

# Epidemiological, Clinical, Therapeutic and Prognostic Profile of Patients Hospitalized for Heat Stroke in the Medical Emergency Department of the Bogodogo University Hospital Center during the Heatwave Period of 2024 from March 1 to May 30 in Burkina Faso

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## Abstract

**Introduction:** Heat waves have adverse effects on people's health, particularly heat stroke which can often be fatal. There is limited data available on this topic in Sub-Saharan Africa, therefore, the aim of our study, was to describe the epidemiological profile of patients hospitalized for heat stroke. **Patients and methods:** we carried out a cross-sectional study with retrospective data collection for descriptive and analytical purposes on the epidemiological, clinical and prognostic aspects. Patients aged over 15 years hospitalized for heat stroke were included. Data were collected from medical records and processed using KoboToolbox and Excel 2019 software. Categorical variables were expressed as numbers or percentages and quantitative variables as means and standard deviations or median and interquartile. The Chi-square test was used to verify the association between categorical variables, and the student t-test to compare means with a significance threshold of  $p \leq 0.05$ . **Results:** During the study period, 167 patients were included, representing an incidence of 17.41%. The mean age was 72.83 years  $\pm$  10.87 with extremes ranging from 50 to 109 years. The mean core temperature was 42°C, 64°C  $\pm$  2°C, 3 with a mortality rate of 51.50% (86 cases). Clinical signs were dominated by dehydration

(164 cases (98.2%)), nausea/vomiting (82 cases (49.1%)) and acute respiratory distress (74 cases (44.31%)). The main complications included acute renal failure (57 cases (34.13%)), multiple organ failure (39 cases (23.35%)), and cardio-vascular shock (26 cases (15.57%)). The comparative analysis according to mortality, age, core temperature, respiratory distress, tachycardia, and altered state of consciousness were associated factors in the death group ( $p < 0.05$ ). However, in the multivariate logistic regression, only initial vital signs were statistically significant (OR = 17.3 [7.24 - 45.3],  $p < 0.001$ ). **Conclusion:** Heat stroke mainly affects elderly people and the severity of cases is linked to very high temperatures, other neurological disorders and high mortality.

## Keywords

Heat Stroke, Heat Wave, Hyperthermia, Burkina Faso

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## 1. Introduction

The increasing frequency of fatal heat waves in different parts of the world raises major concerns about the health of populations in the context of climate change [1]. A heat wave is defined as a series of consecutive days with extremely hot weather both during the day and at night, compared to local seasonal norms [2]. This phenomenon has adverse effects on human health, particularly heat-related illnesses. These include heat cramps, syncope, exhaustion, and heat stroke [3]. Heat stroke is a life-threatening medical emergency. Classical heat stroke is the most severe clinical form of illness resulting from prolonged exposure to heat, defined by central hyperthermia above 40°C, in the absence of infection, and associated with central nervous system disorders such as convulsions, mental confusion or comatose [2] [4] [5].

In developed countries, the incidence of heat stroke observed in some studies varies from one country to another. Indeed, during heat waves in the United States, the incidence varies from 17.6 to 26.5 per 100,000 people [6]. In Canada, studies have shown that summer temperatures are associated with an increase in morbidity [7]. France experienced a heat wave during the summer of 2003, responsible for extreme temperatures with dramatic consequences on morbidity and mortality, with an excess of 14,800 deaths attributed to the heat wave [8] [9]. In Saudi Arabia, the incidence varies from 22 to 250 cases per 100,000 people depending on the pilgrimage seasons, with an estimated mortality rate of 50% [10].

Data on the incidence of classic heatstroke are scarce in sub-Saharan Africa, as the disease is not often recognized. And the limited studies available address the effects of climate change on human health [11] [12]. Burkina Faso is particularly exposed to periods of increasingly frequent and severe heat waves and heat waves [13]. Specifically, in major cities where death statistics are better monitored, there has been an increase in the number of deaths, especially during the month of April 2024. Clinicians who make the observation are almost unanimous that these are

mainly people over 50 years [14]. To date, there has been no study on the medical aspects of the topic in Burkina Faso, which prompted us to carry out this study. The main objective was to describe the epidemiological, clinical, therapeutic and prognostic profile of patients hospitalized for heat stroke in the Medical Emergency Department of the Bogodogo University Hospital Center.

