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Temporal Stability of In-Hospital Mortality in Acute Pancreatitis: A Nine-Year Tertiary Center Cohort Study

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Abstract. ***Background:*** Acute pancreatitis (AP) is a leading cause of gastrointestinal hospitalization and remains associated with measurable in-hospital mortality despite advances in supportive care. While earlier decades were characterized by declining mortality, contemporary temporal patterns within mature tertiary-care systems remain uncertain. We aimed to evaluate longitudinal trends in admission volume, demographic characteristics, intensive care unit (ICU) utilization, and crude, age-standardized, and adjusted in-hospital mortality in a tertiary academic center.

Materials and Methods: We conducted a retrospective cohort study of consecutive adult hospitalizations with a primary diagnosis of acute pancreatitis at a tertiary referral center between 2016 and 2024. Temporal trends were assessed by using linear and logistic regression models. Age-standardized mortality rates were calculated using direct standardization to a fixed reference population. Multivariable logistic regression evaluated the independent association between year of admission and in-hospital mortality, adjusting for age and sex. A prespecified sensitivity analysis excluded ICU admissions. Analyses were limited by the lack of reliably recorded etiologic and standardized severity data within the administrative dataset.

Results: A total of 1,981 hospitalizations were included. Overall, in-hospital mortality was 5.0%. The annual admission volume, median age, sex distribution, and ICU utilization showed no significant temporal trends. Crude mortality ranged from 1.8% to 6.5% annually and demonstrated no significant temporal association. Age-standardized mortality likewise showed no significant trend. In multivariable analysis, the year of admission was not independently associated with mortality, whereas an advancing age was the strongest measured independent predictor, with a 34% increase in odds of death per 10-year increment. Exclusion of ICU admissions yielded consistent findings.

Conclusions: In this nine-year tertiary-center cohort, in-hospital mortality for acute pancreatitis was approximately 5% and did not demonstrate a statistically significant temporal change. After adjustment, the mortality risk was more strongly associated with age than with calendar year of admission. These findings suggest relative stability within this cohort; however, given the limitations of the study, further research using larger and more detailed datasets is needed to better characterize temporal trends and determinants of mortality.

Keywords: acute pancreatitis, in-hospital mortality, temporal trends, age, epidemiology.

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Ūmaus pankreatito hospitalinio mirtingumo pokyčiai laikui bėgant: devynerių metų kohortinis tyrimas tretinio lygio medicinos centre

Santrauka. ***Įvadas:*** Ūmus pankreatitas (ŪP) yra viena iš pagrindinių priežasčių, dėl kurių pacientai hospitalizuojami dėl virškinimo trakto sutrikimų, ir, nepaisant palaikomojo gydymo pažangos, vis dar siejamas su pastebimu mirtingumu ligoninėje. Nors ankstesniais dešimtmečiais mirtingumas mažėjo, šiuolaikinės laiko tendencijos išsivysčiusiose tretinio lygio sveikatos priežiūros sistemose išlieka neaiškios. Mūsų tikslas buvo įvertinti ilgalaikes tendencijas, susijusias su hospitalizuotų pacientų skaičiumi, demografinėmis charakteristikomis, intensyviosios terapijos (IT) skyrių naudojimu bei bendru, pagal amžių standartizuotu ir pakoreguotu mirtingumu ligoninėje viename tretinio lygio akademiniame centre.

Medžiaga ir metodai: Atlikome retrospektyvinį kohortinį tyrimą, apimantį iš eilės hospitalizuotus suaugusiuosius, kuriems 2016–2024 m. viename tretinio lygio referenciniame centre buvo nustatyta pirminė ūmaus pankreatito diagnozė. Laiko tendencijos buvo vertinamos naudojant linijinius ir logistinius regresijos modelius. Amžiaus atžvilgiu standartizuoti mirtingumo rodikliai apskaičiuoti taikant tiesioginį standartizavimą pagal fiksuotą atskaitos populiaciją. Daugiakintamė logistinė regresija įvertino nepriklausomą ryšį tarp hospitalizavimo metų ir mirtingumo ligoninėje, pakoreguojant pagal amžių ir lytį. Iš anksto numatyta jautrumo analizė neįtraukė hospitalizavimo į IT skyrių atvejų. Analizės buvo ribotos dėl patikimai užregistruotų etiologinių ir standartizuotų sunkumo duomenų trūkumo administraciniame duomenų rinkinyje.

