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Influence of seasonal variations on admissions and deaths of pulmonary embolism in the Cardiology Department of the Yalgado Ouedraogo University Hospital Center, Ouagadougou, Burkina Faso

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Abstract

Introduction: *this study's main objective was to determine climate's influence on pulmonary embolism in the Cardiology department of the Yalgado Ouedraogo University Hospital Center (CHU-YO) from 2015 to 2019.* ***Methods:*** *the study was descriptive cross-sectional with an analytical aim by retrospective collection of data on the clinical observations of hospitalized patients.* ***Results:*** *in Burkina Faso, the average monthly mean temperature over the 5 years of the study was 31.13°C with a standard deviation of 2.46°C. The median was 30.77°C with extremes ranging from 27.55 to 35.05°C. The months of April, May and June had recorded the highest average monthly temperatures over our study period with respectively 35.05; 34.83 and 33°C. In the same order, this trio is in the lead in terms of the numbers of admissions for pulmonary embolism with 42 admissions in April, 35 in May and 34 in June over the 5 years of the study. Each increase of 1° Celsius in the monthly average temperature over the 5 years of the study in Burkina Faso led to an increase in admissions of 0.62 individuals per month for pulmonary embolism (p-value=0.0048, tau=0.626). The hospital lethality of pulmonary embolism was 6.1% (19/311) over the 5 years. The months of March and June recorded the highest number of deaths out of the five in the study with three deaths each. There was no statistically significant relationship between monthly deaths over the 5 years of the study and monthly mean temperature over the 5 years of the study (p-value=0.826). Similarly, there was no statistically significant link between the average temperature during deaths over the 5 years of the study and that during survival (p-value=0.6).* ***Conclusion:*** *with regard to pulmonary embolism, the health personnel of the Cardiology Department of the CHU-YO, without realizing it, are facing the health consequences resulting from the current climate crisis. We need to promote and adopt individual and collective climate actions as soon as possible in favor of climate action and the prevention of pulmonary embolism in Burkina Faso.*

Introduction

According to the World Health Organization, climate change is the “greatest threat to human health” [1]. Healthcare professionals around the world are already dealing with the health consequences resulting from the ongoing climate crisis [1]. Regions with weaker health systems, mostly in developing countries, will be the least able to prepare and cope without assistance [1]. Among the causes of death linked to heat waves, major cardiovascular events dominate the tables (up to 90% of mortality), affecting people with or without a cardiovascular history [1-2]. Global warming facilitates or aggravates states of hypovolemia, hemoconcentration, hypercoagulability and blood hyperviscosity, thus increasing the risks of hypovolemic, ischemic and/or thromboembolic cardio-circulatory collapse [1-2].

Pulmonary embolism (PE) constitutes deep vein thrombosis (DVT), the two components of venous thromboembolic disease (VTD) [3]. It is defined as the sudden obliteration (total or partial) of the trunk of the pulmonary artery or one of its branches by a circulating foreign body, most often fibrino-cruoric [4]. Pulmonary embolism (PE) is the third leading cause of cardiovascular death after coronary heart disease and stroke worldwide [4,5]. The main objective of this study was to determine the influence of climate on pulmonary embolism in the Cardiology department of the Yalgado

Ouedraogo University Hospital Center (CHU-YO) from 2015 to 2019, in Ouagadougou, Burkina Faso.

In order to achieve this objective we formulated the following research questions: i) Is there a link between monthly average temperature and the number of monthly admissions for pulmonary embolism (male; female; both)? ii) Is there a link between the average temperature during male admissions over the 5 years of the study and that during female admissions? iii) Is there a link between monthly average temperature and the number of monthly deaths from pulmonary embolism (man; woman; both)? iv) Is there a link between the average temperature during male deaths over the 5 years of the study and that during female deaths? v) Is there a link between the average monthly temperature and the average age of monthly admissions/deaths from pulmonary embolism? vi) Is there a link between the average temperature over the 5 years of the study and the survival modality?

Methods

Study design: the study was cross-sectional, descriptive with an analytical aim of retrospective collection of data on the clinical observations of patients hospitalized in the cardiology department of the CHU-YO in Ouagadougou in Burkina Faso.

Setting: Burkina Faso is a landlocked country in West Africa that is Sahelian in the north and gradually becoming savannah in the south. This low-income country has an intertropical climate with two seasons, a rainy season (June to September) and a dry season (October to May) [6-8]. The Yalgado Ouedraogo Hospital, the first level III University Hospital Center in the capital, the CHU-YO remains a reference hospital to this day. Of the multiple medical-surgical specialties, there is the Cardiology department. With its capacity of 27 hospital beds, including four beds dedicated to cardiological intensive care, the CHU-YO Cardiology department remains a reference in the management of cardiovascular conditions in Ouagadougou.

