





# 10 year trends in hospitalization rates due to heart failure and related in-hospital mortality in Poland (2010–2019)

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## Abstract

**Aims** Heart failure (HF) remains a major public health challenge worldwide. Contemporary epidemiological data on HF hospitalization rates and related in-hospital mortality are scarce also in Poland. The aim of the study was to determine the trends in hospitalization rates due to HF and related in-hospital mortality in Poland in the recent decade.

**Methods and results** Data on HF hospitalizations and in-hospital mortality in patients aged >17 years in Poland between 2010 and 2019 were obtained from the central database of the Polish National Health Fund. Hospitalizations with either primary or secondary diagnosis of HF were identified using the 10th revision of the International Statistical Classification of Diseases and Related Health Problems codes (I50, I42, J81 with extensions, and R57.0). There were 4 259 698 HF hospitalizations and 608 577 in-hospital deaths (14% in-hospital mortality) reported during 2010–2019 in Poland. During this period, there was a steady increase in the number of HF hospitalizations per 1000 inhabitants in subsequent years, being more pronounced in men than in women (in 2019: 16 and 13 HF hospitalizations per 1000 inhabitants in men and women, respectively). The relative risk of HF hospitalization was higher in men than in women, and this gender-related difference steadily increased from 9% in 2010 to 25% in 2019. During 2010–2019, there was an increase in the number of HF hospitalizations per 1000 inhabitants in subsequent age groups, with a trend being more pronounced in men than in women (129 and 99 HF hospitalizations per 1000 inhabitants in men and women aged ≥80 years, respectively). During this period, there was a slight increase in in-hospital mortality during HF hospitalization in subsequent years, being more pronounced in women than in men (in 2019: 16% and 14% of in-hospital mortality in women and men, respectively). The relative risk of in-hospital mortality during HF hospitalization was higher in women than in men, and this gender-related difference steadily increased from 8% in 2010 to 18% in 2019. During this period, in-hospital mortality during HF hospitalization was ~12% for women and men aged 18–29 years, whereas the highest values of in-hospital mortality reached ~19% for patients aged ≥80 years.

**Conclusions** We have observed steady growing trends in HF hospitalization rates and related in-hospital mortality in Poland over the last decade. Both age and gender have differentiated the reported epidemiological patterns.

**Keywords** Heart failure; Heart failure hospitalization; In-hospital mortality; Epidemiology; Poland; Trends; Age differences; Gender differences

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## Introduction

Heart failure (HF) constitutes a major clinical problem and public health challenge worldwide.<sup>1–7</sup> There are >1 million HF

hospitalizations each year in Europe and North America.<sup>8–10</sup> However, contemporary epidemiological data on HF hospitalizations and related in-hospital mortality are largely unknown, especially within European populations.<sup>11</sup> The majority of

existing epidemiological evidence is residual, in most cases already outdated (owing to changing clinical profiles of HF patients and changing standards of HF care) and based on different methodological approaches. All these factors constitute significant limitations of interpretation of existing data and comparisons with other cohorts. It is acknowledged that there is no reliable evidence reflecting the current epidemiology of HF.<sup>12–15</sup>

The response to the scarcity of epidemiological data is the recent initiative raised by the Heart Failure Association of the European Society of Cardiology in collaboration with the Heart Failure National Societies/Working Groups, aiming to establish the structures that would collect updated data on HF epidemiology and related management in European countries.<sup>8,16</sup>

Also in Poland, data on HF epidemiologically are scarce.<sup>17,18</sup> The published studies have several limitations (are related to outdated data and are far from being comprehensive). There is an urgent need to provide contemporary and comprehensive statistics on HF epidemiology for Polish population. This information would be of utmost importance for clinicians, researchers, experts in public health and also for patients with HF.

Information on current realities in HF care and outcomes would support the physicians and health care policymakers in their efforts to improve the systems of HF management, also through the optimal allocation of funds for the prevention, diagnosis, and treatment of HF, and to identify clinical problems that could be targets of innovative diagnostic and therapeutic approaches.<sup>19–21</sup> Moreover, the better understanding of contemporary HF epidemiology would also help in developing better management and educational programmes addressed to patients with HF and their caregivers.<sup>22</sup>

Therefore, we performed study in order to determine the trends in hospitalization rates due to HF and related in-hospital mortality in the recent decade, with an additional focus on age-related and gender-related differences in investigated epidemiological patterns.