Rezultatai: Iš viso buvo įtraukta 1 981 hospitalizacija. Apskritai mirtingumas ligoninėje buvo 5,0 %. Metinis hospitalizavimo skaičius, amžiaus mediana, lyties pasiskirstymas ir intensyviosios terapijos skyrių naudojimas nerodė reikšmingų laiko tendencijų. Neapdorotas mirtingumas svyravo nuo 1,8 % iki 6,5 % per metus ir nerodė reikšmingo laiko ryšio. Amžiumi standartizuotas mirtingumas taip pat nerodė reikšmingos tendencijos. Atlikus daugiametę analizę, hospitalizavimo metai nebuvo nepriklausomai susiję su mirtingumu, o didėjantis amžius buvo stipriausias išmatuotas nepriklausomas prognozės veiksnys, be to, mirties tikimybė padidėdavo 34 % kas 10 metų. Išskyrus hospitalizavimą į intensyviosios terapijos skyrių, gauti rezultatai buvo nuoseklūs.

Išvados: Šioje devynerių metų tretinio lygio centro kohortos studijoje mirtingumas dėl ūminio pankreatito ligoninėje buvo maždaug 5 % ir nerodė statistiškai reikšmingų laiko pokyčių. Atlikus koregavimą, mirtingumo rizika buvo labiau susijusi su amžiumi nei su hospitalizavimo kalendoriniais metais. Šie rezultatai rodo santykinį stabilumą šioje kohortinėje studijoje; tačiau, atsižvelgiant į tyrimo ribojimus, reikia tolesnių tyrimų, naudojant didesnius ir išsamesnius duomenų rinkinius, siekiant geriau apibūdinti laiko tendencijas ir mirtingumo veiksnius.

Raktažodžiai: ūmus pankreatitas, hospitalinis mirtingumas, laiko tendencijos, amžius, epidemiologija.

Introduction

Acute Pancreatitis (AP) is a leading gastrointestinal cause of hospital admission worldwide, and it imposes a substantial healthcare burden [1–3]. While most cases are mild, severe AP remains associated with significant in-hospital mortality due to systemic inflammation, persistent organ failure, and infectious complications [4]. Although advances in fluid resuscitation and critical care reduced mortality in earlier decades [3,5], it remains unclear whether such gains have continued in contemporary mature tertiary-care systems.

Population-based and registry analyses have reported heterogeneous temporal patterns, with some demonstrating continued mortality decline and others suggesting stabilization in recent years [6,7]. However, national datasets aggregate diverse institutions and may obscure center-level variation in the case mix, referral patterns, and local practice structures [8]. Moreover, crude mortality trends are vulnerable to demographic confounding. Age is among the strongest independent predictors of death in AP, and shifts in age distribution across calendar years may distort any interpretation of temporal associations if age-standardized analyses are not performed [1,9]. In tertiary systems with established supportive pathways and ICU protocols, further mortality reductions may be limited, which is consistent with a ceiling effect [10].

Despite these considerations, longitudinal institutional studies integrating crude, age-standardized, and multivariable-adjusted mortality analyses within mature tertiary centers are scarce, particularly in Eastern European healthcare systems. The issue whether temporal trends independently influence short-term mortality after demographic adjustment remains unresolved.

We therefore conducted a nine-year retrospective cohort study of consecutive adult hospitalizations for acute pancreatitis in a tertiary academic center to evaluate temporal trends in in-hospital mortality and to assess whether the calendar year of admission is independently associated with mortality after adjustment for key demographic factors. We hypothesized that, within a tertiary-care system, in-hospital mortality would remain stable over time and that an advancing age – rather than the year of admission – would emerge as the principal determinant of death.

Materials and Methods

Study Design and Setting

This was a retrospective observational cohort study using administrative hospital discharge data obtained from a tertiary academic referral center in Riga, Latvia.

The study was approved by the Medical Research Ethics Committee of the Faculty of Medicine and Life Sciences, University of Latvia (Approval No. 23-37/301). The requirement for informed consent was waived due to the retrospective nature of the study design and the use of anonymized administrative data. The study was conducted in accordance with the Declaration of Helsinki [11].

Study Population

Adult patients (≥18 years) were eligible for inclusion if their primary discharge diagnosis corresponded to acute pancreatitis (ICD-10 codes K85.0–K85.9).

Each hospitalization episode was treated as an independent observation. As a result, individual patients with multiple admissions could be included more than once, and patient-level linkage was not feasible within the administrative dataset. This approach reflects the hospitalization-level analytical framework of the study and should be considered when interpreting the findings.

Data Collection and Variables

Variables extracted from the hospital administrative database included the year of admission; admission and discharge dates; age at admission; sex; hospital department; and discharge disposition, including in-hospital death.

Temporal trends were evaluated using calendar year, modeled as a continuous variable in regression analyses to estimate linear change over time.

Hospital departments were categorized as *Intensive Care Unit* (ICU) and non-ICU services for analytic purposes.

ICD-10 codes K85.0–K85.9 were used to identify eligible hospitalizations.

