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Risk Factor Burden and Management of Acute Coronary Syndromes in a Lebanese Tertiary Hospital

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Abstract

Background: Contemporary data on cardiovascular risk-factor burden and management of acute coronary syndromes (ACS) in Lebanon remain limited. This study assessed risk-factor patterns, treatment strategies, and admission-to-catheterization times at a Lebanese tertiary center. **Methods:** We retrospectively reviewed 285 consecutive patients admitted with ACS to Hôtel-Dieu de France Hospital, Beirut, between January 2023 and December 2024. Cardiovascular risk factors and treatment strategies were compared across ACS subtypes, age groups, and sex. Available admission-to-catheterization intervals were analyzed among patients with ST-segment elevation myocardial infarction (STEMI). **Results:** Mean age was 66.5 years, and 74.4% were male. STEMI, non-ST-segment elevation myocardial infarction, and unstable angina accounted for 17.9%, 43.5%, and 38.6% of presentations, respectively. Hypertension affected 74.4%, dyslipidemia 71.9%, smoking 63.5%, diabetes 38.6%, and obesity 29.1%; 80.7% had multiple modifiable risk factors. Compared with unstable angina, STEMI was associated with higher smoking prevalence (80.4% versus 57.3%; Bonferroni-adjusted $P < 0.05$), but lower hypertension (58.8% versus 81.8%) and dyslipidemia prevalence (54.9% versus 80.0%; both adjusted $P < 0.01$). Hypertension and dyslipidemia increased with age, whereas smoking was more prevalent among younger patients and men. Overall, 51.2% received medical management, 40.4% underwent percutaneous coronary intervention, and 8.4% underwent coronary artery bypass grafting. Among STEMI patients with available timing data, mean admission-to-catheterization time was 107 minutes, and 64.5% underwent catheterization within 90 minutes. Mean intervals were numerically shorter in 2024 than in 2023 (80 ver-

sus 144 minutes). **Conclusion:** This Lebanese ACS cohort had a high burden of modifiable cardiovascular risk factors, with differing patterns by ACS subtype, age, and sex. Prolonged admission-to-catheterization intervals among patients with STEMI suggest opportunities to improve the timeliness of care. These findings support intensified cardiovascular prevention and efforts to reduce treatment delays.

Keywords

Acute Coronary Syndrome, Cardiovascular Risk Factors, Lebanon, Percutaneous Coronary Intervention, Admission-to-Catheterization Time

1. Introduction

Acute coronary syndromes (ACS) are a major manifestation of coronary artery disease, whose development is strongly associated with modifiable risk factors such as smoking, hypertension, dyslipidemia, diabetes, and obesity [1]. Their management requires appropriate medical therapy and timely coronary revascularization when indicated [2]. Previous Lebanese studies have described ACS characteristics and treatment patterns, but updated observations are needed to characterize contemporary practice [3]. Assessing risk factor burden alongside management can help inform local prevention and care priorities. This study therefore aimed to provide a recent description of cardiovascular risk factor burden and management among patients presenting with ACS in Lebanon, examining risk factor patterns by ACS subtype, age, and sex, treatment strategies, and admission-to-catheterization times among patients with ST-segment elevation myocardial infarction (STEMI).

2. Methods

2.1. Study Population

This is a study of 285 consecutive patients admitted for acute coronary syndrome (ACS) at Hôtel-Dieu de France Hospital between January 1, 2023 and December 31, 2024. Hôtel-Dieu de France is one of the largest university hospitals in Lebanon, located in the capital, Beirut. It contains more than 300 beds, several of which are included in the cardiology department, 2 catheterization labs, as well as an active cardiovascular surgery program. Consecutive patients were identified through the hospital's electronic medical record system by reviewing admissions with a diagnosis of ACS during the study period. Repeat admissions of the same patient were excluded, with only the first eligible admission included in the analysis. Patients were classified as STEMI, non-ST-segment elevation myocardial infarction (NSTEMI), or unstable angina (UA) according to the diagnosis established by the treating cardiology team using contemporaneous guideline definitions. STEMI