Study size and participants: the study population included all patients admitted to the CHU-YO cardiology department for pulmonary embolism over a study period extending from January 1, 2015, to June 30, 2019. The only inclusion criterion for the study was confirmation of the pulmonary embolism by chest angiography or ventilation-perfusion lung scintigraphy. The criteria for non-inclusion in the study were files that were unusable, incomplete, or not found.

Variables: data collection used a survey form as a collection tool. The medium for this collection tool was paper. The variables collected were month of admission, year of admission, sex, age and modalities of survival, month of death, and year of death.

Data sources/measurement: data collection was done by using clinical records and outpatient records. The climatic data (average monthly temperatures) had been provided by the site "Weather history: weather archives for the whole world" [9]. This site offers free and open access to the complete weather history of the whole world, day-by-day and month-by-month since 2009.

Data collection: data entry was done using Excel software

Statistical analysis Software: the statistical analysis of the data was done with the statistical analysis software Rstudio version 4.0.2.

Statistical methods

Qualitative variables: the descriptive analysis of the qualitative variables consisted in expressing the modalities of the qualitative variables in the form of absolute frequency, and relative frequency. The "gender" variable was also expressed as a male/female ratio.

Quantitative variables: the descriptive analysis of the quantitative variables was made with the

position parameters (mean, median) and the dispersion parameters (standard deviation, extremes).

Bivariate analysis: when it came to crossing a binary qualitative variable with a quantitative variable, the objective was to find the existence of a statistically significant link between the two unpaired variables by comparing two unpaired means. This was used when comparing the average temperature during male admissions/deaths over the 5 years of the study and that during female admissions/deaths, or, the average temperature over the 5 years of the study and the survival modality. The link was searched with the appropriate statistical test according to its conditions of applicability. When it came to crossing a quantitative variable with a variable quantitative, we made a simple linear correlation of 2 unpaired quantitative variables. The objective was to find the slope of the correlation. This was used when comparing the monthly average temperature and the number of monthly admissions/deaths (male, female, both), or, the average monthly temperature and the average age of monthly admissions/deaths. The slope was sought with the appropriate statistical test according to its conditions of applicability. A link was retained as statistically significant for a p-value < 0.05. We used table to present the monthly average temperatures (°Celsius) in Burkina Faso from January 2015 to June 2019, and figures for all the other results.

Ethical considerations: with regard to the ethical framework, the department head had authorized the study and the survey sheets were anonymous.

Results

Proportion of pulmonary embolism: during our study period, 311 cases of pulmonary embolism were collected out of 3205 patients admitted to cardiology, a proportion of 9.7%.

Socio-demographic characteristics: our study population was predominantly female with a sex ratio of 0.63. The average age was 50.41 years ± 15.81 years with extremes of 16 and 85 years. The average age of women was 49.45 years ± 15.86 and that of men 51.91 years ± 15.94. There was no statistically significant difference (p-value = 0.67). The hospital lethality of pulmonary embolism was 6.1% (19/311) over the 5 years (9 men and 10 women).

Climate: the average monthly mean temperature over the 5 years of the study was 31.13°C with a standard deviation of 2.46°C. The median was 30.77°C with extremes ranging from 27.55 to 35.05°C (Table 1). The months of April, May and June had recorded the highest average monthly temperatures over our study period with respectively 35.05; 34.83 and 33°C (Table 1).

Climate and admissions

Climate and number of admissions per month: the months of April, May and June are the first three months in terms of the number of admissions for pulmonary embolism with 42, 35 and 34 admissions out of all admissions over the 5 years of the study (Figure 1). There was a statistically significant relationship between monthly admissions over the 5 years of the study and mean monthly temperature over the 5 years of the study. Each increase of 1° Celsius in the monthly average temperature over the 5 years of the study in Burkina Faso led to an increase in admissions of 0.62 individuals per month (p-value=0.0048, tau=0.626) (Figure 2).

Climate and number of male admissions per month: there was a statistically significant relationship between the number of male admissions per month over the 5 years of the study and the average monthly temperature over the 5 years of the study. Each increase of 1° Celsius in the monthly average temperature over the 5 years of the study in Burkina Faso led to an increase in male admissions of 0.54 individuals per month (p-value=0.015, tau=0.542) (N=121).

Climate and number of female admissions per month: there was a statistically significant relationship between the number of female admissions per month over the 5 years of the study and the average monthly temperature over the 5 years of the study. Each increase of 1° Celsius in the monthly average temperature over the 5 years of the study in Burkina Faso led to an increase in female admissions of 0.57 individuals per month (p-value=0.012, tau=0.572) (N=190).

Temperature on male admissions vs. temperature on female admissions: there was no statistically significant link between the average temperature during male admissions over the 5 years of the study and that during female admissions. (p-value=0.6) (N = 311).

