



Associations Between Sarcopenia, Heart Failure and Myocardial Infarction in Patients With Systemic Lupus Erythematosus and Rheumatoid Arthritis

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Specialty section:

This article was submitted to
Rheumatology,
a section of the journal
Frontiers in Medicine

Received: 24 February 2022

Accepted: 07 June 2022

Published: 28 June 2022

Citation:

Chang C-M, Lin J-R and Fu T-C
(2022) Associations Between
Sarcopenia, Heart Failure and
Myocardial Infarction in Patients With
Systemic Lupus Erythematosus and
Rheumatoid Arthritis.
Front. Med. 9:882911.
doi: 10.3389/fmed.2022.882911

Objectives: To evaluate associations between sarcopenia, type of autoimmune disease and risk of heart failure (HF) and myocardial infarction (MI) in patients with systemic lupus erythematosus (SLE) and rheumatoid arthritis (RA).

Methods: In this population-based, cross-sectional study, discharge data from the 2005–2014 US Nationwide Inpatient Sample (NIS) of hospitalized patients with SLE or RA were extracted and analyzed. Univariate and multivariable regression analyses were conducted to determine associations between sarcopenia, type of autoimmune disease and risk of HF/MI.

Results: After exclusions, 781,199 hospitalized patients diagnosed with SLE or RA were included. Among the study cohort, 127,812 (16.4%) were hospitalized with HF, and 12,781 (1.6%) were hospitalized with MI. Sarcopenia was found in only 0.1% of HF/MI patients. Logistic regression analyses revealed that sarcopenia was not significantly associated with presence of either HF or MI. Patients with RA had significantly lower odds of HF than SLE patients (aOR = 0.77, 95%CI: 0.76, 0.79) or MI (aOR = 0.86, 95%CI: 0.82, 0.91).

Conclusion: In the US, among hospitalized adults diagnosed with SLE or RA, patients with RA are significantly less likely to have HF or MI than those with SLE. Whether sarcopenia leads to increased HF or MI remains inconclusive. Further studies are warranted to investigate the pathophysiology underlying discrepancies between RA and SLE regarding risk for MI or HF.

Keywords: sarcopenia, heart failure, rheumatoid arthritis, SLE, myocardial infarction

INTRODUCTION

Systemic lupus erythematosus (SLE) and rheumatoid arthritis (RA) are relatively common autoimmune disorders in which the immune system selectively attacks certain healthy tissue in the body, affecting joints and muscles and causing persistent systemic inflammation, pain, reduced physical activity, extra-articular complications, loss of muscle mass and muscle strength, and altered body composition; together these complications lead to daily functional disability and reduced quality of life (1–4). Increased risk of cardiovascular diseases such as heart failure (HF), acute myocardial infarction (AMI), or atherosclerotic cardiovascular disease (ASCVD) were observed in patients with SLE (5–10). In addition, previous studies have shown that an excess burden of CVD in patients with RA is an established pattern (11, 12). However, no prior study directly compared the risk of HF or MI between patients with SLE vs. those with RA.

Previous studies on body composition have reported that sarcopenia is highly prevalent in HF patients, suggesting that it contributes to poor prognosis, and that age-related muscle decline may be the most critical contributor to reduced cardiorespiratory fitness in older adults with HF (13–15). Importantly, systemic inflammation may represent a risk for altered body composition. Women with SLE or RA are more likely to have an abnormal body composition phenotype, although differences exist between the two diseases (16). Other studies have also reported a higher prevalence of sarcopenia and sarcopenic obesity in RA patients (17, 18). However, more evidence is needed before consensus can be reached on the associations between sarcopenia, SLE and RA. Therefore, the present study aimed to evaluate the associations between sarcopenia, HF and MI and the relative risk of these diseases in patients with autoimmune SLE and RA.

