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Hospital trends in pancreatic cancer admissions: Insights from Florida, 2010-2020

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ABSTRACT

Objective: Pancreatic cancer (PC) is one of the deadliest cancers worldwide. This study examines trends and relationships in PC patients' hospital admissions, length of stay (LOS), and in-hospital mortality in Florida, while exploring associations of patient, hospital, and county characteristics.

Methods: Retrospective data from the Florida Agency for Health Care Administration, American Hospital Association Annual Survey, and Area Health Resource Files were merged from 2010 to 2020. A total of 117,278 patients with primary PC diagnosis were analyzed. Mixed effects models analyzed the LOS and in-hospital mortality. All acute general medical and surgical hospitals in Florida were included.

Results: PC admissions increased significantly from 4.68% to 7.09% of total hospital admissions ($p < .001$), representing a 51% relative increase. Patient age increased from 68.75 to 70.99 years, while LOS decreased from 6.89 to 5.9 days. In-hospital mortality remained stable at 5.13%. Mixed effects regression models demonstrated complex county-level social determinants relationships between population health factors and individual clinical outcomes, and significant racial disparities in mortality outcomes. Black patients exhibited 18% higher odds of in-hospital mortality compared to Non-Hispanic White patients. Federal insurance provided protective effects against mortality. Comorbidity burden strongly predicted mortality risk along with market concentration.

Conclusions: Persistent racial disparities in outcomes and pronounced volume-outcome relationships highlight the need for targeted interventions addressing healthcare equity and continued tailored treatment of PC. Policymakers should address these equity issues while supporting regionalization efforts for complex cancer care.

Key Words: Health disparities, Hospital outcomes, In-hospital mortality, Length of stay, Pancreatic cancer

1. INTRODUCTION

In the United States (U.S.), pancreatic cancer (PC) ranks as the 12th most common cause of cancer, but it is the 4th most common cause of cancer-related deaths.[1] This makes it the most challenging type of cancer because of its poor prognosis and high case fatality. Current estimates anticipate about 66,440 new cases and 51,750 deaths by 2024. With an aging population and changing demographics, the incidence of PC is expected to increase. While five-year survival rates have improved in the last 20 years, PC continues to be a deadly solid organ malignancy.[2] The poor prognosis stems from several factors, which include late-stage presentation, aggressive tumor biology, and limited therapeutic responsiveness, which, combined, lead to increased hospitalizations, surgical

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interventions, and complication management.[3] As one of the fastest-growing and aging states in the (U.S.), Florida exemplifies the national burden as it ranks the 2nd in PC deaths.[4] This is also amplified when taking into account the multifaceted disparities due to social determinants of health disparities factors.[5] Prior studies have indicated that various sociodemographic factors contribute to disparities in PC care and outcomes. A recent study found that patients with lower socioeconomic status often face delays in treatment, which can exacerbate health outcomes.[6] A recent 2025 study found that Black/African American individuals face substantially elevated mortality risks, with adjusted odds ratios of 1.339 compared to White individuals.[7] It is important to note that these disparities extend beyond mortality but also to care access and quality of care, such as length of stay (LOS).[4]

In PC care, hospital characteristics have been shown to influence patient outcomes (in-hospital mortality and LOS). Factors such as teaching status, hospital size measured by the number of staffed beds, and nursing ratios are associated with patient outcomes, suggesting the need to understand these factors and optimize them.[8–11] However, current gaps exist in the literature, and prior studies have inadequately examined relationships between patient demographics, hospital characteristics, and county-level social determinants of health in determining PC hospitalization outcomes in a temporal context.[9] Furthermore, to our knowledge, no prior state-level study has applied a multilevel mixed-effects framework to model patient-, hospital-, and county-level predictors of both LOS and in-hospital mortality simultaneously in a PC-specific sample, leaving the relative contribution of each level undefined.

While overall survival for PC remains poor, understanding modifiable factors associated with LOS and in-hospital mortality remains clinically important. Shorter hospital stays with equivalent outcomes reflect more efficient care delivery and reduced patient burden, while in-hospital mortality represents potentially preventable deaths during acute care episodes that may be amenable to system-level interventions.[12] Furthermore, there is no clear evidence on the temporal change in hospital outcome patterns.[12] We hypothesized that hospital structural characteristics, particularly size and teaching status, would demonstrate volume-outcome relationships, while patient-level social determinants, including race/ethnicity and insurance status, would reveal persistent disparities in acute care outcomes. Therefore, this study addressed current literature gaps by investigating the temporal trends in PC hospital admissions, LOS, and in-hospital mortality in Florida from 2010 to 2020, examining patient, hospital, and county-level predictors of these outcomes.