## Methods

### Data source

For the purpose of these analyses, data from the Polish National Health Fund (NHF) were used. NHF is a public institution, established in 2003, that finances health services, within the compulsory health insurance system in Poland. All health services provided by both public and private health care providers financed from public funds are registered in the NHF database. The registration of performed services (with a predefined set of details regarding the patient, the primary and other diagnoses, co-morbidities, performed

procedures, and applied treatment) in the NHF database by health care providers is obligatory in order to obtain the reimbursement of costs by the NHF. It also guarantees the completeness of data. Data are saved and backed up in central servers in the NHF in Warsaw. There are established procedures for quality control of entered data, and a certain percentage of records are validated with hospital source data by the NHF personnel. In Poland, a private sector of health care includes mainly outpatient services. It needs to be acknowledged that 99.9% of admissions due to HF occur in public multidisciplinary hospitals (and very few private cardiology wards), all of which have a contract with NHF.

### Study population

The following cohort of subjects extracted from the NHF database was used for further analyses: (i) men and women aged >17 years (age refers to the date of a recorded index HF hospitalization), (ii) patients admitted between 2010 and 2019 to a hospital, which at that time had a contract with the NHF, (iii) hospitalizations with one of the following assigned codes of either primary or secondary diagnosis [codes based on the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10) codes: I50 (HF), I42 (cardiomyopathy), J81 (pulmonary oedema) with all extensions, and R57.0 (cardiogenic shock)]. In-hospital death was identified when the discharge code 'patient's death' was applied to a particular hospitalization among the aforementioned cohort.

Owing to de-identified patient records, the need for institutional review board and ethics committee approval was waived.

### Statistical analysis

All statistical analyses and methodological assumptions were planned prospectively before the data were extracted, and the subsequent analyses were performed.

Data extraction was performed using Structured Query Language and data preparation with R software Version 3.6.1.<sup>23</sup>

We analysed two determined variables: (i) the number of hospitalizations due to HF per 1000 inhabitants ( $HF_{1000}$ ) and (ii) the percentage of HF hospitalizations terminated by death (in-hospital mortality during HF hospitalization) ( $HF_D$ ). The values were collected for consecutive 10 years (2010–2019), separately for men and women, and within seven separate predefined age groups (18–29, 30–39, 40–49, 50–59, 60–69, 70–79, and 80+ years).

We used linear models to determine the trends in  $HF_{1000}$  and  $HF_D$  for consecutive years, separately for men and women. We compared the scopes of estimated linear

functions between genders using the  $z$  statistics, and the  $P$  value  $< 0.05$  was considered statistically significant.<sup>24</sup> Similarly, we used linear models with aforementioned statistics to determine the gradients for age groups for HF<sub>1000</sub> and HF<sub>D</sub>, separately for men and women.

Gender differences for HF<sub>1000</sub> and HF<sub>D</sub> (in consecutive years) were analysed by calculating the odds ratio (OR) statistic with 95% confidence intervals (95% CIs), as the measure of an effect of male group compared with the control female group. The OR statistics were calculated using a random-effects model.<sup>25</sup> For the assessment of heterogeneity between the different years included in that meta-analysis, we used  $Q$  Cochran test and  $I^2$  statistics, and the  $P$  value  $< 0.05$  was considered statistically significant. All analyses were performed using R software Version 3.5.1.<sup>23</sup>

## Results

There were 4 259 698 HF hospitalizations during the 2010–2019 decade in Poland (52% of these hospitalizations occurred in men), whereas 608 577 in-hospital deaths (14% in-hospital mortality) were reported during this period (52% of these deaths occurred in women). *Table S1* presents the raw numbers of HF hospitalizations and related in-hospital deaths in subsequent years of this report, separately for men and women.