MATERIALS AND METHODS

Study Design and Data Source

This population-based, cross-sectional study extracted data from the US Nationwide Inpatient Sample (NIS) database, which is the largest all-payer, inpatient care database in the US, including about 8 million hospital stays each year (19). The database is administered by the Healthcare Cost and Utilization Project (HCUP) of the US National Institutes of Health (NIH) and developed through a Federal-State-Industry partnership and sponsored by the Agency for Healthcare Research and Quality (AHRQ). All admitted patients are initially considered for inclusion. The continuous, annually updated NIS database derives patient data of about 1,050 hospitals from 44 States in the US, representing a 20% stratified sample of the US community hospitals as defined by the American Hospital Association.

Ethics Statement

All data were obtained through request to the Online HCUP Central Distributor (available at: <https://www.distributor.hcup-us.ahrq.gov/>), which administers the database (certificate # HCUP-833FWV78H). This study conforms to the NIS data-use agreement with HCUP. As this study analyzed secondary data

of the NIS database, patients' data were not used directly used. This study was approved by the Institutional Review Board of the Chang Gung Medical Hospital (202100234B0). As we conducted this retrospective analysis of the NHIRD and all the individual information were de-identified, we could not obtain informed consent from the recruited patients.

Study Population

Adults ≥ 20 years old admitted to US hospitals between 2005 and 2014 with a primary or secondary diagnosis of SLE or RA were identified in the NIS database through the International Classification of Diseases, Ninth Revision (ICD-9) diagnostic codes (code 710.0 or 714.0). Patients with congenital heart disease, asthma, HIV, heart surgery, and cancer were excluded. Patients with incomplete data for outcomes and main variables of interest were also excluded from the study cohort.

HF, MI, and Sarcopenia

HF was identified by ICD-9 code 428.x, which covered any type of HF regardless of ejection or reduced ejection fractions. MI was identified through code 410.x, which covered all types of MI. Since no unique code for "sarcopenia" is included in the ICD-9 coding system, sarcopenia was defined using the code 728.2x (muscular wasting and disuse atrophy) in accordance with a previous study (20).

Covariates

Patients' baseline characteristics included age, gender, race (ethnicity), household income level, insurance status (primary payer), admission type, smoking, alcohol consumption, diabetes, hypertension, and hyperlipidemia. In addition, hospital characteristics, including hospital bed size, location, hospital region, and length of stay, were also extracted from the database as part of the comprehensive data available for all patients in the NIS database. Length of stay is calculated by subtracting the admission date from the discharge date. Details on hospital characteristics are documented on the NIS webpage (https://www.hcup-us.ahrq.gov/db/vars/hosp_locteach/nisnote.jsp).

Statistical Analysis

Descriptive statistics of the patients are presented as unweighted counts (n) and weighted percentage (%) or mean \pm standard error (SE). Differences between the groups were evaluated using PROC SURVEYFREQ and SURVEYREG for analysis of categorical and continuous data. Logistic regression analysis was performed using PROC SURVEYLOGISTIC to determine factors associated with the presence of HF and MI. Variables that were significant in univariate regression analysis were adjusted in multivariable analysis. Since the NIS database covers 20% of samples of the USA annual inpatient admissions, weighted samples (DISCWT), stratum (NIS_STRATUM), cluster (HOSPID) were used to generate national estimates for all analyses. All p -values were two-sided and $p < 0.05$ was considered statistically significant. All statistical analyses were carried out with SAS 9.4. A two-tailed P -value < 0.05 was considered statistically significant.

RESULTS

Patient Selection and Study Cohort

The detailed patient selection process is shown in **Figure 1**. Data of 1,225,241 patients aged 20 years or older who were diagnosed with SLE, RA or both were extracted. After excluding patients with congenital heart diseases ($n = 3,906$), asthma ($n = 127,207$), HIV ($n = 1,334$), previous cardiac procedure ($n = 57,216$), cancer history ($n = 100,882$), and incomplete data ($n = 153,497$), finally 781,199 patients (representing 3,865,575 US inpatients) were included as the study cohort (**Figure 1**).