2. Methods

2.1 Data source

A retrospective cross-sectional analysis was conducted by merging data from three comprehensive sources: the Florida Agency for Health Care Administration's (AHCA), the American Hospital Association (AHA) Annual Survey, and the Area Health Resource Files (AHRF) from 2010 to 2020. The AHCA dataset contains administrative records of over 13 million inpatient hospital discharges from 147 hospitals and collects patient-level discharge data. The AHA Annual Survey is a census-based survey administered to over 6,000 hospitals in the United States and its territories that historically has consistently achieved an over 70% response rate. The survey contains comprehensive information about hospitals' structure, process, and performance outcomes. Lastly, the AHRF is a comprehensive database that collects county information from over 50 sources on health care professions, health facilities, population characteristics, and hospital utilization. Hospitals' Centers for Medicare and Medicaid Services (CMS) Certification Number (CCN) and the county's Federal Information Processing System (FIPS) codes were used to link and merge the three datasets.

2.2 Participants

Adult patients aged 18 years or older with a primary diagnosis of pancreatic cancer were identified using the International Classification of Diseases (ICD) codes. For encounters before October 1, 2015, ICD-9 codes were used,[13] and for encounters after October 2015, ICD-10 codes were used (see Table 1).[14] A total of 105 patients were removed for having a missing hospital CCN. A total of 117,278 patients were identified.

2.3 Measures

We examined the relationship between patient-, hospital-, and county-characteristics and pancreatic cancer patients' hospital LOS and in-hospital mortality. These outcomes were selected because they represent measurable indicators of acute care quality that may be amenable to system-level intervention, even in a disease with a poor long-term prognosis. LOS serves as a proxy for care efficiency and resource utilization,[15] with prolonged stays potentially reflecting complications, care coordination challenges, or disparities in access to post-acute services. In-hospital mortality captures deaths during the acute care episode that may be influenced by hospital structural factors and patient access to timely, appropriate care.[16] Our primary outcomes were LOS, measured as the total number of days from admission to discharge,[9] and in-hospital mortality, defined as death during the index hospitalization (yes/no).[17]

Patient-level variables included in the study were demographic characteristics (age and sex), social determinants of health (insurance status, race/ethnicity, and rural-urban classification),[18] and clinical factors (Elixhauser Comorbidity Index and admission type).[19] Hospital characteristics included in the study were teaching status (yes/no), bed size, rural-urban classification, ownership (government, for-profit, and not-for-profit), and part of a system. The study also included county characteristics, which included market competition and AHCA regions, to account for regional differences in care delivery and outcomes. In this study, the market competition was operationalized using the Herfindahl-Hirschman Index (HHI), whereby an HHI of 1 depicts a monopoly, and 0 is a perfectly competitive market.[11]

Table 1. International Classification of Diseases codes to identify the patient cohort

ICD-9		**ICD-10**	
Code	**Description**	**Code**	**Description**
157	Malignant neoplasm of pancreas	C25.0	Malignant neoplasm of head of pancreas
157.0	Malignant neoplasm of head of pancreas	C25.1	Malignant neoplasm of body of pancreas
157.1	Malignant neoplasm of body of pancreas	C25.2	Malignant neoplasm of tail of pancreas
157.2	Malignant neoplasm of tail of pancreas	C25.3	Malignant neoplasm of pancreatic duct
157.3	Malignant neoplasm of pancreatic duct	C25.4	Malignant neoplasm of endocrine pancreas
157.4	Malignant neoplasm of islets of Langerhans	C25.7	Malignant neoplasm of other parts of pancreas
157.8	Malignant neoplasm of other specified sites of pancreas	C25.8	Malignant neoplasm of overlapping sites of pancreas
157.9	Malignant neoplasm of pancreas, part unspecified	C25.9	Malignant neoplasm of pancreas, unspecified
V10.09	Personal history of malignant neoplasm of other sites in gastrointestinal tract (includes pancreas)	Z85.07	Personal history of malignant neoplasm of pancreas
230.9	Carcinoma in situ of other and unspecified digestive organs	D01.7	Carcinoma in situ of other specified digestive organs

