Somatotype Characteristics of Male Patients with Type 2 Diabetes Mellitus

Atanas G. Baltadjiev
Department of Anatomy, Histology and Embryology, Medical University, Plovdiv, Bulgaria

Abstract

Introduction: Type 2 diabetes is a metabolic disorder and as such it no doubt affects the components of somatotype of diabetics.

Aim: The aim of this study was to determine the somatotype of males with type 2 diabetes.

Patients and Methods: In the study we assessed anthropometrically 169 male patients with type 2 diabetes. The patients were Bulgarian; they were allocated into two age groups: group 1 included 40-60-year-old patients and group 2 – 61-80-year olds. Healthy Bulgarian men without any history of metabolic, neoplastic, or other diseases were used as controls divided into age matched groups. Measurements obtained directly were height, body weight, biepicondylar breadth of humerus, biepicondylar breadth of femur, relaxed upper arm circumference, contracted upper arm circumference, forearm circumference, waist circumference, hip circumference, thigh circumference, calf circumference. Skin folds: subscapular, over rib 10, suprailliac, over abdomen, triceps, biceps, forearm, thigh, calf. Calculated parameters: Heath-Carter anthropometric somatotype components.

Results: Mean somatotype of 40-60-year-old male diabetics was endomorphic mesomorph (endo-mesomorph), (endo 5.03; meso 6.57; ecto 2.01). Mean somatotype 61-80-year-old diabetic males was endomorphic mesomorph (endo-mesomorph), (endo 4.14; meso 5.88; ecto 1.64). The between-age comparison showed the somatotype in both age groups of diabetic males to be endomorphic mesomorph. The mesomorphy was dominant, followed by endomorphy and ectomorphy was far behind. The differences in the ratings of the somatotype components were of high statistical significance (P < 0.001). The mesomorphy and endomorphy ratings in patients with type 2 diabetes aged 40-60 years were greater than those of patients aged 61-80 years with the difference reaching statistical significance (P < 0.001).

Conclusions: Both age groups of male diabetics presented with endomorphic mesomorph somatotype. Mesomorphy was the highest, followed by endomorphy. Ectomorphy lagged substantially behind, leading to a shift in the somatoplot upward to mesomorphy and leftward to endomorphy. Unlike the findings of studies in foreign countries presenting markedly dominating endomorphy, in our study Bulgarian diabetic males presented with dominating mesomorphy. This could be regarded as a characteristic feature of Bulgarian diabetic patients. This could be accounted for by the role played by factors such as lifestyle, habits, environment, diet, methods of treatment, etc. The somatotype of Bulgarian diabetic males (endomorphic mesomorph) is more favourable with regard to the risk, course and prognosis of the disease.

Key words: type 2 diabetes mellitus, somatotype, males, anthropometry

Introduction

Diabetes mellitus is a disorder associated with the impairment of metabolism. It is increasingly becoming a public health problem as the incidence of the disease is rapidly rising, resulting eventually in disability and shortening lifespan of the patients. Current estimates amount to about 220 million people affected by the disease worldwide. In Bulgaria diabetic patients account for approximately 6-8% of the population. The disease is characterized by racial predisposition. The Mongoloid race is the most affected, followed by the Negroid, the least affected are the Caucasians.

All this generates the keen interest of researchers to unravel the etiology and pathogenesis of this disease, find its development, treatment and prognosis. Yet the anthropological evaluation of diabetic patients remains outside the focus of their...
interest or is just superficially touched on in their studies. The anthropological status of the patients with this disease would contribute much to the prevention, prognosis and course of the disease, to improving the working capacity and social integration of diabetic patients, to elucidating the influence of environmental factors, occupation, lifestyle, and physical activity. W. Sheldon was the first to introduce the somatotype concept in defining the morphological constitutional type. He provided the three components, i.e., endomorphic, mesomorphic and ectomorphic, to characterize the human somatotype. Later B. Heath and JEL Carter developed methods of anthropometric measurements and devised the mathematical formulas to determine the components of human somatotype. There is little information in the world literature about the correlation between somatotype and predisposition to various diseases. Studies in which a correlation between various chronic diseases and somatotype is sought were conducted by Koleva, Nacheva, Boev and other researchers. However, they did not search for a correlation between somatotype and type 2 diabetes.

