Association between psoriasis and short-term outcomes of acute myocardial infarction: A matched-pair cohort study using a nationwide inpatient database in Japan

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Background: Psoriasis is a known risk factor for acute myocardial infarction (AMI). However, the associations between psoriasis and short-term outcomes of AMI remain controversial.

Objective: To compare the short-term outcomes of AMI patients with and without psoriasis accounting for patient background characteristics and site-specific effects.

Methods: We identified patients with AMI between July 2010 and March 2020, using a Japanese national inpatient database. We matched patients with and without psoriasis to generate a 1:10 matched-pair cohort matched for sex, hospital, and fiscal year at admission. Multivariable regression analyses with adjustment for background characteristics including age and Killip class at admission were conducted to compare short-term outcomes of AMI.

Results: In this study of AMI patients with psoriasis (n = 455) and without psoriasis (n = 438,534), 30-day in-hospital mortality was 5.6%. Patients with psoriasis had higher proportions of comorbidities than patients without psoriasis. Multivariable regression analyses in the matched-pair cohort revealed that psoriasis was significantly associated with decreased 30-day in-hospital mortality (odds ratio [OR], 0.26; 95% confidence interval [CI], 0.08-0.85).

Limitations: Retrospective study design without data on psoriasis severity.

Conclusion: The matched-pair cohort analyses with adjustment for patient background characteristics and site-specific effects revealed decreased in-hospital mortality in AMI patients with psoriasis. (JAAD Int 2022;8:21-30.)

Key words: acute myocardial infarction; cardiovascular disease; epidemiology; matched-pair cohort; nationwide inpatient database; mortality; psoriasis.

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INTRODUCTION

Psoriasis is a chronic inflammatory disease that involves multiple organ systems[1-3] and has a prevalence of 0.34% to 11.43% in adults.[4,5] Atherosclerotic disease is one of the important comorbidities of psoriasis, and psoriasis was identified as a risk factor for cardiovascular diseases including myocardial infarction (MI).[6-9] A single-center retrospective study in Japan found that psoriasis was significantly associated with MI (adjusted odds ratio [OR], 1.87; 95% confidence interval [CI], 1.26-2.68; $P = .002$).[9]

Although psoriasis is a known risk factor for MI, its associations with short-term outcomes of MI remain controversial. Several studies suggested that psoriasis was an independent risk factor for MI-related death.[7,10,11] However, a recent study on MI in Germany found lower in-hospital mortality in patients with psoriasis compared with control patients (7.1% vs 12.4%).[12] The authors noted that the relatively young age of their patients with psoriasis (68 vs 73 years) would have contributed to better outcomes. Nevertheless, even in their multivariate logistic regression models adjusted for age and age-related coronary risk factors, psoriasis was associated with low in-hospital mortality. Thus, the results could be attributed to site-specific effects (differences among institutions in treatment choices and consequent outcomes[13-15]) that were not adjusted in the study. Furthermore, the external validity requires assessment because the in-hospital mortality of 12.4% in their control group was considerably higher than the corresponding rates in other countries during the same period (7.8% in the United States in 2008[16] and 7.2% in Japan between 2010 and 2014[17]) and the proportions of their patients who received interventional treatments (47.1% in 2005 and 64.7% in 2015) were lower than that in Japan.[17]

The associations of psoriasis with short-term outcomes of acute myocardial infarction (AMI) remain controversial. The present study aimed to compare the short-term outcomes in AMI patients with and without psoriasis using a nationwide inpatient database in Japan.

CAPSULE SUMMARY

- Psoriasis is a known risk factor for cardiovascular diseases including acute myocardial infarction. However, the association between psoriasis and short-term outcomes of AMI remains controversial.
- The matched-pair cohort analyses with adjustment for patient background characteristics and site-specific effects confirmed a significant association between psoriasis and favorable short-term outcomes of acute myocardial infarction.

METHODS

Data source

This nationwide retrospective cohort study was conducted using the Diagnosis Procedure Combination database, which contains hospital administrative claims data and discharge abstracts for ~8,000,000 inpatients per year in more than 1200 hospitals throughout Japan,[18] and covers approximately one-half of all inpatient admissions to acute-care hospitals. All 82 university hospitals in Japan are obliged to participate in the database, whereas participation by community hospitals is voluntary. The Institutional Review Board at The University of Tokyo approved the study. The requirement for informed consent was waived because of the anonymity of the patient database.

