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Somatotype in Elderly Type 2 Diabetes Patients

Roberto Buffa[1], Giovanni Floris[1], Paolo F. Putzu[2], Luciano Carboni[2] and Elisabetta Marini[1]

[1] Department of Experimental Biology, Anthropology Section, University of Cagliari, Cagliari, Italy
[2] Geriatric Division, SS Trinità Hospital, ASL 8, Cagliari, Italy

A B S T R A C T

Somatotyping is a practical technique for the description of physique. Individuals with Type 2 diabetes are characterized by physical peculiarities, such as overweight, obesity and a central pattern of body fat distribution. Somatotype applications to diabetes are limited. The objective of this study is to describe the somatotype of elderly type 2 diabetes patients. The sample consisted of 110 patients with type 2 diabetes (45 men, mean age 69.4±7.0 years; 65 women, mean age 72.9±7.1 years). The pathological subjects were compared with a control group consisting of 280 healthy individuals (134 men, mean age 74.2±7.3 years; 146 women, mean age 74.9±7.4 years). The Heath-Carter somatotype was applied. Diabetic men and women (mean somatotype, respectively: 6.8–5.6–0.6 and 8.6–6.4–0.2) presented significantly higher values of endomorphy than the controls (p=0.043 in men, p=0.003 in women); men also had a lower mesomorphic component (p=0.000). The somatotype method revealed physical peculiarities in type 2 diabetes patients. The marked endomorphy in the pathological individuals can be related to general fatness, which is a well known disease risk factor. The somatotype appears to be a suitable technique for the assessment of physique in type 2 diabetes patients.

Key words: *physique, ageing, health condition, Sardinia*

Introduction

Somatotyping is an effective technique for the description of body shape and composition. An individual's somatotype is defined by three components named endomorphy, mesomorphy and ectomorphy. Endomorphy expresses the level of fatness, mesomorphy the development of the musculoskeletal compartment, ectomorphy the linearity of the body. The photoscopic technique, developed by Sheldon et al.[1], was subsequently modified by other authors, with the definition of anthropometric protocols[2,3]. The Heath-Carter somatotype method, currently the most widely used, is closely related to body composition analysis, although the two approaches should not be considered equivalent[4–7].

Constitutional medicine represents a classical field of application for somatotyping. Early studies, based mainly on the methodological approach of Sheldon and collegues[1], have contributed to a better comprehension of the mechanisms underlying the biological link between physique and disease[8]. In more recent times, the somatotype method has been successfully applied to the study of several risk factors and pathologies[9–13].

Type 2 diabetes is a highly prevalent disease characterized by peculiar variations in body size and shape. The strong association between an excess of body fat, particularly in the trunk, and this pathology was recognized in early studies[14] and is now widely documented[15–18]. However, as far as we know, somatotype applications to diabetes are limited to a few papers published before the 1980s[19–21].

The aim of this study is to describe physique variations in elderly type 2 diabetes patients using the somatotype technique.

Materials and methods

The sample

The type 2 diabetes group consisted of 110 subjects (65 women and 45 men) aged 65 to 90 years. The mean age was 69.4±7.0 years for men and 72.9±7.1 years for women. Patients were chosen from the Diabetes Service, Geriatrics Division, SS. Trinità Hospital, ASL 8 of Cag-

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liari. The diagnosis of diabetes was made at admission to the Diabetes Service according to the World Health Organization criteria[22]. When enrolled, they were being treated only with a diet (45 women and 22 men) or oral hypoglycemic drugs (22 women and 14 men). None of the patients was on insulin therapy.

The control group consisted of 280 healthy individuals (134 men and 146 women) aged 60 to 90 years. The mean age was 74.2±7.3 years for men and 74.9±7.4 years for women. The sampling was performed in cultural and recreational meeting places of the city of Cagliari (Italy). The subjects were questioned by means of a structured interview about personal, behavioral and anamnestic information. Individuals who had been admitted to hospital in the 3 months before the survey, or were under medical treatment, were excluded from the sample. All the selected participants were in good general health. Somatotype characteristics of the control group are discussed in detail by Buffa et al.[23].

All the type 2 diabetes and control individuals were born and resident in the province of Cagliari (Italy), and their Sardinian origin was verified to the first parental generation. All subjects agreed to participate in the study after being informed about the objectives and methods of the research.

Anthropometry

All anthropometric data were collected by a highly trained operator, in accordance with international standard procedures[24]. All measurements were taken on the right side of the body. Height was measured with a portable anthropometer; individuals were asked to inhale deeply and maintain a fully erect position during the measurement. Body weight was recorded to an accuracy of 0.1 kg using a movable spring scale. Minimum waist, hip, flexed upper arm and calf circumferences were measured with a metal anthropometric tape. Humerus and femur breadths were measured with a sliding biepicondylar caliper. Triceps, subscapular, supraspinale and medial calf skinfolds were measured using a Holtain caliper (D.S. Medica, Milan).