Therefore we aimed in the present study to determine the somatotype of males with type 2 diabetes.

PATIENTS

We performed anthropometric assessment of 169 male patients with confirmed diagnosis of type 2 diabetes. The patients were recruited randomly from the inpatients of the Endocrinology Department at the Medical University of Plovdiv. The inclusion criteria were: Bulgarian ethnicity, duration of disease no less than four years and compensated diabetes at the time of the study.

Patients were allocated into two groups by age:

Group 1 (range 40 to 60 years) - 58 patients with a mean age of 52.05 ± 0.73 years (mean ± SEM)

Group 2 (range 61 to 80 years) - 111 patients with a mean age of 68.0 ± 0.532 years (mean ± SEM)

The same anthropometric measurements were carried out in 80 men who formed the control group. The inclusion criteria were: Bulgarian ethnicity and no history of metabolic disorder. The control subjects were randomly selected from a nursing home and surgical clinics. They were divided into two age groups matching those of the patients with diabetes:

Group 1 (range 40 to 60 years) – 40 men with a mean age of 49.06 ± 0.98 years (mean ± SEM).

Group 2 (range 61 to 80 years) – 40 men with a mean age of 69.03 ± 0.91 years (mean ± SEM).

METHODS

The anthropometric measurements obtained to calculate the Heath-Carter somatotype included:

- Height
- Body weight - with Tanita (BC-532) body composition monitor.
- Biepicondylar breadth of the humerus: The greatest distance between the medial and lateral epicondyles of the humerus.
- Biepicondylar breadth of the femur: The greatest distance between the medial and lateral epicondyles of the femur.

LIMB CIRCUMFERENCES

A. Upper limb
1. Upper arm girth, relaxed: The measurement at the greatest girth of the upper arm was taken in relaxed biceps brachii muscle.
2. Upper arm girth, contracted: The measurement at the greatest girth of the upper arm was taken in contracted biceps brachii muscle.
3. Forearm girth: The measurement at the level of greatest development of the forearm muscles.

B. Body
1. Waist girth: The horizontal measurement of the body at the level of greatest concavity on its lateral margin.
2. Hip girth: The horizontal measurement at the level of greatest bulge of the buttocks.

C. Lower Limb
1. Thigh girth: The horizontal measurement at the greatest circumference of the thigh.
2. Calf girth: The horizontal measurement at the greatest circumference of the calf.

SKIN FOLDS

Equipment: Harpenden skinfold calliper
1. Subscapular skinfold: The thickness of a skinfold with subcutaneous fat tissue just below the inferior angle of the scapula.
2. Skinfold over rib 10: The thickness of a skinfold with subcutaneous fat tissue on the chest along rib 10.
3. Suprailiac skinfold: The thickness of a skinfold with subcutaneous fat tissue above the anterior superior iliac spine.
4. Abdominal skinfold: The thickness of a skinfold with subcutaneous fat tissue on the abdomen below the navel.
5. Triceps skinfold: The thickness of a skinfold
with subcutaneous fat tissue of the arm over the triceps brachii muscle.

6. Biceps skinfold: The thickness of a skinfold with subcutaneous fat tissue over the biceps brachii muscle.

7. Forearm skinfold: The thickness of a skinfold with subcutaneous fat tissue on the forearm at the level of the forearm girth.

8. Thigh skinfold: The thickness of a skinfold with subcutaneous fat tissue on the thigh.


**Statistical Analysis**

To define the somatotype of diabetes mellitus patients the three components endomorphy, mesomorphy and ectomorphy were calculated and the data entered into the regression equations introduced by Heath and Carter. Somatoplots were done according to Toteva-Nacheva. The quantitative data obtained were analyzed by the methods of descriptive statistics using SPSS 11.0 and INSTAT programs. The data were analyzed using analysis of variance.

