Prevalence of diabetes and associated risk factors in a Senegalese urban (Dakar) population

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Abstract

Aim. – The aim of this study was to estimate the prevalence of diabetes in the urban population living in Dakar, Senegal, and to investigate the factors associated with diabetes.

Methods. – Data from a 2009 survey of 600 individuals, aged 20 years or above and considered representative of the population of the city of Dakar, were evaluated. Socioeconomic characteristics, hypertension, capillary whole blood glucose, and weight and height measurements of these subjects were collected during face-to-face interviews. The statistical analyses used chi-square (\( \chi^2 \)) tests and binary logistic regressions.

Results. – The percentage of participants with fasting blood glucose levels greater than or equal to 1.10 g/L and/or currently being treated for diabetes was 17.9% (\( n = 107, 95\% \text{ CI: 14.7–20.8} \)). Observed rates of diabetes were significantly higher among women (\( \chi^2 = 6.3; P < 0.05 \)), in subjects aged > 40 years (\( \chi^2 = 33.6; P < 0.001 \)), in those with low educational levels (\( \chi^2 = 11.9; P < 0.05 \)) and in those with hypertension (\( \chi^2 = 13.9; P < 0.001 \)), and in those who were overweight (BMI \( \geq 25 \text{ kg/m}^2 \) and < 30 kg/m\(^2 \)) or obese (BMI \( > 30 \text{ kg/m}^2 \); \( \chi^2 = 40.3; P < 0.001 \)). After adjusting for gender, age, educational level, BMI and blood pressure, the results showed that gender, age and BMI were associated with diabetes: women, older people and those with a higher BMI had significantly greater chances of being diabetic than the rest of the population, whatever their blood pressure and educational level.

Conclusion. – Diabetes is becoming a pressing public-health problem in Senegal, and the major risk factors for the increasing diabetes prevalence in the city of Dakar are gender, age and body mass index.

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Keywords: Biological anthropology; Epidemiology; Type 2 diabetes; Urban population; Prevalence; Obesity; Risk factors; Senegal

Résumé

Prévalence du diabète et des facteurs de risque associés dans une population urbaine du Sénégal (Dakar).

Objectif. – L’objectif de cette étude était d’estimer la prévalence du diabète dans la population urbaine de Dakar (Sénégal) et de déterminer les facteurs de risque associés au diabète dans cette population.

Méthodes. – Un échantillon de 600 individus, représentatif de la population du département de Dakar âgée de 20 ans et plus, a été constitué. Les caractéristiques socioéconomiques des individus, la pression artérielle, la glycémie capillaire ainsi que le poids et la taille des individus ont été mesurés durant des interviews menées en face-à-face. Les analyses statistiques utilisées étaient des tests du \( \chi^2 \) et des régressions logistiques binaires.

Résultats. – Le pourcentage d’individus dont la glycémie capillaire était supérieure ou égale à 1.10 g/L, et/ou sous traitement est de 17.9% (\( n = 107 \)) (IC à 95% : 14.7–20.8). Les proportions observées de diabétiques étaient significativement plus importantes chez les femmes (\( \chi^2 = 6.3; P < 0.05 \)), les sujets âgés de plus de 40 ans (\( \chi^2 = 33.6; P < 0.001 \)), les sujets qui avaient un faible niveau d’éducation (\( \chi^2 = 11.9; P < 0.05 \)), les hypertendus (\( \chi^2 = 13.9; P < 0.001 \)), ainsi que chez les individus en surpoids (25 kg/m\(^2 \) ≤ BMI < 30 kg/m\(^2 \)) ou obèses (BMI > 30 kg/m\(^2 \); \( \chi^2 = 40.3; P < 0.001 \)). Les régressions logistiques binaires ont montré que, toutes choses égales par ailleurs, le sexe, l’âge et l’indice de masse corporelle (IMC) étaient associés au diabète : les femmes, les sujets les plus âgés et les sujets qui présentaient un IMC élevé ont significativement plus de risque d’être diabétique que les autres.