Climate and the average age of admissions by month: there was no statistically significant link between the mean age of admissions per month over the 5 years of the study and the mean monthly temperature over the 5 years of the study (p-value=0.3108) (Figure 3).

Climate and death

Climate and number of deaths per month: the months of March and June recorded the highest number of deaths out of the 5 in the study with 3 deaths each (Figure 4). There was no statistically significant relationship between monthly deaths over the 5 years of the study and monthly mean temperature over the 5 years of the study (p-value=0.826) (Figure 5).

Climate and number of male deaths per month: there was no statistically significant relationship between the number of male deaths per month over the 5 years of the study and the monthly mean temperature over the 5 years of the study (p-value=0.822) (N=9).

Climate and number of female deaths per month: there was no statistically significant relationship between the number of female deaths per month over the 5 years of the study and the monthly average temperature over the 5 years of the study (p-value=0.559) (N = 10).

Temperature at male deaths vs. temperature at female deaths: there was no statistically significant link between the average temperature during male deaths over the 5 years of the study and that during female deaths (p-value=0.6) (N=19).

Climate and average age of death per month: there was no statistically significant link between the mean age of death per month over the 5 years of the study and the mean monthly temperature over the 5 years of the study (p-value=0.6481) (Figure 6).

Climate and modality of survival: there was no statistically significant link between the average temperature during deaths over the 5 years of the study and that during survival (p-value=0.6) (N = 311).

Discussion

Emissions of greenhouse gases, particularly carbon dioxide ($C0_2$), are the cause of global warming [10]. Burkina Faso, with its Sahelian climate with a dry season of 8 to 9 months, galloping urbanization at the expense of tree reserves means that; although it is responsible for only 0.1% of global CO_2 emissions [10], it is more exposed to the effects of global warming. Indeed, over our study period, the average monthly mean temperature in Burkina Faso was 31.13°C with a standard deviation of 2.46°C. The median was 30.77°C with extremes ranging from 27.55 to 35.05°C. Temperatures are much higher than in China, the first country in terms of global CO_2 emissions with 27.8% or in the United States of America, second with 12.7% [10].

This study clearly illustrates the cardiovascular burden caused by global warming in Burkina Faso. The months of April, May and June had recorded the highest average monthly temperatures over our study period with respectively 35.05, 34.83

and 33°C. In the same order, this monthly trio leads in terms of the number of admissions for pulmonary embolism with 42 admissions in April, 35 in May and 34 in June over the 5 years of the study. Each increase of 1° Celsius in the monthly average temperature over the 5 years of the study in Burkina Faso led to an increase in admissions of 0.62 individuals per month for pulmonary embolism (p-value=0.0048, tau=0.626). Indeed, this observed relationship between the increase in temperature and the number of admissions for pulmonary embolism can be explained by at least two parameters of Virchow's triad [11]. On one hand, heat naturally causes vasodilation. This is to maintain the body's core temperature within the range compatible with life (we speak of thermoregulation). However, vasodilation makes venous return from the legs more difficult, where gravity is greatest. This results in blood stasis in the lower legs with a greater risk of venous thrombosis in the lower limbs. In 90% of cases will be complicated by pulmonary embolism.

On the other hand, always with the concern of thermoregulation, the body reacts to heat waves by greater perspiration. In the absence of compensatory fluid intake, dehydration quickly sets in with a decrease in blood volume and hemoconcentration. The consequence is blood hyperviscosity with hypercoagulability and therefore a greater risk of venous thrombosis. While it is true that scorching temperatures increase admissions for pulmonary embolism in the Cardiology department of the CHU-YO, there was however no statistically significant link between monthly deaths over the 5 years of the study and temperature monthly average over the 5 years of the study (p-value=0.826). Similarly, there was no statistically significant link between the average temperature during death over the 5 years of the study and that during survival (p-value=0.6).

The health personnel of the Cardiology Department of the CHU-YO, without realizing it, are facing the consequences on cardiovascular health resulting from the current climate crisis. For the moment, it manages to maintain a dam, in order to prevent the increase in morbidity from pulmonary embolism from turning into an increase in mortality during scorching temperatures. Faced with the rapid increase in population [12,13], the demand for increasingly diversified health care (malaria, tuberculosis, HIV, haemorrhagic fevers, maternal mortality, infant malnutrition, arterial hypertension, diabetes, ischemic heart disease, etc.), the security situation and the displacement of populations [14], the advance of desertification [15], the growing increase in its carbon emissions [10] and those of the world [10], Burkina Faso must save its fragile health system a situation of triple health burden with communicable diseases, those non-communicable due to unhealthy lifestyles and those linked to climates.

