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Anthropometric Characteristics of Limbs and Body Circumferences in Bulgarians with Type 1 Diabetes Mellitus

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The purpose of the study was to examine certain limb and body circumferences in Bulgarians with type 1 Diabetes Mellitus and to compare them with healthy subjects. The study included 120 patients aged 20-40 years and 80 healthy Bulgarians at the same age. Measured circumferences: neck, arm, forearm, waist, hip, thigh, and calf. Calculated indices: Waist-to-hip ratio (WHR), Waist-to-thigh ratio (WTR). The circumferences of neck, arm, forearm, hip, thigh, and calf in the healthy men were significantly greater than in male patients. The circumferences of neck, arm, forearm waist and calf in the female patients were significantly greater than in the healthy controls. The value of WHR was significantly greater in the patients of both sexes than in healthy people. Reduction of subcutaneous, but not of visceral adipose tissue in the male patients was detected. The amount of both subcutaneous and visceral adipose tissue was greater in female patients than in healthy women.

Key words: T1DM, Bulgarians, circumferences, WHR, adipose tissue

Introduction

Diabetes mellitus is a chronic metabolic disease, characterized with hyperglycaemia, which is due to impaired insulin secretion, insulin action or both. An estimated 537 million people are affected by the disease worldwide (8.8% of the adult population). Type 2 diabetes makes up about 90% of the cases [9]. Rates are similar in women and men [18]. This number is predicted to rise to 643 million by 2030 and 783 million by 2045 [19]. Diabetes mellitus is the 7th leading cause of death globally [1]. Type 1 diabetes makes up 5 to 15 percent of diabetic patients and often involves children. Type 1 diabetes

mellitus (T1DM) is an autoimmune disease that leads to the destruction of insulin-producing pancreatic beta cells [16]. Autoimmune destruction of β-cells has multiple genetic predispositions and is also related to environmental factors (that are still poorly defined). The destruction of the beta cells in the pancreatic islets over months or years causes an absolute deficiency of insulin. Insulin is an essential anabolic hormone that exerts multiple effects on glucose, lipid, protein, mineral metabolism, and last but not least growth.The chronic hyperglycemia is associated with long-term damage and failure of various organs, especially eyes, kidneys, nerves, heart and blood vessels [2,10].

Most anthropological studies have been performed in patients with type 2 Diabetes mellitus. It is associated with the obesity in these patients. Not many anthropological surveys have been conducted in patients with type 1 Diabetes mellitus worldwide. This anthropological study is original for Bulgarian patients suffering from T1DM.

The **aim** of the study was to examine certain limb and body circumferences in Bulgarians with type 1 Diabetes mellitus and to compare them with healthy subjects. It will clarify the distribution of adipose connective tissue in the bodies of Bulgarian patients with T1DM.

Material and Methods

Patients. The study included 60 female patients and 60 male patients with type 1 Diabetes mellitus aged 20-40 years. The study was conducted in the Clinic of Endocrinology and Metabolic Diseases at the University Hospital «St. George» – Plovdiv, Bulgaria in the period 2019-2022. The mean age of female patients was 29.09±1.29 and 30.08±1.16 of male patients.

The inclusion criteria were: Bulgarian ethnicity, type 1 Diabetes mellitus, duration of the disease no less than one year, clinically compensated diabetes at the time of the study. The exclusion criteria were: previous or existing metabolic, oncological and other disorder that could compromise the anthropological study: thyroid related diseases, adrenal glands related diseases, carcinoma, type 2 Diabetes mellitus, pregnant and lactating women, the presence of heart, respiratory, renal or hepatic failure, proliferative retinopathy, diabetic macroangiopathy, the presence of acute decompensation of metabolic disease at the time of the study, hormonal (contraceptive) therapy less than 3 months prior to the start of the study, treatment of chronic concomitant pathology that could affect hormonal indices.

The present study included 40 healthy Bulgarian women and 40 healthy Bulgarian men at the same age range (controls). The mean age of healthy women was 30±0.47 years and 31.01±0.31 years for healthy men.