The BMI (Body Mass Index, Kg/m^2) and WHR (Waist to Hip Ratio) were calculated. Anthropometric somatotype ratings were computed following the indications of Carter and Heath[25].

Statistical analyses

Summary statistics of the anthropometric variables were calculated in the pathological and control groups. In the statistical comparison between the two groups (sexes separated), we controlled for the potentially confounding effect of ageing by means of an analysis of covariance design (ANCOVA) with age as the covariate.

As indicated by Carter et al.[26], in each sex/health condition group, we computed the descriptive statistics of the somatotype (mean and standard deviation of the component scores) and the somatotype attitudinal mean (SAM), indicative of the dispersion of somatopoints. Frequencies of subjects in each of somatotype categories were also calculated.

Simple linear correlation analysis was applied to evaluate the relationship between the endomorphic component and the indicators of overall body fatness (BMI) and central adiposity (WHR and waist circumference).

To test the differences between patients and controls (sexes separated), we used the statistical protocol proposed by Cressie et al.[27]. A multivariate analysis of covariance (MANCOVA), with age as a covariate, was applied first. Then, the significance of each somatotype component was determined by means of ANCOVA (controlled for age). Finally, to evaluate which components provide the greatest inter-group discrimination, we performed a forward stepwise discriminant analysis.

The mean somatotypes of each group were plotted in the somatochart.

The software packages Statistica 4.0 (Statsoft Inc.) and Somatotype calculation and analysis[28,29] were used for the statistical analyses.

Results

The sex and age composition of the sample is shown in Table 1. Table 2 shows the descriptive statistics and results of the comparison between the pathological and control groups for the anthropometric variables. Diabetic individuals generally had higher body weight and BMI, larger skinfolds and circumferences, and smaller breadths than the control group.

Table 3 shows the descriptive statistics of the somatotype components and the results of the inter-group comparisons. The mean somatopoints of each sex/health condition group are represented graphically in Figure 1. Table 4 shows the outputs of the discriminant analysis for assessment of the relative contribution of each component.

The mean somatotype of diabetic patients was 6.8–5.6–0.6 (SD: 1.4–1.1–0.8) in men and 8.6–6.4–0.2 (SD: 1.6–1.7–0.3) in women. In the males, 68.0% of the somatopoints fell in *mesomorphic endomorph*, 16.0% in *mesomorph-endomorph*, 16.0% in *endomorphic mesomorph*. The SAM value was 1.77. In the females, 83.0% of the indi-

TABLE 1
SEX AND AGE DISTRIBUTION

Age (y)	Diabetes		Control	
	Men	Women	Men	Women
60–69	28	24	36	40
70–79	12	31	67	66
+80	5	10	31	40
Total	45	65	134	146

60–69y – aged 60 to 69.99 years, 70–79y – aged 70 to 79.99 years, +80y – over 80 years of age

TABLE 2
DESCRIPTIVE AND INFERENTIAL STATISTICS OF THE ANTHROPOMETRIC VARIABLES FOR THE COMPARISON BETWEEN PATHOLOGICAL SUBJECTS AND CONTROLS[1]

	Diabetes				Control			
	Men		Women		Men		Women	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Height	163.0	6.4	149.4	6.8	161.1	5.8	148.5	6.3
Weight	75.0	9.1	69.7*	13.7	72.3	11.0	63.6	13.3
Triceps sk	22.8*	7.6	32.2*	10.0	15.1	7.1	26.9	9.9
Subscapular sk	25.3*	7.7	29.4*	10.9	20.5	7.1	25.6	9.7
Supraspinale sk	24.3*	8.7	32.9*	11.6	26.4	9.0	27.8	10.3
Calf sk	19.0*	9.3	29.1	11.6	14.9	8.1	26.3	8.9
Humerus br	7.1*	0.4	6.3	0.5	7.2	0.4	6.4	0.5
Femur br	9.5*	0.5	9.0*	1.0	9.8	0.8	9.5	0.8
Upper arm crf	30.9	2.9	31.6*	4.6	30.7	3.1	29.5	4.0
Calf crf	34.9*	3.4	35.8*	4.4	35.1	3.0	33.9	3.7
Waist crf	95.8	7.1	95.9*	11.6	94.4	9.1	91.8	13.4
Hip crf	101.1	5.9	108.1	11.3	99.8	7.3	105.3	12.0
BMI	28.24	0.95	31.15*	5.34	27.80	3.69	28.75	5.18
WHR	0.95	0.05	0.87	0.13	0.95	0.06	0.87	0.07