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1. Introduction

Diabetes is affecting people worldwide, and poses major public-health and socioeconomic challenges. Several reports of global estimates and projections have confirmed the diabetes epidemic, and indicate that the numbers of people with diabetes is destined to rise [1–4]. Estimates from 2011 by the International Diabetes Federation (IDF) [1] suggest that the number of adults with diabetes around the world will expand by 50% by 2030. The largest increases are expected to be in the developing regions of the world because of population ageing and urbanization [2–4]. In 2010, 12.1 million people were estimated to be living with diabetes in Africa, and this is projected to increase to 23.9 million by 2030 [4]. Diabetes is thus becoming a pressing public-health problem for sub-Saharan Africa (SSA). While the region faces the double burden of communicable diseases (such as HIV and tuberculosis) and non-communicable diseases and their risk factors (such as diabetes) [5], the paucity of data from Africa on diabetes is significant, as it considerably limits the development of potential preventative strategies.

Type 2 diabetes accounts for more than 90% of diabetes cases in SSA [6,7]. Studies conducted from the 1960s to the early 1980s showed that the prevalence of type 2 diabetes was mostly less than 1% except in South Africa (0.6–3.6%) and the Ivory Coast (5.7%) [8,9]. In fact, diabetes was regarded as a rare disease in SSA prior to the 1990s [10]. However, unlike the past, diabetes is no longer rare in SSA: reported prevalences range from 3% in Benin to 14.5% in the Democratic Republic of Congo [11]. Considerable regional variations persist within the African continent [12] due, in part, to differences in diagnostic methods and criteria [13], and variation within countries is commonly seen between urban and rural environments [7].

Previous suggestions that diabetes prevalence is increasing in Africa have been confirmed [7,13–19]. In SSA, the identified risk factors are not markedly different from those reported in other populations [13,14], including increasing age, urbanization, physical inactivity, hypertension and obesity [5], whereas gender has little effect on diabetes.

Urbanization associated with the westernization of lifestyles, characterized by decreased amounts of physical activity and increased consumption of energy-dense or high-fat diets, can be considered a major determinant of the rising burden of diabetes and other cardiovascular diseases in Africa [4,10,20,21]. From reported studies, the prevalence of diabetes varies considerably between rural and urban areas and, where examined, diabetes prevalence has been higher in urban than in rural communities in the same country [9,22]. Projections show that, by 2050, 60% of Africans will live in cities, with a regional annual urban growth rate of 3.6% [23]. This suggests that the rates of diabetes will continue to rise in SSA.

As for Senegal, in 1960, Payet et al. [24] estimated the prevalence of diabetes in Dakar to be 1.1%. In 2010, the IDF estimated the prevalence to be 4.7%. Today, no epidemiological information is available from Senegal on diabetes, but it is thought to be increasingly widespread, based on clinical observations [25]. Consequently, and considering the previous findings on diabetes, the aim of the present study was to estimate the prevalence of diabetes in the urban population of Dakar and to investigate the factors associated with diabetes.

2. Subjects, materials and methods

To carry out the present study, a comprehensive survey was conducted from January to May 2009 in Dakar. In 2009, according to the National Agency of Statistics and Demographics of Senegal (Agence Nationale de la Statistique et de la Démographie du Sénégal), a total of 990,019 individuals were living in the environs of Dakar. The population sample selected for the present study comprised 600 individuals age 20 years or above. The sample was constructed using the combined quota method (cross-section by age, gender and area of residence) to obtain a population aged 20 years or above and representative of Dakar. For this, data from the National Agency of Statistics and Demographics of Senegal dating from the last census (2002) were used. The quota variables were gender (male/female), age (20–29, 30–39, 40–49 and ≥ 50 years) and area of residence. These areas were grouped according to the four main divisions (arrondissements) of the greater city of Dakar: Plateau-Gorée (five areas); Grand Dakar (six areas); Parcelles Assainies (four areas); and Almadies (four areas). In practice, this method required constructing a sample that reflected the proportions found in the general city population: for example, according to the last census, 2% of men aged 20–29 years were living in the area of Medina (Plateau-Gorée arrondissement). Thus, our sample population was constructed to match this proportion by including 12 men aged 20–29 years living in this area. The method was the same for each quota by gender, age and area.

