Treatment and survival of patients with heart failure: An updated analysis from the Czech National Healthcare Database

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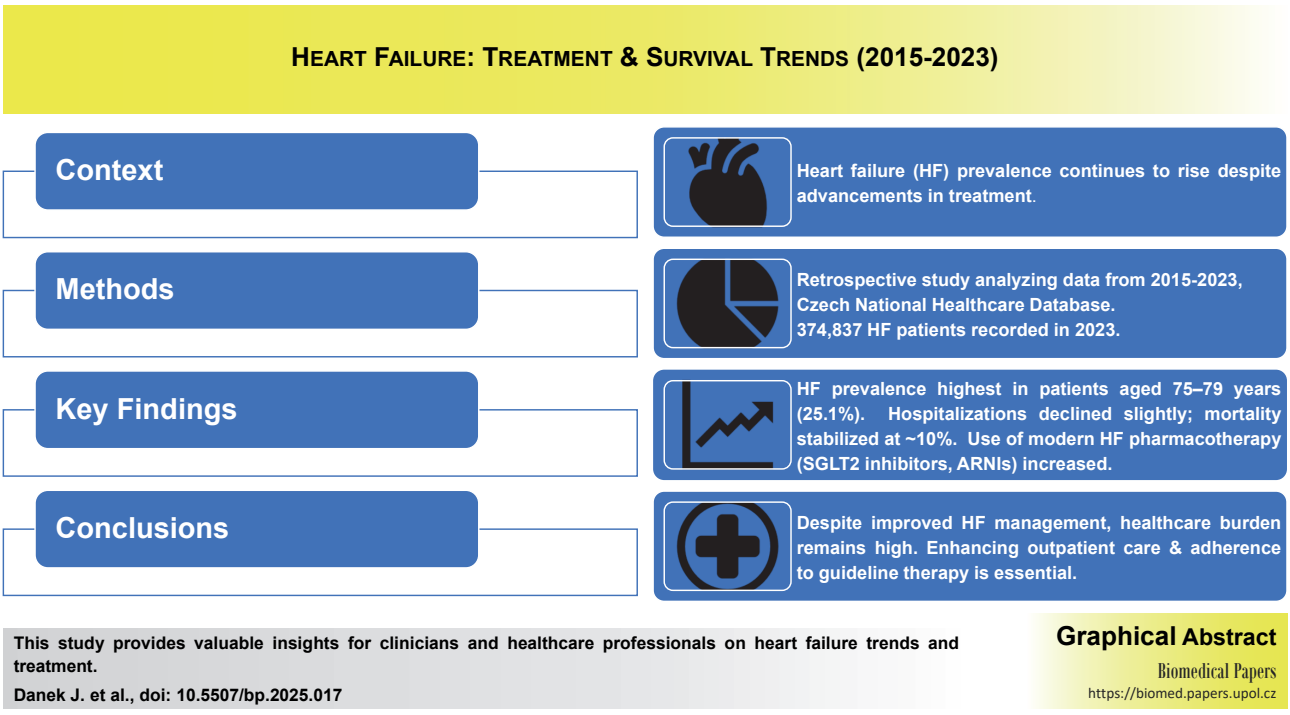
Background. Heart failure (HF) remains a major global health challenge. Despite advancements in treatment, the prevalence of HF continues to rise. This study provides an updated analysis of HF incidence, prevalence, hospitalizations, and mortality trends in the Czech Republic from 2015 to 2023.
Methods. A retrospective observational study was conducted using anonymized data from the Czech National Healthcare Reimbursement Database (NRHZS). Patients diagnosed with HF (ICD-10 codes I50.x) were included. Descriptive statistics and trend analyses were used to analyse the data.
Results. The prevalence of HF has increased significantly, with 374,837 patients registered in 2023. The age-specific prevalence was highest in patients aged 75–79 years (25.1%). The incidence of HF remained stable (51,701 cases in 2023), while hospitalizations declined slightly. The mortality rate showed a minor decrease, with in-hospital mortality stabilizing at ~10% over the past decade. The use of modern HF pharmacotherapy, including SGLT2 inhibitors and ARNIs, has increased substantially over time.
Conclusions. Despite improvements in HF management, the burden on the healthcare system remains high. Enhanced outpatient care and adherence to guideline-directed medical therapy (GDMT) are essential for further reducing hospitalizations and improving patient outcomes.



This study provides valuable insights for clinicians and healthcare professionals on heart failure trends and treatment.
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INTRODUCTION

Heart failure (HF) remains one of the leading causes of morbidity and mortality worldwide. Over the past decades, some countries have observed a modest decline in HF incidence and HF-related hospitalizations[1,2]. However, HF prevalence continues to rise due to an aging population and improved survival rates[3]. Despite advancements in pharmacological and device therapy, HF mortality remains high[4].

