Type 2 Diabetes Family Histories, Body Composition and Fasting Glucose Levels: A Cross-Section Analysis in Healthy Sedentary Male and Female

*Antonino BIANCO*¹, Francesco POMARA², Ewan THOMAS¹, Antonio PAOLI³, Giuseppe BATTAGLIA¹, Marco PETRUCCI¹, Patrizia PROIA¹, Marianna BELLAFIORE¹, Antonio PALMA¹

1. Sport and Exercise Sciences Research Unit, University of Palermo, Italy
2. MEDEOR Research Institute - Palermo, Italy
3. Dept. of Biomedical Science, University of Padua, Italy

*Corresponding Author:* Email: antonino.bianco@unipa.it

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**Abstract**

**Background:** Diabetes type 2 is a world wide spread disease with a multifactorial pathogenetic evolution. Various factors like obesity, physical inactivity and poor lifestyle habits contribute to its development. The aim of this study was to verify if in young healthy sedentary male and female there is positive correlation between family history to type 2 diabetes and an increase in body weight and fat mass, or alterations in basal glycemia values.

**Methods:** Totally 183 male and 237 female healthy sedentary subjects were analysed in 2012, in Italy. They were divided in three groups: FH+ with first degree family history, FH++ with second degree family history and FH- with no family history. Anthropometrics, body composition and blood parameters were assessed.

**Results:** Male had the highest BMI values ($P<0.01$). FH+ and FH++ had increased waist and hip circumferences and body weight ($P<0.005$ for men, $P<0.0001$ for women), body mass index ($P<0.0001$ in both sexes), waist-hip ratio ($P<0.05$ for men and women) and triceps skinfold ($P<0.0005$ for both sexes). Obesity incidence was higher in FH+ and FH++ compared to control groups.

**Conclusions:** The study confirms family history to diabetes type 2 as a risk factor for the development of the illness, mainly in a case of first degree of FH. Preventive interventions are necessary to promote significant life-style changes, such as increased physical activity and controlled quantity and quality of food intake.

**Keywords:** Lifestyle, Fasting glucose level, Type 2 diabetes, Family history, Body composition.

**Introduction**

A deficit in insulin secretion and physiological tissue action induces mellitus diabetes, causing chronic hyper-glycemia and various metabolic diseases(1). In occidental industrialized countries, type 2 diabetes (TD2) is the most widely spread disease, showing a constant increase of incidence also in young population. Moreover, genetic and environmental risk factors influence diabetes development: family history, age, obesity and physical inactivity (2). Maternal influence confirmed the hereditary role in the diabetes pathogenesis: women with positive family history to the illness presented major risks to develop gestational TD2, confirming the inter-generative transmission of this disease(3-11). Further studies showed the precocious influences of positive family history to TD2 on subjects’ phenotype, generating an in-
crease in body weight and a tendency towards obesity and visceral adiposity (12-16).
Other studies showed metabolic disorders related to a positive family history to TD2: glucose metabolic disorders, insulin-resistance, an increase in blood pressure and a reduced glucose tolerance (9, 11, 14, 17-20).
Even energy expenditure showed a strong correlation with positive family history to TD2 in young subjects (21-23), and our experience suggests that familiarity induces a precocious increase in body weight for visceral deposit of body fat (21, 24-26), maybe for a reduction in basal metabolism. Further analysis also showed that subjects with diagnosis to diabetes have a lower energy expenditure level compared to subjects with negative diagnosis to this illness (22, 27, 28). Regular physical activity reduces body weight in these subjects, confirming the protective role of sport on people’s health (4, 29-31).
The aim of this study was to verify if in young healthy sedentary male and female there is positive correlation between family history to TD2 and an increase in body weight and fat mass, or alterations in basal glycaemia values. Moreover, according to our recent study (Bianco et al, 2013) (26), on that case we want to better understand how the degree (first or second) of family history may affect all measured parameters.

