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RESEARCH ARTICLE

COMPARISON OF THE INCIDENCE AND RISK FACTORS OF ACUTE CORONARY SYNDROME IN JAPAN AND THAILAND: A RETROSPECTIVE COHORT STUDY

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ABSTRACT

BACKGROUND:
Acute coronary syndrome (ACS) is a leading cause of premature mortality worldwide. Incidence is declining in high-income nations but rising in low- and middle-income countries, highlighting the need for cross-country comparisons to inform prevention strategies.

OBJECTIVE:
To compare the incidence and risk factors of ACS between Japan and Thailand.

DESIGN AND SETTING:
A retrospective cohort study included 93 ACS patients from Burapha University Hospital, Thailand, and 177 from Wakayama Medical University, Japan, between January and December 2021. Participants were recruited using purposive sampling.

MAIN OUTCOME MEASURES:
Data from electronic medical records and meteorological databases were analyzed using descriptive statistics, chi-square/Fisher's exact test, Student's t-test, and Pearson's correlation.

RESULTS:
There was no significant difference in the onset time of ACS between Japan and Thailand. Japanese patients were older, had more comorbidities, and more frequently presented with STEMI (66% vs. 24%), whereas Thai patients were younger, had a higher BMI (24.3 vs. 22.9 kg/m²), and more often presented with NSTEMI. In Thailand, meteorological analysis revealed negative correlations between temperature and humidity ($r = -0.607$, $p < 0.001$), atmospheric pressure and humidity ($r = -0.502$, $p < 0.001$), and temperature and pressure ($r = -0.356$, $p < 0.001$).

CONCLUSIONS:

Although ACS onset time did not differ, notable demographic, clinical, and meteorological variations were observed between Japan and Thailand. Japanese patients were older with more comorbidities and more STEMI, whereas Thai patients were younger with higher BMI and more NSTEMI; meteorological factors correlated with ACS onset in Thailand, underscoring the need for tailored, country-specific prevention strategies.

KEYWORDS

acute coronary syndrome; epidemiology; risk factors; Thailand; Japan

INTRODUCTION

Acute coronary syndrome (ACS) is defined as reduced blood flow to the coronary myocardium, encompassing ST-elevation myocardial infarction (STEMI), non-ST-elevation myocardial infarction (NSTEMI), and unstable angina (UA) [1–3]. ACS remains a leading global cause of morbidity and mortality, with worldwide deaths projected to reach 23 million annually by 2030 [4]. The burden is disproportionately high in low- and middle-income countries (LMICs) [5], where limited resources and health system constraints exacerbate outcomes.

Global epidemiological data highlight substantial geographic disparities. In 2020, age-standardized mortality rates from ACS were especially elevated in Africa, Asia, Latin America, and the Caribbean compared with Europe, North America, and Oceania. Moreover, premature mortality before age 70 years occurs more frequently in men than in women [5]. Regional data further underscore these differences. In Japan, population-based registries estimate the age-adjusted incidence of acute myocardial infarction at approximately 62 per 100,000 person-years, with STEMI accounting for more than half of cases [6]. In contrast, Thailand, a middle-income country, has experienced a steady increase in ACS mortality, rising from 22.5 per 100,000 in 2011 to 35.1 in 2022 [7]. These trends illustrate both the heterogeneity of ACS epidemiology and the pressing need for region-specific evidence to guide prevention and management strategies.

The pathophysiology of ACS is primarily driven by rupture of an atherosclerotic plaque, platelet activation, thrombus formation, and subsequent coronary occlusion. ST-elevation myocardial infarction (STEMI) typically results from complete arterial obstruction, whereas non-ST-elevation myocardial infarction (NSTEMI) and unstable angina (UA) are more often associated with subtotal obstruction or an imbalance between myocardial oxygen supply and demand [1–3]. Beyond the acute phase, ACS is linked to substantial long-term morbidity and an increased risk of recurrent cardiovascular events [8,9]. Health-related quality of life (HRQOL) remains impaired for many survivors despite advances in treatment and secondary prevention [10]. In addition, ACS imposes a considerable economic burden, encompassing both direct healthcare expenditures and indirect productivity losses [11,12]. This burden is particularly pronounced in LMICs, where limited healthcare resources exacerbate the impact on patients, families, and health systems.

