Type 2 Diabetes Increases Severity but Not Mortality in Acute Pancreatitis: A Large Multicenter Analysis

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ABSTRACT

Background/Aims: *Type 2 diabetes mellitus (T2DM) is increasingly recognized as a factor that may influence the course of acute pancreatitis (AP), but its independent associations with severity and mortality remain uncertain. The study investigated the independent association of preexisting T2DM with disease severity and in-hospital mortality in individuals with AP.*

Materials and Methods: *This multicenter retrospective cohort study included 4458 patients with AP from 3 medical centers. Patients were categorized into T2DM (n = 711) and non-T2DM groups (n = 3747). Demographic and clinical data were collected. Multivariable logistic regression analysis was used to evaluate the associations of T2DM with disease severity and in-hospital mortality after adjustment for potential confounders. Stabilized inverse probability of treatment weighting (sIPTW) analyses were performed to assess the robustness of the results.*

Results: *Compared with the non-T2DM group, the T2DM group was older and had a significantly higher proportion of males, and higher prevalences of hypertension and chronic kidney disease. In multivariable analysis, T2DM was independently associated with increased disease severity (OR = 1.42, 95% CI: 1.19-1.69) but not with in-hospital mortality (OR = 1.14, 95% CI: 0.61-2.02). The sIPTW analysis yielded consistent findings, with T2DM remaining independently associated with increased disease severity but not with in-hospital mortality.*

Conclusion: *Preexisting T2DM is independently associated with increased disease severity in patients with AP but not with in-hospital mortality.*

Keywords: *Diabetes mellitus, mortality, pancreatitis, severity*

INTRODUCTION

Acute pancreatitis (AP) is a common gastrointestinal emergency characterized by severe abdominal pain. In moderately severe and severe cases, AP can progress to pancreatic necrosis, and persistent organ failure may develop in severe cases.[1] Between 1990 and 2021, the global incidence of pancreatitis increased significantly, with age-standardized incidence and associated mortality also rising markedly.[2,3] Severe AP (SAP) accounts for approximately 5%-10% of cases and is associated with a mortality rate of 30%-40%.[4] Severe cases often require prolonged hospitalization, intensive care unit admission, or surgical intervention, resulting in substantial healthcare costs.[5,6]

Diabetes mellitus (DM) is a chronic condition with significant global health and socioeconomic consequences and ranks among the top 10 causes of death in adults.[7] Over the past 3 decades, the global number of people with diabetes has increased substantially, making DM the ninth leading cause of death worldwide. It is estimated that approximately 1 in 11 adults has diabetes, of whom approximately 90% have type 2 diabetes mellitus (T2DM).[8] Observational studies from countries including the United States, Japan, and the United Kingdom have demonstrated a substantially higher incidence of AP among patients with T2DM than among those without diabetes.[9-11] However, whether T2DM is independently associated with AP severity and mortality remains uncertain. Although some studies suggest that T2DM is associated with increased AP severity, others have reported no such association.[12-15]

Additionally, the association between T2DM and in-hospital mortality among patients with AP remains unclear. A single-center study from South Korea reported that

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T2DM was independently associated with increased mortality in patients with AP.[14] A US population-based study supported these findings, reporting a 31% increase in the risk of in-hospital mortality associated with T2DM.[16] Conversely, a larger database study from Taiwan reported an inverse association between preexisting T2DM and in-hospital mortality risk in patients with AP.[17] These discrepant findings underscore the need for further investigation. Using a multicenter retrospective cohort design, this study aimed to explore the independent associations of preexisting T2DM with disease severity and in-hospital mortality in patients with AP.