was defined by clinical evidence of acute myocardial ischemia accompanied by persistent ST-segment elevation in contiguous electrocardiographic leads or an equivalent electrocardiographic pattern. NSTEMI was defined by evidence of acute myocardial ischemia without persistent ST-segment elevation, associated with a rise and/or fall in cardiac troponin levels, with at least one value exceeding the 99th percentile upper reference limit. UA was defined by clinical symptoms suggestive of acute myocardial ischemia without evidence of acute myocardial injury meeting the diagnostic criteria for myocardial infarction [2]. Medical records were retrospectively reviewed for all patients using the hospital's electronic medical record system to determine clinical characteristics (Age, Sex), cardiovascular risk factors (Smoking, Hypertension, Diabetes, Dyslipidemia, Obesity), personal and familial history of coronary artery disease (CAD) and treatment strategy (Medical management, Percutaneous Coronary Intervention [PCI], Coronary Artery Bypass Grafting [CABG]). Treatment strategy was classified as medical management, PCI, or CABG according to revascularization procedures performed at our center during the index admission. Patients who underwent diagnostic coronary angiography without PCI or CABG at our center were classified as receiving medical management. Revascularization performed at another hospital before transfer was not included in this classification; patients who received no additional revascularization at our center were therefore classified as receiving medical management. Smoking was defined as either current or former tobacco use, while patients who had never smoked were classified as nonsmokers. Obesity was defined as a body mass index (BMI) $\geq 30\ kg/m^2$. Hypertension, diabetes mellitus, and dyslipidemia were identified based on documented diagnoses in the medical record or ongoing treatment for the respective conditions. Personal history of CAD was considered positive if the patient had known coronary artery disease. Information on smoking, hypertension, diabetes mellitus, dyslipidemia, obesity and personal history of CAD was available for all 285 patients. Family history of CAD was considered positive if a first-degree family member (parent or sibling) had known coronary artery disease. Positive or negative family-history status was documented in 143 patients, while the remaining 142 had undocumented or unknown status. Percentages and comparisons involving family history were based only on patients with documented status. The admission-to-catheterization interval was calculated for patients with STEMI as the elapsed time between the documented hospital-admission and catheterization-laboratory arrival timestamps. Only patients who underwent catheterization at our center and had both timestamps available were included; patients who did not undergo catheterization at our center or lacked either timestamp were excluded from this analysis. The proportion with an interval of less than 90 minutes was calculated. This cutoff was informed by the guideline-recommended 90-minute first-medical-contact-to-first-device target for patients presenting directly to a PCI-capable hospital [4]. However, admission-to-catheterization time captures only part of this interval and was therefore used as a descriptive indicator of treatment timeliness rather than a measure of guideline

adherence.

2.2. Ethical Considerations

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Approval was obtained from the Ethics Committee of Hôtel-Dieu de France Hospital prior to data collection, with a waiver of the requirement for informed consent.

2.3. Statistical Analysis

All statistical analyses were performed using JASP. Categorical variables were compared using the chi-square (χ^2) test; when the expected cell count was <5, Fisher's exact test was used. Bonferroni correction was applied for pairwise comparisons. Continuous variables were assessed for normality using the Shapiro-Wilk test. When normality was not met, continuous variables were summarized as median and compared using the Mann-Whitney U test for two groups and the Kruskal-Wallis test for three or more groups. Variables were presented as percentages, except for age, which was reported as mean or median as appropriate. A P-value < 0.05 was considered statistically significant.

3. Results

The study included 285 patients with acute coronary syndrome: 51 with STEMI (17.9%), 124 with NSTEMI (43.5%), and 110 with unstable angina (38.6%). The mean age was 66.5 years, and 74.4% were male. Hypertension (74.4%), dyslipidemia (71.9%), and smoking (63.5%) were the most prevalent modifiable cardiovascular risk factors. Diabetes mellitus was present in 38.6% of patients and obesity in 29.1%, while 80.7% had more than one modifiable risk factor. A family history of CAD was reported in 74.8%, and 44.6% had a personal history of CAD. Hypertension prevalence differed across ACS presentations (P < 0.01), at 58.8% among patients with STEMI, 74.2% with NSTEMI, and 81.8% with unstable angina. Dyslipidemia also differed across presentations (P < 0.01), with corresponding prevalences of 54.9%, 71.8%, and 80.0%. Following Bonferroni correction for pairwise comparisons, only the difference between STEMI and unstable angina remained statistically significant for both hypertension and dyslipidemia (both adjusted P < 0.01). Smoking prevalence was highest among patients with STEMI (80.4%), followed by NSTEMI (62.1%) and unstable angina (57.3%; overall P < 0.05). After Bonferroni correction, the difference between STEMI and unstable angina remained statistically significant (adjusted P < 0.05). The prevalence of more than one modifiable risk factor was 64.7%, 83.0%, and 85.5%, respectively (overall P < 0.01). Corrected pairwise comparisons remained significant between STEMI and NSTEMI (adjusted P < 0.05) and between STEMI and unstable angina (adjusted P < 0.01). No statistically significant differences across presentations were observed for age, sex, family or personal history of CAD, obesity, or diabetes mellitus (**Table 1**).

