

Economic Burden Associated with Systemic Inflammation in Patients with Established Atherosclerotic Cardiovascular Disease and Stage 3-4 Chronic Kidney Disease

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Objective

To assess the association between systemic inflammation (SI) and economic burden in patients with established atherosclerotic cardiovascular disease (ASCVD) and stage 3-4 chronic kidney disease (CKD)

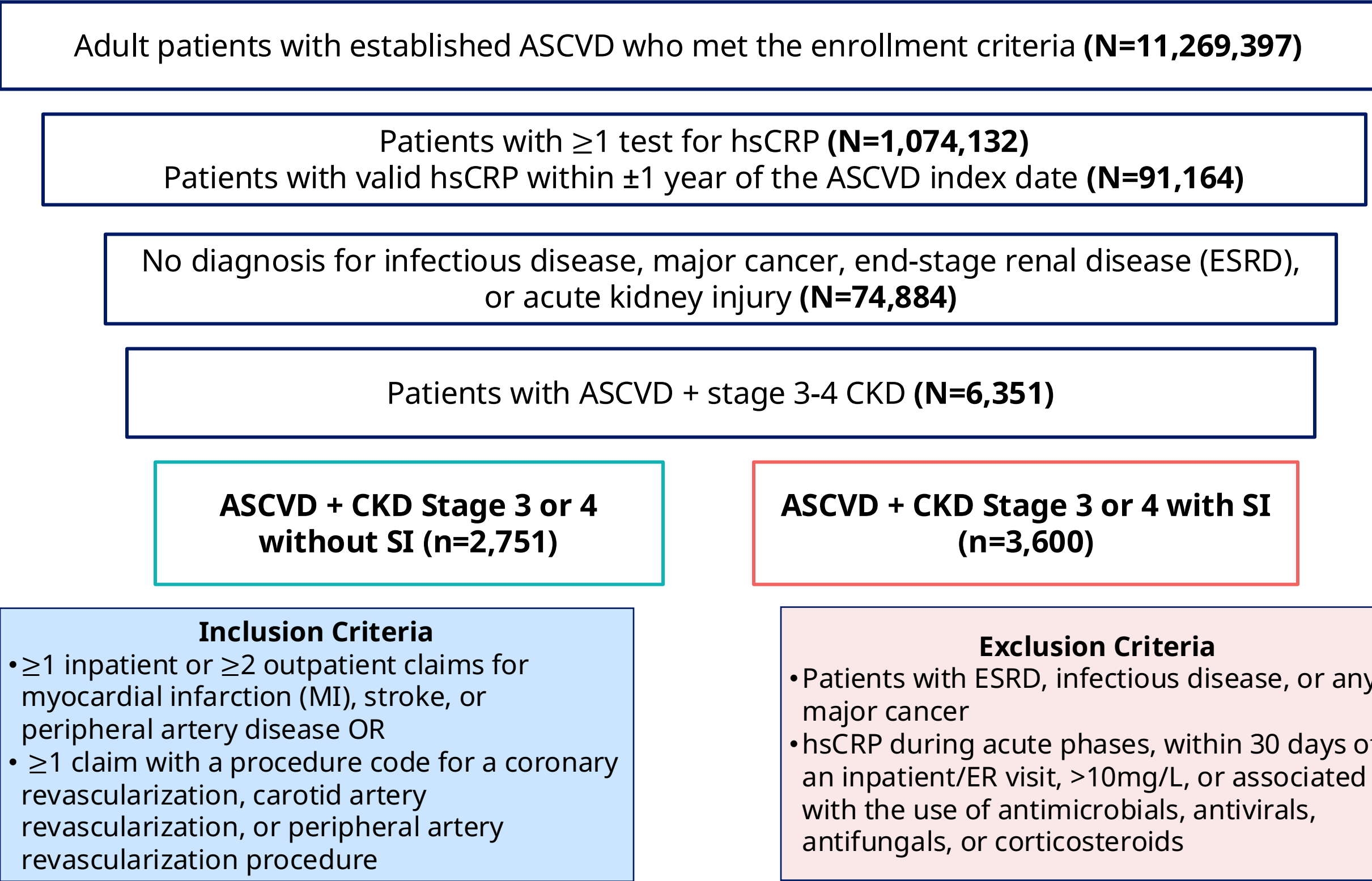
Introduction

- ASCVD is a leading cause of morbidity and mortality in the United States, affecting over 26 million people.¹
- SI plays a critical role in the pathogenesis, progression, and manifestation of ASCVD. SI is associated with an increased risk of subsequent major adverse cardiovascular events (MACE), even among patients receiving guideline-directed medical therapy.²
- Advanced CKD is associated with a persistent inflammatory burden. The prevalence of SI in patients with ASCVD is approximately 38% and higher in patients with ASCVD and stage 3-4 CKD (49-54%).³ Stage 3-4 CKD is defined as having a diagnosis of stage 3-4 CKD or having an estimated glomerular filtration rate (eGFR) between 15-59 mL/min/1.73m².
- However, the real-world economic burden of SI in patients with established ASCVD and stage 3-4 CKD is unclear.

Methods

- This retrospective study identified patients from the Komodo Healthcare Map (Jan 1, 2016 – Apr 30, 2024) based on diagnosis and procedure codes in medical claims (**Figure 1**).