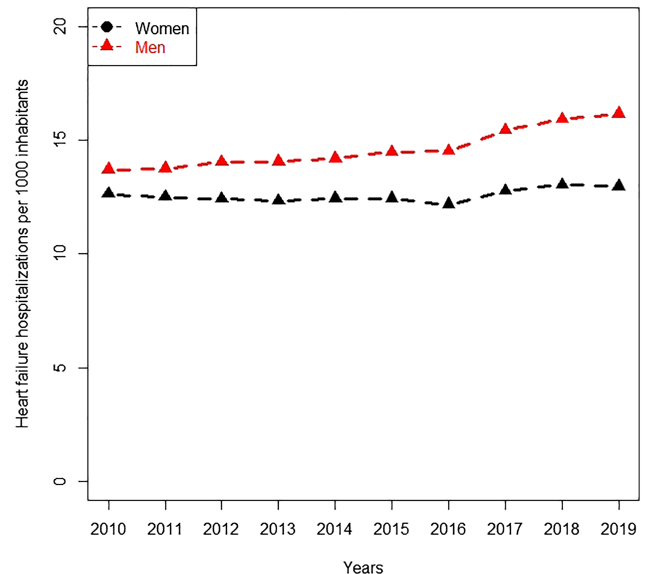
### Heart failure hospitalizations

During the 2010–2019 decade, there was a steady increase in the number of HF hospitalizations per 1000 inhabitants in subsequent years (pooled for all age groups), being more pronounced in men than in women, with the numbers of HF hospitalizations per 1000 inhabitants reaching 16 and 13 in men and women in 2019, respectively (*Figure 1*). When comparing the relative risk of HF hospitalizations (adjusted per 1000 inhabitants) between men and women in consecutive years, we have demonstrated that the relative risk of HF hospitalization was higher in men as compared with women during the whole period, and this gender-related difference steadily increased from 9% in 2010 to 25% in 2019 (*Figure 2*).

During the analysed decade, there was a marked increase in the number of HF hospitalizations per 1000 inhabitants in subsequent age groups (pooled for the whole decade), separately in men and women (*Figure 3*). This trend was more pronounced in men than in women, with the numbers of HF hospitalizations per 1000 inhabitants reaching 129 and 99 in men and women aged  $\geq 80$  years, respectively.

Detailed trends of HF hospitalizations per 1000 inhabitants separately for gender and age groups in subsequent years are shown in *Figure S1* with statistics presented in *Tables S2* and

**Figure 1** Heart failure hospitalizations per 1000 inhabitants by gender in consecutive years in Poland (2010–2019).



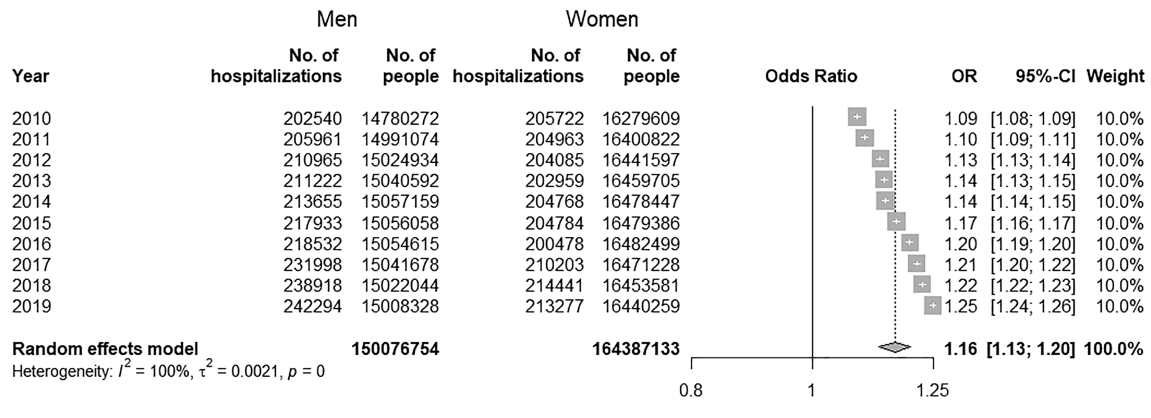
S3. During 2010–2019 in Poland, three factors (consecutive years, gender, and age groups) have been shown to significantly differentiate the reported numbers of HF hospitalizations per 1000 inhabitants, with age groups having the greatest differentiating impact on HF hospitalizations per 1000 inhabitants.