A total of 0.1% patients had sarcopenia, 25.6% had SLE alone, 71.2% had RA alone, and 3.2% had overlapping diagnoses between SLE and RA. Mean age was 63.2, and the majority of patients were female (79.1%), White (71.0%), non-smokers (99.9%) and did not consume alcohol (99.6%). Most patients were admitted emergently (77.8%), with income levels at the lowest quartile (29.6%), and insurance covered by Medicare/Medicaid (72.6%) (**Table 1**).

Characteristic of Patients With or Without HF

Characteristics of patients with or without HF are summarized in **Table 1**. Among all patients, 127,812 (16.4%) had HF and 653,387 (83.6%) did not. Patients with HF had higher proportions of sarcopenia (0.13% vs. 0.10%, p -value = 0.003) and RA (75.9% vs. 70.3%, $p < 0.001$) than those without HF. Also, HF patients were older (74.1 vs. 61.7 years, $p < 0.001$), stayed longer in the hospital (6.2 vs. 4.9 days, p -value < 0.001), included more males (24.7% vs. 20.2%), were White (71.8% vs. 70.8%) or Black race (18.2% vs. 15.4%), had lower household income (Q1:31.9% vs. 29.1%; Q2: 26.0% vs. 25.7%), insurance covered by Medicare/Medicaid (87.0% vs. 69.7%), emergent admission (89.0% vs. 75.6%), were non-drinkers (99.8% vs. 99.5%) and

had more diabetes, hypertension and hyperlipidemia (all p -value < 0.001) (**Table 1**).

Characteristics of Patients With or Without MI

Characteristics of patients with or without MI are summarized in **Table 2**. Among all patients, 12,781 (1.6%) had MI, and 768,418 (98.4%) did not. RA occurred more frequently in MI patients (79.6% vs. 71.1%, p -value < 0.001) than in those without MI. The incidence of sarcopenia was not significantly different between patients with or without MI (**Table 2**).

Prevalence of Sarcopenia in Patients With HF or MI, Stratified by SLE/RA Diagnosis

As shown in **Table 3**, prevalence of sarcopenia among HF patients was 0.1, 0.1, and 0.2% among patients diagnosed with SLE alone, RA alone, and both SLE and RA, respectively. In addition, prevalence of sarcopenia among MI patients was 0.1, 0.1 and 0% among patients diagnosed with SLE alone, RA alone and both, respectively.

Associations Between Sarcopenia, Type of Autoimmune Disease and Presence of HF

The results of univariate and multivariate regression analysis on the associations between sarcopenia, type of autoimmune disease and HF are summarized in **Table 4**. After adjusting for relevant confounders, no significant associations were found between sarcopenia and odds for HF (aOR: 1.12, 95% CI: 0.94–1.33). Patients with RA had significantly lower odds of HF occurrence (aOR = 0.77, 95% CI: 0.76–0.79) than SLE patients.