MATERIALS AND METHODS

Study Population

This study included patients hospitalized with a diagnosis of AP at the Yijishan Hospital of Wannan Medical College (April 2016-December 2024), Ma'anshan People's Hospital (March 2019-December 2024), and Second Affiliated Hospital of Wannan Medical College (January 2017-December 2024). Eligible patients were adults (aged ≥18 years) with a diagnosis of AP based on the Revised Atlanta Classification (2012).[18] Exclusion criteria were (1) a history of recurrent AP or chronic pancreatitis; (2) posttraumatic or postendoscopic retrograde cholangiopancreatography–induced AP; (3) a history of malignant tumor or hematologic malignancy; (4) pregnancy; and (5) incomplete medical records. The study was approved by the Scientific Research and New Technology Institutional Review Board of Yijishan Hospital of Wannan Medical College (Approval no: 2 025 271, Date: November 13, 2025), the ethics committee of Maanshan People's Hospital (Approval no: 202511-01, Date: November 19, 2025), and the ethics committee of Second Affiliated Hospital of Wannan Medical College (Approval no: WYEFYLS2 025 060, Date: December 25, 2025). The requirement for informed consent was waived by all ethics committees in accordance with national legislation and institutional guidelines.This investigation did not use artificial intelligence (AI) and/or LLM tools during the preparation of this manuscript.

Main Points

- *This study demonstrates that preexisting type 2 diabetes mellitus (T2DM) is associated with increased disease severity but not with in-hospital mortality among patients with acute pancreatitis (AP).*
- *This study is 1 of the largest multicenter studies to examine the associations of preexisting T2DM with disease severity and in-hospital mortality among patients with AP.*
- *These findings highlight the need for further prospective studies to determine whether T2DM status may inform risk stratification in patients with AP.*

Data Collection

Data were collected from medical records, including age (<60/≥60), sex, comorbidities (T2DM, coronary artery disease, hypertension, and chronic kidney disease), AP etiology (biliary, alcoholic, hypertriglyceridemic [HTG], and other), and local complications. Patients were classified into the T2DM group if they met any of the following criteria:[19] (1) current use of antidiabetic medications; (2) laboratory evidence meeting diagnostic thresholds, including fasting plasma glucose ≥7.0 mmol/L, 2-hour post-load glucose ≥11.1 mmol/L during an oral glucose tolerance test, glycated hemoglobin (HbA1c) ≥6.5%, or random plasma glucose ≥11.1 mmol/L in the presence of classic hyperglycemic symptoms or hyperglycemic crisis; or (3) a documented history of T2DM in the medical record. All remaining patients were classified into the non-T2DM group.

Study Outcomes

The primary outcomes were disease severity and in-hospital mortality. According to the Revised Atlanta Classification, AP severity was categorized as SAP, moderate SAP, and mild AP.[18] In-hospital mortality was defined as death from any cause during hospitalization.

Statistical Analysis

Categorical variables are presented as frequencies and percentages and were compared using the chi-square test. Multivariable logistic regression was used as the primary method to assess the independent associations of preexisting T2DM with disease severity and in-hospital mortality. A variance inflation factor (VIF) of less than 10 was considered to indicate the absence of multicollinearity.[20] The Hosmer–Lemeshow goodness-of-fit test (P > .05) indicated good model calibration. Subgroup analyses were performed to assess the association between T2DM and disease severity according to AP etiology (biliary and HTG). Stabilized inverse probability of treatment weighting (sIPTW) was used to assess the robustness of the primary findings. Propensity scores for T2DM group assignment were assessed using multivariable logistic regression using the following covariates: age (<60 or ≥60 years), sex (female or male), hypertension (no or yes), coronary artery disease (no or yes), chronic kidney disease (no or yes), and etiology (non-HTG or HTG). Stabilized inverse probability of treatment weights were

used to generate a pseudo-population with balanced covariates. Standardized mean differences (SMDs) were compared before and after weighting, with an SMD of less than 0.1 indicating good covariate balance. All statistical analyses were performed using R software, version 4.4.2 (The R Foundation for Statistical Computing; Vienna, Austria). Statistical significance was defined as a 2-sided $P < .05$.