Materials and Methods

A cross-sectional study with a cohort of young adult people was performed by the University of Palermo in collaboration with the University of Padua. A number of 420 healthy sedentary subjects (183 male and 237 female) living in Palermo area were selected in 2012. All of them were Caucasians, with a middle-low socioeconomic status; the predominant diet regimen Sicily is the Mediterranean diet. These were then divided into three groups according on family history to diabetes type 2. First group (FH+) included all those who had a parent or first degree relative with type 2 diabetes (35 male and 44 female), second group (FH++) included all those subjects having second degree relatives with type 2 diabetes (32 male and 58 female) and third group (FH-) included those subjects with no family history to the illness; in this case we used FH- as control group. A proper six pages questionnaire was made up following the standards of the “MEDICOR clinics for metabolic disorders”. It contained three main sections: a) Demographic information, number of hours of physical activity (hours/week), diet regimen and anthropometrics characteristics; b) History of illness; c) Family history to type 2 diabetes mellitus. Afterwards, the questionnaire was administered to the volunteers in order to detect family history to type 2 diabetes mellitus (TD2) and previous cardiovascular diseases such as myocardial infarction, stroke, vascular peripheral disease, hospitalisation for coronary heart disease (32).

Exclusion criteria

All those subjects resulting positive for the diseases above mentioned were excluded from the study. Moreover, we excluded from the study all people practicing more than 1 hour of physical activity per week and all people who declared were following intensive hypo-caloric diet regimen (a number of 22 subjects were excluded from the study). Height (Seca 709 ± 1g approximation, Hamburg – Germany), weight (Seca 220 ± 1mm approximation, Hamburg – Germany), shoulder, waist and hip circumferences (inelastic flexible meter with ± 1 mm approximation) were recorded. Body Mass Index (BMI, kg/m²), Waist-Hip Ratio (WHR), Body Surface Area (BSA, m²) were then calculated for each subject (33, 34). A bioelectrical impedance analysis (4 ways, 50 kHz frequency and 800 µA amplitude, Skylark, model BT-905 Taiwan, Korea) was then set for both male and female of all groups to assess Fat mass (FM) and Free Fat Mass (FFM) expressed both in kilograms (kg) and percentage (%). Fasting plasma glucose was finally measured for each subject with photometer Accu-check Active (Roche Diagnostic, Germany), with a range measure of 10-600 mg/dl (0.6-33.3 mmol/L). A bioelectrical impedance analysis was performed following standardised procedures: participants have not exercised or taken a sauna within 7 hours before the test; participants were not allowed to drink alcohol (12 hours prior to

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test); participants were not allowed to eat (4 hours prior to test); participants were not allowed to drink water (1 hour prior to test) participants did not have to be covered in sweat or soaked in urine (35). In order to evaluate body size (Shoulder Circum.), BSA and WHR we collected anthropometric measures. To evaluate body composition, for optimal accuracy and reliability we performed the BIA instead to use predictive equations.

Glucose levels were recorded through chemical reaction (mediator glucose-dehydrogenase pirrolochinolinechinone, GDH-PQQ), inducing colour translation on reactive zone. Ethical approval was established by the University of Palermo Ethics Committee (Commissione Etica del Dipartimento DISMOT) in Italy. The principles of the Italian data protection act (196/2003) were observed. All participants provided informed consent. The study was performed in compliance with the Helsinki Declaration.

Statistical Analysis
All recorded data were stored in excel format and were correlated when appropriate. The two-way ANOVA analysis of variance with Bonferroni post tests was used for statistical considerations through Instat-GRAPHPAD PRI-SM 5 Software (San Diego, USA). P values were considered significant when <0.05.

Results
The FH+ males (Table 1) had a greater body mass index (P<0.01) with significant increase of waist and hip circumferences and consequently in WHR (P<0.01) than other groups. Table 2 shows that older FH+ females have an increase in body weight (P<0.01), body surface area (P<0.005), waist (P<0.005) and hip circumferences (P<0.05), greater than other groups. As showed in Table 3 and 4, FH+ subjects had an increase in FM, in relative (P<0.05 between males, P<0.005 between females) and absolute values (P<0.01 between males, P<0.005 between females), with worse FFM/FM ratio (P<0.01 between males, P<0.05 between females) compared to FH++ and the control group (FH-). Table 5 and 6 show blood glucose levels, of male and female subgroups, related to body parameters. Only FH+ males had a significant reduction in fasting glucose levels for kg FM unit (P<0.01). FH+ women showed lower levels of fasting glucose levels for kg of BW and FM unit (P<0.005) and for kg of BSA (P<0.01). Figure 1 shows the linear trend between the basal blood fasting glucose levels and body fat mass (r = 0.12; r² = 0.014). Figure 2 and 3 are highlighting the results stratified by gender.