Mean, standard deviation (SD), standard error of the mean (SEM), coefficient of variation (CV%) were calculated.

Means were compared using the Student t-test and statistical significance was set at four levels: high, \( P < 0.001 \); moderate, \( P < 0.01 \); low, \( P < 0.05 \); no statistical significance, \( P > 0.05 \). A P value less than 0.05 is considered significant.

**Results**

**Mean somatotype of 40-60-year-old diabetic males**

Diabetic males and control subjects in the age group 40-60 years presented with endomorphic mesomorph somatotype. In both groups mesomorphy dominated, followed by endomorphy and ectomorphy was the lowest. The differences between the somatotype components were of high statistical significance (\( P < 0.001 \)) (Table 1).

Endomorphy presented with almost the same values in the diabetic patients and control subjects and the difference was short of statistical significance (\( P > 0.05 \)). This finding suggests that fat deposition is considerable and equal for the two groups.

Mesomorphy was greater in the diabetics compared to the controls and the difference reached moderate level of statistical significance (\( P < 0.01 \)). This indicated that the diabetics had well-developed muscles related to height and more robust skeleton than the controls.

Ectomorphy was lower than endomorphy and mesomorphy both in the diabetics and the controls. Ectomorphy presented with higher ratings in the control subjects than in the diabetic patients, but the difference was of low statistical significance (\( P < 0.05 \)). This finding was explained by the greater body robustness relative to height in the diabetics. The difference between the three somatotype components reached high level of statistical significance (\( P < 0.001 \)).

On the somatoplot an upward shift to mesomorphy and less expressed leftward shift to ectomorphy was evident (Figs 1, 2).

**Mean somatotype of 60-80-year-old diabetic males**

Diabetic patients and control subjects were with endomorphic mesomorph somatotype (endo-mesomorphs). Mesomorphy dominated in both study groups, followed by endomorphy and ectomorphy was the lowest. The differences between the somatotype components were of high statistical significance (\( P < 0.001 \)) (Table 2).

Endomorphy was with almost equal ratings in the diabetic and control subjects and the difference was short of statistical significance (\( P > 0.05 \)). This indicated significant and almost equal fat deposition in both groups subjects with slight excess in the controls.

Mesomorphy was dominant in the diabetics and controls with close ratings and between-group difference failing to reach statistical significance (\( P > 0.05 \)). This indicated well-developed muscles related

**Table 1. Mean somatotype of male diabetic patients and control subjects aged 40-60 years**

<table>
<thead>
<tr>
<th>Somatotype component</th>
<th>Diabetics</th>
<th>Controls</th>
<th>( t )</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n  Mean  SEM  SD  CV%</td>
<td>n  Mean  SEM  SD  CV%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endomorphy</td>
<td>53 5.03 0.24 1.65 32.80</td>
<td>40 5.01 0.29 1.73 34.53</td>
<td>0.057</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Mesomorphy</td>
<td>53 6.57 0.18 1.21 18.42</td>
<td>40 5.95 0.21 1.23 20.67</td>
<td>2.43</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Ectomorphy</td>
<td>53 2.01 0.19 1.31 1.72</td>
<td>40 2.55 0.20 1.16 45.49</td>
<td>2.07</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Mean somatotype</td>
<td>Endomorphic mesomorph</td>
<td>Endomorphic mesomorph</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Between-age comparison of the somatotype in male diabetics

In both age groups the diabetic patients presented with endomorphic mesomorph somatotype. The mesomorphy was dominant, followed by endomorphy and ectomorphy was far behind. The differences between the somatotype components were of high statistical significance (P < 0.001) (Table 3).

The endomorphy showed higher rating in the 40-60-year-old diabetics compared with the 60-80-year-old patients and the difference was highly statistically significant (P < 0.001). This suggested that the 40-60-year-old diabetics had greater fat deposition in their bodies.

The mesomorphy had higher rating in the 40-60-year-old diabetics compared with the 60-80-year-old patients with the difference reaching high level of statistical significance (P < 0.001). This indicated that younger diabetics had more robust skeleton and developed musculature related to height.

