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Research Article

Meta-analysis of the relationship between blood glucose level at admission and prognosis in patients with heart failure

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Abstract

Objective: To investigate the impact of admission blood glucose levels on the prognosis of heart failure (HF) patients using meta-analysis.

Methods: We systematically searched databases including CNKI, Wanfang, VIP, CBM, PubMed, Embase, Web of Science, and Cochrane Library for literature on the correlation between admission blood glucose levels and HF prognosis, from their inception to September 1, 2024. After screening titles, abstracts, and full texts, 17 studies were included. Data were extracted and organized using Excel, while RevMan 5.4 was employed for risk-of-bias assessment and outcome analysis.

Results: A total of 106,870 patients from 17 studies were included. Meta-analysis revealed that hyperglycemia at admission significantly increased all-cause mortality risk (HR = 1.73, 95% CI: 1.52–1.96, P < 0.00001). Patients in the highest admission blood glucose category had significantly higher mortality risk in both short- and long-term follow-ups compared to those with lower glucose levels (HR = 1.75, 95% CI: 1.44–2.12). This association persisted in both diabetic (HR = 1.66, 95% CI: 1.47–1.88, P < 0.00001) and non-diabetic patients (HR = 1.71, 95% CI: 1.47–1.99, P < 0.00001). Subgroup analyses by region and sex ratio showed no statistically significant differences (P > 0.05). Sensitivity analysis confirmed the robustness of the findings after excluding studies with the largest and smallest sample sizes.

Conclusion: Elevated admission blood glucose is strongly associated with adverse prognosis in HF patients and serves as a key predictive factor. Hyperglycemia exacerbates cardiac dysfunction through mechanisms such as oxidative stress, inflammatory responses, and neuroendocrine activation. Future research should focus on intervention studies and mechanistic exploration to develop individualized glucose management strategies (e.g., dynamic glucose monitoring) to optimize glycemic control, reduce hypoglycemic and hyperglycemic episodes, and improve clinical outcomes in HF patients.

Keywords: Heart failure; Prognosis; Admission blood glucose

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Introduction

Heart failure (HF) is a syndrome characterized by structural and/or functional cardiac abnormalities that impair ventricular systolic and/or diastolic function, leading to typical symptoms such as dyspnea and chest discomfort, as well as clinical signs including jugular venous distension and lower extremity edema. The morbidity and mortality of HF have risen significantly due to global population aging and the increasing prevalence of cardiovascular diseases. According to the latest Chinese epidemiological survey, the prevalence of HF in China is 0.9%, with a slightly higher rate in women (1.0%) than in men (0.7%). Approximately 500,000 new HF cases are diagnosed annually. International studies report an HF prevalence of 1.5%–2.0% in individuals aged ≥15 years, increasing to 6%–10% in those ≥74 years. Mortality risk escalates with HF severity.

HF patients frequently exhibit glucose metabolism disorders. Approximately 40% of HF patients have comorbid diabetes, while impaired glucose tolerance is even more prevalent. Conversely, the prevalence of HF in diabetic patients is 9%–22%, four times higher than in the general population [1].

Acute heart failure (AHF) patients often present with elevated blood glucose levels during early disease stages, and stress-induced hyperglycemia is common even in those without prior diabetes [2, 3].

Some studies suggest that elevated admission blood

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glucose correlates with poor HF prognosis. An international multicenter study demonstrated that every 1 mmol/L increase in admission glucose was associated with a 5% rise in 30-day mortality (OR = 1.05, 95% CI: 1.01–1.09) [4]. Another study on elderly Chinese non-diabetic AHF patients found that those with glucose >7.8 mmol/L had a 2.3-fold higher 30-day readmission rate compared to the normoglycemic group [5]. However, a large international cohort study reported no significant association between admission glucose levels and mortality, regardless of diabetes status [6].

Blood glucose fluctuations not only directly influence HF pathophysiology but may also indirectly affect disease progression by altering cardiac energy metabolism and endocrine function [7]. Current evidence remains inconsistent regarding the definition of HF with hyperglycemia, its prognostic implications, and areas of controversy. Thus, a systematic evaluation is warranted to clarify the relationship between admission blood glucose levels and HF prognosis.

1. Materials and Methods

1.1 Study Design

Studies investigating the relationship between admission blood glucose levels and prognosis in heart failure (HF) patients were included. Eligible articles had to provide valid outcome data on post-treatment prognosis. Both Chinese and English publications were considered.

1.2 Study Population

Patients with a confirmed HF diagnosis, regardless of age, sex, disease duration, or ethnicity, were included. All participants met the New York Heart Association (NYHA) functional classification criteria (Class II–IV).

1.3 Outcome Measures

The primary outcome was all-cause mortality risk, reported as hazard ratio (HR) or odds ratio (OR).

1.4 Exclusion Criteria

The following studies were excluded: Review articles or meta-analyses without original data. Studies lacking valid prognostic data. Editorials, case reports, commentaries, brief communications, or conference abstracts without full-text availability. Duplicate publications.

1.5 Literature Search Strategy

We systematically searched the following databases from inception to September 2024: Chinese databases: CNKI, Wanfang, VIP, CBM (China Biology Medicine). International databases: PubMed, Embase, Web of Science, Cochrane Library.

A combination of Medical Subject Headings (MeSH) and free-text terms was used. English keywords: Blood Glucose, Admission blood glucose, Glucose Tolerance Test, Glycated Hemoglobin, Hyperglycemia, Hypoglycemia, Glucose Clamp Technique. Chinese keywords: 心力衰竭 (heart failure), 急性心力衰竭 (acute heart failure), 左心衰 (left-sided heart failure), 慢性心力衰竭 (chronic heart failure), 射血分数减低的心衰 (heart failure with reduced ejection fraction), 血糖 (blood glucose).