Table 1: Anthropometric parameters of male subjects

| Variable                  | FH+ (n = 35) | FH++ (n = 32) | FH- (n = 116) | p     |
|---------------------------|--------------|---------------|---------------|-------|
| Age, years                | 34.80 ± 12.03| 25.50 ± 6.39  | 28.20 ± 10.41 | 0.0005|
| Height, cm                | 172.77 ± 6.57| 174.27 ± 8.89 | 174.02 ± 6.33 | NS    |
| Body weight, kg           | 82.96 ± 18.51| 75.63 ± 12.71 | 77.78 ± 11.58 | NS    |
| BMI, kg/m²                | 27.72 ± 5.62 | 24.83 ± 3.20  | 25.67 ± 3.58  | 0.0078|
| BSA, m²                   | 1.96 ± 0.21  | 1.90 ± 0.19   | 1.92 ± 0.15   | NS    |
| Shoulder circumference, cm| 113.73 ± 8.53| 111.73 ± 9.91 | 114.00 ± 9.23 | NS    |
| Waist circumferences, cm  | 94.21 ± 15.47| 84.17 ± 10.54 | 86.93 ± 10.47 | 0.0007|
| Hip circumferences, cm    | 95.21 ± 13.42| 87.34 ± 9.10  | 89.44 ± 9.34  | 0.0360|
| WHR                       | 0.99 ± 0.05  | 0.96 ± 0.03   | 0.97 ± 0.04   | 0.0079|

NS: no significance
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Fig. 1: Linear trend between glucose levels and fat mass (kg); (correlation Coefficient r = 0.1199; r² = 0.01437)

Fig. 2: Male Subjects variables: WHR (Waist–hip ratio); BSA (Body Surface Area, m²); Glycemia (*) Glucose levels reported in mg/dl *kg FM⁻¹); FM% (**) Body Fat Mass reported in % divided by 10

Fig. 3: Female Subjects variables: WHR (Waist–hip ratio); BSA (Body Surface Area, m²); Glycemia (*) Glucose levels reported in mg/dl *kg FM⁻¹); FM% (**) Body Fat Mass reported in % divided by 10

Table 2: Anthropometric parameters of female subjects

| Variables                        | FH+ (n = 44)   | FH++ (n = 58)  | FH- (n = 135) | P    |
|----------------------------------|----------------|----------------|---------------|------|
| Age, years                       | 34.25 ± 12.31  | 27.62 ± 9.23   | 32.73 ± 11.71 | 0.0047|
| Height, cm                       | 162.28 ± 6.27  | 160.18 ± 6.57  | 159.24 ± 5.09 | NS   |
| Body weight, kg                  | 67.58 ± 14.67  | 61.51 ± 12.82  | 60.75 ± 10.89 | 0.0052|
| BMI, kg/m²                       | 25.77 ± 5.85   | 23.98 ± 4.85   | 23.96 ± 4.14  | NS   |
| BSA, m²                          | 1.71 ± 0.16    | 1.63 ± 0.16    | 1.62 ± 0.13   | 0.0015|
| Shoulder circumferences, cm      | 100.84 ± 8.87  | 98.02 ± 7.05   | 98.38 ± 7.05  | NS   |
| Waist circumferences, cm         | 82.82 ± 12.53  | 75.75 ± 10.79  | 77.46 ± 10.47 | 0.0040|
| Hip circumferences, cm           | 96.07 ± 13.57  | 90.55 ± 12.63  | 90.72 ± 11.35 | 0.0296|
| WHR                              | 0.86 ± 0.05    | 0.84 ± 0.04    | 0.85 ± 0.05   | NS   |