Upstream, Burkina Faso should immediately fully participate in the fight against global warming and its consequences by promoting individual and collective climate actions: 1. implement national and international policies in favour of climate action and health; 2. raising awareness of the health consequences of climate change; 3. conduct awareness campaigns on the importance of continuous oral hydration during the hot summer months in Burkina Faso for primary prevention of pulmonary embolism.

Limitations of the study: the retrospective collection of data on clinical records could certainly have been the source of information bias.

Conclusion

With regard to pulmonary embolism, the health personnel of the Cardiology Department of the CHU-YO, without realizing it, are facing the health consequences resulting from the current climate crisis. We need to promote and adopt individual and collective climate actions as soon as possible in favour of climate action and the prevention of pulmonary embolism in Burkina Faso.

What is known about this topic

- *According to the World Health Organization, climate change is the "greatest threat to human health".*

What this study adds

- *The number of admissions for pulmonary embolism in the Cardiology department of the CHU-YO increases with climatic temperature (p-value=0.0048, tau=0.626);*
- *There was no statistically significant link between the number of deaths by pulmonary embolism in the Cardiology department of the CHU-YO and the climatic temperature (p-value=0.826).*

Competing interests

The authors declare no competing interests.

Authors' contributions

Patrice Zabsonre is the head of department; he authorizes the studies of the department. Nobila Valentin Yameogo supervised the study and writing of the manuscript. Aimé Yiompouén carried out the data collection. Pêngd-Wendé Habib Boussé Traore performed the data analysis and wrote the manuscript. Aminata Niankara/Kargougou, Georges Rosario Christian Millogo, Anna Tall, Koudougou Josias Kologo, Laurence Kabore, André Koudnoaga Samadoulougou and Martial Ouedraogo participated in the proofreading of the manuscript. All the authors have read and agreed to the final manuscript.

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Table and figures

Table 1: history of monthly average temperatures (°Celsius) in Burkina Faso from January 2015 to June 2019

Figure 1: distribution of admissions and temperature according to month in patients hospitalized for pulmonary embolism in the Cardiology department of the Yalgado OUEDRAOGO University Hospital Center from 2015 to 2019, N = 311

Figure 2: comparison of monthly admissions over the 5 years of the study according to the monthly average temperature over the 5 years of the study, in patients hospitalized for pulmonary embolism in the Cardiology Department of the Yalgado Ouedraogo University Hospital Center from 2015 to 2019, N = 311

Figure 3: comparison of the average age of admissions per month over the 5 years of the study according to the average monthly temperature over the 5 years of the study, in patients hospitalized for pulmonary embolism in the Cardiology Department of the Hospital Center University Yalgado Ouedraogo from 2015 to 2019, N = 311

Figure 4: distribution of deaths and temperature according to month in patients who died for pulmonary embolism in the Cardiology department of the Yalgado Ouedraogo university hospital center from 2015 to 2019, N = 19

Figure 5: comparison of monthly deaths over the 5 years of the study with the average monthly temperature over the 5 years of the study, in patients who died of pulmonary embolism in the Cardiology Department of the Yalgado Ouedraogo university hospital center from 2015 to 2019, N = 19

Figure 6: comparison of the average age of death per month over the 5 years of the study with the average monthly temperature over the 5 years of the study, in patients who died of pulmonary embolism in the Cardiology department of the Hospital Center University Yalgado Ouedraogo from 2015 to 2019, N = 19

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Table 1: history of monthly average temperatures (°Celsius) in Burkina Faso from January 2015 to June 2019						
	2015	2016	2017	2018	2019	2015-2019
January	26	27	27	28	29	27.55
February	30	29	30	31	31	30.32
March	32	33	32	34	33	32.87
April	33	35	35	35	36	35.05
May	35	35	35	35	34	34.83
June	33	33	33	33	33	33
July	31	30	31	30	-	30.5
August	29	29	29	28	-	28.77
September	29	30	30	29	-	29.3
October	32	32	32	32	-	32
November	30	31	31	32	-	31.04
December	26	29	29	29	-	28.44