Risk factors for ACS are well established and include advanced age, smoking, hypertension, diabetes, dyslipidemia, obesity, male sex, sedentary lifestyle, and unhealthy diet [13,14]. More recently, environmental and meteorological conditions such as extreme temperatures, humidity, atmospheric pressure, and air pollution have been identified as contributors to seasonal variation in ACS incidence [15–18]. These emerging factors are particularly relevant in regions with marked climatic variation.

Thailand and Japan differ substantially in both socioeconomic and climatic contexts; however, comparative research on ACS between these countries remains scarce. To address this gap, this study aimed to compare ACS incidence and to identify demographic, clinical, and meteorological risk factors among ACS patients in Thailand and Japan. The novelty of this work lies in providing one of the first cross-country comparisons that integrates environmental factors, offering insights beyond single-country studies. The findings are expected to support the development of context-specific prevention strategies and to strengthen healthcare planning in each population, with important public health implications for middle-income countries facing a rising ACS burden and for aging high-income societies managing complex comorbidities.

DESIGN AND SETTING

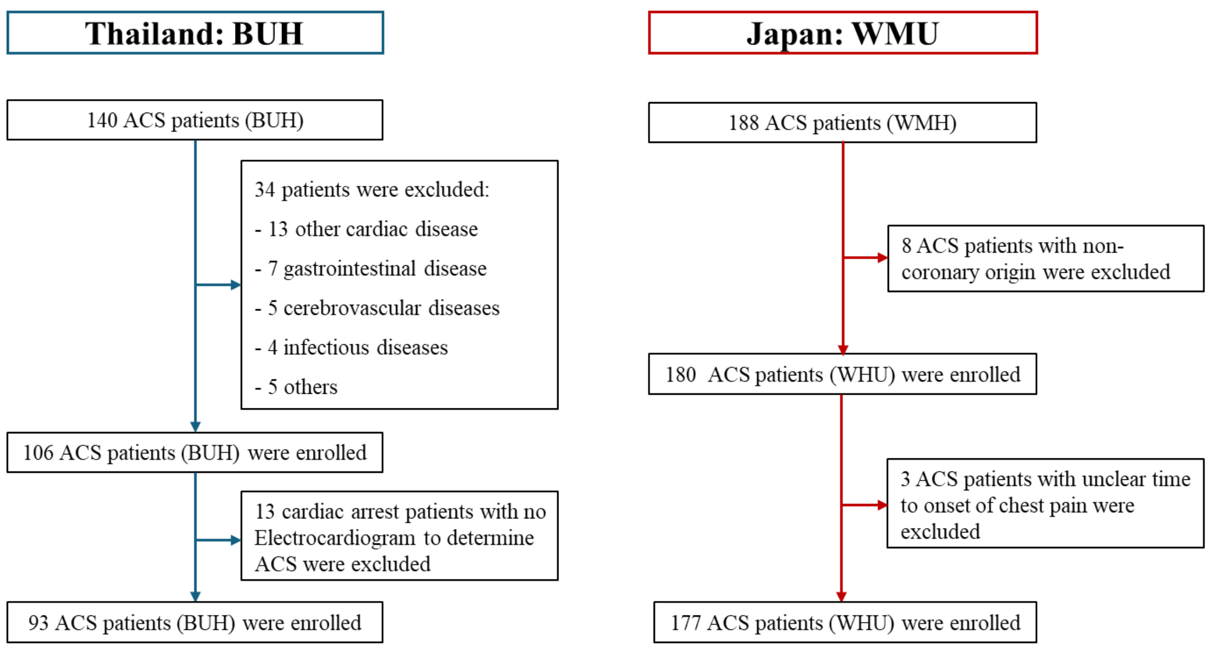
This collaborative retrospective cohort study was conducted in Japan and Thailand. Patients diagnosed with ACS were enrolled from the emergency departments of Wakayama Medical University (WMU), Japan, and Burapha University Hospital (BUH), Thailand, between January and December 2021. ACS was diagnosed according to international guidelines, based on a combination of typical clinical presentation (e.g., chest pain or equivalent ischemic symptoms), electrocardiographic (ECG) changes indicative of myocardial ischemia (such as ST-segment elevation or depression, T-wave inversion, or new left bundle branch block), and elevated cardiac biomarkers, particularly high-sensitivity troponins. Differentiation among STEMI, NSTEMI, and unstable angina was determined primarily by the presence or absence of persistent ST-segment elevation and elevated cardiac enzymes [19]. Data was obtained from electronic medical records.