NS: no significance
Table 3: Body composition (BIA) of male subjects

| Variables          | FH+ (n = 35)       | FH++ (n = 32)      | FH- (n = 116)      | P     |
|-------------------|--------------------|--------------------|--------------------|-------|
| $\text{H}_2\text{O}$, litres | 39.06 ± 8.26       | 37.60 ± 7.50       | 36.95 ± 5.57       | NS    |
| FM, %             | 29.10 ± 5.41       | 25.46 ± 7.97       | 28.59 ± 5.43       | 0.0191|
| FFM, %            | 70.90 ± 5.41       | 74.54 ± 7.97       | 71.41 ± 5.43       | 0.0191|
| FM, kg            | 24.37 ± 7.83       | 19.23 ± 6.87       | 22.35 ± 5.85       | 0.0052|
| FFM, kg           | 58.59 ± 12.40      | 56.40 ± 11.25      | 55.43 ± 8.36       | NS    |
| FFM/FM            | 2.63 ± 1.10        | 3.51 ± 1.94        | 2.72 ± 1.20        | 0.0085|

NS: no significance

Table 4: Body composition (BIA) of female subjects

| Variables          | FH+ (n = 44)       | FH++ (n = 58)      | FH- (n = 135)      | P     |
|-------------------|--------------------|--------------------|--------------------|-------|
| $\text{H}_2\text{O}$, litres | 28.33 ± 3.48       | 27.33 ± 3.20       | 27.96 ± 3.31       | NS    |
| FM, %             | 35.28 ± 11.12      | 31.76 ± 9.82       | 29.90 ± 8.32       | 0.0039|
| FFM, %            | 64.72 ± 11.12      | 68.24 ± 9.82       | 70.10 ± 8.32       | 0.0039|
| FM, kg            | 25.08 ± 13.86      | 20.51 ± 11.19      | 18.81 ± 8.49       | 0.0026|
| FFM, kg           | 42.50 ± 5.22       | 40.99 ± 4.80       | 41.94 ± 4.97       | NS    |
| FFM/FM            | 2.09 ± 0.90        | 2.43 ± 1.00        | 2.60 ± 0.97        | 0.0102|

NS: no significance

Table 5: Fasting blood glucose levels of male subject in absolute and relative values

| Glucose levels       | FH+ (n = 35)       | FH++ (n = 32)      | FH- (n = 116)      | P     |
|---------------------|--------------------|--------------------|--------------------|-------|
| mg/dl               | 73.86 ± 10.14      | 71.72 ± 9.81       | 74.30 ± 9.31       | NS    |
| mg/dl · kg BW⁻¹     | 0.93 ± 0.24        | 0.97 ± 0.20        | 0.97 ± 0.18        | NS    |
| mg/dl · kg FFM⁻¹    | 1.32 ± 0.36        | 1.33 ± 0.34        | 1.37 ± 0.29        | NS    |
| mg/dl · kg FM⁻¹     | 3.36 ± 1.18        | 4.28 ± 1.88        | 3.58 ± 1.08        | 0.0076|
| mg/dl · kg BSA⁻¹    | 38.15 ± 6.81       | 38.15 ± 6.60       | 38.91 ± 5.59       | NS    |

NS: no significance

Table 6: Fasting blood glucose levels of female subject in absolute and relative values

| Glucose levels       | FH+ (n = 44)       | FH++ (n = 58)      | FH- (n = 135)      | P     |
|---------------------|--------------------|--------------------|--------------------|-------|
| mg/dl               | 73.61 ± 8.93       | 73.09 ± 8.75       | 75.33 ± 9.29       | NS    |
| mg/dl · kg BW⁻¹     | 1.13 ± 0.23        | 1.24 ± 0.28        | 1.27 ± 0.23        | 0.0046|
| mg/dl · kg FFM⁻¹    | 1.75 ± 0.29        | 1.81 ± 0.32        | 1.82 ± 0.29        | NS    |
| mg/dl · kg FM⁻¹     | 3.61 ± 1.52        | 4.39 ± 1.93        | 4.67 ± 1.78        | 0.0031|
| mg/dl · kg BSA⁻¹    | 43.25 ± 6.40       | 45.22 ± 7.32       | 46.75 ± 6.30       | 0.0081|

