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Research Article

Epidemiology, Management and Prognosis of Acute Coronary Syndromes in Senegal: A Systematic Review of the Grey Literature with Meta-analysis from 1998 to 2020

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Abstract

Introduction: The management of acute coronary syndromes (ACS) in Senegal continues to pose challenges, despite significant progress in medical care. To comprehensively understand the current state of ACS in Senegal, a systematic review with meta-analysis was deemed essential. The main objective of this study was to determine the prevalence of ACS in Senegal and its trajectory over time. *Methods*: A systematic review of grey literature, encompassing theses and dissertations on ACS conducted in public hospitals in Senegal between 1990 and 2023, was undertaken. The selected studies provided valuable insights into the prevalence, epidemiological characteristics, cardiovascular risk factors, diagnostic approaches, therapeutic interventions, and prognostic outcomes associated with ACS. A meta-analysis of prevalence and mortality data was performed using the DerSimonian-Laird random-effects model, while the remaining data were synthesized descriptively. *Results*: The systematic review yielded 15 eligible studies from 1998 to 2020, out of an initial 101 identified documents. The overall prevalence of ACS was determined to be 9% (95% Cl: 7-11%, $1^2 = 96\%$, $p < 0.01$). Notably, in Dakar, the prevalence exhibited a significant increase between 1998 to 2010 and 2013 to 2020 ($p < 0.01$), rising from 6% (95% Cl: 4-8%, $1^2 = 96\%$, $p < 0.01$) to 13% (95% CI: 9-16%, $1^2 = 95\%$, $p < 0.01$). The proportion of patients presenting with ST-elevation ACS ranged from 44 to 94%. The average age of patients varied between 57 and 64 years, with a consistent male predominance across all studies. A notable improvement in mean admission delay to cardiology services in Dakar was observed, decreasing from 186 hours in 2002 to 28 hours in 2018. Thrombolysis utilization for ST-elevation ACS patients in Dakar ranged from 2.1 to 64.8%, while other regions reported rates of 10% in Kaolack, 53.8% in Saint-Louis, and 52.6% in Thies. In Dakar, the rate of coronary angiography increased substantially from 0% to 60.6% between 1998 and 2020, with percutaneous coronary intervention performed in 4.3% to 35.3% of cases. The frequency of heart failure ranged from 6.7 to 52.9%, and cardiogenic shock occurred in 1 to 18.5% of

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patients. The overall mortality rate was 10% (95% CI: 7-13%, $1^2 = 64\%$, $p < 0.01$). *Conclusion*: Our study demonstrates that despite an increase in prevalence, there is an improvement in the management of ACS. However, the establishment of a national registry and a comprehensive network for ACS management is crucial to further improve morbidity and mortality outcomes.

Keywords

Acute Coronary Syndromes, Meta-analysis, Senegal

1. Introduction

Acute coronary syndromes (ACS) encompass a spectrum of conditions that include patients presenting with recent changes in clinical symptoms or signs, with or without changes on 12-lead electrocardiogram (ECG) and with or without acute elevations in cardiac troponin concentrations [1]. It is estimated that over seven million people worldwide are diagnosed with ACS annually [1]. Additionally, cardiovascular diseases were the leading cause of death globally in 2019, according to the World Health Organization (WHO), with coronary artery disease (CAD) being the primary cause of mortality [2]. These deaths attributed to CAD have shown the most significant increase since 2000 [2].

The prevalence of ACS varies across different regions worldwide. In France, the France PCI 2022 registry estimates 120,000 myocardial infarctions annually [3]. A recent systemic review revealed that the hospital frequency of ACS in 13 sub-Saharan African countries ranged from 0.21 to 22.3% between 2011 and 2020 [4].

In Senegal, the actual national prevalence of acute coronary syndrome remains elusive due to limited data in certain regions. However, several studies, primarily conducted in Dakar, indicates that prevalence, similar to other countries, is rising [5, 6]. While advancements in coronary reperfusion have enhanced ACS management and outcomes, the development of comprehensive national strategies in Senegal requires a thorough understanding of the epidemiology and unique challenges associated with ACS.

This systematic review and meta-analysis aim to assess the state of ACS management in Senegal, with the main objective of determining the prevalence of ACS and its evolution over the years.

