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Research Article

Seasonal Variations of Hyperglycemic Crises in Diabetic Patients at a National Hospital Center, Benin: a Cross Sectional Study

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Abstract

Aim: To study the seasonal characteristics of hyperglycemic decompensations in the endocrinology department of the CNHU-HKM of Cotonou.

Materials and methods: It was a cross-sectional, descriptive, and study of diabetic patients hospitalized from January 1, 2010 to December 31, 2019. Diabetic patients hospitalized for ketosis decompensation and/or hyperglycemic hyperosmolar syndrome were included in this study. The meteorological data used were obtained from the climate observation network of the Direction de la Météorologie Nationale (DMN) du Bénin. We have considered the means of rainfall and temperature per month and per year.

Results: A total of 613 patients were included during the study period. The mean age of the patients was 46.77±15.84 years. The frequency of hyperglycemic hyperosmolar syndrome and ketoacidosis was 14.7% and 69.5% respectively. Hyperglycemic crises were more frequent during the rainy season and periods of low temperature. The main precipitating factors were infections and non-adherence to treatment. The main infectious sites involved in hyperglycemic crises were pulmonary (19%), urogenital (21.3%) and malaria (26.8%). The frequency of these different infections was higher during the rainy season with a statistically significant difference ($p=0.02$) for malaria.

Conclusion: The frequency of hyperglycemic crises was high and had a seasonal distribution. The most frequent precipitating factors were infections and non-adherence to treatment. Those factors were more frequent in the rainy season.

Key words: diabetes ; complications; hyperglycemic crises; infections ; climate

Introduction

Diabetes mellitus is a public health problem that concerns every continent. According to the International Diabetes Federation (IDF), the number of people living with diabetes will rise from 19 million in 2019 to 47 million by 2045 [1] in Africa region. Its course can lead to complications such as hyperglycemic crises including diabetic ketoacidosis and hyperglycemic hyperosmolar syndrome [2]. In West Africa, the prevalence of ketoacidosis is high and ranges from 28.99% to 59.1% depending on the studies [2-4]. Many factors are involved in these acute complications; the most frequent are infections, non-adherence to treatment and lack of recognition of the disease [2, 5, 6]. Infectious causes remain predominant and are mainly urogenital infections, pneumonia and malaria [2, 3, 7,8]. The seasonal period for each acute infectious disease is determined by geographical locations [9]. Results from earlier studies demonstrate a strong and consistent association between the climatic seasons and the glycemic conditions. For instance, Kalliora et al [10] and Mianowska et al [11] in 2011 reported the lowest values of glycated hemoglobin (A1C) in summer and the highest values in winter in their studies studies involving children and adults with T1DM. In 2013, a study of 8020 children in Sweden had reported that 53% of new cases of type 1 diabetes were diagnosed during the autumn and winter months [12]. In a recent study in Cameroon, a slight increase in the incidence of diabetes was found during the rainy season, with more cases during the month of October which is characterized by heavy precipitations [13]. The objective of this study was then to determine the seasonal pattern of diabetic hyperglycemic crises in the climatological data of Benin.

Materials and methods

This study was carried out in the endocrinology and metabolism department of the Hubert Koutoukou Maga National University Hospital Center (CNHU) in Cotonou. It was a cross-sectional, descriptive study of diabetic patients hospitalized from January 1, 2010 to December 31, 2019. Diabetic patients hospitalized for ketosis decompensation and/or hyperglycemic hyperosmolar syndrome were included in this study.

Study population was constitued by patients with diabetes of both genders hospitalized in the endocrinology and metabolism department of the Hubert Koutoukou Maga National University Hospital Center (CNHU) in Cotonou. Data were collected using a questionnaire established for the needs of the study Inclusion criteria All diabetic patient who has been hospitalized during the study period was included. Exclusion criteriaPatients with an incomplete medical records were not includedSample size we have done a complete recruitment of all cases of ketosis decompensation and Hyperosmolar hyperglycemic syndrome during the study period.

The ketosis decompensation of diabetes mellitus was defined by a glycemia ≥ 250 mg/dL and a ketonuria ≥ two crosses with positive glycosuria [14].

Hyperosmolar hyperglycemic syndrome was defined by a hyperglycemia greater than or equal to 600 mg/dL and an osmolarity greater than 320 mOsmol/L [15].

When the patient presented with both ketotic decompensation and hyperosmolar hyperglycemic syndrome, we retained a combined decompensation.