RESULTS

Baseline Characteristics

A total of 4458 eligible patients were included, of whom 711 (15.9%) had preexisting T2DM (Figure 1). Baseline characteristics are presented in Table 1. Compared with the non-T2DM group, patients with T2DM were older (age ≥60 years, 68% vs. 60%, $P < .001$) and more likely to be male (57% vs. 52%, $P = .012$). Patients with T2DM had a higher prevalence of hypertension (54% vs. 31%, $P < .001$) and chronic kidney disease (6% vs. 3%, $P < .001$), whereas the prevalence of coronary artery disease was comparable between groups. Patients with T2DM also had a higher rate of local complications. Before admission, T2DM management consisted of dietary intervention alone (28.0%, n = 199), oral antidiabetic agents (46.4%, n = 330), insulin therapy alone (20.0%, n = 142), and combination therapy with insulin and oral agents (5.6%, n = 40).

Association of Preexisting Type 2 Diabetes Mellitus with Outcomes

Univariable analysis showed that T2DM was associated with increased disease severity (OR = 1.66, 95% CI: 1.40-1.96) but not with in-hospital mortality (OR = 1.71, 95% CI: 0.95-2.90). Multivariable analysis demonstrated that T2DM remained independently associated with increased disease severity (OR = 1.42, 95% CI: 1.19-1.69) but was not independently associated with in-hospital mortality (OR = 1.14, 95% CI: 0.61-1.14) (Table 2). In the etiology-stratified subgroup analysis, T2DM was not significantly associated with disease severity among patients with biliary AP (OR = 1.13, 95% CI: 0.89-1.13) or HTG AP (OR = 1.49, 95% CI: 0.96-1.49). In the sIPTW analysis, 5 of the 6 covariates showed significant imbalance before weighting (SMD > 0.1). After sIPTW, all covariates were well balanced (SMD < 0.1; Supplementary Table 1). The weighted analysis yielded findings consistent with the primary analysis, with T2DM remaining independently associated with increased disease severity (OR = 1.52; 95% CI = 1.28) but not with in-hospital mortality (OR = 1.22; 95% CI = 0.652) (Table 2).

DISCUSSION

This study is one of the largest multicenter studies to examine the associations of preexisting T2DM with disease severity and in-hospital mortality among patients