In the Czech Republic, HF epidemiology has been primarily studied through various registries[5,6]. However, these datasets did not cover the entire population, limiting their generalizability. In 2021, Táborský et al. published the first nationwide population-based study on HF trends and survival, revealing stable HF incidence but a significant rise in prevalence[7]. The study also highlighted suboptimal adherence to guideline-directed medical therapy (GDMT). Since then, HF management has evolved significantly, necessitating an updated analysis.

This study aimed to assess HF prevalence, incidence, hospitalizations, and mortality trends in the Czech Republic between 2015 and 2023, focusing on rehospitalization rates among patients receiving complete GDMT versus those on incomplete therapy. Special attention is given to patients treated with sacubitril/valsartan and SGLT2 inhibitors. Additionally, we evaluate the implementation of multidisciplinary HF care models.

METHODS

Study design and data source

This retrospective observational study analyzed anonymized patient data from the Czech National Healthcare Reimbursement Database (NRHZS) from 2015 to 2023. The study adhered to ethical guidelines, utilizing de-identified data in compliance with national regulations (Act No. 372/2011). AI-based analytical tools, including SPSS Modeler and Python-based statistical libraries such as SciPy and Pandas, were utilized for data processing, with all findings reviewed and validated by the authorial team.

Patient selection

Patients with a primary or secondary diagnosis of HF (ICD-10 codes I50.0, I50.1, I50.9) were included. This approach includes patients with both heart failure with reduced ejection fraction (HFrEF) and preserved ejection fraction (HFpEF), as the diagnosis codes do not differentiate between subtypes. Additional inclusion criteria involved HF-related pharmacotherapy (loop diuretics, spironolactone, eplerenone, sacubitril/valsartan) or advanced HF treatments (LVAD, CRT, heart transplantation).

Statistical analysis

Descriptive statistics were used to summarize patient demographics and epidemiological trends. Trend significance was assessed using linear regression models. Mortality and hospitalization trends were analyzed using Kaplan-Meier survival estimates. All analyses were performed using SPSS 25.0 and R-3.6.1. A *P*-value <0.05 was considered statistically significant.

RESULTS

HF epidemiology in the Czech Republic

In 2023, 374,837 patients with a history of HF treatment were recorded. The mean patient age was 75 years (± 12 years), with a median of 77 years. HF prevalence was highest among individuals aged 75+ years, reaching 25.1% (Table 1). Males represented 50.7% of HF patients, with higher prevalence in middle-aged groups, while females predominated in older age categories (Fig. 1, 2).

The incidence of HF remained stable, with 51,701 new cases in 2023, translating to ~450 per 100,000 inhabitants annually. Regional disparities in HF prevalence were not-

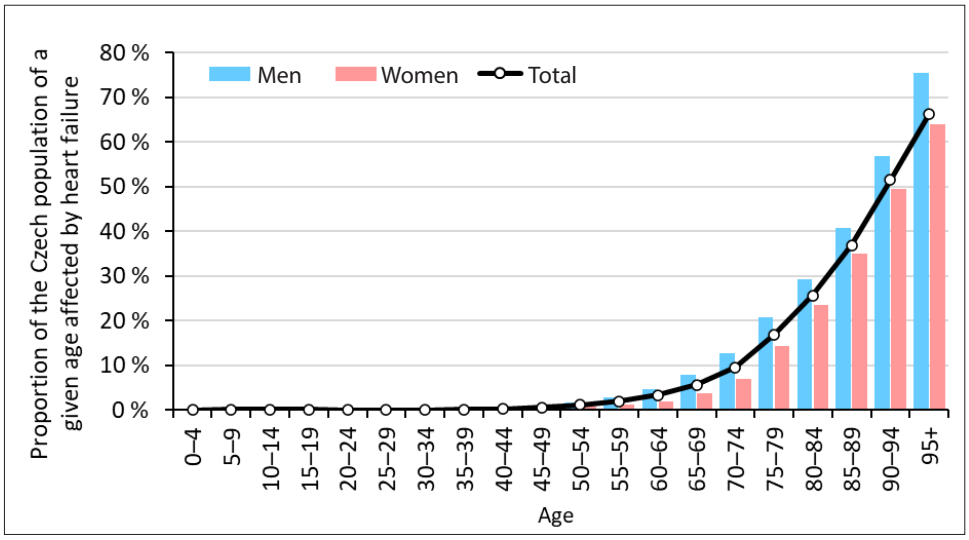

Fig. 1. Prevalence of heart failure by age in the Czech Republic.