The ectomorphy had higher rating in the 40-60-year-old diabetics compared to the 60-80-year olds with low level of statistical significance

### Table 2. Mean somatotype of male diabetic patients and control subjects aged 60-80 years

<table>
<thead>
<tr>
<th>Somatotype component</th>
<th>Diabetics</th>
<th>Controls</th>
<th>t</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>SEM</td>
<td>SD</td>
</tr>
<tr>
<td>Endomorphy</td>
<td>97</td>
<td>4.14</td>
<td>0.16</td>
<td>1.38</td>
</tr>
<tr>
<td>Mesomorphy</td>
<td>97</td>
<td>5.88</td>
<td>0.16</td>
<td>1.34</td>
</tr>
<tr>
<td>Ectomorphy</td>
<td>97</td>
<td>1.64</td>
<td>0.16</td>
<td>1.54</td>
</tr>
<tr>
<td>Mean somatotype</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Mean somatotype of 40-60-year-old diabetic males.

Figure 2. Mean somatotype of 40-60-year-old control males.

Figure 3. Mean somatotype of 60-80-year-old diabetic males.
Studies of male patients with type 2 diabetes mellitus using the same somatotypic method have been conducted in India. The findings (7.2-4.9-0.7) also show uppermost rating of endomorphy, followed by mesomorphy and highly reduced ectomorphy.

In Bulgaria somatotype study of male patients with type 2 diabetes mellitus was performed by A. Baltadjiev. The somatotyping was performed using the Heath-Carter method. Somatotype of diabetic males was defined as endomorphic mesomorph in both 40-60 and 61-80 age groups. Mesomorphy is with the highest rating, followed by endomorphy and ectomorphy with the lowest rating. Unlike the findings of highest endomorphy ratings in studies conducted in other countries, our results show that mesomorphy is the dominant somatotype component in the Bulgarian male diabetic patients. This can be regarded as a characteristic feature of Bulgarian diabetic patients. This could be accounted for by the role played by factors such as lifestyle, habits, environment, diet, methods of treatment, etc.

**Figure 4.** Mean somatotype of 60-80-year-old control males.

(P < 0.05). In both age groups the ectomorphy lagged substantially behind the other two components (P < 0.001), denoting greater body weight related to height. This imbalance distorts the somatoplot in left-wise direction.

**Table 3.** Between-age comparison of mean somatotype in male diabetics

<table>
<thead>
<tr>
<th>Somatotype component</th>
<th>Mean ± SEM 40-80 years</th>
<th>Mean ± SEM 60-80 years</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endomorphy</td>
<td>5.03 ± 0.24</td>
<td>4.14 ± 0.16</td>
<td>3.52</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Mesomorphy</td>
<td>6.57 ± 0.18</td>
<td>5.88 ± 0.16</td>
<td>3.12</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Ectomorphy</td>
<td>2.01 ± 0.19</td>
<td>1.64 ± 0.16</td>
<td>1.48</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>

**DISCUSSION**

The human somatotype is expressed in three ratings representing endomorphy, mesomorphy, and ectomorphy. Endomorphy reflects development of tissues with endodermal origin, relative domination of structures associated with digestion and assimilation, including fat deposition. Mesomorphy reflects development of human body structures with mesodermal origin, mostly bone and muscle systems. Ectomorphy reflects development of structures derived from ectoderm.

In the world literature little analysis of somatotype characteristics of male patients with type 2 diabetes mellitus is available. Studies using the Heath-Carter somatotyping method have been conducted in Italy (Buffa et al.). Endomorphy is dominant - 6.8, followed by mesomorphy - 5.6, and highly reduced ectomorphy - 0.6. The findings correspond with overall obesity, high BMI, high risk of coronary and metabolic diseases.

The somatotype of the Bulgarian diabetic patients (endomorphic mesomorph) is more favourable with regard to risk, course and prognosis of the disease.

