Original Article https://doi.org/10.70084/mru/pmrcc/042.P32

Managing Acute Coronary Syndrome in Sudan: A Tertiary Hospital Experience

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Cite: *Osman* et al. Managing Acute Coronary Syndrome in Sudan: A Tertiary Hospital Experience. Medical Research Updates Journal 2026;4(2):33-42. https://doi.org/10.70084/mru/pmrcc/042.P32

ABSTRACT

Background: Acute Coronary Syndrome (ACS) is the leading cause of death and loss of disability-adjusted life years (DALYs) in the world, particularly in low- and middle-income countries. The present study aimed to examine management trends in acute coronary syndrome (ACS) at a prominent tertiary hospital in Sudan. **Methodology:** This is a prospective descriptive hospital-based study conducted at Al Shaab Teaching Hospital in Khartoum, Sudan, the country's principal tertiary hospital, which hosts the National Cardiac Center. The study includes all patients admitted to the emergency department with ACS, irrespective of demographic characteristics. The study includes all patients hospitalized in the emergency department with ACS, irrespective of demographic characteristics. **Results:** We enrolled 110 patients with ACS, aged 35 to 78 years, including 66.4% males and 33.6% females. Most of the patients (74.5%) were diagnosed with ST-elevation ACS (STE-ACS), with 62% being males. The relative risk (RR) of males developing ACS is 0.792, with a 95% confidence interval (95% CI) of 0.612 to 1.023 and a P-value of 0.086. Most of the patients (72.7%) received streptokinase thrombolysis. About 1.8% of patients had primary percutaneous coronary intervention (PPCI), and 44.5% had percutaneous coronary intervention (PCI). Around 25.5% had a coronary angiography (CAG) for NSTA-ACS. PCI was performed on 44.5% of patients, while 32.7% received medicinal therapy, 18% were discharged from the cardiothoracic-cardiology conference (CTC), and 5% underwent coronary artery bypass graft surgery. **Conclusion:** ACS, especially NSTE-ACS, predominates in men; streptokinase thrombolysis dominates treatment with PCI and limited PPCI. Angiographic disease load is mostly SVD, and severe disease presentation is common. ACS type and treatment routes differ by gender; however, the RR for males was not statistically significant, indicating that more research is needed to validate sex-related risk differences.

Keywords: Acute Coronary Syndrome, STEMI, NSTEMI, Thrombolysis, PCI, Sudan

Introduction

Despite the recent advances concerning the diagnosis and treatments of coronary artery disease (CAD), the disease remains the commonest single cause of mortality and loss of Disability Adjusted Life Years (DALYs) in the world, particularly in low and middle-

income nations. It is responsible for about 7 million deaths and 129 million DALYs annually. There are rapid changes regarding the age-standardized mortality rates (ASMRs) for ACS. In 2020, low- and middle-income countries around the world had higher ASMRs. This is a change from 20 years ago, when high-income countries had the highest rates. A more stable range of mortality levels for ACS is found in Asia, Latin America, and the Caribbean, in contrast to the high-income nations like Europe, North America, and Oceania, which reported a progressive decline in mortality [1-3]. ACS encompasses two categories: ST-Segment Elevation (STE-ACS) and Non-ST-Segment Elevation (NSTE-ACS). Most of the STE-ACS and NSTE-ACS result from acute rupture or erosion of an underlying atherosclerotic plaque, with rupture dominating in STEMI. Rupture and erosion primarily occur in thin-cap microatheromatous plaques, which contain abundant lipids and an active zone of inflammatory cells, whereas the more stable thick-cap atheromatous plaques, characterized by fewer lipid cores, inflammation, and abundant calcium, tend to present with more stable disease (Chronic Coronary Syndrome (CCS)). Recently, a lot of attention has been exerted on the other less frequent causes of ACS, like coronary artery spasm, microvascular circulation dysfunction, coronary embolism, spontaneous coronary artery dissection (SCAD), and acute emotional disturbances [4-6]. Sudan stands as one of the very few countries in Africa and the world in offering free thrombolytic therapy, besides cardiac catheterization (Cath lab) laboratory services, for the public [7]. These services saved the lives of many Sudanese people before and during the armed conflict, particularly in the hot zone areas of the 2023 war [8, 9]. The current study aims to investigate the management patterns of ACS in the major Sudanese tertiary hospital.