2.4 Statistical analysis

Statistical analysis began with descriptive statistics to summarize patient, hospital, and county characteristics. In this study, cases with missing key variables or implausible values were excluded. Univariate analyses examined associations between independent variables and outcomes using *t*-tests and ANOVA for LOS and chi-square (χ^2) tests for in-hospital mortality. Mixed effects linear regression was used to analyze factors associated with LOS, while mixed effects logistic regression identified predictors of in-hospital mortality.[10] All models were adjusted for patient clustering within hospitals to account for the correlation of outcomes within hospitals and counties. We conducted a correlation matrix of hospital covariates to ensure that all regression assumptions were met, which included testing for multicollinearity using variance inflation factors (VIFs) < 10 to address the need for any key interactions. Sensitivity analyses stratified results by period to assess any impact of the ICD-9 to ICD-10 transition. Statistical significance was determined at a $p < .05$, and all analyses were performed using Stata version 17MP.[20]

2.5 Ethical considerations

This study was declared "not research involving human subjects" by the University Institutional Review Board (IRB) based on the definitions provided in the U.S. Department of Health and Human Services Code of Federal Regulations found at 45 CFR 46.102. Accordingly, this project qualified for a Waiver of IRB Review. The waiver did not absolve the researchers from complying with other federal, state, or local laws or institutional policies and procedures that are applicable in the conduct of this project.

3. Results

3.1 Trends in admission diagnoses

Analysis of admission diagnoses from 2010 to 2020 revealed significant temporal trends and coding transitions. Abdominal pain is the leading diagnosis throughout the decade, accounting for almost 12% of admissions in 2016 before declining to 8.5% by 2020 (see Figure 1). PC, which remained the second most common diagnosis throughout the study period, showed a significant upward trend, increasing from 4.68% in 2010 to 7.09% in 2020 ($p < .001$). Chi-square analysis for trend confirmed this increase ($\chi^2 = 156.3$, $p < .001$). Sepsis emerged dramatically after 2017, rising to become the third most common diagnosis by 2020 (approximately 6%). Fever and pancreatic head cancer remained relatively stable at 3%-4.5% of admissions. Statistical comparison, not shown, of diagnostic patterns before and after the ICD-10 transition showed no significant disruption in overall distribution (Mann-Whitney U = 45.3, $p = .08$), suggesting successful code mapping between systems.

