Impact of socioeconomic status on diabetes and cardiovascular risk factors:
Results of a large French survey

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Abstract

Aim. – This study examined the association between deprivation and diabetes in a large French population, and evaluated the impact of deprivation on diabetes after taking in account a number of confounding factors.

Methods. – A total of 32,435 men and 16,378 women, aged 35 to 80 years, who had a health checkup at the “Centre d’Investigations Préventives et Cliniques” (IPC Centre: a preventive medical center in Paris, France), between January 2003 and December 2006, were evaluated. Socioeconomic deprivation was assessed using the EPICES score. The most deprived subjects were those in the fifth quintile of score distribution.

Results. – Several cardiovascular risk markers increased significantly in deprived subjects. In both genders, deprivation was associated with deleterious health status and lifestyle habits. In women, BMI, central obesity and the metabolic syndrome were associated with deprivation. The prevalence of diabetes increased with deprivation level. Compared with the first quintile of EPICES score distribution, the prevalence of diabetes was three to eight times higher in the fifth quintile. After taking into account age, and biological, clinical and lifestyle parameters, the risk of diabetes onset (odds ratio) among deprived vs. non-deprived subjects was 2.54 (95% CI: 1.99–3.24) in men and 2.2 (95% CI: 1.44–3.35) in women.

Conclusion. – In the general French population, deprivation was associated with deleterious health status and lifestyle. Risk of diabetes increased linearly with deprivation level and, after taking into account various confounding factors, the risk of diabetes remained significantly higher among deprived subjects. Other factors such as nutrition should now be examined to explain the excess risk of diabetes among the most deprived people.

Keywords: Diabetes; Deprivation; Epidemiology; Risk factors; Cardiovascular disease; Depression; Score EPICES

Résumé

Impact du statut socio-économique sur le diabète et les facteurs de risque cardiovasculaire : étude d’une large population française.

Objectif. – Étudier l’association entre la précarité et le diabète dans une large population française après prise en compte des facteurs associés.


Résultats. – La prévalence des facteurs de risque augmente avec la précarité. Dans les deux sexes, la précarité est associée à une altération de l’état de santé et des habitudes de vie. Comparativement au premier quintile du score EPICES, dans le cinquième quintile, la prévalence du diabète est trois à huit fois plus élevée. Après prise en compte de l’âge, des facteurs cliniques et biologiques et du style de vie associé à la précarité, le risque d’être diabétique (odds ratio), comparé à celui des sujets non précaires était de 2,54 (1,99–2,34) et 2,2 (1,44–3,35) respectivement chez les hommes et les femmes.
Conclusion. – Dans l’ensemble de la population, la précarité est associée à une altération de l’état de santé et des habitudes de vie. Le risque d’être diabétique augmente avec la précarité indépendamment des autres facteurs associés. Des facteurs comme la nutrition pourraient expliquer l’excès de diabète chez les sujets en situation de précarité.

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Mots clés : Diabète ; Précarité ; Épidémiologie ; Facteurs de risque ; Maladies cardiovasculaires ; Dépression ; Score EPICES

1. Introduction

Cardiovascular disease and diabetes are major contributors to health problems in industrialized countries, and type 2 diabetes is increasing rapidly in all parts of the world [1]. Many risk factors are implicated and most of them are also involved in the growing incidence of cardiovascular disease. The association of type 2 diabetes with a low socioeconomic status (SES) has been previously described. Several studies from developing countries have demonstrated a positive relationship between low SES and the incidence [2,3] and prevalence [4–9] of type 2 diabetes. However, the role of the different components of deprivation in the burden of diabetes remains unclear. For example, anxiety and depression scores were worse among low SES people in both genders. Several reports have pointed out the relationship between level of SES and psychological behavior. Patients with lower levels of education and reduced SES have higher rates of depression than subjects of higher SES. It has been suggested that diabetic patients are almost twice as likely to suffer from anxiety and depression as non-diabetic subjects [10–13].