[1] statistical differences in anthropometric variables determined by ANCOVA, with age as the covariate (weight is expressed in kg; skinfolds (sk) in mm; BMI in kg/m^2; all other measurements are expressed in cm), * – $p<0.05$, SD – standard deviation, sk – skinfold, br – breadth, crf – circumference, BMI – Body Mass Index, WHR – Waist to Hip Ratio

TABLE 3
DESCRIPTIVE AND INFERENTIAL STATISTICS FOR THE COMPARISON BETWEEN SOMATOTYPES[1]

	Diabetes Mean SD	Control Mean SD	Diabetes vs. control		
			Wilk's λ	F ratio	*p*
Men					
Somatotype	–	–	0.86	–	0.000
Endomorphy	6.8 1.4	6.1 1.4	–	4.16	0.043
Mesomorphy	5.6 1.1	6.3 1.2	–	18.71	0.000
Ectomorphy	0.6 0.8	0.6 0.7	–	0.49	0.485
Women					
Somatotype	–	–	0.94	–	0.007
Endomorphy	8.6 1.6	7.7 1.4	–	9.02	0.003
Mesomorphy	6.4 1.7	6.3 1.5	–	0.02	0.895
Ectomorphy	0.2 0.3	0.4 0.6	–	2.79	0.096

[1] – statistical differences in overall somatotype tested by MANCOVA, with age as the covariate; differences in somatotype components determined by ANCOVA, with age as the covariate, SD – standard deviation, *p* – probability

vidual somatotypes were *mesomorphic endomorph*, 14.0% *mesomorph-endomorph*, 3.0% *endomorphic mesomorph*. The SAM index was 1.98.

The mean somatotype of the control group was 6.1–6.3–0.6 (SD: 1.4–1.2–0.7) in men and 7.7–6.3–0.4 (SD: 1.4–1.5–0.6) in women. In the males, 30.1% of the somatotypes belonged to *mesomorphic endomorph*, 28.6% to *mesomorph-endomorph*, 40.6% to *endomorphic mesomorph*, 0.7% to *ectomorphic mesomorph*. The SAM index was 1.67. In the females, 69.9% of the subjects were *mesomorphic endomorph*, 20.5% *mesomorph-endomorph*, 8.9% *endomorphic mesomorph*, 0.7% *central*. The SAM value was 2.05.

In both males and females of the diabetes and control groups, the endomorphic component was significantly related to the BMI (correlation coefficients ranging between 0.64 in the diabetic men and 0.73 in the healthy women) and to the waist circumference (*r*-values between 0.47 in the diabetic men and 0.63 in the healthy men). The association between endomorphy and WHR was less evident, being significant only for the male control group ($r = 0.38$).

The comparison between diabetic individuals and controls showed significant differences in both sexes (MANCOVA, males: $p=0.000$; females: $p=0.007$) (Table

TABLE 4
FORWARD STEPWISE DISCRIMINANT ANALYSES FOR DIFFERENCES IN SOMATOTYPE[1]

Diabetes vs. control	Step 1	Step 2	Step 3	Wilk's λ	*p*
Men	Mesomorphy (12.26)	Endomorphy (15.32)	Ectomorphy (0.16)	0.86	0.000
Women	Endomorphy (10.65)	Mesomorphy (3.33)	Ectomorphy (0.15)	0.94	0.003

[1] – F–value to enter is given in parentheses. Wilk's lambda and *p*–values refer to the discriminant function with Endo-, Meso- and Ectomorphy considered in the model, *p* – probability

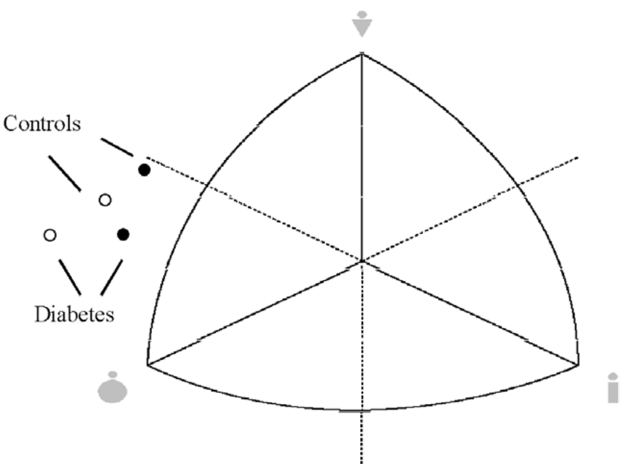

Fig. 1. Somatocharts with mean somatotypes in Type 2 diabetes patients and controls. (●) – men, (○) – women.