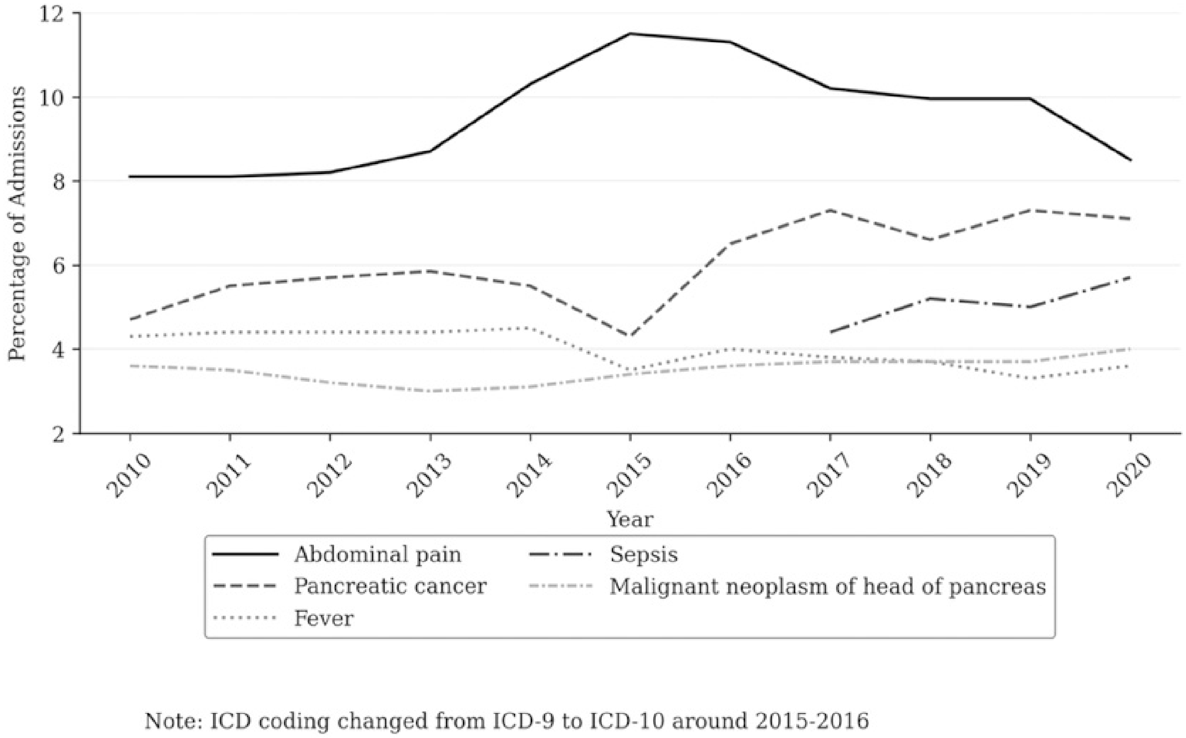

Figure 1. Top 5 diagnosis trends over time (2010-2020)

3.2 Patient and hospital characteristics

Analysis of patient and hospital characteristics from 2010 to 2020 demonstrated several trends (see Table 2). Mean patient age increased steadily from 68.75 (SD = 12.81) to 70.99 (SD = 33.92) years. Racial/ethnic composition analysis showed White patients constituted the majority (69.71% overall) but decreased from 72.4% to 68.14%. Hispanic representation increased significantly (12.88% to 14.84%), while Black patient proportion remained stable with an average of 12.31%. Length of stay decreased slightly from 6.89 (SD = 7.47) to 5.9 (SD = 6.11) days, though variation remained high. Even though the Elixhauser Comorbidity Index showed an increase from 4.22 (SD = 2.06) to 5.08 (SD = 2.21), inpatient mortality remained stable throughout the period, averaging 5.13%. Insurance coverage patterns revealed a shift toward federal insurance such as Medicare, Medicare Managed care, Tricare, and VA (increasing from 64.86% to 70.32%), while uninsured rates decreased (3.11% to 2.14%). Private insurance demonstrated a steady decline from 21.09% to 18.87%.

When examining hospital characteristics, there was a growth in bed capacity, with mean beds increasing from 563.31 (SD = 517.46) to 600.32 (SD = 582.34). Medicare percentage (proportion of total Medicare inpatient days) remained relatively stable (mean = 50.32%, SD = 13.21%) while Medicaid percentage (proportion of total Medicaid inpatient visits) showed a small decline from 18.74% to 17.58%. The Herfindahl-Hirschman Index, measuring market concentration, increased from 0.14 (SD = 0.2) in 2010 to 0.28 (SD = 0.22) by 2020, indicating market consolidation. Lastly, ownership patterns showed slight shifts toward not-for-profit status (57.84% to 60.76%), while for-profit ownership decreased (28.21% to 25.97%).

3.3 Predictors of length of stay

The comprehensive regression model (see Table 3) analyzing patient, hospital, and county characteristics as predictors of average length of hospital stay showed that several patient-level factors were significantly associated with longer hospital stays. Compared to emergency admission priority, elective admissions were associated with longer stays (Coefficient = 1.93, $p < .001$). Patients who were admitted with an urgent priority also had longer stays (Coefficient = 0.90, $p < .001$). Additional factors associated with longer stays included the "other" race/ethnicity category and "black" compared to Non-Hispanic White (Coefficient = 0.29, $p = .009$; Coefficient=0.40, $p \leq .001$), female (Coefficient = 0.19, $p < .001$), and higher Elixhauser Comorbidity Index scores (Coefficient = 0.78, $p < .001$).

Table 2. Patient demographics and hospital structural characteristics across all years (2010-2020)