The aim of the present study was to evaluate the impact of low SES on diabetes occurrence and cardiovascular risk biomarkers after adjusting for several confounding factors.

2. Design and methods

2.1. Participants and procedure

Subjects were examined at the “Centre d’Investigations Préventives et Cliniques” (IPC Centre) in Paris, France. This medical centre, which is subsidized by the French national healthcare system [Sécurité Sociale – Caisse Nationale de l’Assurance Maladie des Travailleurs Saliéris (CNAMTS); National Health Insurance Fund for Employees], offers all working and retired individuals and their families a free medical examination every five years. It carries out approximately 25,000 examinations per year of people living in the Paris area.

Our study population was composed of all subjects who had a health checkup at the IPC Centre between January 2003 and December 2006. The population included 32,435 men and 16,378 women, aged 35 to 80 years, with no known history of cardiovascular disease.

Supine blood pressure (BP) was measured in the right arm, using a manual mercury sphygmomanometer, after a 10-minute rest period. The first and fifth Korotkoff phases were used to define systolic BP (SBP) and diastolic BP (DBP). The mean of three measurements was considered the BP value. Pulse pressure (PP = SBP – DBP) was also determined. Hypertension was diagnosed if the patient was taking antihypertensive drugs or if BP was greater than 135 mmHg for SBP and greater than 80 mmHg for DBP. Obesity was defined as a body mass index (BMI) greater than 30 kg/m². Waist circumference was measured using a non-stretch measuring tape placed midway between the lowermost ribs and tops of the iliac crests in the mid-axillary line in standing position; normal values were less than 88 cm for women and less than 102 cm for men.

Standard biological parameters, measured by an enzymatic method using an automatic analyzer (Hitachi 917, Tokyo, Japan) or a colorimetric method for albumin dosage and hematology (ABX Pentra 120 analyzer, Horiba Medical, Montpellier, France), were recorded under fasting conditions; high-density lipoprotein (HDL) cholesterol was measured by a direct enzymatic method using cyclodextrin. All clinical and biological parameters were evaluated on the same day as the examination. During the health checkup, dental care (based on the presence of dental plaque and number of cavities) was also evaluated by a dentist, while hearing and eye tests were assessed by a nurse using standard tools. Tobacco use, physical activity, personal medical history and current medications were assessed using a self-administered questionnaire. Another self-administered questionnaire provided data for the EPICES (Évaluation de la Précarité et des Inégalités de santé dans les Centres d’Examens de Santé; Evaluation of Deprivation and Inequalities of Health in Healthcare Centres) score, and included educational level, profession, perception of access to healthcare and perception of job security. The diagnosis of type 2 diabetes was assessed in patients who reported being diabetic, whether treated or not with antidiabetic drugs, or by the discovery of fasting glycaemia equal to or greater than 1.26 g/L in those with undiagnosed diabetes.

The IPC Centre received authorization from the Comité National d’Informatique et des Libertés (CNIL; National Committee for Data Protection) to conduct analyses with data collected during the standard health checkup. All subjects gave their informed consent to participate at the time of examination.

2.2. Socioeconomic deprivation assessment: EPICES scores

Socioeconomic deprivation was assessed using the EPICES score [14]. This score was elaborated from a self-administered questionnaire completed by 7208 subjects, aged 16 to 59 years, who had undergone a standard health checkup at one of the 18 participating health examination centres. The questionnaire was composed of 42 questions including nationality, occupational status, family status and financial difficulties. After factorial correspondence analysis, 11 questions were found to explain
### Table 1
Population characteristics according to gender and deprivation status.