## 2. Patients and Methods

### 2.1. Type of Study

This was a single-center, cross-sectional study, retrospective data collection, descriptive and analytical purposes on the epidemiological, clinical, paraclinical, therapeutic and prognostic characteristics of patients hospitalized for heatstroke at the Medical Emergency Department of the Bogodogo University Hospital Center. Our study took place over 3 months (March 1<sup>st</sup> to May 30, 2024) during the heat wave period in Burkina Faso.

### 2.2. Study Population

The study included all patients aged over 15 years and admitted to the department during the study period for heat stroke diagnosed on the basis of recognized clinical and biological criteria: hyperthermia  $> 40^{\circ}\text{C}$  neurological disorders, heat exposure [6]. The core temperature was measured using either an electronic oral or tympanic thermometer according to the standard method. The first measurement was performed immediately after triage to minimize fluctuations related to delay. The elapsed time between triage and the first measurement was between 5 - 10 minutes to ensure that the temperature had reached a stable and representative level of the patient's condition. However, it is important to maintain a high suspicion for Heat stroke, as patients presenting to the Hospital with a temperature  $< 40^{\circ}\text{C}$  may have experienced effective pre-hospital cooling (such as placement of ice packs on the neck, axillae, and groin) [3].

Heat stroke was not medically documented, patients who died or were transferred before complete data collection, and incomplete medical records were not included.

### 2.3. Data Collection Methods

Data were collected from hospital medical records, treatment sheets and the consultation register (paper) using an individual collection sheet digitized in KoboToolbox data collection software, including the variables that are summarized in **Table 1**:

**Table 1.** Description of variables.

Independent variables		Dependent variables
Socio-demographic:	Age, gender, occupation, physical activity level, residence, medical history	Death

**Continued**

Clinical data on admission:	Core temperature, blood pressure, heart rate, saturation, state of consciousness, neurological signs
Initial biological tests:	Blood Count, creatinine, transaminases, CRP, blood ionogram, blood sugar
Therapeutic support:	*Cooling, hydration, other treatments
Prognostic aspects	complications,

\*Cooling measure are the cornerstone of treatment and should be initiated as early as possible. The goal is to lower the core body temperature below 39.4°C. The cooling process should be as rapid as possible, with no safety concerns about the speed of correction on the contrary. Complete patient undressing is the first step, followed by positioning in the shade. Conduction is achieved by applying crushed ice or ice packs directly on the skin or over a damp sheet “mummifying” the patient. Convection is used with a fan directed tangentially to the cooled skin covered with ice or damp cloths over vascular areas. Evaporative cooling, which can be deficient during heat stroke, can be reset by alternating ice application and spraying lukewarm water on the cooled skin [2].

## 2.4. Data Analysis

Data were entered and processed using Excel 2019 software. The analysis was performed by describing the sample studied according to sociodemographic, epidemiological, clinical, paraclinical and prognostic characteristics. Categorical variables were expressed as numbers and percentages and quantitative variables as means and standard deviations, as well as the median and interquartile range. The Chi-square test was used to verify the association between categorical variables, and the student’s t-test was used to compare means. The significance threshold was set at  $p \leq 0.05$ .

### - Ethical considerations

The confidentiality of personal data was respected and authorization from the Bogodogo University Hospital Center ethics committee was obtained with number 2025-07/MS/SG/CHU-B/CE.