Table 1. Baseline characteristics and cardiovascular risk factors by acute coronary syndrome presentation.

Risk factors	Overall (n = 285)	STEMI (n = 51)	NSTEMI (n = 124)	UA (n = 110)	P-value
Nonmodifiable risk factors					
Mean age, years	66.5	63.5	67.0	67.2	NS
Male sex	74.4%	70.6%	75.8%	74.5%	NS
Family history of CAD	74.8%	82.6%	73.5%	73.0%	NS
History of CAD	44.6%	33.3%	46.77%	47.27%	NS
Modifiable risk factors					
Hypertension	74.4%	58.8%	74.2%	81.8%	<0.01
Dyslipidemia	71.9%	54.9%	71.8%	80.0%	<0.01
Obesity	29.1%	23.5%	32.3%	28.2%	NS
Diabetes mellitus	38.6%	39.2%	43.5%	32.7%	NS
Smoking	63.5%	80.4%	62.1%	57.3%	<0.05
>1 modifiable risk factor	80.7%	64.7%	83.0%	85.5%	<0.01

Abbreviations: STEMI, ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; UA, unstable angina; CAD, coronary artery disease; NS, not statistically significant. Family-history percentages were calculated among patients with documented positive or negative status (overall n = 143); 142 patients had undocumented or unknown status.

Overall, 51.2% of patients received medical management, 40.4% underwent PCI, and 8.4% underwent CABG. Treatment strategy differed significantly by ACS presentation ($P < 0.0001$). PCI was the most frequent treatment among patients with STEMI (64.7%), whereas medical management predominated among those with NSTEMI (50.8%) and unstable angina (66.4%). CABG was performed in 15.7% of patients with STEMI, 8.9% with NSTEMI, and 4.5% with unstable angina. Treatment strategy also differed across age groups ($P < 0.01$). Among patients aged <45 years, 54.5% underwent PCI, 45.5% received medical management, and none underwent CABG. PCI was also the most frequent strategy among patients aged 45 - 65 years (51.3%), followed by medical management (40.2%) and CABG (8.5%). Among patients aged >65 years, medical management predominated (59.9%), while PCI and CABG were performed in 31.2% and 8.9%, respectively (Table 2).

Table 2. Treatment strategy by acute coronary syndrome presentation, overall and stratified by age.

Treatment strategy	Overall	STEMI	NSTEMI	UA
All patients	**n = 285**	**n = 51**	**n = 124**	**n = 110**
Medical management	51.2%	19.6%	50.8%	66.4%
PCI	40.4%	64.7%	40.3%	29.0%
CABG	8.4%	15.7%	8.9%	4.5%
<45 years				
Medical management	45.5%	33.3%	25.0%	75.0%
PCI	54.5%	66.7%	75.0%	25.0%
CABG	0.0%	0.0%	0.0%	0.0%

Continued

45 - 65 years				
Medical management	40.2%	7.4%	41.7%	59.5%
PCI	51.3%	74.0%	54.2%	33.3%
CABG	8.5%	18.5%	4.2%	7.2%
>65 years				
Medical management	59.9%	33.3%	58.3%	70.3%
PCI	31.2%	52.4%	29.2%	26.6%
CABG	8.9%	14.3%	12.5%	3.1%

Abbreviations: STEMI, ST-segment elevation myocardial infarction; NSTEMI, non-ST-segment elevation myocardial infarction; UA, unstable angina; PCI, percutaneous coronary intervention; CABG, coronary artery bypass grafting.