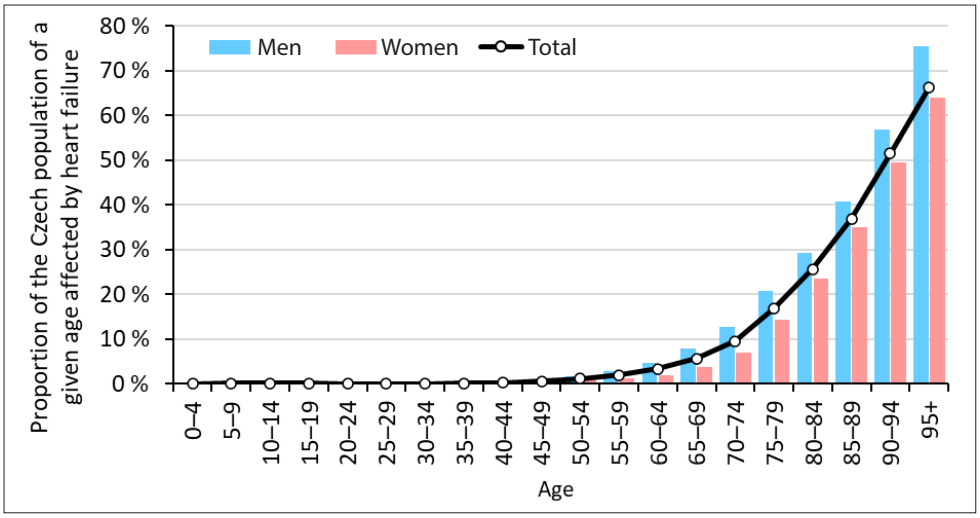

Fig. 2. Age-specific prevalence of heart failure in the Czech Republic (2023) by gender. Blue lines represent men, red lines represent women, and the solid line indicates the total number of patients.

ed, with the highest rates in the Moravian-Silesian region (4,093 per 100,000) and the Vysočina region (3,864 per 100,000), while the lowest prevalence was found in Prague (2,687 per 100,000) (Fig. 3). A notable discrepancy exists between the number of diagnosed HF patients and those receiving active treatment across different regions of the Czech Republic. While prevalence rates indicate the total burden of HF, treatment rates reflect access to and utilization of healthcare services. In regions such as the Moravian-Silesian and Vysočina regions, the number of diagnosed patients is significantly higher compared to other areas. However, the number of treated patients does not proportionally match the prevalence, suggesting barriers in accessing guideline-directed medical therapy (GDMT). In Prague, although the overall prevalence of HF is lower, the proportion of diagnosed patients receiving evidence-based treatment is higher, indicating better access to specialist care and adherence to recommended therapies. The disparity between diagnosed and treated patients can be linked to the availability of cardiologists, HF clinics, and multidisciplinary teams. Regions with fewer specialized facilities tend to have more undermanaged HF cases despite a high disease burden (Fig. 4).

Hospitalization and mortality trends

Between 2015 and 2023, HF-related hospitalizations slightly declined from 35,774 to 32,462 cases annually (Fig. 5). Thirty-day post-hospitalization mortality remained stable at ~ 13.2% in 2023, while in-hospital mortality was consistently around 10% (Fig. 6). Rehospitalization rates were higher among patients receiving incomplete GDMT compared to those on optimized therapy.

Hospitalization mortality and contributing factors

In-hospital mortality remained stable at approximately 10% over the study period, consistent with rates reported in other European cohorts. According to national registry data from 2014–2023, in-hospital mortality among HF patients showed slight variability, ranging from 10.5% to 12%, with the highest values recorded in 2015 (12.1%) and a decline to 10.1% in 2023 (Fig. 6).

Table 1. Prevalence of heart failure by gender and age.

Age	n	Average (SD)	Median (IQR)	Age 65+
Men	190 174	73 (12)	74 (67; 81)	79.9%
Women	184 663	78 (12)	80 (73; 86)	90.8%
Total	374 837	75 (12)	77 (70; 84)	85.3%

Factors associated with increased in-hospital mortality included advanced age, multimorbidity, and delays in initiating guideline-directed medical therapy (GDMT). Patients over 85 years exhibited mortality rates exceeding 20%, with a particularly high burden among those requiring intensive care admission (Fig. 7). In contrast, individuals with chronic HF receiving optimal GDMT showed significantly lower mortality rates, underscoring the importance of adherence to evidence-based management strategies.

