Seasonality in diabetes in Yaounde, Cameroon: a relation with precipitation and temperature

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Abstract

Background: Diabetes is a growing health concern in developing countries, with Cameroon population having an estimated 6% affected. Of note, hospital attendees appear to be increasing all over the country, with fluctuating numbers throughout the annual calendar. The aim of the study was to investigate the relationship between diabetes hospitalization admission rates and climate variations in Yaounde.

Methods: A retrospectively designed study was conducted in four health facilities of Yaounde (Central Hospital, University teaching hospital, Biyem-Assi and Djoungolo District Hospitals), using medical records from 2000 to 2008. A relationship between diabetes (newly diagnosed diabetes patients or decompensated diabetics) hospitalization admissions and climate variations was determined using the “2000–2008” national meteorological database (precipitation and temperature).

Results: The monthly medians of precipitation and temperature were 154mm and 25 °C, respectively. The month of October received 239mm of precipitation. The monthly medians of diabetic admissions rates (newly diagnosed or decompensated diabetes patients) were 262 and 72 respectively. October received 366 newly diagnosed diabetics and 99 decompensated diabetics. Interestingly, diabetic hospitalization admissions rates were higher during the rainy (51 %, 1633/3232) than the dry season, though the difference was non-significant. The wettest month (October) reported the highest cases (10 %, 336/3232) corresponding to the month with the highest precipitation level (239mm). Diabetes hospitalization admissions rates varied across health facilities [from 6 % (189/3232) in 2000 to 15 % (474/3232) in 2008].

Conclusion: Diabetes is an important epidemiological disease in the city of Yaounde. The variation in the prevalence of diabetes is almost superimposed to that of precipitation; and the prevalence seems increasing during raining seasons in Yaoundé.

Keywords: Seasons, Diabetes, Yaounde, Cameroon, Sub-Saharan Africa

Background

Diabetes mellitus, and type 2 diabetes (T2DM) in particular, is becoming increasingly important worldwide, assuming epidemic proportions in many populations, especially in developing countries including those in sub-Saharan Africa (SSA) [1, 2]. There is evidence that human activities have an effect on the climate of the planet, and they also have multiple effects on human health [3]. Gherard, in 1988, showed the impact of climate on health, particularly with a seasonal increase in mortality and morbidity [4]. Diabetes is a disease that affects the body’s metabolism, and so far science assigns no direct vector to the agent. The role of climate and environment in the pathogenesis of diabetes is only mentioned indirectly. Seasonality in the presentation of diabetes, especially Type 1 diabetes, has been recognized for many years. Type 2 diabetes has, however, also been shown to be associated with a seasonal incidence [5],
suggesting that both types of diabetes may share common environmental precipitating factors. Several studies have shown that in the northern hemisphere the incidence of juvenile diabetes diagnosed during the fall or winter season were relatively higher than in the summer or spring [6]. The first report of seasonal variation in the new cases of diabetes was presented by Adams in the 1920s [7]. Since then, there have been a number of studies demonstrating seasonality in the time of clinical presentation of T1DM, although a consistent and integrated picture on the actual seasonality of the disease has not been established [8–20]. This seasonality variation has been taken as indirect argument in favour of the environmental factors, it has been suggested that there is also a relationship between factors such as infections and vitamin D levels, and the seasonality of diabetes [21–27].

A recent study of the data on seasonal variation in diabetes in 53 countries has suggested that seasonality in the diagnosis of T1DM is indeed a real phenomenon and that this seasonality pattern appears to be related to the geographical location, at least as far as the northern/southern hemisphere is concerned [28]. The suggestion has also been made that metabolic changes during winter months could account for the seasonality of presentation [29]. Seasonal variation in the presentation of diabetes has not only been observed in the Northern Hemisphere but also in the Southern Hemisphere such as Australia [30], South Africa [31] and Tanzania [32]. However, data on many regions of the world are still lacking. According to an observation made in the National Obesity Centre of the Yaoundé Central Hospital, Yaoundé, Cameroon, more patients with diabetes are received during rainy seasons in Yaoundé, being in a tropical environment. Therefore, this study was carried out to analyze the relationship between diabetes hospital admission rates (newly diagnosed diabetic or decompensated) and climate variations.