Hypertension prevalence increased across age groups, from 18.2% among patients aged <45 years to 58.1% among those aged 45 - 65 years and 90.5% among those aged >65 years ($P < 0.0001$). Dyslipidemia prevalence was 45.5%, 61.5%, and 81.5%, respectively ($P < 0.0001$). Conversely, smoking prevalence was lower in older age groups, at 90.9%, 69.2%, and 57.3%, respectively ($P < 0.05$). Obesity, diabetes mellitus, and family history of CAD did not differ significantly across age groups. Female patients were older than male patients, with median ages of 74 and 64 years, respectively ($P < 0.001$). Smoking was more prevalent among male than female patients (70.7% versus 42.5%; $P < 0.0001$), while the other reported cardiovascular risk factors did not differ significantly by sex (Table 3).

Table 3. Cardiovascular risk factors by age group and sex.

Panel A. Distribution by age group				
Characteristic	**<45 years**	**45 - 65 years**	**>65 years**	**P-value**
Hypertension	18.2%	58.1%	90.5%	<0.0001
Dyslipidemia	45.5%	61.5%	81.5%	<0.0001
Obesity	27.3%	30.8%	28.0%	NS
Diabetes mellitus	18.2%	37.6%	40.8%	NS
Smoking	90.9%	69.2%	57.3%	<0.05
Family history of CAD	75.0%	80.9%	68.7%	NS
Panel B. Distribution by sex				
Characteristic	**Male**	**Female**		**P-value**
Age, years, median	64	74		<0.001
Hypertension	72.2%	80.8%		NS
Dyslipidemia	71.2%	74.0%		NS
Obesity	29.7%	27.4%		NS
Diabetes mellitus	37.7%	41.1%		NS
Smoking	70.7%	42.5%		<0.0001
Family history of CAD	76.4%	70.3%		NS

Abbreviations: CAD, coronary artery disease; NS, not statistically significant.

Of the 51 patients with STEMI, 31 (60.8%) had usable admission-to-catheterization intervals. The remaining 20 patients either did not undergo catheterization at our center or lacked the timestamps required to calculate the interval. Among the 31 patients included, the mean interval was 107 minutes, and 20 (64.5%) underwent catheterization within 90 minutes. The mean interval was numerically shorter in 2024 (n = 18) than in 2023 (n = 13), at 80 versus 144 minutes; the corresponding proportions undergoing catheterization within 90 minutes were 13/18 (72.2%) and 7/13 (53.8%). By age group, mean intervals were 108 minutes among patients aged <45 years (n = 3), 102 minutes among those aged 45 - 65 years (n = 17), and 117 minutes among those aged >65 years (n = 11). The corresponding proportions undergoing catheterization within 90 minutes were 2/3 (66.7%), 13/17 (76.5%), and 5/11 (45.5%), respectively (Table 4).

Table 4. Admission-to-catheterization time among STEMI patients, overall and by year and age group.

Characteristic	Mean admission-to-catheterization time, minutes	Admission-to-catheterization time ≤ 90 minutes, %
Overall	107	64.52
Admission year		
2023	144	53.85
2024	80	72.22
Age group		
<45 years	108	66.67
45 - 65 years	102	76.47
>65 years	117	45.45

4. Discussion

4.1. Risk-Factor Burden in Regional and Temporal Context

The present cohort demonstrated a substantial cardiovascular risk-factor burden, with hypertension affecting 74.4%, dyslipidemia 71.9%, smoking 63.5%, diabetes 38.6%, and obesity 29.1%; 80.7% had more than one modifiable risk factor. Hypertension, dyslipidemia, and smoking were more prevalent than in PEACE MENA, which reported corresponding prevalences of 57.1%, approximately 41%, and 51.6% [5]. A similar comparison emerges with Gulf COAST, a registry of 3188 patients with ACS from four Gulf countries, where hypertension affected 66%, dyslipidemia 55.8%, and active smoking 23.2% [6]. However, diabetes was less prevalent in our cohort than in either registry, indicating that the excess burden was concentrated in particular risk factors rather than uniformly greater across all cardiometabolic conditions.