Materials and Methods

This is a prospective descriptive hospital-based study conducted at Alshaab Teaching Hospital, Khartoum, Sudan, which is the main tertiary hospital in Sudan, where there is the National Cardiac Center. The study spanned from September 1, 2020, to December 1, 2020. The study encompasses all patients admitted to the emergency department with ACS regardless of any restricted conditions or demographic characteristics. We collected the relevant patients' data as part of the requisites for patient management in the hospital. We obtained ethical approval from the hospital authorities. We implemented the recent European Society of Cardiology (ESC) guidelines for the diagnosis of ACS [10].

Statistical analysis

After data collection, we put them into a data sheet before entering them into the computer software Statistical Package for the Social Sciences (SPSS), version 20, Chicago, USA. The relevant variables and cross-tabulation were computed. We calculated the relative risks (RR) and chi-square test at a 95% confidence interval (CI), and a P-value of less than 0.05 was deemed significant.

Results

We investigated 110 patients with ACS, aged 35 to 78 years, with a mean age of 58 years and a standard deviation (SD) of 10.81. Males represented 73/110 (66.4%) of the total, while females represented 37 (33.6%). The bulk of the patients, 82/110 (74.5%), in this series were diagnosed with STE-ACS, 51/82 (62%) of whom were males and 31 (37.8%) of whom were females. Of the 28/110 (25.5%) patients with NSTE-ACS, 22/28 (78.57%) were males, and 6 (27.27%) were females. The risk of males developing ACS is RR (95% CI) = 0.792 (0.612 to 1.023), P-value = 0.086. Concerning reperfusion

therapy, 80/110 (72.7%) received thrombolysis with streptokinase, 2/110 (1.8%) had primary percutaneous coronary intervention (PPCI), and the remaining 28/110 (25.5%) underwent coronary angiogram (CAG) for NSTA-ACS. Most of the thrombolysis group, 51/80 (63.8%), and those with the NSTE-ACS group who had CAG, 22/28 (78.6%), were males, while 2/2 (100%) of the PPCI group were females, as indicated in Table 1 and Fig. 1.

Table 1: Illustrations of individuals based on sex, ACS type, and mode of reperfusion therapy.

Variable	Males n= 73	Females n = 37	Total n= 110
ACS type			
STE-ACS	51	31	82
NSTE-ACS	22	6	28
Total	73	37	110
Reperfusion			
Thrombolysis	51	29	80
PPCI	0	2	2
CAG for NSTE-ACS	22	6	28
Total	73	37	110