<table>
<thead>
<tr>
<th></th>
<th>Men Not deprived</th>
<th>Men Deprived</th>
<th>Women Not deprived</th>
<th>Women Deprived</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subjects (n)</strong></td>
<td>20,750</td>
<td>5837</td>
<td>10,628</td>
<td>2840</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td>48.45 (8.81)</td>
<td>49.71 (9.74)</td>
<td>51.18 (10.20)</td>
<td>49.27 (10.28)</td>
</tr>
<tr>
<td><strong>Clinical markers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>25.7 (0.02)</td>
<td>25.8 (0.05)</td>
<td>23.9 (0.04)</td>
<td>27.6 (0.09)</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>88.7 (0.07)</td>
<td>89.0 (0.13)</td>
<td>96.3 (0.09)</td>
<td>102.10 (0.18)</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>130.1 (0.11)</td>
<td>133.3 (0.22)**</td>
<td>125.3 (0.17)</td>
<td>131.2 (0.34)**</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>78.8 (0.07)</td>
<td>80.5 (0.14)**</td>
<td>76.40 (0.11)</td>
<td>79.24 (0.21)**</td>
</tr>
<tr>
<td><strong>Biological markers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glycaemia (g/L)</td>
<td>0.98 (0.001)</td>
<td>1.00 (0.002)**</td>
<td>0.92 (0.002)</td>
<td>0.98 (0.31)**</td>
</tr>
<tr>
<td>Triglycerides (g/L)</td>
<td>1.13 (0.006)</td>
<td>1.27 (1.05)**</td>
<td>0.83 (0.005)</td>
<td>1.01 (0.09)**</td>
</tr>
<tr>
<td>Total cholesterol (g/L)</td>
<td>2.19 (0.003)</td>
<td>2.12 (0.005)**</td>
<td>2.16 (0.004)</td>
<td>2.13 (0.70)**</td>
</tr>
<tr>
<td>HDL cholesterol (g/L)</td>
<td>0.56 (0.001)</td>
<td>0.54 (0.002)**</td>
<td>0.71 (0.002)</td>
<td>0.62 (0.03)**</td>
</tr>
<tr>
<td>Metabolic syndromea (%, n)</td>
<td>6.49 (1294)</td>
<td>11.7 (628)***</td>
<td>3.94 (400)</td>
<td>16.30 (431)***</td>
</tr>
<tr>
<td>Gamma-glutamyl transferase (IU/L)</td>
<td>38.7 (0.38)</td>
<td>52.9 (0.72)**</td>
<td>23.6 (0.37)</td>
<td>32.2 (0.007)**</td>
</tr>
<tr>
<td><strong>Lifestyle characteristics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker (%, n)</td>
<td>25.6 (5309)</td>
<td>42.2 (2465)***</td>
<td>21.7 (2302)</td>
<td>24.1 (685)***</td>
</tr>
<tr>
<td>Regular physical activity (%, n)</td>
<td>46.4 (9625)</td>
<td>43.9 (2561)***</td>
<td>44.9 (4768)</td>
<td>34.8 (989)***</td>
</tr>
<tr>
<td>Anxiety score</td>
<td>2.94 (0.02)</td>
<td>5.75 (0.04)**</td>
<td>4.05 (0.03)</td>
<td>6.70 (0.06)**</td>
</tr>
<tr>
<td>Depression score</td>
<td>0.93 (0.02)</td>
<td>2.32 (0.03)***</td>
<td>1.87 (0.03)</td>
<td>3.60 (0.06)**</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>61.9 (0.07)</td>
<td>54.5 (0.19)***</td>
<td>63.8 (0.10)</td>
<td>66.5 (0.22)**</td>
</tr>
<tr>
<td>ECG abnormalities (%, n)</td>
<td>1.74 (349)</td>
<td>3.70 (198)***</td>
<td>1.93 (198)</td>
<td>3.81 (97)*****</td>
</tr>
<tr>
<td>Previous myocardial infarction (%, n)</td>
<td>0.33 (69)</td>
<td>0.87 (51)*****</td>
<td>0.10 (11)</td>
<td>17 (0.60)*****</td>
</tr>
<tr>
<td>Vision &lt; 6/10 (%, n)</td>
<td>6.2 (828)</td>
<td>18.4 (824)***</td>
<td>11.7 (837)</td>
<td>18.9 (401)***</td>
</tr>
<tr>
<td>Dental plaque (%, n)</td>
<td>13.1 (1275)</td>
<td>34.2 (1064)***</td>
<td>9.3 (416)</td>
<td>20.5 (294)***</td>
</tr>
<tr>
<td>Limited access to healthcare (%, n)</td>
<td>0.37 (76)</td>
<td>14.4 (822)***</td>
<td>0.84 (88)</td>
<td>18.0 (497)***</td>
</tr>
<tr>
<td>Never visited a physician (%, n)</td>
<td>13.7 (2838)</td>
<td>20.0 (1168)***</td>
<td>5.7 (605)</td>
<td>8.9 (252)***</td>
</tr>
</tbody>
</table>