Several factors may contribute to these differences. The cited PEACE MENA analysis included patients with myocardial infarction, whereas 38.6% of our cohort had unstable angina. This difference in diagnostic composition may influence the observed risk-factor prevalences and limits direct comparison between the cohorts. Our cohort was older than PEACE MENA (mean 66.5 vs. 58 years), poten-

tially allowing longer exposure to elevated blood pressure and lipid abnormalities and more opportunities for their diagnosis [5]. Its tertiary-center referral setting may also select patients with a greater burden of established disease. These are plausible explanations rather than demonstrated determinants, and differences in risk-factor definitions and ascertainment must also be considered. In particular, comparisons of smoking prevalence require consistent classification of current and former smoking. Nevertheless, the high smoking prevalence is compatible with evidence of substantial tobacco exposure in Lebanon: the multinational ACE study reported current smoking in 43% of its Lebanese outpatient sample, the highest country-specific proportion among participating countries [7]. Although that population was not an ACS cohort, the finding provides context for the prominence of smoking in our patients.

Independent Lebanese studies provide evidence of adverse changes in population health that could contribute to the contemporary risk-factor burden. Two national surveys using comparable methods documented an increase in adult obesity from 17.4% in 1997 to 28.2% in 2009 [8]. Analysis of dietary changes over the same period found declining consumption of fruit and milk and increasing consumption of added fats and oils and several snack-food categories, consistent with an ongoing nutrition transition [9]. Such changes offer a plausible background for the accumulation of metabolic risk. Moreover, risk factors may persist because prevention involves both detection and sustained treatment: a Lebanese study of hospitalized cardiovascular patients identified low adherence to dietary, medication, and physical activity recommendations [10]. Taken together, our findings suggest a substantial opportunity for prevention through systematic blood pressure and lipid assessment, effective long-term treatment, smoking cessation, and accessible dietary and physical activity support. The higher prevalence of cardiovascular risk factors compared with historical Lebanese ACS cohorts may effectively reflect a true increase over time, although differences in age, referral patterns, diagnostic criteria, and documentation could also contribute to the observed differences [3].

4.2. Risk-Factor Profiles across ACS Subtypes

Risk-factor profiles differed across admission diagnoses, with smoking most prevalent in STEMI, whereas hypertension and dyslipidemia were more prevalent in non-ST-elevation presentations. This pattern broadly resembles PEACE MENA, where smoking was more common in STEMI and hypertension and prior coronary disease were more common in NSTEMI; hypercholesterolemia was numerically higher in NSTEMI but did not differ significantly [5]. Smoking's promotion of platelet activation and coagulation provides a plausible explanation for its prominence in STEMI, where abrupt coronary thrombotic occlusion commonly drives presentation [11] [12]. Conversely, sustained blood-pressure exposure and lipid accumulation contribute to the development and progression of coronary atherosclerosis, potentially explaining the greater clustering of hypertension and dyslipidemia

in NSTEMI and UA [1] [11]. These interpretations remain hypotheses: the observed risk-factor distribution cannot establish coronary anatomy or the mechanism of the presenting event, and plaque disruption and thrombosis can occur across ACS subtypes [11].

4.3. Age and Sex Patterns

Hypertension and dyslipidemia were more prevalent at older ages, potentially reflecting age-related arterial stiffening and changes in lipid metabolism, including reduced LDL clearance [13] [14]. Smoking was more prevalent among younger patients and men, consistent with the smoking-predominant profile described among younger MENA patients with ACS [15]. Smoking promotes endothelial dysfunction, inflammation, platelet activation, and thrombosis, providing a biological basis for its association with premature coronary disease [12]. Women were approximately a decade older than men at presentation, consistent with the older age of women in the Malaysian NCVD-ACS registry [16]. Women generally develop coronary disease later than men, and the menopausal transition is accompanied by adverse changes in lipids, body composition, and vascular health that may contribute to increasing cardiovascular risk in midlife [17]. The higher prevalence of smoking among men may also partly contribute to their younger age at presentation, given its association with premature coronary disease [12] [15]. The findings support tobacco prevention and cessation, particularly among younger adults and men, alongside cardiovascular risk assessment in women during midlife.

