Research Square

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No-Show Frequency, Travel Distance, and All-Cause Mortality among Adults with Cancer in a Rural Health System: A Retrospective Cohort Study, 2014–2024

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Abstract

Purpose

To evaluate whether oncology no-shows were associated with all-cause mortality and whether this association differed by distance to cancer clinic.

Methods

Retrospective cohort study of adults with cancer who initiated treatment at Essentia Cancer Centers, between 2014–2024 (N = 5793). The outcome was all-cause mortality at last recorded follow-up. The exposure was no-show frequency, categorized as 0, 1 to 2, 3 to 5, and ≥ 6 missed visits. Analyses were conducted using Stata/SE 19.5, with descriptive and inferential models (adjusting for covariates) and significance defined as P≤.05.

Results

Among 5,793 adults with cancer, median age was 68 (Interquartile Range (IQR), 61–75) years, 3557 (61.4%) were male, and 5488 (94.7%) were non-Hispanic White. Overall, 2492 (43.0%) lived > 20 miles from the clinic, and 2921 (50.4%) were deceased at follow-up. A total of 1967 patients (33.9%) had at least 1 no-show. No-show frequency was 1–2 visits for 1,355 patients (23.4%), 3–5 for 411 (7.1%), and ≥ 6 for 201 (3.5%). In adjusted analysis, 3–5 missed visits were associated with higher odds of mortality compared with no missed visits (Adjusted Odds Ratio (AOR):1.78; 95% CI:1.11–2.86). In distance-stratified models, the association was strongest among patients living > 20 miles from care, where 3–5 missed visits were associated with higher odds of mortality (AOR:2.50; 95% CI:1.23–5.08).

Conclusion

Missed appointments were common and associated with mortality. Moderate appointment disruption was associated with higher odds of death among patients living > 20 miles from care. Cumulative no-shows may serve as a warning signal for disrupted oncology care.

Introduction

Missed appointments, commonly called no-shows, remain a persistent issue for health systems, compromising timely access, disrupting clinic flow, and contributing to inefficient resource use. In a large health system analysis, the mean no-show rate was 18.8% across 10 major clinics, carrying a significant financial burden [1]. Reminder systems reduced no-shows only modestly, suggesting that missed visits reflect more than forgetfulness or scheduling inefficiency [1].

Recent studies show that no-shows are shaped by demographic, socioeconomic, clinical, and appointment-related factors. In primary care, patients who missed appointments were less likely to have patient portal access [2]. No-shows were more common among non-Hispanic Black, Hispanic, publicly insured, and uninsured patients [2]. Adults younger than 65 years and patients scheduled for first-time visits had higher odds of nonattendance [3]. Longer waiting time also increased the likelihood of a no-show [3]. Missed appointments were associated with younger age, parental responsibilities, and poorer financial status [4].

Rural health systems face additional issues because patients often travel long distances for care. In prior rural provider network studies, no-show rates were higher among younger adults, Medicaid beneficiaries, Spanish-speaking patients, and patients with prior no-shows [5, 6]. Appointment lead time was also strongly associated with nonattendance [5, 6]. One rural predictive model showed strong discrimination for future no-shows, with an Area Under the Curve (AUC) of 0.83 in the test dataset [6]. Another rural study found that patients living less than 5 miles and more than 20 miles from clinic had higher no-show rates [5]. These findings suggest that rural no-shows are not random events, but predictable markers of access burden.

In oncology, missed visits may have more serious consequences than in general outpatient care. Patients with cancer often require repeated visits for diagnosis, treatment, surveillance, symptom management, and supportive care. In stage I lung cancer, incomplete oncologic follow-up was associated with worse overall survival [7]. For every 10% increase in missed oncology follow-up appointments, the hazard of death increased by 44% [7]. Among patients referred through an urgent suspected-cancer pathway, non-attendance was associated with worse early mortality [8]. Although nonattenders were less likely to receive a cancer diagnosis, their 1-year mortality was higher than attenders [8].

Evidence from advanced cancer and radiation oncology supports the same concern. Among advanced cancer patients referred to supportive care, those who missed appointments had shorter median survival [9]. Missed appointments were also associated with more emergency department use within 2 weeks [9]. In curative-intent radiation therapy, noncompliance was associated with higher recurrence risk and inferior overall survival [10]. Other radiation oncology studies found that missed appointments were associated with low-income status, unstable housing, and Black or Latino race [11]. Automated text reminders improved radiation therapy compliance, but prospective trials are still needed [12]. Delayed postoperative radiotherapy and treatment interruptions have also been linked with poorer outcomes [13, 14].

Travel burden is another major barrier to cancer care. A review of 27 studies found that increasing travel requirements were associated with more advanced disease, inappropriate treatment, worse prognosis, and poorer quality of life [15]. Rural cancer patients may face limited transportation, lack of public transit, long travel distance, and reduced access to specialized oncology care [16]. National data show that nonurban residents have longer travel times to specialized cancer care settings [17]. Rural cancer care is

further challenged by limited oncology workforce, transportation barriers, financial issues, and reduced clinical trial access [18].