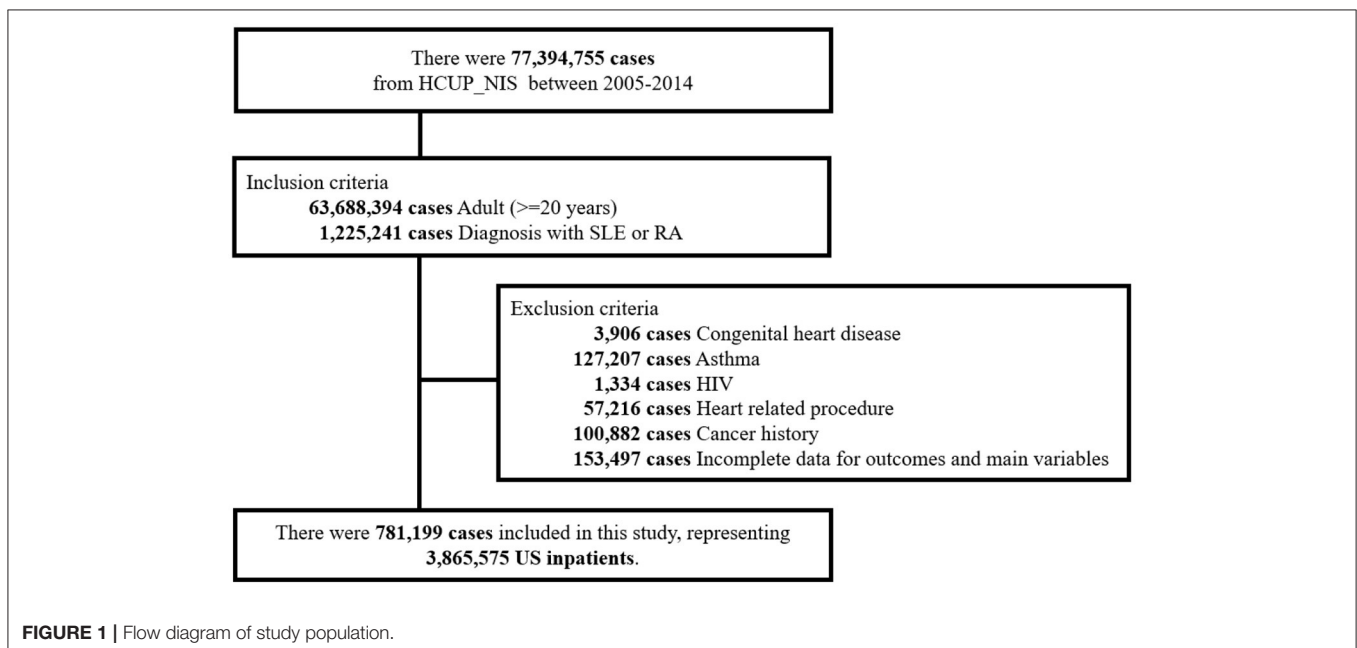


TABLE 1 | Characteristics of SLE/RA patients with or without HF.

Study variables	Total (n = 781,199)	HF		P-value
		Yes (n = 127,812)	No (n = 653,387)	
Sarcopenia				0.003
No	780,405 (99.9)	127,651 (99.9)	652,754 (99.9)	
Yes	794 (0.1)	161 (0.1)	633 (0.1)	
Autoimmune disease				<0.001
SLE alone	200,007 (25.6)	27,529 (21.5)	172,478 (26.4)	
RA alone	555,837 (71.2)	96,886 (75.9)	458,951 (70.3)	
Both	25,355 (3.2)	3,397 (2.7)	21,958 (3.4)	
Patients' characteristics				
Age, years	63.2 ± 0.07	71.4 ± 0.08	61.7 ± 0.07	<0.001
20 to <45	121,423 (15.5)	7,259 (5.6)	114,164 (17.4)	<0.001
45–64	254,411 (32.5)	27,532 (21.5)	226,879 (34.7)	
65+	405,365 (52.0)	93,021 (72.8)	312,344 (47.9)	
Gender				<0.001
Male	163,205 (20.9)	31,480 (24.7)	131,725 (20.2)	
Female	617,994 (79.1)	96,332 (75.3)	521,662 (79.8)	
Race/ethnicity				<0.001
White	554,326 (71.0)	91,715 (71.8)	462,611 (70.8)	
Black	124,166 (15.9)	23,240 (18.2)	100,926 (15.4)	
Hispanic	67,856 (8.7)	8,086 (6.3)	59,770 (9.1)	
Asian/Pacific Islander	12,497 (1.6)	1,659 (1.3)	10,838 (1.6)	
Native American	5,653 (0.7)	772 (0.6)	4,881 (0.8)	
Others	16,701 (2.2)	2340 (1.8)	14,361 (2.2)	
Household Income				<0.001
Lowest quartile	230,541 (29.6)	40,692 (31.9)	189,849 (29.1)	
Second quartile	200,960 (25.7)	33,224 (26.0)	167,736 (25.7)	
Third quartile	185,559 (23.7)	29,167 (22.8)	156,392 (23.9)	
Fourth quartile	164,139 (21.0)	24,729 (19.3)	139,410 (21.3)	
Insurance status/Primary Payer				<0.001
Medicare/Medicaid	566,518 (72.6)	111,201 (87.0)	455,317 (69.7)	
Private including HMO	176,900 (22.6)	13,473 (10.5)	163,427 (25.0)	
Self-pay/no charge/other	37,781 (4.8)	3,138 (2.5)	34,643 (5.3)	
Admission type				<0.001
Elective	174,045 (22.2)	14,086 (11.0)	159,959 (24.4)	
Emergent	607,154 (77.8)	113,726 (89.0)	493,428 (75.6)	
Smoking				0.149
No	780,109 (99.9)	127,652 (99.9)	652,457 (99.9)	
Yes	1,090 (0.1)	160 (0.1)	930 (0.1)	
Alcohol consumption				<0.001
No	777,879 (99.6)	127,585 (99.8)	650,294 (99.5)	
Yes	3,320 (0.4)	227 (0.2)	3,093 (0.5)	
Diabetes				<0.001
No	602,763 (77.1)	85,242 (66.7)	517,521 (79.2)	

