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LETTERS TO THE EDITORS

Regional and seasonal variations in heart failure admissions and mortality in the USA

Variations saisonnières et régionales des admissions et de la mortalité pour insuffisance cardiaque aux États-Unis

Keywords Seasonal variations; Region in USA; Heart failure; Readmission; Mortality
Mots clés Variations saisonnières ; Régions des États-Unis ; Insuffisance cardiaque ; Admissions ; Mortalité

Seasonal variations in the incidence of angina [1] and acute myocardial infarction are well-known entities [2—6], with higher incidences noted in winter months. Seasonal variation has also been observed for sudden cardiac death [7]. Seasonal variation in heart failure (HF) has been studied in Scotland [8], France [9], Canada [10], Nigeria [11], Bangladesh [12] and Israel [13]. Increased numbers of HF admissions and higher mortality were noted in cooler seasons. European authors from Italy [14] and Spain [15] have reported similar findings. In contrast, a study involving 16,147 patients in China reported an increase in HF admissions in both summer and winter, compared with autumn and spring [16].

Although studied in several countries worldwide, the effects of regional and seasonal variations in HF admissions and mortality across the USA have not been well described. We sought to determine if regional and seasonal variability in HF admissions and mortality exists in the USA, as well as the possible factors influencing these variations. We used the National Inpatient Sample from the National Institutes of Health, which collects data from the entire USA. Primary HF hospitalizations from 1 January 2005 to 31 December 2014 in the database were analysed to determine seasonal and yearly trends in HF admissions and mortality, after excluding

Table 1 Baseline characteristics and hospital mortality among heart failure admissions according to region.

	Northeast	Midwest	South	West	*P*
Age (years)	74.4 ± 13.8	73.4 ± 14.1	70.8 ± 14.6	71.8 ± 14.9	< 0.001
Women	50.3	51.2	50.2	47.6	< 0.001
Race					
White	71.8	76.2	63.3	61.6	< 0.001
African American	17.0	18.7	25.9	11.2	< 0.001
Obesity[a]	11.4	15.1	15.2	14.8	< 0.001
Hypertension[b]	65.0	64.9	64.7	63.5	< 0.001
Diabetes mellitus	42.1	43.3	44.0	42.9	< 0.001
Dyslipidaemia	35.6	38.9	35.6	37.2	< 0.001
Chronic pulmonary disease	35.3	38.0	36.8	34.5	< 0.001
Peripheral vascular disease	9.9	11.8	10.7	11.5	< 0.001
Renal failure	34.9	36.8	35.8	37.1	< 0.001
Atrial fibrillation or flutter	40.7	38.6	33.9	37.8	< 0.001
Acute myocardial infarction	4.9	4.7	4.6	5.1	< 0.001
Shock (presented with or developed)	1.2	1.1	1.1	1.6	< 0.001
Mean Elixhauser point-scale index[c]	2.98 ± 1.6	3.21 ± 1.7	3.12 ± 1.7	3.21 ± 1.75	< 0.001
Inhospital mortality	3.9	3.2	3.2	3.4	< 0.001

Data are expressed as mean ± standard deviation or %.
[a] Body mass index ≥ 30 kg/m^2.
[b] Blood pressure ≥ 140/90 mmHg.
[c] Elixhauser et al., 1998 [20].

Abbreviation: HF, heart failure.