**Methods**

**Ethics statement**
The study was granted approval by the Institutional Review Board of the National Obesity Centre of the Yaounde Central Hospital. As the study is based on retrospective data, informed consent was not needed.

**Study population and settings**
A retrospective study was conducted in four health facilities in Yaoundé, Cameroon, using hospital admission registers of diabetes patients from 2000 to 2008 hospitalized in the general medicine services of the Yaounde Central Hospital, the University teaching Hospital of Yaounde, the Djoungolo District Hospital and the Biyem-Assi District Hospital, and monthly data of precipitation and temperature over the same period (2000–2008) from the Weather Station of Nkolbisson, IRAD Yaounde, Cameroon.

**Measurements**

**Patients**
Diabetes hospital admission rates were recorded using hospital admission registers of patients in general medicine in our study sites. Up to 31 December 2008, 3232 ethnic Africans were registered. Registration particulars included date of presentation to hospital. Diabetes was diagnosed based on a fasting plasma glucose >1.26g/l at least two times [33]. 74.7 % of newly diagnosed diabetes patients presented with classical symptoms of diabetes. Of the 3232 patients, 818 (25.3 %) were considered to have insulin-requiring diabetes on the basis of insulin need for control of symptoms and hyperglycaemia(decompensated diabetes) and where coming only from de Yaoundé Central Hospital.

**Climate data**
Climate variations were performed using the “2000–2008” national meteorological database from the weather station Nkolbisson IRAD Yaounde, Cameroon. This is the monthly data of precipitation and temperature over a period of 9 years (2000–2008).

**Definitions**
The subjects were divided into groups according to the month of attendance to the hospital: January, February, March, April, May, June, July, August, September, October, November and December. Subjects were also grouped according to year (from 2000 to 2008) and the season they were attended in the hospital as follows: November to February (long dry season); March to June (long rainy season); July and August (short dry season); September and October (short rainy season) [34].

**Calculations**

**Average rain fall**

\[
P_m(2000-2008) = \frac{\sum P_x}{n}
\]

\(P_m = \) Average precipitation(mm)
\(n = \) Number of years, months, seasons
\(P_x = \) Amount of precipitation in a year x, a month x, a season x

**IDFM: index of deviation from the mean**

\[
\Delta x = P_x - P_m (2000-2008)
\]

\(\text{If} \Delta x = 0 \text{ years/ month/ season constant} \)
\(\Delta x < 0 \text{ years/ month/ season deficit} \)
\(\Delta x > 0 \text{ years/ month/ season wet} \)
Rainfall index

\[ RI = \frac{P_x}{P_m} \text{ (2000–2008)} \]

A year is described as wet if the ratio is greater than 1 and dry if it is less than 1.

Results

During a 9 years period from 2000 to 2008, 3232 African diabetes patients were registered at University teaching Hospital, Yaounde Central Hospital, Djoungolo district Hospital, Biyem-Assi district Hospital, Cameroon. Newly diagnosed diabetes patients represented 74.7 % (n = 2414) of the study population whereas 25.3 % (n = 818) of participants where decompensated diabetes coming only from the Yaounde Central Hospital. The monthly medians of precipitation and temperature were estimate (min-max): 154 (9–239)mm and estimate (min-max): 25(24–26)°C, respectively (Table 1).

The number of diabetic patients registered to the Yaounde Central Hospital is 8 times higher than that recorded in the three combined study site. The Yaounde Central Hospital alone holds 88 % of diabetic patients in the city according to the results obtained in the study sites (Table 2).