The database includes the following patient data: age, sex, and body mass index at admission; smoking history (current and former smoking); main diagnoses, comorbidities at admission, and complications after admission recorded with Japanese text data and *International Statistical Classification of Diseases, Tenth Revision* (ICD-10) codes; Killip class at admission; emergency admission; ambulance use; unique hospital identifier; interventional/surgical procedures indexed by original Japanese codes; length of stay; discharge status; and hospitalization costs. Hospitalization costs were based on reference prices in the Japanese national fee schedule for item-by-item prices on surgical, pharmaceutical, laboratory, and other inpatient services. We defined the currency exchange rate as 110 Japanese yen per 1 US$. All discharge abstract data for patients were recorded at discharge by the attending physicians. Several validation studies have confirmed that the validity of the diagnostic and procedural records in the database is generally high.[19-21]

Study protocol

We identified hospitalized patients aged ≥20 years with a diagnosis of AMI (ICD-10 code: I21) who

Abbreviations used:

AMI:	acute myocardial infarction
CABG:	coronary artery bypass graft
ICD-10:	*International Statistical Classification of Diseases, Tenth Revision*
MI:	myocardial infarction
PCI:	percutaneous coronary intervention
OR:	odds ratio

underwent diagnostic or therapeutic procedures for AMI from July 2010 to March 2020. We defined diagnostic procedures as coronary angiography and therapeutic procedures as coronary reperfusion therapy including percutaneous coronary intervention (PCI) and coronary artery bypass graft (CABG). We excluded patients who were discharged on the day of admission. The eligible patients were classified into 2 groups: patients with psoriasis (ICD-10 code: L40) (psoriasis group) and patients without psoriasis (control group).

The primary outcome was 30-day in-hospital mortality, defined as all-cause in-hospital death within 30 days after admission. The secondary outcomes were 7-day in-hospital mortality, overall in-hospital mortality, in-hospital morbidity, 30-day readmission, length of stay, and total hospitalization costs. In-hospital morbidity was identified using ICD-10 codes (pulmonary embolism [I26], deep venous thrombosis [I80.2], stroke [I60-I64], acute renal failure [N17], respiratory complications [J12-J18, J69.0, J80, J95-J99], urinary tract infection [N10, N30, N390], and sepsis [A40, A41]).

Statistical analysis

We investigated the patient background characteristics, including, age, sex, body mass index, smoking history, comorbidities, Killip class at admission, and infarct site, as well as emergency admission, ambulance use, type of hospital, and hospital volume. Body mass index was categorized into 5 groups: <18.5 kg/m^2 (underweight), 18.5 to 24.9 kg/m^2 (normal weight), 25.0 to 29.9 kg/m^2 (overweight), ≥30.0 kg/m^2 (obese), and missing data. The Killip classification was used to categorize patients with AMI based on physical examination findings.[22] The Killip classification was previously shown to predict short-term mortality in patients with AMI.[23,24] Comorbidities were assessed by the Charlson Comorbidity Index[25] and categorized into 3 groups: 0 to 1, 2, and ≥3. Hospital volume was defined as the number of patients with AMI admitted to each hospital and categorized into tertiles (low, medium, and high) with approximately equal numbers of patients in the groups.

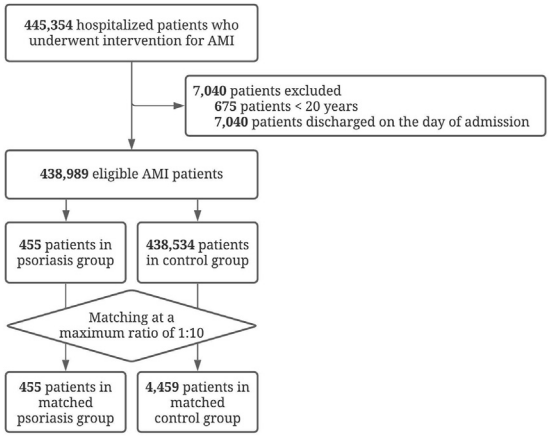

Fig 1. Selection of the study patients. *AMI*, Acute myocardial infarction.

We investigated in-hospital treatments of AMI including coronary reperfusion therapy, mechanical support, and blood transfusion. Coronary reperfusion therapy included PCI and CABG. Mechanical support included intra-aortic balloon pumping, extracorporeal membrane oxygenation, temporary pacing, mechanical ventilation, intermittent hemodialysis, and continuous hemodiafiltration.

As the main analyses, we performed 1:10 matched-pair cohort analyses to cancel out site-specific effects such as physician practice patterns and treatment outcomes.[26] For each patient in the psoriasis group, we identified a set of control patients who had the same sex and were admitted to the same hospital in the same fiscal year. From the pooled population of control patients, we randomly selected 10 control patients for each patient in the psoriasis group, constituting a 1:10 matched-pair cohort. After generating the 1:10 matched-pair cohort, we performed the following univariable and multivariable regression analyses: logistic regression analyses for 30-day in-hospital mortality, 7-day in-hospital mortality, overall in-hospital mortality, in-hospital morbidity, and 30-day readmission; and linear regression analyses for the length of stay and total hospitalization costs. These regression analyses were fitted with generalized estimating equations to adjust for within-pair clustering. In the multivariable regression analyses, we adjusted for the aforementioned background characteristics except for variables used to generate the 1:10 matched-pair cohort (admitted hospital and fiscal year of admission). As sensitivity analyses, we performed univariable and multivariable regression analyses for the original cohort (ie, before 1:10 matching) with generalized estimating equations to adjust for within-hospital clustering.