3). In men, the difference was due to the endomorphic component, higher in diabetic subjects than controls (ANCOVA, $p=0.043$), and the mesomorphic component, lower in diabetics (ANCOVA, $p=0.000$). In women, differences were significant only in the case of endomorphy, which was greater in the diabetic group (ANCOVA, $p=0.003$). The forward stepwise discriminant analysis confirmed that endomorphy and mesomorphy greatly contribute to inter-group diversification in both sexes ($p=0.000$, males; $p=0.003$, females) (Table 4).

Discussion

Physical peculiarities of type 2 diabetes patients were described in early somatometric studies, carried out in the past half century. These studies showed that diabetes patients have a tendency to endomorphy and an excess of weight and body fat, particularly in the trunk[13,19–21]. It is now widely accepted that overweight, obesity and a central pattern of body fat distribution are major contributors to the development of type 2 diabetes[15–18]. Epidemiological research has shown that a large proportion of the prevalence of the disease (60–90%) is attributable to these factors[30]. Patients with a BMI of 35 have a 92-fold higher risk of developing type 2 diabetes[31].

In the present study, the somatotype characteristics of the diabetic individuals were significantly distinct from those of the control group (Tables 3 and 4, Figure 1). There was strong development of the endomorphic component in both diabetic men and women, as observed in the previously mentioned specific literature[19–21]. A similar development of endomorphy has been observed in other studies on the somatotype of individuals with pathologies correlated with diabetes, such as coronary artery disease[32] and metabolic risk factors[9,10]. In fact, it has been suggested that endomorphy can be considered a general indicator of the predisposition to various chronic diseases[11,33].

The convergence of the results of the somatotype and other anthropometric techniques is remarkable. The values of endomorphy and anthropometric indicators of fatness were particularly high in the pathological individuals. Moreover, the BMI and the waist circumference were significantly related to endomorphy. In contrast, the WHR was similar in the diabetes and control groups, and it was not related to endomorphy. This suggests a lower suitability of WHR as a risk factor, as observed in other studies[34].

Our study also showed lower mesomorphy in diabetic men. This result does not agree with the literature. Fredman[20,21], applying both the Parnell and Heath-Carter anthropometric methods, found that diabetic Tamil Indians tended to be more mesomorphic than healthy individuals. This observation was corroborated by Katzmarzyk et al.[10] who showed that the mesomorphic component was associated with glycemia in females. The inconsistency of results could be due to population differences or to random fluctuations in the samples.

In conclusion, type 2 diabetes patients were characterized by somatotypic peculiarities. Diabetic individuals were more endomorphic and, in the case of men, less mesomorphic. The development of endomorphy is in accordance with the literature and summarizes morphological variations already known to play a role in health-related physical fitness. Somatotype can be considered a suitable tool for the assessment of physical peculiarities of pathological subjects. It has the advantage of providing concise, quantifiable and comparable data, and it could be applied in the monitoring of health status in the elderly population and in the planning of nutrition intervention programs.

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E. Marini

Department of Experimental Biology, Anthropology Section, University of Cagliari, Cittadella Universitaria Monserrato, 09042 Monserrato (Cagliari), Italy
e-mail: emarini@unica.it

SOMATOTIP KOD STARIJIH PACIJENATA KOJI BOLUJU OD DIJABETESA TIPA 2

SAŽETAK

Somatotipiziranje je uobičajna tehnika za opisivanje fizičkih osobina. Za osobe oboljele od dijabetesa tipa 2, karakteristični su pretilost i centralizacija tjelesnih masnoća. Somatotipske aplikacije za dijabetes su ograničene. Predmetnost ove studije je opisati somatotip kod starijih pacijenata koji boluju od dijabetesa tipa 2. Uzorak je sadržavao 110 pacijenata (45 muških, prosjek godina 69.4±7.0; 65 žena, prosjek godina 72.9±7.1). Patološki subjekti uspoređivani su sa kontrolnom grupom od 280 zdravih osoba (134 muških, prosjeka godina 74.2±7.3; 146 žena prosjeka godina 74.9±7.4). U studiji je primjenjena »Heath-Carter« somatotipizacija. Dijabetičari oba spola (prosječnog somatotipa: 6.8–5.6–0.6 i 8.6–6.4–0.2) pokazivali su značajno visoke endomorfične vrijednosti u odnosu na kontrolnu skupinu (p=0.043 kod muškaraca, p=0.003 kod žena). Metoda somatotipizacije otkrila je fizičke osobitosti kod pacijenata oboljelih od dijabetesa tipa 2. Generalno, morfologiju oboljelih možemo povezati sa debljinom. Somatotipizacija bi trebala biti standardna tehnika u određivanju fizičkih osobina kod dijabetičara.