(Continued)

TABLE 1 | Continued

Study variables	Total (n = 781,199)	HF		P-value
		Yes (n = 127,812)	No (n = 653,387)	
Yes	178,436 (22.9)	42,570 (33.3)	135,866 (20.8)	
Hypertension				<0.001
No	773,213 (99.0)	124,801 (97.7)	648,412 (99.2)	
Yes	7,986 (1.0)	3,011 (2.3)	4,975 (0.8)	
Hyperlipidemia				<0.001
No	575,079 (73.6)	86,219 (67.4)	488,860 (74.8)	
Yes	206,120 (26.4)	41,593 (32.6)	164,527 (25.2)	
Hospital characteristics				
Hospital bed size				<0.001
Large	468,746 (60.2)	74,911 (58.8)	393,835 (60.5)	
Medium	199,574 (25.6)	33,590 (26.3)	165,984 (25.5)	
Small	112,879 (14.2)	19,311 (14.9)	93,568 (14.0)	
Location/teaching status				<0.001
Rural	92,880 (12.0)	17,963 (14.2)	74,917 (11.6)	
Urban-nonteaching	334,551 (42.6)	54,396 (42.3)	280,155 (42.6)	
Urban-teaching	353,768 (45.4)	55,453 (43.5)	298,315 (45.8)	
Hospital region				<0.001
Northeast	152,063 (19.9)	24,267 (19.4)	127,796 (20.0)	
Midwest	141,999 (18.3)	26,491 (20.9)	115,508 (17.8)	
South	335,202 (42.7)	54,740 (42.6)	280,462 (42.7)	
West	151,935 (19.1)	22,314 (17.1)	129,621 (19.5)	
Length of stay, days	5.1 ± 0.01	6.2 ± 0.03	4.9 ± 0.01	<0.001

HF, heart failure; HMO, Health maintenance organization; RA: rheumatoid arthritis; SE, standard error; SLE, systemic lupus erythematosus. Categorical data are presented as unweighted counts (weighted %); continuous data are presented as mean ± SE. Significant results were shown in bold.

Associations Between Sarcopenia, Type of Autoimmune Disease and the Presence of MI

The results of univariate and multivariate regression analysis on associations between sarcopenia, type of autoimmune disease and MI are summarized in **Table 5**. Univariate analysis revealed no associations between sarcopenia and odds for MI. After adjusting for relevant confounders, RA patients had significantly lower odds for MI (aOR = 0.86, 95% CI: 0.82–0.91) than SLE patients.

