Influence of migration on characteristics of type 2 diabetes in sub-Saharan Africans


Abstract

**Aim.** This study compared the clinical and biochemical characteristics and microvascular complications found in three groups of type 2 diabetes (T2D) patients: Africans living in Africa; African immigrants living in France; and Caucasians living in France.

**Methods.** Diagnosed T2D Africans living in Cameroon (n = 100) were compared with 98 African migrants diagnosed with T2D after having moved to France, and a group of 199 T2D Caucasian patients living in France. All underwent clinical and biochemical evaluations, and all were assessed for microvascular complications.

**Results.** The median duration of stay of the migrants in France was 15 years before being diagnosed with diabetes. Despite similar durations of diagnosis, they were 8.9 years younger at the time of diagnosis than Africans living in Cameroon (P < 0.001). Caucasians and African immigrants in France had lower HbA1c values than Africans in Cameroon (P < 0.001); they were also more aggressively treated for hypertension and dyslipidaemia and, therefore, had significantly lower blood pressure levels and better lipid profiles. Diabetic nephropathy and retinopathy rates were higher in Cameroon than in the two other groups. After adjusting for age, diabetes duration, HbA1c, hypertension and other covariates, only the prevalence of diabetic nephropathy (OR: 5.61, 95% CI: 2.32–13.53; P < 0.0001) was higher in Cameroon compared with those living in France.

**Conclusion.** Our results suggest that Africans who emigrate to France may develop diabetes earlier than those staying in their home country. However, the latter may be a reflection of late diagnosis of diabetes. Also, the less adequate diabetes and hypertension control in the latter would explain their higher rates of nephropathy. Large-scale cohorts are now warranted to substantiate these observations.

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Keywords: Type 2 diabetes; Migration; Complications; Africans; Caucasians

1. Introduction

Populations of sub-Saharan African origin are considered at high risk of developing diabetes [1]. The incidence of type 2 diabetes (T2D) reported in the Atherosclerosis Risk in Communities (ARIC) Study carried out in the US was 1.5- to 2.4-fold greater in African Americans compared with their white American counterparts [2]. In the third National Health and Nutrition Examination Survey (NHANES III), it was also reported that black Americans were diagnosed with T2D at a significantly younger age compared with whites living in the same environment [3]. In Africa, the prevalence of T2D varies widely depending on the degree of urbanization of the geographical location and time spent in that particular environment [4,5]. Accordingly, many reports have found that the prevalence of T2D shows a rising gradient from Africans living in Africa to...
Afro-Caribbeans, African Americans and African immigrants living in other developed countries. Mbanya et al. [4] reported T2D prevalence of 0.8% and 2% in rural and urban Cameroon, respectively, of 8.5% in Jamaica and of 14.6% among blacks living in Manchester, UK. Likewise, Cooper et al. [5] reported prevalence of 2% in Nigeria, 9% in the Caribbean, and 11% among African Americans in the US and African immigrants in the UK. This disease pattern has been attributed to the effects of environmental factors, especially lifestyle changes. Indeed, epidemiological transition, urbanization and emigration to a more developed geographical environment can often lead to rapid changes in lifestyle that together with genetic background, increase the propensity to develop non-communicable diseases [6,7].

The link between lifestyle changes and the development of T2D is alterations in insulin sensitivity and secretion, the two underlying mechanisms of the disease, as shown by metabolic studies. Osei et al. [8] demonstrated differences in insulin secretion and sensitivity between African Americans and Africans residing in Africa, with the former having greater insulin secretion, but also more insulin resistance. However, no difference was found on comparing African Americans with African immigrants who had settled as adults in the US one to 18 years prior to the study, suggesting that the metabolic changes leading to T2D may be arising soon after their emigration [9].

In the absence of immigrant cohorts, our present study aimed to assess the impact of migration on the characteristics of T2D by comparing three diabetic populations: Africans living in sub-Saharan Africa; Africans who emigrated to France before being diagnosed with the disease; and a Caucasian population living in France serving as a reference population.