Relationship between monthly precipitation, temperature and newly diagnosed and decompensated diabetes

The monthly medians of precipitation and temperature were estimate (min-max): 154 (9–239) mm and estimate (min-max): 24.7 (24–26)°C, respectively. The monthly medians (min-max) of hospital admission rates for newly diagnosed diabetes patients and decompensated diabetics were 262 (234–366) and 72 (46–99) people respectively. The highest level of precipitation was observed in October [estimate (min-max): 239 (9–239)mm] which coincided with the highest number of newly diagnosed [n (min-max): 366 (234–366)]

Table 1 General characteristics of the study

| Variables                        | Values          |
|----------------------------------|-----------------|
| Number of patients (n):          | 3232            |
| Diabetes decompensation (n)      | 818             |
| Overall average temperature °C   | (25; 24; 26)    |
| (median; min; max)               |                 |
| Overall average precipitation mm | (154; 9; 239)   |
| (median; min; max)               |                 |
| Average seasonal precipitation mm| (154; 9; 239)   |
| (median; min; max)               |                 |
| “Long dry season”                | (25; 9; 99)     |
| “Short dry season”               | (238; 237; 239) |
| “Short rainy season”             | (186; 123; 199) |
| “Long rainy season”              | (154; 138; 169) |

and decompensated diabetes patients [n (min-max): 99 (46–99)] (Fig. 1).

Relationship between seasonal precipitation, temperature and newly diagnosed and decompensated diabetes hospital admission rates

During the rainy seasons, the median of precipitation was estimate (min-max): 195.8 (123.2–238.6)mm compared to dry seasons estimate (min-max): 67.8 (9.1–168.9)mm. Seasonal data on diabetes hospitalization admissions rate at our study sites from 2002 to 2008 indicated that the greatest number of admissions occurred during the rainy seasons (51 %, 1633/3232) compared to the dry seasons (49 %, 1599/3232), though the difference was non-significant (Tables 3 and 4).

Diabetes hospitalization admissions rates varied across health facilities [from 6 % (189/3232) in 2000 to 15 % (474/3232) in 2008]. As depicted in Fig. 2, there was a constant increase of new cases of diabetes over time.

Discussion

In this study, the number of hospitalizations related to newly diagnosed and decompensated diabetes evolved gradually between 2000 and 2008 in line with WHO estimates for developing countries (WHO, 2006). The major finding of this study is that, the variation in the incidence of diabetes is almost superimposed to that of precipitation, the hospital admission rate of diabetes patients is slightly higher during the rainy season. The month of October (the wettest month), reported the highest number of cases in the four health facilities involved in our study.

Knowing that glycemic control in diabetes depends not only on endogenous factors [35], but also has exogenous determinants [36], it is important to determine the nature of the evolution of newly and decompensated diabetes throughout months and seasons. This could allow to grasp the possible factors responsible for the seasonal incidence of the disease. The prevention of diabetes, including the environmental factors associated, may therefore need to be intensified and seasonally adapted.
Possible reasons for the seasonal patterns observed may relate to nutritional variability. During the long rainy season (March to June), physical activity diminishes due to frequent rainfall, and people tend to consume high-fat and high-calorie food while awaiting the harvest. Therefore, it is also possible that increased caloric intake could increase hyperglycaemia and the emergence of symptoms. West showed in 1978 that the decrease in the daily intake of calories in World War II Europe was associated with a decrease in the incidence of diabetes [37]. Also, viral infections have been implicated for many years as a possible environmental factor in the aetiology of type 1 and type 2 diabetes [27, 38]. There appears to be a seasonal variation in the onset of acute type 1 diabetes, with a peak in the autumn [7, 39]; diseases with seasonal incidences are often caused by viral infections. There also have been numerous anecdotal reports of a temporal association between viral infections and the development of diabetes in some patients [40]. Little information are available on the seasonality of viral infections in the tropics, although the increase in hospital admission rates for respiratory diseases, including asthma, makes it likely that there is an increase in viral-related respiratory infections during the rainy season. The development of diabetes has also been associated with viral hepatitis in West Africa, but the stress due to the infection may be a confounding factor in the exacerbation of pre-existing hyperglycaemia [41].