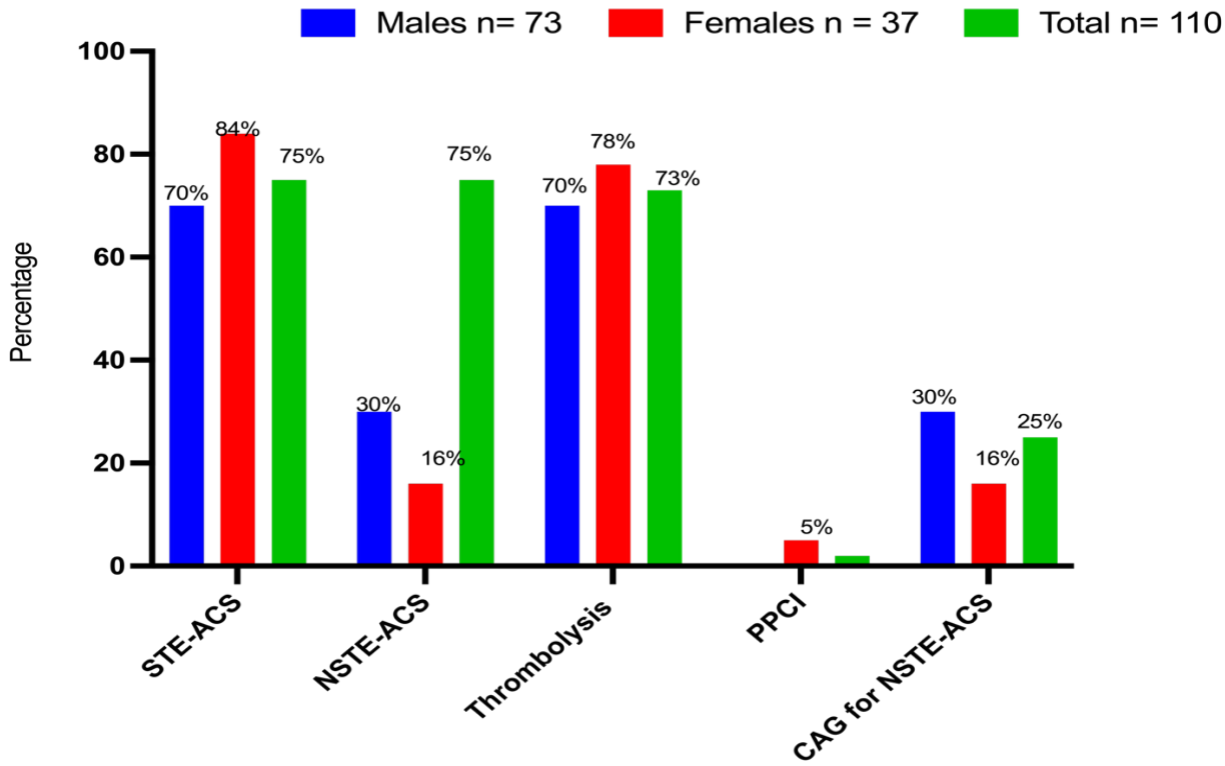

Figure 1. Depiction of individuals based on sex, ACS type, and mode of reperfusion

Table 2, Fig. 2, summarizes the distribution of the participants according to sex and the results of CAG, STEMI site, and lesion severity. Most of those who underwent CAG

had single-vessel disease (SVD), followed by three-vessel disease (TVD) and 2-vessel disease (2VD), representing 44/110 (40%), 33/110 (30%), and 20/110 (18%), respectively. Males were more frequently encountering SVD, followed by TVD and 2VD, constituting 27/73 (37%), 24/73 (33%), and 12/73 (16%), in that order, whereas most females encountered SVD, followed by TVD and 2VD, representing 17/37 (46%), 9/37 (24%), and 8/37 (22%), in that order.

For the STEMI site (available for 82 patients), most patients presented with anterior, followed by inferior and anterolateral, representing 37/82 (45%), 25/82 (30.4%), and 12/82 (14.6%), respectively.

The severity of disease data is available for 97 patients. Most patients were presented as severe (>70%), followed by moderate (50-70%) and mild (<50%), representing 54/97 (55.7%), 35/97 (36%), and 8/97 (8.3%), in that order.

Table 2: Distribution of the participants according to sex and the result of CAG, STEMI site, and lesion severity.

Variable	Males	Females	Total
Results of CAG			
Normal	10	3	13
SVD	27	17	44
2VD	12	8	20
TVD	24	9	33
Total	73	37	110
STEMI site			
Anterior STEMI	24	13	37
Inferior STEMI	15	10	25
Anterolateral STEMI	8	4	12
Lateral STEMI	2	2	4
Inferolateral STEMI	2	2	4
Total	51	31	82
Lesion severity			
Mild (< 50%)	6	2	8
Moderate (50-70%)	22	13	35
Severe (>70%)	35	19	54
Total	63	34	97

