Anthropometric parameters and type 2 diabetes: a case-control study in a Guadeloupean population

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Summary

Objective: The aim of this study was to quantify the association between three anthropometric parameters and type 2 diabetes in an adult population in Guadeloupe and to evaluate the effect of age on these associations.

Designs and methods: We conducted a case-control study in a population recruited in an Health Center of Guadeloupe in year 2000. A total of 309 subjects with documented type 2 diabetes were matched on sex and age (± 2 years) with controls free of any glycemic abnormality. Student t-test was used and conditional logistic regressions were performed separately for men and women to quantify the association between type 2 diabetes and the explanatory variables, body mass index (BMI), waist to hip ratio (WHR) and waist circumference (WC).

Results: Mean (SD) WC was 89.0 cm (0.9) in non diabetics men and 97.3 cm (1.1) in diabetics ones, \( p < 10^{-4} \). In women, it was 87.7 (0.8) cm for non diabetics and 96.3 cm (0.9) for diabetics. This difference was persistent for any tertile of age in each sex. It was discordant for BMI and WHR at higher tertile for men and women. In the multivariate analysis, Odds ratio [CI 95\%] for WC was 9.67 [2.32-40.20] in men and 2.97 [1.70-5.19] in women. Results for BMI were non significant in both sex.

Conclusion: Differences between WC and WHR over age groups and sex in predicting type 2 diabetes should be taken into account when using these parameters routinely in medical practice.

Key-words: Type 2 diabetes - Guadeloupe - Waist circumference - Waist to hip ratio - Body mass index.

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Received: June 2nd, 2003; revised: October 1st, 2003
In Guadeloupe, a French Caribbean island of 420 000 inhabitants, prevalence of diabetes mellitus (DM) is high and was estimated at 5.8% [1] whereas this prevalence is at 3.06% in France [2].

Moreover, diabetes complications are also more frequent and prevalence of diabetics patients suffering from end stage renal disease (ERSD) is three fold higher than in the French population [3-5].

Insulin resistance in type 2 DM result in sum of polygenic abnormalities [6, 7] and acquired factors. Thus, a family history of diabetes is strongly linked to type 2 DM [8] and genetic susceptibility of some populations is well documented [7, 9, 10]. Obesity and particularly abdominal obesity are strongly associated with insulin resistance [7, 9, 10]. These acquired factors, as well as low physical activity, are potential targets that can be modify in primary health care. Obesity is becoming a growing international public health problem [11-13]. Weight loss or regularly physical activity bring a better insulin sensibility and then a better glycemic level [14, 15].

Three main anthropometrics parameters allow to evaluate fat repartition in adults: the Body Mass Index (BMI), defined as the weight in kilograms divided by the height in meters squared, the Waist to Hip Ratio (WHR), and the Waist Circumference (WC). Some authors showed that BMI and WHR were predictors of type 2 diabetes outcome [16] whereas in other studies, WC was a better predictor of non insulin-dependent diabetes and was more strongly correlated to intra-abdominal fat than WHR [17, 18]. These parameters have ethnic susceptibility [19, 20] and could varied according to age [21, 22].

Our aim was to quantify the association between body mass index, waist to hip ratio, waist circumference and type 2 diabetes mellitus in an adult population in Guadeloupe and to evaluate the effect of age on these associations.

Subjects and methods

The subjects of this study were recruited among the insured individuals, who are prompted by mail to have a clinical and biological examination every 5 years in the referring Health Center of Guadeloupe (FWI). A case-control study was conducted for our purpose and the patients were recruited among the subjects seen between January 01 and December 31 of year 2000 who had blood samples determinations.

Among those patients, 357 (3.8%) subjects had a type 2 diabetes with current oral medication, excluding insulin. Forty eight patients of this group were excluded because of incomplete data. Finally, the study sample included 309 type 2 diabetes patients. One control was matched to each case on the basis of gender and age (± 2 years). These 309 normo glycemic controls (glycemia < 7 mmol, no history of diabetes or use of current hypoglycemic agent) were selected, by means of a computer program in the same population.

Measures

The individuals were interviewed by a physician using a standard questionnaire that provided information on age, gender, history of diabetes, or hypertension or dyslipidemia, and use of antidiabetic, antihypertensive, antihyperlipemic and menopausal treatments.

Height and weight were measured with participants standing without shoes and lightly clothed. Body mass index (BMI) was calculated as weight/height² (kg/m²). Waist circumference (WC) in centimeters was measured, with participants standing, at the point yielding the smallest circumference between the lower rib margin and the iliac crest. Hip circumference was recorded at the point yielding the maximum circumference over the buttocks. The waist-to-hip ratio (WHR) was calculated. Obesity was defined as BMI ≥ 30 kg/m². We used the criteria of the National Heart, Lung, and Blood Institute (NHLBI) [23] to define the cut-points for central (or abdominal) obesity. A measure of WC over 88 cm in women and in102 cm in men was considered at risk. High level of WHR was defined as ≥ 0.95 in men and ≥ 0.85.