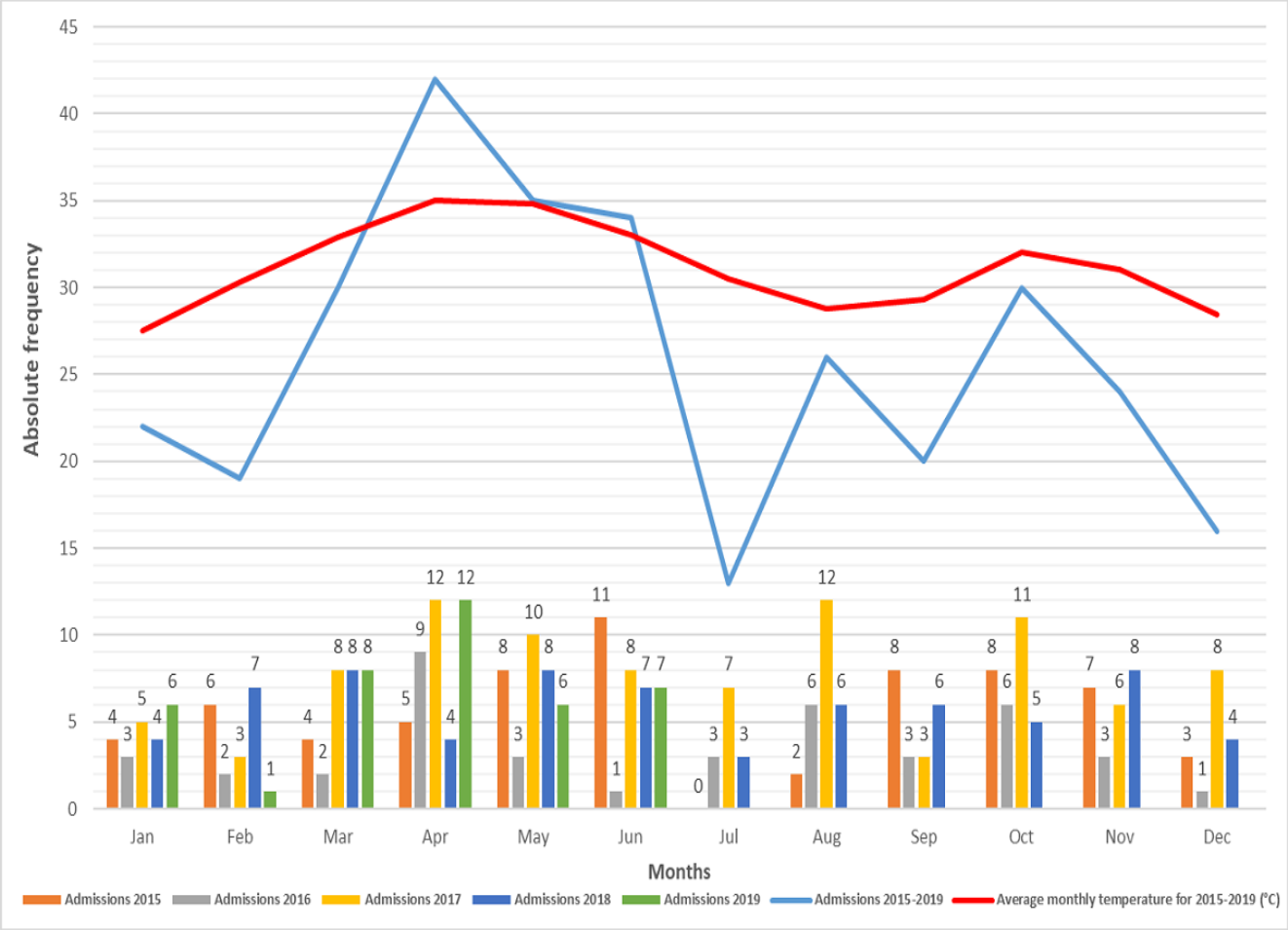

Figure 1: distribution of admissions and temperature according to month in patients hospitalized for pulmonary embolism in the Cardiology department of the Yalgado OUEDRAOGO University Hospital Center from 2015 to 2019, N = 311