We expanded the search by reviewing references of included studies and manually screening key cardiovascular journals.

1.6 Study Selection and Data Extraction

Two independent researchers screened titles and abstracts for eligibility, followed by full-text assessment. Discrepancies were resolved by a third reviewer. Extracted data included: Study characteristics: Author, publication year, sample size. Patient demographics: Age, disease duration. Glucose stratification criteria. Outcome measures (HR/OR with 95% CI).

1.7 Risk of Bias Assessment

The Newcastle-Ottawa Scale (NOS) was used to evaluate study quality, assessing: Selection of participants (0–4 points). Comparability between groups (0–2 points). Outcome assessment (0–3 points). Studies scoring ≥6 were considered high quality.

1.8 Statistical Analysis

Effect measures: HR, OR, and 95% CI.

Heterogeneity assessment: Significant heterogeneity was defined as $P < 0.10$ and $I^2 > 50\%$. Subgroup and sensitivity analyses were conducted if substantial heterogeneity existed. A random-effects model was applied if heterogeneity persisted after methodological adjustments.

Publication bias: Funnel plots were generated if ≥10 studies were included. All analyses were performed using RevMan 5.4.

2.1 Literature Search Results

Initial database searches yielded 2,202 records. After duplicate removal and title/abstract screening, 56 full-text articles were assessed. Following detailed evaluation (Figure 2-1), 17 studies (3 Chinese, 14 English) were included in the meta-analysis.

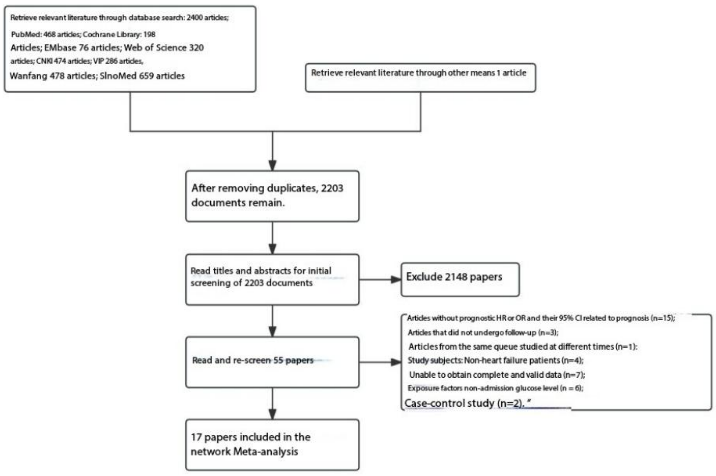

Figure2- 1 Flowchart of document screening

2. Results

Table 1 The main characteristics of inclusion in the literature

Study	Country	Population Type	Sample Size	Age (years)	Female (%)	Follow-up Period	Measurement Method	Diagnostic Cut-off (mmol/L)	Outcome Event	Outcome Measure	Blood Glucose Type	With/Without Diabetes
Lin et al., 2021[8]	China	AHF	991	66–82	35.9	In-hospital, 1 year	NA	≥11.1	All-cause Mortality	HR	② Random	Yes
He et al., 2017[9]	China	AHF	286	65–87	46.5	30 days	Enzymatic Method	≥6.1	All-cause Mortality	OR	① Fasting	Yes/No
Quan et al., 2014[10]	China	AHF	150	42–91	32	30 days	Enzymatic Method	NA	All-cause Mortality	OR	① Fasting	Yes/No
Hu et al., 2024[11]	China	ADHF	1462	68	42.5	30 days	NA	NA	All-cause Mortality	HR	② Random	Yes/No
Cho et al., 2019[12]	South Korea	AHF	5543	NA	NA	In-hospital, 1 year	NA	>11.1	All-cause Mortality	HR	② Random	Yes/No
Chen et al.,	China	AHF	587	19–10	34	6.98	NA	≥7.0 (High),	All-cause	HR	①	Yes/No

2018[13]				3		years		5.6–6.9, 3.9–5.5 (Ref)	Mortality		Fasting	
Aljohar et al., 2018[14]	Saudi Arabia	AHF	2511	61.34 ±15	34.2	30 days, 1 year	Enzymatic Method	≥11.1	All-cause Mortality	OR	② Random	Yes/No
Berry et al., 2008[15]	UK	AHF	454	73	51	2.22 years	Enzymatic Method	≥11.1 (High), 8–10.9, <8 (Ref)	All-cause Mortality	HR	② Random	Yes/No
Zadok et al., 2017[16]	Israel	HF	3993	65–84	43.4	4.2 years	Enzymatic Method	>11.1 (High), 7.8–11.1, 6.1–7.8, <6.1 (Ref)	All-cause Mortality	HR	② Random	Yes/No
Mebazaa et al., 2013[2]	Multinational	AHF	6,212	72	47.5	30 days	Enzymatic Method	10, 7	All-cause Mortality	OR	② Random	Yes/No
Kattel et al., 2017[17]	Japan	ADHF	495	55–85	36	1.8 years	Enzymatic Method	≥6.3	All-cause Mortality	HR	② Random	Yes/No
Kosiborod et al., 2009[6]	USA	HF	50,532	79.4	59.4	30 days, 1 year	NA	≥7.8	All-cause Mortality	HR	② Random	Yes/No
Newton et al., 2006[18]	UK	CHF	528	43–79	43	3.44 years	NA	NA	All-cause Mortality	HR	② Random	Yes/No
Yano et al., 2021[19]	Japan	AHF	486	77–88	56.6	1.1 years	Enzymatic Method	≥7	All-cause Mortality	HR	② Random	No
Targher et al., 2017[3]	Multinational	AHF	6,926	69	37	In-hospital, 1 year	Enzymatic Method	NA	All-cause Mortality	OR/HR	② Random	Yes/No
Sud et al., 2015[20]	Canada	AHF	17,524	70–85	51	30 days, 1 year	Enzymatic Method	6.1, 11.1	All-cause Mortality	HR	② Random	Yes/No
Masip et al., 2021[21]	Spain	HF	9,192	76–88	44.3	30 days, 0.25 year	Enzymatic Method	≥10	All-cause Mortality	OR, HR	② Random	Yes/No