2. Patients and methods

2.1. Patients

This cross-sectional study included and compared three groups of people with T2D. The first was from a population of around 250 T2D patients of West and Central African origin attending the department of diabetes and endocrinology at the Saint-Louis Hospital in Paris (a referral centre for Africans with T2D in Paris and its suburbs) [10–13]: those who had emigrated from Africa to France as adults (age ≥ 18 years) and been diagnosed with T2D within at least 1 year of their arrival were consecutively selected over a 1-year period (from November 2005 to October 2006). This yielded a sample population of 98 patients, all of whom agreed to participate in our study. The second group comprised Cameroonian adults who were consecutively enrolled at the outpatients department of the Yaoundé Central Hospital in the capital city of Cameroon during the same time period. Details of the study setting have been described elsewhere [14]. The third group included 199 Caucasian patients consecutively enrolled during the same period from the outpatients department of diabetes and endocrinology at the Saint-Louis Hospital, all of whom were receiving chronic diabetes care at the department.

All patients gave their informed consent to participate in the study, and the procedures used at both sites (Yaoundé and Paris) were standardized to allow comparison. The diagnosis of diabetes was based on 1998 World Health Organization (WHO) criteria [15] and included non-ketotic diabetes, which does not require insulin within the first 2 years of diagnosis.

2.2. Clinical examination

Age, gender, history of hypertension, smoking and year of diabetes diagnosis were recorded for each patient using a structured questionnaire. Also, anthropometric parameters were measured using validated methods, and included weight to the nearest 0.5 kg using a scale, height to the nearest 0.5 cm using a wall-mounted stadiometer and body mass index (BMI) calculated as weight divided by the square of height (kg/m²). Overweight was defined as a BMI score ≥ 25 kg/m² and < 30 kg/m², and obesity as a BMI ≥ 30 kg/m². Blood pressure (BP) was measured on the right arm as per the British Hypertension Society guidelines [16], using an automatic BP monitor (HEM-711, Omron Healthcare, Inc., Lake Forest, IL, USA). The average of two readings (first and second) taken 5 min apart was calculated. Hypertension was defined as a self-reported history of hypertension diagnosis and/or the use of antihypertensive medications, or an average systolic BP ≥ 140 mmHg and/or diastolic BP ≥ 90 mmHg. The number and class of antihypertensive drugs used were also recorded.

2.3. Assessment of microvascular complications

The fundus of the eye was examined by retinal photography, and fluorescein angiography when necessary, performed by a specialized ophthalmologist. The same ophthalmologist, who was experienced in diabetic retinopathy, was also in charge of reading the results from each study centre. Examination of sensory function of the lower limbs, including Semmes–Weinstein monofilament (10 g) and tendon reflex test, was performed to assess the presence of peripheral neuropathy. Diabetic neuropathy was defined as the presence of any sensory symptoms or signs, or abnormal monofilament perception with or without abnormal tendon reflexes. All patients underwent urinary albumin excretion (UAE) and serum creatinine measurements, and diabetic nephropathy was defined as UAE ≥ 20 mg/L or ≥ 30 mg/24 h as confirmed by a second sample, with or without an increase in serum creatinine levels. Patients with kidney disease without abnormal albumin excretion or known to be due to a cause other than diabetes were classified as having non-diabetic kidney disease (NDKD). The participants were further divided into two categories—one with and the other without complications—with no further subclassifications. Because it was not possible to thoroughly assess the presence or absence of macrovascular complications in all patients in Cameroon (ankle–brachial index, stress electrocardiography testing, cardiac scintigraphy), these tests were excluded from the scope of our study.
2.4. Biochemical parameters

Lipid profiles, UAE and serum creatinine were measured with appropriate methods using an automatic analyzer (Modular® Hitachi, Ltd, Tokyo, Japan). Diabetes control was assessed by HbA1c values as measured by an automated device (DCA 2000® Bayer Diagnostics Europe, Dublin, Ireland).

