

Economic evaluation of Qili Qiangxin capsules for the treatment of chronic heart failure

Hua-liang Deng^{1,§}, Si-jun Yu^{2,§}, Fan Wang³, Chun-hui Liu³, Xia Liu³, Xiao-ye Wang³, Wen-ling Xu³, Jia-xin Wang⁴, Guan-zhong Zheng⁵, Jian-hua Zhou⁶, Xing-ze Xie⁷, Yong He⁸, Kai-yan Zhang⁹, Di-fei Gao¹⁰, Jia-yu Cui¹¹, Gui-fang Sun¹², De-cai Li¹³, Xing-hong Xie¹⁴, Iokfai Cheang^{15,16}, Ning-xin Ding^{17,✉}, Zhen-hua Jia^{15,18,✉}

¹ Department of Gastroenterology, Shandong University of Traditional Chinese Medicine Affiliated Hospital, Jinan, 250011, China

² Department of Cardiology, Third Medical Center of Chinese People's Liberation Army General Hospital, Beijing, 100039, China

³ Department of Health Economics, Beijing Guoming Bosi Pharmaceutical Technology Co., Ltd, Beijing, 100071, China

⁴ College of Business Administration, China University of Political Science and Law, Beijing, 100088, China

⁵ Department of Cardiology, Zibo Municipal Hospital, Zibo, 255400, China

⁶ Department of Cardiology, Weihai Central Hospital, Weihai, 264400, China

⁷ Department of Cardiology, Zhuzhou 331 Hospital, Zhuzhou, 412000, China

⁸ Department of Cardiology, Hengyang First People's Hospital, Hengyang, 421002, China

⁹ Department of Cardiology, The People's Hospital of Pingyi County, Linyi, 273300, China

¹⁰ Department of Cardiology, Yushu People's Hospital, Yushu, 130499, China

¹¹ Department of Cardiology, Binzhou People's Hospital, Binzhou, 256610, China

¹² Department of Cardiology, Binzhou Central Hospital, Binzhou, 251700, China

¹³ Department of Cardiology, Mianyang 404 Hospital, Mianyang, 621000, China

¹⁴ Department of Cardiology, The Third Affiliated Hospital of Sun Yat-Sen University Yuedong Hospital, Meizhou, 510630, China

¹⁵ State Key Laboratory for Innovation and Transformation of Luobing Theory, Shijiazhuang, 052165, China

¹⁶ Department of Cardiology, The First Affiliated Hospital with Nanjing Medical University, Nanjing, 210029, China

¹⁷ School of Economics and Finance, Wellington School of Business and Government, Victoria University of Wellington, Wellington, 6140, New Zealand

¹⁸ Department of Cardiology, Hebei Yiling Hospital, Shijiazhuang, 050090, China

Received: December 21, 2025; Revised: February 15, 2026; Accepted: March 20, 2026

ABSTRACT

Introduction Chronic heart failure (CHF) confers high mortality and heavy economic burden as a critical public health issue. Qili Qiangxin (QLQX) capsules, a traditional Chinese patent medicine, may improve clinical outcomes in CHF patients. This study evaluated the economic value of QLQX capsules for CHF. **Methods** A health economic analysis was performed from the healthcare system perspective. Cost-effectiveness analysis was used for short-term outcomes, and a Markov model-based cost-utility analysis for long-term outcomes. Robustness was tested using one-way and probabilistic sensitivity analyses. **Results** A total of 1555 patients were equally randomized to two groups: QLQX capsules plus standard of care (QLQX group) or standard of care alone (control group). Baseline characteristics were comparable between groups. In the QLQX group, 1-year direct medical costs were ¥9368.08 (\$1311.53; 95% confidence interval [CI]: [¥8980.61, ¥9755.55]), versus ¥6402.21 (\$896.31; 95% CI: [¥5903.50, ¥6900.91]) in the control group. The higher costs in the QLQX group were primarily driven by medication expenses. Composite endpoint events occurred in 19.00% (95% CI: [17.07%, 21.03%]) of the QLQX group compared with 23.40% (95% CI: [21.34%, 25.61%]) of the control group ($P = 0.003$). The incremental cost-effectiveness ratio (ICER) was ¥67 406.14 (\$9436.86). Over a 15-year time horizon, the QLQX group incurred total costs of ¥57 096 (\$7993.44) and achieved 5.46 QALYs, whereas the control group incurred ¥34 016 (\$4762.24) and achieved 5.07 QALYs, resulting in an ICER of ¥58 946 per QALY (\$8252.44/QALY). This value is below China's 2023 per capita gross domestic product threshold (¥89 358; \$12 510.12), suggesting that QLQX capsule is highly cost-effective. Sensitivity analyses further confirmed the robustness of these findings. **Conclusion** QLQX capsules were associated with higher short-term costs but greater efficacy than standard care, and long-term modeling supports their high cost-effectiveness.

KEYWORDS

Qili Qiangxin capsules, chronic heart failure, pharmacoeconomics, cost-effectiveness analysis, cost-utility analysis

CITE THIS ARTICLE

Deng HL, Yu SJ, Wang F, et al. Economic evaluation of Qili Qiangxin capsules for the treatment of chronic heart failure. Evidence-Based Chinese Medicine and Technology Assessment, 2026, 2: 9570029. <https://doi.org/10.26599/eCMTA.2026.9570029>

1. Introduction

Chronic heart failure (CHF) is a prevalent and severe condition that typically represents the terminal stage of various cardiac diseases. Between 1990 and 2010, the global prevalence of CHF impacted 1%–2% of the adult population, with more than 5 million cases reported in the United States (U.S.). Its

prevalence increases with age, and CHF-related healthcare expenditures in the U.S. reached \$39.3 billion in 2010.^{1,2} Recent guidelines highlight that heart failure prevalence increases with age, reaching 8%–10% in those aged ≥70 years.³ In China, the prevalence of CHF among adults is estimated to be 0.90%, according to an epidemiological study.⁴ Moreover, recent data indicate an age-standardized heart failure prevalence of 1.10%, corresponding to 12.1 million cases among adults aged 25 years and older.⁵ In addition, a 2012 analysis of 197 countries identified China as having the highest disease cost burden for CHF among middle- and low-income countries, accounting for 5.01% of worldwide costs.⁶ These findings highlight the significant and growing financial burden of CHF on China's healthcare system.