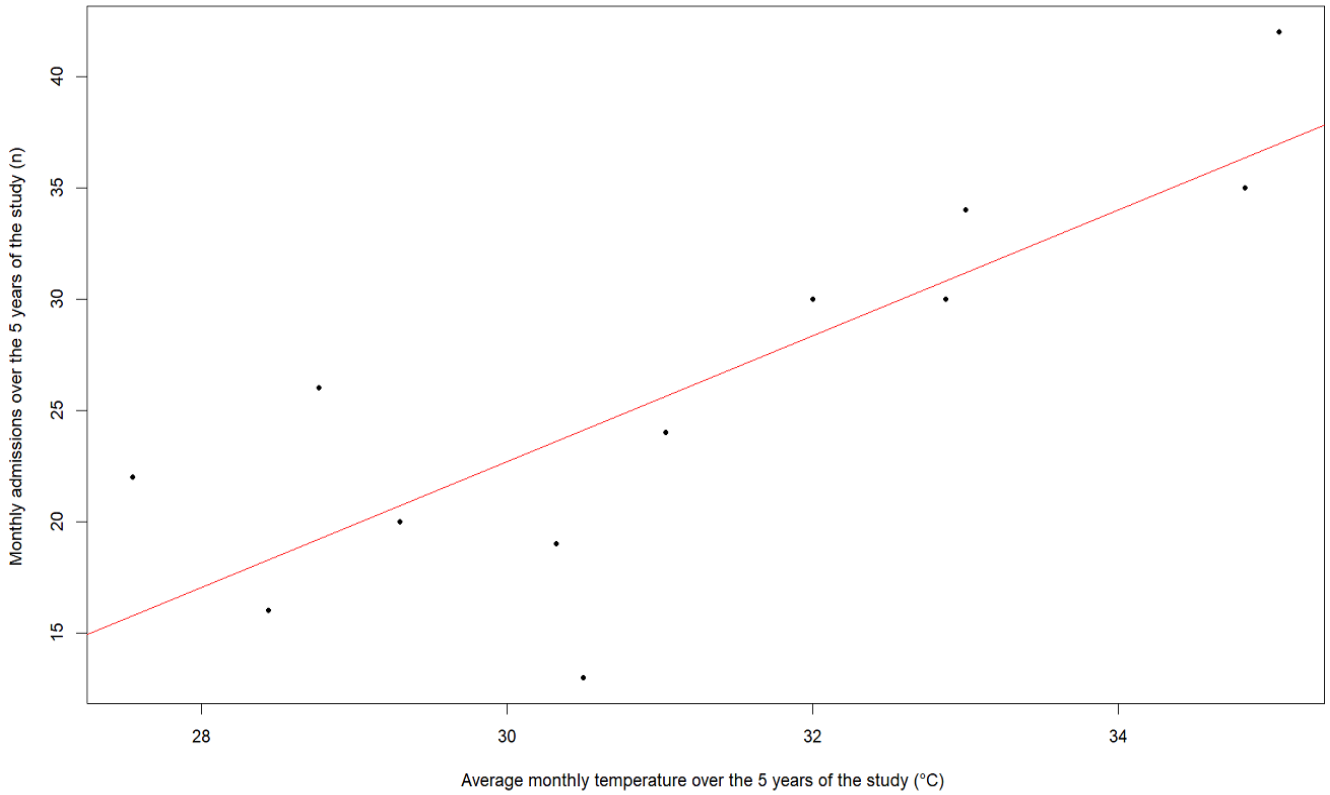

Figure 2: comparison of monthly admissions over the 5 years of the study according to the monthly average temperature over the 5 years of the study, in patients hospitalized for pulmonary embolism in the Cardiology Department of the Yalgado Ouedraogo University Hospital Center from 2015 to 2019, N = 311