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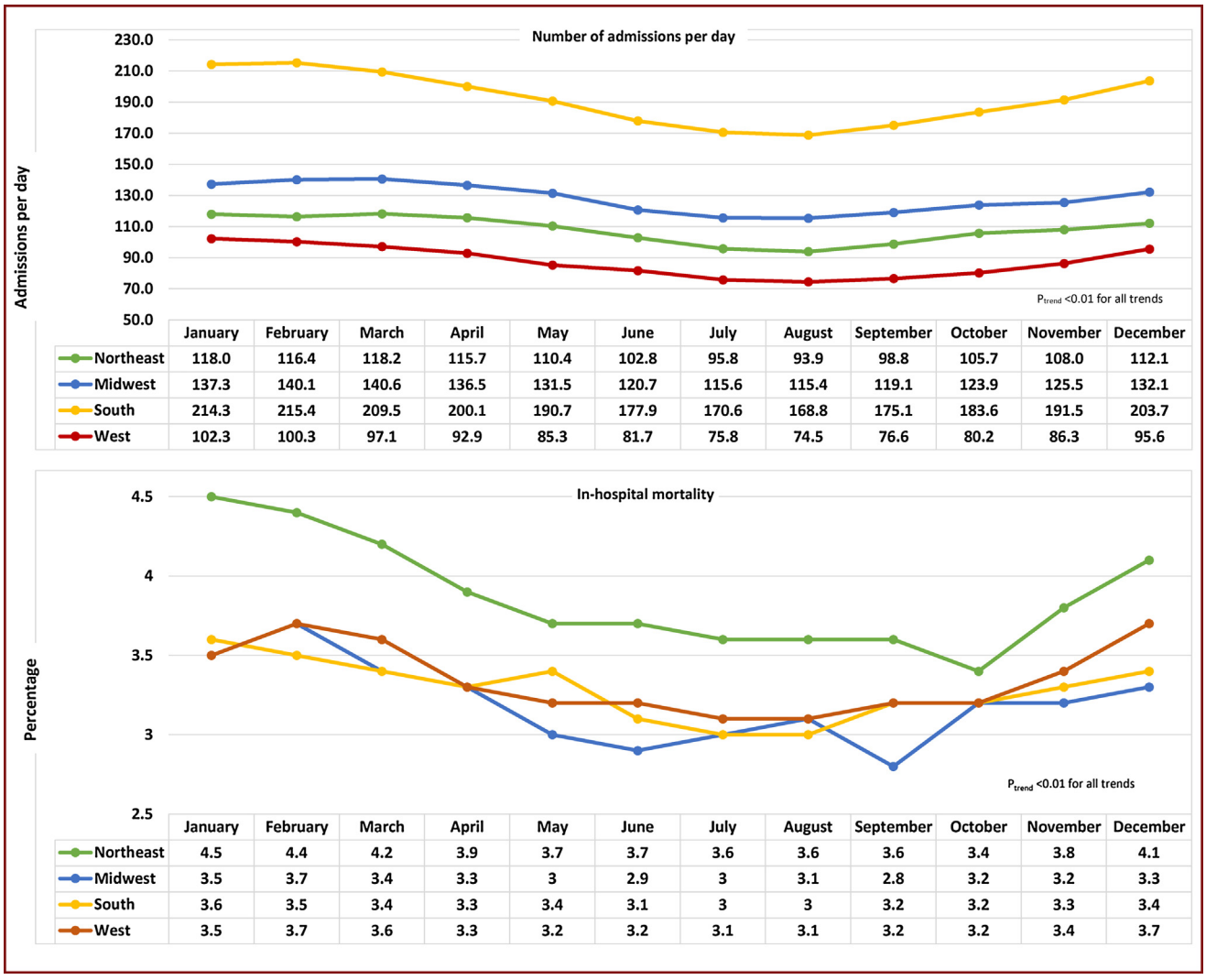

	January	February	March	April	May	June	July	August	September	October	November	December
Northeast	118.0	116.4	118.2	115.7	110.4	102.8	95.8	93.9	98.8	105.7	108.0	112.1
Midwest	137.3	140.1	140.6	136.5	131.5	120.7	115.6	115.4	119.1	123.9	125.5	132.1
South	214.3	215.4	209.5	200.1	190.7	177.9	170.6	168.8	175.1	183.6	191.5	203.7
West	102.3	100.3	97.1	92.9	85.3	81.7	75.8	74.5	76.6	80.2	86.3	95.6

	January	February	March	April	May	June	July	August	September	October	November	December
Northeast	4.5	4.4	4.2	3.9	3.7	3.7	3.6	3.6	3.6	3.4	3.8	4.1
Midwest	3.5	3.7	3.4	3.3	3	2.9	3	3.1	2.8	3.2	3.2	3.3
South	3.6	3.5	3.4	3.3	3.4	3.1	3	3	3.2	3.2	3.3	3.4
West	3.5	3.7	3.6	3.3	3.2	3.2	3.1	3.1	3.2	3.2	3.4	3.7

Figure 1. Heart failure admissions per day and inhospital mortality trends in the different US regions according to month of admission.

patients aged < 18 years and those transferred out. Comparisons were made between four regions:

- Northeast;
- Midwest;
- South;
- West [17].

Trend analysis was performed using the Mantel–Haenszel test of linear association or the analysis of variance test for categorical and continuous variables, respectively. Fisher's exact test or Pearson's χ^2 test and Student's t test were used for analysis of categorical and continuous variables, respectively. Admission rate per day for any given month was calculated as the total regional admissions during that month divided by the total number of days in the month, over 10 years. SPSS statistics software, version 23.0 (IBM, Armonk, NY, USA) was used to perform data analysis. A P value < 0.05 was used to infer statistical significance.

A total of 2,024,868 admissions were included: 49.9% were men and 50.1% were women; 56.8% were white, 17.0% were African American, 6.7% were Hispanic and the remainder belonged to other races or was unspecified. Between 2005 and 2014, there was an overall downtrend in the number of patients admitted with HF (from 231,080 to 152,304 admissions; $P < 0.001$), which was consistent across all regions. Within our sample size, 41.6% of admissions were from the South, followed by the Midwest (23.1%), the Northeast (19.5%) and the West (15.7%). The mean age was 72.2 ± 14.5 years at admission. The mean length of stay was 5.19 ± 5.65 days. Baseline characteristics of the study population are shown in Table 1. Overall, maximum HF admissions per day were observed in February, whereas the lowest numbers of admissions per day were seen in August (Fig. 1). Within individual regions, the highest numbers of total admissions were noted in January (Northeast, South and West) and March (Midwest), whereas the lowest numbers of total admissions were noted either in August (Northeast and South) or in September (Midwest and West), as seen in Fig. 2. This peak in admissions during the winter and the trough during the summer was seen in the trends across all four regions. Regional trends indicate that the peak admission rate during winter was most markedly increased in the West, where a 37.3% relative increase in admission rates was noted in January from its lowest point in August, followed by the South

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