STUDY POPULATION & SAMPLING

We conducted a collaborative retrospective cohort study of patients with ACS who presented to the emergency departments of WMU, Japan and BUH, Thailand between January and December 2021. We tried to identify the ACS onset time from chest pain based on medical records but excluded cases where the onset time was unknown due to a lack of chest pain or incomplete medical history in records. At WMU, 188 patients were initially identified; 11 were excluded (8 with non-coronary ACS and 3 with unknown onset time), leaving 177 eligible cases. At BUH, 140 patients were screened; 34 with non-ACS diagnoses and 13 with cardiac arrest in the emergency department were excluded, resulting in 93 eligible cases. Patient selection was conducted using a purposive sampling approach.

The Thai sample size was determined a priori using G*Power Version 3.1.9.2 for a point-biserial correlation, with a power of 0.90, an effect size of 0.30, and a significance level of 0.05 [20]. After adjusting for a 5% dropout rate, the required sample size was 93, and all 93 consecutive eligible patients were included. In contrast, the Japanese cohort comprised all eligible registry-confirmed cases (n = 177). The difference in sample size thus reflected the methodological design: the Thai cohort was based on pre-specified sample size estimation, whereas the Japanese cohort represented the entire registry population. Both cohorts exceeded the minimum requirement to ensure adequate statistical power, with the larger Japanese cohort further improving the precision of estimates. A patient enrollment flow diagram is presented in Figure 1.

FIGURE 1. PATIENT ENROLLMENT FLOW DIAGRAM OF ACS CASES AT WMU (JAPAN) AND BUH (THAILAND)



DATA COLLECTION

Data were obtained from electronic medical records and included demographic characteristics (age, sex, body mass index), clinical variables (blood pressure, heart rate, body temperature, Hypertension (systolic blood pressure ≥130 mmHg and/or diastolic blood pressure ≥80 mmHg),white blood cell count, hemoglobin, platelet count, creatinine kinase, and troponin T), ACS subtype, and 30-day mortality. Data abstraction was performed by trained medical staff who had undergone standardized training to ensure accuracy and reliability of data extraction. All data collectors were blinded to the study hypotheses. Interrater reliability was assessed by independent verification of a random sample of cases, with discrepancies resolved through consensus. Meteorological data (annual temperature, humidity, and atmospheric pressure) were retrieved from the national meteorological databases of Japan and Thailand.

ETHICAL CONSIDERATIONS:

The study protocol was approved by the ethics committees of Wakayama Medical University (No. 3780) and Burapha University (HS065). All procedures complied with the Declaration of Helsinki and Good Clinical Practice guidelines.

STATISTICAL ANALYSIS

Data were analyzed using JMP Pro version 16 (SAS Institute, Cary, NC, USA). Continuous variables are expressed as mean ± SD and compared using Student's t-test. Pearson's correlation coefficient was used to assess correlations. Categorical variables are presented as counts and percentages and compared using the Chi-square test or Fisher's exact test when the expected cell frequency was less than 5. Statistical significance was set at $p < 0.05$.

RESULTS

PART 1: DEMOGRAPHIC, CLINICAL, AND METEOROLOGICAL CHARACTERISTICS OF ACS PATIENTS AT WMU AND BUH

The demographic clinical and meteorological characteristics of ACS patients at WMU and BUH are summarized in Table 1. Patients at WMU were older (mean age 71.3 vs. 65.6 years) and more often male (80% vs. 62%) compared with BUH, and had a higher prevalence of comorbidities including hypertension, diabetes mellitus, and chronic kidney disease. In contrast, BUH patients had a higher body mass index (24.3 vs. 22.9). Blood pressure and heart rate on admission did not differ significantly between groups. Similarly, 30-day mortality following ACS onset showed no significant difference between groups. Average annual temperature, atmospheric pressure and humidity in 2021 also differed significantly between Thailand and Japan ($p < 0.001$). Regarding ACS subtypes (Table 2), STEMI was more frequent at WMU (66% vs. 24%), whereas NSTEMI predominated at BUH (62% vs. 27%).