Hospitalization mortality varied across regions, with the highest rates observed in areas with lower healthcare resource availability. In comparison to international data, the Czech Republic's in-hospital mortality rates align with reports from Germany and France (9–11%), whereas Scandinavian countries report slightly lower rates (7–9%), attributed to earlier detection and broader implementation of multidisciplinary HF management programs.

Pharmacotherapy trends

The landscape of heart failure (HF) treatment has evolved significantly over the past decade, with increasing adoption of guideline-directed medical therapy (GDMT). This study analyzed trends in HF pharmacotherapy among patients in the Czech Republic between 2015 and 2023, highlighting the uptake of novel agents and adherence to established treatments.

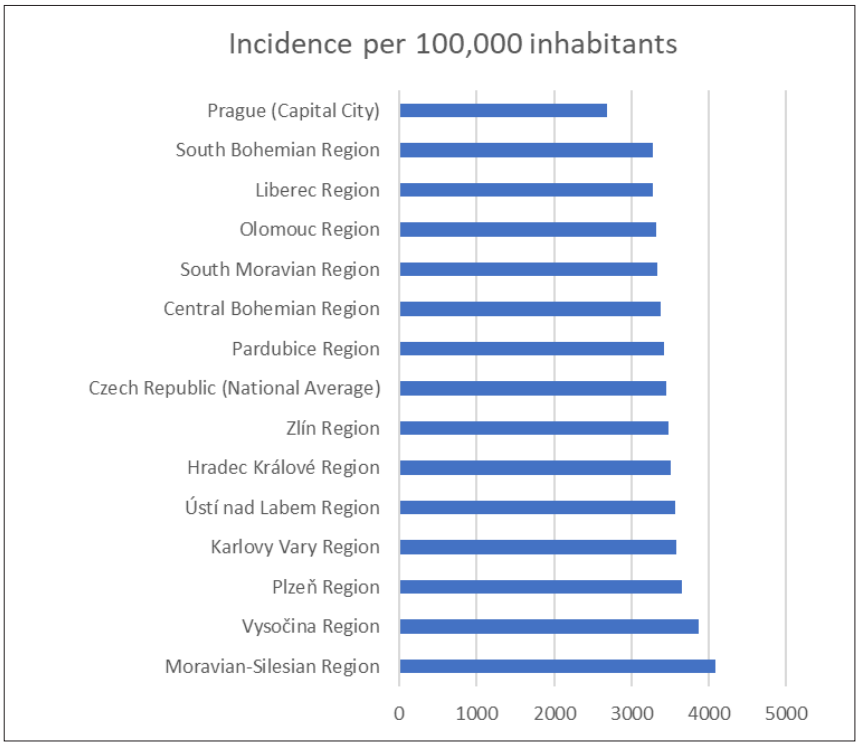

Fig. 3. Incidence of heart failure by region of the Czech Republic.

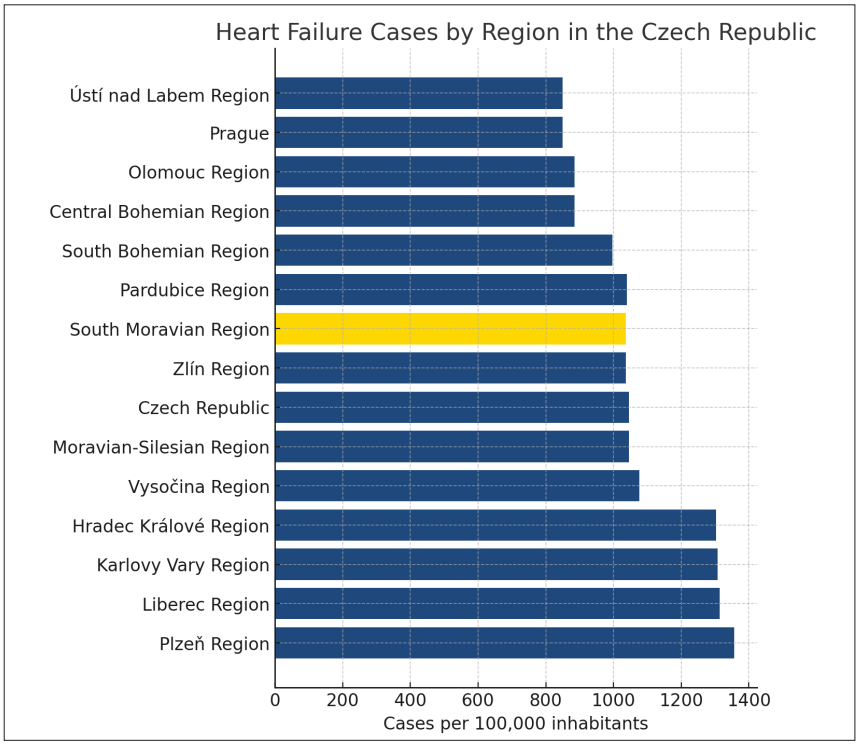

Fig. 4. Number of treated heart failure patients by region.