Physical activity was categorized in occupational activity and regular or moderate intensity activity.

Blood pressure was measured according to a standardized protocol with an automatic oscillometric method (dynamap) at least after 5 min of rest. The retained value was the average of the 2 readings (left and right arm). Hypertension was defined, according to the JNC VI report (the 6th report of the Joint National Committee), as a blood pressure ≥ 140 mmHg systolic or ≥ 90 mmHg diastolic or current use of antihypertensive medication.

Blood samples were obtained from participants after overnight fasting. Plasma total cholesterol and triglycerides were measured by enzymatic methods (Boehringer Mannheim). All blood analyses were performed at the same medical analysis laboratory with standardized programs. Dyslipidemia was defined by a cholesterolemia ≥ 6.20 mmol/L (240 mg/dL) or a triglyceridemia ≥ 2.3 mmol/L (200 mg/dL) or use of anti hyperlipidemic medications. This classification was conform to ATP III (Adult Treatment Panel III) guidelines [24] but in this Health Center, measures of HDL and LDL-cholesterol were not routinely done.

Statistical methods

Statistics were computed with Stata 7.0 (Stata corporation, Texas).

For the descriptive analysis, we considered the three anthropometrics parameters according to sex and tertiles of age for each sex. Tertiles of age were categorized as ≤ 51 years;
diabetes and their 95 % confidence intervals [CI95%] were their high intercorrelation. The odds ratios (ORs) of type 2 for each sex and for each parameter separately because of variables (BMI, WC, WHR). The analysis were performed between type 2 diabetes and the explanatory and categorical regressions were performed to quantify the association. Statistical significance was set at 64 years in men. The Student t-test was used to assess ≥ differences between groups. Hypertension was defined for either a systolic tension ≥ 140 mmhg or a diastolic ≥ 90 mmhg or use of an antihypertensive medication. Dyslipidemia was defined by a cholesterolemia > 6.20 mmol/L or a triglyceridemia > 2.3 mmol/L or an ongoing medication.

Characteristics of diabetic and non diabetic patients by sex.

<table>
<thead>
<tr>
<th>Quantitative variables</th>
<th>Total (N = 309)</th>
<th>Men (N = 101)</th>
<th>Women (N = 208)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (year)</td>
<td>57.3 ± 0.6</td>
<td>58.5 ± 1.2</td>
<td>56.8 ± 0.8</td>
</tr>
<tr>
<td>BMI (Kg/m²)</td>
<td>29.3 ± 0.3</td>
<td>24.7 ± 0.3</td>
<td>30.0 ± 0.4</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>96.6 ± 0.7</td>
<td>97.3 ± 1.08</td>
<td>96.3 ± 0.8</td>
</tr>
<tr>
<td>WHR</td>
<td>0.92 ± 0.005</td>
<td>0.91 ± 0.007</td>
<td>0.91 ± 0.006</td>
</tr>
</tbody>
</table>

Qualitative variables

| Hypertension *         | 230 (81.0)     | 63 (67.7)     | 159 (81.9)      |
| Dyslipidemia **        | 103 (35.6)     | 28 (30.8)     | 66 (33.2)       |
| Family history of diabetes | 152 (49.2) | 14 (13.9)  | 100 (48.1)     |
| Regular physical activity | 149 (48.2) | 55 (54.5)  | 94 (45.2)       |
| Menopause              | 112 (53.9)     | 63 (64.5)     | 89 (42.8)       |

** Hypertension was defined for either a systolic tension ≥ 140 mmhg or a diastolic ≥ 90 mmhg or use of an antihypertensive medication.

** Dyslipidemia was defined by a cholesterolemia > 6.20 mmol/L or a triglyceridemia > 2.3 mmol/L or an ongoing medication.

52-63 years; ≥ 64 years in women and ≤ 54 years; 55-63 years; ≥ 64 years in men. The Student t-test was used to assess differences between groups. Statistical significance was set at p ≤ 0.05. Unadjusted and adjusted conditional logistic regression analyses were performed to quantify the association between type 2 diabetes and the explanatory and categorical variables (BMI, WC, WHR). The analysis were performed for each sex and for each parameter separately because of their high intercorrelation. The odds ratios (ORs) of type 2 diabetes and their 95 % confidence intervals [CI95%] were estimated. Adjustment was done on all significant covaribles in the univariate analysis (among tertiles of age, family history of diabetes, hypertension, dyslipidemia, physical activity and menopause in women).