Outcomes

The primary outcome was in-hospital mortality. Secondary outcomes included the annual admission volume, temporal changes in the median age at admission, trends in the proportion of ICU admissions, and mortality trends after exclusion of ICU admissions as part of a predefined sensitivity analysis.

Statistical Analysis

The statistical analysis was structured into four components: admission volume trends, demographic trends, mortality analyses, and multivariable modelling.

Continuous variables were assessed for normality by using the Shapiro–Wilk test and visual inspection of histograms. Normally distributed variables were summarized as mean ± standard deviation (SD), whereas non-normally distributed variables were reported as the median with first and third quartiles (Q1–Q3). Categorical variables were expressed as counts and percentages. No missing data were observed for the primary outcome or included covariates.

Admission Volume Trend

Temporal trends in the annual admission volume were evaluated by using linear regression, with the year of admission entered as a continuous term. Model assumptions were assessed through residual diagnostics and showed no violation of linearity or homoscedasticity.

Demographic Trends

Changes in age distribution across study years were assessed by using the Kruskal–Wallis test. Linear regression analysis was additionally performed with age as the dependent variable and the year of admission as a continuous predictor to quantify temporal change. Temporal trends in the sex distribution and ICU admission proportion were assessed by using the chi-square test for trend evaluation.

Crude Mortality Trend

Annual crude in-hospital mortality rates were calculated as the proportion of in-hospital deaths among all acute pancreatitis admissions within each year of admission. Temporal changes in mortality were evaluated by using logistic regression, with the year of admission treated as a linear predictor to estimate the annual change in odds of death.

Age-Standardized Mortality

To account for potential demographic shifts over time, age-standardized in-hospital mortality rates were calculated by using the direct method of standardization [9] across predefined age strata (18–39, 40–49, 50–59, 60–69, 70–79, and ≥80 years). Age-specific mortality rates for each calendar year were weighted to a fixed reference population defined as the pooled age distribution of all admissions during the 2016–2024 study period. This reference distribution was applied uniformly across study years with the objective to ensure comparability. Standardization was restricted to age and did not include sex adjustment. Temporal trends in age-standardized mortality were evaluated by using linear regression, with the calendar year being modeled as a continuous predictor so that to estimate the annual change in standardized mortality.

Multivariable Analysis

Sequential multivariable logistic regression models were constructed to evaluate the association between the year of admission and in-hospital mortality. Two prespecified models were fitted. Model 1 examined the unadjusted association between the year of admission and mortality. Whereas, Model 2 adjusted for age and sex.

Length Of Stay (LOS) was additionally evaluated as a hospitalization-level variable; however, due to its non-normal distribution and potential dependence on the outcome, it was not included in the primary multivariable models and was instead analyzed descriptively. Age was modeled continuously and scaled per 10-year increment in order to aid interpretability. Adjusted *Odds Ratios* (ORs) with 95% confidence intervals (CIs) were reported. The modeling year categorically yielded similar results, thus supporting a linear specification.

The ICU admission status was excluded from the primary models, as 100% mortality in this subgroup caused complete separation, precluding stable maximum-likelihood estimation [12]. The influence of ICU case-mix was evaluated separately in a prespecified sensitivity analysis excluding ICU admissions. *Variance Inflation Factors* (VIFs) were calculated to assess potential multicollinearity among covariates, and no evidence of significant multicollinearity was observed. Given the explanatory aim of the analysis, model calibration was not a primary focus.

ICU Complete Separation and Statistical Considerations

ICU admission demonstrated complete separation (100% mortality), precluding stable maximum-likelihood estimation in logistic regression models [13,14]. This approach reflects established handling of separation in regression modelling, for which, penalized-likelihood methods such as Firth's bias-reduction, are recognized alternatives [12,13]. Sensitivity analyses excluding ICU cases were performed to confirm robustness of the effect estimates [8,15].

Sensitivity Analysis

To assess the influence of ICU case-mix severity, a sensitivity analysis excluding ICU admissions was performed. Logistic regression analyses were then repeated by using only the non-ICU cohort to evaluate the mortality trends without the impact of extreme-severity cases.

All tests were two-sided, with statistical significance defined as $p < 0.05$. Analyses were performed by using *Python* (version 3.11; *Python Software Foundation*, Wilmington, DE, USA). Data management and statistical computations were conducted using the *pandas* and *NumPy* libraries.

Results

Study Population

Between 1 January 2016 and 31 December 2024, 1,981 adult hospitalizations with a primary discharge diagnosis of acute pancreatitis were identified. The overall in-hospital mortality was 5.0% (100/1,981).