All participants have given their written consent in accordance with the Declaration of Helsinki, as the study was approved by the Scientific Ethics Board of the Research Council at the Medical University – Plovdiv.

Methods. We used the anthropological methodic of Martin-Saller, modified by Y. Yordanov.

*Directly measured parameters***.** The following circumferences were measured: neck, arm relaxed (right, in the middle), arm contracted (right, at the greatest diameter), forearm (right, proximal), waist (between the 12th rib and the iliac crest), hip (between

the widest part of the gluteal region and the pubic symphysis), thigh (right, proximal third) and calf (right, the greatest circumference).

Calculated indices. Waist-to-hip ratio (WHR), Waist-to-thigh ratio (WTR)

Statistics. Data were analyzed using statistical software SPSS version 23 (SPSS Inc., Chicago, IL). Statistical significance was considered high at $p \leq 0.001$, moderate – at $p \leq 0.01$, low – at $p \leq 0.05$ and no significance – at $p > 0.05$.

Results

Eight significant differences between the means of measured circumferences in male patients and healthy controls were found. The circumferences' values of thigh and calf in the healthy men were significantly greater than in the male patients ($p<0.001$). The circumferences' values of neck, arm relaxed, arm contracted, forearm and hip in the healthy men were also significantly greater than in male patients, but the degree of statistical significance was low ($p<0.05$). Opposite, the value of waist circumference in male patients was significantly higher than in healthy men ($p<0.05$). These results are shown in **Table 1**.

Table 1. Limb and body circumferences in male patients with type 1 Diabetes mellitus and healthy men

circumferences	Male patients				Healthy men				P
	N	Mean	SE	SD	N	Mean	SE	SD	
Neck	60	38.08	0.49	2.81	40	39.06	0.26	1.63	p<0.05
Arm relaxed	60	27.77	0.66	3.77	40	29.48	0.46	2.86	p<0.05
Arm contracted	60	31.62	0.71	4.10	40	33.75	0.50	3.13	p<0.05
Forearm	60	26.72	0.40	2.28	40	27.66	0.25	1.56	p<0.05
Waist	60	84.46	1.76	10.13	40	80.57	1.08	6.74	p<0.05
Hip	60	95.38	1.28	7.37	40	98.76	1.06	6.59	p<0.05
Thigh	60	53.45	1.21	6.96	40	58.50	0.83	5.20	p<0.001
Calf	60	35.93	0.54	3.12	40	38.40	0.40	2.51	p<0.001

The values of both indices W/H ratio and W/T ratio were significantly higher in the male patients than in healthy men, shown in **Table 2**. The degree of statistical significance was high ($p<0.001$).

Our team found five statistically significant differences between the means of circumferences in female patients and healthy women. The circumferences' values of neck, forearm and waist in the female patients were significantly greater than in healthy controls ($p<0.001$). The circumference's values of arm contracted and calf in female patients were significantly greater than in healthy women ($p<0.05$). The results are shown in **Table 3**.

Table 2. Calculated indices in male patients with type 1 Diabetes mellitus and healthy men

Indices	Male patients				Healthy men				P
	N	Mean	SE	SD	N	Mean	SE	SD	
W/H ratio	60	0.88	0.01	0.06	40	0.82	0.06	0.04	p<0.001
W/T ratio	60	1.59	0.03	0.15	40	1.39	0.01	0.06	P<0.001

Table 3. Limb and body circumferences in female patients with type 1Diabetes mellitus and healthy women

circumferences	Female patients				Healthy women				P
	N	Mean	SE	SD	N	Mean	SE	SD	
Neck	60	33.72	0.36	1.20	40	31.27	0.29	1.70	p<0.001
Arm relaxed	60	26.81	0.69	3.80	40	25.61	0.46	2.71	p>0.05
Arm contracted	60	29.12	0.72	3.97	40	26.55	0.46	2.70	p<0.05
Forearm	60	24.38	0.36	1.96	40	22.97	0.26	1.52	p<0.001
Waist	60	75.67	1.54	8.43	40	67.98	1.07	6.22	p<0.001
Hip	60	99.17	1.65	9.02	40	98.62	1.28	7.46	p>0.05
Thigh	60	57.99	1.29	6.93	40	55.33	1.81	1054	p>0.05
Calf	60	35.68	0.60	3.26	40	33.85	1.01	5.88	p<0.05

The value of W/H ratio was significantly greater in the female patients than in healthy women. The degree of statistical significance was high (p<0.001), shown in **Table 4**.