- CKD and its stage were determined from medical claims or laboratory measurements of creatinine or eGFR within 1 year before or after the ASCVD index date.
- SI was defined using high-sensitivity C-reactive protein (hsCRP) results within 1 year before or after the ASCVD index date: with SI, ≥1 hsCRP value of 2-10 mg/L; without SI, all hsCRP values <2 mg/L (**Figure 1**).
- The study endpoints were healthcare resource utilization, reported as number of visits per-patient-per-year (PPPY), and healthcare costs reported in 2023 US dollars PPPY.
- Logistic regression and generalized linear models were used to examine the association of SI and healthcare utilization and costs, adjusting for baseline characteristics.

Figure 1: Patient selection flow chart



Results

Patient Baseline Characteristics

- A total of 6,351 patients with ASCVD + stage 3-4 CKD and a qualifying hsCRP were eligible for analysis.
 - Of the eligible patients, 3,600 (57%) had SI (**Table 1**).
 - The average follow-up was 38 months (**Table 1**).
- Compared to patients without SI, patients with SI were:
 - More likely to be female and to have comorbidities, including hypertension (74% vs 68%), type 2 diabetes (41% vs 34%), obesity (20% vs 13%), smoking (11% vs 9%), heart failure (9% vs 6%), and autoimmune disease (7% vs 5%) (**Table 1**).
 - More likely to use medications such as antihypertensives (79% vs 74%), cardiovascular medications (15% vs 13%), and glucagon-like peptide-1 receptor agonists (GLP-1 RAs) (29% vs 25%) (**Table 1**).
 - Less likely to use lipid lowering medications (58% vs 61%), including statins (53% vs 57%) (**Table 1**).