Table I. Demographic and clinical characteristics of all patients and the matched patients

	All patients			1:10 matched patients*		
	Psoriasis group	Control group		Psoriasis group	Control group	
	n = 455	*n* = 438,534	ASD†	*n* = 455	*n* = 4459	ASD†
Age, y	66 (57-74)	70 (61-79)	3.2	66 (57-74)	70 (61-78)	2.6
Female sex	65 (14)	111,789 (26)	28.4	65 (14)	601 (14)	2.3
BMI, kg/m^2						
<18.5 (underweight)	19 (4.2)	25,832 (5.9)	7.8	19 (4.2)	220 (4.9)	3.6
18.5-24.9 (normal weight)	237 (52)	242,981 (55)	6.7	237 (52)	2407 (54)	3.8
25.0-29.9 (overweight)	124 (27)	111,452 (25)	4.2	124 (27)	1140 (26)	3.8
≥30 (obese)	40 (8.8)	24,720 (5.6)	12.2	40 (8.8)	280 (6.3)	9.5
Missing data	35 (7.7)	33,549 (7.7)	0.2	35 (7.7)	412 (9.2)	5.6
Past/current smoker	360 (79)	258,566 (59)	44.7	360 (79)	2891 (66)	32.2
Comorbidities						
Hypertension	319 (70)	274,849 (63)	15.8	319 (70)	2975 (67)	7.3
Diabetes mellitus	153 (34)	133,475 (30)	6.8	153 (34)	1398 (31)	4.9
Dyslipidemia	182 (40)	149,455 (34)	12.3	182 (40)	1652 (37)	6.1
Charlson comorbidity index						
0-1	134 (30)	140,835 (32)	5.8	134 (30)	1357 (30)	2.1
2	189 (42)	168,014 (38)	6.6	189 (42)	1774 (40)	3.6
≥3	132 (29)	129,685 (30)	1.2	132 (29)	1328 (30)	1.7
Killip class at admission						
I	217 (48)	195,555 (45)	6.2	217 (48)	2019 (45)	4.8
II	118 (26)	103,745 (24)	5.3	118 (26)	1055 (24)	5.3
III	27 (5.9)	32,785 (7.5)	6.2	27 (5.9)	307 (6.9)	3.9
IV	42 (9.2)	49,506 (11)	6.8	42 (9.2)	497 (11)	6.3
Missing data	51 (11)	56,943 (13)	5.4	51 (11)	581 (13)	5.6
Infarct site						
Anterior wall	184 (40)	180,750 (41)	1.6	184 (40)	1891 (42)	4.0
Inferior wall	150 (33)	143,561 (33)	0.5	150 (33)	1414 (32)	2.7
Other wall	68 (15)	46,446 (11)	13.1	68 (15)	483 (11)	12.3
Site unspecified	74 (16)	85,942 (20)	8.7	74 (16)	870 (20)	8.5
Emergency admission	438 (96)	410,963 (94)	11.7	438 (96)	4143 (93)	14.9
Ambulance use	298 (66)	277,387 (63)	4.7	298 (66)	2759 (62)	7.5
Teaching hospital	423 (93)	392,004 (89)	12.6	423 (93)	4098 (92)	4.0
Hospital volume, cases/year						
Low (<67)	160 (35)	145,614 (33)	4.1	160 (35)	1517 (34)	2.4
Medium (67-118)	147 (32)	145,357 (33)	1.8	147 (32)	1462 (33)	1.0
High (≥119)	148 (33)	147,563 (34)	2.4	148 (33)	1480 (33)	1.4

Data are presented as *n* (%) or median (interquartile range).

ASD, Absolute standardized difference; *BMI,* body mass index.

*When generating the 1:10 matched-pair cohort, we identified a set of control patients who were of the same sex and were admitted to the same hospital in the same year as the case patients. After generating the matched-pair cohort, we conducted multivariable regression analyses with adjustment for the patient and hospital characteristics.

†An ASD of ≤10% denotes a negligible difference between the 2 groups.

We also conducted univariable and multivariable logistic regression analyses for in-hospital treatments (coronary reperfusion therapy, mechanical support, and blood transfusion) in the 1:10 matched-pair cohort to observe differences in treatment patterns between the 2 groups.

We used the χ^2 test to compare categorical variables and the Wilcoxon rank sum test to compare continuous variables. We used a significance level of $P < .05$ for all statistical tests, and all reported *P* values were 2-sided. All statistical analyses were conducted using Stata/MP 17.0 (StataCorp).