Note: "NA" indicates not mentioned; ① Fasting blood glucose; ② Random blood glucose

2.2 Characteristics of Included Studies

This meta-analysis incorporated 17 cohort studies. Table 2-1 summarizes the detailed characteristics of each study, including author, country, study population, sample size, age, sex distribution, follow-up duration, glucose measurement method, diagnostic cutoff for elevated blood glucose, outcome events, and glucose type.

Among the included studies:

3 studies reported fasting blood glucose levels [9,10,13].

14 studies reported random blood glucose levels [2,3,6,11,12,14,16–20,22,23].

10 studies examined the association between admission glucose and short-term prognosis (≤30 days) [3,6,9–12,14,21].

7 studies investigated long-term prognosis (≥1 year) [8,13,15–19].

9 studies stratified patients into diabetic and non-diabetic subgroups [3,8,11,12,16–18,20,22]. Three studies (Lin Yongjun 2021, Berry 2008, Chen 2018) provided extractable data only for diabetic patients. Four studies (Quan Junmin 2014, He Bosheng 2017, Aljohar 2018, Kosiborod 2009) did not stratify by diabetes status. Yano 2021 reported data exclusively for non-diabetic patients.

Study quality was assessed using the Newcastle-Ottawa Scale (NOS), with scores ranging from 6 to 8 (Table 2-2), indicating high methodological quality across all 17 studies.

Table 2-2 The quality of the included study was scored by NOS score.

	Selection	Comparability	Outcome	NOS Score
Junyong Liu, 2021	***	**	*	6
Bosheng HE, 2017	***	*	**	6
Junmin Quan, 2014	***	**	**	7
Hu,2024	***	**	***	8
cho,2020	***	*	**	6
chen,2018	***	**	***	8
Aljohar,2018	***	*	**	6
berry,2008	***	**	***	8
Zadok,2017	***	**	***	8
Mebazaa,2013	****	**	**	8
Kattel,2017	**	**	**	6
Kosiborod,2009	***	**	***	8
Newton,2006	***	**	**	7
Yano,2021	***	**	**	7
Targher,2017	***	**	***	8
Sud,2015	***	**	***	8
Masip,2021	***	**	**	7

Note: *, **, ***, and **** are 1 point, 2 points, 3 points, and 4 points respectively. Abbreviation: NOS, Newcastle-Ottawa Quality Assessment Form

2.3 Association Between Admission Blood Glucose and Mortality Risk in HF Patients

Analyses were performed using RevMan 5.4. For studies reporting subgroup-specific hazard ratios (HRs) for diabetic and non-diabetic participants without an overall estimate, subgroup estimates were included separately in the pooled analysis. If both overall and diabetes-specific HRs were provided, the overall estimate was used for primary analysis.

Primary Meta-Analysis

Heterogeneity: Significant heterogeneity was observed (I^2 = 78%), warranting a random-effects model.

Pooled HR: 1.73 (95% CI: 1.51–1.97) (Figure 2-2).

The lower confidence limit (>1) confirms that elevated admission glucose is significantly associated with increased mortality risk in HF patients, establishing it as a critical prognostic indicator.

Subgroup Analyses

Given substantial heterogeneity ($P < 0.00001$, I^2 = 77%), subgroup analyses were conducted by:

Diabetes status

Follow-up duration

Geographic region (Asian vs. non-Asian studies)

Sex distribution

Results are illustrated in Forest Plots (Figures 2-3 to 2-6):

Diabetes Subgroups

Diabetic patients: HR = 1.66 (95% CI: 1.47–1.88; $P < 0.00001$; $I^2 = 21\%$).

Non-diabetic patients: HR = 1.71 (95% CI: 1.47–1.99; $P < 0.00001$; $I^2 = 52\%$).

Between-subgroup heterogeneity: Absent ($I^2 = 0\%$, $P = 0.75$).

Follow-up Duration

Short-term (≤30 days): $I^2 = 83\%$ ($P < 0.00001$).

Long-term (≥1 year): $I^2 = 58\%$ ($P < 0.00001$).

Between-subgroup heterogeneity: Absent ($I^2 = 0\%$, $P = 0.94$).

Geographic Region

Asian studies: $I^2 = 85\%$ ($P = 0.001$).

Non-Asian studies: $I^2 = 56\%$ ($P < 0.00001$).

Between-subgroup heterogeneity: Absent ($I^2 = 0\%$, $P = 0.33$).

Sex Distribution

Male-predominant studies (≥50% male): $I^2 = 61\%$ ($P < 0.00001$).

Female-predominant studies (<50% male): $I^2 = 94\%$ ($P = 0.003$).

Between-subgroup heterogeneity: Absent ($I^2 = 0\%$, $P = 0.53$).