DISCUSSION

The present study is the first to analyze hospitalized SLE/RA patients and to compare their relative risk for the occurrence of HF and MI, as well as to evaluate the role of sarcopenia in this patient population. The prevalence of HF and MI in the whole study population was 16.4 and 1.6%, respectively. The overall prevalence of sarcopenia in SLE/RA patients was relatively low (0.1%). These results suggest that sarcopenia may not be

TABLE 2 | Characteristics of SLE/RA patients with or without MI.

Study variables	MI		P-value
	Yes (n = 12,781)	No (n = 768,418)	
Sarcopenia			0.568
No	12,770 (99.9)	767,635 (99.9)	
Yes	11 (0.1)	783 (0.1)	
Autoimmune disease			<0.001
SLE alone	2,323 (18.2)	197,684 (25.7)	
RA alone	10,175 (79.6)	545,662 (71.1)	
Both	283 (2.2)	25,072 (3.3)	
Patients' characteristics			
Age, years			<0.001
20 to <45	73.4 ± 0.13	63.1 ± 0.07	<0.001
45–64	421 (3.3)	121,002 (15.7)	<0.001
65+	2,498 (19.5)	251,913 (32.8)	
	9,862 (77.2)	395,503 (51.5)	
Gender			<0.001
Male	3,376 (26.4)	159,829 (20.8)	
Female	9,405 (73.6)	608,589 (79.2)	
Race/ethnicity			<0.001
White	9,949 (77.9)	544,377 (70.9)	
Black	1,479 (11.6)	122,687 (16.0)	
Hispanic	815 (6.3)	67,041 (8.7)	
Asian/Pacific Islander	220 (1.7)	12,277 (1.6)	
Native American	77 (0.6)	5,576 (0.7)	
Others	241 (1.9)	16,460 (2.2)	
Household Income			0.044
Lowest Quartile	3,607 (28.3)	226,934 (29.6)	
Second quartile	3,383 (26.5)	197,577 (25.7)	
Third quartile	3,049 (23.8)	182,510 (23.7)	
Fourth quartile	2,742 (21.4)	161,397 (21.0)	
Insurance status/Primary Payer			<0.001
Medicare/Medicaid	10,921 (85.5)	555,597 (72.3)	
Private including HMO	1,511 (11.8)	175,389 (22.8)	
Self-pay/no charge/other	349 (2.7)	37,432 (4.9)	
Admission type			<0.001
Elective	972 (7.6)	173,073 (22.5)	
Emergent	11,809 (92.4)	595,345 (77.5)	
Smoking			0.817
No	12,764 (99.9)	767,345 (99.9)	
Yes	17 (0.1)	1,073 (0.1)	
Alcohol consumption			0.413
No	12,733 (99.6)	765,146 (99.6)	
Yes	48 (0.4)	3,272 (0.4)	
Diabetes			<0.001
No	9,079 (71.0)	593,684 (77.2)	
Yes	3,702 (29.0)	174,734 (22.8)	
Hypertension			<0.001
No	12,552 (98.2)	760,661 (99.0)	
Yes	229 (1.8)	7,757 (1.0)	
Hyperlipidemia			<0.001
No	8,047 (62.9)	567,032 (73.7)	

(Continued)

TABLE 2 | Continued

Study variables	MI		P-value
	Yes (n = 12,781)	No (n = 768,418)	
Yes	4,734 (37.1)	201,386 (26.3)	
Hospital characteristics			
Hospital bed size			<0.001
Large	7,262 (57.1)	461,484 (60.2)	
Medium	3,466 (27.1)	196,108 (25.6)	
Small	2,053 (15.8)	110,826 (14.2)	
Location/teaching status			<0.001
Rural	1,881 (14.9)	90,999 (11.9)	
Urban-nonteaching	5,666 (44.0)	328,885 (42.6)	
Urban-teaching	5,234 (41.0)	348,534 (45.5)	
Hospital region			<0.001
Northeast	3,009 (24.1)	149,054 (19.8)	
Midwest	2,402 (18.9)	139,597 (18.3)	
South	4,876 (37.9)	330,326 (42.8)	
West	2,494 (19.1)	149,441 (19.1)	
Length of stay, days	6.6 ± 0.07	5.1 ± 0.01	<0.001