In each area, four investigators (PhD students in medicine and pharmacy) started out from different starting points each day to interview individuals in Wolof or French in every third home. Investigators had a certain number of individuals they had to interview (women aged 20–29 years/men aged 20–29 years/women aged 30–39 years/men aged 30–39 years/women aged 40–49 years/men aged 40–49 years/women aged ≥ 50 years/men aged ≥ 50) in each area to meet the quotas. Only one person was selected as the respondent for each home. Investigators entered these homes, asked to see the inhabitants and then chose the first person they saw who met the
characteristics needed for the quotas. The participation rate in Dakar was extremely high: 99.2% of the individuals agreed to participate to the study. In-person interviews, lasting from 30–45 min depending on the respondent’s availability and desire to talk, were then conducted.

2.2. Variables studied

2.2.1. Socioeconomic variables

The socioeconomic and demographic variables collected were: age (20–29/30–39/40–49/≥ 50 years); gender (male/female); educational level, defined in accordance with the educational system in Senegal (0/1–5/6–9/10–12/> 12 years of schooling).

2.2.2. Diabetes

Subjects were examined in the morning after fasting since the previous evening meal. The day before the investigation, subjects were informed of the necessity to have nothing to drink and eat, to properly measure capillary whole blood glucose. Capillary whole blood was obtained from a finger prick, and was immediately analyzed using a HemoCue® blood glucose analyzer. Participants were then divided into two categories according to international standards [26]: those who were not diabetic, with capillary whole blood glucose less than 110 mg/dL; and those with diabetes who had been either previously diagnosed with diabetes or had capillary whole blood glucose greater than or equal to 110 mg/dL.

2.2.3. Blood pressure

Blood pressure (BP) was measured, using an OMRON M5-I automatic BP monitor, in the sitting position, using the right upper arm and an appropriately sized cuff after a 5-min rest period. Three readings were taken during the interview. The first was discarded, and the mean of the last two readings used in the analysis. The first measurement was taken on both arms to detect any difference in BP between arms. If this was the case, the higher measure of arterial BP was used.

Hypertension was defined as a systolic BP greater than or equal to 140 mmHg and/or a diastolic BP greater than or equal to 90 mmHg or reported treatment for hypertension.

2.2.4. Body mass index

Weight was measured using a digital scale (accurate to within 100 g), with subjects wearing minimal clothing and barefoot. Following World Health Organization (WHO) recommendations, body mass index (BMI) was calculated by dividing weight (kg) by the square of height (m²). Overweight was defined as BMI greater than or equal to 25 kg/m² and less than 30 kg/m²; obesity corresponded to a BMI greater than or equal to 30 kg/m² and underweight was a BMI less than 18.5 kg/m².

2.3. Statistical analysis

Files compiled on the basis of the 600 participants’ questionnaires were processed and coded in Excel (2007). Chi-square (chi²) tests were used to measure the presence, strength and independence of the statistical association of sociodemographic variables, BMI and hypertension with diabetes. Binary logistic regression analysis was also carried out to estimate the risk factors for diabetes. Binary logistic regression sets out to produce a model that permits the prediction of binary variable values from a set of illustrative variables (continuous and/or binary). Each illustrative variable was adjusted in relation to the others. The association measure computed