Categorical Variables	*N*	Percent
Sex		
Male	58,756	52.79
Female	52,535	47.21
Insurance Type		
Uninsured	2,682	2.41
State insurance	9,667	8.69
Federal	76,207	68.48
Private	21,811	19.6
Other	924	0.83
Race/Ethnicity		
White	77,579	69.71
Black	13,704	12.31
Hispanic	16,274	14.62
Other	3,734	3.36
Admission Priority		
Emergency	78,289	70.35
Urgent	15,181	13.64
Elective	17,595	15.81
Trauma	226	0.2
In-hospital Mortality		
No	105,582	94.87
Yes	5,709	5.13
Hospital Teaching Status		
Not Teaching	21,737	19.53
Minor Teaching	68,150	61.24
Major Teaching	21,404	19.23
Hospital Location		
Urban	109,649	98.52
Rural	1,642	1.48
Hospital Ownership Status		
Government	14,554	13.08
For-Profit	29,776	26.76
Not-For-Profit	66,961	60.17
Hospital Part of a system		
No	16,543	14.86
Yes	94,748	85.14
Continues Variables	**Mean**	**SD**
Age	69.20	17.51
Length of Stay	6.36	6.85
Elixhauser Comorbidity Index	4.59	2.12
Number of Hospital Beds	623.37	649.76
Hospital Medicare Percentage	50.40	12.80
Hospital Medicaid Percentage	18.16	8.27
Hospital Herfindahl–Hirschman Index	0.25	0.22

Federal, private, and other insurance types versus the uninsured were significantly linked to shorter stays. Among hospital characteristics, For-profit ownership compared to government ownership was associated with longer stays (Coefficient = 3.01, p = .008). Higher Herfindahl-Hirschman Index scores were significantly associated with shorter stays (Coefficient = -0.60, p = .002). Minor teaching status was significantly associated with shorter stays (Coefficient = -2.31, p = .001), while major teaching status did not reach significance (Coefficient = -1.10, p = .491). Hospital bed size as a continuous variable was not independently significant (Coefficient = 0.03, p = .727). Rural location was not significant (Coefficient = 0.28, p = .313).

County-level social determinants, entered as standardized variables (z-scores) to permit direct comparison across scales, showed several significant associations with LOS. Better clinical care was associated with shorter stays (Coefficient = -0.18, p < .001). Higher socioeconomic disadvantage predicted longer stays (Coefficient = 0.22, p < .001), as did worse health behaviors (Coefficient = 0.15, p = .002). Better quality of life (Coefficient = -0.10, p = .002) and worse physical environment (Coefficient = -0.06, p = .010) were also associated with shorter stays. Length of life reached statistical significance in this model (Coefficient = -0.09, p = .049).

3.4 Predictors of in-hospital mortality

The comprehensive logistic regression model (see Table 4) showed that Social Economic Factors demonstrate a significant association with in-hospital mortality (OR = 1.06, 95% CI: 1.01-1.12, p = .027). Physical Environment (OR = 1.00, p = .988), Length of Life approaches significance (OR = 0.94, 95% CI: 0.88-1.01, p = .086). Health Behaviors, Quality of Life, and Clinical Care show no significant associations with mortality. Hospital bed size does not independently predict mortality (OR = 1.02, p = .656). Higher Herfindahl-Hirschman Index scores were associated with reduced mortality (OR = 0.76, 95% CI: 0.61-0.95, p = .017). Teaching hospitals show lower mortality odds compared to non-teaching hospitals: minor teaching (OR = 0.83, p = .009) and major teaching (OR = 0.76, p = .040). Rural location is associated with substantially higher mortality odds (OR = 2.37, 95% CI: 1.19-4.72, p = .014), though the rural-by-size interaction term suggests this risk attenuates at larger rural hospitals (OR = 0.73, p = .111). For-profit hospitals show higher mortality odds relative to government hospitals (OR = 1.27, p = .038). Individual patient characteristics show strong associations with mortality.

Table 3. Comprehensive regression model for pancreatic cancer patients' length of stay (N = 117,278)

