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Secular Trends in Prevalence of Heart Failure Diagnosis over 20 Years (from the US NHANES)

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Heart failure (HF) is a well-recognized global public health problem with a diverse natural history and negative quality-of-life effects.[1] The definition of HF has also changed, covering an increasingly broad clinical condition and phenotypic spectrum of patients.[2] Previous projections suggested a substantial increase in HF prevalence by the year 2030 for patients of all ages[3] and increasing trends of predicted risk for HF development.[4] However, it is unknown to what extent the evolution of definition criteria, availability of effective prevention strategies, improved survival rates, aging of populations, and changes in epidemiology of cardiovascular risk factors and coronary heart disease (CHD) over the last 20 years have affected HF prevalence in the United States. We examined secular trends in a serial cross-sectional study cohort of the US National Health and Nutrition Examination Survey (NHANES).[5]

We considered adults in NHANES between 1999 and 2018 with available information on HF diagnosis and the relevant medical conditions of CHD and myocardial infarction at each 2-year survey cycle. The information of interest was self-reported according to predefined questionnaires.[3] We gathered information on age and sex and investigated the secular change in HF prevalence by calculating age- and sex-adjusted prevalence rates of HF for each 2-year survey cycle. We calculated the prevalence of HF for each NHANES cycle using survey-weighted methods.[6] Linear and restricted cubic spline meta-regression models were used to examine the secular trends over time (using survey cycles) while controlling for CHD prevalence as the main cause of HF in adults. Myocardial infarction was not considered in the models because of multicollinearity with the CHD variable. All analyses were conducted with R, version 4.0.2 (R Foundation, Vienna, Austria).

An unweighted total of 53,409 subjects (27,802 women, 25,607 men) over 10 survey cycles with available information on previously medically diagnosed HF were included in our analysis. Overall, 1,834 NHANES participants across all survey cycles reported HF (832 women, 1,002 men) Table 1. displays the range of prevalence estimates in subgroups. The HF prevalence remained relatively stable over the 20-year period and ranged from 1.9% to 2.6%, 1.6% to 2.9%, and 2.0% to 2.9% for all subjects, women, and men, respectively, without evident secular trend (Table 1, Figure 1). In ≥65-year-old subjects, the HF prevalence was considerably higher, with a wider range of estimates of 5.5% to

10.4%, 4.7% to 10.8%, and 6.2% to 12.2% for all subjects, women, and men, respectively. The HF prevalence increased sharply during the survey cycles from 1999 to 2004 in all subjects (5.5% to 9.8%), women (4.9% to 8.0%), and men (6.2% to 12.2%), with p <0.05 for all changes in the slope (Table 1). After 2004, the same subgroups followed a similar pattern without pronounced variation in prevalence estimates, but with a trend toward lower values. By 2017 to 2018, the prevalence decreased to 6.4%, 5.7%, and 7.3%, respectively (Figure 1). The meta-regression model indicated stable HF prevalence over 20 years for younger subjects (<65-years-old). The sample sizes in each cycle were different, and the precision of HF prevalence estimates was not homogeneously distributed along the entire range of subgroup sizes (Figure 1). The higher prevalence estimate variability per cycle pertained to the older subjects for whom small-sized subgroups and less precise estimates were available.

Overall, despite population aging and increasing broadness of HF definition over time, we found a relatively stable HF prevalence in NHANES over the 20-year period (1999 to 2018), with a change of <5% in prevalence across all cycles and subgroups. A sharp increase in HF prevalence was observed in older subjects in between 1999-2004, which was diminished in the subsequent years. This analysis is limited to self-reported medical conditions, which prevented us from further distinguishing HF phenotypes and separately examining potential differential trends in the prevalence of those phenotypes. Although our findings do not validate previous projections from 2013,[3] they are in concordance with age- and sex-standardized estimates of HF prevalence in other countries with increasing absolute HF burden, such as the United Kingdom.[7] The advantage of the prevalence estimates presented here includes the representativeness of the US NHANES. The present analysis calls into question whether the observed relatively stable HF prevalence pattern is the result of the evolved HF definition, population aging, and improved control of cardiovascular risk factors evident at the population level in the United States.[8,9]

Disclosures

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Data are publicly available and code can be provided by the authors upon request. All authors had access to the data and a role in writing the manuscript. The National Center for Health Statistics Research Ethics Review Board approved NHANES.