RESULTS

We identified 438,989 eligible AMI patients, comprising 455 patients in the psoriasis group and 438,534 patients in the control group (Fig 1). The matching process created a matched-pair cohort of 4914 patients, including the same 455 patients in the

Table II. Comparisons of in-hospital treatments in all patients and the matched patients

	All patients					1:10 matched patients*				
	Psoriasis group		Control group			Psoriasis group		Control group		
	n = 455		*n* = 438,534			*n* = 455		*n* = 4459		
	n	%	*n*	%	ASD†	*N*	%	*n*	%	ASD†
Coronary reperfusion therapy	410	(90)	398,054	(91)	2.2	410	(90)	4037	(91)	1.4
PCI	405	(89)	387,192	(88)	2.3	405	(89)	3942	(88)	1.9
CABG	8	(1.8)	14,598	(3.3)	10.0	8	(1.8)	125	(2.8)	7.0
Mechanical support										
IABP	56	(12)	73,795	(17)	12.8	56	(12)	766	(17)	13.8
ECMO	10	(2.2)	14,967	(3.4)	7.4	10	(2.2)	168	(3.8)	9.2
Temporary pacing	36	(7.9)	36,919	(8.4)	1.9	36	(7.9)	355	(8.0)	0.2
Mechanical ventilation	67	(15)	77,123	(18)	7.8	67	(15)	782	(18)	7.7
Intermittent hemodialysis	13	(2.9)	17,084	(3.9)	5.8	13	(2.9)	183	(4.1)	6.8
Continuous hemodiafiltration	10	(2.2)	18,044	(4.1)	11.0	10	(2.2)	179	(4.0)	10.5
Blood transfusion										
Red blood cells	36	(7.9)	58,042	(13)	17.4	36	(7.9)	547	(12)	14.5
Fresh-frozen plasma	15	(3.3)	25,471	(5.8)	12.1	15	(3.3)	239	(5.4)	10.2
Platelets	9	(2.0)	18,161	(4.1)	12.6	9	(2.0)	179	(4.0)	12.0

ASD, Absolute standardized difference; *CABG,* coronary artery bypass graft; *ECMO,* extracorporeal membrane oxygenation; *IABP,* intra-aortic balloon pumping; *PCI,* percutaneous coronary intervention.

*When generating the 1:10 matched-pair cohort, we identified a set of control patients who had the same sex and were admitted to the same hospital in the same year as the case patients. After generating the matched-pair cohort, we conducted multivariable regression analyses with adjustment for the patient and hospital characteristics.

†An ASD ≤10% denotes a negligible difference between the 2 groups.

psoriasis group from the original cohort and 4459 patients in the matched control group (Table I).

Among all patients, those in the psoriasis group were more likely to be men and to smoke than those in the control group. The psoriasis group had higher proportions of high body mass index, hypertension, and dyslipidemia than the control group. Charlson Comorbidity Index categories and Killip classes at admission were comparable between the 2 groups. There were differences in the proportions of emergency admission and admission to teaching hospitals between the 2 groups. After matching for sex, hospital, and fiscal year of admission, differences remained in some characteristics such as smoking history and emergency admission between the 2 groups.

More than 90% of patients in both groups received coronary reperfusion therapy, with <10% of the cohort receiving diagnostic procedures only (Table II). Intra-aortic balloon pumping, continuous hemodiafiltration, and blood transfusion were performed less frequently in the psoriasis group compared with the control group. However, the multivariable regression analyses showed no significant differences in any of the in-hospital treatments (Table III).

The unadjusted comparisons of outcomes in the matched patients showed that the psoriasis group had lower 30-day in-hospital mortality than the control group (0.9% vs 5.6%, $P < .001$), as well as lower 7-day and overall in-hospital mortality, and in-hospital morbidity (Table IV). Length of stay was slightly longer in the psoriasis group compared with the control group (15 days vs 14 days, $P < .001$), but the total hospitalization costs did not differ significantly between the 2 groups.

The main analyses in the matched patients are shown in Table V. The multivariable logistic regression analyses showed that psoriasis was significantly associated with lower 30-day in-hospital mortality (OR, 0.26; 95% CI, 0.08-0.85) and overall in-hospital mortality (OR, 0.22; 95% CI, 0.07-0.71), but was not significantly associated with 7-day in-hospital mortality (OR, 0.20; 95% CI, 0.03-1.50) or in-hospital morbidity (OR, 0.82; 95% CI, 0.55-1.24). The multivariable linear regression analysis showed no significant difference in length of stay between the 2 groups (coefficient, 0.48; 95% CI, −1.52 to 2.47). The sensitivity analyses in all patients showed similar results to those of the main analyses (Tables VI and VII).

DISCUSSION

In this study, we examined the association of psoriasis with short-term outcomes of AMI patients, using a nationwide inpatient database in Japan. The findings demonstrated that patients with psoriasis had significantly lower 30-day in-hospital mortality (0.9% vs 5.6%) and overall in-hospital mortality (1.8% vs 7.0%) than patients without psoriasis. To account

Table III. Univariable and multivariable regression analyses of the in-hospital treatments in the matched patients