### In-hospital mortality during heart failure hospitalizations

During the 2010–2019 decade, there was a slight increase in in-hospital mortality during HF hospitalization in subsequent years (pooled for all age groups), being more pronounced in women than in men, with in-hospital mortality during HF hospitalization reaching in 2019 at 16% and 14% in women and men, respectively (*Figure 4*). When comparing the relative risk of in-hospital mortality during HF hospitalization between women and men in consecutive years, we have demonstrated that the relative risk of in-hospital mortality during HF hospitalization was higher in women as compared with men during the whole period, but this gender-related difference steadily increased from 8% in 2010 to 18% in 2019 (*Figure 5*).

During the analysed decade, in-hospital mortality during HF hospitalization was  $\sim 12\%$  for both women and men aged 18–29 years. In subsequent age groups, in women, there was an increase in in-hospital mortality up to an age group of 40–49 years (15%), whereas in men, there was a decline in in-hospital mortality down to an age group of 50–59 years (9%). During the age groups of 60–79, in-hospital mortality

**Figure 2** Relative risk of heart failure hospitalization per 1000 inhabitants in men in comparison with women in consecutive years in Poland (2010–2019).



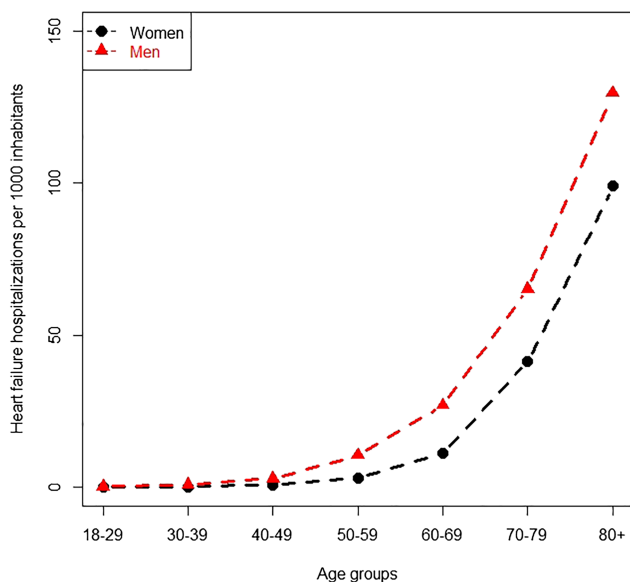
during HF hospitalization was similar for both genders (11%), which was followed by a marked increase up to ~19% in men and women aged  $\geq 80$  years (Figure 6).

Detailed trends of in-hospital mortality during HF hospitalization separately for gender and age groups in subsequent years are shown in Figure S2 with statistics presented in Tables S2 and S3. During 2010–2019 in Poland, three factors (consecutive years, gender, and age groups) have been shown to significantly differentiate the reported in-hospital mortality during HF hospitalization, with age groups having the greatest differentiating impact on in-hospital mortality during HF hospitalization.

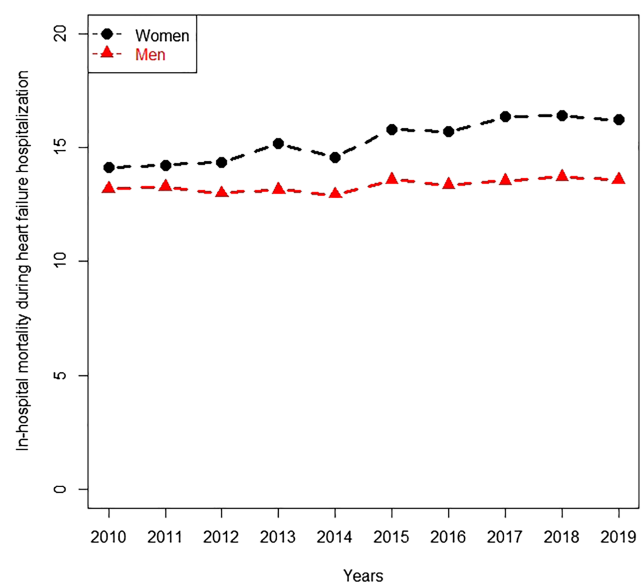
### Discussion

On the basis of contemporary and comprehensive data, we have demonstrated that HF hospitalization rate and related in-hospital mortality have been growing in both men and women over the last decade in Poland. The provided report identifies HF as a significant burden for public health care system in Poland. We have demonstrated gender differences in these epidemiological patterns; increasing numbers of HF hospitalizations are more pronounced among men, whereas growing in-hospital mortality during HF hospitalization is more pronounced in women. Importantly, older groups are