4.4. Treatment Strategy by Diagnosis and Age

PCI was performed in 64.7% of STEMI patients and was more frequent in younger patients, whereas medical management predominated among patients with NSTEMI, unstable angina, and those older than 65 years. The higher PCI rate in STEMI is consistent with the need for urgent reperfusion, for which primary PCI is the preferred strategy when achievable within recommended timelines. In contrast, invasive management in NSTE-ACS is guided by clinical risk, with immediate angiography indicated for very-high-risk presentations and subsequent revascularization determined by coronary anatomy and clinical suitability [2] [4]. The lower revascularization rate among older patients may reflect more individualized treatment decisions, balancing the anticipated benefit of intervention against frailty, comorbidities, procedural risk, functional status, and patient preferences [13]. For regional context, the PEACE MENA pilot reported primary PCI in 56.4% of STEMI patients, thrombolysis in 24%, and no acute reperfusion in 19.5% [18]. Direct comparison with our PCI rate requires caution because procedure definitions, patient characteristics, and referral patterns may differ. Possible explanations for STEMI patients without recorded revascularization include late presentation after a completed infarction without ongoing ischemia, coronary anatomy unsuitable for intervention, or treatment decisions based on comorbidity and goals of care [2] [13].

The procedural data captured only interventions performed at our center, therefore patients transferred after revascularization at another hospital could also have been classified as receiving medical management during the index admission.

4.5. Reperfusion Timelines

Mean admission-to-catheterization time was numerically shorter in 2024 than in 2023 (1 h 20 min versus 2 h 24 min), while the proportion of STEMI patients undergoing catheterization within 90 minutes increased from 53.85% to 72.22%, suggesting improved timeliness of access to catheterization. However, catheterization precedes reperfusion, and the measured interval excludes the additional time from catheterization to reperfusion. The interval relevant to guideline-recommended reperfusion targets would therefore be longer. Consequently, the proportion undergoing catheterization within 90 minutes may overestimate timely reperfusion and should not be interpreted as the proportion achieving guideline targets [2] [4]. Delays were also documented in a study published in 2013 and conducted at the American University of Beirut Medical Center, which reported a median door-to-balloon time of 110 minutes, with only 30% of patients achieving an interval of ≤90 minutes. Although differences in centers, populations, and timing definitions preclude direct comparison, these earlier observations and our findings suggest that treatment delays may remain a concern in Lebanon [19]. Older patients experienced longer delays, with a mean interval of 1 h 57 min and 45.45% undergoing catheterization within 90 minutes. Atypical presentations and diagnostic challenges described in older adults may contribute to such delays, although these mechanisms were not assessed in this study [13]. The reasons for the year-over-year improvement remain uncertain. Nevertheless, the observed delays identify opportunities for further improvement through rapid triage and ECG acquisition, standardized catheterization-laboratory activation, and coordinated STEMI systems of care [2] [4] [20] [21].

4.6. Limitations

This study has several limitations. It is a single-center, retrospective analysis at a large urban tertiary hospital, which limits generalizability to community settings and to the broader Lebanese population, and introduces potential referral and selection bias. Risk factors were ascertained from electronic records and depend on documentation completeness, risking misclassification. Subgroup comparisons were unadjusted, and differences across ACS presentations and treatment groups may reflect confounding by age, sex, and prior CAD rather than independent associations. The sample size, particularly the STEMI subgroup (n = 51), limits statistical power for subgroup and pairwise comparisons, and the Bonferroni-corrected analyses may therefore be conservative. Clinical outcomes, including in-hospital and longer-term mortality, reinfarction, and heart failure, were not assessed, so the prognostic implications of the observed management patterns and

treatment delays cannot be determined. Finally, admission-to-catheterization time captures only part of the delay to reperfusion. It excludes prehospital delays, including the interval from symptom onset to seeking medical care, emergency transport, and any transfer before admission to our center. It also excludes the interval between the start of catheterization and reperfusion. Consequently, catheterization within 90 minutes should not be interpreted as achievement of guideline-recommended reperfusion targets, which measure the interval from first medical contact or STEMI diagnosis to first-device activation or wire crossing during PCI, rather than from hospital admission to the start of catheterization [2] [4].

5. Conclusion

In this contemporary Lebanese ACS cohort, modifiable cardiovascular risk factors were highly prevalent, with smoking more prominent in STEMI and hypertension and dyslipidemia more common in non-ST-elevation presentations. Admission-to-catheterization times among patients with STEMI were numerically shorter in 2024 than in 2023, although delays persisted, particularly among older patients. These findings support intensified tobacco prevention and cessation, sustained control of metabolic risk factors, and continued strengthening of STEMI systems of care. Prospective multicenter studies incorporating prehospital delays, time to reperfusion, and clinical outcomes are needed to guide prevention and evaluate ACS care in Lebanon.