Pharmacotherapy prior to hospitalization

Pharmacotherapy prior to hospitalization plays a critical role in reducing HF-related admissions and improving patient outcomes. Data from 2015–2023 indicate that a significant proportion of patients hospitalized for HF were not receiving optimal GDMT. Among those admitted, only 64.2% were on beta-blockers, 58.5% were on ACE inhibitors or ARBs, and 49.3% were receiving MRAs. Notably, adherence to ARNIs and SGLT2 inhibitors prior to admission remained low, with only 8.6% and 19.8% of hospitalized patients, respectively, receiving these evidence-based therapies.

Patients who were hospitalized despite being on optimal GDMT exhibited lower in-hospital mortality compared to those receiving suboptimal therapy. In contrast, individuals not receiving ACEi/ARB or ARNI therapy

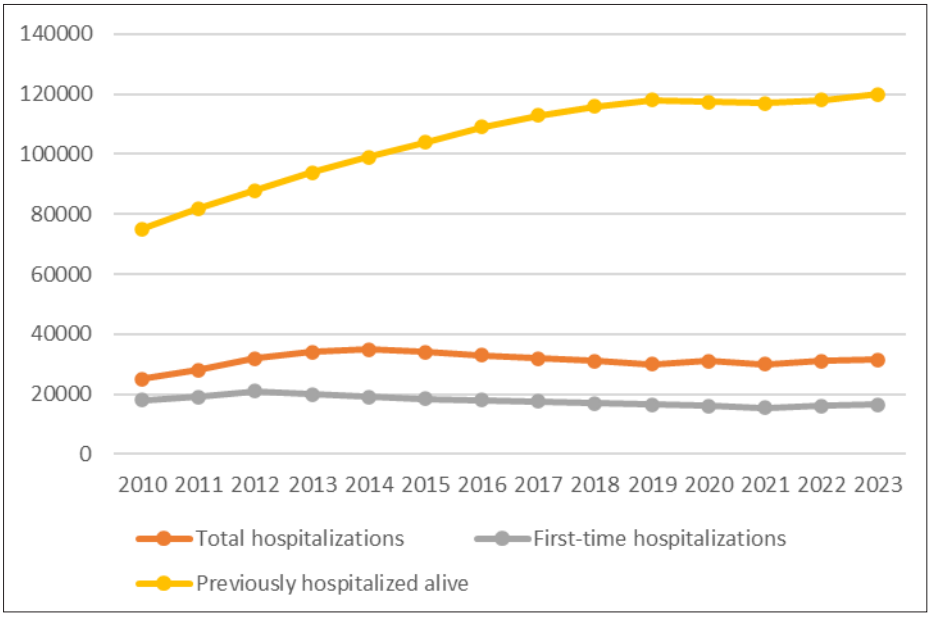

Fig. 5. Number of patients hospitalized with heart failure.

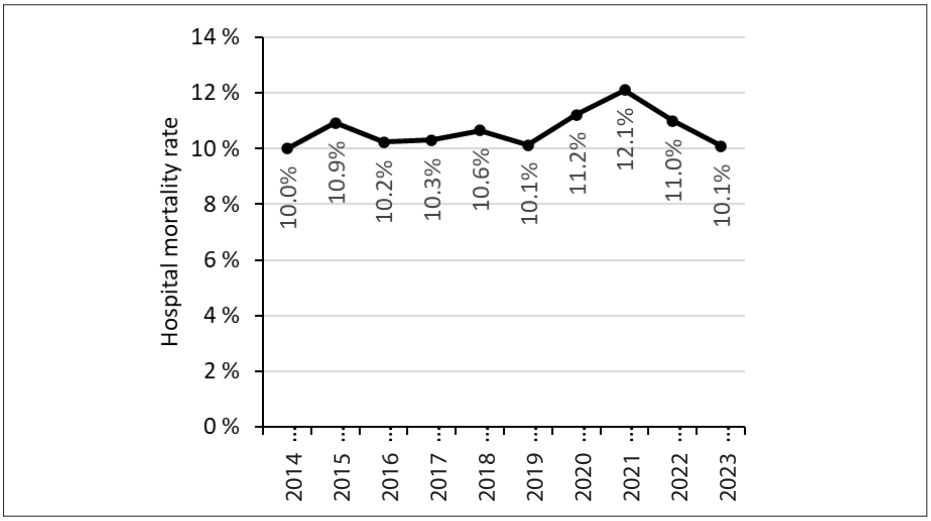

Fig. 6. Development of hospitalization mortality in the years 2014–2023.

prior to admission demonstrated significantly higher mortality rates, reinforcing the importance of early and sustained pharmacologic intervention. Additionally, polypharmacy and undertreatment were particularly prevalent among elderly and multimorbid patients, highlighting the need for enhanced outpatient care strategies to optimize therapy prior to hospitalization.