The median age was 51.0 years (Q1–Q3: 40.0–65.0), and 61.4% of hospitalizations involved male patients. The median length of stay was 5.1 days (Q1–Q3: 3.2–8.3). Twenty-two hospitalizations (1.1%) involved ICU admission, and all 22 resulted in in-hospital death. Baseline characteristics stratified by the year of admission are presented in Table 1.

Table 1. Baseline characteristics of acute pancreatitis admissions by year of admission (2016–2024)

Year	Admissions (n)	Median Age, years (Q1–Q3)	Male, n (%)	ICU, admissions (%)	In-hospital Deaths, n (%)	Median LOS, days (Q1–Q3)
2016	222	51.0 (37.2–67.0)	133 (59.9)	1 (0.5)	4 (1.8)	4.9 (3.4–8.2)
2017	220	50.5 (40.0–65.0)	142 (64.5)	4 (1.8)	12 (5.5)	4.8 (3.2–8.0)
2018	240	52.0 (41.0–66.2)	147 (61.3)	2 (0.8)	13 (5.4)	5.5 (3.5–8.7)
2019	240	52.0 (40.0–67.2)	141 (58.8)	0 (0.0)	15 (6.2)	5.4 (3.2–8.4)
2020	251	52.0 (43.0–66.5)	157 (62.5)	2 (0.8)	11 (4.4)	4.4 (3.0–8.1)
2021	186	53.0 (42.2–66.0)	108 (58.1)	4 (2.2)	12 (6.5)	5.0 (3.2–8.1)
2022	217	49.0 (37.0–61.0)	137 (63.1)	3 (1.4)	13 (6.0)	5.1 (2.9–7.9)
2023	221	48.0 (37.0–62.0)	138 (62.4)	2 (0.9)	10 (4.5)	6.0 (3.6–8.7)
2024	184	49.0 (39.0–65.0)	114 (62.0)	4 (2.2)	10 (5.4)	4.9 (3.1–8.9)
Overall	1,981	51.0 (40.0–65.0)	1,217 (61.4)	22 (1.1)	100 (5.0)	5.1 (3.2–8.3)

Temporal Trends

The annual admission volume ranged from 184 to 251 hospitalizations and did not demonstrate a significant linear trend (β = −4.15 per year; 95% CI fluctuated from 10.67 to 2.37; $p = 0.176$).

Annual crude in-hospital mortality ranged from 1.8% to 6.5% and showed no significant temporal association (OR 1.05 per year; 95% CI 0.97–1.13; $p = 0.264$; Figure 1). Age-standardized mortality likewise showed no significant temporal trend (β = 0.25 percentage points per year; 95% CI from 0.17 to 0.66; $p = 0.202$; Figure 2).

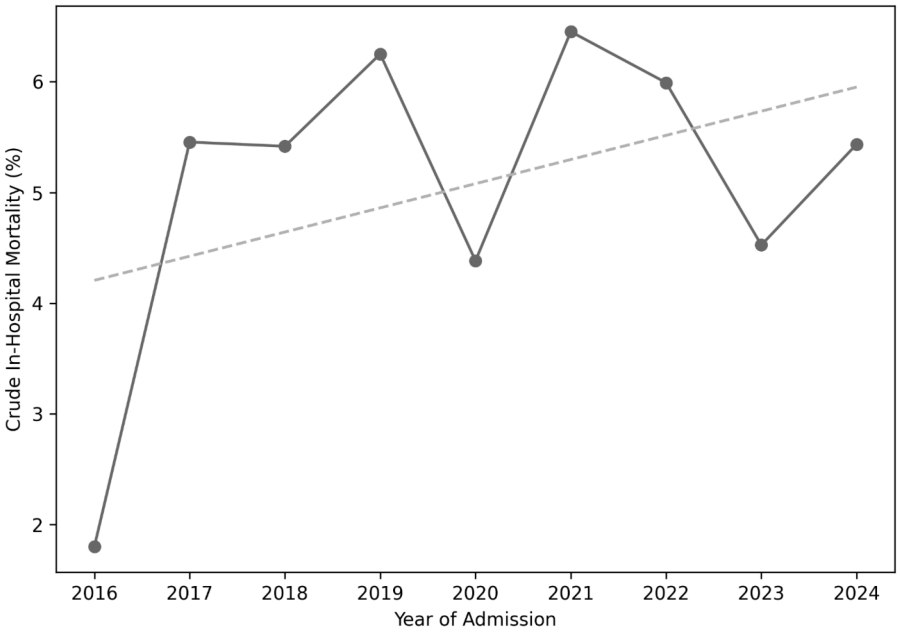

Figure 1. Annual crude in-hospital mortality among adult hospitalizations for acute pancreatitis, 2016–2024. The dashed line represents the fitted logistic regression trend