	1:10 matched patients					
	Univariable analysis			Multivariable analysis*		
	OR†	95% CI	*P* value	OR†	95% CI	*P* value
Coronary reperfusion therapy	0.95	(0.70-1.30)	.76	0.89	(0.57-1.38)	.59
PCI	1.06	(0.79-1.43)	.68	0.97	(0.64-1.46)	.88
CABG	0.62	(0.31-1.26)	.19	0.93	(0.42-2.04)	.85
Mechanical support						
IABP	0.68	(0.51-0.90)	.008	0.74	(0.51-1.06)	.10
ECMO	0.57	(0.30-1.10)	.092	0.67	(0.27-1.63)	.38
Temporary pacing	1.00	(0.71-1.40)	.98	0.98	(0.65-1.48)	.92
Mechanical ventilation	0.81	(0.62-1.06)	.13	1.04	(0.73-1.49)	.81
Intermittent hemodialysis	0.69	(0.39-1.22)	.20	0.56	(0.24-1.32)	.18
Continuous hemodiafiltration	0.54	(0.28-1.02)	.057	0.41	(0.14-1.14)	.086
Blood transfusion						
Red blood cells	0.61	(0.43-0.87)	.006	0.69	(0.44-1.10)	.12
Fresh-frozen plasma	0.60	(0.36-1.02)	.058	0.69	(0.34-1.41)	.31
Platelets	0.48	(0.25-0.94)	.033	0.47	(0.19-1.18)	.11

CABG, Coronary artery bypass graft; *ECMO,* extracorporeal membrane oxygenation; *IABP,* intra-aortic balloon pumping; *OR,* odds ratio; *PCI,* percutaneous coronary intervention.

*The explanatory variables were age, sex, body mass index, smoking history, hypertension, diabetes mellitus, dyslipidemia, Charlson Comorbidity Index, Killip class, infarct site, emergency admission, ambulance use, type of hospital, and hospital volume.

†Odds ratios are for the psoriasis group relative to the control group. A generalized estimating equation was used to adjust for within-pair clustering.

Table IV. Unadjusted comparisons of outcomes in the matched patients

	1:10 matched patients*				
	Psoriasis group		Control group		
	n = 455		*n* = 4459		
	n	%	*n*	%	*P* value
30-day in-hospital mortality	4	(.9)	226	(5.1)	<.001
7-day in-hospital mortality	2	(.4)	119	(2.7)	.003
Overall in-hospital mortality	8	(1.8)	278	(6.2)	<.001
In-hospital morbidity	35	(7.7)	488	(11)	.032
30-day readmission	47	(10)	383	(8.6)	.21
	Median	IQR	Median	IQR	*P* value
Length of stay, days	15	11-22	14	10-21	<.001
Total hospitalization costs, US$	16,764	13,754-23,860	16,981	12,928-24,494	.59

IQR, Interquartile range.

*When generating the 1:10 matched-pair cohort, we identified a set of control patients who had the same sex and were admitted to the same hospital in the same year as the case patients. After generating the matched-pair cohort, we conducted multivariable regression analyses with adjustment for the patient and hospital characteristics.

for site-specific effects in addition to adjustment for patient background characteristics, we performed multivariable regression analyses based on a matched-pair cohort. The results confirmed a significant association between psoriasis and short-term outcomes of AMI.

The psoriasis group in our cohort had higher prevalences of traditional risk factors of AMI such as hypertension, dyslipidemia, obesity, and smoking than the control group. Consequently, the age at AMI onset was younger in the psoriasis group than in the control group. These baseline demographic and clinical characteristics were consistent with the findings in previous reports,[7,9,10,12] including a difference in the predominance of male sex between the 2 groups. However, on generation of the 1:10 matched-pair cohort matched for sex, hospital, and fiscal year of admission only, the prevalences of

Table V. Univariable and multivariable regression analyses of outcomes in the matched patients

	1:10 matched patients					
	Univariable analysis			Multivariable analysis*		
	OR†	95% CI	*P* value	OR†	95% CI	*P* value
30-day in-hospital mortality	0.17	(0.06 to 0.45)	<.001	0.26	(0.08 to 0.85)	.026
7-day in-hospital mortality	0.16	(0.04 to 0.65)	.011	0.20	(0.03 to 1.50)	.12
Overall in-hospital mortality	0.27	(0.13 to 0.55)	<.001	0.22	(0.07 to 0.71)	.011
In-hospital morbidity	0.68	(0.48 to 0.96)	.028	0.82	(0.55 to 1.24)	.35
30-day readmission	1.23	(0.90 to 1.68)	.20	1.25	(0.89 to 1.75)	.21
	Coef†	95% CI	*P* value	Coef†	95% CI	*P* value
Length of stay, days	−0.31	(−2.37 to 1.74)	.76	0.48	(−1.52 to 2.47)	.64
Total hospitalization costs, US$	−1311.15	(−2923.05 to 300.75)	.11	−664.31	(−2079.77 to 751.15)	.36

Coef, Coefficient; *OR,* odds ratio.

*The explanatory variables for the multivariable analysis were age, sex, body mass index, smoking history, hypertension, diabetes mellitus, dyslipidemia, Charlson Comorbidity Index, Killip class, infarct site, emergency admission, ambulance use, type of hospital, and hospital volume.