Table 1: Baseline characteristics

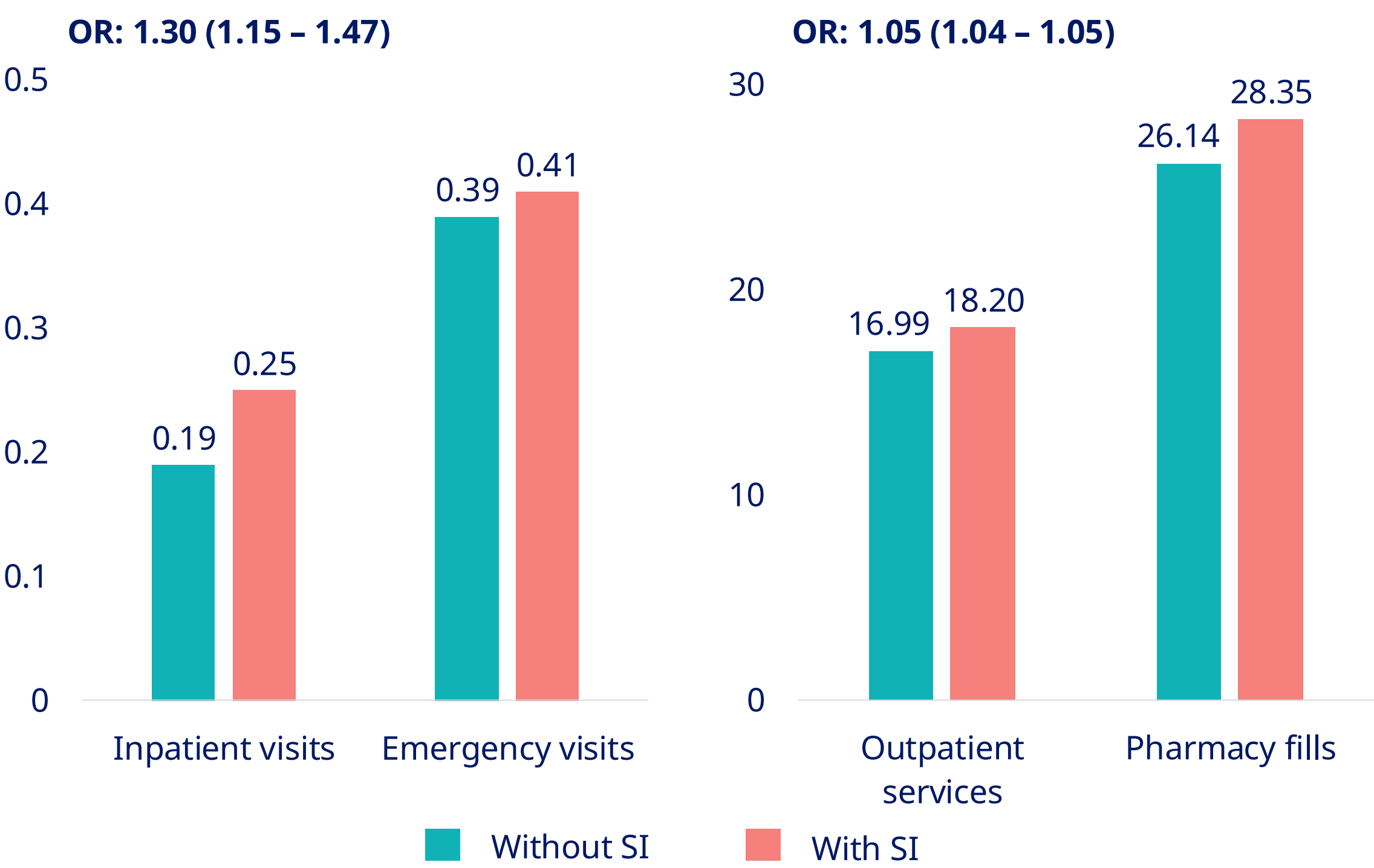
Baseline variable	Without SI (N=2,751)	With SI (N=3,600)	p-value
Length of follow-up in months, mean (SD)	37.7 (26.1)	37.7 (25.9)	0.90
Mean (SD) age, years	70.8 (9.5)	70.6 (9.6)	0.40
Sex, n (%)			<0.01
Male	1,352 (49)	1,462 (41)	
Female	1,300 (47)	2,047 (57)	
Unknown	99 (4)	91 (3)	
Quan-Charlson Comorbidity Index, mean (SD)	0.9 (1.2)	1.1 (1.3)	<0.01
Health plan type, n (%)			<0.01
Commercial	801 (29)	902 (25)	
Medicare	1,808 (66)	2,459 (68)	
Medicaid	140 (5)	236 (7)	
Baseline comorbidities, n (%)			
Hypertension	1,874 (68)	2,678 (74)	<0.01
Dyslipidemia	1,791 (65)	2,371 (66)	0.50
Type 2 diabetes	930 (34)	1,468 (41)	<0.01
Obesity	345 (13)	727 (20)	<0.01
Atrial fibrillation	262 (10)	349 (10)	0.80
Smoking	236 (9)	383 (11)	<0.01
Heart failure	159 (6)	321 (9)	<0.01
Autoimmune disease	136 (5)	243 (7)	<0.01
Baseline medication use, n (%)			
Antihypertensives	2,039 (74)	2,840 (79)	<0.01
Lipid-lowering medications	1,668 (61)	2,069 (58)	0.01
Statins	1,557 (57)	1,893 (53)	0.01
Antiplatelets	353 (13)	451 (13)	0.70
Cardiovascular medications	353 (13)	540 (15)	0.01
Immunosuppressants	441 (16)	636 (18)	0.09
NSAIDs	634 (23)	883 (25)	0.20
GLP-1 RAs	696 (25)	1,051 (29)	<0.01