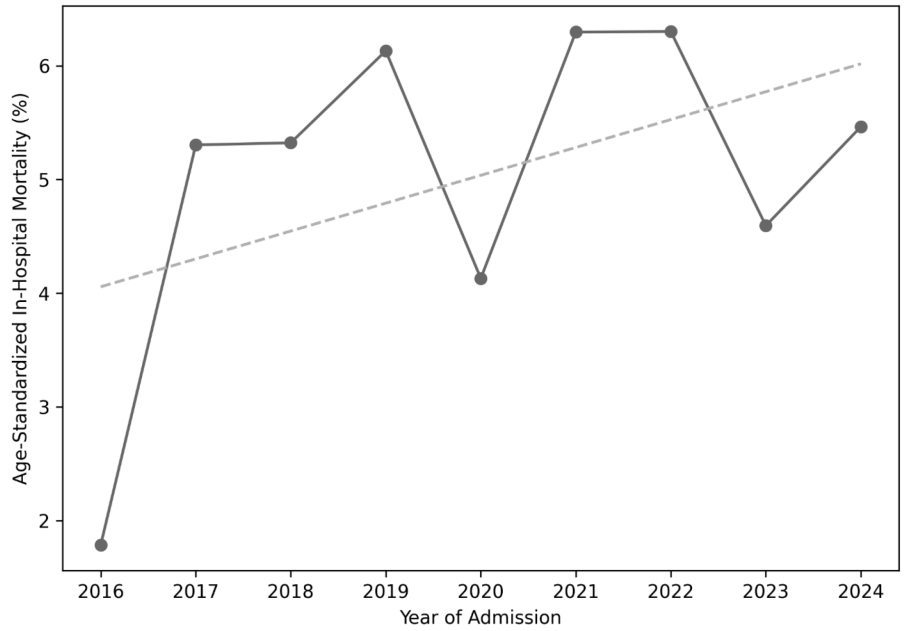

Figure 2. Annual age-standardized in-hospital mortality among adult hospitalizations for acute pancreatitis, 2016–2024. The dashed line represents the fitted linear regression trend

The median age did not change significantly across years (Kruskal–Wallis p = 0.067; β = −0.24 per year; $p = 0.116$; Figure 3). The proportions of hospitalizations involving male and female patients did not change significantly over time (χ^2 for trend = 0.05; $p = 0.827$). Similarly, the proportion of hospitalizations involving ICU admission showed no significant temporal trend (χ^2 for trend = 1.56; $p = 0.211$).

To assess whether the ICU case mix influenced the mortality findings, crude mortality was compared with mortality after exclusion of ICU admissions. Exclusion of ICU admissions resulted in lower annual mortality estimates in all years except for 2019, when no ICU admissions occurred. However, no significant temporal trend was observed in the non-ICU cohort (OR 1.03 per year; 95% CI 0.94–1.12; $p = 0.541$; Figure 4).

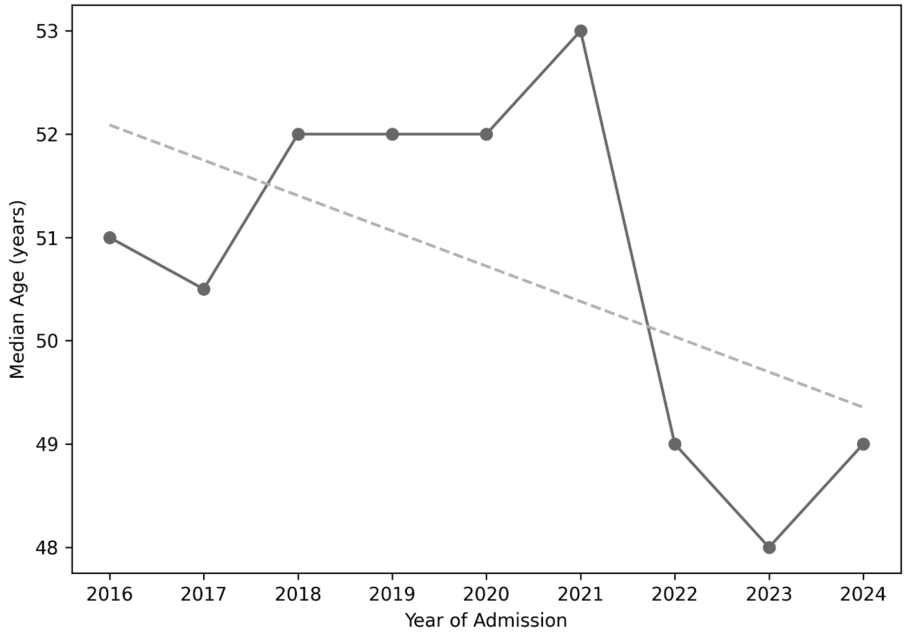

Figure 3. Annual median age of adult patients hospitalized with acute pancreatitis, 2016–2024. The dashed line represents the fitted linear regression trend