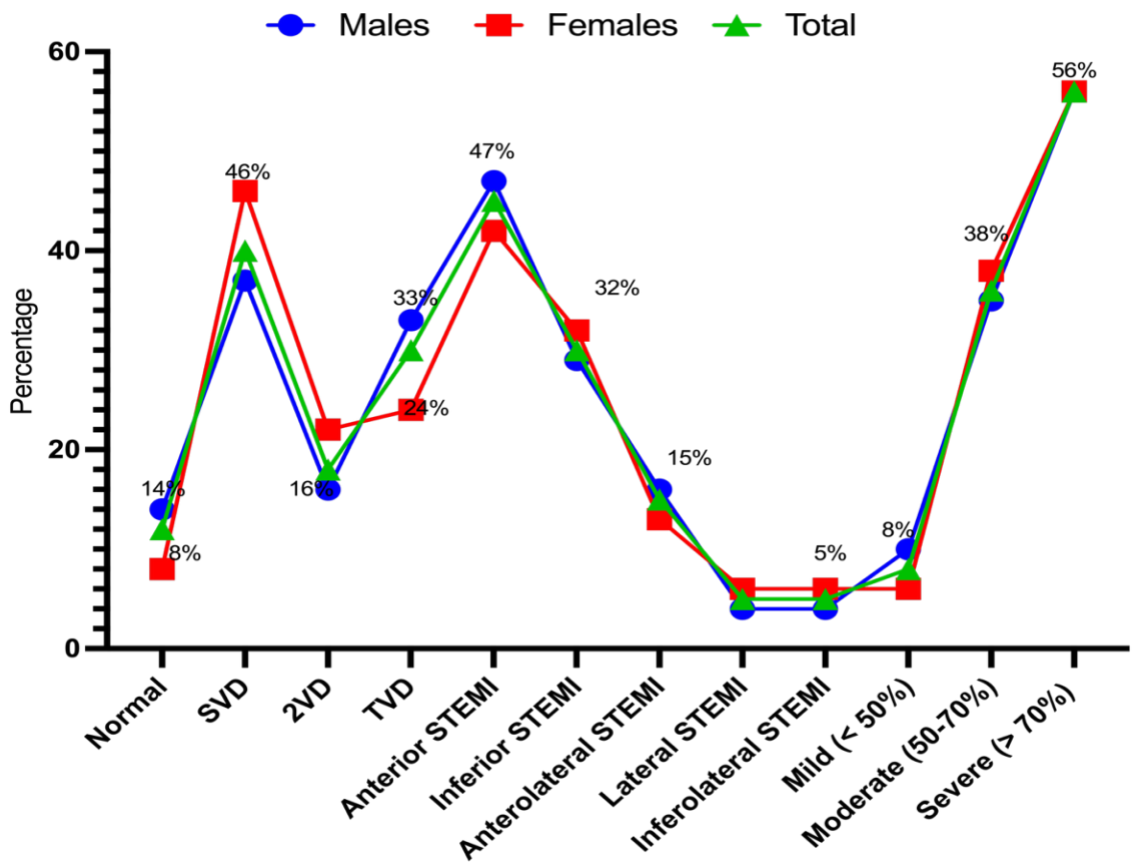

Figure 2. Depiction of the participants according to sex and the result of CAG, STEMI site, and lesion severity.

Concerning the therapeutic options, the bulk of the participants underwent PCI, followed by those who received medical therapy and cardiothoracic cardiology conference (CTC), which constituted 49/110 (44.5%), 36 (32.7%), and 20 (18%), respectively. For the PCI group, most of them were males, 32/49 (65.3%). About 2/49 (4%) were smokers, and 10/49 (20.4%) were ex-smokers. About 17/49 (38.7%) were hypertensive, and 25/49 (51%) were diabetic patients. For those who received medical therapy, 22/36 (61.1%) were males, including 2/36 (5.6%) smokers, 18/36 (50%) hypertensives, and 19/36 (52.8%) diabetics. The CTC group included 14/20 (70%) males, 10/20 (50%) ex-smokers, 8/20 (40%) hypertensives, and 10/20 (50%) diabetics, as illustrated in Table 1 and Fig. 1.