The following variables were collected: age, gender, profession, duration of diabetes, type of diabetes, decompensation factors, blood glucose, glycosuria, ketonuria, test for malaria, bacteriological analysis of urine, chest X-ray, blood culture.

Infectious sites were classified as follows

Pneumonia was considered when there were clinical symptoms suggestive such as fever, chest pain, sputum cough, and pulmonary condensation syndrome, systematized opacities, non-retractile with or without a bronchogram on the chest X-ray

The urinary tract site was retained in the presence of mictional burning, pollakiuria, dysuria, or hypogastric pain, with a bacteriological analysis of urine showing $\geq 10^4$ leukocyturia and $\geq 10^5$ bacteriuria [16].

The genital site was retained in a woman with symptoms such as vulvar pruritus, leukorrhea.

The meteorological data used were obtained from the climate observation network of the Direction de la Météorologie Nationale (DMN) du Bénin. The climatological parameters considered were temperature (in °C) and the rainfall (in mm). The average monthly values of these parameters for each year has been considered. Cotonou is characterized by two rainy seasons and two dry seasons: a long rainy season from mid-March to mid-July; a short dry season which begins in mid-July and ends at the end of August; a short rainy season that starting in September and ends in mid-November; and a long dry season that runs from mid-November to mid-March [17].

Statistical analysis

The source of data was the records of hospitalized diabetic patients and the hospitalization register, and for the climatological data, the climate observation network of the National Meteorological Department (DMN) was used. We checked the consistency of the data and outliers and duplicates were removed. Data management and analysis were performed using SPSS software version 21 and R software version 3.6.1. The qualitative variables had been described as proportions and the quantitative variables as position parameters. Comparisons of means were made using the t-test and comparisons of proportions were done using the Chi-square test or Fisher's test as required. A p value <0.05 was considered significant. Since climate data for the last year (2019) were not available, the seasonal variations study was therefore based on the period from 2010 to 2018 including 90.70% (556/613) of patients.

Results

Study population characteristics

A total of 613 patients were included during the study period. The mean age of the patients was 46.77±15.84 years, and there was a slit predominance of women the other general characteristics of the study population are shown in Table 1.

Parameters	Mean± SD Or %
Age (year)	46.77 ± 15.84
Sex ratio	0.9
Duration of diabetes	4.50 ± 8.08
Type of diabetes Type 1 Type 2 Others	 12.5 86.4 1.1
Type of hyperglycemic crises Ketosis Hyperosmolar hyperglycemic syndrome Combined decompensation	 69.5 14.7 15.8
Hyperglycemic crises revealing diabetes	38.3
Mean glycemia (mg/dL)	442 ± 131

Level of ketonuria	
++	24.1
+++	49.3
++++	26.6
Mean osmolarity (mOsmol/L)	342.73 ± 23.59

Table 1: *General characteristics of patients admitted for diabetic decompensations*

Hyperglycemic crises and seasons

The frequency of hyperglycemic crises was high during the rainy seasons (Figure 1 and 2). Moreover, the number of cases of hyperglycemic crises was positively correlated with rainfall and low temperatures (August) (figure 3).

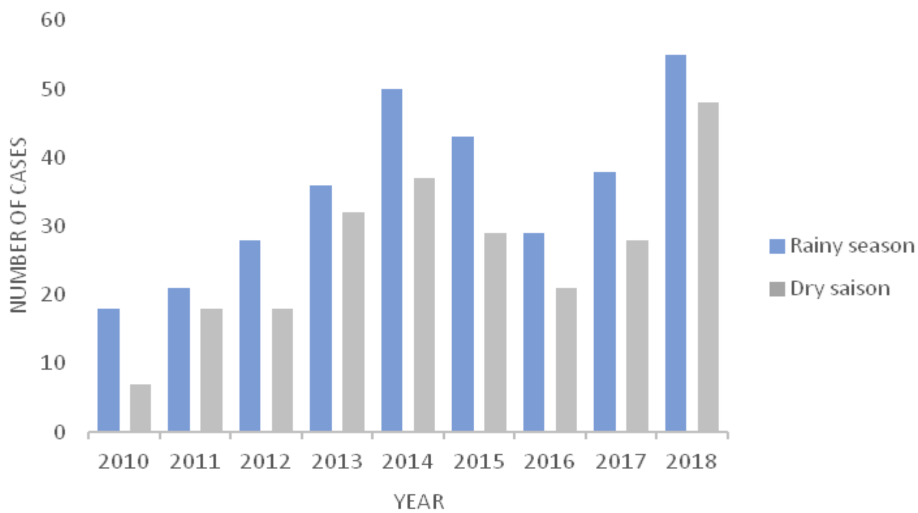

Figure 1: *Seasonal patterns of hyperglycemic crises during the period 2010 – 2018*