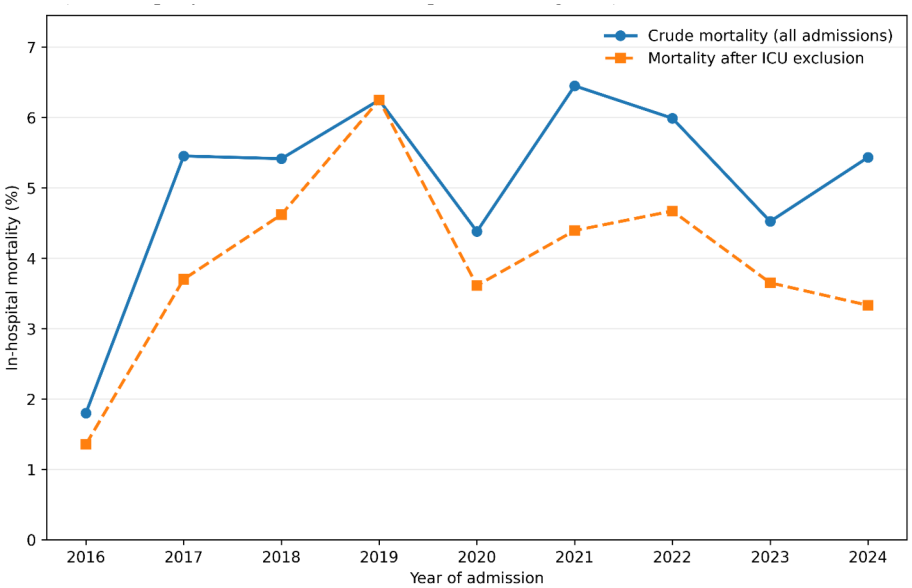

Figure 4. Annual crude in-hospital mortality among all acute pancreatitis hospitalizations compared with mortality after exclusion of ICU admissions, 2016–2024. The solid line represents crude mortality among all hospitalizations, and the dashed line represents mortality after exclusion of ICU admissions

Multivariable Analysis

Multivariable logistic regression results are presented in Table 2. In the unadjusted model, the year of admission was not significantly associated with in-hospital mortality (OR 1.05 per year; 95% CI 0.97–1.13; $p = 0.264$). After adjustment for age and sex, the year of admission remained non-significant (adjusted OR 1.05 per year; 95% CI 0.97–1.14; $p = 0.195$).

Increasing age was independently associated with higher mortality (adjusted OR 1.34 per 10-year increment; 95% CI 1.18–1.52; $p < 0.001$), whereas the male sex was not significantly associated with mortality (adjusted OR 1.46; 95% CI 0.93–2.28; $p = 0.098$).

The length of stay was reported descriptively and was not included in the primary multivariable model because of its non-normal distribution and potential dependence on the outcome. The ICU admission status was excluded from the primary model because complete separation precluded stable maximum-likelihood estimation. The sensitivity analysis excluding ICU admissions likewise showed no significant temporal mortality trend.

Table 2. Multivariable logistic regression analysis of factors associated with in-hospital mortality (n = 1,981)

Variable	Model 1 (Unadjusted) OR (95% CI)	p-value	Model 2 (Age + Sex) OR (95% CI)	*p*-value
Year of admission (per 1-year increment)	1.05 (0.97–1.13)	0.264	1.05 (0.97–1.14)	0.195
Age (per 10-year increment)	—	—	1.34 (1.18–1.52)	<0.001
Male sex (vs. female)	—	—	1.46 (0.93–2.28)	0.098

Note. Abbreviations in use: OR = odds ratio; CI = confidence interval. Model 1 shows the unadjusted association between year of admission and mortality. Model 2 adjusts for age (per 10-year increment) and sex. The year was modeled continuously. The ICU status was excluded due to complete separation (100% mortality).

Discussion

Principal Findings

In this nine-year tertiary cohort, the overall in-hospital mortality for acute pancreatitis was approximately 5% and showed no significant temporal change. This stability persisted across crude, age-standardized, and multivariable-adjusted analyses. The advancing age emerged as the dominant independent predictor of in-hospital mortality. Across the full 2016–2024 study period, in-hospital mortality remained statistically stable.

Mortality Stability and the Potential Ceiling Effect

Although earlier population-based analyses demonstrated substantial declines in case-fatality from acute pancreatitis, many of these gains occurred during the late 20th and early 21st centuries, preceding the present study period [16]. Improvements were largely attributed to advances in supportive care, earlier organ failure recognition, and the shift to minimally invasive 'step-up' strategies, which reduced complications without improving survival [17].