## 3. Results

### 3.1. Frequency

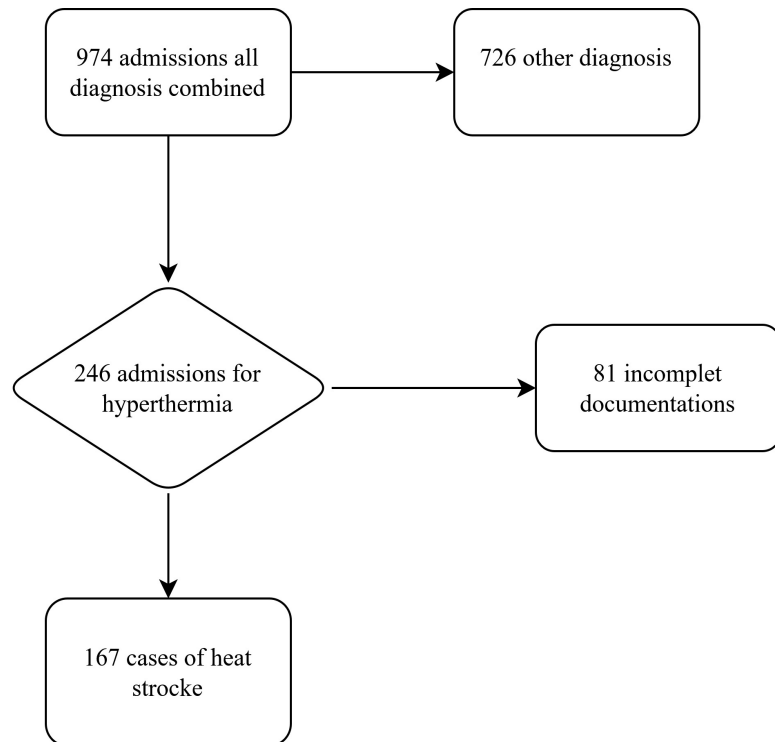
During the study period, there were 974 admissions for all diagnoses, including 167 cases of heat stroke, representing a proportion of 17.41%. **Figure 1** shows the collection process.

The distribution of cases by month: we recorded 27 cases (16.17%) in March, 92 cases (55.09%) in April and 48 cases (28.74%) in May. **Figure 2** summarizes this distribution according to the month.

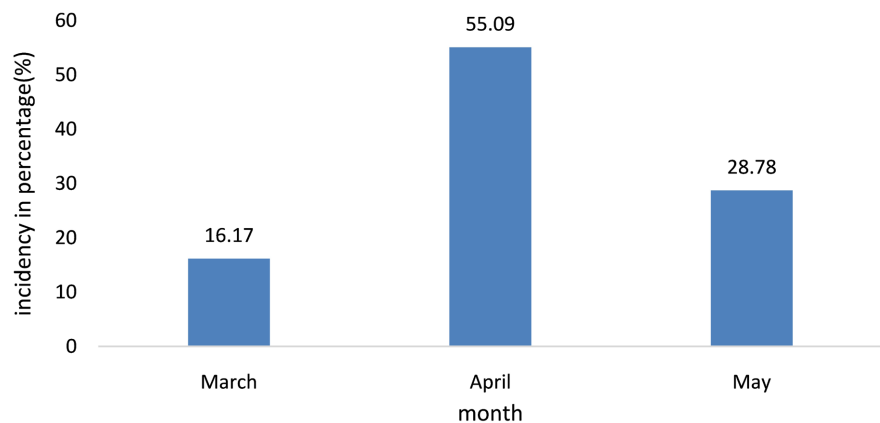
### 3.2. Sociodemographic Characteristics

The average age was 72.83 years  $\pm 10.87$  years with extremes ranging from 50 to 109 years old. There were 103 women (61.68%) and 64 men (38.32%) with a sex

ratio M/F of 0.53. Housewives were the most frequent profession, 94 cases (56.29%) followed by pensioner, 39 cases (23.35%). 108 cases (64.67%) and 50 cases (29.94%) had respectively a moderate level of activity and a loss of autonomy. The patients who resided in urban areas (Ouagadougou) were 148 (88.62%). Patients with medical history were 85 (50.9%) for cardiovascular diseases, 23 cases (13.77%) for diabetes and 18 cases (10.78%) for neurological diseases.