The secondary objectives were to:

1) Describe the epidemiological characteristics of the patients and their progression over the years
2) Describe the management of ACS in Senegal and its evolution over the years
3) Determine the morbidity and mortality of ACS in Senegal and its evolution over the years.

2. Methods

We conducted an exclusively gray literature search focusing on thesis and dissertations related to ACS conducted in Senegalese public hospitals between 1990 and 2023 as the vast majority of peer-reviewed articles on the subject originate from these dissertations and thesis. Search was conducted on June 19, 2023, using the digital library of Cheikh Anta Diop University of Dakar and other public and private university medical libraries across Senegal.

We included observational studies conducted between 1998 and 2020 that focused on ACS, with or without persistent ST-segment elevation. Studies involving specific populations such as only men, women, young, or elderly individuals, reperfused or non-reperfused patients, diabetics, or those with angiographically healthy coronary arteries, were excluded.

The selection of studies was conducted by a single examiner (PMG), a fourth-year cardiology resident during the study. In case of uncertainty regarding a study's inclusion, the final decision was made by (MD), a professor of cardiology.

The data analyzed encompassed a range of factors, including epidemiological aspects, cardiovascular risk factors, transportation methods, admission delays, clinical presentation, coronary angiography performance, therapeutic data (reperfusion methods and adjunct therapies), and prognostic data (complications and in-hospital mortality).

We assessed the risk of bias in the included studies using the Loney scoring system, which evaluates the quality of prevalence or incidence studies. A score ≥5 indicates a high-quality study, whereas a score <5 suggests low quality [7, 8].

A meta-analysis was conducted to estimate the prevalence and mortality of ACS using OpenStat version 6.5, a statistical software based on R. The Freeman-Tukey double arcsine transformation was employed to stabilize the variance of proportions, and the DerSimonian- Laird random-effects model was used to pool the estimates [9, 10]. Confidence intervals for individual studies were determined using the score test, while those for pooled estimates were derived using Wald's test [11]. Heterogeneity among studies was assessed using the I^2 statistic [12].

We conducted subgroup analysis based on location (Dakar

vs. other regions between 2013 and 2020) and time periods for Dakar alone (Period 1: 1998–2010; Period 2: 2013–2020). A descriptive synthesis of the remaining data was also provided.

This systematic review adhered to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 guidelines. Since no human intervention was involved, no patient consent or ethics committee approval was required.

3. Results

A total of 101 documents were identified, and 15 studies were ultimately included in the review. The flow diagram in Figure 1 illustrates this selection process. Studies covered a period from 1998 to 2020. Ten studies addressed ACS broadly, while four focused specifically on ST-segment elevation myocardial infarction (STEMI) and one on non-ST-segment elevation ACS (NSTE-ACS). breakdown is further detailed in Table 1.