Traditional Chinese medicine (TCM) has emerged as a potential comple-

✉ Corresponding authors.

E-mail addresses: dingning1@myvu.ac.nz (NX. Ding); jzhjiazhenhua@163.com (ZH. Jia)

§ These authors contributed equally to this work.

© 2026 Beijing University of Chinese Medicine. Production and hosting by Tsinghua University Press. This is an open access article under the CC-BY license (<http://creativecommons.org/licenses/by/4.0/>).

mentary approach to CHF management. Current guidelines recommend standard pharmacological therapy for heart failure with reduced ejection fraction, including angiotensin receptor-neprilysin inhibitors, beta-blockers, mineralocorticoid receptor antagonists, and sodium-glucose cotransporter-2 inhibitors.^{3,7,8} Studies on Qili Qiangxin (QLQX) capsules have shown encouraging results. A 2013 study reported that patients receiving QLQX capsules in addition to optimized standard of care had significantly lower serum N-terminal pro-B-type natriuretic peptide (NT-proBNP) levels and a greater likelihood of achieving a >30% reduction in NT-proBNP. In addition, adverse event rates were lower, underscoring the efficacy and safety of QLQX capsules.⁹ Further recent studies indicate that QLQX capsule exerts cardioprotective effects through the miR133a-endoplasmic reticulum stress pathway.¹⁰ More recently, a study with a larger sample size, published in a high-impact academic journal, further verified these findings, thereby enhancing the evidence base for the clinical use of QLQX capsules.¹¹

Despite these advances, health economic evaluations of QLQX capsules remain limited. In this study, we aimed to evaluate the cost-effectiveness of QLQX capsules as an adjunct to standard CHF treatment using individual-level data, to provide more precise evidence for clinical practice and health-care decision-making.

2. Methods

2.1. Ethical approval

This study was approved by the Ethics Committee of the First Affiliated Hospital of Nanjing Medical University (approval no.: 2018-SR-275).

2.2. Study design and population

We used individual-level data from a previously published randomized, double-blind clinical trial.¹¹ The trial was conducted at 133 sites between 24 May 2019 and 24 May 2021. Of the 4064 patients initially screened, 3119 were ultimately enrolled. Participants in the intervention group received QLQX capsules combined with standard of care, while those in the control group received standard of care alone. The study population corresponded to the full analysis set (FAS) of the trial. The follow-up periods for participants ranged from 12 to 36 months, providing sufficient data to evaluate the impact of the intervention.

2.3. Costs

This cost analysis adopted a healthcare system perspective and focused on the total direct medical costs incurred by patients during the study period. These costs were categorized into pharmacy expenses, outpatient and emergency services, hospitalization costs, and other expenses, including costs related to the management of adverse events.

2.4. Health outcomes

Health outcomes were assessed using two primary indicators. The first was the 1-year incidence of a composite endpoint—cardiovascular mortality or heart failure rehospitalization—which directly evaluated the intervention's impact on major clinical events. The second was a utility measure based on EuroQol 5-Dimension 5-Level (EQ-5D-5L) instrument (EuroQol Research Foundation, Rotterdam, The Netherlands), which was used to calculate quality-adjusted life years (QALYs) and capture improvements in quality of life.

2.5. Statistical analysis

Analyses were performed using SAS 9.4 (SAS Institute, Cary, NC). All statistical analyses were conducted using two-tailed tests, with a *P*-value < 0.05 considered statistically significant. Group comparisons were performed using the two-sample *t*-test or the rank-sum test, depending on the data distribution. Continuous variables are presented as mean (standard deviation) if normally distributed or as median (interquartile range) if non-normally dis-

tributed; categorical variables are presented as number (percentage). Cost data and EQ-5D-5L scores were analyzed based on the clinical FAS population. To address missing data, several imputation methods were applied, including K-nearest neighbor imputation, mean substitution, and fixed-value substitution.

2.6. Economic evaluation

This economic evaluation included both cost-effectiveness and cost-utility analyses. The incremental cost-effectiveness ratio (ICER) was used to assess the short-term economic benefits of the intervention within 1 year, evaluating the additional cost required to achieve one additional unit of health benefit compared with standard of care.

For the long-term economic evaluation, the incremental cost-utility ratio was calculated to determine the cost per QALY gained. The willingness-to-pay (WTP) threshold was set at 1–3 times the 2023 per capita gross domestic product (GDP) in China.^{12,13} This threshold served as a benchmark for assessing whether the intervention provided favorable economic value relative to its cost. Specifically, a Markov model was developed based on clinical trial results to simulate long-term treatment outcomes in patients with CHF. The model used a 1-month cycle length, applied a half-cycle correction, and discounted all model parameters at an annual rate of 5%. Following previous studies,^{14,15} the model included three health states: stable survival, heart failure rehospitalization, and death (Figure 1).

The Markov model was constructed with several key assumptions. The patient cohort entered the model at a mean age of 63 years, derived from the baseline characteristics of the clinical trial. Based on this starting age, the time horizon was set to 15 years, corresponding to the difference between this age and China's 2020 average life expectancy of 77.93 years.¹⁶ The analysis used a 1-month cycle length, resulting in 180 cycles over the study period. Key clinical assumptions included limiting transitions to the three defined health states, excluding other complications due to their low incidence, and assuming perfect medication adherence.