Table 4. Shows the individuals' treatment modality, sex, and risk factors of CAD.

Variable	PCI	Medical therapy	CTC	CABG	Total
Sex					
Males	32	22	14	5	73
Females	17	14	6	0	37
Total	49	36	20	5	110
Smoking					
Yes	2	2	0	0	4
No	37	34	10	3	84
Ex-smoker	10	0	10	2	22
Total	49	36	20	5	110

Hypertension					
Yes	17	18	8	5	48
No	32	18	12	0	62
Total	49	36	20	5	110
DM					
Yes	25	19	10	5	59
No	24	17	10	0	51
Total	49	36	20	5	110

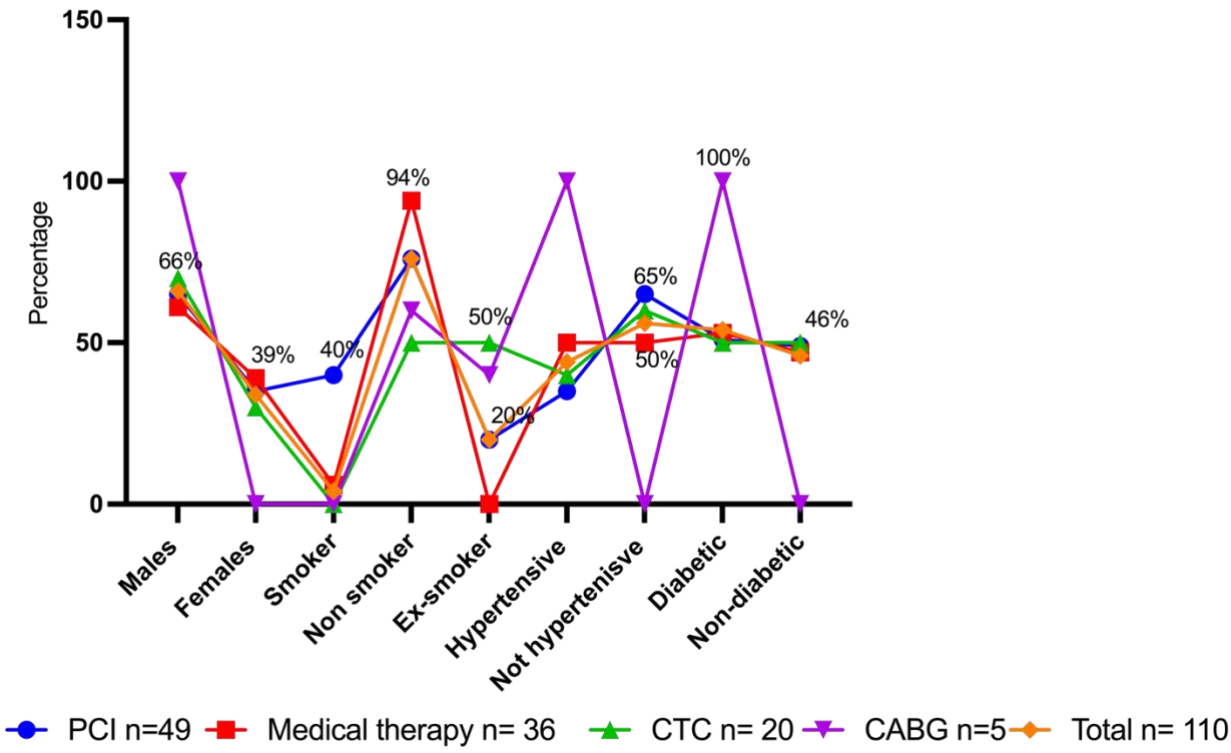

Figure 3. Shows the individual's treatment modality, sex, and risk factors of CAD.