All the baseline characteristics reported are 6 months prior to Index date (first diagnosis of ASCVD). Cardiovascular medications include anticoagulants, thrombolytics, vasodilators, and others. Abbreviations: GLP-1 RA, glucagon-like peptide-1 receptor agonist; NSAID, nonsteroidal anti-inflammatory drug; SD, standard deviation; SI, systemic inflammation.

Healthcare resource utilization (HCRU)

- During the follow-up, HCRU was higher in patients with SI compared to those without SI:
- SI was associated with higher inpatient visits (0.25 vs 0.19), outpatient services (18.20 vs 16.99), emergency visits (0.41 vs 0.39), and visits for pharmacy fills (28.35 vs 26.14) PPPY compared with patients without SI (**Figure 2**).
 - After adjusting for patient characteristics, SI was associated with a 30% increase (OR 1.30, 95% CI: 1.15-1.47) in inpatient admissions and a 5% increase (OR 1.05; 95% CI: 1.04-1.05) in outpatient services (**Figure 2**).

Figure 2: All-cause healthcare resource utilization



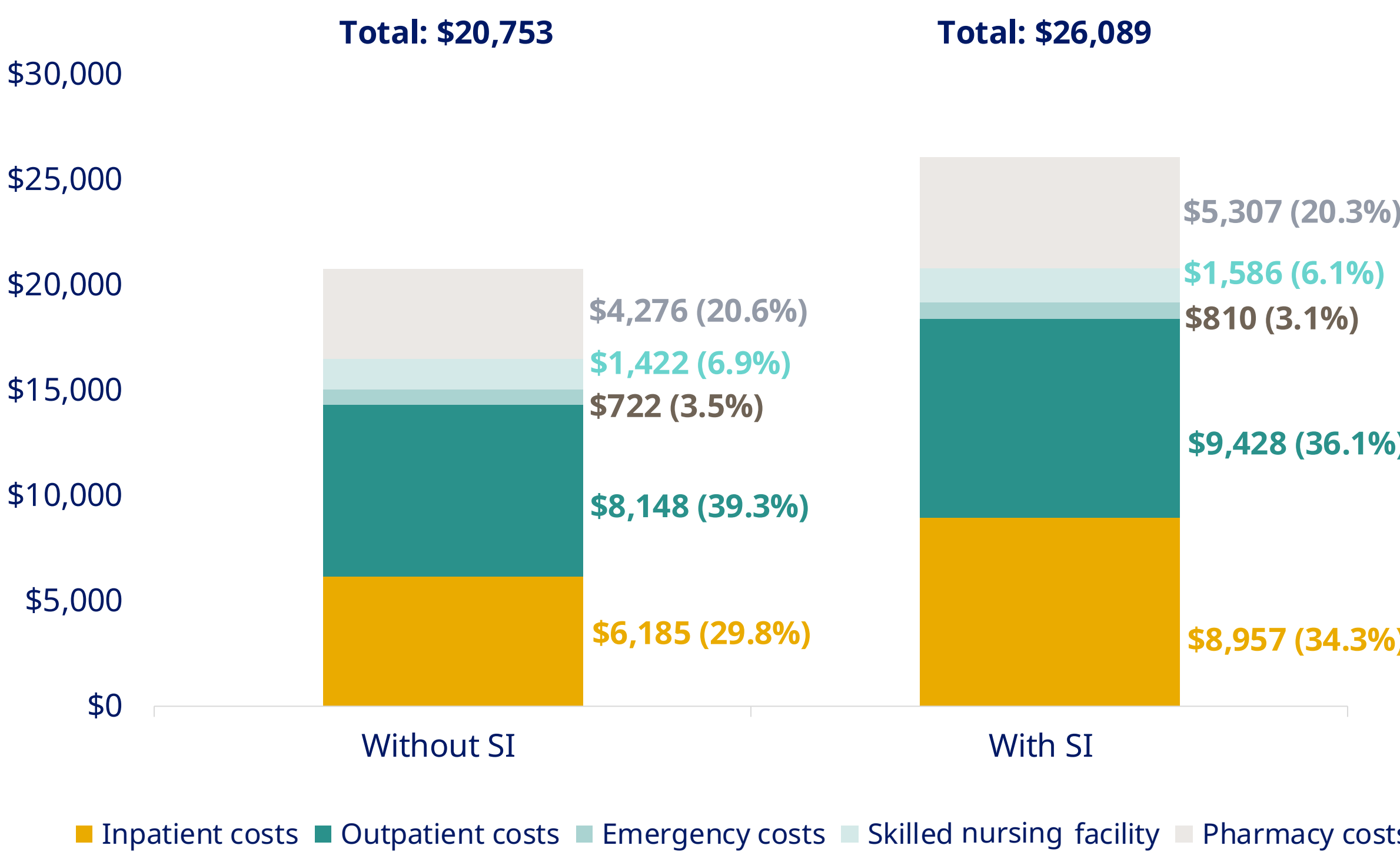
Healthcare costs

- The total all-cause healthcare cost PPPY was \$26,089 for those with SI and \$20,753 for those without SI (**Figure 3**).
 - Inpatient visits and outpatient services were the primary drivers of the total healthcare costs, accounting for approximately 70% of the overall costs incurred (**Figure 3**).
- After adjusting for patient characteristics and baseline costs, SI was associated with a 20% increase in total healthcare costs (p<0.01) (**Figure 4**).
 - SI was also significantly associated with increased hospitalization costs due to MI (p<0.01) and stroke (p<0.01) (**Figure 4**).