To estimate monthly costs for the stable survival state, we calculated 1-year direct medical costs using individual patient data and divided the total by 12. Costs associated with heart failure rehospitalization were obtained from the published literature. Similarly, utility values for the stable survival state were derived from 1-year patient-level QALY data and converted to monthly values, while utilities for heart failure rehospitalization were obtained from published sources.

To define the plausible parameter ranges used in the sensitivity analyses, we determined the cost and utility ranges for the stable survival state using 95% confidence intervals (CIs) calculated from individual patient data. The corresponding ranges for the heart failure rehospitalization state were obtained from the literature.

Transition probabilities were determined according to the source of the underlying data. For parameters derived from individual patient records, namely the probability of transitioning from stable survival to heart failure readmission and from stable survival to cardiovascular death, we followed a

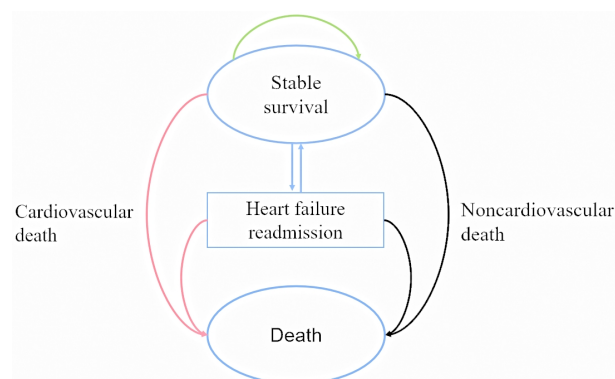


Figure 1 Markov model

multi-step process. First, we calculated 1-year event rates. Second, we converted these rates to annual probabilities. Finally, we transformed them into monthly probabilities using the `probtobprob` function in `TreeAge Pro 2019` (Limited Liability Company, Williamstown, MA).

To characterize model uncertainty, we assigned plausible ranges to each parameter according to its data source. The parameters for “stable survival to heart failure readmission” and “stable survival to cardiovascular death,” derived from individual patient data, were varied by $\pm 10\%$. The ranges for the other three parameters were obtained from the published literature: “stable survival to noncardiovascular death,” “heart failure readmission to cardiovascular death,” and “heart failure readmission to noncardiovascular death.” All parameters are presented in Appendix 1.

To model the composite endpoint of heart failure rehospitalization or cardiovascular death, individual patient data were used to identify each type of event. Within each cycle of the Markov model, two rules were applied to determine patient transitions between health states.

Rule A (direct death) stipulated that patients who experienced cardiovascular death during a cycle moved directly to the death state, and no other events occurred during that cycle.

Rule B (hospitalization followed by death) specified that patients who experienced nonfatal heart failure rehospitalization first transitioned to the hospitalization state, from which they could subsequently face the risk of death within the same cycle or in subsequent cycles.

Sensitivity analyses were performed using both one-way and probabilistic approaches to test the robustness of the results. In the one-way sensitivity analysis, key parameters, including price, treatment duration, incidence of composite endpoint events, utility values, and transition probabilities, were varied individually, and the results were presented using tornado diagrams.

For the probabilistic sensitivity analysis, uncertainties in multiple parameters were evaluated simultaneously. Nonparametric bootstrap resampling (1000 iterations) was performed using individual data from the clinical trial,

and Monte Carlo simulations were conducted for the cost-utility analysis. Uncertain parameters, including costs, drug effectiveness, and transition probabilities, were assigned Gamma and Beta distributions. A total of 1000 Monte Carlo simulations were performed to assess variation in outcomes across different scenarios, and the results were summarized using cost-effectiveness acceptability curves.

3. Results

3.1. Baseline characteristics of patients

A total of 3110 patients were finally enrolled and assigned to two groups (1555 in the QLQX group and 1555 in the control group), after 9 patients were excluded due to poor compliance or loss to follow-up. The demographic and clinical characteristics of the patients, including age, sex, height, weight, and occupation, were statistically comparable between the QLQX and control groups in the FAS population (Table 1). In addition, earned income was reported by 18.84% (293/1555) of participants in the QLQX group and 16.78% (261/1555) in the control group. These findings confirm baseline equivalence between the two groups.

3.2. Cost-effectiveness analysis

3.2.1. Cost analysis

The analysis showed that the QLQX group incurred an average cost of ¥9368.08 (\$1311.53; 95% CI: ¥5903.50, ¥6900.91), compared with ¥6402.21 (\$896.31; 95% CI: ¥5903.50, ¥6900.91) for the control group (Table 2). The primary cost difference was attributed to the inclusion of QLQX medication costs. However, when medication costs were excluded, the QLQX group demonstrated savings of ¥800.72 (\$112.10) in other medical expenses, likely

Table 1 Baseline demographic and clinical characteristics of the full-analysis set

Variable	Total	QLQX group	Control group	P
Age (y), mean (SD)	62.54 (12.36)	62.56 (12.18)	62.52 (12.54)	0.931
Sex				0.034
Male, <i>n</i> (%)	2243 (72.12)	1095 (70.42)	1148 (73.83)	
Females, <i>n</i> (%)	867 (27.88)	460 (29.58)	407 (26.17)	
Weight (kg), mean (SD)	66.94 (12.57)	66.95 (12.37)	66.92 (12.77)	0.819
Height (cm), mean (SD)	166.47 (7.82)	166.35 (7.70)	166.60 (7.94)	0.145
BMI (kg/m ²), mean (SD)	24.06 (3.67)	24.11 (3.60)	24.02 (3.73)	0.347
Working status				0.1337
Employed, <i>n</i> (%)	554 (17.81)	293 (18.84)	261 (16.78)	
Unemployed, <i>n</i> (%)	2556 (82.19)	1262 (81.16)	1294 (83.22)	

Notes: QLQX: Qili Qiangxin capsule; SD: standard deviation; y: year.