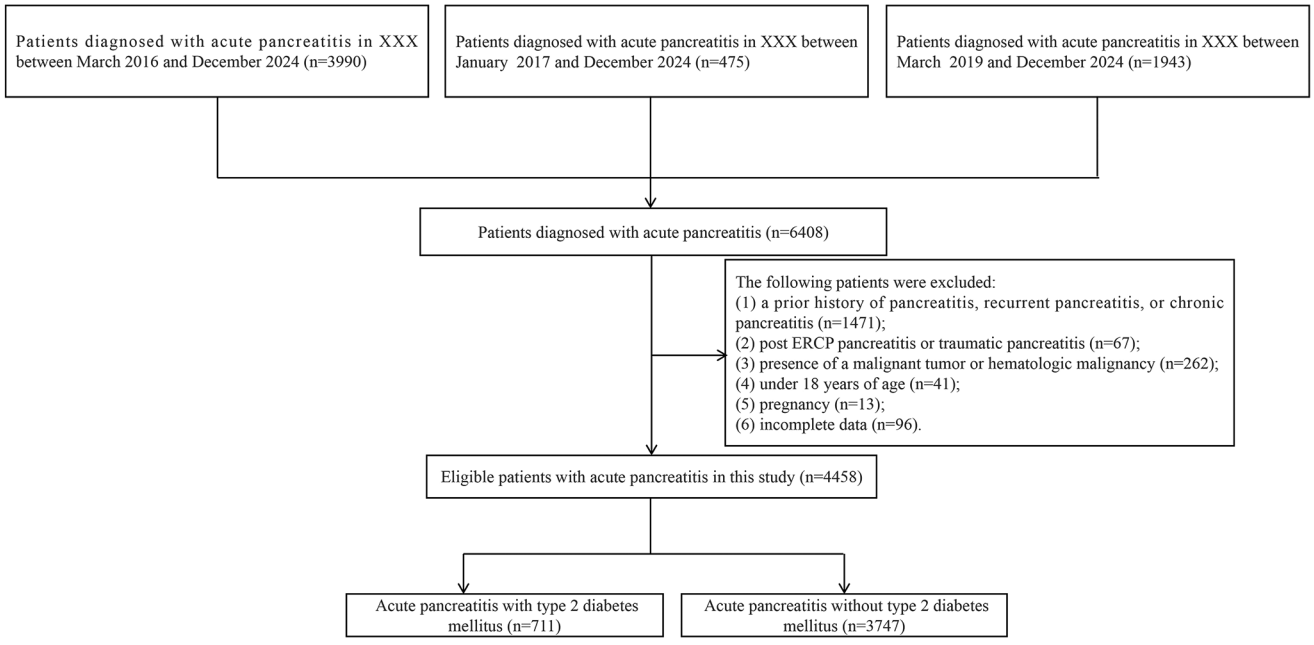

Figure 1. Flowchart of patient selection.

Table 1. Baseline Characteristics of Patients with Acute Pancreatitis with or Without Preexisting Type 2 Diabetes Mellitus

Variables	All Patients (N = 4458)	Preexisting Type 2 Diabetes Mellitus (N = 711)	No Preexisting Type 2 Diabetes Mellitus (N = 3747)	*P*
Sex (n, %)				.012
Male (%)	2354 (52.8)	406 (57.1)	1948 (52.0)	
Female (%)	2104 (47.2)	305 (42.9)	1799 (48.0)	
Age, years [n (%)]				<.001
<60	1719 (38.6)	226 (31.8)	1493 (39.8)	
≥60	2739 (61.4)	485 (68.2)	2254 (60.2)	
Hypertension [n (%)]				<.001
Yes	1550 (34.8)	382 (53.7)	1168 (31.2)	
No	2908 (65.2)	329 (46.3)	2579 (68.8)	
Coronary artery disease [n (%)]				.836
Yes	473 (10.6)	77 (10.8)	396 (10.6)	
No	3985 (89.4)	634 (89.2)	3351 (89.4)	
Chronic kidney disease [n (%)]				.001
Yes	134 (3.0)	40 (5.6)	94 (2.5)	
No	4324 (97.0)	671 (94.4)	3653 (97.5)	
In-hospital mortality [n (%)]				.055
Yes	70 (1.6)	17 (2.4)	53 (1.4)	
No	4388 (98.4)	694 (97.6)	3694 (98.6)	
Disease severity [n (%)]				<.001
MAP	3184 (71.4)	442 (62.2)	2742 (73.2)	
MSAP	1065 (23.9)	215 (30.2)	850 (22.7)	
SAP	209 (4.7)	54 (7.6)	155 (4.1)	
Etiology [n (%)]				
Biliary	2984 (66.9)	412 (57.9)	2572 (68.6)	
Hypertriglyceridemic	435 (9.8)	128 (18.0)	307 (8.2)	
Alcoholic	257 (5.8)	33 (4.6)	224 (6.0)	
Other	782 (17.5)	138 (19.4)	644 (17.2)	
Local complications [n (%)]				<.001
APFC	739 (16.6)	152 (21.4)	587 (15.7)	
ANC	42 (0.9)	8 (1.1)	34 (0.9)	
PPC	46 (1.0)	11 (1.5)	35 (0.9)	
WON	7 (0.1)	3 (0.4)	4 (0.1)	
Type 2 diabetes mellitus management strategies				
Oral antidiabetic medications	/	330 (46.4%)	/	
Insulin therapy	/	142 (20.0%)	/	
Combination therapy with insulin and oral antidiabetic medications	/	40 (5.6%)	/	
Dietary intervention alone	/	199 (28.0%)	/	

ANC, acute necrotic collection; APFC, acute peripancreatic fluid collection; MAP, mild acute pancreatitis; MSAP, moderately severe acute pancreatitis; PPC, pancreatic pseudocyst; SAP, severe acute pancreatitis; WON, walled-off necrosis.