Data are presented as means (SD) for quantitative data and as % (n) for qualitative variables.

* P<0.05.
*** P<0.0001.

91% of the ‘precarity’ variable. The EPICES score was calculated using coefficient regression as estimated from these 11 questions (Appendix 1; see supplementary material associated with this article online). As previously described by Bihan et al. [15], the EPICES score has been validated and ranges from 0 to 100: the higher the score, the higher the level of socioeconomic deprivation. Subjects with a score greater than 38.5 (limit of the last quintile of distribution) were considered socioeconomically deprived. After distributing score values across the quintiles, those included in the first three were considered to have normal SES whereas those in the fourth and fifth quintiles were considered to have a low socioeconomic situation.

2.3. Psychological status: anxiety and depression scores

Perceived anxiety and depression scores were assessed for each subject using validated self-administered questionnaires. Perceived anxiety was evaluated using a questionnaire [16] composed of four questions (Appendix 2; see supplementary material associated with this article online), and depression was evaluated with a questionnaire [17] consisting of 13 yes/no questions (Appendix 3; see supplementary material associated with this article online).

2.4. Statistical analysis

The following two groups were compared: the first included the first, second and third quintiles of EPICES scores; and the second included the fifth quintile of distribution. The fourth quintile was excluded from the analysis. In the first step of the analysis, the characteristics of the two groups were compared. In the second step, the comparison focused on diabetic status. Logistic-regression models were used to evaluate the risk [odds ratios (ORs) and 95% confidence interval (CI)] of being diabetic in each quintile of EPICES score after taking into account age, BMI, waist circumference, depression and anxiety scores, physical activity and tobacco use.

Stepwise-regression logistic models were used to determine the factors involved in the excess risk of diabetes among deprived subjects. For this, subjects were divided into two groups: the “more-deprived” group included all those falling within the last (fifth) quintile of the EPICES score distribution; and the “less-deprived” group included the first, second and third quintiles of EPICES distribution. The two groups were compared using multivariate analyses, including age for quantitative parameters and Chi-square tests for qualitative parameters.

All statistical analyses were performed using the SAS statistical software package, version 8.2.
3. Results

3.1. Prevalence of diabetes

In the present study population, 1768 subjects were found to have type 2 diabetes. Of the subjects aged 35 to 59 years, 835 men and 315 women had diabetes, representing 2.94% and 2.41%, respectively, of the study population. Of subjects aged 60 to 80 years, 417 men and 201 women were diabetic, representing 10.4% and 3.11%, respectively, of the population.

3.2. Markers of cardiovascular risk and other variables

Table 1 shows the main characteristics of subjects according to gender and deprivation status. Age was similar in both groups for each gender. BMI and waist circumference were significantly higher in deprived women, while the differences were less significant in men. In deprived subjects, SBP, DBP and heart rate were also significantly higher, and abnormalities on electrocardiography (ECG) and previous myocardial infarction were more frequent. Fasting blood glucose was higher, HDL cholesterol was lower and triglycerides were higher. In general, the metabolic syndrome (MetS), according to the US National Cholesterol Education Program (NCEP) definition, was more frequent especially among deprived women. As for lifestyle habits, among the deprived people and mostly in men, there were more smokers, and significantly less physical activity particularly among women. Poor eyesight and dental plaque were more frequent. Deprived subjects were also more likely to declare having limited access to healthcare and to not have seen their physician in the last 2 years.