Table 2 Comparison of direct medical costs between the QLQX group and the control group during 1-year treatment period

1-year cost ^a	QLQX group, mean (95% CI)	Control group, mean (95% CI)	Difference	P
Direct medical cost	¥9368.08 (¥8980.61, ¥9755.55), \$1311.53	¥6402.21 (¥5903.50, ¥6900.91), \$896.31	¥2965.87, \$415.22	<0.001
Pharmaceutical costs	¥1397.03 (¥1333.09, ¥1460.97), \$195.58	¥1439.27 (¥1372.98, ¥1505.56), \$201.50	¥42.24, \$5.91	0.69
Outpatient and emergency department costs	¥1871.60 (¥1790.56, ¥1952.64), \$262.02	¥1912.12 (¥1829.11, ¥1995.13), \$267.70	¥40.52, \$5.67	0.76
Inpatient hospitalization costs	¥2245.59 (¥2088.33, ¥2402.85), \$314.38	¥2966.28 (¥2769.68, ¥3162.88), \$415.28	¥720.69, \$100.90	0.12
Other direct medical costs	¥87.26 (¥77.77, ¥96.75), \$12.22	¥84.54 (¥76.23, ¥92.85), \$11.84	¥2.72, \$0.38	0.85
Cost of QLQX capsules	¥3766.59 (¥3749.73, ¥3783.45), \$527.32	NA	¥3766.59, \$527.32	<0.001

Notes: CI: confidence interval; NA: not applicable; QLQX: Qili Qiangxin capsule. ^a the exchange rate of the RMB to the US dollar is calculated at 1 RMB = 0.14 USD, effective September 23, 2025.

due to reduced costs associated with disease progression.

3.2.2. Effectiveness

The primary efficacy outcome was the 1-year incidence of composite endpoint events. The QLQX group demonstrated a significantly lower event rate of 19.00% (95% CI: 17.07%, 21.03%), than 23.40% (95% CI: 21.34%, 25.61%) in the control group ($P = 0.003$).

3.2.3. Cost-effectiveness analysis

The ICER was ¥67 406.14 (\$9436.86), indicating that an additional cost of ¥67 406.14 (\$9436.86) was required to prevent one additional composite endpoint event. Detailed results are presented in Table 3.

A one-way sensitivity analysis revealed that the incidence of composite endpoint events and other medical costs were the key factors influencing the ICER. The results showed that the incidence of composite endpoint events and other medical costs in both the QLQX and control groups had significant impact on the ICER. The parameter ranges for these factors are summarized in Table 2, and the results are illustrated in the tornado diagram (Figure 2).

Further, probabilistic sensitivity analysis indicated that, at a WTP threshold of ¥68 000 (\$9520), the probability that the QLQX group was cost-effective was 51.16%. For WTP thresholds above ¥68 000 (\$9520), the QLQX group consistently showed a higher probability of cost-effectiveness than the control group, as illustrated in Figure 3.

3.3. Cost-utility analysis

As described in the Methods section, a Markov model was developed for the cost-utility analysis, with parameters derived from individual patient data and relevant literature sources. Transition probabilities, including those related to heart failure rehospitalization and cardiovascular death, were based on clinical efficacy and follow-up results, while non-cardiovascular mortality rates and other transition probabilities were obtained from the published literature.¹⁷ Detailed parameter sources are provided in Appendix 1.

Over a 15-year treatment period, the QLQX group incurred total costs of ¥57 096 (\$7993.44), compared with ¥34 016 (\$4762.24) for the control group. The corresponding QALYs were 5.46 and 5.07, respectively. The ICER was ¥58 946 (\$8252.44), indicating that one additional QALY gained required an

Table 3 Cost-effectiveness/utility analysis results of QLQX group and control group

Item	QLQX group, mean (95% CI)	Control group, mean (95% CI)	Difference	<i>P</i>	ICER/ICUR	Threshold ^a
1 year						
Cost	¥9368.08 (¥8980.61, ¥9755.55), \$1311.53	¥6402.21 (¥5903.50, ¥6900.91), \$896.31	¥2965.87 (\$415.22)	<0.001	¥67 406.14 (\$9436.86)	NA
Incidence of composite endpoint events	19% (17.07%, 21.03%)	23.4% (21.34%, 25.61%)	4.40%	0.003		
15-year						
Cost	¥57 096 (\$7993.44)	¥34 016 (\$4762.24)	¥23 080 (\$3231.2)	NA		
QALYs	5.46	5.07	0.39	NA	¥58 946 (\$8252.44)	0.66 GDP

Notes: CI: confidence interval; GDP: gross domestic product; ICER: incremental cost-effectiveness ratio; ICUR: incremental cost-utility ratio; NA: not applicable; QALYs: quality-adjusted life years; QLQX: Qili Qiangxin capsule. ^a China's per capita GDP in 2023 is ¥89 358; the exchange rate of the RMB to the US dollar is calculated at 1 RMB = 0.14 USD, effective September 23, 2025.