Limitations

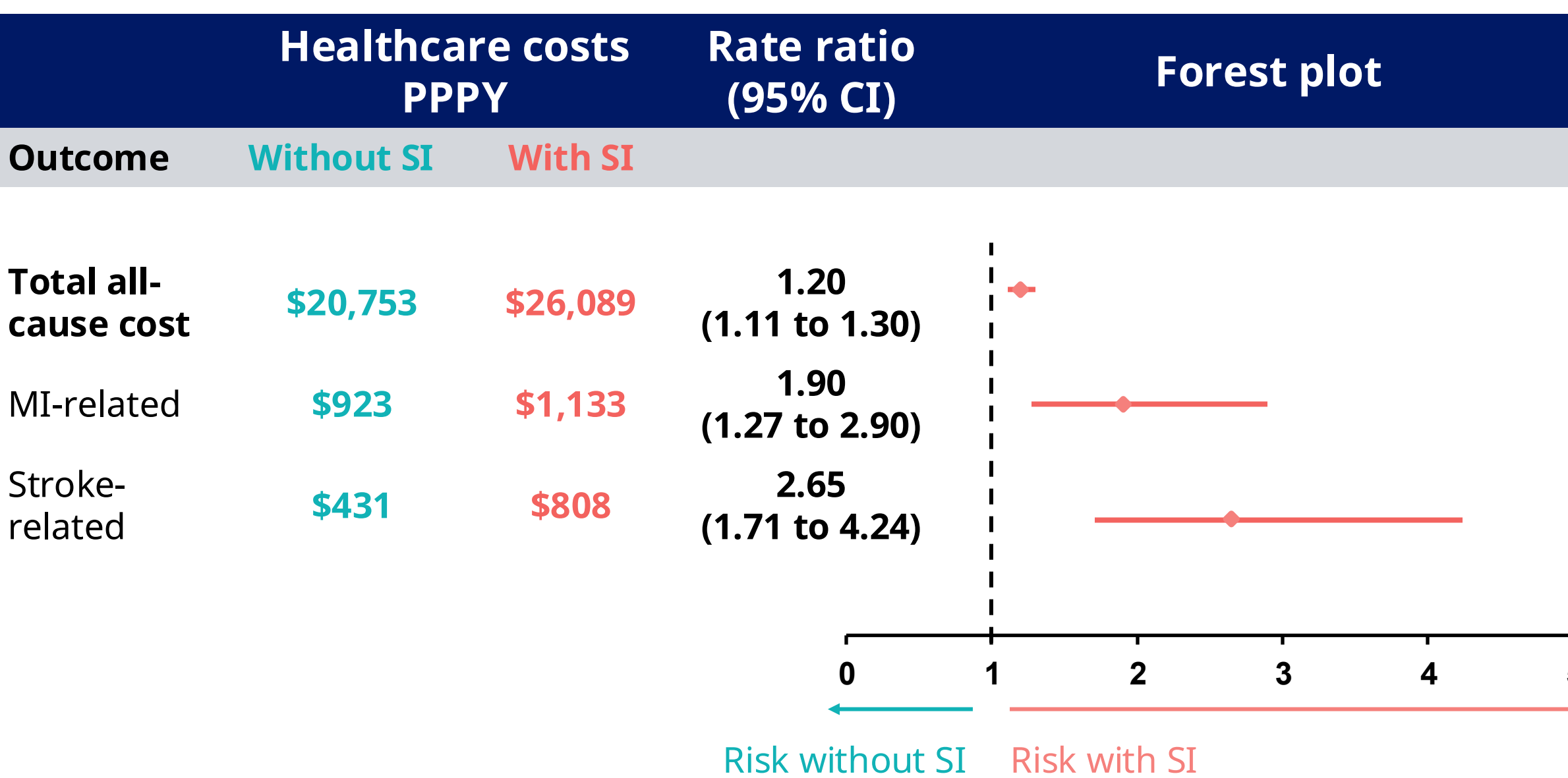
- The study was limited to patients with ASCVD and stage 3-4 CKD who were tested for hsCRP, with available test results; these patients may differ from the general population with ASCVD and stage 3-4 CKD.
- CKD may be underreported in administrative claims data, and laboratory data were only available for a subset of patients, potentially leading to misclassification of CKD stage 3-4.
- The healthcare cost data used in this analysis were imputed by Komodo based on publicly available Medicare fee-for-service pricing and actual allowed amounts in administrative claims. This method has shown that the annual total cost of care per patient falls within a defined range based on these benchmarks.⁴

Figure 3: All-cause healthcare costs (per-patient-per-year)



Costs are adjusted for 2023 US dollars based on US Consumer Price Index. Percentages may exceed 100% due to rounding. Total all-cause health care costs are calculated by adding inpatient, outpatient, skilled nursing facility, emergency, and pharmacy costs.

Figure 4: All-cause and MACE-related costs



Summary & Conclusions

- SI is associated with overall HCRU and costs in patients with ASCVD and stage 3-4 CKD.
- This study highlights the economic burden related to SI in this population and the need for intervention or better treatment options for this population.
- Optimized care could potentially reduce costs and overall HCRU.

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Abbreviations: ASCVD, atherosclerotic cardiovascular disease; CI, confidence interval; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; ER, emergency room; ESRD, end-stage renal disease; GLP-1 RAs, glucagon-like peptide-1 receptor agonists; HCRU, healthcare resource utilization; hsCRP, high-sensitivity C-reactive protein; MACE, major adverse cardiovascular event; MI, myocardial infarction; NSAID, nonsteroidal anti-inflammatory drug; OR, odds ratio; PPPY, per-patient-per-year; SD, standard deviation; SI, systemic inflammation.

References:
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