2.5. Statistical analysis

All statistical analyses were performed using R 2.6.2 statistical software (R Foundation for Statistical Computing, Vienna, Austria). Results are presented as means ± standard deviation (SD), medians (25th–75th percentiles) and percentages unless otherwise stated. Categorical variables were compared across the three groups using the chi² test; whenever a significant difference was found, groups were then compared two-by-two with correction of the chi² test by the Hochberg method to account for multiple tests. Comparison of the prevalence of microvascular complications between Cameroonians and emigrants was made after adjusting for age, gender, diabetes duration, history of hypertension, HbA1c level, and systolic and diastolic BP using logistic regression. Other quantitative variables were compared among the three groups using the Kruskal–Wallis test, with two-by-two comparisons using the Wilcoxon test, corrected by the Hochberg method to account for multiple tests. A P value < 0.05 was considered statistically significant.

3. Results

3.1. Clinical and demographic characteristics of participants

Table 1 presents the clinical and demographic characteristics of the study patients. Age ranged from 30 to 80 years in Cameroonians, from 26 to 75 years in migrants, and from 28 to 89 in Caucasians. The median duration of the immigrants’ stay in France was 15 years (range: 1–28) before diabetes diagnosis. There was a male predominance among Caucasians and immigrants, whereas patients in Cameroon were diagnosed with diabetes at an older age (Table 1). Age- and gender-adjusted prevalence of hypertension were similar in Cameroonians and in immigrants (OR: 1.34, 95% CI: 0.69–2.60; P = 0.39). There were no differences in mean BMI, prevalence of overweight and obesity, and smoking habits between Africans in Cameroon and those in France. However, Caucasians had higher rates of smokers and obese individuals than the two other groups (Table 1).

3.2. Cardiovascular treatments and biochemical parameters

Only 31% of Cameroonians had BP ≤ 130/80 mmHg vs 58% of immigrants (P < 0.001). The mean number of antihypertensive drugs used by patients with hypertension was 1.6 (range: 1–4) in Cameroonians, 2.4 (range: 0–5) in immigrants and 2.0 (range: 0–5) in Caucasians (P < 0.001). Also, 15% and 54% of immigrants and Caucasians, respectively, were using statin treatment compared with no patient in Cameroon (Table 1).

Cameroonians and immigrants had better lipid profiles and better diabetes control than Caucasians (Table 2). In immigrants, there was no significant correlation between length of stay in France at the time of inclusion and BMI or any parameter in the lipid profile (data not shown).

3.3. Microvascular complications

Of the three study groups, Cameroonians had the highest rates of nephropathy and diabetic retinopathy, whereas migrants had the lowest rate of diabetic retinopathy (Table 2). However, NDKD was significantly more frequent in Cameroonians (10.0% vs 2.0% for migrants; P < 0.0001). After adjusting for age, gender, HbA1c, history of hypertension, systolic and diastolic BP and diabetes duration, Cameroonians had a higher rate of diabetic nephropathy compared with immigrants (OR: 5.61, 95% CI: 2.32–13.53; P < 0.0001), but there was no significant difference in diabetes retinopathy between the two groups (OR: 1.96, 95% CI: 0.76–5.08; P = 0.16; Fig. 1). Also, the frequency of neuropathy was similar in the three groups (Table 2).

Table 1
Clinical and demographic characteristics of the study patients.