Average Length of Stay	Coefficient	Standard Error	*P*-Value	95% CI
Length of Life	-0.09	0.05	.049	(-0.19, -0.00)
Quality of Life	-0.09	0.03	.002	(-0.16, -0.04)
Health Behaviors	0.14	0.05	.002	(0.05, 0.24)
Clinical Care	-0.18	0.04	< .001	(-0.26, -0.11)
Social Economic Factors	0.22	0.04	< .001	(0.15, 0.30)
Physical Environment	-0.06	0.02	.010	(-0.11, -0.02)
Herfindahl–Hirschman Index	-0.60	0.19	.002	(-0.97, -0.23)
Hospital Bed Size	0.03	0.09	.727	(-0.15, 0.21)
Location (Ref: Urban)				
Rural	0.28	0.28	.313	(-0.26, 0.82)
Rural × Bed Size (interaction)	0.03	0.39	.943	(-0.73, 0.79)
Teaching status (Ref: Non-teaching)				
Minor Teaching	-2.31	0.68	.001	(-3.65, -0.97)
Major Teaching	-1.10	1.59	.491	(-4.22, 2.03)
Part of a System (Ref: No)				
Yes	-0.80	1.03	.439	(-2.82, 1.23)
Ownership (Ref: Government)				
For-Profit	3.01	1.12	.008	(0.81, 5.21)
Not-For-Profit	0.24	1.12	.829	(-1.95, 2.43)
Age	-0.01	0.00	< .001	(-0.01, -0.01)
Elixhauser Comorbidity Index	0.78	0.01	< .001	(0.76, 0.80)
Sex (Ref: Male)				
Female	0.19	0.04	< .001	(0.11, 0.26)
Race/Ethnicity (Ref: Non-Hispanic White)				
Black	0.40	0.06	< .001	(0.28, 0.53)
Hispanic	-0.08	0.07	.229	(-0.22, 0.05)
Other	0.29	0.11	.009	(0.07, 0.51)
Insurance Type (Ref: Uninsured)				
State insurance	0.01	0.15	.928	(-0.27, 0.30)
Federal	-0.69	0.13	< .001	(-0.95, -0.43)
Private	-0.39	0.14	.004	(-0.66, -0.12)
Other	-3.45	0.25	< .001	(-3.95, -2.95)
Admission Priority (Ref: Emergency)				
Urgent	0.90	0.07	< .001	(0.77, 1.03)
Elective	1.93	0.06	< .001	(1.81, 2.04)
Trauma	1.74	0.44	< .001	(0.87, 2.61)

Table 4. Comprehensive regression model for pancreatic cancer patients' in-hospital mortality (N = 117,278)

In-hospital Mortality	Odds Ratio	Standard Error	*P*-Value	95% CI
Length of Life	0.94	0.03	.0860	(0.88, 1.01)
Quality of Life	1.01	0.02	.5370	(0.98, 1.04)
Health Behaviors	1.01	0.04	.7920	(0.94, 1.09)
Clinical Care	1.03	0.03	.3470	(0.97, 1.10)
Social Economic Factors	1.06	0.03	.0270	(1.01, 1.12)
Physical Environment	1.00	0.00	.9880	(1.00, 1.00)
Herfindahl–Hirschman Index	0.76	0.09	.0170	(0.61, 0.95)
Hospital Bed Size	1.02	0.05	.6560	(0.93, 1.11)
Location (Ref: Urban)				
Rural	2.37	0.83	.0140	(1.19, 4.72)
Rural × Bed Size (interaction)	0.73	0.14	.1110	(0.49, 1.08)
Teaching status (Ref: Non-teaching)				
Minor Teaching	0.83	0.06	.0090	(0.72, 0.96)
Major Teaching	0.76	0.10	.0400	(0.59, 0.99)
Part of a System (Ref: No)				
Yes	1.11	0.11	.3240	(0.90, 1.36)
Ownership (Ref: Government)				
For-Profit	1.27	0.15	.0380	(1.01, 1.59)
Not-For-Profit	0.95	0.11	.6620	(0.76, 1.19)
Age	1.00	0.00	.0020	(1.00, 1.00)
Elixhauser Comorbidity Index	1.30	0.01	.0000	(1.28, 1.31)
Sex (Ref: Male)				
Female	0.83	0.02	.0000	(0.79, 0.88)
Race/Ethnicity (Ref: Non-Hispanic White)				
Black	1.18	0.05	.0000	(1.08, 1.28)
Hispanic	1.05	0.05	.2470	(0.96, 1.16)
Other	1.27	0.10	.0020	(1.09, 1.47)
Insurance Type (Ref: Uninsured)				
State insurance	0.82	0.08	.0570	(0.67, 1.01)
Federal	0.70	0.07	.0000	(0.59, 0.85)
Private	0.87	0.08	.1640	(0.72, 1.06)
Other	7.71	0.93	.0000	(6.12, 9.8)
Admission Priority (Ref: Emergency)				
Urgent	1.33	0.06	.0000	(1.21, 1.45)
Elective	1.14	0.05	.0030	(1.03, 1.22)
Trauma	2.25	0.56	.0010	(1.36, 3.64)