**Figure 1.** Flux diagram of collection process.



**Figure 2.** Distribution of incidence by month.

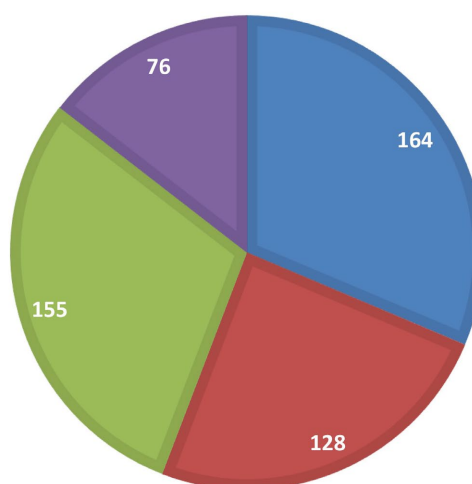
### 3.3. Clinical, Biologic, Treatment and Prognostic Aspects

- Clinical aspects: The most frequent reasons for consultation were hyperthermia (100%), followed by convulsions (92 cases or 55%) and alteration of the

general condition (85 cases or 50.1%). The mean core temperature was  $42.64^{\circ}\text{C} \pm 2.3^{\circ}\text{C}$ , the means systolic and diastolic blood pressures were  $130.31 \pm 32.92$  mmHg and  $74.64 \pm 19.05$  mmHg. The mean heart rate was 107 beats per minute and the mean saturation was  $92.45\% \pm 5.46\%$ . The Glasgow Coma Scale score was less than 10 in 97 cases or 58.08%. Other clinical signs were dehydration (164 cases or 98.2%), nausea/vomiting (82 cases or 49.1%) and respiratory distress (74 cases or 44.31%).

- The anomalies observed at biological aspects were hypernatremia (112 cases or 67%), hepatic cytolysis (110 cases or 66%), renal failure (57 cases or 34.13%), hyperglycemia (85 cases or 50%) and biological inflammation in 87% of the cases having carried out these examinations.
- Treatment consisted of intravenous rehydration in 98.2% of cases, wet wrapping or cooling in 92.80% and the use of antipyretic drugs in 76.65%. **Figure 3** describes the distribution of this treatment.
- Prognostic aspects are summarized in **Table 2**.

■ intravenous rehydration ■ antipyretic drugs ■ therapeutic cooling ■ other treatments



**Figure 3.** Distribution of treatment received in hospital.

**Table 2.** Summary of socio-demographic, clinical, biological and prognostic characteristics of the 167 patients with heat stroke.

Variables	Number (%) / mean $\pm$ standard deviation
<b>Socio-demographic characteristics and comorbidities</b>	
*Age (years)	72.83 $\pm$ 10.87
Loss of autonomy	50 (29.94)
Moderate activity level	108 (64.67)
Cardiovascular disease	85 (50.9)
Diabetes	23 (13.77)
Kidney disease	5 (2.99)

## Continued

Neurological disease	18 (10.78)
Existence of treatment	47 (28.14)
<b>Clinical aspects</b>	
*Core temperature	42.64 ± 2.31
*Systolic blood pressure	133.59 ± 34.86
*Diastolic blood pressure	75.69 ± 19.05
*Heart rate	111.02 ± 31.24
Saturation	92.45 ± 5.46
*Glasgow Score	9.83 ± 3.88
Dehydration	164 (98.2)
Breathing distress	74 (44.31)
Nausea/vomiting	82 (49.1)
<b>Biological characteristics</b>	
*Leukocytes	12993.53
*Neutrophils	8378.68
*Hemoglobin level	11.63 ± 2.33
*Bracelets	189680.50
*Protein C reactive	45.88 ± 35.2
*Creatininemia	258.36 ± 101.2
*Na <sup>+</sup>	136.50 ± 14.56
*K <sup>+</sup>	3.69 ± 1.06
*Cl <sup>-</sup>	95.58 ± 13.06
*Baking Soda	23.21 ± 5.93
*ASAT	117 ± 50.8
*ALAT	51.62 ± 15
*Blood sugar	9 ± 3.2
<b>Evolution and prognostic characteristics</b>	
Length of hospitalization	2.55 ± 0.95
Kidney failure	57 (34.13)
Multiple organ failure	39 (23.35)
State of shock	26 (15.57)
Death	86 (51.49)

\*mean ± standard deviation or median if non-normal distribution.

### 3.4. Statistical Analysis

In the comparative analysis according to mortality, age, core temperature, respiratory distress, tachycardia, and altered state of consciousness were associated factors in the death group. However, in the multivariate logistic regression, only ini-

tial vital signs were statistically significant. **Table 3** and **Table 4** summarize the different analyses.