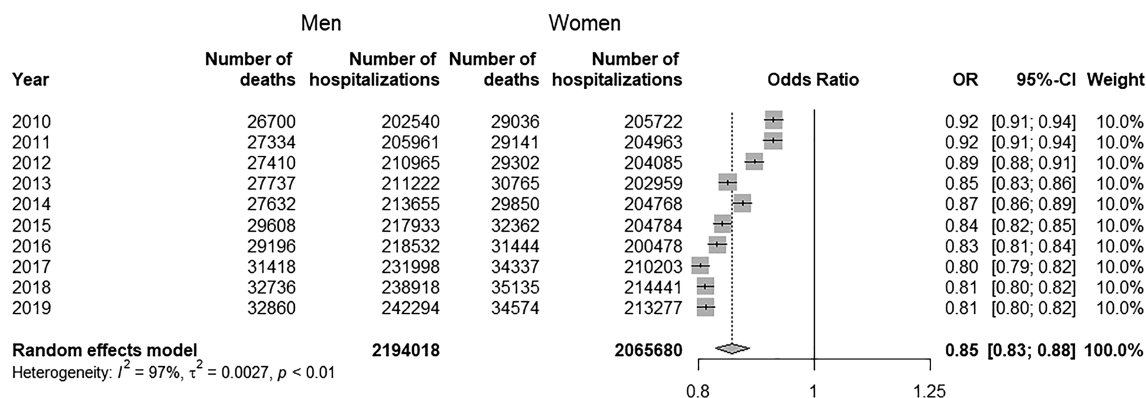
**Figure 3** Heart failure hospitalizations per 1000 inhabitants by gender and age groups in Poland (2010–2019).



**Figure 4** In-hospital mortality during heart failure hospitalization by gender in consecutive years in Poland (2010–2019).



**Figure 5** Relative risk of in-hospital mortality during heart failure hospitalization in men in comparison with women in consecutive years in Poland (2010–2019).



characterized by the highest numbers of HF hospitalizations per 1000 inhabitants and related in-hospital mortality.

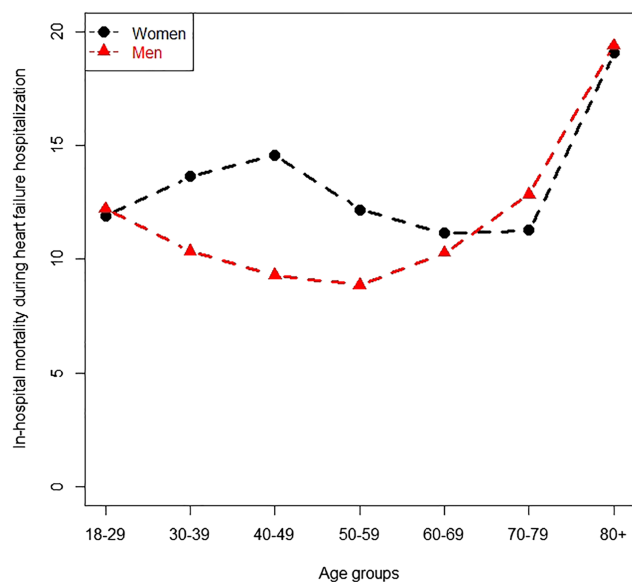
There is scarce evidence on HF hospitalization rates and in-hospital mortality in European countries. Available few studies have focused mainly on prevalence, incidence, and survival in HF.<sup>12,13</sup> Those describing HF hospitalization rates and/or in-hospital mortality are already outdated or consider small groups of patients with HF.<sup>14,15,18,26–29</sup> Such an example could be an analysis performed by Omersa *et al.* demonstrating 8 year trends in HF hospitalization rates in Slovenia with 2 million inhabitants; however, presented data referred to years 2004–2012 and therefore had to be interpreted with caution, as they might be already obsolete.<sup>30</sup> Our report

reveals data on 10 year trends in all HF hospitalizations and related in-hospital mortality in the whole adult Polish population (about 31 million inhabitants aged >17 years), which covers virtually all events reported in the national database from NFH. Thus, we believe that our analysis can significantly contribute to better understanding of actual HF epidemiology in central Europe.