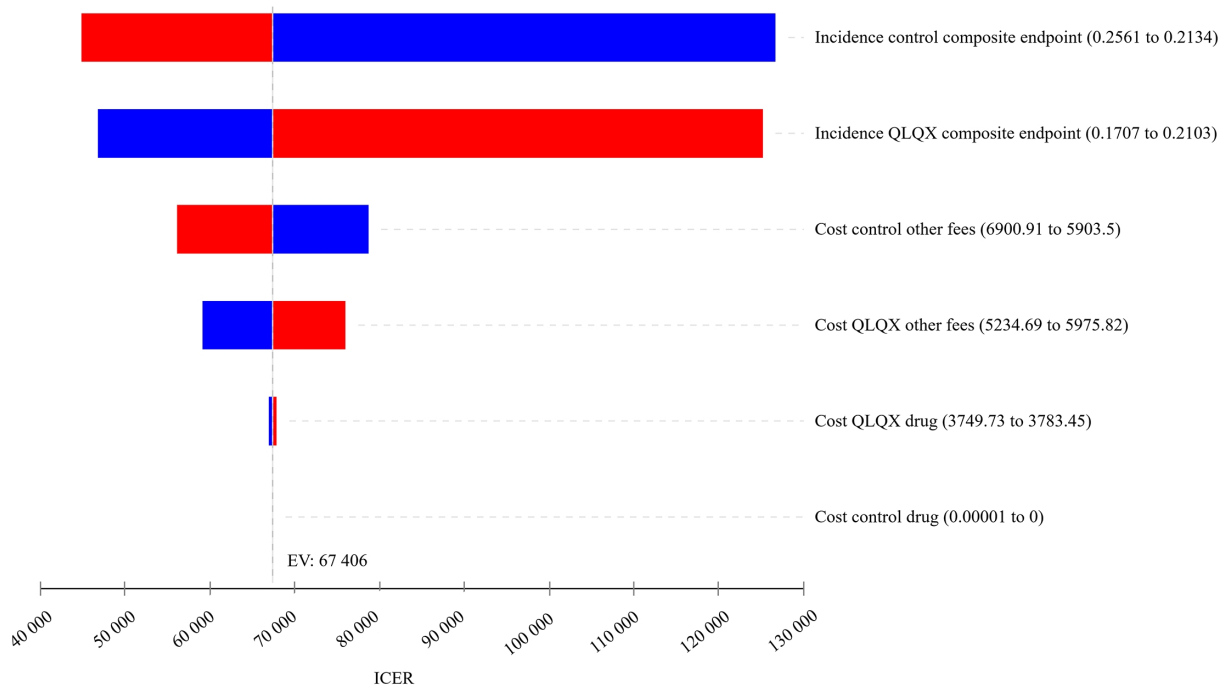


Figure 2 Tornado diagram of one-way sensitivity analysis for 1 year

Notes: EV: extreme value; ICER: incremental cost-effectiveness ratio; QLQX: Qili Qiangxin capsule.

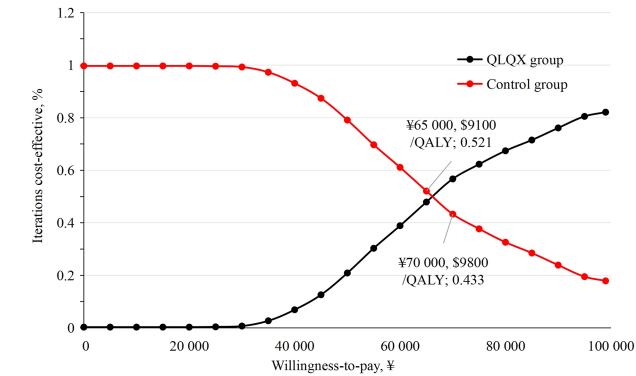


Figure 3 The cost-effectiveness acceptability curve for 1 year

Notes: QALY: quality-adjusted life year; QLQX: Qili Qiangxin capsule. The exchange rate of the RMB to the US dollar is calculated at 1 RMB = 0.14 USD, effective September 23, 2025.

additional cost of ¥58 946 (\$8252.44). This value is below the 2023 per capita GDP threshold for China (¥89 358; \$12 510.12), suggesting that the QLQX group is highly cost-effective. Further details are presented in Table 3.

Key parameters, including costs, utility values, transition probabilities, and the time horizon, were varied across their respective 95% CIs or plausible ranges. The three parameters with the greatest influence on the ICER were the cardiovascular death rates in both groups and the time horizon. These findings are illustrated in the tornado diagram (Figure 4).

At a WTP threshold of ¥89 358 (approximately equivalent to China’s 2023 per capita GDP), the QLQX group had a 66.3% probability of being cost-effective. When the WTP threshold was ¥60 000 (\$8400), the probability of cost-effectiveness for the QLQX group was 50.20%. For WTP thresholds exceeding ¥60 000 (\$8400), the QLQX group consistently showed a higher probability of cost-effectiveness than the control group. The results are illustrated in Figure 5.

4. Discussion

The management of CHF, which relies on standard therapies including diuretics, angiotensin-converting enzyme inhibitors, and beta-blockers, can be augmented by TCM. QLQX capsules, for instance, contain bioactive ingredients such as astragalus and ginseng. Their active components—astragaloside IV and ginsenosides—are associated with improved cardiac function, enhanced myocardial metabolism, and beneficial effects on cardiac remodeling, offering a complementary and holistic approach to CHF management.^{18–23} In addition, clinical evidence supports the benefits of QLQX. Systematic reviews have shown that QLQX combined with sacubitril/valsartan significantly improves left ventricular ejection fraction and walking distance, while also reducing cardiovascular events and rehospitalizations.²⁴

In this study, we evaluated the cost-effectiveness of QLQX capsules and found that, despite higher total costs, the QLQX group saved ¥800.72 (\$112.10) in disease progression-related medical costs and had a lower composite endpoint event rate (19.00% vs. 23.40%). A long-term cost-utility analysis over 15 years showed total costs of ¥57 096 (\$7993.44) for QLQX capsules, yielding 5.46 QALYs, compared with ¥34 016 (\$4762.24) and 5.07 QALYs for standard of care. The ICER of ¥58 946 (\$8252.44) per QALY gained demonstrates strong cost-effectiveness, well below the 2023 per capita GDP threshold in China.