Traditional pharmacotherapy

The cornerstone of HF management remains beta-blockers, ACE inhibitors (ACEi), and angiotensin receptor blockers (ARBs), which continue to be widely prescribed. In 2023, beta-blockers were prescribed to approximately 72.2% of HF patients, maintaining their role in reducing mortality and improving cardiac function. ACEi/ARBs were administered to 67.5% of patients, demonstrating high adherence to foundational HF therapy. However, there was a gradual shift in prescribing patterns, with a slight decline in ACEi/ARB usage attributed to the introduction of angiotensin receptor-neprilysin inhibitors (ARNIs).

Aldosterone antagonists (mineralocorticoid receptor antagonists, MRAs), including spironolactone and eplerenon, remained essential in HF therapy. Their utilization remained relatively stable, with 57.7% of patients receiving MRAs in 2023. These agents play a crucial role in reducing hospitalization rates and mortality, particularly in patients with HF with reduced ejection fraction (HFrEF).

Emerging therapies and adoption of novel agents

The adoption of ARNIs (sacubitril/valsartan) increased significantly between 2015 and 2023. Initially not prescribed in 2015, ARNIs were administered to 12.3% of HF patients by 2023, reflecting growing awareness and guideline incorporation. This class of medication has demonstrated superior outcomes in reducing HF-related

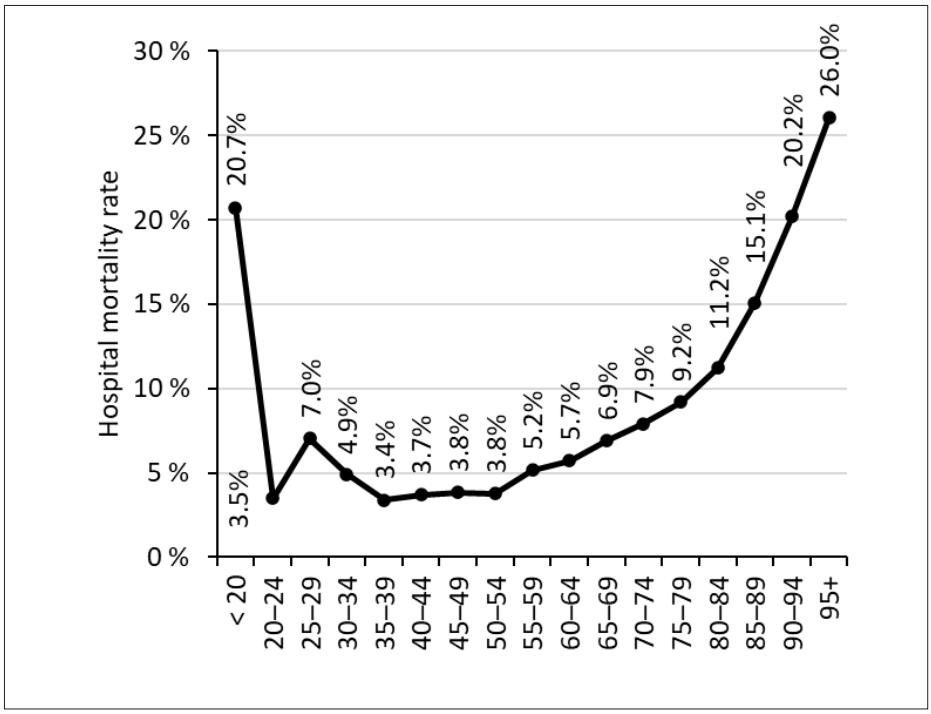

Fig. 7. Hospitalization mortality by age of patients.