Table 4. Calculated indices in female patients with type 1 Diabetes mellitus and healthy women

Indices	Female patients				Healthy women				P
	N	Mean	SE	SD	N	Mean	SE	SD	
W/H ratio	60	0.76	0.01	0.05	40	0.69	0.01	0.05	p<0.001
W/T ratio	60	1.31	0.02	0.10	40	1.28	0.07	0.38	p>0.05

Discussion

Anthropological measurements of certain body's circumferences are used for assessment of deposition of adipose connective tissue in different parts of the human body. Waist circumference is very important. Its value is indirectly related to the deposition of visceral adipose tissue intra-abdominal. The values of anthropological parameters waist circumference, hip circumference and thigh circumference are used for calculating the following indices: waist-to-hip ratio (WHR) and waist-to-thigh ratio (WTR). These indices are mainly used to evaluate the degree of obesity in humans. WHR is closely related to the deposition of visceral fat tissue into abdominal cavity. Obesity, particularly visceral, is very common in patients with T2DM [3, 11, 14].

Although the impaired glucose metabolism is essential for both type 1 and type 2 Diabetes mellitus, the pathogenesis is very different between the two conditions. The examined anthropological parameters waist circumference (WC) and WHR are useful to predict the presence of metabolic syndrome in adult patients with T1DM [7, 13]. Some authors reported about the relationship between central obesity and retinopathy, as well as other complications in patients with T1DM [8, 15].

We found that the values of the following circumferences: neck, arm (both contracted and relaxed), forearm, hip, thigh, and calf were significantly lower than the same in healthy men. In our opinion these findings are related to some reduction of subcutaneous connective fat tissue. On the contrary, the waist circumference in male patients was greater than in healthy controls. The values of WHR and WTR were significantly greater in men with DMT1than in healthy men. In our opinion the accumulation of visceral fat tissue is greater in the male patients than in the controls. It didn't occur any reduction of intra-abdominal fat tissue in the body of male patients. Similar results were reported by Fernández-Miró et al. [6].

Not the same results were found for female patients in the current study. The values of the measured circumferences: neck, arm contracted, forearm, waist and calf were significant lyreater in female patients than in healthy women. Cho et al. reported that the large neck circumference had a negative impact in the development of DM [4]. This is the result of more subcutaneous fat deposition in these parts of the female body. We found that the value of WHR was higher in female patients than in healthy women. It is in accordance with significant greater value of waist circumference in female patients than in the controls. In our opinion the accumulation of visceral fat tissue is greater in the female patients than in the healthy women. Darabian et al., and Momesso et al. reported close to our results concerning the accumulation of visceral fat tissue in patients with T1DM [5,12]. Wegeberg et al. reported lack of reduction of subcutaneous fat tissue in patients with T1DM [17].

The values of measured circumferences can be used for calculating of the somatotype's components of Bulgarian patients suffering from T1DM.

Conclusion

The data of the survey show that healthy men have greater circumferences of neck, arm (contracted and relaxed), forearm, hip, thigh, and calf than in men diagnosed with type 1 Diabetes mellitus. The circumference of waist is greater in male patients.

Opposite, the circumferences of neck, arm (contracted), forearm, waist and calf are greater in female patients with type 1 DM than in the healthy women. The values of WHR were higher in the patients with type 1 DM of both sexes in comparison to healthy individuals. Reduction of subcutaneous, but not of visceral adipose tissue in male patients suffering from T1DM was detected. The amount of both subcutaneous and visceral adipose tissue was greater in female patients than in healthy women.

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