Certain limitations should be noted. First, the follow-up period was relatively short, ranging from 12 to 36 months. Because the analysis primarily relied on 1-year data, the long-term cost-effectiveness of QLQX capsules may not have been fully captured, potentially underestimating its benefits over an extended period. Notably, we observed a reduction in rehospitalization and mortality rates after 3 years, suggesting that QLQX capsules may demonstrate greater cost-effectiveness with prolonged use. In addition, the Markov model used in this study excluded less frequent clinical events, which may have resulted in an incomplete representation of real-world outcomes. This omission may limit the generalizability of the findings, as it does not account for all potential clinical scenarios. Among the cost parameters, only the cost of heart failure rehospitalization was obtained from the published literature, based on 2021 data. In contrast, the cost associated with the stable survival

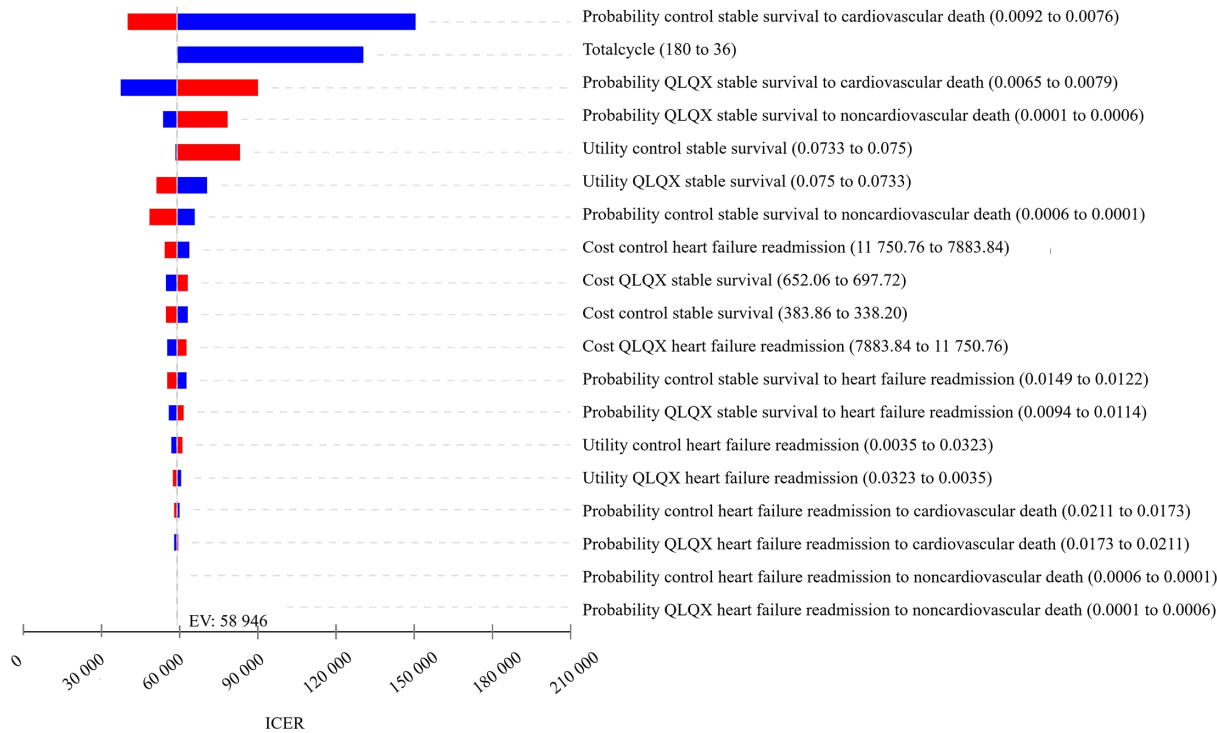


Figure 4 Tornado diagram of one-way sensitivity analysis for lifetime

Notes: EV: extreme value; ICER: incremental cost-effectiveness ratio; QLQX: Qili Qiangxin capsule.

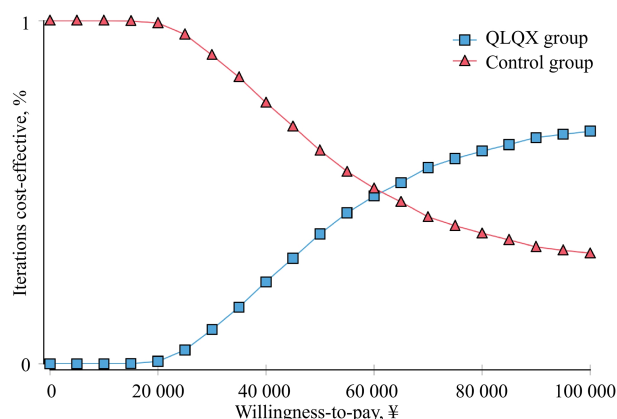


Figure 5 The cost-effectiveness acceptability curve for lifetime

Notes: QLQX: Qili Qiangxin capsule.

state was derived from individual patient data collected between 2019 and 2021. We used approximately unified price years; however, differences in data sources and timeframes may introduce some degree of bias into the cost analysis.