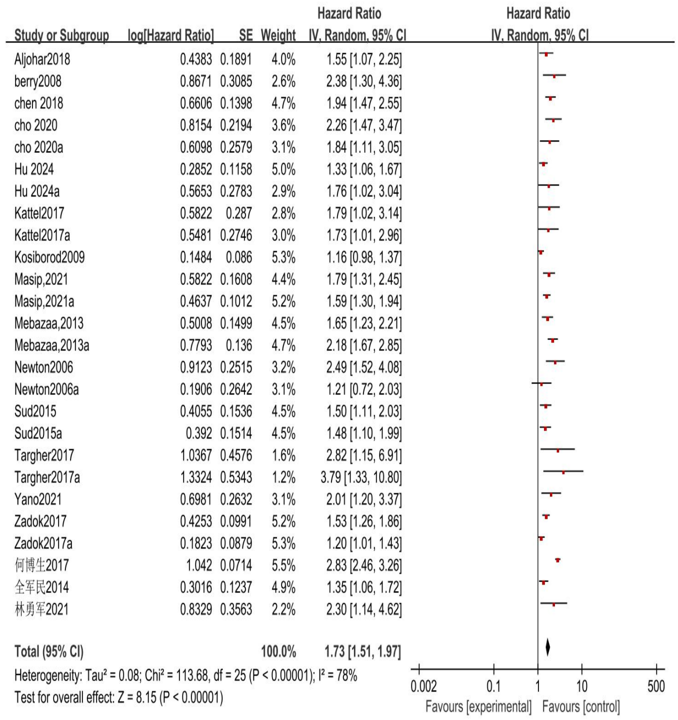

Figure 2-2 Forest plot of the relationship between elevated admission blood glucose level and prognosis