HMO, Health maintenance organization; MI, myocardial infarction; RA, rheumatoid arthritis; SE, standard error; SLE, systemic lupus erythematosus. Categorical data are presented as unweighted counts (weighted %); continuous data are presented as mean ± SE. Significant results were shown in bold.

TABLE 3 | Prevalence of sarcopenia in patients with HF or MI, stratified by SLE/RA.

	Total	Autoimmune disease			P-value
		SLE alone	RA alone	Both	
HF					0.019
No sarcopenia	127,651 (99.9)	27,507 (99.9)	96,755 (99.9)	3,389 (99.8)	
Sarcopenia	161 (0.1)	22 (0.1)	131 (0.1)	8 (0.2)	
MI					-
No sarcopenia	12,770 (99.9)	2,321 (99.9)	10,166 (99.9)	283 (100.0)	
Sarcopenia	11 (0.1)	2 (0.1)	9 (0.1)	-	

HF, heart failure; MI, myocardial infarction; RA, rheumatoid arthritis; SLE, systemic lupus erythematosus.

associated with increased risk for HF or MI among patients with these autoimmune diseases. Logistic regression analysis showed that RA patients were significantly less likely to have cardiovascular events such as HF or MI than SLE patients after adjusting for relevant confounders.

The increased risk of CVDs, including HF and MI, among SLE patients has been recognized consistently during the past two decades (7–10, 21–23). Specifically, SLE has been reported to be associated with significant alterations in cardiac structure and function (8). Risk of HF is reported to be increased by various SLE manifestations and therapies together with the conventional

TABLE 4 | Associations between sarcopenia, type of autoimmune disease and the presence of HF.

		Univariate		Multivariate	
		OR (95% CI)	p-value	aOR (95% CI)	p-value
Sarcopenia					
No	Ref	Ref	Ref	Ref	Ref
Yes		1.30 (1.09, 1.54)	0.003	1.12 (0.94, 1.33)	0.219
Autoimmune disease					
SLE	Ref	Ref	Ref	Ref	Ref
RA		1.32 (1.30, 1.35)	<0.001	0.77 (0.76, 0.79)	<0.001

CI, confidence interval; aOR, adjusted odds ratio; HF, heart failure; RA, rheumatoid arthritis; SLE, systemic lupus erythematosus. Adjusted for age, gender, race/ethnicity, household income, insurance status/primary payer, admission type, alcohol consumption, diabetes, hypertension, hyperlipidemia, hospital bed size, location/teaching status, hospital region. Significant results were shown in bold.

TABLE 5 | Associations between sarcopenia, type of autoimmune disease and the presence of MI.

		Univariate		Multivariate	
		OR (95% CI)	p-value	aOR (95% CI)	p-value
Sarcopenia					
No	Ref	Ref	Ref	Ref	Ref
Yes		0.82 (0.41, 1.63)	0.569	–	–
Autoimmune disease					
SLE	Ref	Ref	Ref	Ref	Ref
RA		1.58 (1.51, 1.66)	<0.001	0.86 (0.82, 0.91)	<0.001

CI, confidence interval; aOR, adjusted odds ratio; MI, myocardial infarction; RA, rheumatoid arthritis; SLE, systemic lupus erythematosus. Adjusted for age, gender, race/ethnicity, household income, insurance status / primary payer, admission type, diabetes, hypertension, hyperlipidemia, hospital bed size, location/teaching status, hospital region. Significant results were shown in bold.

risk factors for atherosclerotic CVD (9). In the US Medicaid population, the incidence of HF among SLE patients was 2.7-fold higher than among those without SLE (10).