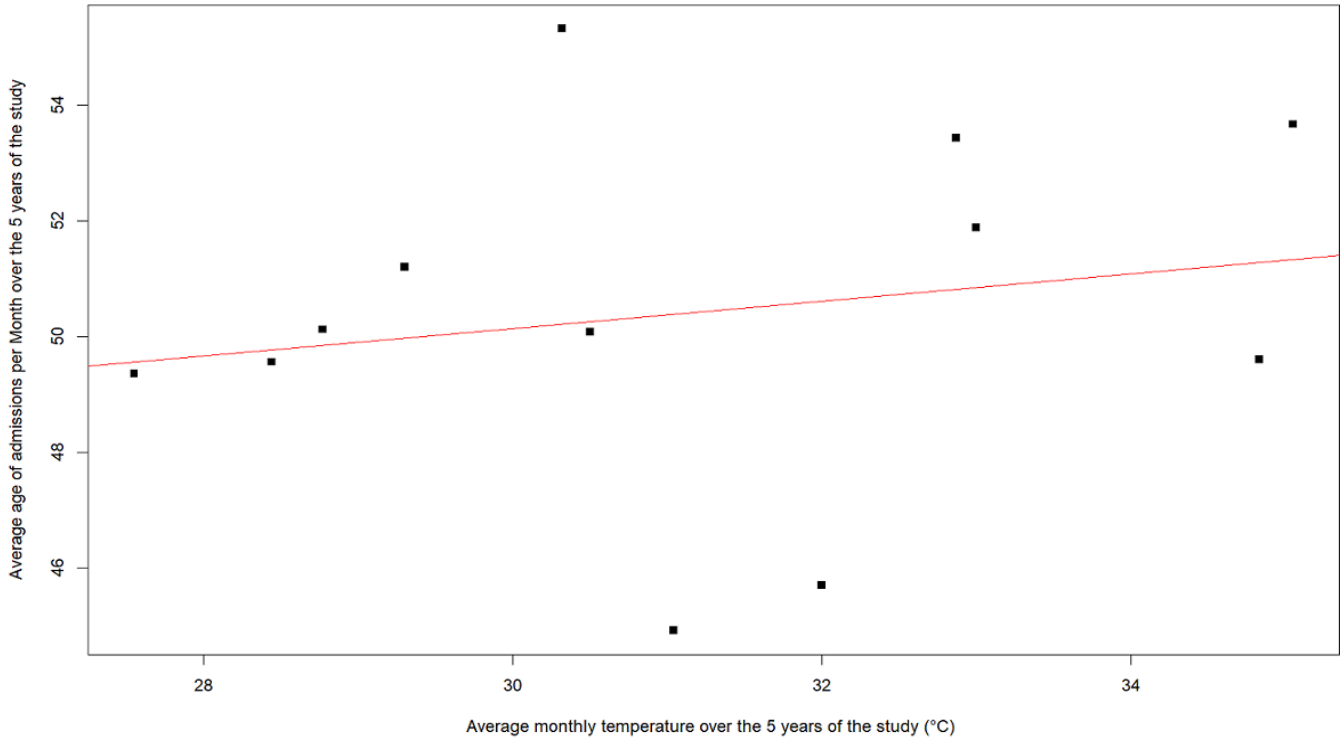

Figure 3: comparison of the average age of admissions per month over the 5 years of the study according to the average monthly temperature over the 5 years of the study, in patients hospitalized for pulmonary embolism in the Cardiology Department of the Hospital Center University Yalgado Ouedraogo from 2015 to 2019, N = 311

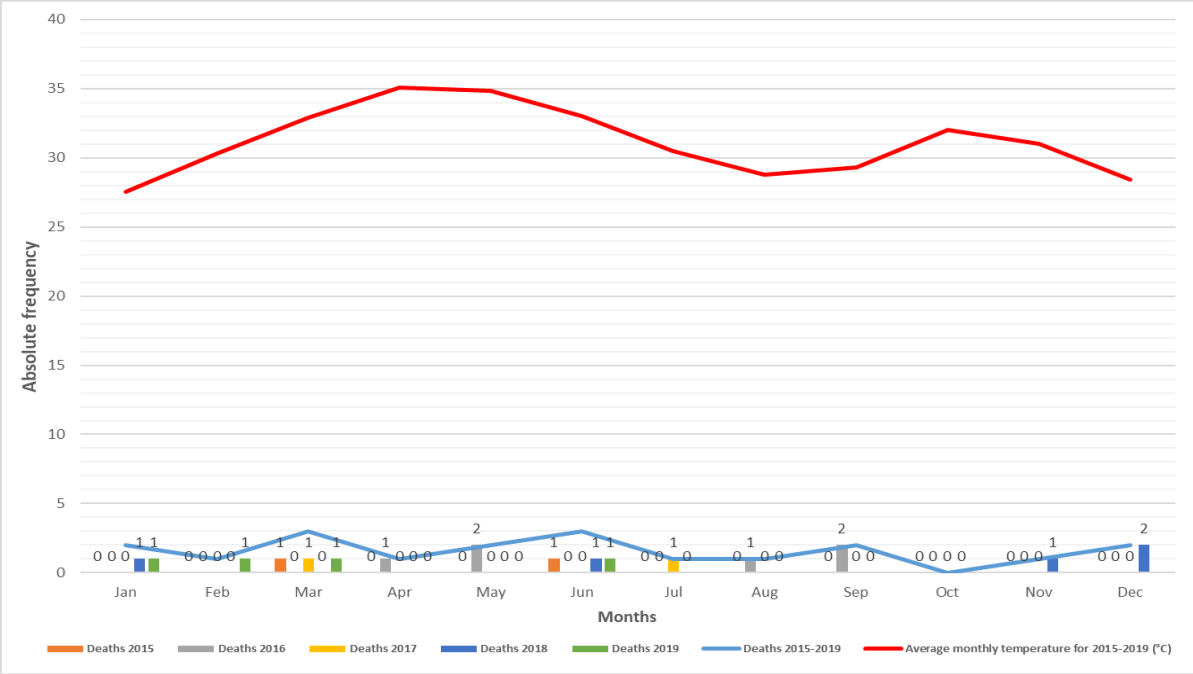

Figure 4: distribution of deaths and temperature according to month in patients who died for pulmonary embolism in the Cardiology department of the Yalgado Ouedraogo university hospital center from 2015 to 2019, N = 19