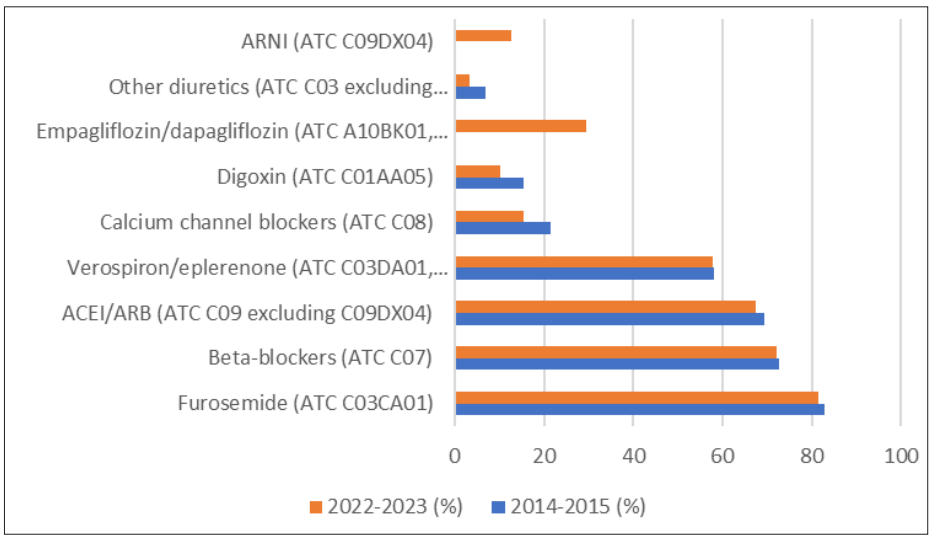

Fig. 8. Medication reported in patients within 6 months of completion of first hospitalization for heart failure.

hospitalizations and mortality compared to ACEi/ARBs alone. However, the relatively modest uptake suggests potential barriers such as cost, physician familiarity, and access limitations.

Sodium-glucose cotransporter-2 (SGLT2) inhibitors (empagliflozin, dapagliflozin) have emerged as key agents in HF treatment due to their cardio-protective effects, independent of diabetes status. Their usage increased dramatically from 0.9% in 2015 to 29.4% in 2023, reflecting strong evidence supporting their efficacy in reducing HF progression and mortality (Fig. 8). Despite this rapid adoption, further efforts are needed to ensure broader implementation in clinical practice.

Implications for clinical practice

Despite improvements in GDMT adherence, gaps remain in the optimization of HF pharmacotherapy. The underutilization of ARNIs and slower-than-expected uptake of SGLT2 inhibitors suggest the need for educational initiatives targeting clinicians and patients. Ensuring early initiation and titration of evidence-based therapies can further improve patient outcomes and reduce the burden of HF-related hospitalizations.

These findings underscore the importance of continued monitoring of pharmacotherapy trends and reinforcing adherence to international treatment guidelines to maximize the benefits of HF management strategies.

DISCUSSION

This study provides an updated analysis of heart failure (HF) epidemiology, hospitalization trends, and pharmacotherapy in the Czech Republic from 2015 to 2023. Our findings reveal a rising HF prevalence, a stable incidence rate, and a modest decline in hospitalizations. Despite advancements in guideline-directed medical therapy (GDMT), challenges in the implementation of optimal treatment persist.

Comparison with international data

Our findings align with global epidemiological trends. Similar studies from Germany and France report a HF prevalence of 2–4% in the general population, comparable to the Czech Republic[8]. However, hospitalization rates for HF in Germany (approximately 390 per 100,000 inhabitants) are lower than those observed in the Czech Republic, suggesting differences in outpatient management and accessibility of specialized HF care[9]. In contrast, the United Kingdom has experienced a decline in HF-related hospitalizations due to widespread implementation of multidisciplinary HF care programs and increased adoption of novel pharmacotherapies[10].

Pharmacotherapy trends in the Czech Republic demonstrate increasing adherence to international HF management guidelines, particularly with the introduction of ARNIs and SGLT2 inhibitors. However, the adoption of these therapies lags behind Western European countries. In the Netherlands and Sweden, ARNIs are prescribed to nearly 25% of eligible HF patients, whereas in the Czech Republic, their utilization reached only 12.3% in 2023 (ref.[11]). This discrepancy may reflect healthcare policy differences, medication reimbursement strategies, and physician prescribing behaviors. Similarly, the uptake of SGLT2 inhibitors has been more pronounced in North America, where their integration into HF management has significantly reduced HF-related hospitalizations[12].

Regional disparities and healthcare system challenges

Significant regional disparities in HF prevalence were observed in our study, with the highest rates reported in the Moravian-Silesian and Vysočina regions. These findings are consistent with prior European studies that highlight geographic differences in HF burden, which may be attributed to socioeconomic factors, healthcare access, and comorbidity prevalence[13]. In Scandinavian countries, aggressive prevention strategies, including earlier detection of HF and optimized comorbidity management, have contributed to lower overall HF mortality[14]. A comparison of five-year survival rates indicates that Scandinavian patients with HF have a higher survival probability (56–62%) than those in Central Europe, including the Czech Republic (49–54%) (ref.[10]).