More contemporary registry data from high-income systems suggest that in-hospital mortality has stabilized rather than continued to decline [18]. This stabilization likely reflects the central role of persistent organ failure rather than modifiable procedural factors [10,19]. The revised Atlanta framework emphasizes early organ failure as the key prognostic phase, limiting the impact of procedural refinements once supportive care has matured [20].

ICU-based analyses support a diminishing-returns model, with temporal shifts occurring predominantly in late deaths rather than the early organ-failure phase [10,21,22]. Randomized trials reinforce this pattern: moderated fluid strategies reduce overload without improving mortality [23], and endoscopic versus surgical step-up approaches differ in complications but not survival [24].

These findings may be consistent with relative stability in in-hospital mortality within advanced referral settings; however, this interpretation should be made with caution given the limitations of the dataset and the absence of a statistically significant temporal trend.

Comparison With Existing Literature

The observed 5% in-hospital mortality aligns with contemporary European tertiary-center data, where mortality in unselected hospitalized acute pancreatitis populations typically remains in the mid-single-digit range, although estimates vary by the referral structure and case mix [25–28]. A Romanian tertiary-center cohort reported a mortality of approximately 5.5%, closely mirroring our findings [25], and additional European hospital-based cohorts report comparable estimates [27].

Long-term Scandinavian population data demonstrate that, although 30-day mortality declined substantially over prior decades, more recent gains have been modest [29]. Importantly, early post-discharge mortality remains clinically relevant, indicating that in-hospital endpoints may underestimate the near-term risk [30]. This pattern may be consistent with relative stability in in-hospital mortality, with residual risk appearing to be concentrated in more vulnerable patient groups; however, this interpretation should be made with caution given the limitations of the dataset.

Notably, stabilization of the short-term mortality has occurred alongside rising global incidence and hospitalization rates for acute pancreatitis [31]. Registry-based analyses from Germany and the United States similarly demonstrate relatively stable short-term mortality in recent years despite the evolving ICU infrastructure and supportive care refinement [6,7,28]. ICU-specific cohorts reinforce that severe disease requiring organ support continues to carry substantial baseline mortality even within mature critical care environments [32].

Differences likely reflect variation in the case mix and referral pathways. Tertiary referral centers disproportionately manage patients with persistent organ failure and multiorgan involvement, which are features that are strongly linked to mortality risk [19,20], whereas the ICU capacity, multidisciplinary expertise, and administrative coding practices may influence the reported rates [5,8].

Collectively, these findings may be consistent with relative stability in in-hospital mortality within a tertiary-care system; however, this interpretation should be made with caution given the limitations of the study.

Eastern European Context and External Validity

Institutional outcome data from Eastern European tertiary centers remain limited compared with Western registry analyses [28]. While registry-based studies provide valuable population-level benchmarking, they often lack granular insight into institutional case mix, referral dynamics, and temporal stability within individual centers. Healthcare organization and the critical care infrastructure vary across European regions [33–35].

Available institutional cohorts from Eastern Europe report mortality levels comparable to Western settings, though data remain sparse [25]. Multicenter prospective data from Central and Eastern Europe, including the Hungarian Pancreatic Study Group cohort, further support regional consistency in contemporary management patterns and outcomes [36]. Recent hospital-based data from Poland likewise report persistent mid–single-digit in-hospital mortality, with deaths predominantly driven by organ failure phenotypes rather than local pancreatic complications [37]. Institutional analyses complement registry data by providing center-level estimates.

Age as the Primary Measured Predictor of Mortality

Age demonstrated a strong and independent association with in-hospital mortality in our cohort, with an approximately 34% increase in the odds of death per 10-year increment. This magnitude is consistent with contemporary acute pancreatitis cohorts, in which, the advancing age remains a robust predictor of mortality after adjustment for organ failure and other clinical variables [10]. Recent analyses in elderly acute pancreatitis populations confirm age as an independent determinant

of adverse outcomes even after controlling for physiologic and laboratory severity markers [38], and nationwide database studies similarly demonstrate an increasing mortality with an advancing age across diverse healthcare systems [39].

Chronological age likely reflects accumulated biological vulnerability rather than functioning as a causal determinant. Emerging evidence suggests that frailty independently predicts mortality and healthcare utilization beyond chronological age and comorbidity burden [39]. Application of the Hospital Frailty Risk Score in a nationwide Japanese cohort further demonstrated that the physiologic reserve, rather than age alone, drives outcome risk in middle-aged and older patients with acute pancreatitis [40].

Frailty reduces tolerance to systemic inflammatory stress and predisposes to persistent organ failure. Immunosenescence and chronic inflammation further impair recovery from organ dysfunction [41]. These mechanisms align with contemporary pathophysiologic models in which persistent organ failure and dysregulated host response, rather than local pancreatic injury alone, determine the mortality risk [19,20].