In our report, in-hospital mortality during the HF hospitalization was relatively high (~14%) in Poland during 2010–2019. It might be assessed in the context of data from Spain collected almost 10 years ago (2003–2013), where in-patient mortality was estimated at 9%.<sup>26,27</sup> It should be remembered, that during recent decades the clinical profile of patients has significantly changed. Contemporary cohorts of patients with HF worldwide include more elderly subjects with numerous cardiovascular and non-cardiovascular comorbidities, which most likely translates into higher rates of HF hospitalizations and increased in-hospital mortality. Our findings have been confirmed by Niedziela *et al.* who demonstrated crude 14% in-hospital mortality in patients hospitalized due to HF in a regional cohort of 3.8 million adult population of Silesia (a region in Poland) between 2010 and 2016. Importantly, after adjustment for gender and age, they described a decrease in in-hospital mortality rates from 17.2% in 2010 to 11.5% in 2016.<sup>18</sup>

In our study, beyond secular trends in analysed epidemiological indices, the age itself appeared to be at very strong factor influencing and differentiating both HF hospitalization rate and in-hospital mortality in contemporary cohort of patients with HF. Older patients, particularly those aged ≥80 years, demonstrated the highest rate of HF hospitalizations (129 and 99 for men and women in 2019), and these hospitalizations were characterized by the highest in-hospital mortality (19%). Gasso *et al.*, who analysed a cohort of patients with HF from Region of Murcia (Spain) between 2003 and 2013, also described a sustained increase

**Figure 6** In-hospital mortality during heart failure hospitalizations by gender and age groups in Poland (2010–2019).



in standardized rates of HF hospitalizations in elderly patients (aged  $\geq 75$  years) who also had numerous concomitant comorbidities.<sup>26</sup> The already outdated report from the Swedish population (1990–2007) also demonstrated a substantial 77% increase in HF hospitalization rate in patients aged 85–99 years, which was consistent with demographic changes.<sup>28</sup> Aging and its consequences are becoming currently the challenges of contemporary societies and public health systems.<sup>31–33</sup> Secular trends in the age distribution in Poland are most likely responsible for the increase of HF hospitalizations in the recent decade. In the pathophysiological context, frailty and multimorbidity accompanying aging clearly predispose to circulatory decompensations. But also owing to an increasing number of elderly patients, the established public system for outpatient care in Poland is becoming highly inefficient, resulting in suboptimal care (lack of optimization of guideline recommended therapies and lack of education of patients and their caregivers) and not being able to prevent hospitalizations. Therefore, there is no doubt that there is an urgent call for action to establish strategies of HF management including the dedicated support to elderly patients, which are the most vulnerable part of the entire contemporary cohort. Public health care systems need to be adjusted to offer the elderly patients with HF the adequate inpatient and outpatient services.<sup>34</sup>

Importantly, we found gender differences regarding epidemiological patterns of HF hospitalizations and related in-hospital mortality in contemporary Poland. The risk of being hospitalized for HF was greater in men than in women, and this gender gradient increased during the recent decade. Our study confirmed the recent findings from France and Sweden regarding male dominance among patients admitted to hospital with HF<sup>28,35</sup> but was in contrast to more distant papers reporting epidemiological status in Slovenian (2004–2012) and Spanish registries (2003–2013).<sup>26,30</sup> This might be due to the increasing prevalence of men among patients with HF in recent years. Indeed, in 2010 in Poland, there was a balance distribution of women and men hospitalized owing to HF, whereas already in 2019, men constituted the majority of hospitalized subjects (52%). A similar pattern was already seen in Sweden in 2005.<sup>28</sup>