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Author Contributions

Conceptualization, A.M., H.M., and T.A.M.; methodology, A.M. and H.M.; formal analysis, A.M. and H.M.; investigation, A.M., H.M., A.C., P.S., and H.N.; data curation, A.M., H.M., A.C., P.S., and H.N.; writing—original draft preparation, A.M. and H.M.; writing—review and editing, A.M., H.M., A.C., P.S., H.N., and T.A.M.; supervision, T.A.M. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Yusuf, S., Hawken, S., Ôunpuu, S., Dans, T., Avezum, A., Lanas, F., *et al.* (2004) Effect of Potentially Modifiable Risk Factors Associated with Myocardial Infarction in 52 Countries (the INTERHEART Study): Case-Control Study. *The Lancet*, **364**, 937-952. https://doi.org/10.1016/s0140-6736(04)17018-9

[2] Byrne, R.A., Rossello, X., Coughlan, J.J., Barbato, E., Berry, C., Chieffo, A., *et al*. (2023) 2023 ESC Guidelines for the Management of Acute Coronary Syndromes. *European Heart Journal*, **44**, 3720-3826. https://doi.org/10.1093/eurheartj/ehad191

[3] Abdallah, M., Karrowni, W., Shamseddeen, W., Itani, S., Kobeissi, L., Ghazzal, Z., *et al*. (2010) Acute Coronary Syndromes: Clinical Characteristics, Management, and Outcomes at the American University of Beirut Medical Center, 2002-2005. *Clinical Cardiology*, **33**, E6-E13. https://doi.org/10.1002/clc.20636

[4] Rao, S.V., O'Donoghue, M.L., Ruel, M., Rab, T., Tamis-Holland, J.E., Alexander, J.H., *et al*. (2025) 2025 ACC/AHA/ACEP/NAEMSP/SCAI Guideline for the Management of Patients with Acute Coronary Syndromes: A Report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation*, **151**, e771-e862.

[5] Al Saleh, A., Jamee, A., Sulaiman, K., Sobhy, M., Gamra, H., Alkindi, F., *et al*. (2024) Clinical Features, Socioeconomic Status, Management, Short and Long-Term Outcomes of Patients with Acute Myocardial Infarction: Phase I Results of PEACE MENA Registry. *PLOS ONE*, **19**, e0296056. https://doi.org/10.1371/journal.pone.0296056

[6] Zubaid, M., Thani, K.B., Rashed, W., Alsheikh-Ali, A., Alrawahi, N., Ridha, M., *et al*. (2014) Design and Rationale of Gulf Locals with Acute Coronary Syndrome Events (Gulf COAST) Registry. *The Open Cardiovascular Medicine Journal*, **8**, 88-93. https://doi.org/10.2174/1874192401408010088

[7] Alsheikh-Ali, A.A., Omar, M.I., Raal, F.J., Rashed, W., Hamoui, O., Kane, A., *et al*. (2014) Cardiovascular Risk Factor Burden in Africa and the Middle East: The Africa Middle East Cardiovascular Epidemiological (ACE) Study. *PLOS ONE*, **9**, e102830. https://doi.org/10.1371/journal.pone.0102830

[8] Nasreddine, L., Naja, F., Chamieh, M.C., Adra, N., Sibai, A. and Hwalla, N. (2012) Trends in Overweight and Obesity in Lebanon: Evidence from Two National Cross-Sectional Surveys (1997 and 2009). *BMC Public Health*, **12**, Article No. 798. https://doi.org/10.1186/1471-2458-12-798

[9] Nasreddine, L., Ayoub, J.J., Hachem, F., Tabbara, J., Sibai, A.M., Hwalla, N., *et al*. (2019) Differences in Dietary Intakes among Lebanese Adults over a Decade: Results from Two National Surveys 1997-2008/2009. *Nutrients*, **11**, Article No. 1738. https://doi.org/10.3390/nu11081738

[10] Al Daccache, M., Al-Shaar, L., Sibai, A.M., Ismaeel, H., Badr, K. and Nasreddine, L. (2023) Psychosocial Characteristics Are Associated with Adherence to Dietary, Drugs and Physical Activity Recommendations Amongst Cardiovascular Disease Patients in Lebanon. *PLOS ONE*, **18**, e0287844. https://doi.org/10.1371/journal.pone.0287844