Discussion

Despite significant patient care advancements, ACS has been the leading cause of death worldwide for decades. New cardiology interventions, beyond drug therapy, have improved patient care and mortality, but many regions still lack basic cardiac services like electrocardiography (ECG), thrombolytic therapy, defibrillators, and trained frontline cardiac service providers. Another obstacle to optimal patient care in low-resource settings in sub-Saharan Africa is the lack of cardiac catheterization laboratory facilities, especially during wartime, and adequately qualified cardiology staff. Although Sudan is one of the leading African countries in cardiology and interventional cardiology, the 2023–2026 military conflict has interrupted the health system, harming cardiac patient care. Thus, this study examines acute coronary syndrome medical treatment in Sudan before the war.

In this study, STE-ACS accounts for 75% of the ACS patients. This conclusion is greater than earlier Sudanese data from another tertiary hospital at 58% [11], as well as

reports from certain African research (56%) [12]. However, our findings are more in line with studies from India and China, ranging from 60 to 80 percent [13]. Acute emergency department presentations of CAD are most often ST-segment elevation myocardial infarction (STEMI), in which the culprit artery is completely or partially blocked. Over 3 million occurrences occur annually worldwide. This condition is caused by the abrupt rupture of atherosclerotic plaques, which leads to platelet adhesion, aggregation, and activation, resulting in vascular blockage due to thrombus development. STEMI symptoms ranged from chest discomfort to abrupt cardiac arrest. Early recognition and interpretation of the ECG, along with other modalities for acute chest pain evaluation, such as cardiac troponins and echocardiography, within the designated time frame, is needed to salvage the myocardium by providing viable reperfusion therapy that preserves the culprit vessels. Studies have shown that this therapy can improve overall mortality and patient care if delivered promptly. ECGs have traditionally been used to diagnose STEMI, which is characterized by persistent ST-segment elevation (STE), although studies have shown that up to 25–34% of NSTEMI cases may have total coronary artery blockage [14–17].

In this study, males account for the majority (66.4%) of patients, indicating a clear sex imbalance in the ACS burden within this cohort.

Males constituted 62% of STE-ACS, compared to 37.8% of females, implying that men constituted a greater share of STEMI presentations in this sample. Males dominated NSTE-ACS (78.6%), with females accounting for 27.3%. Overall, the predicted risk of males getting ACS was RR = 0.792 (95% confidence interval: 0.612-1.023), p = 0.086. Despite a trend towards a female advantage (RR < 1), the correlation was not statistically significant at the 0.05 level. The large confidence interval covering 1.0 indicates uncertainty, most likely due to sample size and case dispersion among ACS categories. This series, like most previously published Sudanese data [18, 19], is dominated by men, which is also consistent with worldwide statistics [20] and African literature. In one big meta-analysis from Africa encompassing 11,507 patients who underwent PCI, 74% were males [21]. However, female predominance for NSTE-ACS has been documented in Sudan, associated with a higher risk of intervention-related problems and a lower rate of obtaining thrombolytic therapy [7, 22].

In terms of reperfusion and diagnostic method, most patients (72.7%) received streptokinase-based thrombolysis. PPCI was infrequent (1.8%). The sex distribution varied by therapy pathway: 63.8% of thrombolysis recipients were male, compared to 78.6% in the CAG-for-NSTE-ACS group. The two PPCI patients were both females, but the interpretation is constrained due to the small sample size (n=2).

These findings may indicate that most individuals with STEMI presented to our center within 12 hours of the onset of chest pain, in contrast to previously published Sudanese data, in which only 34% received thrombolytic therapy due to a late presentation after the window period of lysis [23]. Despite the ongoing armed conflict, Sudan continued to provide free thrombolytic therapy under the supervision of the National Cardiac Center; however, many people in the country face difficulties accessing these centers or arrive late, which are major barriers for Sudanese patients due to the war and its negative consequences. In the absence of PPCI facilities due to time constraints and other challenges in this ongoing armed conflict, thrombolysis is the best option for treating STEMI patients in Sudan.