TABLE 1. DEMOGRAPHIC, CLINICAL, AND METEOROLOGICAL CHARACTERISTICS OF ACS PATIENTS AT WMU AND BUH

Variables	BUH (n=93) Mean±SD	WMU (n=177) Mean±SD	P value
Age (years)	65.6±14.0	71.3±11.3	< 0.01
Male (%)	59 (62)	142 (80)	< 0.01
Body Mass Index (kg/m^2)	24.3±4.3	22.9±4.0	< 0.05
Systolic blood pressure at ER (mmHg)	136±27	137±35	.866
Diastolic blood pressure (mmHg)	80±17	81±21	.621
Heart rate at ER (beats/min)	91±25	87±24	.164
Body temperature at ER (°C)	36.5±0.4	36.3±0.7	< 0.01
White blood cell count	10,384±4,187	9,218±3,436	< 0.05
Hemoglobin (g/dL)	12.6±2.5	13.3±2.4	< 0.05
Platelet count (x10^3/µL)	265±72	221±76	< 0.001
Maximum creatinine kinase (normal value = 41-153 U/L)	-	1,653±2,927	-

Variables	BUH (n=93) Mean±SD	WMU (n=177) Mean±SD	P value
Maximum troponin T (normal value <= 14 ng/L)	28.8±61.9	-	-
Hypertension (%)	42 (45)	146 (82)	< 0.01
Diabetes mellitus (%)	27 (29)	72 (40)	< 0.001
Chronic kidney disease (%)	6 (6)	50 (28)	< 0.001
Death within 30 days of ACS onset (%)	6 (6.5)	8 (4.5)	.497
Average annual temperature (°C)	29.4±1.8	17.4±7.6	< 0.001
Average annual atmospheric pressure (hPa)	1,008.9±2.6	1,013.5±6.5	< 0.001
Average annual humidity (%)	75.8.±9.6	69.5±16.7	< 0.05

BUH = Burapha University Hospital, WMU = Wakayama Medical University, ACS = Acute coronary syndrome

TABLE 2. DISTRIBUTION OF ACS SUBTYPES IN PATIENTS AT WMU AND BUH

ACS categories	BUH (n=93)	WMU (n=177)	P value
STEMI (%)	22 (24)	117 (66)	< 0.001
NSTEMI (%)	58 (62)	47 (27)	< 0.001
UA (%)	13 (14)	13 (7)	< 0.001

BUH = Burapha University Hospital, WMU = Wakayama Medical University, ACS = Acute coronary syndrome, STEMI = ST-elevation myocardial infarction, NSTEMI = non-ST-elevation myocardial infarction, UA = unstable angina

PART 2: METEOROLOGICAL FACTORS ASSOCIATED WITH ACS ONSET AT BUH

The correlations among meteorological variables at the time of ACS onset in BUH are summarized in Table 3. Temperature and atmospheric pressure demonstrated a mild negative correlation (r = –0.356). Moderate negative correlations were observed between temperature and humidity (r = –0.607) and between atmospheric pressure and humidity (r = –0.502).

TABLE 3 PEARSON'S CORRELATION (R) OF METEOROLOGICAL VARIABLES IN ACS PATIENTS AT BUH

Variables	Correlation coefficient	*P*-value
T vs. P	-0.356	< 0.001
T vs. H	-0.607	< 0.001
P vs. H	-0.502	< 0.001

T = temperature, P = atmospheric pressure, H = humidity

DISCUSSION

This retrospective cohort study compared the incidence and risk factors of ACS in Thailand and Japan. No significant differences were observed in ACS onset time or 30-day mortality between the two countries, despite marked variations in patient characteristics. However, meteorological conditions, including temperature, atmospheric pressure, and humidity, differed substantially. These findings suggest that effective acute care systems in both countries may help mitigate short-term adverse outcomes following ACS, even under differing risk contexts.

Patient characteristics and ACS subtypes differed markedly between the two cohorts. Thai patients were younger and had higher body mass index (BMI), whereas Japanese patients were older with a greater prevalence of comorbidities including hypertension, diabetes, and chronic kidney disease. These demographic and clinical differences were reflected in the distribution of ACS subtypes: NSTEMI predominated in Thailand, while STEMI was more frequent in Japan. Obesity is increasingly recognized as a driver of premature coronary artery disease, particularly among younger adults, by promoting low-grade systemic inflammation, insulin resistance, and endothelial dysfunction [21-22]. These mechanisms may accelerate atherosclerosis progression and contribute to the higher proportion of NSTEMI in the Thai cohort. In contrast, aging, vascular stiffness, and multimorbidity may predispose Japanese patients to STEMI, consistent with previous studies demonstrating higher STEMI rates among older populations with advanced atherosclerotic burden [6]. These cross-country differences underscore the importance of early lifestyle interventions to address obesity and metabolic risk factors in Thailand, while highlighting the need for comprehensive management of comorbidities in aging populations such as Japan.