RA has also been found to be associated with increased risk for CVD compared with the general population (24). RA patients were reported to have almost twice the risk of HF than individuals without RA (25). A previous population-based study using the same NIS database as used in the present study documented an increased number of hospitalizations with AMI-RA in the US from 2002 to 2016. More recently, RA was also reported to be associated with lower in-hospital mortality, particularly in cases of STEMI (26).

However, few studies in the medical literature have directly compared CVD risk between RA and SLE. A population-based study in Taiwan found that RA and SLE are associated with in-hospital mortality, overall mortality and major adverse cardiac events either after AMI or stroke (27), although differences in risk of developing MI between the two autoimmune diseases was not studied. Another recent database study focusing on younger adult patients < 55 years reported that SLE was associated with

higher risk of AMI, whereas RA was associated with lower risk (28). However, that study still did not directly compare the risk of HF or MI between RA and SLE. An earlier single-center, small-sample study assessed lipid profiles in women with RA or SLE, concluding that women with SLE and RA have a distinct CVD risk profile and the contribution of traditional CV risk factors to atherogenesis may be different in these two autoimmune diseases (29). The present study found that RA patients had a significantly lower risk for MI or HF compared to SLE patients. We surmise that the pathophysiology underlying the distinct cardiovascular risk between RA patients vs. SLE patients could be multifactorial and cannot be answered by the present study design. Nevertheless, these preliminary results highlight directions for future research.

Previous studies have reported that sarcopenia was highly prevalent in HF patients, contributing to its poor prognosis, and suggesting that age-related muscle decline may be an important cause of reduced cardiorespiratory fitness in older adult patients with HF (13–15). Nevertheless, the prevalence of sarcopenia in the present study was relatively low (<0.2%), and it is probable that the discharge code utilized in the present analysis did not capture sarcopenic patients accurately. Therefore, although the present analysis did not show an increased risk for MI or HF in patients with sarcopenia, a firm conclusion cannot be made on the associations between sarcopenia and risk for MI or HF in patients with autoimmune SLE/RA.

Strengths and Limitations

The major strengths of this study were the use of the large national representative database of the US, which provided good statistical power. In addition, traditional risk factors for MI or HF were considered and carefully adjusted. However, the study still has several limitations. First, the study uses secondary cross-sectional data and retrospective analysis, both of which may limit generalization to other populations or locations outside the US and prevent long-term follow-up of patients. Also, the lack of information regarding disease duration or activity for SLE and RA populations hindered further adjustment in the analyses. Subgroup analyses based on different severity levels, ejection fraction type and stage of HF, or types of MI (i.e., STEMI, NSTEMI) were also not performed. Lastly, although important, medications used and laboratory parameter values were not provided for patients in the NIS database and could not be included in data analysis, which may have shed light on individual differences between SLE/RA patients. Prospective studies are needed to help elucidate such differences.

CONCLUSION

The prevalence of HF and MI in patients with SLE or RA in the US is notable. Patients with RA alone are significantly less likely to have HF or MI than those with SLE alone. Whether sarcopenia leads to increased HF or MI remains inconclusive. Further well-designed prospective studies are highly warranted to explain the pathophysiology underlying discrepancies between RA and SLE regarding risk for MI or HF.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

C-MC: acquisition of data, analysis and interpretation of data, drafting of the manuscript, and guarantor of integrity of the entire study. J-RL: acquisition of data, drafting of

the manuscript, and statistical analysis. T-CF: conception and design, critical revision of the manuscript, and guarantor of integrity of the entire study. All authors read and approved the final manuscript.

FUNDING

This work was supported by Taipei Veterans General Hospital, Taipei, Taiwan and also a grant from Chang Gung Memorial Hospital, Keelung, Taiwan (CMRPG2C0402 and CMRPG2F0193).

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