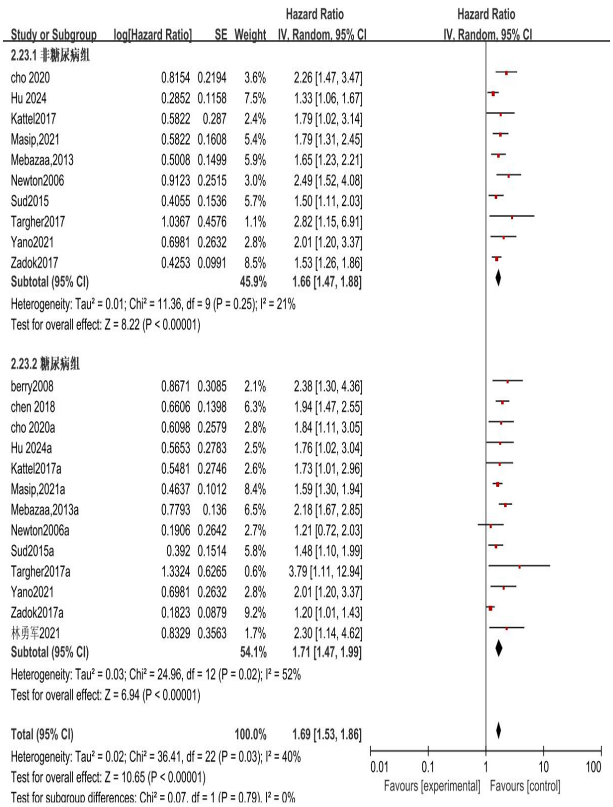

Figure 2-3 Forest maps for diabetic and non-diabetic subgroups

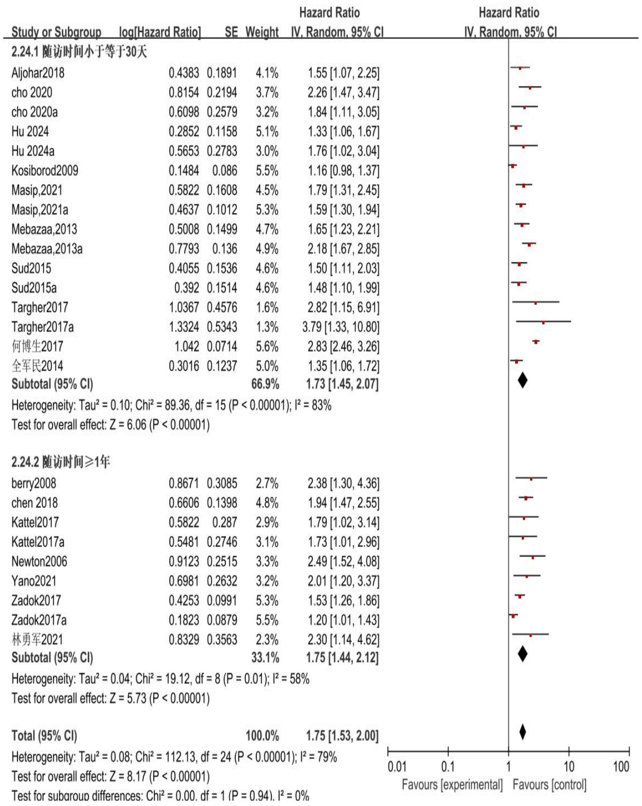

Figure2- 4 Forest maps of subgroups at different follow-up times

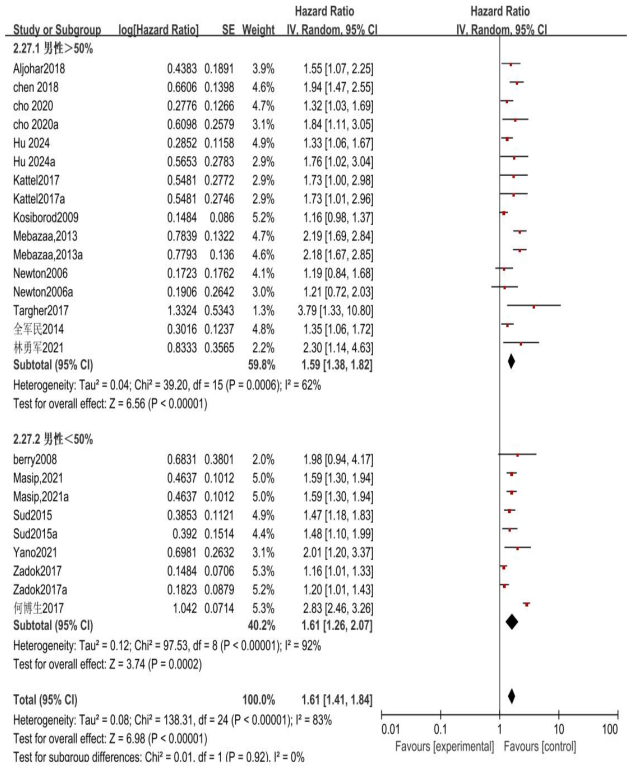

Figure 2-6 Forest map for gender subgroup analysis

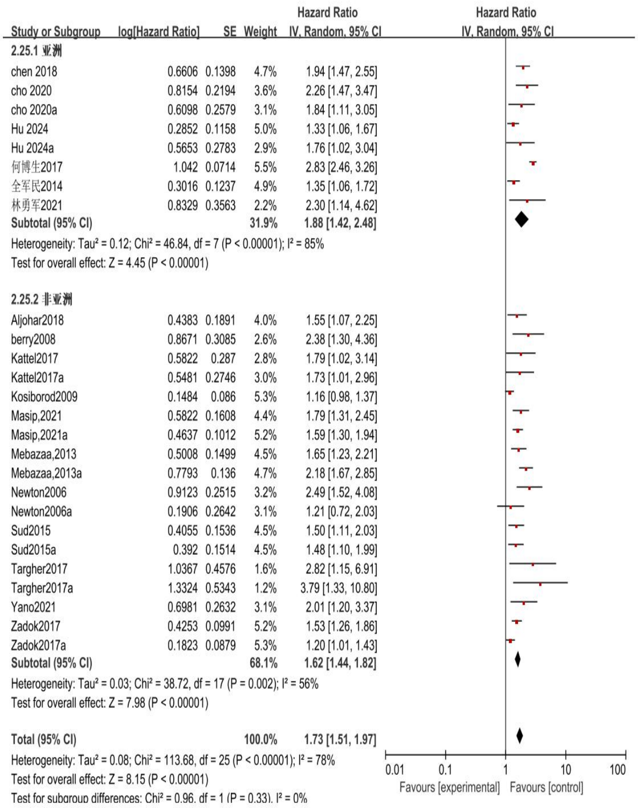

Figure 2-5 Forest map for regional subgroup analysis

Sensitivity Analysis:

A leave-one-out sensitivity analysis was performed. The pooled HR values showed no directional change (range: 1.63-1.76), indicating robust and reliable results. After sequentially excluding each study, the analysis revealed that exclusion of He Bosheng 2017 resulted in: HR=1.63 (95%CI: 1.48-1.79, P<0.00001), with significantly reduced heterogeneity (I^2 decreased from 78% to 52%) (Figure 2-7). This suggests He Bosheng's study may be the primary source of heterogeneity, possibly due to incomplete covariate selection in their multivariate analysis.

After removing the largest study [6], the pooled HR was 1.79 (95%CI: 1.57-2.04) (Figure 2-9). Exclusion of the smallest study [10] yielded HR=1.75 (95%CI: 1.53-2.01) (Figure 2-10). Both results were consistent with the original finding (HR=1.73, 95%CI: 1.51-1.97) and remained statistically significant, demonstrating stable meta-analysis outcomes.

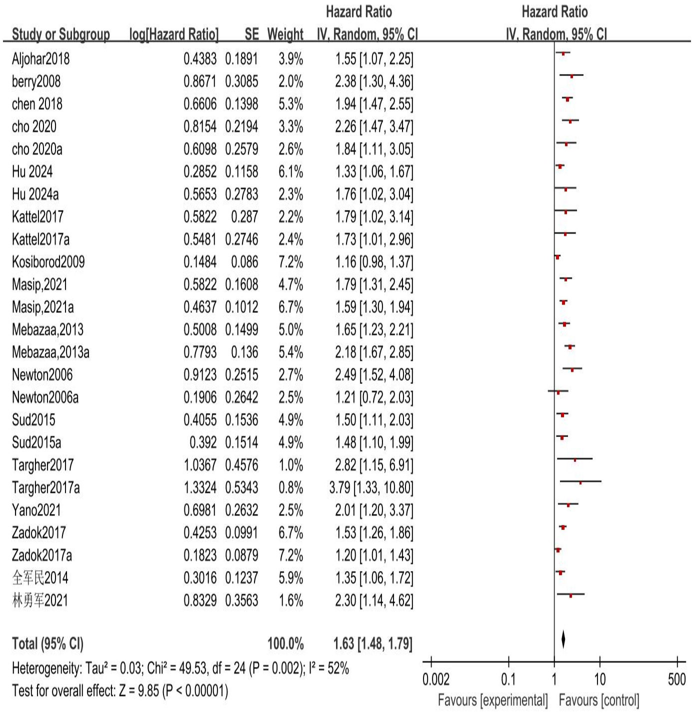

Figure 2-7 Forest map of elevated blood glucose levels and prognosis after excluding the He Bosheng study

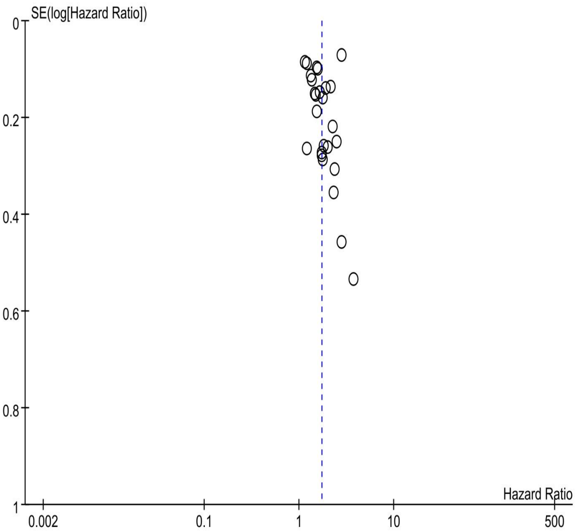

Figure 2-8 Funnel diagram of the relationship between elevated blood glucose levels and prognosis in heart failure