Several cancer-specific studies show that distance can affect diagnosis, treatment, and survival. Among Medicaid patients with breast, colorectal, or lung cancer, travel burden was associated with later breast cancer stage and longer time to colorectal cancer treatment [19]. Rural cancer survivors also report greater financial problems related to cancer care [20]. Qualitative work in gynecologic cancer found that long-distance travel created time, cost, childcare, navigation, and physical discomfort burdens [21]. In ovarian cancer, patients living farther from high-volume treatment facilities had worse long-term survival [22]. In adrenocortical carcinoma, increased travel distance was associated with lower receipt of adjuvant chemotherapy and worse survival [23]. Models that deliver oncology treatment closer to home can reduce travel burden, time toxicity, caregiver needs, and improve patient satisfaction [24].

Despite this literature, important gaps remain. Most no-show studies have focused on general outpatient care, primary care, or scheduling efficiency [1–6]. Most oncology studies have examined a single cancer type, supportive care setting, radiation treatment course, or urgent referral pathway [7–14]. Distance studies often focus on travel burden, treatment receipt, or survival without measuring cumulative appointment nonattendance [15–24]. Less is known about whether repeated no-shows across oncology care identify patients at higher mortality risk in rural health systems. It is also unclear whether this association differs by distance to clinic.

To address these gaps, we evaluated no-show frequency, travel distance, and all-cause mortality in a large rural oncology cohort. We used Electronic Health Record (EHR) data from adults with cancer treated within an integrated rural health system from 2014 to 2024. We first described the prevalence and distribution of missed oncology appointments. We then examined patient, clinical, and care-delivery factors associated with no-shows. Finally, we estimated whether no-show frequency was associated with mortality and whether this association varied by travel distance. We hypothesized that repeated missed oncology appointments would identify clinically meaningful care disruption, especially among patients traveling farther for care.

Methods

Study design, setting, data sources, and population

Using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [25], we conducted a retrospective cohort study of adults with cancer treated within Essentia Health between January 1, 2014, and December 31, 2024. Essentia Health is a predominant rural health system serving patients across Minnesota, North Dakota, and Wisconsin. The health system provides comprehensive oncology care through regional cancer centers and community-based oncology sites. Oncology services include medical oncology, hematology, radiation oncology, infusion services, imaging, and supportive care. Our study was reviewed and approved by the Essentia Health Institutional Review

Board (IRB; EH25918-EHIR-1.0). The IRB approved the study under an expedited review procedure, and informed consent was waived because the study posed no more than minimal risk.

Data were extracted from the Essentia Health Epic EHR. The source population included 1,160,176 unique patients with at least 1 scheduled visit during the study period. Extracted data included demographic characteristics, insurance status, distance to clinic, appointment history, oncology department, cancer diagnosis, treatment era, cancer stage, metastasis status, comorbidity burden, and vital status. Appointment-level data were used to identify completed and missed oncology appointments. Cancer-related variables were derived from structured EHR fields available at treatment initiation or during oncology care. Eligible patients were adults aged 18 years or older with a cancer diagnosis who initiated chemotherapy or radiation therapy during the study period. Patients were required to have at least 1 recent oncology visit within Essentia Health. Patients were excluded if they were younger than 18 years, received care outside the study window, or were treated exclusively with palliative or supportive care. The final analytic cohort included 5,793 adults with cancer.

Study measures

Our overall study outcome was all-cause mortality at the last recorded follow-up. Vital status was obtained from the EHR and coded as alive or deceased (binary). Deceased status was coded as 1, and alive status was coded as 0. The independent variable/exposure was non-attendance at oncology appointments or patient no-shows, similar to previous studies [5, 6]. No-shows were defined as scheduled oncology appointments that patients did not attend. The exposure was evaluated as both a binary and a categorical variable. Any no-show was defined as 1 or more missed oncology appointments. No-show frequency was categorized as 0, 1 to 2, 3 to 5, and 6 or more missed visits. These groups were labeled none, low disruption, moderate disruption, and high disruption.

Covariates were age group, sex, race and ethnicity, insurance type, distance from the patient's residence to the oncology clinic, department category, appointment category, treatment era, missed initial consultation, cancer type, cancer stage, metastatic disease, and Charlson Comorbidity Index (CCI). Age was categorized as 18 to 49, 50 to 64, 65 to 74, and 75 years or older. Sex was male and female. Race and ethnicity were categorized as non-Hispanic White, non-Hispanic Black, non-Hispanic American Indian or Alaska Native, non-Hispanic Asian or Pacific Islander, Hispanic of any race, and other or unknown, and were collapsed as non-Hispanic White vs non-White. Insurance was categorized as Government or Medicaid, Medicare, and Private or Other. Distance was categorized as less than 5 miles, 5 to 10 miles, 10 to 20 miles, and more than 20 miles. Department categories included medical oncology or hematology, radiation oncology, radiology, and infusion or procedural care. Appointment categories included visit or telehealth, general appointment, and infusion. Treatment era was categorized as 2014 to 2016, 2017 to 2019, 2020 to 2022, and 2023 to 2024. Cancer types were collapsed into hematologic, ill-defined or secondary, respiratory, digestive, genitourinary, and other cancers. Stage was categorized as early stage, advanced stage, and unknown or unspecified. Early-stage disease included stage 0 to II.

Advanced-stage disease included stage III to IV. Metastatic disease was coded as present and absent. Charlson Comorbidity Index was categorized as 0, 1 to 2, 3 to 4, and 5 or higher.