One of the key barriers to improved HF outcomes in the Czech Republic appears to be access to specialized HF clinics. Countries with well-established HF specialist networks, such as Sweden and the UK, report better adherence to GDMT and improved survival rates. In contrast, our findings suggest that limited availability of multidisciplinary HF care contributes to suboptimal treatment initiation and titration, particularly in rural areas. Expanding HF clinics and fostering greater collaboration between primary care physicians and cardiologists may help address these disparities[9].

Implications for clinical practice and future directions

Despite progress in HF management, the Czech Republic faces ongoing challenges in reducing HF-related hospitalizations and increasing adherence to guideline-recommended therapies. Lessons from Western European and North American models emphasize the importance of multidisciplinary HF teams, early intervention, and the integration of digital health technologies. The expansion of remote monitoring and telemedicine services could further support the early identification of decompensated HF, ultimately reducing hospitalizations and improving patient outcomes[11].

Future research should focus on identifying barriers to the adoption of novel HF therapies, evaluating the cost-effectiveness of emerging treatments, and exploring patient-centered approaches to HF management. Further investment in HF research, physician education, and healthcare infrastructure will be crucial to achieving sustainable improvements in HF outcomes in the Czech Republic.

CONCLUSIONS

The burden of HF in the Czech Republic continues to rise, necessitating improved adherence to GDMT and expanded access to multidisciplinary HF care. Despite increasing utilization of modern HF therapies, further efforts are required to optimize treatment strategies and reduce hospitalizations.

To achieve significant improvements in HF outcomes, healthcare systems must prioritize early detection and intervention, enhance patient education, and expand access to specialized HF clinics. The role of primary care physicians in HF management should also be strengthened, ensuring timely referrals to cardiologists and multidisciplinary teams. Additionally, further integration of digital health technologies, such as remote monitoring and telemedicine, may support early identification of worsening HF symptoms and reduce the need for hospitalizations.

International comparisons suggest that countries with well-established HF care networks and structured follow-up programs have demonstrated lower hospitalization rates and improved long-term survival. Implementing best practices from successful HF management models in Western Europe and North America could further optimize care delivery in the Czech Republic.

Future research should focus on identifying barriers to the adoption of novel HF treatments, assessing the cost-effectiveness of emerging therapies, and exploring personalized treatment strategies tailored to patient-specific risk factors. Continued investment in HF research and healthcare infrastructure will be crucial to achieving sustainable improvements in patient outcomes.

Limitations

Despite the strengths of this study, several limitations should be acknowledged: Retrospective Observational Design – the study relies on retrospective data from the Czech National Healthcare Reimbursement Database (NRHZS), which limits causal inferences. Although trends can be identified, the lack of prospective validation may introduce biases. Administrative healthcare databases are prone to misclassification and coding errors. The reliance on ICD-10 codes for HF diagnosis and treatment data may not fully capture all HF cases, especially those managed in outpatient settings without a formal diagnosis in hospital records. The study does not include individual patient-level clinical parameters, such as left ventricular ejection fraction (LVEF), NT-proBNP levels, or functional status. These factors are critical for risk stratification and treatment optimization. Although this is a nationwide study, the findings may not be directly applicable to countries with different healthcare infrastructures, socioeconomic factors, or HF management strategies. Variability in healthcare access, physician prescribing behavior, and patient adherence may influence outcomes differently across regions. While the study highlights trends in pharmacotherapy, it does not account for patient adherence, medication discontinuation, or the reasons for suboptimal uptake of novel therapies such as ARNIs and SGLT2 inhibitors.

In addition, the current reporting system based on ICD-10 coding does not distinguish between heart failure phenotypes (e.g., HFrEF vs HFpEF), as mentioned in the methodology. Consequently, the aggregated statistics on pharmacotherapy – particularly for medications acting on the renin-angiotensin system – may be underestimated, since their indication often depends on reduced left ventricular ejection fraction.

The study primarily focuses on hospitalization and mortality trends, but lacks insights into quality of life, functional outcomes, or patient-reported experiences, which are crucial for comprehensive HF management evaluation. To address these limitations, future research should incorporate prospective cohort designs, integrate biomarker and imaging data, and explore patient-centered outcomes. Additionally, qualitative studies assessing barriers to guideline adherence and real-world medication use could provide further insights into improving HF care.

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Conflict of interest statement: The authors state that there are no conflicts of interest regarding the publication of this article.

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