**Table 3.** Bivariate comparative analysis according to mortality.

Variables	Mortality		p-value <sup>2</sup>
	No N = 81 <sup>1</sup>	Yes N = 86 <sup>1</sup>	
<b>Socio-demographic characteristics and comorbidities</b>			
<b>Age (years)</b>			<b>0.044</b>
≤60	11 (39%)	17 (61%)	
>60	70 (50%)	69 (50%)	
<b>Cardio-vascular disease</b>			0.4
No	37 (45%)	45 (55%)	
Yes	44 (52%)	41 (48%)	
<b>Respiratory disease</b>			>0.9
No	80 (48%)	85 (52%)	
Yes	1 (50%)	1 (50%)	
<b>Kidney disease</b>			0.2
No	77 (48%)	85 (52%)	
Yes	4 (80%)	1 (20%)	
<b>Diabete</b>			0.4
No	68 (47%)	76 (53%)	
Yes	13 (57%)	10 (43%)	
<b>Neurological disease</b>			0.9
No	72 (48%)	77 (52%)	
Yes	9 (50%)	9 (50%)	
<b>Existence of treatment</b>			0.4
No	56 (47%)	64 (53%)	
Yes	25 (53%)	22 (47%)	
<b>Core temperature</b>			<b>0.006</b>
≤41	74 (53%)	65 (47%)	
>41	7 (25%)	21 (75%)	
<b>Clinical aspects</b>			
<b>systolic blood pressure</b>			0.7
Anormal	4 (14%)	24 (86%)	
Normal	2 (8.7%)	21 (91%)	
<b>diastolic blood pressure</b>			0.7
Anormal	3 (14%)	18 (86%)	
Normal	3 (10%)	27 (90%)	

## Continued

<b>Pulse or heart rate</b>			<b>&lt;0.001</b>
<b>Anormal</b>	43 (38%)	71 (62%)	
<b>Normal</b>	38 (72%)	15 (28%)	
<b>Saturation</b>			0.7
<b>≤90</b>	3 (9.4%)	29 (91%)	
<b>&gt;90</b>	3 (16%)	16 (84%)	
<b>Glasgow score</b>			<b>&lt;0.001</b>
<b>≤10</b>	22 (23%)	75 (77%)	
<b>&gt;10</b>	59 (84%)	11 (16%)	
<b>Dehydration</b>			0.6
<b>Non</b>	2 (67%)	1 (33%)	
<b>Oui</b>	79 (48%)	85 (52%)	
<b>Respiratory distress</b>			<b>&lt;0.001</b>
<b>Non</b>	59 (63%)	34 (37%)	
<b>Oui</b>	22 (30%)	52 (70%)	

<sup>1</sup>n (%); <sup>2</sup>Pearson's Chi-squared test.

**Table 4.** Multivariable logistic regression that adjusts for age, initial vital signs and mortality.

Characteristic	Death <sup>1</sup>	Multivariable regression		
		OR <sup>2</sup>	95% CI <sup>2</sup>	p-value
<b>Core temperature</b>				
<b>≤41</b>	46.8% (65/139)	—	—	
<b>&gt;41</b>	75.0% (21/28)	2.46	0.79, 8.48	0.13
<b>Pulse or heart rate</b>				
<b>Normal</b>	28.3% (15/53)	—	—	
<b>Anormal</b>	62.3% (71/114)	4.66	1.84, 12.6	<b>0.002</b>
<b>Respiratory distress</b>				
<b>No</b>	36.6% (34/93)	—	—	
<b>Yes</b>	70.3% (52/74)	2.67	1.14, 6.39	<b>0.024</b>
<b>Age (years)</b>				
<b>≤60</b>	61.7% (17/28)	—	—	
<b>&gt;60</b>	49.6% (69/139)	9.00	1.85, 52.2	0.058
<b>Glasgow score</b>				
<b>&gt;10</b>	15.7% (11/70)	—	—	
<b>≤10</b>	77.3% (75/97)	17.3	7.24, 45.3	<b>&lt;0.001</b>

<sup>1</sup>% (n/N), <sup>2</sup>OR = Odds Ratio, CI = Confidence Interval.