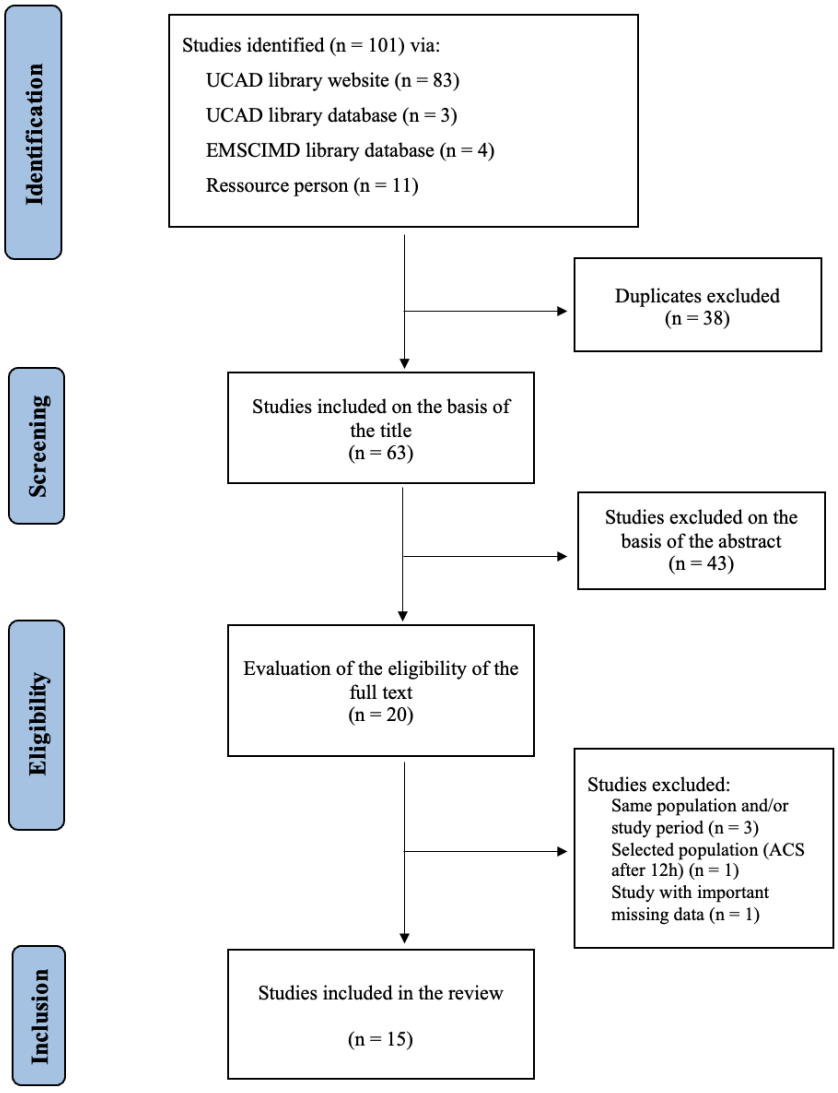

Figure 1. *Flow diagram of studies selection.*

Table 1. *Characteristics of studies included.*

Author	Type of document	University	Study period	Type of study	Hospital	Study population	Patients included
Ba [13]	Thesis	UCAD	1998-2000	Prospective	HALD	ACS	68
Mboup [14]	Thesis	UCAD	2005-2006	Prospective	HALD-HPD	ACS	59

Author	Type of document	University	Study period	Type of study	Hospital	Study population	Patients included
Diallo [15]	Thesis	UCAD	2005-2007	Retrospective	HOGIP	STEMI	54
Hakim [16]	Thesis	UCAD	2004-2008	Retrospective	HOGIP	ACS	134
Ndene [17]	Thesis	UCAD	2004-2010	Retrospective	HALD	NSTE-ACS	30
Savadogo [18]	Dissertation	UCAD	2013-2014	Retrospective	HOGIP	ACS	133
Samb [19]	Dissertation	UCAD	2014-2015	Retrospective	HALD	STEMI	40
Loum [20]	Thesis	UCAD	2013-2015	Retrospective	HOGIP	STEMI	164
Dieye [21]	Thesis	UCAD	2016	Prospective	HOGIP	ACS	100
Sene [22]	Thesis	UCAD	2016-2018	Retrospective	HOGIP	ACS	141
Ibouroi [23]	Thesis	UCAD	2019-2020	Retrospective	HALD	ACS	343
Sabaly [24]	Thesis	UCAD	2014-2017	Retrospective	CHREINK	STEMI	40
Mbaye [25]	Thesis	UAAS	2016-2019	Retrospective	CHRZ - HPZ	ACS	57
Ndao [26]	Thesis	UGB	2018-2019	Retrospective	CHRSL	ACS	47
Akouete [27]	Thesis	UIDT	2018-2019	Prospective	HSJDT	ACS	29

The studies were conducted in Dakar and four other regions: Ziguinchor, Thies, Saint-Louis, and Kaolack as illustrated in Figure 2. Thirteen studies were deemed high quality based on the Loney scoring system represented in table 2.