†Odds ratios and coefficients are for the psoriasis group relative to the control group. A generalized estimating equation was used to adjust for within-pair clustering.

Table VI. Unadjusted comparisons of outcomes in all patients

	All patients				
	Psoriasis group		Control group		
	n = 455		*n* = 438,534		
	N	%	*n*	%	*P* value
30-day in-hospital mortality	4	(.9)	24,607	(5.6)	<.001
7-day in-hospital mortality	2	(.4)	13,643	(3.1)	.001
Overall in-hospital mortality	8	(1.8)	30,708	(7.0)	<.001
In-hospital morbidity	35	(7.7)	43,716	(10)	.11
30-day readmission	47	(10)	37,660	(8.6)	.19
	Median	IQR	Median	IQR	*P* value
Length of stay, days	15	11-22	14	10-21	<.001
Total hospitalization costs, US$	16,764	13,754-23,860	16,982	13,080-24,419	.66

IQR, Interquartile range.

comorbidities other than smoking became comparable between the 2 groups. We consider that the sex predominance and site-specific effects were closely associated with comorbidities, and thus our matched-pair cohort analyses suited the adjustment for background characteristics.

In the present study, >90% of AMI patients underwent therapeutic procedures in both the psoriasis group and the control group, suggesting that coronary reperfusion therapy, particularly PCI, is readily available in Japan. A previous study showed that coexisting rheumatoid arthritis did not affect the likelihood of receiving coronary reperfusion therapy in Japan.[17] The present study showed that management of AMI including coronary reperfusion therapy was similar between patients with and without psoriasis in Japan. The proportions of patients who underwent CABG were comparable between the psoriasis group and the control group in this study, whereas a study in Germany found a higher proportion of CABG in the psoriasis group compared with the control group (7.7% vs 4.7%).[12] The difference between Japan and Germany in the selection of coronary reperfusion therapy may be partially explained by the availability of PCI in each country.

Although previous studies suggested an impaired prognosis in AMI patients with psoriasis,[7,11] a recent study in Germany found substantially lower in-hospital mortality in AMI patients with psoriasis than in AMI patients without psoriasis (7.1% vs 12.4%).[12] The present findings were consistent with the study in Germany, although the in-hospital mortality rates for both groups in Japan were lower than the corresponding rates for both groups in

Table VII. Univariable and multivariable regression analyses of the outcomes in all patients

	All patients					
	Univariable analysis			Multivariable analysis*		
	OR†	95% CI	*P* value	OR†	95% CI	*P* value
30-day in-hospital mortality	0.14	(0.05 to 0.40)	<.001	0.28	(0.10 to 0.84)	.023
7-day in-hospital mortality	0.13	(0.03 to 0.55)	.005	0.18	(0.03 to 1.24)	.081
Overall in-hospital mortality	0.24	(0.12 to 0.47)	<.001	0.22	(0.08 to 0.65)	.006
In-hospital morbidity	0.70	(0.49 to 1.00)	.051	0.85	(0.58 to 1.29)	.48
30-day readmission	1.26	(0.94 to 1.69)	.12	1.40	(1.02 to 1.92)	.034
	Coef†	95% CI	*P* value	Coef†	95% CI	*P* value
Length of stay, days	−0.4	(−2.6 to 1.8)	.74	0.6	(−1.2 to 2.5)	.50
Total hospitalization costs, US$	−1262.15	(−2959.71 to 435.40)	.15	−756.75	(−2357.09 to 843.59)	.35

Coef, Coefficient; *OR,* odds ratio.

*The explanatory variables were age, sex, body mass index, smoking history, hypertension, diabetes mellitus, dyslipidemia, Charlson Comorbidity Index, Killip class, infarct site, emergency admission, ambulance use, type of hospital, and hospital volume.

†Odds ratios and coefficients are for the psoriasis group relative to the control group. A generalized estimating equation was used to adjust for within-hospital clustering.

Germany. Furthermore, even after adjustment for Killip class at admission (a predictor of short-term mortality in patients with AMI), which was not considered in the study in Germany, the present multivariable regression analyses showed better outcomes in the psoriasis group than in the control group. We thus consider that the associations between psoriasis and favorable outcomes of AMI are generalizable.

There are several possible explanations for why patients with psoriasis had better short-term outcomes than patients without psoriasis. First, better control of comorbidities related to AMI may have contributed to the better outcomes in the psoriasis group, although these patients were likely to have well-known risk factors for AMI. For example, the patients could have received more intense treatment for diabetes mellitus in an outpatient setting before the onset of AMI[27] than the general population because of their periodic access to medical services. Therefore, early and proper consultation between dermatologists and physicians in other departments regarding comorbidities may have improved the prognosis of AMI in patients with psoriasis. Second, biologics that specifically target cytokines are now widely available treatment options for psoriasis, especially in patients with severe symptoms.[28-30] These biologics include tumor necrosis factor αinhibitors,[31] interleukin-12/23 inhibitors,[32] and interleukin-17 inhibitors,[33-35] which may have protective effects for AMI through suppression of systemic inflammation.[6,36]