Table 1
Distribution of sociodemographic variables based on fasting blood glucose levels (n = 600).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories</th>
<th>Fasting blood glucose</th>
<th>&lt; 1.10 g/L</th>
<th>≥ 1.10 g/L</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>264</td>
<td>53.6</td>
<td>43</td>
<td>40.2</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>229</td>
<td>46.4</td>
<td>64</td>
<td>59.8</td>
</tr>
<tr>
<td>Age range (years)</td>
<td>20–29</td>
<td>219</td>
<td>44.4</td>
<td>31</td>
<td>28.9</td>
</tr>
<tr>
<td></td>
<td>30–39</td>
<td>139</td>
<td>28.2</td>
<td>16</td>
<td>14.9</td>
</tr>
<tr>
<td></td>
<td>40–49</td>
<td>70</td>
<td>14.2</td>
<td>29</td>
<td>27.1</td>
</tr>
<tr>
<td></td>
<td>≥ 50</td>
<td>65</td>
<td>13.2</td>
<td>31</td>
<td>29.1</td>
</tr>
<tr>
<td>Educational level</td>
<td>0</td>
<td>108</td>
<td>21.9</td>
<td>34</td>
<td>31.8</td>
</tr>
<tr>
<td></td>
<td>1–5</td>
<td>126</td>
<td>25.6</td>
<td>31</td>
<td>29.1</td>
</tr>
<tr>
<td></td>
<td>6–9</td>
<td>82</td>
<td>16.6</td>
<td>21</td>
<td>19.6</td>
</tr>
<tr>
<td></td>
<td>10–12</td>
<td>78</td>
<td>15.8</td>
<td>11</td>
<td>10.3</td>
</tr>
<tr>
<td></td>
<td>&gt;12</td>
<td>99</td>
<td>20.1</td>
<td>10</td>
<td>9.2</td>
</tr>
<tr>
<td>Hypertension</td>
<td>No</td>
<td>373</td>
<td>75.7</td>
<td>62</td>
<td>57.9</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>120</td>
<td>24.3</td>
<td>45</td>
<td>42.1</td>
</tr>
<tr>
<td>Body mass index(Kg/m²)</td>
<td>&lt; 18.5</td>
<td>67</td>
<td>13.6</td>
<td>7</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>302</td>
<td>61.3</td>
<td>40</td>
<td>37.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>92</td>
<td>18.7</td>
<td>42</td>
<td>39.3</td>
</tr>
<tr>
<td></td>
<td>≥ 30</td>
<td>32</td>
<td>6.4</td>
<td>18</td>
<td>16.8</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>493</td>
<td>100.00</td>
<td>107</td>
<td>100.00</td>
</tr>
</tbody>
</table>
in this model was the odds ratio (OR), which quantifies the strength of the association between an event’s occurrence (represented by a dichotomous variable) and the factors that could influence it (represented by illustrative variables). All analyses were performed using SPSS software, version 16. A two-sided \( P \) value < 0.05 was considered statistically significant.

### 3. Results

The percentage of individuals having fasting blood glucose levels greater than or equal to 1.10 g/L and/or currently being treated for diabetes in our representative sample was 17.9\% (\( n = 107 \), 95\% CI: 14.7–20.8). Ten (9.3\%) of the 107 subjects knew of their diabetes before screening, and only one (0.9\%) had a fasting blood glucose level less than 1.10 g/L.

As shown in Table 1, the observed proportions of diabetic subjects were significantly higher among women (chi\(^2 = 6.3; \ P < 0.05\)) in subjects aged over 40 (chi\(^2 = 33.6; \ P < 0.001\)), in subjects with low levels of education (chi\(^2 = 11.9; \ P < 0.05\)), in those with hypertension (chi\(^2 = 13.9; \ P < 0.001\)), and in those who were either overweight (BMI \( \geq 25 \text{ kg/m}\(^2\) and \(< 30 \text{ kg/m}\(^2\)\)) or obese (BMI \( \geq 30 \text{ kg/m}\(^2\)\); chi\(^2 = 40.3; \ P < 0.001\)). The relationships between diabetes and gender, age, educational level, hypertension and BMI were also verified using binary logistic regression, taking into account all variables studied (Table 2).