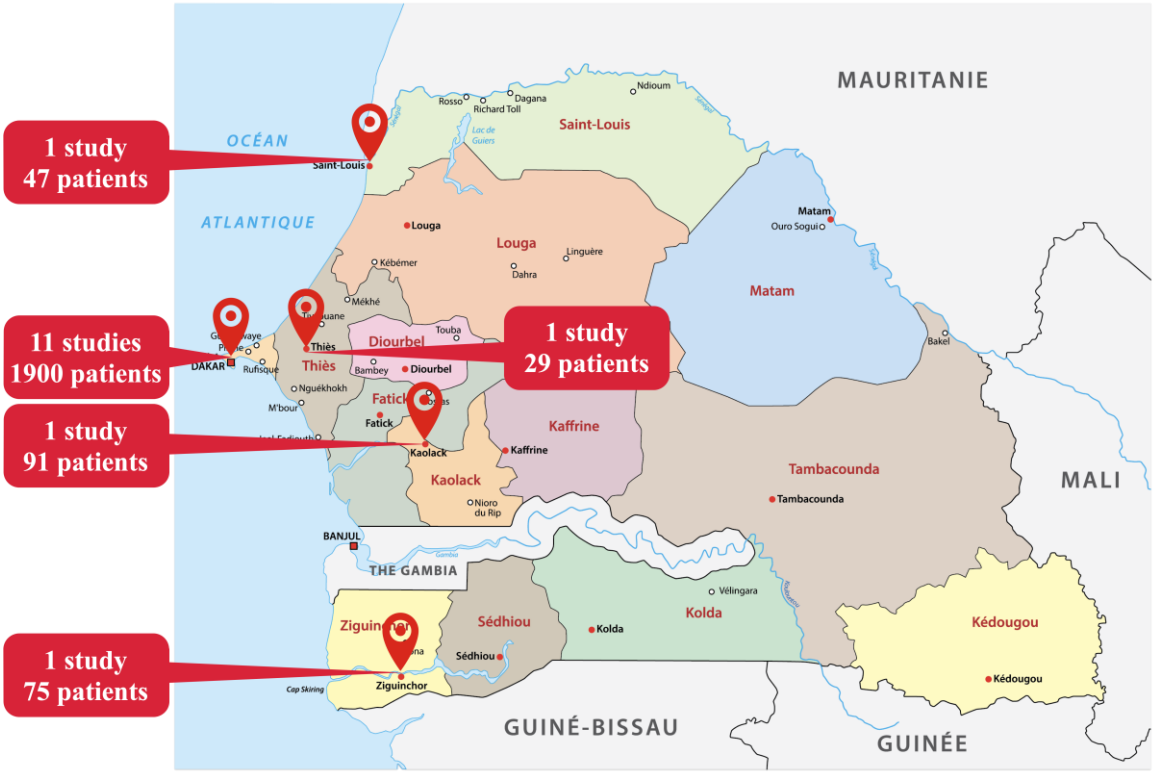

Figure 2. *Distribution of studies by region of Senegal.*

Table 2. *Quality bias assessment according to Loney's criteria. Green crosses indicate the fulfilled criteria.*

	Random sample	Unbiased sampling	Adequate size	Validated criteria	Unbiased interviewers	Response rate	Confidence interval, Subgroup analysis	Subjects description
Ba [13]	X	X		X	X	X		X
Mboup [14]	X	X		X	X	X		X
Diallo [15]	X	X		X	X	X		X
Hakim [16]			X	X	X			X
Ndene [17]	X	X		X	X	X		X
Savadogo [18]				X	X			X
Samb [19]	X	X			X	X		X
Loum [20]	X	X		X	X	X		X
Dieye [21]	X	X		X	X	X		X
Sene [22]	X	X		X	X	X		X
Ibouroi [23]	X	X	X	X	X	X		X
Sabaly [24]	X	X		X	X	X		X
Mbaye [25]	X	X		X	X	X		X
Ndao [26]	X	X		X	X	X		X
Akouete [27]	X	X		X	X	X		X

3.1. Epidemiological Data

The overall prevalence was 9% (95% CI: 7–11%, I^2= 96%, p < 0.01), as shown in Figure 3. In Dakar, prevalence gradually increased, with a significant difference between period 1 (1998–2010) and period 2 (2013–2020) (p < 0.01), rising from 6% (95% CI: 4–8%, I^2= 96%, p < 0.01) to 13% (95% CI: 9–16%, I^2= 95%, p < 0.01) as represented in figure 4.