Several limitations of the present study should be acknowledged. First, because the study was based on administrative claims data, the detailed symptoms of the patients were not considered. For example, previous studies showed that patients with severe psoriasis were at higher risk and had worse outcomes of AMI than patients with mild psoriasis.[37,38] The present study did not account for the severity of psoriasis owing to a lack of available data. Second, because the study was based on inpatient data, outpatient data were unavailable. Treatment with biologics in the outpatient setting may have affected the outcomes of AMI.[6] In addition, discharged patients who died within 30 days of admission were not identified in the study, which may have resulted in an underestimation of the 30-day overall mortality. However, we considered that a comparison of in-hospital mortality is acceptable to study the association between a disease and short-term outcomes of AMI. Third, there may have been a recording bias for comorbidities, including psoriasis, in patients with severe AMI. If coexisting psoriasis was unlikely to be recorded in patients with severe AMI, it could have resulted in better outcomes in the psoriasis group compared with the control group. However, several validation studies have confirmed that the validity of the diagnostic and procedural records in the database is generally high.[19-21] Moreover, even after adjustment for severity of AMI (Killip class), the present study revealed better outcomes in the psoriasis group than in the control group.

CONCLUSION

We compared the short-term outcomes of AMI patients with and without psoriasis using a nationwide inpatient database, with adjustments for patient and hospital characteristics. Our matched-pair cohort analyses demonstrated that patients with

psoriasis had lower in-hospital mortality than patients without psoriasis.

Conflicts of interest

Dr Miyachi has received honoraria from companies that manufacture drugs used for the treatment of psoriasis, including Janssen Pharmaceutical KK, Taiho Pharmaceutical Co Ltd, and AbbVie GK. The other authors have no conflicts of interest to disclose.