The Elixhauser Comorbidity Index is a predictor (OR = 1.30, 95% CI: 1.28-1.31, $p < .0001$). Demographic factors are significant, with females showing lower mortality odds than males (OR = 0.83, 95% CI: 0.79-0.88, $p < .0001$), and racial disparities evident for Black patients (OR = 1.18, 95% CI: 1.08-1.28, $p < .0001$) and "Other" races (OR = 1.27, 95% CI: 1.09-1.47, $p = .002$) compared to Non-Hispanic White patients. Insurance status plays a crucial role, with federal insurance showing protective effects (OR = 0.70, 95% CI: 0.59-0.85, $p < .0001$) compared to being uninsured. Admission type is also significant, with trauma admissions showing the highest risk (OR = 2.23, 95% CI: 1.36-3.64, $p = .001$) compared to emergency admissions.

4. DISCUSSION

The significant increase in pancreatic cancer as a primary admission diagnosis parallels national trends documented in previous studies. This trend parallels national data reported by Bhandari, Abdul[21] and Dahiya, Inamdar[9] suggesting systemic factors driving increased healthcare utilization for pancreatic cancer patients, consistent with national data. The magnitude of this increase cannot be attributed solely to population aging: the data demonstrate concurrent increases in comorbidity burden as measured by the Elixhauser Index, indicating more medically complex patients presenting for care. These trends directly address the study's first objective and establish the epidemiological context in which hospital and patient-level predictors operate.

The emergence of sepsis as a leading diagnosis after 2017 merits particular attention from a clinical standpoint. This pattern may reflect enhanced sepsis recognition following implementation of Sepsis-3 criteria and systematic screening protocols, or may indicate genuine changes in disease presentation or complications.[22, 23] From a gastroenterological perspective, this trend warrants investigation of potential relationships with interventional procedures, biliary obstruction management, or immunocompromised states associated with chemotherapy regimens.

Addressing the study's temporal trend objective for in-hospital mortality, the data show stable rates over a decade despite a significant increase in patient complexity. Mean patient age and the Elixhauser Comorbidity Index both rose, indicating that hospitals were treating older and sicker patients. Maintaining stable mortality in this context is significant: it suggests that advances in perioperative care, critical care management, and complication response have offset the expected rise in mortality driven by patient acuity. This finding is clinically meaningful because it reframes stable mortality not as stagnation but as a quality achievement against a deteriorating case-mix baseline.[24] Addressing the LOS objective directly, the data show a modest but significant reduction in LOS over the study period. This gain was achieved despite rising comorbidity burden and likely reflects improvements in care coordination, including the implementation of enhanced recovery after surgery (ERAS) protocols that have demonstrated effectiveness in major pancreatic surgeries.[25] The significance of this finding extends beyond efficiency: shorter stays with stable mortality indicate improved care value, not simply cost compression. However, this analysis does not capture post-discharge outcomes, and the clinical implications of shorter stays must be weighed against potential readmission risk.

The observed racial disparities in mortality outcomes confirm the study's hypothesis that patient-level social determinants reveal persistent disparities in acute care outcomes. Black patients faced 18% higher in-hospital mortality odds compared to Non-Hispanic White patients, a finding that persisted after adjusting for age, comorbidity, insurance status, and hospital characteristics. The significance of this finding lies in its magnitude and its resistance to risk adjustment: the disparity cannot be explained by the clinical factors measured, implicating structural barriers including differential access to subspecialty care, implicit bias in clinical decision-making, and unequal utilization of palliative resources. These findings align with established literature demonstrating reduced access to care, delayed diagnosis, and differential treatment patterns for racial minorities with pancreatic cancer.[26–28]