<table>
<thead>
<tr>
<th></th>
<th>Cameroonians</th>
<th>African migrants</th>
<th>Caucasians</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>100</td>
<td>98</td>
<td>199</td>
<td></td>
</tr>
<tr>
<td>Age at diagnosis, mean (SD) years</td>
<td>52.9 (10)</td>
<td>57.5 (10)</td>
<td>72 (72)</td>
<td></td>
</tr>
<tr>
<td>Female gender, n (%)</td>
<td>47 (47)</td>
<td>29 (30)</td>
<td>68 (34)</td>
<td>0.03</td>
</tr>
<tr>
<td>Age at inclusion, mean (SD) years</td>
<td>52 (9)</td>
<td>52 (11)</td>
<td>51 (52)</td>
<td></td>
</tr>
<tr>
<td>Known duration of diabetes, median (Q1–Q3) years</td>
<td>4 (1–8)</td>
<td>5 (2–10)</td>
<td>11 (6–20)</td>
<td></td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>72 (72)</td>
<td>51 (52)</td>
<td>139 (70)</td>
<td>0.012</td>
</tr>
<tr>
<td>Smokers, n (%)</td>
<td>14 (14)</td>
<td>19 (21)</td>
<td>52 (26)</td>
<td></td>
</tr>
<tr>
<td>BMI, mean (SD) kg/m²</td>
<td>27.9 (4.7)</td>
<td>27.4 (4.6)</td>
<td>30 (5.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BMI ≥ 25 kg/m² (%)</td>
<td>74.0</td>
<td>68.4</td>
<td>81.4</td>
<td></td>
</tr>
<tr>
<td>BMI ≥ 30 kg/m² (%)</td>
<td>32.0</td>
<td>24.5</td>
<td>44.2</td>
<td></td>
</tr>
<tr>
<td>SBP, mean (SD) mmHg</td>
<td>144 (24)</td>
<td>128 (16)</td>
<td>130 (18)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DBP, mean (SD) mmHg</td>
<td>86 (12)</td>
<td>75 (10)</td>
<td>72 (12)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Antihypertensive drug use, mean (range) n</td>
<td>1.6 (1–4)</td>
<td>2.4 (0–5)</td>
<td>2.0 (0–5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Statin use, n (%)</td>
<td>0 (0)</td>
<td>15 (15)</td>
<td>108 (54)</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; Q1: 25th percentile; Q3: 75th percentile.
Table 2
Biochemical characteristics and prevalence of microvascular complications.

<table>
<thead>
<tr>
<th></th>
<th>Cameroonians</th>
<th>African migrants</th>
<th>Caucasians</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>100</td>
<td>98</td>
<td>199</td>
<td></td>
</tr>
<tr>
<td>HbA1c, %</td>
<td>9.9 (8.7–11.5)</td>
<td>8.6 (7.2–11.4)</td>
<td>8.1 (7.3–9.4)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Patients with HbA1c ≤ 7%, %</td>
<td>6.0</td>
<td>21.4</td>
<td>21.1</td>
<td></td>
</tr>
<tr>
<td>Creatinine, μmol/L</td>
<td>106 (84–117)</td>
<td>92 (73–106)</td>
<td>79 (66–93)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Total cholesterol, mg/dL</td>
<td>202 (166–243)</td>
<td>185 (165–212)</td>
<td>194 (174–221)</td>
<td>0.02</td>
</tr>
<tr>
<td>HDL cholesterol, mg/dL</td>
<td>40 (34–48)</td>
<td>50 (42–62)</td>
<td>50 (46–62)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LDL cholesterol, mg/dL</td>
<td>130 (98–170)</td>
<td>119 (96–138)</td>
<td>116 (97–143)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Triglycerides, mg/dL</td>
<td>140 (98–162)</td>
<td>86 (66–114)</td>
<td>124 (77–188)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Retinopathy, n (%)</td>
<td>45 (45)</td>
<td>25 (26)</td>
<td>72 (36)</td>
<td>0.002</td>
</tr>
<tr>
<td>Nephropathy, n (%)</td>
<td>74 (74)</td>
<td>31 (32)</td>
<td>56 (28)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Neuropathy, n (%)</td>
<td>31 (31)</td>
<td>33 (34)</td>
<td>56 (28)</td>
<td>0.54</td>
</tr>
</tbody>
</table>

Data are presented as medians (25th–75th percentile) unless otherwise stated; HbA1c: glycated haemoglobin; HDL: high-density lipoprotein; LDL: low-density lipoprotein.

![Fig. 1](image-url) Adjusted odds ratios for microvascular complications between Cameroonians and African immigrants in France. *P* < 0.0001.

4. Discussion

Our main objective was to compare Africans with T2D living in urban environments in their home country with those who had emigrated to a developed country before being diagnosed with T2D to evaluate the effects of environmental changes on the occurrence and course of the disease. Our main findings were that African immigrants living in France are diagnosed with diabetes at a younger age than Africans living in Cameroon, whereas Africans living in Cameroon have a higher rate of nephropathy and poorer control of their diabetes and BP.