3.3. Risk of diabetes according to deprivation level

Fig. 1 shows the percentages of diabetic subjects according to quintiles of EPICES score distribution in two age groups (< 60 years and ≥ 60 years) in men (A) and in women (B). In both genders, the percentage of diabetic patients increased in tandem with deprivation scores (trends in both genders was \( P < 0.0001 \)).

Fig. 2 shows the OR (95% CI) for the risk of diabetes according to EPICES score in men and women adjusted for age only (A), and for age plus biological and clinical markers, including BMI and lifestyle factors (B).

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Fig. 2 shows the OR (95% CI) for the risk of diabetes according to EPICES score in men and women adjusted for age only (A), and for age plus biological and clinical markers, including BMI and lifestyle factors (B).

After taking age into account, diabetes risk increased significantly in men from 1.8 to 4 from the third to the last (fifth) quintile, with similar results observed in women (from 1.6 to 8.5). After accounting for age, biological and clinical markers, and lifestyle differences across EPICES score quintiles, the risk of being diabetic was significantly higher in the last quintile of
Previous studies [1,18–20] have confirmed the inverse relationship between deprivation scores in both men [2.54 (1.99–3.24)] and women [2.20 (1.44–3.35)].

4. Conclusion

Evaluation of SES was assessed using the EPICES score [14], which takes into account the multidimensional aspects of deprivation, including its material, psychological and social aspects. The EPICES score is an individual index whereas other indices used in the literature were aggregate scores. Most published reports have used household income, area of residence, car ownership and level of education as markers of poverty. However, biases may be introduced by the use of such limited indices, as any missing information can affect the precise evaluation of household income, for example. The level of education is associated with income, professional occupation, physical activity and social prestige. Education also improves willingness to seek health information and encourages healthy lifestyle behaviors. Previous studies [1,18–20] have confirmed the inverse relationships between educational level and diabetes, prevalence of obesity and risk of cardiovascular disease. However, in a recent unpublished survey by our group, it was observed that a significant number of young men presented with low SES despite having high levels of education, including secondary and post-secondary graduation. This new situation can most likely be explained by the rise in unemployment that is affecting young educated people more and more. These observations highlight the importance of using the multifactorial EPICES score to evaluate all components of SES.

Our present study has confirmed the strong prevalence of undiagnosed diabetes mainly in the subgroup of men less than 60 years of age. These subjects were diagnosed thanks to the systematic screening of fasting glycaemia in all our study patients. These data also emphasize the risk of underestimating the prevalence of diabetes if only self-reported data are used, as was the case with several surveys [1,19–21]. Fasting glycaemia, used as a diagnostic tool in our study, is a robust test that is universally accepted, including by the World Health Organization (WHO) [22]. However, if an oral glucose tolerance test (OGTT) had been used instead [23], the prevalence of diabetes would have undoubtedly been higher. In addition, if the cut-off value for impaired fasting glucose had been lower at 5.6 mmol/L instead of the 7 mmol/L proposed by the American Diabetes Association [23], the number of diabetic patients would have been even larger.

The prevalence of diabetes was higher in deprived subjects, and progressively increased from the first to fifth quintiles of EPICES scores. The prevalence was also slightly higher in women. In fact, several authors [3,18,19,24], except for Connolly et al. [25] and Williams [26], have reported a more marked risk of diabetes in low SES women than in men. The reasons for these gender differences remain unclear. However, the effect of deprivation on health may differ according to gender perhaps because men and women have different notions of healthy behaviors and lifestyles. Sedentary lifestyles are more frequently seen in women and contribute to obesity, which is a strong predictor of diabetes and cardiovascular disease. In any case, it is evident that gender differences need to be examined more extensively. The relationship of SES with an increased incidence or prevalence of type 2 diabetes is well documented, but the mechanisms involved may be related to a wide range of factors. Of these factors, some are generally accepted as determinants of diabetes and cardiovascular disease risk such as diets high in calories and saturated fats, physical inactivity, central obesity and low birth weight, all of which are also more frequently seen in deprived populations [27]. However, the problem is not only to evaluate the role played by these classical factors in deprivation, but also to take into account any other social and psychological determinants of behavior in deprived subjects. For this reason, the relative risk of becoming diabetic was also evaluated after taking into account various confounding factors such as age, BMI, waist circumference, and depression and anxiety scores. A progressive increase in risk from the first to fifth quintiles of EPICES scores was then observed. This relationship was more pronounced in the subgroup of subjects aged less than 60 years and also mostly in women. These data confirm the complexity of the mechanisms by which deprivation increases the risk of becoming diabetic.