Results

Population characteristics

Among the 10396 patients seen in year 2000, 5339 (55.9%) were female and 9456 (91%) of them had a glycemic determination. A glycemia over 7 mmol (126 mg/dL) without history of diabetes was found in 215 patients (2.3%), a known insulin dependant diabetes in 59 patients (0.6%) and a non insulin dependant diabetes with oral medication in 357 (3.8%). In this latest group, women represented 66.1% of non insulin dependant diabetic patients (NIDD).

Mean age was 58.4 years in men (range: 30-86 years) and 56.9 years in women (range: 20-82 years). No difference was found between groups. There were 101 (32.7%) men and 208 (67.3%) women in each group. Family History of diabetes were more frequently found in cases than in controls in both sex. Hypertension was found in 78.9% of cases and 67.7% of controls among men; p = 0.09 and in 81.9% of cases and 59.2% of controls, p < 10⁻⁴ among women.

No significant difference was found between cases and controls in both sex for dyslipidemia and physical activity. Prevalence of current menopause was significantly higher in controls than in cases, but only 4.1% of the overall women population were taken a specific medication.

Clinical and biological data are summarized in Table I. Table II shows distribution of the anthropometric parameters [Waist Circumference (WC), Body Mass Index (BMI) and Waist to Hip Ratio (WHR)] between cases and controls by sex, all age group included, and by tertile of age.

The mean values of these parameters were significantly higher in diabetics than in controls all age group included in the three tertiles of age, except in women for BMI in tertile 3 and in men for WHR in tertile 3. In these three situations, no significant differences were found between cases and controls.

Table III shows the results of the conditional logistic regression analysis.

In the univariate regression analysis (IIIA), there were statistically significant relations between type 2 DM and WC, BMI and WHR in both sex. The other variables associated to type 2 DM were: family history of diabetes and dys-
Table III
Regression coefficients for the association between each anthropometric parameter and type 2 diabetes over tertile of age in Men and women.

<table>
<thead>
<tr>
<th></th>
<th>ABC</th>
<th>OR* IC 95%</th>
<th>p</th>
<th>OR* IC 95%</th>
<th>p</th>
<th>Or** IC 95%</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men (n = 202)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Waist circumference</td>
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<td></td>
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</tr>
<tr>
<td>WC (cm)</td>
<td>10.0</td>
<td>3.05-32.77</td>
<td>&lt; 10^{-4}</td>
<td>10.10</td>
<td>3.03-33.62</td>
<td>&lt; 10^{-4}</td>
<td>9.67</td>
</tr>
<tr>
<td>WHR</td>
<td>3.57</td>
<td>2.25-5.66</td>
<td>&lt; 10^{-4}</td>
<td>3.64</td>
<td>2.28-5.81</td>
<td>&lt; 10^{-4}</td>
<td>2.97</td>
</tr>
<tr>
<td>BMI</td>
<td>3.14</td>
<td>1.34-7.36</td>
<td>0.008</td>
<td>3.07</td>
<td>1.29-7.28</td>
<td>0.01</td>
<td>1.78</td>
</tr>
<tr>
<td><strong>Women (n = 416)</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>WHR</td>
<td>1.8</td>
<td>1.19-2.72</td>
<td>0.005</td>
<td>1.87</td>
<td>1.23-2.86</td>
<td>0.004</td>
<td>1.50</td>
</tr>
<tr>
<td><strong>Women (n = 416)</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>WHR</td>
<td>6.06</td>
<td>3.57-10.29</td>
<td>&lt; 10^{-4}</td>
<td>6.01</td>
<td>3.53-10.25</td>
<td>&lt; 10^{-4}</td>
<td>6.15</td>
</tr>
</tbody>
</table>

A: The coefficient are unadjusted
B: The coefficient are adjusted on tertile of age
C: The coefficients are adjusted on tertile of age, family history of diabetes and dyslipidemia in men and on tertile of age, hypertension, family history of diabetes and menopause in women.

Table II
Distribution of main anthropometric parameters between cases and controls for each sex all age groups included and by tertile of age.