Statistical analysis

Descriptive statistics were used to summarize baseline characteristics. Categorical variables were reported as frequencies and percentages. Continuous variables were reported as median with Interquartile Range (IQR), mean with Standard Deviation (SD), and range. No-show rates were compared across patients' characteristics using Pearson χ^2 tests. Fisher exact tests were used when sparse cell counts (< 5) were present. Among patients with at least 1 no-show, mortality was compared across patient characteristics. Pearson χ^2 tests were used for these bivariate comparisons. Stage and metastasis analyses were restricted to patients with available staging data. Row percentages were reported for categorical comparisons. Multivariable logistic regression was used to estimate the association between no-show frequency and all-cause mortality. The reference group was patients with 0 no-shows. Models estimated Adjusted Odds Ratios (AOR) and 95% Confidence Intervals (CI). The primary model adjusted for age group, sex, race and ethnicity, insurance type, distance to clinic, department category, appointment category, treatment era, missed initial consultation, cancer type, cancer stage, metastatic disease, and CCI. Distance-stratified logistic regression models were then fitted to examine whether the association varied by travel distance. Separate models were estimated for patients living less than 5 miles, 5 to 10 miles, 10 to 20 miles, and more than 20 miles from the clinic. Stratified models adjusted for the same covariates as the primary model, except for the distance category. All analyses used complete-case data for regression models. Statistical significance was defined as a 2-sided $P < .05$. All analyses were conducted using Stata/SE version 19.5.

Results

Our study comprised 5793 adults with cancer treated between 2014 and 2024 (Table 1). The median age was 68 years (IQR, 61–75 years), and the mean age was 66.9 years (SD, 12.4 years). Overall, 3557 patients (61.4%) were male, and 5488 (94.7%) were non-Hispanic White. A total of 2492 patients (43.0%) lived more than 20 miles from the oncology clinic. The median distance to clinic was 12.2 miles (IQR, 5.2–46.0 miles).

Table 1
Descriptive Characteristics of Study Population (N = 5,793)

Characteristic	***n (%)***
Age Group	
18–49	482 (8.3)
50–64	1,630 (28.1)
65–74	2,129 (36.7)
75+	1,552 (26.8)
***Age, years**	68 (61–75), 66.9 (12.4), 18–99
Sex	
Male	3,557 (61.4)
Female	2,236 (38.6)
Race/Ethnicity	
Non-Hispanic White	5,488 (94.7)
Non-Hispanic Black	53 (0.9)
Non-Hispanic AI/AN	124 (2.1)
Non-Hispanic Asian/PI	15 (0.3)
Hispanic (any race)	35 (0.6)
Other/Unknown	78 (1.4)
Race (Binary)	
Non-Hispanic White	5,488 (94.7)
Non-White	305 (5.3)
Insurance Type	
Govt/Medicaid	468 (8.1)
Notes:	
**All continuous variables reported as: Median (interquartile range), Mean (standard deviation), and Range.*	
Abbreviations: *AI/AN = American Indian/Alaska Native; PI = Pacific Islander;*	
Govt = Government; IQR = Interquartile range; SD = Standard deviation; COVID = Coronavirus Disease; mi = miles.	

Characteristic	*n (%)*
Age Group	
Medicare	1,683 (29.0)
Private/Other	3,642 (62.9)
Patient-Distance from Clinic	
< 5 miles	1,362 (23.5)
5–10 miles	1,332 (23.0)
10–20 miles	607 (10.5)
> 20 miles	2,492 (43.0)
***Patient-Distance to Clinic (mi)**	12.2 (5.2–46.0), 51.2 (164.2), 0–2,289
Department Category	
Medical Oncology/Hematology	1,201 (20.7)
Radiation Oncology	681 (11.8)
Radiology	58 (1.0)
Infusion/Procedural	3,853 (66.5)
Appointment Category	
Visit/Telehealth	838 (14.5)
General Appointment	1,274 (22.0)
Infusion	3,681 (63.5)
Treatment Era	
2014–2016 (Early)	1,127 (19.5)
2017–2019 (Mid)	1,708 (29.5)
2020–2022 (COVID-era)	1,792 (30.9)
2023–2024 (Recent)	1,166 (20.1)
Notes:	
**All continuous variables reported as: Median (interquartile range), Mean (standard deviation), and Range.*	
Abbreviations: *AI/AN = American Indian/Alaska Native; PI = Pacific Islander;*	
Govt = Government; IQR = Interquartile range; SD = Standard deviation; COVID = Coronavirus Disease; mi = miles.	

Characteristic	***n (%)***
Age Group	
Missed Initial Appointment	
No	5,358 (92.5)
Yes	435 (7.5)
Cancer Type	
Hematologic	1,151 (19.9)
Ill-defined/Secondary	582 (10.1)
Respiratory	1,053 (18.2)
Digestive	966 (16.7)
Genitourinary	1,485 (25.6)
Other	556 (9.6)
Cancer Stage	
Stage 0	18 (0.3)
Stage I	269 (4.6)
Stage II	395 (6.8)
Stage III	483 (8.3)
Stage IV	519 (9.0)
Missing/Unknown	4,109 (70.9)
Stage (Binary)	
Early (0–II)	682 (11.8)
Advanced (III–IV)	1,002 (17.3)
Unknown/Unspecified	172 (3.0)
Missing	3,937 (68.0)
Notes:	
**All continuous variables reported as: Median (interquartile range), Mean (standard deviation), and Range.*	
Abbreviations: *AI/AN = American Indian/Alaska Native; PI = Pacific Islander;*	
Govt = Government; IQR = Interquartile range; SD = Standard deviation; COVID = Coronavirus Disease; mi = miles.	