It is possible that in the rainy season which is also associated with infectious diseases, seasonal patterns observed in our study may also relate to diseases such as malaria. Diabetes is frequently associated with infections as seen in clinical practice. Of them, bacterial, viral and fungal infections are common [42]. Though bacterial infection remains the most common precipitating factor of diabetes keto-acidosis worldwide,

### Table 3

| Seasons          | Long dry season | Short dry season | Long rainy season | Short rainy season |
|------------------|-----------------|------------------|-------------------|-------------------|
| T (°C)           | 25 (25–26)      | 24 (24–24)       | 25 (24–26)        | 24 (24–24)        |
| P (mm)           | 25 (9–99)       | 154 (138–169)    | 186 (123–199)     | 238 (237–239)     |
| NDDP (n)         | 268 (239–293)   | 266 (241–291)    | 253 (234–268)     | 313 (260–366)     |
| DD (n)           | 73 (61–77)      | 73 (71–74)       | 53 (46–73)        | 82 (65–99)        |

NDDP Newly Diagnosed Diabetic Patients, DD Decompensated Diabetes, November to February (long dry season); July and August (short dry season); March to June (long rainy season); September and October (short rainy season)

Data are presented as median, minimum and maximum during the season
malaria has been emphasized as a precipitant in developing countries [43]. Ketosis, precipitated by falciparum malaria has already been reported [44]. In African populations, there is general agreement on the role of environmental factors such as diet, viral infections in diabetes, but malaria has not been proved to be a causal factor. Therefore, in tropical countries, malaria should be looked for in patients with diabetes. In diabetic animal models, malaria infection dramatically lowers blood glucose [45]. Unexplained hypoglycemia caused by falciparum malaria in patients with diabetes before initiation of quinine therapy has been reported [46, 47]. Since little information is available on the profile of falciparum malaria infection in diabetic patients in tropical areas. A possible role of malaria in the sesonality of diabetes cannot be excluded.

The major limitations of the study are that the types of diabetes and age at diagnosis or onset were not reported. Screening for different types of diabetes may have strengthened the findings. The study was also limited by the time period of the data collection (9 years). Over such a time period, changes in unidentified environmental factors could have confounded the results. Another limitation of the present study is that the narrow sample which is not representative of the total population in Cameroon and therefore cannot be generalized to that population. Moreover, data collection did not include the geographical origin of each participant, a factor that could also have influenced the results. A previous study in Cameroon, showed that the prevalence of diabetes is higher in urban than in rural areas [48]. Further studies, particularly cohort studies with larger numbers of diabetes patients, are required to draw definite conclusions regarding the seasonality of diabetes hospitalization admission rate, thus possibly offering data on the etiology and epidemiology of this disease. A comparison with viral epidemiology data during the same period could likely yield useful results.

**Conclusion**

In conclusion, the variation in the prevalence of diabetes is almost superimposable to that of precipitation; the hospital admission rate of diabetes patients is slightly higher during the rainy season. Seasonality of diabetes hospital admissions rates seems to encountered in the Cameroonian population. This study is the first to explore the seasonality of diabetes in Cameroon. Nevertheless, it should be stated that this is an observational study on the seasonality of acute diabetic flares, from which no conclusions can be drawn regarding the pathophysiology of diabetes.

### Table 4

|                | Dry season | Rainy season | P   |
|----------------|------------|--------------|-----|
| T (°C) median  | 25 (24–26) | 25 (24–26)   | 0.879|
| P (mm) median  | 68 (9–169) | 196 (123–239)| 0.005|
| NDDP (n)       | 1599       | 1633         | 0.802|

Data are presented as median, minimum and maximum during the season.

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**Fig. 2** Relationship between annual precipitation, newly diagnosed and decompensated diabetes hospital admission rates.

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Authors’ contributions

Study conception and design: MT, JLN, MD, ES. Data collection: LMTT, JLN, MD. Statistical analysis: ELY, LMTT, JNIN, EVB. Drafting: ELY, LMTT, JNN, EVB. Critical discussion and manuscript revision: ELY, MT, JNN, MD, ES. All the authors approved the final version of the manuscript.

Competing interests

The authors declare that they have no competing interests.

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