<table>
<thead>
<tr>
<th></th>
<th>Non Diabetics</th>
<th>diabetics</th>
<th>p</th>
<th>Non Diabetics</th>
<th>diabetics</th>
<th>p</th>
<th>Non Diabetics</th>
<th>diabetics</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>WC (cm)</td>
<td>89.0 ± 0.9</td>
<td>97.3 ± 1.1</td>
<td>&lt; 10^{-4}</td>
<td>87.7 ± 0.8</td>
<td>96.3 ± 0.9</td>
<td>&lt; 10^{-4}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHR</td>
<td>0.91 ± 0.007</td>
<td>0.95 ± 0.007</td>
<td>&lt; 10^{-4}</td>
<td>0.83 ± 0.005</td>
<td>0.91 ± 0.006</td>
<td>&lt; 10^{-4}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>24.7 ± 0.3</td>
<td>27.9 ± 0.4</td>
<td>&lt; 10^{-4}</td>
<td>27.8 ± 0.3</td>
<td>30.0 ± 0.4</td>
<td>&lt; 10^{-4}</td>
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</tr>
</tbody>
</table>

*Tertiles of age were calculated as ≤ 51 years; 52-63 years; ≥ 64 years in women and ≤ 54 years; 55-63 years; ≥ 64 years in men.
lipidemia in men and family history of diabetes, hypertension and menopause in women.

The associations were still significant for the three parameters after adjustment on tertiles of age alone (IIIB). But after adjustment on tertiles of age and on the other significant factors of the univariate analysis, associations between type 2 DM and BMI were no more significant in both sex (IIIC). The regression coefficient for WC was 9.67 [2.32-40.20], \( p < 10^{-4} \) in men and 2.97 [1.70-5.19], \( p < 10^{-4} \) in women. For WHR, it was 2.94 [0.99-8.74], \( p = 0.05 \) in men and 6.15 [3.11-12.17], \( p < 10^{-4} \) in women.

**Discussion**

In this case control study performed over 618 subjects aged 20-86 years, we documented significant associations between WC, WHR and type 2 diabetes whereas BMI was not significantly associated with diabetes in both sex. Moreover, waist circumference was more strongly related to type 2 diabetes in men whereas higher odds ratios for WHR were found in women. These results are concordant with those of a previous study for women [22]. In our population with a median age of 57.4 years, age didn’t modified the strength of the association between type 2 DM and the three anthropometric parameters.

In a previous study in 5149 consecutive Guadeloupean women [25], WC and BMI were evaluated as screening tools for identification of subjects with cardiovascular risk factors. The area under the Receiver Operating Characteristics (ROC) curves indicated that WC and BMI identified people at increased risk for cardiovascular risk factors but that waist circumference had a higher discriminant ability even after considering the effect of age. Unfortunately, the waist to hip ratio was not evaluated in this study. The authors also showed that the differences between the two ROC curves had a higher value in identifying diabetes than the other cardiovascular risk factors, with a higher discriminant ability for WC than for BMI. Our results confirms that the abdominal fat localization is more important than the total amount of body fat or subcutaneous adipose tissue in the prediction of type 2 DM [16]. Visceral adiposity has been suggested to increase insulin resistance but the mechanisms are still to be defined. Role of free fatty acids (FFAs) are highlighted by many authors. At high concentration in the blood stream, these FFA impair muscle uptake of glucose by competitive inhibition [26-28]. Genetic influence are also discussed and factors of insulin resistance syndrome were found to have susceptibility loci on chromosome 6 and 7 [29].

In our study group, no relationship was found between diabetes and physical activity which was defined as occupational or moderate activity. Previous studies have focused on the inverse association between physical activity and type 2 DM [22, 30, 31]. But some authors have also noted the absence of relationship with household activity [22].

Our study population had a median age of 57 years for women and 60 years for men and prevalence of hypertension was over 60% in both group as in many studies [32-34]. We found no difference in lipid between diabetics subjects and control in both men and women. But low values of blood lipids have been reported in black adult population [35-37] compared to European people [38].

Limitations in our study could be misclassification of patients between cases and controls. We limited such bias by selecting for cases only patients with known type 2 diabetes and an ongoing medication. The other risk factors such as family history of diabetes and physical activity might have been also differently recorded between cases and controls. Finally, the rather small sample of men might be another limitation of our study.

This study conducted through different age groups and by sex showed than over age, waist circumference and waist to hip ratio were both strongly associated with type 2 diabete. Waist circumference was a better predictor of type 2 DM in men whereas Waist to Hip Ratio was a better predictor in women. These two parameters which are good measures of abdominal fat should be used in routine practice for the follow up of patients with type 2 diabetes.

**Acknowledgments** – The authors acknowledge Dr A. Daoud and Dr. JE. Rozet for their contribution in the study.

**References**


17. Wei M, Gaskill SP, Huffner SM and Stern MP. Waist circumference as the best predictor of noninsulin-dependent diabetes mellitus (NIDDM) compared to body mass index, waist/hip ratio and other anthropometric measurements in Mexican Americans — a 7-year prospective study. Obes Res, 1997, 5, 16-23.


