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 [CI95%] for WC was 9.67 [2.32-40.20] in men and 2.97 [1.70-5.19] in women. For the rapport TT/TH, it was 2.94 [0.99-8.74] chez les hommes et 6.15 [3.11-12.17] chez les femmes. 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.

Deloumeaux J, Ninin E, Foucan L. Anthropometric parameters and type 2 diabetes: a case-control study in a Guadeloupean population
Diabetes Metab 2004,30,75-80

SSLUMBRE
Objectif : Le but de cette étude était de quantifier l’association entre diabète de type 2 et trois paramètres anthropométriques et d’évaluer l’effet de l’âge sur ces associations dans une population adulte en Guadeloupe.

Matériels et méthodes : Une étude cas-témoins a été effectuée parmi les consultants du centre de santé de la Guadeloupe en l’an 2000. Trois cent neuf sujets porteurs d’un diabète de type 2 confirmé ont été apparisés sur le sexe et l’âge (± 2 ans) à des témoins indemnes d’anomalies glycémiques. Le test t de Student a été utilisé et des régressions logistiques conditionnelles ont été appliquées séparément chez les hommes et les femmes afin de quantifier l’association entre diabète de type 2 et les variables explicatives, l’indice de masse corporelle (IMC), le tour de taille (TT) et le rapport tour de taille sur tour de hanche (TT/TH).

Résultats : Chez les hommes, la moyenne du tour de taille (Écart-type) était de 89,0 (0,9) cm pour les non diabétiques et de 97,3 (1,1) cm pour les diabétiques, \( p < 10^{-4} \). Chez les femmes, elle était de 87,7 (0,8) cm pour les non diabétiques et de 96,3 (0,9) cm pour les diabétiques. Cette différence persistait dans chaque sexe pour tous les tertiles d’âge. Par contre, les résultats de l’IMC et du rapport TT/TH différaient chez les hommes et les femmes pour les tertiles les plus élevés. En analyse multivariée, l’Odds Ratio [Intervalle de Confiance 95 %] associé au diabète de type 2 pour le tour de taille était de 9,67 [2,32-40,20] chez les hommes et de 2,97 [1,70-5,19] chez les femmes. Pour le rapport TT/TH, il était de 2,94 [0,99-8,74] chez les hommes et 6,15 [3,11-12,17] chez les femmes. Les OR pour l’IMC n’étaient pas significatifs dans les deux sexes.

Conclusion : La variation des risques associés au diabète de type 2, en fonction du sexe et de l’âge pour le tour de taille et le rapport TT/TH, devrait être prises en compte en pratique médicale courante.

Mots-clés : Diabète de type 2 · Guadeloupe · Tour de taille · Rapport tour de taille/tour de hanche · Indice de masse corporelle.

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I
n 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 his-
tory of diabetes is strongly linked to type 2 DM [8] and ge-
netic 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 poten-
tial targets that can be modify in primary health care. Obes-
ity is becoming a growing international public health prob-
lem [11-13]. Weight loss or regularly physical activity bring a
better insulin sensibility and then a better glycaemic level
[14, 15].

Three main anthropometrics parameters allow to evalu-
ate 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 cor-
related to intra-abdominal fat than WHR [17, 18]. These
parameters have ethnic susceptibility [19, 20] and could vary
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 in-
sured individuals, who are prompted by mail to have a clini-
cal 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 re-
cruited among the subjects seen between January 01 and
December 31 of year 2000 who had blood samples determi-
nations.

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 cir-
cumference (WC) in centimeters was measured, with par-
ticipants standing, at the point yielding the smallest circum-
ference between the lower rib margin and the iliac crest. Hip
circumference was recorded at the point yielding the maxi-
mum circumference over the buttocks. The waist-to-hip ra-
tio (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 standard-
ized protocol with an automatic oscillometric method (dy-
namap) at least after 5 min of rest. The retained value was
the average of the 2 readings (left and right arm). Hyperten-
sion 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 Man-
nheim). 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 hyperlipemic
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 corpora-
tion, Texas).

For the descriptive analysis, we considered the three an-
thropometrics parameters according to sex and tertiles of age
for each sex. Tertiles of age were categorized as ≤51 years;
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 \( p \leq 0.05 \). 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 for each sex and for each parameter separately because of differences between groups. 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 BMI, WC, and WHR in both sex. The other variables associated to type 2 DM were: family history of diabetes and dyslipidemia.

### 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.
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>Parameter</th>
<th>Men (n = 202)</th>
<th>Women (n = 416)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A: Unadjusted</td>
<td>B: Adjusted</td>
</tr>
<tr>
<td></td>
<td>C: Further adjusted</td>
<td></td>
</tr>
<tr>
<td>Waist circumference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men (n = 202)</td>
<td>10.0</td>
<td>3.05-32.77</td>
</tr>
<tr>
<td>Women (n = 416)</td>
<td>3.57</td>
<td>2.25-5.66</td>
</tr>
<tr>
<td>BMI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men (n = 202)</td>
<td>3.14</td>
<td>1.34-7.36</td>
</tr>
<tr>
<td>Women (n = 416)</td>
<td>1.8</td>
<td>1.19-2.72</td>
</tr>
<tr>
<td>WHR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men (n = 202)</td>
<td>2.56</td>
<td>1.18-5.52</td>
</tr>
<tr>
<td>Women (n = 416)</td>
<td>6.06</td>
<td>3.57-10.29</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>Parameter</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non Diabetics</td>
<td>Diabetics</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>Non Diabetics</td>
<td>Diabetics</td>
</tr>
<tr>
<td>BMI</td>
<td>Non Diabetics</td>
<td>Diabetics</td>
</tr>
<tr>
<td>WHR</td>
<td>Non Diabetics</td>
<td>Diabetics</td>
</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 modify 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 diabetes 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 diabetes. 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.

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