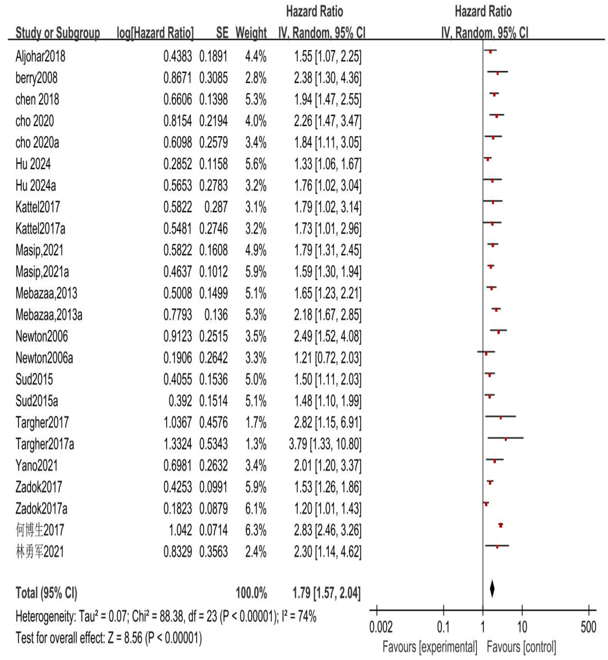

Figure 2-9 Forest map of elevated blood glucose levels and prognosis after excluding the largest literature sample

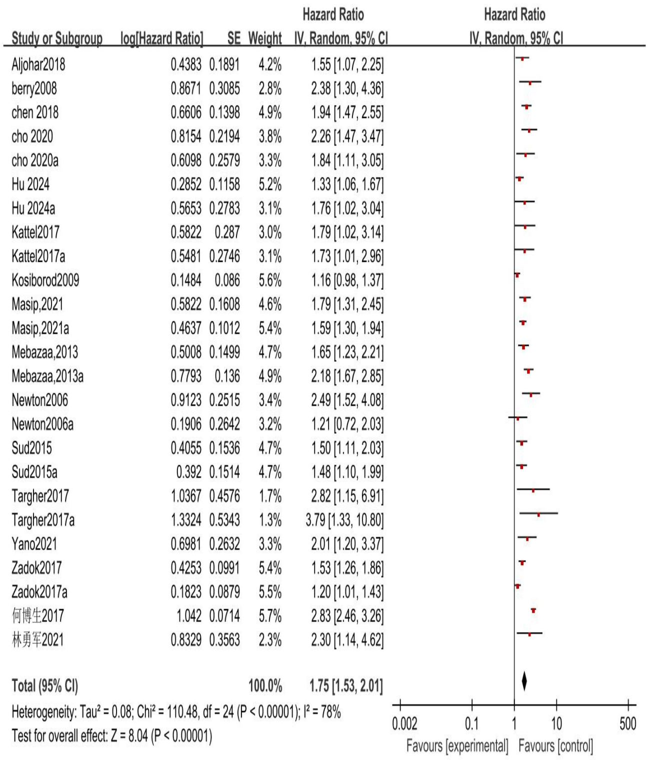

Figure 2-10 Forest map of elevated blood glucose levels and prognosis after excluding the smallest literature sample

3 Discussion

Cardiovascular diseases remain the leading cause of death globally, accounting for over 30% of mortality worldwide.

Heart failure (HF), as a severe clinical syndrome and end-stage manifestation of various cardiac diseases, poses a significant public health challenge. With aging populations and rising prevalence of chronic conditions such as coronary artery disease, diabetes, hypertension, and obesity—coupled with advances in medical technology—the incidence of HF continues to increase [24]. In developed countries, HF affects 1.0%-2.0% of adults [25], while in China, its prevalence reaches 1.3% among adults aged ≥35 [26]. HF is not only highly prevalent but also associated with elevated mortality and rehospitalization rates [25], imposing a growing socioeconomic burden.

Early detection, screening, diagnosis, and individualized treatment of HF can significantly reduce hospitalization and mortality while improving patients' quality of life [27, 28]. HF is typically diagnosed and assessed through clinical symptoms, physical examination, laboratory tests, and echocardiography. Blood glucose, as a rapidly measurable and cost-effective indicator, could facilitate risk stratification and personalized treatment if proven to correlate with HF prognosis, thereby improving clinical outcomes.

The pathophysiological effects of hyperglycemia are well-established in acute myocardial infarction (AMI), where elevated glucose directly damages the heart by exacerbating oxidative stress, endothelial dysfunction, and inflammatory responses, increasing multi-organ injury risk [29]. Intensive glucose control may reduce cardiovascular events through both coronary and non-coronary mechanisms [30]. Consequently, researchers have sought to determine whether the link between hyperglycemia and adverse outcomes in AMI also applies to HF. While some studies, such as Kosiborod et al. (n=50,532), found no association between glucose levels and 30-day or 1-year mortality [6], most evidence supports a correlation between hyperglycemia and poor HF prognosis, as demonstrated by Hu (2024), Sud (2015), and Masip (2021) [11, 20, 21]. These discrepancies may stem from population heterogeneity.

