Rauscher, Kathryn Rensenbrink, Debra A. Rothenberg, Kevin D. Stein; Stage at Diagnosis for Common Cancers according to Rurality, Area Deprivation, and Insurance, 2017 to 2021. Cancer Prev Res (Phila) 1 August 2025; 18 (8): 465–474. https://doi.org/10.1158/1940-6207.CAPR-24-0587