Table 2. Impact of Preexisting Type 2 Diabetes Mellitus on In-Hospital Mortality and Disease Severity in Patients with Acute Pancreatitis

Analysis (with Preexisting T2DM vs. Without Preexisting T2DM)	Odds Ratio	95% CI	*P*
In-hospital mortality			
Univariable analysis	1.71	0.95-2.90	.058
Multivariable analysis[a]	1.14	0.61-2.02	.677
Stabilized inverse probability weighting[b]	1.22	0.65-2.29	.535
Disease severity			
Univariable analysis	1.66	1.40-1.96	<.001
Multivariable analysis[a]	1.42	1.19-1.69	<.001
Stabilized inverse probability weighting[b]	1.52	1.28-1.81	<.001

CAD, coronary artery disease; CKD, chronic kidney disease; HTG, hypertriglyceridemic.
[a]Primary analysis from the multivariable logistic model, adjusted for age, sex, hypertension, CAD, CKD, and etiology (non-HTG/HTG).
[b]Odds ratios from the multivariate logistic model using stabilized inverse probability of treatment weighting, adjusted for the same confounding factors.

with AP. The findings demonstrate that preexisting T2DM is independently associated with increased disease severity but not with in-hospital mortality among patients with AP.

Prior evidence regarding the relationship between T2DM and AP severity remains inconsistent. Several retrospective studies from Romania, South Korea, and Türkiye identified T2DM as a risk factor for SAP.[12-14] Conversely, the large multicenter prospective Acute Pancreatitis Patient Registry to Examine Novel Therapies In Clinical Experience (APPRENTICE) registry, which included 22 centers across North America, Europe, Latin America, and India, found no significant associations between preexisting T2DM and AP severity.[15] The findings strongly support an association between T2DM and increased AP severity. Several mechanisms may contribute to the association between T2DM and more severe AP. First, hyperglycemia may exacerbate systemic inflammation, while diabetes-associated microvascular complications may contribute to pancreatic ischemia and impaired immune function.[21-23] Second, lipid metabolism disorders may contribute to increased AP severity. The etiology of HTG was more common in the T2DM group, and severe HTG may promote AP through free fatty acid toxicity, enhanced trypsin activation, and microcirculatory dysfunction.[24,25] Third, comorbidities may also contribute. In this study, patients with AP and T2DM had significantly higher prevalences of hypertension and chronic kidney disease. These comorbidities reduce physiological reserve and compensatory capacity, creating a synergistic effect that predisposes patients to SAP and multiorgan failure.[26,27] Fourth, insulin resistance, a fundamental pathological defect of T2DM, may contribute to metabolic disturbances and inflammatory responses during the acute phase of AP while impairing tissue repair during recovery.[28-30] These mechanisms could collectively contribute to increased AP severity. Furthermore, a hyperglycemic milieu may promote bacterial proliferation, potentially increasing the risk of infected pancreatic and peripancreatic necrosis, which are important determinants of AP outcomes. Consequently, patients with AP and concomitant T2DM warrant heightened clinical vigilance and early, intensive management.

The association between T2DM and in-hospital mortality among patients with AP remains uncertain. Studies have reported conflicting findings: a retrospective study from South Korea found that T2DM was independently associated with increased in-hospital mortality, whereas a database study from Taiwan reported a lower risk of in-hospital mortality among patients with preexisting T2DM.[14,17] A US nationwide inpatient sample study reported a higher risk of in-hospital mortality among patients with T2DM.[16] A systematic review reported a trend toward increased AP-related mortality with preexisting diabetes, although the association was of boderline statistical significance.[31] In the present study, preexisting T2DM was not independently associated with in-hospital mortality. Although this finding may appear paradoxical given the association between T2DM and increased disease severity, it may reflect the multifactorial nature of disease progression and the effectiveness of contemporary critical care in preventing death among patients with severe disease. The inconsistencies across studies may reflect differences in study populations, predominant AP etiologies, and importantly, the heterogeneity of hyperglycemic states.[32] Evidence suggests that acute stress-induced hyperglycemia during critical illness is strongly associated with an increased risk of mortality among

individuals without diabetes.[33] In contrast, patients with chronic hyperglycemia due to T2DM may have adaptive mechanisms that render them less susceptible to the adverse effects of acute glycemic fluctuations.[32] This physiological distinction provides a plausible framework for interpreting the findings.