Characteristic	***n (%)***
Age Group	
Metastatic Disease	
No	1,480 (25.6)
Yes	376 (6.5)
Missing	3,937 (68.0)
Charlson Comorbidity Index Category	
0 (None)	905 (15.6)
1–2 (Low)	1,617 (27.9)
3–4 (Moderate)	1,181 (20.4)
5+ (High)	2,090 (36.1)
***Charlson Score**	3 (2–6), 3.8 (2.9), 0–17
Vital Status	
Alive	2,872 (49.6)
Deceased	2,921 (50.4)
No-show (Any)	
No (0)	3,826 (66.1)
Yes (1+)	1,967 (33.9)
No-show Category	
0 (None)	3,826 (66.1)
1–2 (Low Disruption)	1,355 (23.4)
3–5 (Moderate Disruption)	411 (7.1)
6+ (High Disruption)	201 (3.5)
No-show Visits	0 (0–1), 0.94 (2.67), 0–94
Notes:	
**All continuous variables reported as: Median (interquartile range), Mean (standard deviation), and Range.*	
Abbreviations: *AI/AN = American Indian/Alaska Native; PI = Pacific Islander;*	
Govt = Government; IQR = Interquartile range; SD = Standard deviation; COVID = Coronavirus Disease; mi = miles.	

Most patients received care in infusion or procedural settings (3853 [66.5%]). Appointment categories included infusion visits for 3681 patients (63.5%), general appointments for 1274 (22.0%), and visit or telehealth encounters for 838 (14.5%). The most common cancer types were genitourinary cancers (1485 [25.6%]), hematologic cancers (1151 [19.9%]), respiratory cancers (1053 [18.2%]), and digestive cancers (966 [16.7%]). Advanced-stage disease was documented for 1002 patients (17.3%), and metastatic disease was documented for 376 (6.5%). Stage and metastasis data were missing for 3937 patients (68.0%).

Comorbidity was high in this cohort. The median CCI score was 3 (IQR, 2–6), and the mean score was 3.8 (SD, 2.9). A Charlson score of 5 or higher was present in 2090 patients (36.1%). At last follow-up, 2921 patients (50.4%) were deceased. Overall, 1967 patients (33.9%) had at least 1 missed oncology appointment. No-show frequency was categorized as 0 missed visits in 3826 patients (66.1%), 1 to 2 missed visits in 1355 (23.4%), 3 to 5 missed visits in 411 (7.1%), and 6 or more missed visits in 201 (3.5%). The median number of no-show visits was 0 (IQR, 0–1), and the mean was 0.94 (SD, 2.67).

Factors associated with oncology no-shows

No-show rates differed significantly across patients' characteristics **(**Table 2**)**. Younger adults had the highest no-show rates. No-shows occurred in 206 of 482 patients aged 18 to 49 years (42.7%) and 655 of 1630 aged 50 to 64 years (40.2%). In contrast, no-shows occurred in 440 of 1552 patients aged 75 years or older (28.3%; P < .001). Female patients had higher no-show rates than male patients. No-shows occurred in 825 of 2236 female patients (36.9%) and 1142 of 3557 male patients (32.1%; P < .001). Non-White patients had a higher no-show rate than non-Hispanic White patients. No-shows occurred in 158 of 305 non-White patients (51.8%) and 1809 of 5488 non-Hispanic White patients (33.0%; P < .001). No-show rates did not differ significantly by insurance type (P = .407).

Table 2
Factors Associated with Oncology No-Show Rates (N = 5,793)

Characteristic	No Show (0)	≥ 1 No-Show	P value
	3,826 (66.1)	1,967 (33.9)	
Age group, y			< .001
18–49	276 (57.3)	206 (42.7)	
50–64	975 (59.8)	655 (40.2)	
65–74	1,463 (68.7)	666 (31.3)	
≥ 75	1,112 (71.7)	440 (28.3)	
Age, mean (SD), range	66.9 (12.4), 18–99		
Sex			< .001
Male	2,415 (67.9)	1,142 (32.1)	
Female	1,411 (63.1)	825 (36.9)	
Race			< .001
Non-Hispanic White	3,679 (67.0)	1,809 (33.0)	
Non-White	147 (48.2)	158 (51.8)	
Insurance			.407
Government/Medicaid	314 (67.1)	154 (32.9)	
Medicare	1,090 (64.8)	593 (35.2)	
Private/Other	2,422 (66.5)	1,220 (33.5)	
Distance to clinic			< .001
< 5 miles	848 (62.3)	514 (37.7)	
5–10 miles	841 (63.1)	491 (36.9)	
10–20 miles	397 (65.4)	210 (34.6)	
> 20 miles	1,740 (69.8)	752 (30.2)	
Department type			< .001*
Medical oncology/hematology	466 (38.8)	735 (61.2)	
Radiation oncology	541 (79.4)	140 (20.6)	
Radiology	4 (6.9)	54 (93.1)	
Infusion/procedural	2,815 (73.1)	1,038 (26.9)	