Beyond clinical differences, our study identified significant variations in meteorological conditions. Average annual temperature, atmospheric pressure, and humidity differed substantially between Thailand and Japan. Within the Thai cohort, temperature showed mild to moderate negative correlations with both atmospheric pressure and humidity. Specifically, lower temperatures were associated with increased humidity and reduced atmospheric pressure, conditions that may intensify vascular stress and elevate ACS risk [23]. These findings are consistent with prior evidence linking ambient temperature extremes and pressure fluctuations with myocardial infarction [16-18]. Cold exposure can induce vasoconstriction, increase sympathetic activity, and elevate blood pressure, while reduced atmospheric pressure may impair oxygen delivery and promote hemodynamic instability Meanwhile, high humidity can impair thermoregulation, placing additional stress on the cardiovascular system [23-26]. Although prior studies have typically examined these factors in isolation, our findings contribute novel evidence on the combined role of temperature, humidity, and pressure in ACS onset across different climate settings in Japan and Thailand. In addition to meteorological stressors, environmental pollution is a major public health concern in Thailand. Fine particulate matter (PM2.5) and other pollutants are prevalent in urban and industrialized regions and may act synergistically with meteorological changes to increase ACS incidence. Short-term exposure to PM2.5 has been associated with increased hospitalizations for myocardial infarction through mechanisms involving systemic inflammation, endothelial dysfunction, and enhanced thrombogenicity [27-29]. The combined effects of cold weather with high pollution levels, or conversely hot weather with low humidity, may amplify oxidative stress and vascular instability, precipitating acute coronary events [23-25]. Although air pollution data were not directly measured in this study, the co-existence of meteorological extremes and air pollution in many tropical and urbanizing environments highlights an important contextual factor. Future research integrating high-resolution meteorological and air quality data could further clarify the synergistic impact of these exposures on ACS onset. This direction is particularly relevant in Southeast Asia, where rapid urbanization, seasonal weather shifts, and recurrent haze episodes compound cardiovascular risks [30].

The differences identified between Thailand and Japan have important implications for prevention strategies. In Thailand, where younger patients with higher BMI and NSTEMI predominate, prevention efforts should prioritize obesity reduction and lifestyle modification. Public health programs promoting healthy diet, regular physical activity, and early cardiovascular risk screening in young and middle-aged adults could help mitigate premature coronary disease. In Japan, where patients are older with more comorbidities and a higher proportion of STEMI, prevention should focus on comprehensive management of chronic conditions such as hypertension and diabetes, dietary salt reduction, and regular cardiovascular health assessments. In both contexts, public education campaigns and primary care engagement are critical to encourage early detection and sustained risk-factor control.

At a broader level, climate adaptation and environmental health policies may also reduce ACS burden. For Thailand, strengthening air pollution control and urban planning to mitigate PM2.5 exposure could be integrated into cardiovascular prevention frameworks. For Japan, public health strategies may need to adapt to the cardiovascular risks of an aging society in a temperate climate with substantial seasonal variation. These tailored approaches highlight the importance of integrating clinical, environmental, and demographic perspectives in designing cardiovascular disease prevention strategies.

The main strength of this study is that it is among the first to compare ACS characteristics between Japan and Thailand while integrating meteorological perspectives, thereby offering novel context-specific insights. However, important limitations should be acknowledged, including its retrospective, single-center design with modest sample sizes, reliance on regional rather than individual meteorological data, and the absence of air pollution measures such as PM2.5, which may restrict the generalizability of the findings. Future multicenter prospective studies with larger cohorts, high-resolution environmental and pollution data, and longer follow-up are warranted to better elucidate the combined effects of meteorological and pollution exposures on ACS risk.

CONCLUSION

This study found no significant difference in ACS onset time between Thailand and Japan but revealed marked cross-country differences in demographic, clinical, and environmental profiles. Younger Thai patients with higher BMI more frequently presented with NSTEMI, whereas older Japanese patients with multiple comorbidities had a greater proportion of STEMI. Meteorological factors, particularly temperature, atmospheric pressure and humidity, were significantly associated with ACS onset in Thailand. These findings emphasize the need for tailored prevention strategies in each setting and underscore the importance of future research integrating clinical, meteorological, and environmental data to strengthen cardiovascular disease prevention in the context of climate change.

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CONFLICS OF INTEREST:

The authors declare that there is no conflict of interest.

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