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3D BODY SCANNING TECHNOLOGY, A METHOD FOR ASSESSING EARLY RISK OF DIABETES

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3D Body Scanning is a noninvasive and fast technology able to scan the human body in seconds. The system is able to achieve accurate, precise and reproducible measurements. Data are stored in the computer and can be accessed and processed later. Applications of this technology have extended to other areas: animation, art, ergonomics, cosmetics, anthropometry, apparel industry and others. The current trend is to use the data in bio-medical field. Most of the scanners use the principle of triangulation. A laser beam scans the entire body length, and special cameras pick up the signal. The cameras generate a 3D cloud of points on the body surface and create automatically a virtual body. The purpose of this study is to identify the existence of anthropometric indicators of risk for diabetes, using data acquired by 3D Body Scanning technology.We acquired data from 357 subjects (40–56 years age category), divided into two groups (159 diabetics, 198 nondiabetics). Were considered age, sex, and 150 anthropometric measurements including body weight, BMI, lengths and circumferences. We performed comparison between groups. Pearson's correlation coefficients showed a poor correlation of diabetes: negative by sex, positive with body weight and BMI and negative with ratio hip / waist.

Key words: anthropometry, 3D Body Scanning, obesity, diabetes.

INTRODUCTION

Civilized lifestyle of modern man brings a new challenge to the human body, by exposure to factors for which the human species has not designed. Current generation and at least a generation from now are vulnerable to weight gain, for several reasons. Well-insulated and heated buildings do not stimulate thermogenesis, favoring white adipose tissue growth detrimental of production of brown adipocytes. Excessive food intake, poor diet with many calories and physical inactivity are the true enemies that favor the development of white adipose tissue, sometimes to pathological limits. Attempts to decrease fat often came too late, when they have already appeared several disorders and associated diseases.

Presence of obesity is associates frequent with insulin resistance (a prediabetic condition), diabetes, dyslipidemia, arterial hypertension and other severe metabolic complications, generically known as the metabolic syndrome. It is not imperative that an obese patient to develop diabetes, as evidenced by the existence of obese patients with normal blood sugar, but the risk is increased.

The relationship between obesity and diabetes is bidirectional, so that a patient diagnosed with diabetes may gain weight if not well treated the disease.

Obesity and diabetes are the most common metabolic disease of the modern world, together affecting nearly half of all adults[1]. Prevalence of obesity is not the only factor that worried, but also the growth rate of this phenomenon. Age category that develops these disorders falls more and more and affects growing children: preschool, school or younger children.

We are in the middle of an unprecedented situation in human history, represented by the “globezity”, a recent WHO term for phenomenon of global epidemic obesity. It is closely related to another serious problem with the trend of globalization-“diabezity”-a popular term used for the common clinical association between type two diabetes mellitus and obesity.

The big disadvantage is that the appearance of diabetes symptoms are delayed, at which time most 70% of the mass of pancreatic beta is destroyed[2]. In this situation, interventions may be directed towards maintaining the function of pancreatic tissue mass remained unaffected.

It is therefore imperative to develop strategies to control obesity and early assessment of risk of diabetes.

Anthropometric measurements, assessment of height, weight and body fat, waist to hip ratio and body mass index calculation can determine actual state and trends of population health.

Advanced and integrated technologies, the optical measurement, digital signal processing electronic data, computer software and hardware have pushed the classical 2D measurement of anthropometric data to a new trend, the use of 3D scanning system to obtain anthropometric data (3D scanning technologies).

The war industry was the cause of development of practical application of anthropology in the world of apparel. This requires human dimensions, both for manufacturing equipment and for sizing weapons. The first research of this type is due to Davenport and Love anthropologists, who measured more than a million American soldiers in 1921[3].

3D Body Scanning was used in the past 15 years in the fashion and apparel industry. It is a noninvasive and fast technology able to scan the human body in less than 30 seconds and to generate three-dimensional model of the body, to make accurate, precise and reproducible measurements of body [4]. By using this technology based in most cases on the principle of triangulation, we can determine sizes ratio, body shape, surface and volumes.

A laser beam illuminates the body and special cameras generate a 3D cloud of points outside the human body. The body size is taken automatically from the virtual body.

The body shapes and measurements are stored in the computer and can be accessed and processed later.

This technology has recently begun to be used in medical applications and is useful for estimation of human body surface area[5,6] and in studying the prevalence of metabolic syndrome, obesity[7,8], and the risk of cardiovascular diseases.

The purpose of our study was to identify the existence of anthropometric indicators of diabetes risk, using comparative analysis of anthropometric data acquired by 3D Body Scanning.