This meta-analysis of 17 studies (n=102,543) revealed that hyperglycemia at admission significantly increases all-cause mortality risk in HF patients (HR=1.73, 95% CI: 1.51–1.79, $P < 0.00001$). Notably, this association persisted in both diabetic (HR=1.66, 95% CI: 1.47–1.88, $P < 0.00001$) and non-diabetic patients (HR=1.71, 95% CI: 1.47–1.99, $P < 0.00001$), suggesting a universal pathophysiological effect of hyperglycemia. Potential mechanisms include:

Oxidative stress and inflammation: Hyperglycemia activates the polyol pathway, PKC, and hexosamine pathway, increasing ROS production and promoting myocardial fibrosis/apoptosis [31]. Mediation analyses indicate that inflammation (e.g., elevated IL-6) accounts for 8.77%–11.15% of hyperglycemia-associated mortality [11].

Endothelial dysfunction: Hyperglycemia reduces NO bioavailability and increases ET-1 release, exacerbating vasoconstriction and microcirculatory impairment.

Neuroendocrine activation: Hyperglycemia amplifies sympathetic nervous system (SNS) and RAAS activation in HF, worsening cardiac load and remodeling [32].

Clinical complexities: Stress hyperglycemia in emergency settings may mask chronic diabetes, necessitating HbA1c-based stratification [33, 34]. Hypoglycemia from insulin/sulfonylureas may trigger arrhythmias [35], while elderly patients with multi-organ dysfunction face compounded risks from glucose metabolism abnormalities (e.g., hyperglycemic nephropathy) [34].

Despite strengths such as multicenter data and large sample size, limitations include:

Observational design precluding causal inference; unmeasured confounders (e.g., neuroendocrine activity) may bias results.

Significant heterogeneity due to varying diagnostic cutoffs, glucose measurement methods, and population differences.

Subgroup analyses by HF type (e.g., HFrEF vs. HFpEF) were not performed.

Admission hypoglycemia also correlates with adverse outcomes [36], underscoring the need for individualized glucose targets.

Future research should:

Investigate mechanisms using omics (e.g., metabolomics/transcriptomics) to delineate myocardial injury pathways.

Standardize glucose monitoring (e.g., combining continuous glucose monitoring and HbA1c).

Develop dynamic glucose management strategies to optimize HF risk stratification.

4 Conclusion

This meta-analysis confirms that admission blood glucose is a key prognostic predictor in HF. Hyperglycemia exacerbates cardiac dysfunction via oxidative stress, inflammation, and neuroendocrine activation. Personalized glucose management (e.g., dynamic monitoring) is warranted to balance glycemic control and minimize hypoglycemia/hyperglycemia risks, ultimately improving HF outcomes.

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Conflict of Interest

None.

Acknowledgements

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References

1. Ke Jing, Zhao Dong, Chen Yanyan. The Relationship between Type 2 Diabetes and Heart Failure: A Hot Report from the 70th Scientific Session of the American College of Cardiology [J]. Chinese Journal of Endocrinology and Metabolism, 2021,37(11):1029-1034.
2. Mebazaa A, Gayat E, Lassus J, et al. Association Between Elevated Blood Glucose and Outcome in Acute Heart Failure Results From an International Observational Cohort[J]. JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY, 2013,61(8):820-829.
3. Targher G, Dauriz M, Laroche C, et al. In-hospital and 1-year mortality associated with diabetes in patients with acute heart failure: results from the ESC-HFA Heart Failure Long-Term Registry[J]. Eur J Heart Fail, 2017,19(1):54-65.
4. Mebazaa A, Gayat E, Lassus J, et al. Association between elevated blood glucose and outcome in acute heart failure: results from an international observational cohort[J]. J Am Coll Cardiol, 2013,61(8):820-829.
5. Zhang Lanfang, Jia Xinwei, Zhao Shujun, et al. The influence of elevated blood glucose levels on cardiac function and prognosis in elderly patients with acute heart failure without diabetes [J]. Chinese Medicine, 2020,15(05):650-653.
6. Kosiborod M, Inzucchi S E, Spertus J A, et al. Elevated admission glucose and mortality in elderly patients hospitalized with heart failure[J]. Circulation, 2009119 (14) : 1899-1907.