After adjusting for gender, age, educational level, BMI and BP, the results showed that gender, age and BMI were associated with diabetes: women, older-age subjects and those with a higher BMI had significantly greater chances of becoming diabetic than the rest of the sample population, whatever their educational level and systolic BP [1].

### 4. Discussion

This study provides the first representative population-based estimates of the prevalence of diabetes in Dakar. These data provide baseline figures for the planning of healthcare policy and the establishment of medical priorities in Dakar, the most urbanized region of Senegal. Based on our results, it is estimated that 17.9\% of the urban population has diabetes. Not surprisingly, this high urban prevalence was higher than the IDF 2010 estimate, which included data from rural areas. The prevalence of type 2 diabetes in Dakar was also slightly higher than the range of prevalence in other SSA countries, which varies from 3\% in Benin to 14.5\% in the Democratic Republic of the Congo [11].

It is also noteworthy that, in comparison to the data from Dakar reported by Payet et al. [24], it appears that the prevalence of diabetes in the Senegalese capital has increased by 16.7\% over half a century. Furthermore, it appears that, in Dakar, awareness of the diabetic condition and levels of control are low (9.3\% and 0.9\%, respectively), indicating the need to develop a national programme for the prevention, early detection and control of diabetes.

On bivariate analysis, those with diabetes were older, less educated, had hypertension more often, and were more overweight and obese [22]. The prevalence of diabetes was greater in women compared with men. However, binary logistic regression showed that, after taking into account all the variables studied (gender, age, level of education, BMI and BP), gender, age and BMI proved to be the principal risk factors for developing diabetes. Therefore, the hypothesis that the demographic transition (the increase in life expectancy leading to an increasingly elderly population) is at the root of the drastic increase of diabetes has been confirmed by our findings [5,13,22]. In addition, the fact that BMI is associated with diabetes highlights the importance of the impact of the nutritional transition [27]—which is associated with a greater prevalence of obesity—that is currently taking place in Dakar.

Finally, the acceleration of urbanization in Africa—and the associated rise in obesity—plays an important role in the increased prevalence of diabetes [11]. Indeed, the prevalence of diabetes in African communities is clearly increasing with the lifestyle changes associated with rapid urbanization: dietary changes (greater consumption of refined sugars and saturated fat, and a reduction in fiber intake); less physical activity; and growing rates of obesity [28]. The rural community is still engaged in more physical occupations such as farming, walking and cooking, and is probably more active than the urban population in general [28]. Thus, the projections that, by 2025, 70\% of Africans will live in cities suggest that levels of type 2 diabetes will continue to rise in the region [14]. In Senegal, 45\% of the population is concentrated in Dakar and, by 2030, it is projected that more than half of all Senegalese will be living in urban areas [29].

For these reasons, preventing obesity is important for reducing the onset of type 2 diabetes. In 2010, more than 30\% of Dakar citizens aged 20 years or above were either overweight or obese [30], and 27.5\% had hypertension [31]. These data show how urgent it is to combat the rise of obesity and hypertension if we are to prevent the burden of chronic disease from becoming too heavy for Senegal to bear.

### 5. Limitations and perspectives

The main limitation of the present study is its cross-sectional design, which does not allow longitudinal evaluation to examine how diabetes has evolved over time. For this
reason, caution should be used when interpreting any causal links between different risk factors (excess weight, obesity) and diabetes. Also, given the limited resources and poor infrastructure during the study, it was not possible to establish the procedures to be followed when administering the 75g oral fasting blood glucose test. Nevertheless, the present study is the first to provide data on the prevalence of diabetes in Senegal using a representative sample of the population.

6. Conclusion

Diabetes is fast becoming a pressing public-health problem for SSA. The major risk factors for the increasing diabetes prevalence in the city of Dakar, Senegal, are hypertension, overweight and obesity. These risk factors are associated with urbanization. As there continues to be a growing number of people moving to urban areas from the rural parts of Senegal, these results highlight the emergence of an increasingly high prevalence of type 2 diabetes, with implications for an increased disease-related mortality.

Disclosure of interest

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

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