This study has several limitations. First, despite adjustment for key confounders, residual confounding is possible. Unmeasured factors, such as body mass index, smoking status, glycemic control status (e.g., HbA1c levels), and duration of diabetes, were unavailable. Accordingly, the findings should be interpreted cautiously and should be considered evidence of a causal relationship. Second, the retrospective design and reliance on medical records may have introduced information and selection biases. Third, the cohort was drawn from a specific region of China, which may limit the generalizability of findings to populations in other countries, ethnic groups, or healthcare systems. Future large-scale, prospective, multicenter studies are needed to validate these findings.

In conclusion, preexisting T2DM was independently associated with increased disease severity in patients with AP but not with in-hospital mortality. These findings underscore the clinical importance of recognizing patients with AP and T2DM as a group at increased risk for disease progression. Future prospective studies are needed to confirm these findings and clarify the underlying mechanisms.

Data Availability Statement: The data that support the findings of this study are available on request from the corresponding author.

Artificial Intelligence Usage Statement: The authors declared that no artificial intelligence tool was used in the preparation of the manuscript.

Ethics Committee Approval: Ethical committee approval was received from the Scientific Research and New Technology Institutional Review Board of Yijishan Hospital of Wannan Medical College (Approval no: 2025271, Date: November 13, 2025), the ethics committee of Maanshan People's Hospital (Approval no: 202511-01, Date: November 19, 2025), and the ethics committee of the Second Affiliated Hospital of Wannan Medical College (Approval no: WYEFYLS2 025 060, Date: December 25, 2025).

Informed Consent: Due to the nature of retrospective study, informed consent was exempted.

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Declaration of Interests: The authors have no conflicts of interest to declare.

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Supplementary Table 1. Stabilized Inverse Probability of Treatment Weighting-Adjusted and Unadjusted Baseline Characteristics of Patients with Acute Pancreatitis According to Type 2 Diabetes Mellitus History

	Before sIPTW			After sIPTW		
	No pre-existing type 2 diabetes mellitus	Pre-existing type 2 diabetes mellitus	SMD	No pre-existing type 2 diabetes mellitus	Pre-existing type 2 diabetes mellitus	*SMD*
Variables	(n=3747)	(n=711)		(n=3748.3)	(n=705.7)	
Sex (n, %)			0.103			0.019
Male	1948 (52.0%)	406 (57.1%)		1980.1 (52.8%)	379.4 (53.8%)	
Female	1799 (48.0%)	305 (42.9%)		1768.3 (47.2%)	326.3 (46.2%)	
Age (years)			0.126			0.017
<60	1493 (39.8%)	123 (51.5%)		1655.1 (44.2%)	317.7 (45.0%)	
>=60	2254 (60.2%)	485 (68.2%)		2093.3 (55.8%)	388.0 (55.0%)	
Hypertension (n, %)			0.469			0.014
Yes	1168 (31.2%)	382 (53.7%)		1304.9 (34.8%)	250.3 (35.5%)	
No	2579 (68.8%)	329 (46.3%)		2443.5 (65.2%)	455.5 (64.5%)	
Coronary artery disease (n, %)			0.008			0.007
Yes	396 (10.6%)	77 (10.8%)		398.6 (10.6%)	76.5 (10.8%)	
No	3351 (89.4%)	634 (89.2%)		3349.8 (89.4%)	629.3 (89.2)	
Chronic kidney disease (n, %)			0.158			0.013
Yes	94 (2.5%)	40 (5.6%)		113.0 (3.0%)	22.9 (3.2%)	
No	3653 (97.5%)	671 (94.4%)		3635.4 (97.0%)	682.9 (96.8%)	
Etiology			0.294			0.006
non-HTG	3440 (91.8%)	583 (82.0%)		3381.7 (90.2%)	635.3 (90.0%)	
HTG	307 (8.2%)	128 (18.0%)		366.7 (9.8%)	70.4 (10.0%)	

sIPTW, stabilized inverse probability of treatment weights; SMD, Standardized Mean Difference, HTG, Hypertriglyceridemic.