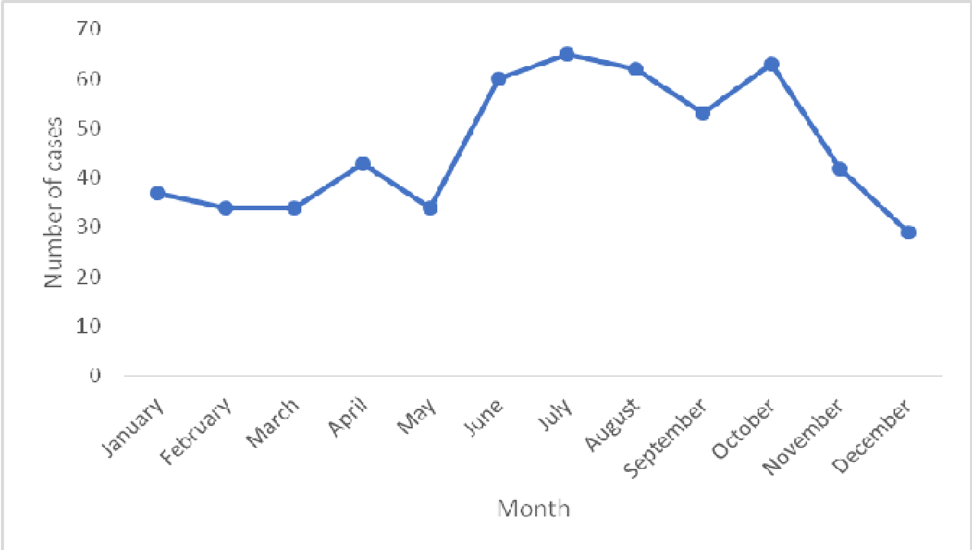

Figure 2: *Monthly trends in hyperglycemic crises during the period 2010 – 2018*

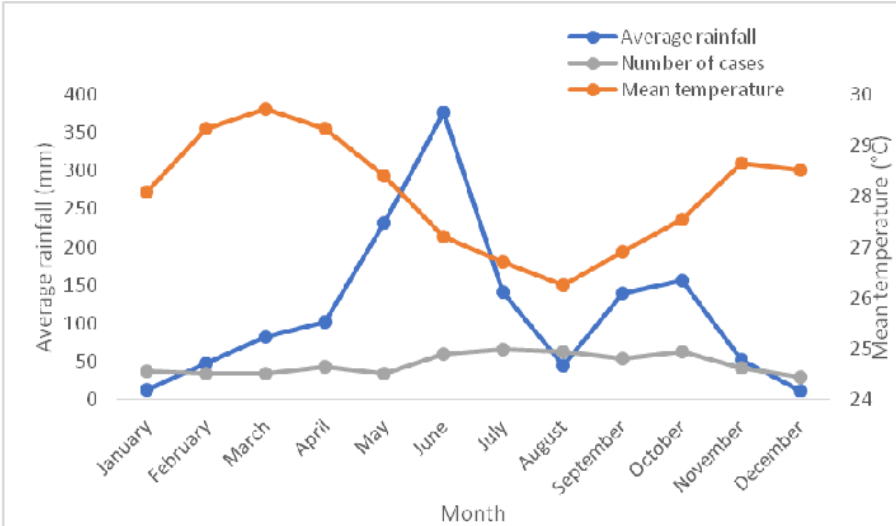

Figure 3: *Distribution of hyperglycemic crises according to temperature and rainfall during the period 2010 – 2018*

Precipitating factors of hyperglycemic crises and seasons

The main precipitating factors for hyperglycemic crises were infections (59.32%), non-adherence to treatment (19.32%) and malaria was the most frequent infection (26.8%). (Table 2)

Precipitating factors	N (%)
Infections	353 (59,32)
Non-adherence to treatment	115 (19,32)
No factor identified	53 (8,9)
Ignorance of diabetes	43 (7,20)
Intercurrent disease	21 (3,52)
Corticotherapy	5 (0,84)
Infectious sites	
Urogenital	82 (21,30)
Pulmonary	73 (19,0)
Diabetic foot	43 (11,10)
Malaria	103 (26,80)
Others	68 (17,50)
None	15 (3,9)