Our present study highlights the fact that a number of risk factors for cardiovascular diseases are more prevalent in subjects with low SES. This was the case for central obesity and the MetS, which are associated with low SES particularly in women. ECG abnormalities, increases in SBP and DBP, and current smokers were also more frequent in deprived subjects. Plasma levels of triglycerides increased and HDL cholesterol decreased in both genders with low SES. Similarly, earlier studies have reported such variations in plasma lipids according to social status. Connolly et al. [25] and Unwin et al. [28] found an inverse relationship between total cholesterol levels and social status in type 2 diabetics. Kavanagh et al. [18] reported an increase in plasma triglycerides and lower HDL levels in subjects with low incomes or low education, although these changes were less pronounced when behavioral risk factors were included in the analysis. The increase in plasma triglycerides may be related to central obesity and excess carbohydrate and fat consumption, whereas the decrease in HDL may be dependent on physical inactivity, which was significantly more frequent among deprived subjects in our study.

Furthermore, a reduction in visual capacity, an increase in dental plaque deposits and limited access to healthcare were also noted in our deprived patients. Moreover, low SES subjects, mostly men, were less likely to visit the doctor, an observation that differed from the Larranaga et al. [7] results of their Basque survey.

Anxiety and depression have negative impacts on glycaemic control and the resulting diabetic complications. In their meta-analysis, De Groot et al. [29] reported a significant correlation between depression, diabetes complications and sexual dysfunction. It is also important to remember that severe complications affect mood and increase the likelihood of mental disorders. Depression is associated with higher rates of mortality in diabetic patients [30]. Depressed and anxious diabetic subjects are less likely to comply with the burden of self-care recommendations. They are also less physically active, and less likely to...
follow a dietary regimen and take their medications. Moreover, anxiety and depression are more frequent in smokers and heavy drinkers. Egede and Zheng [31] found the following factors to be independently associated with severe depression: younger age; female gender; lower SES; perceived decrease in health status; and smoking. Collins et al. [10] observed a relationship between higher depression scores and lower educational levels. Both Bell et al. [11] and Thomas et al. [12] reported that patients with lower levels of education and lower SES have higher rates of depression than patients without these characteristics. These data underscore the importance of assessing and treating co-morbid mental disorders in all deprived subjects and especially diabetic patients [32,33]. Recently, using the same deprivation scores, Bihan et al. [34] showed that a deprived state was associated with altered quality of life as assessed by the short-form (SF-36) health survey.

Our present study also had some limitations. First, the definition of diabetes was established by only a single measurement of glycemia and, second, no data for dietary habits were available.

In conclusion, in the general French population, deprivation was associated with deleterious health status and lifestyle habits, and the risk of diabetes increased linearly with the level of deprivation. After taking into account a wide range of metabolic, lifestyle and other confounding factors, the risk of diabetes appeared to be significantly higher among subjects with greater levels of deprivation. Further studies including other factors such as nutrition are now necessary to explain the excess risk of diabetes among deprived subjects.

Disclosure of interest

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

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Appendices 1–3. Supplementary material

Supplementary material associated with this article can be found at http://www.sciencedirect.com, at http://dx.doi.org/10.1016/j.diabet.2012.09.002.

References