The lifestyle changes that accompany the process of epidemiological transition are considered the main driving force behind the change in the global burden of non-communicable diseases, including diabetes [7]. Previous studies in populations of African origin have reported a clear environmental influence on metabolic changes that might lead to T2D [8,9,17] and its prevalence [4,5]. T2D is also known to appear at a younger age in people of African descent, as revealed by the NHANES III, in comparison to whites living in the same environment [3].

In our present study, the fact that diabetes was also diagnosed at a younger age in the immigrant group prompts several hypotheses. The first is that the diagnosis of diabetes is late in Cameroonians, which is supported by their higher rate of diabetes nephropathy compared with emigrants; the clinical diagnosis of T2D was usually made at least 4–7 years after the actual onset of the disease [18]. This delay in diagnosis might be even longer in resource-limited settings due to difficulties in accessing healthcare facilities. However, the adjusted prevalence of diabetic retinopathy did not differ significantly between Cameroonians and emigrants, suggesting that delayed diagnosis is not the only explanatory factor for differences in age at diagnosis.

Another hypothesis is the earlier development of diabetes in immigrants, perhaps due to rapid changes in lifestyle. Osei et al. [9] showed that in Africans who emigrated to a developed country, metabolic changes that could lead to the development of T2D appeared soon (mean: 6 years, range: 1–18) after emigration. Knowledge of the characteristics of the emigrating population at the time of migration, especially their BMI, would help to clarify the picture. To note, another study carried out in France showed that the age at T2D diagnosis was 39.6 years among Africans and Caribbeans [10].

Yet another explanation is the potential role of selection bias. Emigrants are more likely to be younger than Africans who stay in Cameroon and, consequently, there are probably few diabetic elderly people among the immigrant population. Nevertheless, it is noteworthy that the age pyramids for the Cameroonian population (see online at http://perspective.usherbrooke.ca/bilan/servlet/BMPPagePyramide?code Pays=CMR) and immigrant population in France (albeit including many countries besides Africa; see online at http://www.insee.fr/fr/fich/docs_fic/ref/IMMFRA05d.PDF) for the year 2000 were similar for adults from the fourth decade of age onwards. Indeed, this issue of age difference is likely to have multiple determinants that may only be ascertained through further large-scale studies.

There are at least three potential reasons to explain the higher rate of diabetes nephropathy in Cameroonians: delayed diabetes diagnosis; less adequate chronic diabetes control as reflected by higher HbA1c values; and other confounding factors. The lower rate of nephropathy in Caucasians despite their longer dura-
tion of diabetes supports the role of delayed diagnosis and poor diabetes control in the development of nephropathy in Cameroonian. Potential confounding causes of glomerulonephritis include parasitic (such as malaria, schistosomiasis, loiasis and onchocerciasis) and viral (hepatitis C and B viruses, human immunodeficiency virus) infections, which are highly prevalent in sub-Saharan Africa and known causes of kidney diseases with albuminuria [19–21]. These potential confounders were not assessed in our study. Differences in lipid profiles were attributed to the use of statins in immigrants and Caucasians, drugs that are still largely unaffordable in most parts of sub-Saharan Africa. Differences in dietary habits may also play a role.

The aim of our present study was to assess the effects of westernization in the development of diabetes by studying patients in France who had immigrated long before their diagnosis of T2D. However, the following potential limitations should be acknowledged: the limited sample size per group; the potential bias resulting from the selection of patients attending health departments devoted to the care of diabetes; and the inclusion of patients from only one centre at each study location. Nevertheless, this study has provided relevant preliminary data that can pave the way for further large-scale cohort studies to substantiate our present findings.

In conclusion, our results suggest that Africans who emigrate to France may be developing diabetes earlier than those who remain in their home country. However, this might be a reflection of late diagnosis of diabetes and poorer control of both diabetes and hypertension, as demonstrated by the higher rate of diabetic nephropathy in Cameroonian.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.diabet.2013.07.004.

References