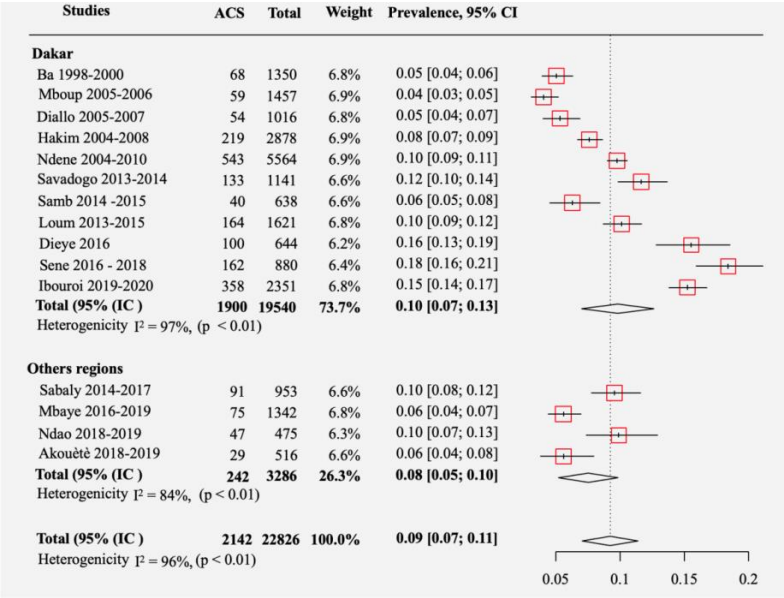

Figure 3. *Overall prevalence.*

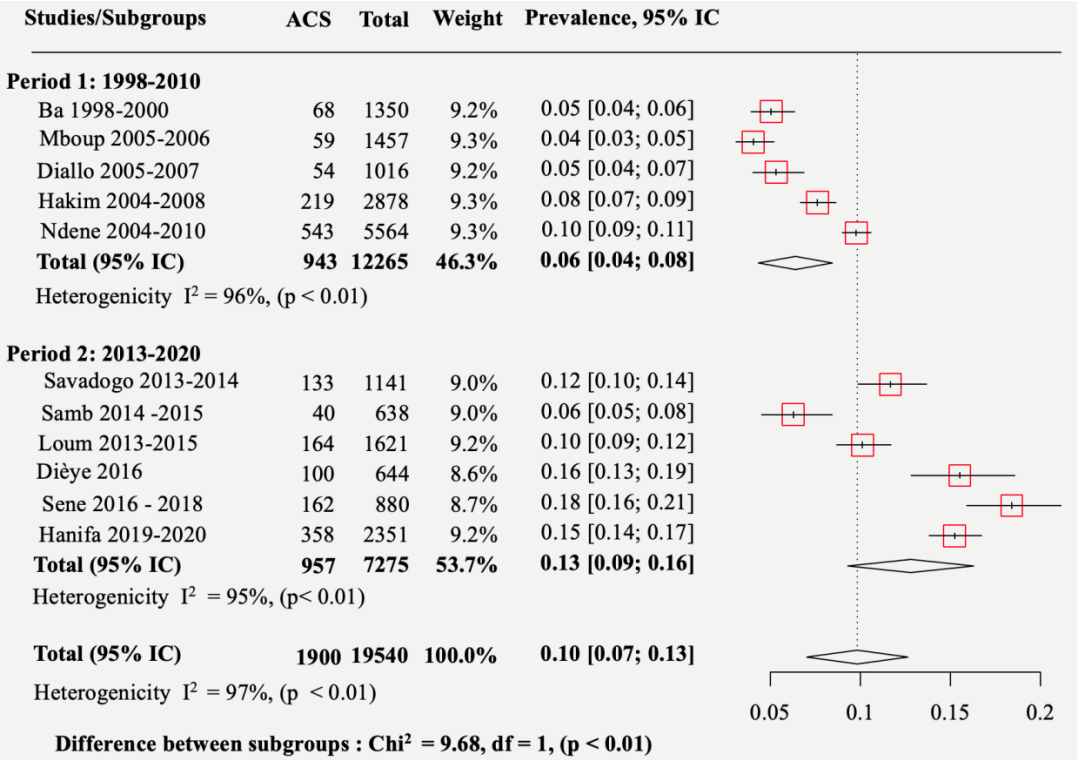

Figure 4. *Prevalence difference in Dakar between 2 periods (1998-2010) and (2013-2020).*

All but one study found a predominance of STEMI, with its frequency ranging from 44 to 94%. The mean age of patients ranged from 57.1 to 64 years. Across all studies, there was a male predominance, with the proportion of men ranging from 51 to 79%.

The prevalence of hypertension ranged from 47.5 to 69%; diabetes from 15 to 41.3%; obesity from 6.9 to 40.7%; smoking from 14 to 60%; physical inactivity from 12.5 to 96.5%; and a family history of cardiovascular disease from 2.5 to 6.1%.