Characteristic	No Show (0) 3,826 (66.1)	≥ 1 No-Show 1,967 (33.9)	P value
Appointment category			< .001
Visit/telehealth	681 (81.3)	157 (18.7)	
General appointment	197 (15.5)	1,077 (84.5)	
Infusion	2,948 (80.1)	733 (19.9)	
Treatment era			< .001
2014–2016	667 (59.2)	460 (40.8)	
2017–2019	1,013 (59.3)	695 (40.7)	
2020–2022	1,190 (66.4)	602 (33.6)	
2023–2024	956 (82.0)	210 (18.0)	
Missed initial consultation			< .001*
No	3,826 (71.4)	1,532 (28.6)	
Yes	0 (0.0)	435 (100.0)	
Cancer type			< .001
Hematologic	747 (64.9)	404 (35.1)	
Ill-defined/secondary	370 (63.6)	212 (36.4)	
Respiratory	666 (63.3)	387 (36.7)	
Digestive	600 (62.1)	366 (37.9)	
Genitourinary	1,097 (73.9)	388 (26.1)	
Other	346 (62.2)	210 (37.8)	
Cancer stage†			.182
Early (0–II)	457 (67.0)	225 (33.0)	
Advanced (III–IV)	630 (62.9)	372 (37.1)	
Unknown	115 (66.9)	57 (33.1)	
Metastatic disease†			.953
No	958 (64.7)	522 (35.3)	
Yes	244 (64.9)	132 (35.1)	
Charlson Comorbidity Index			< .001

Characteristic	No Show (0)	≥ 1 No-Show	P value
	3,826 (66.1)	1,967 (33.9)	
0	649 (71.7)	256 (28.3)	
1–2	1,093 (67.6)	524 (32.4)	
3–4	742 (62.8)	439 (37.2)	
≥ 5	1,342 (64.2)	748 (35.8)	
Vital status at follow-up			< .001
Alive	2,050 (71.4)	822 (28.6)	
Deceased	1,776 (60.8)	1,145 (39.2)	
No-show category			< .001*
0 (None)	3,826 (100.0)	0 (0.0)	
1–2 (Low disruption)	0 (0.0)	1,355 (100.0)	
3–5 (Moderate disruption)	0 (0.0)	411 (100.0)	
6+ (High disruption)	0 (0.0)	201 (100.0)	

Footnotes

** P value from Fisher's exact test due to sparse cell counts (department category, missed initial consultation).*

† Stage and metastasis variables restricted to the subset with available staging data (n = 1,856).

Rows display **frequency (row %)**.

Pearson χ^2 tests used unless otherwise indicated.

No-show rates varied significantly by travel distance. Patients living less than 5 miles from the clinic had the highest no-show rate (514 of 1362 [37.7%]). Rates were also high among those living 5 to 10 miles away (491 of 1332 [36.9%]). Patients living more than 20 miles away had the lowest no-show rate (752 of 2492 [30.2%]; P < .001). No-show rates differed by care setting. Radiology had the highest no-show rate (54 of 58 [93.1%]), followed by medical oncology or hematology (735 of 1201 [61.2%]). Infusion or procedural care had a lower no-show rate (1038 of 3853 [26.9%]; P < .001). By appointment category, general appointments had the highest no-show rate (1077 of 1274 [84.5%]). Visit or telehealth encounters and infusion appointments had lower rates (18.7% and 19.9%, respectively; P < .001). No-show rates declined across treatment eras. Rates were highest in 2014 to 2016 (460 of 1127 [40.8%]) and 2017 to 2019 (695 of 1708 [40.7%]). They declined during 2020 to 2022 (602 of 1792 [33.6%]) and were lowest in 2023 to 2024 (210 of 1166 [18.0%]; P < .001). All patients who missed the initial consultation had at least 1 no-show (435 of 435 [100.0%]; P < .001).

No-show rates also differed by cancer type. The highest rates were observed for digestive cancers (366 of 966 [37.9%]), other cancers (210 of 556 [37.8%]), respiratory cancers (387 of 1053 [36.7%]), and ill-defined or secondary cancers (212 of 582 [36.4%]; P < .001). No-show rates did not differ significantly by stage (P < .182) or metastatic disease (P < .953) in the staged subset. Patients with higher comorbidity burden had higher no-show rates, including 439 of 1181 patients with Charlson scores of 3 to 4 (37.2%) and 748 of 2090 with scores of 5 or higher (35.8%; P < .001). Deceased patients had a higher no-show rate than patients alive at follow-up (1145 of 2921 [39.2%] vs 822 of 2872 [28.6%]; P < .001).

Mortality among patients with at least 1 no-show

Among 1967 patients with at least 1 no-show (Table 3), 1145 (58.2%) were deceased at follow-up. Mortality increased with age. Death occurred in 73 of 206 patients aged 18 to 49 years (35.4%), 372 of 655 aged 50 to 64 years (56.8%), 395 of 666 aged 65 to 74 years (59.3%), and 305 of 440 aged 75 years or older (69.3%; P < .001). Mortality was higher among male patients than female patients with no-shows. Death occurred in 686 of 1142 male patients (60.1%) and 459 of 825 female patients (55.6%; P = .049). Mortality did not differ significantly by race and ethnicity (P = .241). Medicare-insured patients had the highest mortality among insurance groups (373 of 593 [62.9%]; P = .018).