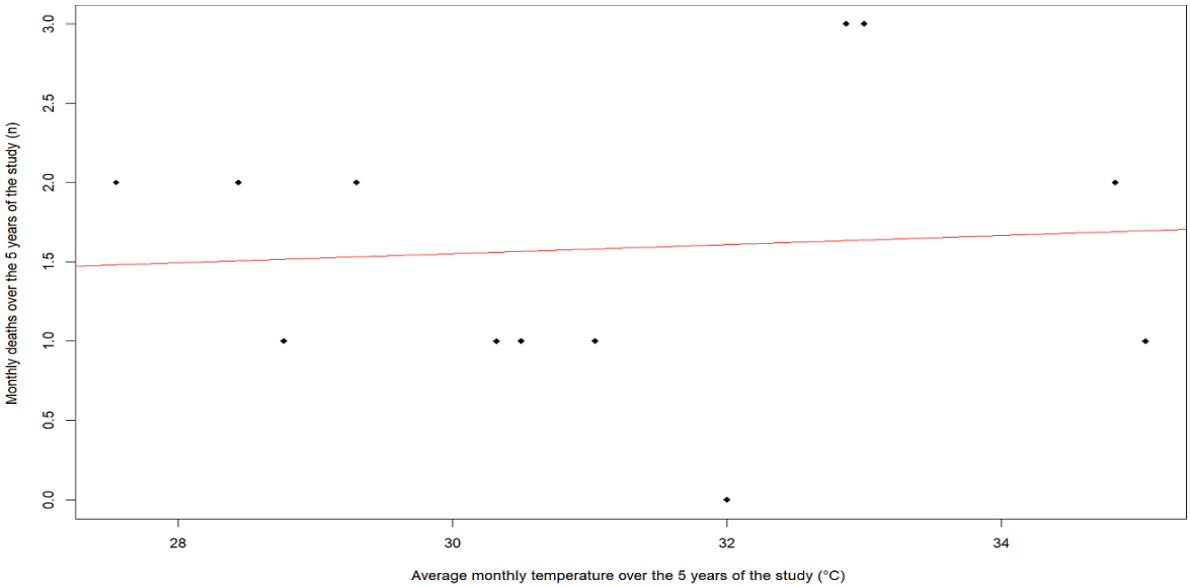

Figure 5: comparison of monthly deaths over the 5 years of the study with the average monthly temperature over the 5 years of the study, in patients who died of pulmonary embolism in the Cardiology department of the Yalgado Ouedraogo university hospital center from 2015 to 2019, N = 19

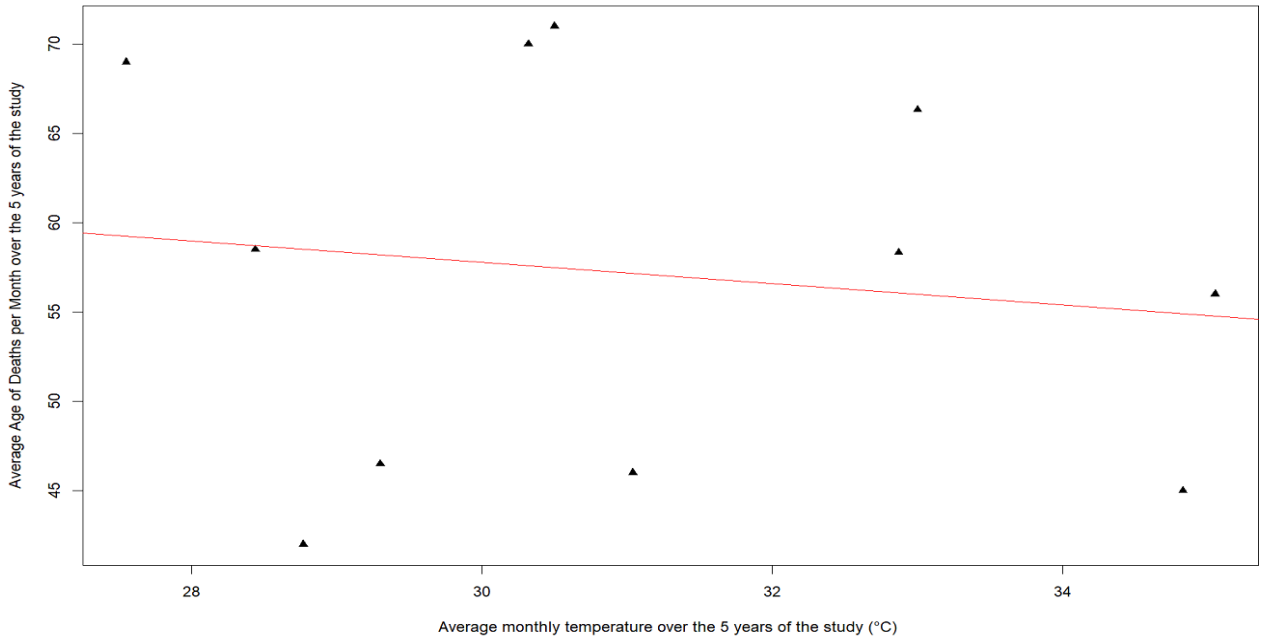

Figure 6: comparison of the average age of death per month over the 5 years of the study with the average monthly temperature over the 5 years of the study, in patients who died of pulmonary embolism in the Cardiology department of the Hospital Center University Yalgado Ouedraogo from 2015 to 2019, N = 19