There are established gender differences in epidemiology and risk profiles in patients with HF.<sup>36</sup> There are several concepts explaining these differences, including sex hormone influences on myocardium and the whole organism,<sup>37,38</sup> the different profiles of HF, different aetiologies and associated co-morbidities occurring in men and women with HF,<sup>36,39</sup> and social-related and self-behaviour-related factors resulting in diversities in administered therapies and compliance.<sup>40,41</sup> The observed higher HF hospitalization rates in men than in women (regardless of age groups) may be due to the fact that HF symptoms are more specific in men, and there is a greater awareness of heart disease in men. The majority of men have HF with reduced ejection

fraction and HF with mid-range ejection fraction, and ischaemic aetiology usually predominates<sup>39</sup>—these are clinical features predisposing to recurrent cardiovascular hospitalizations.<sup>36</sup> Higher in-hospital mortality in women may be due to the greater delay in admission to hospitals in women owing to less specific symptoms. Also, the background HF therapy is less optimal in women than men (less effective neurohormonal blockade regarding the classes of drugs and administered doses).<sup>41</sup> The prevalence of co-morbidities known to increase mortality (diabetes, valve disease, depression, atrial fibrillation, anaemia, iron deficiency, renal disease, and frailty) is higher in women than in men.<sup>36,39</sup> Importantly, potential sex differences in HF characteristic and risk profiles may be even underestimated owing to the underrepresentation of women in cardiovascular research and studies.

It needs to be acknowledged that in our report HF hospitalizations were recognized using ICD-10 codes only, and there was no alternative verification of the diagnosis of HF. Owing to lack of other clinical and demographic data, no detailed characteristics of studied population were possible, including plasma N-terminal pro-brain natriuretic peptide and echocardiographic findings (such as left ventricular ejection fraction). However, all ICD-10 codes linked with different types of HF were included in the analyses.

When interpreting the data, we need to be aware of the risk of overusing the ICD-10 codes identifying HF, as the diagnosis of HF affects the reimbursement level by the NHF. On the other hand, there is also a risk that some patients with HF were not identified, when other codes were prioritized when reporting other major diseases and/or specific procedures.

## Conclusions

We have observed steady growing trends in HF hospitalization rates and related in-hospital mortality in Poland over the last decade. Two factors (age and gender) have been shown to significantly differentiate the reported epidemiological patterns. This study depicts HF as a tremendous burden in contemporary Poland. This information cannot be ignored by clinician, researchers, and first of all by managers and policymakers, who need to take into account these numbers when allocating funds for prevention, diagnosis, and treatment of HF on the national level. The global problem of increasing HF hospitalizations in Poland requires the synchronized changes in the whole public health care system. Clinicians require regular education in order to implement guideline recommended therapies, which has been shown to reduce the burden of HF hospitalizations. The comprehensive care of HF patients must be perceived as a team work, involving well-educated and encouraged cardiologists, general practitioners, geriatricians, nurses, physiotherapists, dieticians, psychologist, and social care workers, to name but a

few. Importantly, the emphasis should be laid on the measures that can prevent HF hospitalizations, such as screening programmes for HF,<sup>42</sup> an optimization and investments in outpatient care (both general practitioners and cardiologists), the networking between wards of different reference level, and the education and support for patients and their caregivers. All these and other ideas have been formulated in the programme ‘Comprehensive Heart Failure Care’ developed by Polish Cardiac Society, which is expected to launch its pilot phase.<sup>43</sup>

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## Conflict of interest

All authors declare no potential conflicts of interest.

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## Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

**Table S1** Raw numbers of heart failure hospitalisations and in-hospital deaths during heart failure hospitalisation by gender in consecutive years in Poland (2010–2019).

**Table S2.** Gradients between subsequent 10 years for heart failure hospitalisations per 1000 inhabitants and in-hospital mortality during heart failure hospitalisation by gender in subsequent age groups (Poland, 2010–2019).

**Table S3.** Gradients between subsequent 7 age groups for heart failure hospitalisations per 1000 inhabitants and in-hospital mortality during heart failure hospitalisations by gender in subsequent years of this report (Poland, 2010–2019).

**Figure S1.** Heart failure hospitalisations per 1000 inhabitants by gender and age groups in consecutive years in Poland (2010–2019).

**Figure S2.** In-hospital mortality rates during heart failure hospitalisation by gender and age groups in consecutive years in Poland (2010–2019).

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