REFERENCES

1. Nestle FO, Kaplan DH, Barker J. Psoriasis. *N Engl J Med*. 2009; 361:496-509.
2. Boehncke WH, Schön MP. Psoriasis. *Lancet*. 2015;386:983-994.
3. Griffiths CEM, Armstrong AW, Gudjonsson JE, Barker JNWN. Psoriasis. *Lancet*. 2021;397:1301-1315.
4. Michalek IM, Loring B, John SM. A systematic review of worldwide epidemiology of psoriasis. *J Eur Acad Dermatol Venereol*. 2017;31:205-212.
5. Kubota K, Kamijima Y, Sato T, et al. Epidemiology of psoriasis and palmoplantar pustulosis: a nationwide study using the Japanese national claims database. *BMJ Open*. 2015;5:e006450.
6. Garshick MS, Ward NL, Krueger JG, Berger JS. Cardiovascular Risk in Patients With Psoriasis: JACC review topic of the week. *J Am Coll Cardiol*. 2021;77:1670-1680.
7. Prodanovich S, Kirsner RS, Kravetz JD, Ma F, Martinez L, Federman DG. Association of psoriasis with coronary artery, cerebrovascular, and peripheral vascular diseases and mortality. *Arch Dermatol*. 2009;145:700-703.
8. Jung KJ, Kim TG, Lee JW, et al. Increased risk of atherosclerotic cardiovascular disease among patients with psoriasis in Korea: A 15-year nationwide population-based cohort study. *J Dermatol*. 2019;46:859-866.
9. Shiba M, Kato T, Izumi T, et al. Risk of myocardial infarction in patients with psoriasis: a cross-sectional patient-population study in a Japanese hospital. *J Cardiol*. 2019;73:276-279.
10. Mehta NN, Azfar RS, Shin DB, Neimann AL, Troxel AB, Gelfand JM. Patients with severe psoriasis are at increased risk of cardiovascular mortality: cohort study using the General Practice Research Database. *Eur Heart J*. 2010;31:1000-1006.
11. Ahlehoff O, Gislason GH, Lindhardsen J, et al. Prognosis following first-time myocardial infarction in patients with psoriasis: a Danish nationwide cohort study. *J Intern Med*. 2011;270:237-244.
12. Karbach S, Hobohm L, Wild J, et al. Impact of psoriasis on mortality rate and outcome in myocardial infarction. *J Am Heart Assoc*. 2020;9:e016956.
13. Thiemann DR, Coresh J, Oetgen WJ, Powe NR. The association between hospital volume and survival after acute myocardial infarction in elderly patients. *N Engl J Med*. 1999;340:1640-1648.
14. Gupta T, Patel K, Kolte D, et al. Relationship of hospital teaching status with in-hospital outcomes for ST-segment elevation myocardial infarction. *Am J Med*. 2018;131:260-268.e1.
15. Matsuzawa Y, Konishi M, Nakai M, et al. In-hospital mortality in acute myocardial infarction according to population density and primary angioplasty procedures volume. *Circ J*. 2020;84: 1140-1146.
16. Yeh RW, Sidney S, Chandra M, Sorel M, Selby JV, Go AS. Population trends in the incidence and outcomes of acute myocardial infarction. *N Engl J Med*. 2010;362:2155-2165.
17. Isogai T, Matsui H, Tanaka H, Yokogawa N, Fushimi K, Yasunaga H. Treatments and in-hospital mortality in acute myocardial infarction patients with rheumatoid arthritis: a nationwide retrospective cohort study in Japan. *Clin Rheumatol*. 2017;36:995-1004.
18. Yasunaga H. Real world data in Japan: chapter II the diagnosis procedure combination database. *Annals Clin Epidemiol*. 2019; 1:76-79.
19. Yamana H, Moriwaki M, Horiguchi H, Kodan M, Fushimi K, Yasunaga H. Validity of diagnoses, procedures, and laboratory data in Japanese administrative data. *J Epidemiol*. 2017;27:476-482.
20. Ando T, Ooba N, Mochizuki M, et al. Positive predictive value of ICD-10 codes for acute myocardial infarction in Japan: a validation study at a single center. *BMC Health Serv Res*. 2018; 18:895.
21. Nakai M, Iwanaga Y, Sumita Y, et al. Validation of acute myocardial infarction and heart failure diagnoses in hospitalized patients with the nationwide claim-based JROAD-DPC database. *Circ Rep*. 2021;3:131-136.
22. Killip T III, Kimball JT. Treatment of myocardial infarction in a coronary care unit. A two year experience with 250 patients. *Am J Cardiol*. 1967;20:457-464.
23. DeGeare VS, Boura JA, Grines LL, O'Neill WW, Grines CL. Predictive value of the Killip classification in patients undergoing primary percutaneous coronary intervention for acute myocardial infarction. *Am J Cardiol*. 2001;87:1035-1038.
24. Khot UN, Jia G, Moliterno DJ, et al. Prognostic importance of physical examination for heart failure in non-ST-elevation acute coronary syndromes: the enduring value of Killip classification. *JAMA*. 2003;290:2174-2181.
25. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40:373-383.
26. Hennessy S, Bilker WB, Berlin JA, Strom BL. Factors influencing the optimal control-to-case ratio in matched case-control studies. *Am J Epidemiol*. 1999;149:195-197.
27. Mamadjanov T, Volaklis K, Heier M, et al. Admission glucose level and short-term mortality in older patients with acute myocardial infarction: results from the KORA Myocardial Infarction Registry. *BMJ Open*. 2021;11:e046641.
28. Menter A, Strober BE, Kaplan DH, et al. Joint AAD-NPF guidelines of care for the management and treatment of psoriasis with biologics. *J Am Acad Dermatol*. 2019;80:1029-1072.
29. Saeki H, Terui T, Morita A, et al. Japanese guidance for use of biologics for psoriasis (the 2019 version). *J Dermatol*. 2020;47: 201-222.
30. Miyachi H, Konishi T, Kumazawa R, et al. Treatments and outcomes of generalized pustular psoriasis: a cohort of 1516 patients in a nationwide inpatient database in Japan. *J Am Acad Dermatol*. 2022;86:1266-1274.
31. Mehta NN, Shin DB, Joshi AA, et al. Effect of 2 psoriasis treatments on vascular inflammation and novel inflammatory cardiovascular biomarkers: a randomized placebo-controlled trial. *Circ Cardiovasc Imaging*. 2018;11:e007394.
32. Gelfand JM, Shin DB, Alavi A, et al. A Phase IV, randomized, double-blind, placebo-controlled crossover study of the effects of ustekinumab on vascular inflammation in psoriasis (the VIP-U Trial). *J Invest Dermatol*. 2020;140:85-93.e2.
33. Makavos G, Ikonomidis I, Andreadou I, et al. Effects of interleukin 17A inhibition on myocardial deformation and vascular function in psoriasis. *Can J Cardiol*. 2020;36:100-111.
34. von Stebut E, Reich K, Thaçi D, et al. Impact of secukinumab on endothelial dysfunction and other cardiovascular disease parameters in psoriasis patients over 52 weeks. *J Invest Dermatol*. 2019;139:1054-1062.

35. Gelfand JM, Shin DB, Duffin KC, et al. A randomized placebo-controlled trial of secukinumab on aortic vascular inflammation in moderate-to-severe plaque psoriasis (VIP-S). *J Invest Dermatol*. 2020;140:1784-1793.e2.
36. Langley RG, Poulin Y, Srivastava B, et al. Reduced risk of mortality associated with systemic psoriasis treatment in the Psoriasis Longitudinal Assessment and Registry (PSOLAR): a nested case-control analysis. *J Am Acad Dermatol*. 2021;84:60-69.
37. Gelfand JM, Neimann AL, Shin DB, Wang X, Margolis DJ, Troxel AB. Risk of myocardial infarction in patients with psoriasis. *JAMA*. 2006;296:1735-1741.
38. Gelfand JM, Troxel AB, Lewis JD, et al. The risk of mortality in patients with psoriasis: results from a population-based study. *Arch Dermatol*. 2007;143:1493-1499.