Table 2: *Distribution of the different precipitating factors of hyperglycemic crises.*

The frequency of malaria, urogenital infections and pneumonia was higher during the rainy season and respectively represented 60.19%, 62.20% and 58.90% of cases with a statistically significant difference for malaria. (Table 3)

Infectious sites	**Seasons**						**p**
	Long rainy season	**Long dry season**	**Short rainy season**	**Short dry season**	**Overall dry season**	**Overall rainy season**	
Urogenital	41.46%	30.49%	20.73%	7.31%	37.80%	62.20%	0.38
Pulmonary	41.09%	34.25%	17.81%	6.85%	41.10%	58.90%	0.06
Malaria	45.63%	29.13%	14.56%	10.68%	39.81%	60.19%	0.02

Table 3: *Distribution of the main infectious sites according to the seasons of the year.*

Discussion

We have determined from retrospective hospital data over a decade the prevalence and the precipitating factors of hyperglycemic crises according to the different seasons of the year in a tropical region among diabetic patients. The current study found that the prevalence of hyperglycemic crises was higher during rainy seasons and periods of cold weather. Another important finding was the high prevalence of infections, in particular malaria, in diabetic patients during rainy seasons.

Indeed, 57.19% of the cases of hyperglycemic crises had been diagnosed during the rainy season versus 42.81% of them during the dry season. When considering the climatological data of rain and temperature, the number of cases of decompensation was positively linked to the precipitation (Figure 5). These results are in agreement with Lontchi-Yimagou et al [13] findings in Cameroon which showed a high incidence of hyperglycemic crises during October, a month of heavy rainfall in their study. This high number of cases during periods of heavy rainfall could be related to the increased frequency of the most important precipitating factors such as infections (59.32%). A possible explanation for this might be that infections induce hyperglycemia by a considerable increase in the global metabolism and turnover of glucose, while its oxidation is barely increased [18]. Another possible explanation for this is that other seasonal conditions may contribute to hyperglycemia. Indeed, these conditions may include eating habits and lifestyle changes. In the rainy season, there is a decrease in physical activity due to frequent rainfall and a proneness to consumption of high-calorie meals that could contribute to hyperglycemia [13].

Low temperatures (July-August-September), especially in August, were also associated with a higher number of cases of hyperglycemic crises whereas precipitation decreased (Figure 5). These findings are in agreement with those obtained by other authors such as Butalia et al [19] and Chin-Li Lu et al [20]. Butalia et al. [19] reported an increase in the incidence of cases of ketoacidosis in type 1 diabetics during the winter, and especially during the month of December. Chin-Li Lu et al. [20]. noted a higher incidence of hyperglycemic crises in the winter compared to the summer. However, there are studies that report an increase in the incidence of ketoacidosis in equatorial countries. These authors suggest that the high temperature in equatorial countries results in more rapid dehydration and acute hyperglycemia, more particularly in young children [21, 22].

The main infectious sites involved in hyperglycemic crises were pulmonary (19%), urogenital (21.3%) and malaria (26.8%). These results are in keeping with previous observational studies [8,22]. This also accords with our recent and earlier observations, which showed similar prevalences of pulmonary and urogenital sites (18.04% and 23.3% respectively) [2]. Moreover, in the same study, malaria was the most frequent infection (32.33%). The frequency of infections, especially malaria, was higher during the rainy season. Seasonality of infections is well known and described in the literature. These variations seem to be related to environmental conditions, including temperature, precipitation, humidity, insolation, pH and salinity [24]. In the United States, the prevalence of bacterial pneumonia is higher during the mid-winter period [25]. Seasonal variations of malaria are well known in Africa and climate being the main factor influencing the development of malaria. Malaria is a disease closely linked to the availability of liquid water in the environment and to favorable temperatures for the development of Anopheles mosquitoes which are malaria transmitters [26]. The rainy season seems to provide the necessary conditions for the development of these mosquitoes, resulting in high malaria transmission during this period. The metabolic impact in the diabetic patient is hyperglycemia, which may lead to hyperglycemic crises.

Conclusion

This is the first study that has documented the seasonalty of hyperglycemic crises and their precipitating factors in Benin. The frequency of hyperglycemic crises was high and seasonally related. The incidence of hyperglycemic crises was higher during the rainy season. The most frequent precipitating factors were malaria and non-adherence to treatment. Educating diabetic patients about mosquito control and the use of insecticide treated bed nets could contribute to reducing the frequency of decompensation, especially during the rainy season.

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