Our findings provide important insights into the therapeutic alternatives used by patients with cardiovascular diseases, emphasizing the prevalence of PCI among therapy methods. PCI was performed in 44.5% of the participants, followed by medical therapy (32.7%) and cardiothoracic cardiology consultation (18%). This distribution highlights a trend toward interventional techniques in cardiovascular disease management, which is most likely related to

the acute nature of many presentations, necessitating more urgent intervention. The current study's findings are almost double those of the previous Sudan studies. Edris et al. (2024) published data under the supervision of the National Cardiac Center for patients who underwent PCI between 2018 and 2023, with a range of 23% from a total of 38,694 coronary angiography operations [24]. Furthermore, this finding is greater than Humida et al. (2025)'s publication in the hot-armed conflict zone, which reported 32% of 314 cardiac catheterization procedures [9]. In the majority of cases in this cohort, we used the pharmaco-invasive method, and only 1.8% of patients got PPCI; nonetheless, PPCI remained the standard of care for STEMI patients when it could be performed within 120 minutes, and it was found to cut mortality from 9% to 7%. In circumstances when logistics do not allow for the authorized time for PPCI fibrinolytic therapy, alteplase, reteplase, or tenecteplase are the primary choices in full dose in patients under 75 years old and half the dose in those over 75. Streptokinase in full dose may be considered in cases where these drugs are unavailable or cost prohibitive [25].

PCI patients were mostly male (65.3%), which is consistent with research showing that cardiovascular illnesses are more severe and prevalent in men. The CTC group (70%), like the medicinal therapy group (61.1%), was mostly male. These findings suggest that males are at increased risk for cardiovascular problems and need specialized protection.

PCI patients had a low smoking history, with only 4% current smokers and 20.4% ex-smokers. This shows a tobacco use trend shift or effective cessation approaches for this demographic. Even though this group has a low smoking rate, smoking is still a major cardiovascular disease risk factor. Hypertension (38.7% in PCI, 50% in medical therapy, and 40% in CTC and diabetes (51% in PCI, 52.8% in medical therapy, and 50% in CTC) is prevalent across all treatment groups, highlighting their importance in cardiovascular health care. The high prevalence of both illnesses is consistent with similar demographics and reflects higher risk factor monitoring.

The increased prevalence of hypertension and diabetes in both males and females receiving medical therapy and the CTC cohort shows that a multimodal approach to cardiovascular health, including comorbidity control, is necessary to improve patient outcomes.

Clinicians should target hypertensive and diabetic patients for cardiovascular disease risk assessment.

Overall, this study sheds light on demographic and clinical aspects affecting cardiovascular patient treatment options. They emphasize the necessity for comprehensive cardiovascular health programs for varied patient populations, focusing on modifiable risk factors and comorbidities.

In conclusion, overall, the cohort shows (1) a male predominance of ACS, particularly NSTE-ACS, (2) a treatment pattern dominated by streptokinase thrombolysis with minimal use of PPCI and high use of PCI, (3) a high angiographic disease burden, primarily SVD, and (4) a high proportion of severe disease presentations. While sex differences exist in ACS type and treatment routes, the RR for males was not statistically significant, implying that larger sample sizes are required in future research to establish sex-related risk differences.

Acknowledgment

The authors extended their sincere gratitude to the cardiac patients and to the people in Al Shaab Teaching Hospital for their help regarding data collection.

Ethical Approval

The Sudan Medical Specialization Board (SMSB) ethical committee approved this research. Also, ethical consideration was obtained from the Sudan Ministry of Health and from Al Shaab Teaching Hospital authorities. Ethical clearance was obtained from both the SMSB ethical committee and the hospital.

Conflict of interest

The authors declare no conflict of interest.

Data availability

Data regarding this study are available from the corresponding author

Author contributions

All authors approved the final version of the publishable manuscript.

Osman EO: Concept and design, Supervision, Data Interpretations, Editing, Approval.

Alfadul NA: Conceptual, Design, Data Acquisition, Data analysis, and Interpretation, and Approval.

Humida EHM: Data analysis, and Interpretation, Manuscript drafting, Critical Revision, Approval.

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