**CONCLUSIONS**

Diabetics and controls at 40-60 years of age have endomorphic mesomorph somatotype. Endomorphy is equally expressed, while the difference in mesomorphy and ectomorphy, reaches moderate level of statistical significance (P < 0.01). The somatoplot is shifted to endomorphy.

Diabetics and controls in the 60-80-year-old are endomorphic mesomorphs. Endomorphy and mesomorphy are equally presented in both groups, while it is in ectomorphy, with lower rating in diabetics, that the difference reaches high level of statistical significance (P < 0.001).

The mean somatotype is endomorphic mesomorph in both age groups of male diabetics. Endomorphy and mesomorphy dominate in 40-60-year-old
диабетиков с разницей достигающей высокого уровня статистической значимости (P < 0.001). Эктоморфия отстает значительно за эндоморфия, за которой следует мезоморф. При сравнении результатов других авторов (у болгарских диабетиков полученные авторами результаты различаются от результатов проведенных исследований в других странах, где видимо преобладает эндоморфный компонент), этот факт можно принять как особенность болгарских диабетиков. Объяснение по всей вероятности можно поиска в роли некоторых факторов как быт, окружающая среда, режим питания, способы лечения и т.д. Соматотип болгарских диабетиков (эндоморфный мезоморф) более благоприятен по отношению к риску, течению и прогнозу заболевания.

REFERENCES

СОМАТОТИПНАЯ ХАРАКТЕРИСТИКА МУЖЧИН, БОЛЬНЫХ САХАРНЫМ ДИАБЕТОМ ТИПА 2

А. Балтаджиев

РЕЗЮМЕ

ВВЕДЕНИЕ: Сахарный диабет типа 2 как заболевание метаболизма несомненно оказывает воздействие на компоненты соматотипа у больных диабетом индивидов.

ЦЕЛЬ: Исследовать и определить соматотип мужчин, больных сахарным диабетом типа 2.

ПАЦИЕНТЫ И МЕТОДЫ: Пациенты болгарского происхождения разделены на две возрастные группы: первая группа – от 40 до 60 лет, вторая группа – от 61 до 80 лет. В качестве контрольной группы измерены здоровые мужчины болгарского происхождения разделены на две возрастные группы: первая группа – от 40 до 60 лет, вторая группа – от 61 до 80 лет. В качестве контрольной группы измерены здоровые мужчины болгарского происхождения, которые не болеют обменными, онкологическими и другими заболеваниями (распределение по группам здоровых мужчин болгарского происхождения разделены на две возрастные группы: первая группа – от 40 до 60 лет, вторая группа – от 61 до 80 лет.

РЕЗУЛЬТАТЫ: Средний соматотип мужчин диабетиков в возрасте от 61 до 80 лет: эндоморфный мезоморф (эндо-мезоморфный соматотип), (teso 5.88; endo 4.14; ecto 1.64). Средний соматотип мужчин диабетиков в возрасте от 40 до 60 лет: эндоморфный мезоморф (эндо-мезоморфный соматотип), (meso 5.88; endo 4.14; ecto 1.64). Межвозрастное сравнение среднего соматотипа у мужчин диабетиков: средний соматотип и при обеих возрастных группах диабетиков это эндоморфный мезоморф. Доминирует эндоморфный мезоморф. Доминирует мезоморфный компонент, за которым следует эндоморфный, а эктоморфный отстает. Разницы в стоимости, характеризующих отдельные компоненты соматотипа отмечено высокой степенью статистической достоверности (p < 0.001). Стоимости компонентов тeso и endo соматотипа у больных диабетом типа 2 в возрасте от 40 до 60 лет достоверно более высокие, чем у пациентов в возрасте от 61 до 80 лет (p < 0.001).

ЗАКЛЮЧЕНИЕ: Средний соматотип и для обеих возрастных групп мужчин диабетиков это эндоморфный мезоморф. Доминирует мезоморфный компонент, за которым следует эндоморфный.

Соматотип болгарских диабетиков (эндоморфный мезоморф) более благоприятен по отношению к риску, течению и прогнозу заболевания.