Table 3
Patient Characteristics Associated with Mortality Among Oncology Patients with ≥ 1 No-Show (N = 1,967)

Characteristic	Alive, No. (%)	Deceased, No. (%)	P value
	822 (41.8)	**1,145 (58.2)**	
Age Group			< .001
18–49	133 (64.6)	73 (35.4)	
50–64	283 (43.2)	372 (56.8)	
65–74	271 (40.7)	395 (59.3)	
≥ 75	135 (30.7)	305 (69.3)	
Sex			.049
Male	456 (39.9)	686 (60.1)	
Female	366 (44.4)	459 (55.6)	
Race/Ethnicity			.241
Non-Hispanic White	749 (41.4)	1,060 (58.6)	
Non-White	73 (46.2)	85 (53.8)	
Insurance Type			.018
Government/Medicaid	64 (41.6)	90 (58.4)	
Medicare	220 (37.1)	373 (62.9)	
Private/Other	538 (44.1)	682 (55.9)	
Distance to Clinic			.043
< 5 miles	235 (45.7)	279 (54.3)	
5–10 miles	190 (38.7)	301 (61.3)	
10–20 miles	76 (36.2)	134 (63.8)	
> 20 miles	321 (42.7)	431 (57.3)	
Department Category			< .001

[a] *Metastasis analysis also restricted to cases with staging/metastasis data available (n = 654).*

Percentages represent row percentages (alive vs deceased within each category).

χ^2 tests are Pearson chi-square tests comparing mortality distribution across levels of each variable.

The analytic sample includes only patients with ≥ 1 no-show.

Characteristic	Alive, No. (%)	Deceased, No. (%)	P value
	822 (41.8)	**1,145 (58.2)**	
Medical Oncology/Hematology	340 (46.3)	395 (53.7)	
Radiation Oncology	65 (46.4)	75 (53.6)	
Radiology	33 (61.1)	21 (38.9)	
Infusion/Procedural	384 (37.0)	654 (63.0)	
Appointment Category			< .001
Visit/Telehealth	98 (62.4)	59 (37.6)	
General Appointment	453 (42.1)	624 (57.9)	
Infusion	271 (37.0)	462 (63.0)	
Treatment Era			< .001
2014–2016	158 (34.4)	302 (65.7)	
2017–2019	251 (36.1)	444 (63.9)	
2020–2022	280 (46.5)	322 (53.5)	
2023–2024	133 (63.3)	77 (36.7)	
Missed Initial Appointment			.427
No	633 (41.3)	899 (58.7)	
Yes	189 (43.5)	246 (56.6)	
Cancer Type			< .001
Hematologic	241 (59.7)	163 (40.3)	
Ill-defined/Secondary	56 (26.4)	156 (73.6)	
Respiratory	102 (26.4)	285 (73.6)	
Digestive	136 (37.2)	230 (62.8)	
Genitourinary	188 (48.5)	200 (51.6)	
Other	99 (47.1)	111 (52.9)	

[a] Metastasis analysis also restricted to cases with staging/metastasis data available (n = 654).

Percentages represent row percentages (alive vs deceased within each category).

χ^2 tests are Pearson chi-square tests comparing mortality distribution across levels of each variable.

The analytic sample includes only patients with ≥ 1 no-show.

Characteristic	Alive, No. (%)	Deceased, No. (%)	P value
	822 (41.8)	**1,145 (58.2)**	
Stage (analytic subset: n = 654)			.004
Early (0–II)	132 (58.7)	93 (41.3)	
Advanced (III–IV)	167 (44.9)	205 (55.1)	
Unknown	31 (54.4)	26 (45.6)	
Metastasis[a] (analytic subset: n = 654)			< .001
No	292 (55.9)	230 (44.1)	
Yes	38 (28.8)	94 (71.2)	
Charlson Comorbidity Index			< .001
0	128 (50.0)	128 (50.0)	
1–2	265 (50.6)	259 (49.4)	
3–4	174 (39.6)	265 (60.4)	
≥ 5	255 (34.1)	493 (65.9)	

[a] *Metastasis analysis also restricted to cases with staging/metastasis data available (n = 654).*

Percentages represent row percentages (alive vs deceased within each category).

χ^2 tests are Pearson chi-square tests comparing mortality distribution across levels of each variable.

The analytic sample includes only patients with ≥ 1 no-show.

Mortality among patients with no-shows differed by distance to clinic. The highest mortality was observed among patients living 10 to 20 miles away (134 of 210 [63.8%]). Mortality was 301 of 491 (61.3%) among those living 5 to 10 miles away. Mortality was 431 of 752 (57.3%) among those living more than 20 miles away and 279 of 514 (54.3%) among those living less than 5 miles away (P = .043). Mortality also differed by care-delivery factors. Patients receiving infusion or procedural care had the highest mortality (654 of 1038 [63.0%]; P < .001). By appointment category, mortality was highest among patients with infusion appointments (462 of 733 [63.0%]). Mortality was lower among those with visit or telehealth encounters (59 of 157 [37.6%]; P < .001). Mortality was higher in earlier treatment eras. Death occurred in 302 of 460 patients treated during 2014 to 2016 (65.7%) and 444 of 695 treated during 2017 to 2019 (63.9%). Mortality declined to 322 of 602 patients during 2020 to 2022 (53.5%) and 77 of 210 during 2023 to 2024 (36.7%; P < .001). Mortality did not differ significantly by missed initial consultation status (P = .427).