[11] Bergmark, B.A., Mathenge, N., Merlini, P.A., Lawrence-Wright, M.B. and Giugliano, R.P. (2022) Acute Coronary Syndromes. *The Lancet*, **399**, 1347-1358. https://doi.org/10.1016/s0140-6736(21)02391-6

[12] Ishida, M., Sakai, C., Kobayashi, Y. and Ishida, T. (2024) Cigarette Smoking and Atherosclerotic Cardiovascular Disease. *Journal of Atherosclerosis and Thrombosis*, **31**, 189-200. https://doi.org/10.5551/jat.rv22015

[13] Damluji, A.A., Forman, D.E., Wang, T.Y., Chikwe, J., Kunadian, V., Rich, M.W., *et al*. (2023) Management of Acute Coronary Syndrome in the Older Adult Population: A Scientific Statement from the American Heart Association. *Circulation*, **147**, e32-e62. https://doi.org/10.1161/cir.0000000000001112

[14] Ericsson, S., Eriksson, M., Vitols, S., Einarsson, K., Berglund, L. and Angelin, B. (1991) Influence of Age on the Metabolism of Plasma Low Density Lipoproteins in Healthy Males. *Journal of Clinical Investigation*, **87**, 591-596.

https://doi.org/10.1172/jci115034

[15] Manla, Y. and Almahmeed, W. (2023) The Pandemic of Coronary Heart Disease in the Middle East and North Africa: What Clinicians Need to Know. *Current Atherosclerosis Reports*, **25**, 543-557. https://doi.org/10.1007/s11883-023-01126-x

[16] Lee, C.Y., Liu, K.T., Lu, H.T., Ali, R.M., Fong, A.Y.Y. and Ahmad, W.A.W. (2021) Sex and Gender Differences in Presentation, Treatment and Outcomes in Acute Coronary Syndrome, a 10 Year Study from a Multi-Ethnic Asian Population: The Malaysian National Cardiovascular Disease Database—Acute Coronary Syndrome (NCVD-ACS) Registry. *PLOS ONE*, **16**, e0246474. https://doi.org/10.1371/journal.pone.0246474

[17] El Khoudary, S.R., Aggarwal, B., Beckie, T.M., Hodis, H.N., Johnson, A.E., Langer, R.D., *et al*. (2020) Menopause Transition and Cardiovascular Disease Risk: Implications for Timing of Early Prevention: A Scientific Statement from the American Heart Association. *Circulation*, **142**, e506-e532. https://doi.org/10.1161/cir.0000000000000912

[18] Alhabib, K.F., Gamra, H., Almahmeed, W., Hammoudeh, A., Benkheddah, S., Al Jarallah, M., *et al*. (2020) Acute Myocardial Infarction and Acute Heart Failure in the Middle East and North Africa: Study Design and Pilot Phase Study Results from the PEACE MENA Registry. *PLOS ONE*, **15**, e0236292. https://doi.org/10.1371/journal.pone.0236292

[19] Rabah, A., El-Sibai, K., Dakik, A., Itani, S. and Dakik, H.A. (2013) Current Reperfusion Strategies for ST-Elevation Myocardial Infarction in an Academic Medical Center in a Developing Country. *Critical Pathways in Cardiology: A Journal of Evidence-Based Medicine*, **12**, 24-27. https://doi.org/10.1097/hpc.0b013e31827853ae

[20] Nascimento, B.R., Brant, L.C.C., Marino, B.C.A., Passaglia, L.G. and Ribeiro, A.L.P. (2019) Implementing Myocardial Infarction Systems of Care in Low/Middle-Income Countries. *Heart*, **105**, 20-26. https://doi.org/10.1136/heartjnl-2018-313398

[21] Su, H.-Y., Tsai, J.-L., Hsu, Y.-C., Lee, K.-H., Chang, C.-S., Sun, C.-K., *et al*. (2021) A Modified Cardiac Triage Strategy Reduces Door to ECG Time in Patients with ST Elevation Myocardial Infarction. *Scientific Reports*, **11**, Article No. 6358. https://doi.org/10.1038/s41598-021-86013-8