3.2. Diagnostic Data

In Dakar, the average admission time to the cardiology department decreased significantly from 186 hours in 2002 to 28 hours in 2018. In other regions, the average admission time varied: 47 hours in Kaolack, 81.6 hours in Ziguinchor, 50 hours in Saint-Louis, and 31 hours in Thies.

In Dakar, the percentage of STEMI patients admitted within 12 hours of pain onset ranged from 42.5 to 72.3%. In other regions, this percentage was 37.5% in Kaolack, 32.5% in Ziguinchor, 66% in Saint-Louis and 58% in Thies.

Four studies analyzed transport methods, showing that the proportion of patients transported by ambulance ranged from 1.9 to 30%. The proportion of patients experiencing typical anginal chest pain varied between 36.6 and 95%.

In Dakar, the use of coronary angiography increased from 0 to 60.6% between 1998 and 2020. In other regions, no patients underwent coronary angiography during hospitalization.

3.3. Therapeutic Data

In Dakar, the proportion of STEMI patients who received thrombolysis ranged from 2.1 to 64.8%. The average thrombolysis time varied between 5.2 and 6.3 hours, with a success rate of 49 to 62.7%. In other regions, the percentage of patients who received thrombolysis was 10% in Kaolack (with an average time of 3.8 hours), 53.8% in Saint-Louis (6 hours), and 52.6% in Thiès (5.6 hours). In Ziguinchor, no patients received thrombolysis.

Streptokinase was the only thrombolytic agent used in all studies, except for the most recent study in Dakar, where four patients were treated with tenecteplase. No patients in other regions underwent angioplasty during hospitalization. In Dakar, the percentage of percutaneous coronary intervention (PCI) increased from 4.3% to 35.3%, with primary PCI performed only in the latest study as shown in Figure 5. Across all studies, no patients underwent coronary artery bypass grafting during hospitalization.

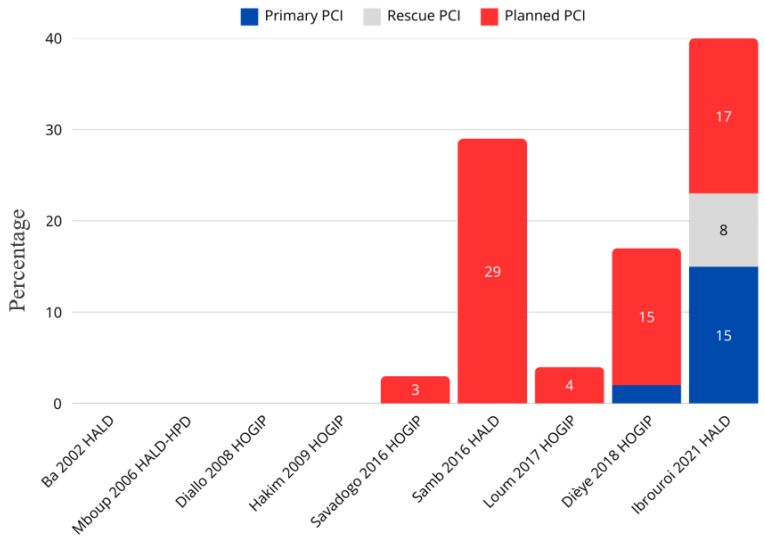

Figure 5. *Distribution of different types of PCI.*

The use of parenteral anticoagulants ranged from 63.2 to 100%. Antiplatelet agents were prescribed in 59.7 to 100% of patients. Statins were administered to between 54.2 and 100% of patients, while beta-blockers were prescribed in 57.9 to 88.3% of cases. Renin-angiotensin-aldosterone system blockers were also commonly used, with prescription rates ranging from 63.2 to 96.6%.

In Dakar, the average hospital stay for patients significantly decreased from 20.2 days in 1998 to 7 days in 2020. In other regions, the average length of stay ranged from 5 to 8.5 days.

3.4. Prognostic Data

The frequency of complications varied as follows:

1) Heart failure: 6.7 to 52.9%
2) Cardiogenic shock: 1 to 18.5%
3) Atrial fibrillation: 0 to 13.4%
4) Severe ventricular arrhythmias: 0 to 6.7%
5) Significant atrioventricular conduction block: 0 to 8.5%
6) Left ventricular thrombus: 0 to 20.3%
7) Hemorrhages: 2 to 6.7%

Notably, most of these complications have decreased in frequency over time.