In addition, a scenario analysis was conducted to assess the impact of medication persistence. The base-case analysis assumed 100% continuous treatment, whereas this scenario explored a setting in which treatment in the QLQX group was discontinued after 1 year. From that point onward, the QLQX group was assumed to have the same transition probabilities as the control group for the remaining years. Under this assumption, the QLQX group incurred total costs of ¥37 703, compared with ¥34 016 for the control group, and generated 5.14 QALYs versus 5.07 QALYs, resulting in an ICER of ¥49 807 per QALY gained. This value did not differ significantly from the base-case ICER of ¥58 946 per QALY gained. We also performed internal and external validation to assess the accuracy of the model. For internal validation, we compared the model's short-term outputs with the observed 1-year clinical trial data. When the cycle length was set to 1 year, the model estimated that the QLQX group incurred costs of ¥8565 and gained 0.82 QALYs, compared with ¥5363 and 0.81 QALYs in the control group, yielding an ICER of ¥201 411. These results closely mirrored the 1-year individual patient data, which showed costs of ¥9368.08 versus ¥6402.21, QALYs of 0.8069 versus 0.7922, and an ICER of ¥201 759.86. This agreement between the modeled and observed outcomes supports the internal validity of the model.

For external validation, we assessed whether the model could reproduce long-term outcomes reported in the literature. Previous studies have reported a median survival of approximately 5 years in patients with heart failure.^{25,26} In addition, a Chinese retrospective study reported 5-year and 15-year all-cause mortality rates of 46.10% and 74.70%, respectively.²⁷ Using our model, we simulated median survival and all-cause mortality over the same time horizons. The model produced a median survival of 6.5 years for the control group, 5-year mortality rates of 37.50% for the QLQX group and 41.20% for the control group, and 15-year mortality rates of 75.54% and 79.68%, respectively. The close agreement between these simulated rates and the literature benchmarks indicates that the model extrapolates reliably beyond the clinical trial period. This agreement represents a key strength of the study, as it enhances the generalizability and robustness of the findings.

Another limitation is the generalizability of the findings outside China. QLQX capsule, which is rooted in TCM, may have varying efficacy across different populations due to genetic differences that influence drug metabolism and treatment response. In addition, cultural attitudes toward healthcare differ globally, which may affect patient acceptance and treatment outcomes. Therefore, further research is needed to evaluate the effectiveness and economic value of QLQX capsules in diverse populations worldwide.

5. Conclusion

We demonstrate the cost-effectiveness of QLQX capsules as an adjunct to

standard CHF treatment. The capsules improved clinical outcomes, including reducing composite endpoint events and enhancing QALYs, with an ICER below the 2023 per capita GDP threshold in China. Higher upfront costs were observed; however, these were partially offset by reductions in disease progression-related medical costs. The study's limitations, including the short follow-up period and focus on Chinese populations, may limit the generalizability of the findings. Nevertheless, these findings suggest that QLQX capsules may enhance CHF management and provide valuable evidence for clinical and healthcare decision-making.

Funding

The study was supported by the National Key Technologies R&D Program, Modernization of Traditional Chinese Medicine of Ministry of Science and Technology of the People's Republic of China (grant nos.: 2017YFC1700500 and 2017YFC1700505), and received partial funding from Shijiazhuang Yiling Pharmaceutical Co., Ltd. (Shijiazhuang, China).

Data Availability

Additional data related to this paper may be obtained from the corresponding author upon reasonable request.

Author Contribution Statement

Hua-liang Deng: Data curation, formal analysis, and writing – original draft. **Si-jun Yu:** Investigation, Data curation, methodology, and writing – original draft. **Fan Wang:** Methodology, resources, and writing – review & editing. **Chun-hui Liu:** Visualization, formal analysis, and supervision. **Xia Liu:** Software, data curation, formal analysis, and visualization. **Xiao-ye Wang:** Formal analysis. **Wen-ling Xu:** Investigation and Supervision. **Jia-xin Wang:** Investigation and visualization. **Guan-zhong Zheng:** Data curation. **Jian-Hua Zhou:** Data curation. **Xing-ze Xie:** Data curation. **Yong He:** Data curation. **Kai-yan Zhang:** Data curation. **Di-fei Gao:** Data curation. **Jia-yu Cui:** Data curation. **Gui-fang Sun:** Data curation. **De-cai Li:** Data curation. **Xing-hong Xie:** Data curation. **Iokfai Cheang:** Data curation. **Ning-xin Ding:** Conceptualization, writing – original draft, supervision, and writing – review & editing. **Zhen-hua Jia:** Conceptualization, project administration, supervision, and writing – review & editing.

Use of AI Statement

None.

Declaration of Competing Interest

Dr. Ning-xin Ding is affiliated with Victoria University of Wellington, New Zealand. Dr. Ding declares no financial interests, relationships, or other affiliations with any commercial entities that could be perceived to influence the work presented in this manuscript. Prof. Zhen-hua Jia serves as the Chief Scientist at Hebei Yiling Pharmaceutical Research Institute Co., Ltd (Shijiazhuang, China). He is the spouse of Ms. Rui Wu, who holds shares in and serves as the director of Shijiazhuang Yiling Pharmaceutical Co., Ltd. He has fully disclosed these interests to the research committee, developed an approved plan to manage any potential conflicts arising from this arrangement, and ensured the scientific rigor, objectivity, and authority of the research results. The study drug for this research was provided by Shijiazhuang Yiling Pharmaceutical Co., Ltd.

Electronic Supplementary Material

The online version contains supplementary material available at <https://doi.org/10.26599/eCMTA.2026.9570029>.