The insurance-related findings address the hypothesis regarding patient-level predictors and extend it to the domain of financial access. Federal insurance coverage—primarily Medicare—is associated with 30% lower odds of in-hospital mortality (OR = 0.70, $p < .001$), and state insurance with 18% lower odds (OR = 0.82, $p = .057$). These associations carry specific significance for end-of-life care policy. The protective association between federal insurance (primarily Medicare) and in-hospital mortality warrants careful interpretation. For a disease with a poor overall prognosis, in-hospital mortality may reflect where death occurs rather than whether it can be prevented. Insured patients likely have greater access to hospice and palliative care services, enabling discharge to home or dedicated facilities for end-of-life care. A recent 2022 study showed that palliative care utilization has increased from 2.9% to 11.9% over time among insured patients.[29] Uninsured patients may lack these options, resulting in death during hospitalization by default rather than care failure. Therefore, rather than suggesting that coverage expansion reduces PC mortality, these findings suggest that insurance facilitates appropriate transitions to community-based end-of-life care. A recent systematic review of 29 observational studies found evidence to support that health insurance interruption adversely affects cancer care.[30] This interpretation aligns with the shorter LOS observed among insured patients, potentially reflecting more efficient discharge planning and post-acute care coordination. The substantially elevated mortality risk for patients with "other" insurance types (OR = 7.74) warrants additional investigation, as this category may include patients with specific coverage limitations or administrative barriers to care.[31] The pronounced volume-outcome relationships observed in this analysis reinforce the importance of care centralization for complex pancreatic procedures.

Rural location is associated with substantially elevated in-hospital mortality (OR = 2.37, CI: 1.19–4.72, p = .014). Rural patients with pancreatic cancer face documented barriers, including delayed diagnosis, limited access to specialized oncology care, and lower rates of guideline-concordant treatment.[33] The rural-by-bed-size interaction approaches but does not reach significance (OR = 0.73, p = .111), suggesting that larger rural hospitals may partially attenuate this mortality gap, though this warrants confirmation in multi-state analyses. These findings carry direct significance for healthcare delivery: they support selective referral of rural PC patients to regional teaching centers rather than closer community hospitals, and investment in rural oncology infrastructure where referral is not feasible. The association between market concentration and improved outcomes presents an intriguing finding that challenges[32] conventional assumptions about healthcare competition.[33] The 30% mortality reduction in more concentrated markets may reflect the development of centers of excellence, improved care coordination, or economies of scale in maintaining specialized capabilities. This finding warrants further investigation to understand optimal market structures for complex cancer care.

This analysis of county-level social determinants revealed the complex relationship between population health factors and individual clinical outcomes. The significant association between Social Economic Factors and mortality, while modest in magnitude, suggests that upstream interventions addressing community-level socioeconomic conditions may yield downstream benefits for cancer patients.[34] This finding supports the growing recognition that healthcare quality cannot be divorced from broader social and economic conditions. The lack of association between most county-level health measures and acute care outcomes may reflect the temporal disconnect between long-term population health factors and immediate hospitalization outcomes. These factors likely exert greater influence on cancer prevention, early detection, and long-term survival rather than acute care mortality. The relatively homogeneous socioeconomic landscape within Florida may also limit the detectability of these relationships compared to more geographically diverse populations.[35]

Study limitations

This study is limited by the data source and data points available. First, the administrative dataset used for this analysis is limited to hospital encounters and does not account for events outside of the encounter. Second, the administrative data lacks granular clinical details on disease stage, functional status, and the treatment decision that may significantly impact PC outcomes. The absence of staging information limits the interpretation of the disparities found in the study. Third, the study focuses on in-hospital outcomes and does not capture any long-term outcomes. Finally, the findings from this study provide state-specific insights; it limits the study findings' generalizability to similar regions and States. Even with these limitations, the findings from this study have important healthcare policy implications. This study sets the foundation that will allow future research to explore the granular clinical outcomes of social determinants of health.

5. Conclusions

This study examined trends in PC hospital admissions, LOS, and in-hospital mortality, and the study findings have direct implications for patient care. First, the persistent racial disparities in mortality outcomes signal the need for targeted screening and early intervention programs in underserved communities. Reducing time to diagnosis and ensuring equitable access to specialized care could improve survival for Black patients and other at-risk populations. Second, the strong volume-outcome relationship supports continued regionalization of PC care. Patients may benefit from referral to high-volume centers for complex procedures, though healthcare systems must balance centralization with geographic access. Third, the protective effect of federal insurance suggests that coverage expansion could improve outcomes for uninsured patients. Policymakers should consider these findings when designing programs to reduce financial barriers to cancer care. Lastly, the stable mortality rates despite increasing patient complexity indicate that advances in perioperative and critical care management have been effective. Hospitals should continue implementing enhanced recovery protocols and evidence-based complication management. Addressing these modifiable factors through policy interventions, care coordination, and targeted outreach programs may lead to a reduction in preventable deaths and improve the quality of life for PC patients.

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AUTHORS CONTRIBUTIONS

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DATA SHARING STATEMENT

No additional data are available.

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