The overall mortality rate was 10% (95% CI: 7–13%, I^2= 64%, p < 0.01), as illustrated in figure 6. In Dakar, mortality decreased over time, but there was no significant difference between period 1 and period 2 (p = 0.31). The mortality rate was 14% (95% CI: 3–25%, I^2 = 88%, p < 0.01) between 1998 and 2010 and 9% (95% CI: 9–16%, I^2= 11%, p = 0.34) between 2013 and 2020.

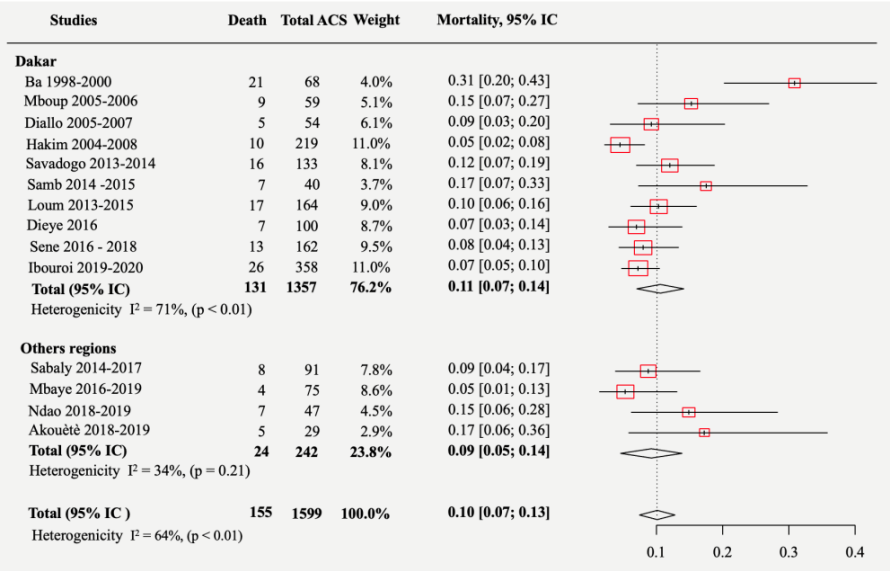

Figure 6. *Overall mortality.*

4. Discussion

In sub-Saharan Africa, existing data on CAD suggest that it is one of the three leading causes of death [4]. These data are primarily based on hospital surveys of ACS, whose frequency is steadily increasing. Indeed, the prevalence rose from 3.17% in 1991 in the multicenter prospective CORONAFRIC-I study [28], which covered 11 sub-Saharan African countries, to 16% in the CORONAFRIC-II study [29] in 2017.

In Ivory Coast according to one study [30], prevalence increased from 7.3% between 2002 and 2009 to 22.6% between 2010 and 2016. Senegal is no exception to this trend, as evidenced by our findings. In Dakar, prevalence doubled between period 1 (1998–2010) and period 2 (2013–2020). A more recent study reported an even higher prevalence of 22% in four public hospitals in Dakar in 2022 [6].

This rise in ACS prevalence is partly due to significant lifestyle changes that promote cardiovascular risk factors and partly to improvements in diagnostic methods. A paradigm shift in the fight against cardiovascular diseases is therefore essential to reduce their incidence and associated morbidity and mortality.

Overall, the relative incidences of STEMI and NSTEMI are decreasing and increasing, respectively. In France, for example, the proportion of NSTEMI cases in the FAST-MI registry [31] rose from one-third in 1995 to more than half in 2015. This shift is primarily due to improved diagnosis of NSTEMI, particularly with the advent of high-sensitivity troponin assays and modern cardiac imaging techniques.

In Senegal, although there has been a slight increase in the proportion of NSTEMI cases over the years, as evidenced by our study, STEMI remains significantly more prevalent. Similar findings have been reported across sub-Saharan Africa, where, according to a systematic review by Yao et al. [4], STEMI is the predominant clinical presentation in most studies.

In France, the median delay between symptom onset and hospital admission for STEMI decreased from 240 minutes in 1995 to 168 minutes in 2015, according to the FAST-MI registry [31]. In Africa, however, admission delays are significantly longer than in Western countries. Yao et al., in their systematic review, found that the average time to admission in cardiology units ranged from 2.3 hours in South Africa to 6.6 days in Tanzania [4].