Cancer type was strongly associated with mortality among patients with no-shows. Mortality was highest among patients with respiratory cancers (285 of 387 [73.6%]) and ill-defined or secondary cancers (156 of 212 [73.6%]). Mortality was also high among patients with digestive cancers (230 of 366 [62.8%]; P < .001). In the staging analytic subset, mortality was higher among patients with advanced-stage disease than early-stage disease. Death occurred in 205 of 372 patients with advanced-stage disease (55.1%) and 93 of 225 with early-stage disease (41.3%; P = .004). Mortality was also higher among patients with metastatic disease than those without metastasis. Death occurred in 94 of 132 patients with metastatic disease (71.2%) and 230 of 522 without metastatic disease (44.1%; P < .001). Mortality increased with comorbidity burden. Death occurred in 128 of 256 patients with a Charlson score of 0 (50.0%). Mortality increased to 493 of 748 patients with a Charlson score of 5 or higher (65.9%; P < .001).

Adjusted association between no-show frequency and mortality

In the complete-case multivariable logistic regression model (Table 4), no-show frequency was associated with all-cause mortality. Compared with patients with no missed visits, patients with 3 to 5 missed visits had significantly higher adjusted odds of mortality (AOR, 1.78, 95% CI, 1.11–2.86; P = .017). Patients with 1 to 2 no-shows had higher but nonsignificant odds of mortality (AOR, 1.21 95% CI, 0.88–1.68; P = .244). Patients with 6 or more no-shows also had higher but nonsignificant odds of mortality (AOR, 1.61, 95% CI, 0.88–2.94; P = .123). The multivariable model adjusted for demographic, access-related, care-delivery, and clinical covariates. These included age, sex, race and ethnicity, insurance type, distance to clinic, department type, appointment category, treatment era, missed initial consultation, cancer type, stage, metastatic disease, and Charlson Comorbidity Index. The model demonstrated strong overall fit, with a likelihood ratio χ^2 of 573.09 (P < .001) and pseudo R^2 of 0.2304.

Table 4
Adjusted Odds of All-Cause Mortality by No-Show Frequency Among Cancer Patients (N = 1,856)

No-Show Frequency (Exposure)	Adjusted Odds Ratio (95% CI)	P Value
0 No-Shows (Reference)		—
1–2 No-Shows	1.21 (0.88–1.68)	.244
3–5 No-Shows	1.78 (1.11–2.86)	**.017**
6 + No-Shows	1.61 (0.88–2.94)	.123

Notes:

- Multivariable logistic regression model evaluating the association between appointment disruption and all-cause mortality at follow-up (1 = deceased, 0 = alive).

- The exposure/independent variable was the number of missed oncology appointments, categorized as 0 (reference), 1–2, 3–5, and ≥ 6 missed visits.

- The model adjusted for covariates such as age, sex, race/ethnicity, insurance type, distance to clinic, department type, appointment category, treatment era, missed initial consultation, cancer type, stage at diagnosis, presence of metastatic disease, and Charlson comorbidity index.

- The model was estimated among 1,856 patients with complete data and demonstrated strong overall fit (Likelihood Ratio $\chi^2 = 573.09$, $P < .001$; pseudo $R^2 = 0.2304$).

In distance-stratified models (Table 5), the association between no-show frequency and mortality was strongest among patients living more than 20 miles from the clinic. In this group, patients with 3 to 5 no-shows had significantly higher adjusted odds of mortality (AOR, 2.50, 95% CI, 1.23–5.08). No other distance-specific estimate reached statistical significance.

Table 5
Adjusted Odds of All-Cause Mortality by No-Show Frequency, Stratified by Distance to Clinic

No-Show Frequency (Exposure)	< 5 Miles (n = 662)	5–10 Miles (n = 221)	10–20 Miles (n = 194)	> 20 Miles (n = 775)
0 No-Shows (Reference)				
1–2 No-Shows	1.01 (0.59–1.74)	1.94 (0.78–4.83)	0.83 (0.24–2.87)	1.60 (0.95–2.68)
3–5 No-Shows	1.74 (0.75–4.04)	2.07 (0.48–9.00)	0.78 (0.12–5.33)	2.50 (1.23–5.08)*
≥ 6 No-Shows	1.81 (0.59–5.53)	3.37 (0.64–17.84)	1.54 (0.12–19.80)	1.59 (0.59–4.27)

Abbreviations: *OR, odds ratio; CI, Confidence Interval.*

[a] *Odds ratios were derived from stratified multivariable logistic regression models, each adjusted for age group, sex, race/ethnicity, insurance type, department type, appointment category, treatment era, missed initial consultation, cancer stage, presence of metastatic disease, and Charlson comorbidity index.*

[b] *Models included only patients with complete data within each distance stratum.*

[c] *Significant association at P < .05.*

Discussion

In this large rural oncology cohort, missed appointments were common and clinically meaningful. One in 3 patients had at least 1 oncology no-show, and more than half of the patients with any no-show were deceased at follow-up. To our knowledge, this is the first study to evaluate no-show frequency, travel distance, and mortality across a broad rural cancer population. The main finding was that moderate appointment disruption, measured as 3 to 5 missed oncology visits, was independently associated with higher odds of all-cause mortality. This association persisted after adjustment for covariates such as demographic, access-related, care-delivery, and clinical factors. The association was strongest among patients living more than 20 miles from care, where moderate disruption was associated with more than twice the adjusted odds of mortality. Our findings suggest that repeated missed visits may identify patients with clinically important care disruption, especially when travel distance compounds oncology access barriers.