References

- [1] Forouzanfar MH, Moran A, Phillips D, et al. Prevalence of heart failure by cause in 21 regions: global burden of diseases, injuries and risk factors–2010 study. *J Am Coll Cardiol*. 2013;61(10):E786.
- [2] McCormack PL. Sacubitril/valsartan: a review in chronic heart failure with reduced ejection fraction. *Drugs*. 2016;76(3):387–396.
- [3] Heidenreich PA, Bozkurt B, Aguilar D, et al. 2022 AHA/ACC/HFSA Guideline for the Management of Heart Failure: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation*. 2022;145(18):e895–e1032.
- [4] Gu DF, Huang GY, He J, et al. Investigation of prevalence and distributing feature of chronic heart failure in Chinese adult population. *Chin J Cardiol*. 2003;31(1):3–6.
- [5] Wang H, Chai K, Du M, et al. Prevalence and incidence of heart failure among urban patients in china: a national population-based analysis. *Circ Heart Fail*. 2021;14(10):e008406.
- [6] Cook C, Cole G, Asaria P, Jabbour R, Francis DP. The annual global economic burden of heart failure. *Int J Cardiol*. 2014;171(3):368–376.
- [7] McDonagh TA, Metra M, Adamo M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. *Eur Heart J*. 2021;42(36):3599–3726.
- [8] McMurray JJV, Solomon SD, Inzucchi SE, et al. Dapagliflozin in patients with heart failure and reduced ejection fraction. *N Engl J Med*. 2019;381(21):1995–2008.
- [9] Li X, Zhang J, Huang J, et al. A multicenter, randomized, double-blind, parallel-group, placebo-controlled study of the effects of Qili Qiangxin capsules in patients with chronic heart failure. *J Am Coll Cardiol*. 2013;62(12):1065–1072.
- [10] Ji XD, Yang D, Cui XY, et al. Mechanism of Qili Qiangxin capsule for heart failure based on miR133a-endoplasmic reticulum stress. *Chin J Integr Med*. 2024;30(5):398–407.
- [11] Cheang I, Yao W, Zhou Y, et al. The traditional Chinese medicine Qiliqiangxin in heart failure with reduced ejection fraction: a randomized, double-blind, placebo-controlled trial. *Nat Med*. 2024;30(8):2295–2302.
- [12] Liu GN, Wu J, Xie F, Sun X, Li HC, Guan HJ. *Chinese Guidelines for Pharmacoeconomic Evaluations: A Manual (2022)*. Beijing: China Market Press; 2022.
- [13] National Bureau of Statistics. Statistical communiqué of the People's Republic of China on the 2023 national economic and social development. https://www.stats.gov.cn/sj/zxfb/202402/t20240228_1947915.html. Accessed March 20, 2025.
- [14] Cohen LP, Isaza N, Hernandez I, et al. Cost-effectiveness of sodium-glucose cotransporter-2 inhibitors for the treatment of heart failure with preserved ejection fraction. *JAMA Cardiol*. 2023;8(5):419.
- [15] Yu DS, Li PW, Li SX, Smith RD, Yue SC, Yan BPY. Effectiveness and cost-effectiveness of an empowerment-based self-care education program on health outcomes among patients with heart failure: a randomized clinical trial. *JAMA Netw Open*. 2022;5(4):e225982.
- [16] National Bureau of Statistics. Annual data. <https://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A0301&sj=2025>. Accessed March 20, 2025.
- [17] Chen C, Wu H, Zhou J, et al. Pharmacoeconomics of ivabradine in the treatment of CHF in the context of “Quadruple Therapy”. *China Pharm*. 2024;35(1):63–68.
- [18] Zhao Q, Li H, Chang L, et al. Qiliqiangxin attenuates oxidative stress-induced mitochondrion-dependent apoptosis in cardiomyocytes via PI3K/AKT/GSK3 β signaling pathway. *Biol Pharm Bull*. 2019;42(8):1310–1321.
- [19] Li F, Wang J, Song Y, et al. Qiliqiangxin alleviates Ang II-induced CMECs apoptosis by downregulating autophagy via the ErbB2-AKT-FoxO3a axis. *Life Sci*. 2021;273:119239.
- [20] Li Y, Zhang Z, Hao X, Yu T, Li S. Qiliqiangxin capsule modulates calcium transients and calcium sparks in human induced pluripotent stem cell-derived cardiomyocytes. *Evid Based Complement Alternat Med*. 2022;2022:9361077.
- [21] Packer M. Qiliqiangxin: a multifaceted holistic treatment for heart failure or a pharmacological probe for the identification of cardioprotective mechanisms? *Eur J Heart Fail*. 2023;25(12):2130–2143.
- [22] Wang Y, Fu M, Wang J, et al. Qiliqiangxin improves cardiac function through regulating energy metabolism via HIF-1 α -dependent and independent mechanisms in heart failure rats after acute myocardial infarction. *Biomed Res Int*. 2020;2020:1276195.
- [23] Sun X, Chen G, Xie Y, et al. Qiliqiangxin improves cardiac function and attenuates cardiac remodelling in doxorubicin-induced heart failure rats. *Pharm Biol*. 2020;58(1):417–426.
- [24] Chen W, Chang H, Wang X, Wang Y, Liu Y, Wang D. The efficacy and safety of a Qiliqiangxin capsule combined with sacubitril/valsartan in the treatment of chronic heart failure: a systematic review and meta-analysis. *Evid Based Complement Alternat Med*. 2023;2023:2701314.
- [25] Gerber Y, Weston SA, Redfield MM, et al. A contemporary appraisal of the heart failure epidemic in Olmsted County, Minnesota, 2000 to 2010. *JAMA Intern Med*. 2015;175(6):996.
- [26] Zarrinkoub R, Wettermark B, Wändell P, et al. The epidemiology of heart failure, based on data for 2.1 million inhabitants in Sweden. *Eur J Heart Fail*. 2013;15(9):995–1002.
- [27] Wang Z, Chi HJ, Lin XM, et al. Analysis of long-term mortality and influencing factors in patients with chronic heart failure. *Chin J Med*. 2021;56(6):639–642.