In Senegal, particularly in Dakar, the average admission delay has significantly decreased, from 186 hours in 2002 to 28 hours in 2018, according to our findings. However, this delay remains well above the recommended delays. Several factors contribute to these prolonged delays, including:

1) Limited public awareness of ACS symptoms, leading to late healthcare-seeking behavior in both prehospital and hospital settings.
2) Unavailability of electrocardiograms in some healthcare facilities, causing diagnostic delays.
3) An inadequately structured prehospital transport system.

Our study observed a significant increase in the use of coronary angiography and PCI among patients hospitalized for ACS. This intervention only began routinely in 2013 in Dakar's public hospitals. Primary PCI was first performed in the most recent study conducted at HALD between 2019 and 2020 [23]. However, it was performed more frequently than scheduled angioplasty, accounting for 17.8% of all STEMI patients.

These findings contrast with those from European countries. For example, in France, according to the FAST-MI registry, the proportion of patients undergoing coronary angiography was 99% in 2015, while the percentage of STEMI patients receiving primary PCI increased from 12% in 1995 to 76% in 2015 [31]. According to the 2022 France PCI annual report, this percentage further rose to 89.8% [3].

The primary reasons for this discrepancy are financial and organizational. Financially, coronary angiography is costly in Senegal, as it is a paid procedure. The cost of a diagnostic coronary angiography in most hospitals is 500,000 CFA francs (approximately 800 US dollars), whereas the Guaranteed inter-professional minimum wage in the country does not exceed 65,000 CFA francs (about 100 US dollars) [32].

Organizationally, there is still no well-structured ACS management network, leading to prolonged intervention delays.

Globally, improved ACS management—particularly through thrombolysis and coronary angioplasty—has contributed to reduced mortality rates. For instance, in France, the 30-day mortality rate for STEMI decreased from 14% to 3% between 1995 and 2015 [31]. In sub-Saharan Africa, although mortality remains high, there is a decreasing trend [30].

In Senegal, specifically in Dakar, we observed a reduction in mortality rates from 14% in 1998–2010 to 9% in 2013–2020, although this decline was not statistically significant.

However, our study has certain limitations, including:

1) Literature screening and data extraction performed by a single reviewer
2) The limited number of studies conducted in regions outside Dakar.
3) The absence of studies in major hospitals such as the National University Hospital Center of Fann and the Dalal Jamm National Hospital Center.
4) The lack of recent studies (2021–2023) covering ACS as a whole, with most recent research focusing on specific aspects like coronary reperfusion techniques.

5. Conclusion

Our study has provided comprehensive data on the evolving epidemiology and management of ACS. It could serve as a starting point for further research into the burden of ACS in

our country. The findings highlight that while the implementation of well-established ACS management guidelines remains a significant challenge, there has been notable progress over the years.

Key areas for improvement include:

1) Establishing a national ACS registry to obtain more reliable data on epidemiology, treatment delays, and patient outcomes with the following key steps: define objectives, standardize case definitions and inclusion criteria, design data collection tools, select participating centers, train healthcare staff, implement data management system, ensure ethical compliance, pilot and monitor the registry, use and disseminate results.
2) Developing an ACS care network linking peripheral healthcare facilities with PCI-equipped centers through an efficient emergency medical system.

Abbreviations

ACS	Acute Coronary Syndromes
CAD	Coronary Artery Disease
CHREINK	Centre Hospitalier Régional El Hadji Ibrahima Niasse de Kaolack
CHRSL	Centre Hospitalier Régional de Saint-Louis
CHRZ	Centre Hospitalier Régional de Ziguinchor
HALD	Hôpital Aristide Le Dantec
HOGIP	Hôpital Général Idrissa Pouye
HPD	Hôpital Principal de Dakar
HPZ	Hôpital de la Paix de Ziguinchor
HSJDT	Hôpital Saint Jean De Dieu de Thiès
NSTE-ACS	Non-ST-segment Elevation Acute Coronary Syndromes
PCI	Percutaneous Coronary Intervention
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
STEMI	ST-segment Elevation Myocardial Infarction
UAAS	Université Amadou Assane Seck
UCAD	Université Cheikh Anta Diop de Dakar
UGB	Université Gaston Berger
UIDT	Université Iba Der Thiam de Thiès
WHO	World Health Organization

Conflicts of Interest

The authors declare no conflicts of interest.

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