NS: no significance

Table 7: Fasting blood glucose levels of female subject in absolute and relative values

| Glucose levels       | FH+ (n = 44)       | FH++ (n = 58)      | FH- (n = 135)      | P     |
|---------------------|--------------------|--------------------|--------------------|-------|
| mg/dl               | 73.61 ± 8.93       | 73.09 ± 8.75       | 75.33 ± 9.29       | NS    |
| mg/dl · kg BW⁻¹     | 1.13 ± 0.23        | 1.24 ± 0.28        | 1.27 ± 0.23        | 0.0046|
| mg/dl · kg FFM⁻¹    | 1.75 ± 0.29        | 1.81 ± 0.32        | 1.82 ± 0.29        | NS    |
| mg/dl · kg FM⁻¹     | 3.61 ± 1.52        | 4.39 ± 1.93        | 4.67 ± 1.78        | 0.0031|
| mg/dl · kg BSA⁻¹    | 43.25 ± 6.40       | 45.22 ± 7.32       | 46.75 ± 6.30       | 0.0081|

NS: no significance

Table 8: Fasting blood glucose levels of male subject in absolute and relative values

| Glucose levels       | FH+ (n = 35)       | FH++ (n = 32)      | FH- (n = 116)      | P     |
|---------------------|--------------------|--------------------|--------------------|-------|
| mg/dl               | 73.86 ± 10.14      | 71.72 ± 9.81       | 74.30 ± 9.31       | NS    |
| mg/dl · kg BW⁻¹     | 0.93 ± 0.24        | 0.97 ± 0.20        | 0.97 ± 0.18        | NS    |
| mg/dl · kg FFM⁻¹    | 1.32 ± 0.36        | 1.33 ± 0.34        | 1.37 ± 0.29        | NS    |
| mg/dl · kg FM⁻¹     | 3.36 ± 1.18        | 4.28 ± 1.88        | 3.58 ± 1.08        | 0.0076|
| mg/dl · kg BSA⁻¹    | 38.15 ± 6.81       | 38.15 ± 6.60       | 38.91 ± 5.59       | NS    |

NS: no significance

Table 9: Fasting blood glucose levels of female subject in absolute and relative values

| Glucose levels       | FH+ (n = 44)       | FH++ (n = 58)      | FH- (n = 135)      | P     |
|---------------------|--------------------|--------------------|--------------------|-------|
| mg/dl               | 73.61 ± 8.93       | 73.09 ± 8.75       | 75.33 ± 9.29       | NS    |
| mg/dl · kg BW⁻¹     | 1.13 ± 0.23        | 1.24 ± 0.28        | 1.27 ± 0.23        | 0.0046|
| mg/dl · kg FFM⁻¹    | 1.75 ± 0.29        | 1.81 ± 0.32        | 1.82 ± 0.29        | NS    |
| mg/dl · kg FM⁻¹     | 3.61 ± 1.52        | 4.39 ± 1.93        | 4.67 ± 1.78        | 0.0031|
| mg/dl · kg BSA⁻¹    | 43.25 ± 6.40       | 45.22 ± 7.32       | 46.75 ± 6.30       | 0.0081|

NS: no significance

Discussion

The development of TD2 during years has relevantly increased in occidental countries as shown by WHO (32, 36-38). This has demonstrated the multifactorial pathogenesis of this disease correlating its manifestation not only with genetic factors or predispositions but also with age, gender,
Family history on TD2 especially in FH+ influences body composition and weight in healthy sedentary male and women. The multifactorial pathogenetic mechanism of TD2 makes this disease difficult to approach but it is also known the protective role of regular physical activity in order to maintain health and control body weight and blood glycemia. FH+ compared to other groups showed greater body mass and WHR. This important finding, highlighted for the first time on that study, is confirming the hypothesis that the first degree of FH is a strong indicator of pre-cocious modifications of body composition. Other studies are needed to confirm these encouraging results especially for unhealthy or athletes with family history to TD2.

**Ethical considerations**

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.
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