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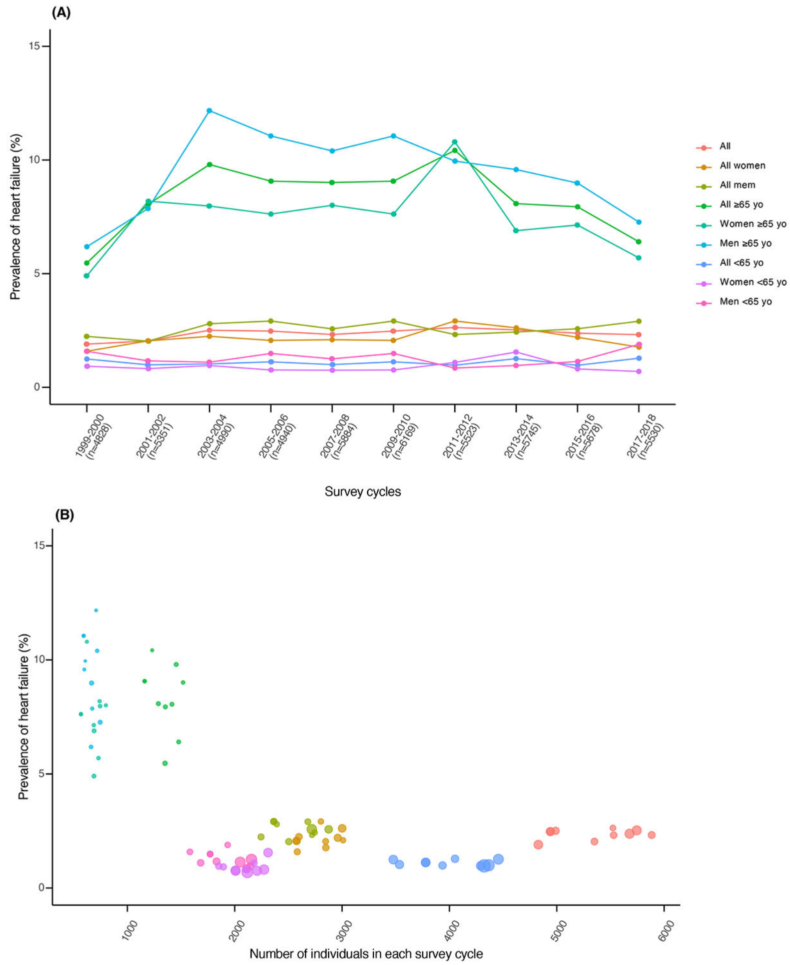

Figure 1.

Heart failure prevalence in NHANES over a 20-year period. (A) Changes in prevalence of heart failure stratified by sex and age in NHANES cohort from 1999 to 2018. In parentheses is indicated the total number of subjects in each survey cycle. (B) Distribution of heart failure prevalence and number of subjects included in each survey cycle; the area of each cycle is proportional to the precision (inverse of the variance) of the prevalence estimate in each cycle and subgroup. The colors correspond to the groups indicated in (A).

Table 1

Range of prevalence estimates of heart failure among sex-/age-subgroups across all survey cycles 1999–2018 and meta-regression estimates for the time of cycle-survey

		Prevalence of heart failure (%)		Meta-regression				
				Linear model		Restricted cubic splines		
	Number of individuals / Number of cases	**Range (min – max)**	**Median (IQR)**	**Estimate (95%CI)**	***P* value**	**Splines**	**Estimate (95%CI)**	***P* value**
All individuals	53409 / 1834	1.9 – 2.6	2.4 (2.3 – 2.5)	0.04 (−0.02 – 0.10)	0.187	1	0.13 (−0.04 – 0.31)	0.129
						2	−0.10 (−1.58 – 1.39)	0.898
						3	−0.03 (−4.06 – 4.00)	0.989
All women	27802 / 832	1.6 – 2.9	2.1 (2.1 – 2.2)	0.02 (−0.05 – 0.10)	0.548	1	0.13 (−0.12 – 0.38)	0.305
						2	0.31 (−1.49 – 2.10)	0.736
						3	−1.27 (−6.01 – 3.48)	0.602
All men	25607 / 1002	2.0 – 2.9	2.6 (2.4 – 2.9)	0.03 (−0.04 – 0.09)	0.395	1	0.11 (−0.12 – 0.34)	0.330
						2	−0.15 (−2.16 – 1.87)	0.886
						3	0.20 (−5.28 – 5.68)	0.942
All ≥65 yo	13414 / 1219	5.5 – 10.4	8.5 (8.0 – 9.1)	−0.06 (−0.33 – 0.22)	0.675	1	0.74 (0.02 – 1.45)	0.044
						2	−1.74 (−7.90 – 4.41)	0.579
						3	2.80 (−13.8 – 19.4)	0.741
Women ≥65 yo	6844 / 569	4.7 – 10.8	7.6 (7.0 – 8.0)	0.03 (−0.31 – 0.38)	0.850	1	0.88 (0.06 – 1.71)	0.035
						2	−2.28 (−9.45 – 4.89)	0.532
						3	4.09 (−15.2 – 23.4)	0.678
Men ≥65 yo	6570 / 650	6.2 – 12.2	9.8 (8.1 – 10.9)	−0.11 (−0.51 – 0.30)	0.599	1	1.13 (0.01 – 2.25)	0.048
						2	−1.91 (−11.1 – 7.29)	0.684
						3	2.47 (−22.2 – 27.1)	0.844
All <65 yo	39995 / 615	1.0 – 1.3	1.1 (1.0 – 1.2)	0.01 (−0.04 – 0.06)	0.666	1	−0.02 (−0.16 – 0.11)	0.723
						2	0.48 (−0.64 – 1.61)	0.402
						3	−1.31 (−4.42 – 1.80)	0.408
Women <65 yo	20958 / 263	0.7 – 1.6	0.8 (0.8 – 0.9)	0.00 (−0.07 – 0.06)	0.973	1	−0.02 (−0.24 – 0.20)	0.875
						2	0.81 (−0.68 – 2.31)	0.287
						3	−2.34 (−6.31 – 1.64)	0.249

		Prevalence of heart failure (%)		Meta-regression				
				Linear model		Restricted cubic splines		
	Number of individuals / Number of cases	Range (min – max)	Median (IQR)	Estimate (95%CI)	*P* value	Splines	Estimate (95%CI)	*P* value
Men <65 yo	19037 / 352	0.8 – 1.9	1.2 (1.1 – 1.5)	0.04 (−0.04 – 0.12)	0.377	1	0.01 (−0.17 – 0.19)	0.892
						2	0.01 (−1.83 – 1.84)	0.996
						3	0.05 (−5.02 – 5.11)	0.986