## 4. Discussion

Our study aimed to investigate the epidemiological profile of patients hospitalized for heatstroke in the Medical Emergency Department of Bogodogo University Hospital Center and identify associated factors. However, the results of our study must be interpreted considering certain methodological limitations notably: the underestimation or overestimation of events (Out-of-hospital deaths are not accounted for, which may lead to an incomplete assessment of mortality) and the Selection bias (excluding incomplete or missing records can introduce bias if these records systematically differ from complete ones). This limits the representativeness of the sample; In addition, the retrospective nature limits the ability to make causal relationships.

During our study period, we recorded 974 admissions to the department, including 167 cases of heat stroke, a proportion of 17.15%, which constituted an epidemic since it was the first time that we observed this phenomenon in our country. In the literature, the incidences of studies carried out in America, Europa and Asia vary between 10% - 30% [6] [8] [10] [15] [16]. The occurrence of this epidemic is linked to climate change, which leads to increasingly frequent heat waves [1] [9].

The average age in our study was nearly 73 years, indicating that the population most vulnerable is mainly composed of elderly people. Indeed, aging leads to a reduction in thermoregulatory capacity, a decreased response to heat, and an increased prevalence of comorbidities, which increases vulnerability to heat stroke [2] [5] [17]. The advanced age observed in our study aligns with most other research findings [8] [17] [18].

The high frequency of cardiovascular diseases (50.9%) and diabetes (13.77%) highlights that these pathologies increase susceptibility to heat stroke. These diseases can impair the ability to regulate heat and increase the severity of complications. The use of antihypertensives, neuroleptics or other medications can have side effects related to thermoregulation or increase dehydration. Other authors also report that comorbidities are risk factors for the occurrence of heat stroke [3]-[5] [10].

The mean core temperature in our study was 42.2°C with extremes from 39.8°C to 42.6°C. Temperatures below 40°C could be explained by the peripheral treatment received before admission. Adam BRUT in his study, “diagnosis and management of heat stroke” said that it was important to include such cases in the diagnosis of heatstroke [3]. We found that temperature is a prognostic factor when exceeding 41°C ( $p < 0.05$ ). In humans, a temperature above 41°C - 42°C for a period of 45 minutes to 8 hours is considered to result in cellular damage and constitutes a critical temperature [5] [18] [19]. Management must therefore be immediate to reduce body temperature. The majority of patients presented almost systematic dehydration (98.2%), which reflected hydro electrolytic disorders including hypernatremia (92 cases or 55%). Convulsions and alterations in the state of consciousness with Glasgow score less than 10 (97 cases 58%) reflected the neurodynamic severity, increasing the risk of major complications. These findings are

consistent with European and American studies conducted during heatwaves in 2007 and 1998 [3] [5].

The average hospital stay was 2.55 days, with a mortality rate of 86 cases (51.15%). This excess mortality highlighted the severity of heat stroke during this epidemic in our context. This is due to the lack of knowledge of this pathology by the population and healthcare providers. The prognostic factors included renal failure (57 cases or 34%), multi-organ failure (39 cases or 23%), cardiovascular shock (26 cases or 15%). This mortality is consistent with those observed in studies conducted in developed countries which vary between 30% and 65% [6] [8] [15] [16].

Data comparing according to the mortality show that age, core temperature, respiratory distress, tachycardia, and altered state of consciousness were associated factors in the death group. However, in the multivariate logistic regression, only initial vital signs were statistically significant. Aurélia Marfisi and colleagues also found in their 2008 study that central hyperthermia on admission was a prognostic factor for heat stroke [8] [17].

## 5. Conclusion

This was the first epidemic of heat stroke in our context. Our study shows that heat stroke primarily affects older people. Clinical features were dominated by neurological signs, dehydration, and respiratory distress. Multiple organ failure and shock constituted the majority of complications, which conducted a high mortality. Treatment consisted mainly of rehydration and cooling, extremely high core temperatures (>41 °C) were associated with poorer prognosis and higher mortality rates. Rapid and appropriate management is crucial to improve the prognosis. Given the retrospective nature of the study, identifying factors associated with survival was a limitation.

## Conflicts of Interest

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

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