7. McDonagh T A, Metra M, Adamo M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure[J]. Eur Heart J, 2021 and (36) : 3599-3726.
8. Lin Yongjun, Lin Huiqin, Huang Chaoying, et al. The influence of admission blood glucose on the prognosis of patients with acute heart failure complicated with diabetes [J]. Chinese Journal of Emergency Medicine, 2021,41(5):390-396.
9. He Bosheng, Liang Zhenhua. The relationship between blood glucose levels and short-term prognosis in Elderly patients with acute heart failure [J]. Journal of Internal Medicine Critical Care, 2017,23(2):127-129.
10. Quan Junmin, Yao Qi, Tao Yuan, et al. Relationship between Admission hyperglycemia and short-term Prognosis of patients with acute Heart failure [J]. Electrocardiogram and circulation, 2014,33(5):389-392.
11. Hu J, Yang H, Yu M, et al. Admission blood glucose and 30-day mortality in patients with acute decompensated heart failure: prognostic significance in individuals with and without diabetes[J]. Front Endocrinol (Lausanne), 24,15:1403452.
12. Cho J Y, Kim K H, Lee S E, et al. Admission hyperglycemia is a predictor of mortality of acute heart failure: Comparison between patients with and without diabetes mellitus[J]. European Heart Journal, 2019,40:2130.
13. Chen Y Y, Chen Y, Liang S M, et al. Prognostic Impact of Fasting Plasma Glucose on Mortality and Re-Hospitalization in Patients with Acute Heart Failure[J]. Chin Med J (Engl), 2018,131(17):2032-2040.
14. Aljohar A, Alhabib K F, Kashour T, et al. The prognostic impact of hyperglycemia on clinical outcomes of acute heart failure: Insights from the heart function assessment registry trial in Saudi Arabia[J]. Journal of the Saudi Heart Association, 2018, 30 (4) : 319-327.
15. Berry C, Brett M, Stevenson K, et al. Nature and prognostic importance of abnormal glucose tolerance and diabetes in acute heart failure[J]. Heart, 2008 hanjie xuebao/transactions (3) : 296-304.
16. Ben Zadok O I, Kornowski R, Goldenberg I, et al. Admission blood glucose and 10-year mortality among patients with or without pre-existing diabetes mellitus Youdaoplaceholder0 with heart failure[J]. CARDIOVASCULAR DIABETOLOGY, 2017,16.
17. Kattel S, Kasai T, Matsumoto H, et al. Association between elevated blood glucose level on admission and long-term mortality in patients with acute decompensated heart failure[J]. J Cardiol, 2017,69(4):619-624.
18. Newton J D, Squire I B. Glucose and haemoglobin in the assessment of prognosis after first hospitalisation for heart failure[J]. Heart, 2006,92(10):1441-1446.
19. Yano M, Nishino M, Ukita K, et al. Impact of admission hyperglycaemia on clinical outcomes in non-diabetic heart failure with preserved ejection fraction[J]. ESC Heart Fail, 2021,8(5):3822-3834.
20. Sud M, Wang X, Austin P C, et al. Presentation blood glucose and death, hospitalization, and future diabetes risk in patients with acute heart failure syndromes[J]. Eur Heart J, 2015,36(15):924-931.
21. Masip J, Povar-Echeverria M, Peacock W F et al. Impact of diabetes and on-arrival hyperglycemia on short-term outcomes in acute heart failure patients[J]. Intern Emerg Med, 2021,17(5):1503-1516.
22. Masip J, Povar-Echeverria M, Peacock W F et al. Impact of diabetes and on-arrival hyperglycemia on short-term outcomes in acute heart failure patients[J]. Intern Emerg Med, 2022,17(5):1503-1516.
23. argher G, Dauriz M, Tavazzi L, et al. Prognostic impact of in-hospital hyperglycemia in hospitalized patients with acute heart failure: Results of the IN-HF (Italian Network on Heart Failure) Outcome registry[J]. Int J Cardiol, 2016,203:587-593.
24. Cardiovascular Disease Branch of Chinese Medical Association, Cardiovascular Internal Medicine Physicians Branch of Chinese Medical Doctor Association, Heart Failure Professional Committee of Chinese Medical Doctor Association, etc. Chinese Guidelines for Diagnosis and Treatment of Heart Failure 2024[J]. Chinese Journal of Cardiovascular Diseases, 2024,52(03):235-275.
25. Virani S S, Alonso A, Benjamin E J, et al. Heart Disease and Stroke Statistics-2020 Update: A Report From the American Heart Association[J]. Circulation, 2020,141(9):e139-e596.
26. Wang H, Chai K, Du M, et al. Prevalence and Incidence of Heart Failure Among Urban Patients in China: A National Population-Based Analysis[J]. Circ Heart Fail, 2021,14(10):e8406.
27. Electrocardiogram and Cardiac Function Branch of the Chinese Geriatrics Society, Expert Committee of the Chinese Heart Failure Center Alliance, Editorial Committee, Chinese Medical Association, Chinese Journal of General Practitioners. Chinese Expert Consensus on Early Screening and Primary Prevention of Heart Failure (2024) [J]. Chinese Journal of General Practitioners, 24,23(01):7-18.

28. Marx N, Federici M, Schutt K et al. 2023 ESC Guidelines for the management of cardiovascular disease in patients with diabetes[J]. Eur Heart J, 2023, 44 (39) : 4043-4140.
29. Luo Xiaorong, Yu Fei, Jing Hongmei. Study on the Correlation between Acute Hyperglycemia and Adverse Cardiovascular Events in Patients with Acute Myocardial Infarction [J] Chinese Journal of Cardiovascular Diseases, 2020,18(01):86-92.
30. Ray K K, Seshasai S R, Wijesuriya S, et al. Effect of intensive control of glucose on cardiovascular outcomes and death in patients with diabetes mellitus: a meta-analysis of randomised controlled trials[J]. Lancet, 2009,373(9677):1765-1772.
31. Shirakabe A, Hata N, Kobayashi N, et al. Decreased blood glucose at admission has a prognostic impact in patients with severely decompensated acute heart failure complicated with diabetes mellitus[J]. Heart Vessels, 2018,33(9):1008-1021.
32. Xiao Li, Xia Zhenwei, Zheng Jianmeng, et al. The impact of stress-induced hyperglycemia on risk stratification and prognosis in patients with acute heart failure [J]. Chinese Journal of Evidence-Based Cardiovascular Medicine, 2023,15(4):495-497.
33. Wu Fupeng. Study on the Prognosis of Patients with Acute Heart Failure Due to the Ratio of Stress-Induced Hyperglycemia [D]. Shanghai Jiao Tong University, 2020.
34. Zhang Lanfang, Qi Xiaoyong, Jia Xinwei. The impact of hyperglycemia on the short-term prognosis of elderly patients with acute heart failure [J]. Chinese Journal of Gerontology, 2017,37(23):5827-5829.
35. Ma Hong The Relationship between Admission Blood Glucose Levels and Prognosis in Patients with Non-diabetic acute Heart Failure [D]. Zhejiang University, 2007.
36. Cha S A, Yun J S, Kim G H, et al. Impact of hypoglycemia at the time of hospitalization for heart failure from emergency department on major adverse cardiovascular events in patients with and without type 2 diabetes[J]. Cardiovascular Diabetology, 2022,21(1).