Our present study extends prior oncology research by demonstrating the association between missed appointments and mortality across a large rural cancer population. Earlier studies have shown that missed follow-up in stage I lung cancer, nonattendance at urgent suspected-cancer referral appointments, and missed supportive care consultations in advanced cancer are each associated with worse survival [7–9]. Similar findings have been reported in radiation oncology, where treatment noncompliance, missed appointments, treatment interruptions, and delayed radiotherapy have been

linked with poorer disease control or survival [10–14]. These studies establish that missed cancer care can carry clinical consequences, but most have focused on a single cancer type, treatment modality, or referral pathway. Our study adds a broader rural health-system perspective by evaluating cumulative no-show frequency across oncology care and linking it with mortality after adjustment for demographic, access-related, care-delivery, and clinical factors.

Prior work has also shown that travel burden can negatively influence stage at diagnosis, receipt of appropriate treatment, outcomes, and quality of life [15]. Transportation barriers have also been associated with delayed follow-up after abnormal screening, reduced access to specialized oncology care, and lower receipt of guideline-concordant treatment [16]. Geographic access studies further show that rural and nonurban patients often face longer travel times and limited access to specialty cancer services [17–24]. In our cohort, the association between missed visits and mortality was strongest among patients living more than 20 miles from care, where 3 to 5 missed visits were associated with more than twice the adjusted odds of death. This finding suggests that repeated no-shows may capture more than appointment nonadherence; they may signal accumulated illness burden and access barriers to cancer care. By bringing together appointment behavior, geographic access, comorbidities, and mortality in one EHR-based analysis, this study identifies cumulative missed visits as a practical warning signal for earlier outreach, navigation, transportation support, and care models closer to home.

Our study has several strengths and limitations. We used a large EHR-derived cohort of 5793 adults with cancer treated over 10 years in a rural health system. The analysis included appointment-level data, vital status, distance to clinic, cancer type, stage, metastasis, and comorbidity burden. We also adjusted for demographic, access-related, care-delivery, and clinical factors. Distance-stratified models allowed us to examine whether missed visits mattered differently by travel burden. These strengths support the interpretation that repeated no-shows may be a meaningful marker of disrupted oncology care. However, our study also has limitations. Our findings should not be interpreted as causal (though not the original intention) because the design was observational. No-shows may reflect unmeasured illness severity, transportation barriers, financial hardship, caregiving burden, or patient preference. Stage and metastasis data were missing for many patients, limiting precision in adjusted and stratified models. Vital status was based on EHR data, and cause-specific mortality was not available. Our data came from one rural health system, which may limit generalizability. Still, the findings suggest that cumulative missed visits can help identify patients who may need earlier outreach and support.

Our findings have implications for research, policy, and clinical practice. Future studies should validate cumulative no-shows as a risk marker in other rural oncology systems. Research should also examine why patients miss visits, including transportation, symptoms, finances, caregiving, and treatment burden. From a policy perspective, missed oncology visits should be treated as a care-access signal, not only a scheduling metric. Health systems and payers should support transportation, navigation, tele-oncology, and care closer to home. Clinically, oncology teams can use repeated no-shows to trigger early outreach before patients fully disengage from care. This is especially important for patients living farther from oncology clinics, where missed visits may reflect compounded access barriers.

Conclusion

In this large rural oncology cohort, missed appointments were common and associated with mortality. One in 3 patients had at least 1 no-show, and mortality was higher among patients with missed visits. After adjustment for confounding factors, 3 to 5 missed oncology visits were independently associated with higher odds of death. This association was strongest among patients living more than 20 miles from care. These findings suggest that cumulative no-shows may serve as an early warning signal for disrupted oncology care. Rural oncology programs should consider repeated missed visits as a trigger for timely outreach, navigation, transportation support, and care closer to home.

Declarations

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Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

A.R.S. conceived and designed the study, conducted the statistical analysis, interpreted the findings, and drafted the manuscript. B.E.F., R.A., and A.A.O. contributed to the study design, clinical interpretation, and critical revision of the manuscript. All authors reviewed and approved the final manuscript.

Data Availability

The data were derived from Essentia Health electronic health records and are not publicly available because of patient privacy and institutional restrictions. Deidentified data may be considered upon reasonable request to the corresponding author and approval from Essentia Health.

Ethics Approval

The Essentia Health Institutional Review Board approved this study under expedited review (EH25918-EHIR-1.0). The study involved secondary analysis of electronic health record data and posed no more than minimal risk.

Consent to Participate

The Essentia Health Institutional Review Board waived informed consent because the study involved retrospective analysis of existing electronic health record data.

Consent to Publish

Not applicable. The manuscript contains no identifiable individual-level information, images, or case details requiring consent for publication.

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