This vulnerability is reflected in severity indices such as BISAP, which incorporate age ≥60 years [4]. However, age within such indices may obscure the contribution of frailty and physiologic reserve, which are not captured in administrative datasets. Elderly patients with acute pancreatitis warrant early risk stratification, closer hemodynamic monitoring, and proactive escalation strategies, even when classical severity markers are not yet overt at admission.

Temporal Stability Across the Study Period

Across the full 2016–2024 study period, in-hospital mortality did not demonstrate a statistically significant temporal trend. The study period included the COVID-19 pandemic; however, the analysis was not designed to isolate pandemic-specific effects or evaluate changes in referral pathways, ICU availability, or procedural timing.

All ICU admissions resulted in in-hospital mortality. In the prespecified sensitivity analysis excluding ICU admissions, annual mortality estimates were lower in all years except 2019, when no ICU admissions occurred, and no significant temporal trend was observed in the non-ICU cohort (OR 1.03 per year; 95% CI 0.94–1.12; $p = 0.541$). This supports the robustness of the primary finding of temporal mortality stability.

Clinical Implications

The absence of a statistically significant temporal decline may indicate that factors beyond temporal improvements in care could influence mortality; however, this interpretation should be made with caution given the limitations of the study. Contemporary management frameworks already emphasize early severity assessment and structured escalation pathways [3,5,20]. Our findings indicate that biologic vulnerability, and particularly an advanced age and frailty, remains a central determinant of outcome.

These results support structured early risk stratification at admission, incorporating assessment of physiologic reserve alongside the conventional severity indices such as BISAP [4]. Early identification of patients at risk for organ dysfunction may justify lower thresholds for higher-acuity monitoring, earlier multidisciplinary involvement, and proactive critical care consultation in biologically vulnerable individuals.

Continued institutional surveillance remains essential to monitor case mix and detect modifiable drift. In high-resource settings where baseline mortality appears stable, further progress will likely depend on earlier vulnerability recognition and optimized escalation strategies rather than additional procedural innovation.

Strengths and Limitations

This study has several methodological strengths. It included consecutive adult hospitalizations over a nine-year period, minimizing selection bias and enhancing internal validity. Mortality analyses incorporated direct age standardization, thus strengthening comparability across years. A prespecified multivariable framework evaluated independent associations. The sensitivity analysis excluding ICU admissions demonstrated consistent findings.

This study has important limitations. First, the single-center tertiary-care design may limit external generalizability to institutions with different referral structures, ICU capacity, or case-mix severity.

Second, detailed physiologic variables and standardized severity indices such as BISAP or APACHE II were not available, precluding granular adjustment for the organ dysfunction burden at admission. Persistent organ failure is the principal determinant of mortality in acute pancreatitis [19], and inability to directly adjust for validated severity scores introduces potential residual confounding. Unmeasured comorbidity and physiologic severity may partially mediate the age–mortality association. The Length of stay (LOS) was available and is reported descriptively; however, it was not included in multivariable models due to its potential dependence on the outcome and its role as a hospitalization-level variable rather than a baseline predictor.

Third, reliance on administrative discharge data introduces inherent constraints. Administrative datasets may be vulnerable to misclassification bias, coding variability, and incomplete capture of clinical parameters [8,42].

Fourth, mortality assessment was restricted to in-hospital events. Early post-discharge mortality may therefore be underestimated [30].

ICU admissions exhibited complete separation due to extreme-severity clustering and were therefore excluded from primary multivariable models. Sensitivity analyses confirmed that exclusion did not materially alter mortality trends.

Finally, the hospitalization-level analytic structure may have included repeat admissions for individual patients, thus precluding patient-level longitudinal inference.

Conclusions

In this nine-year tertiary-center cohort, in-hospital mortality for acute pancreatitis remained at approximately 5% and did not demonstrate a statistically significant temporal change. The calendar year of admission was not independently associated with mortality, whereas an advancing age emerged as the strongest measured predictor of death.

These findings suggest relative stability in short-term mortality within this tertiary-care setting. However, given the limitations of the dataset, including its single-center design and lack of detailed clinical severity measures, these results should be interpreted with caution. Further studies using larger, multicenter datasets with more granular clinical variables are needed to better characterize temporal trends and determinants of mortality in acute pancreatitis.

Author contributions

A. A.-D.: conceptualization, methodology, formal analysis, investigation, writing – original draft preparation, writing – review and editing.
D. V.: methodology, data curation, writing – review and editing.
M. D.: investigation, validation, writing – review and editing.
D. F.: supervision, writing – review and editing.

Conflict of Interest

The authors declare no conflict of interest.

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