MATERIALS AND METHODS

Changing diet and lifestyle led to modification of Romanian population measures. In order to resize patterns used in the apparel industry, in The National Research and Development Institute for Textiles and Leather has initiated an anthropometric survey of the population of Romania made in 2009–2010 years. Were scanned approximately 4000 subjects of which were retained for statistical processing, data from 684 women and 722 men aged 20–65 years.

The results of this study and others showed that the general trend of the population is to gain weight. The adult population was framed in the category of overweight and obese subject class[9,10].

In parallel with this study, we acquired and processed anthropometric data from an 1848 visitors to The National Institute of Diabetes, Nutrition and Metabolic Diseases “Nicolae Paulesco”, randomly selected. They are newly diagnosed diabetics, old diabetics and healthy subjects. We considered age, sex, diabetes and a series of 150 anthropometric measurements, including body weight, BMI, different length and girth, as well as reports and amounts.

The 3D scanning system used in the present study is a mobile model 3D ANTHROSCAN (Human Solutions). The 3D photon scan technology is a noninvasive optical method based on the principle of triangulation. This is an effective system for serial measurement programs.

Mobile system of 3D scanning consists in hardware and software.

The hardware containing one body scanner Vitus Smart XXL with four laser sensors consisting of four eye-safe lasers and eight high-speed digital cameras (CCD: charge-coupled device cameras), a scale and two PCs. In Figure 1 are represented schematically the structure of hardware used for 3D body scanning technology.

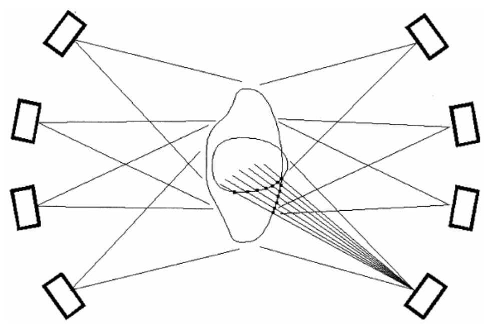

Fig. 1. The structure of hardware used for 3D body scanning technology [11].

The software containing two components: ScanWorX software to control the scanner, scanner-user interface and software Anthroscan Central Server for archiving and management database of measures scanned, for statistical analysis and evaluation.

Operating principle – method without contact with the subject

Laser illuminates the subject. Based on the known distance and angle between the CCD camera and laser are calculated 3D coordinates of points along the laser line on the scanned body, turning them into a cloud of points. The name of this process is triangulation.

To represent the 3D surface, the laser sensor is moved linearly along the scanned object, while the camera takes a set of points. For each set of 3D points along the laser line are derived their coordinates by triangulation.

By combining, the derived surface taken during the scan can generate three-dimensional model of the object surface. When this system of virtual body scan is performed and the image representing the standard position, then measurements are made. The system captures the surface of the body in 12 seconds. It is able to measure a body with a volume of about 2 m high, 0.8 m deep and 1 m wide. 3D scanning methodology is according to EN ISO 20685:2005-Methodology for 3D scan compatible international databases.

Dimensions measured

The system allows the extraction of various sizes, for example: measuring the length, depth, width, measurement of high; measuring angles; creating plans; making sections; measuring distances in sections; measuring the circumferences, measuring tape open. In Figure 2 we give an example of several measurements performed with the scanner.

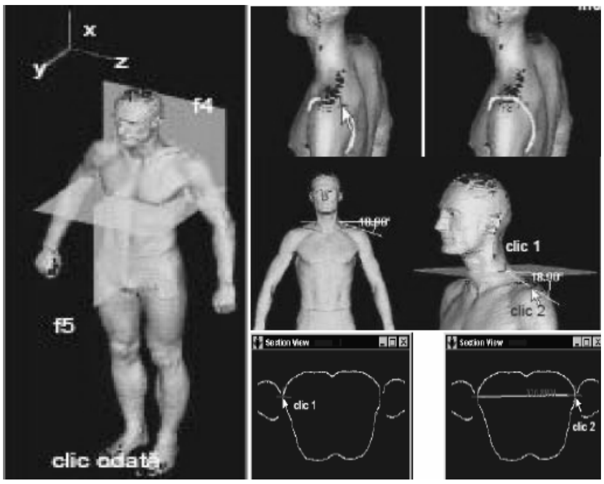

Fig. 2. Sizes that can be extracted from the virtual body scan.

Standardized Protocols for Positioning Subject for Scan

We instructed the subjects to stand in the center of anthropometric room (which was clearly marked on the floor), with arms and legs apart so that different parts of the body is not in contact with each other.

Then we performed a quick scan of the body after a full exhalation, so that the lungs remain a minimal amount of residual air. In Figure 3 we presented a sample of standard image for 3D body scanning.

Study group

After 40 years (men even earlier) BMI increases, becoming alarming rates with age. Increasing BMI increases the risk coefficient for the installation of various diseases one of the most feared being diabetes.

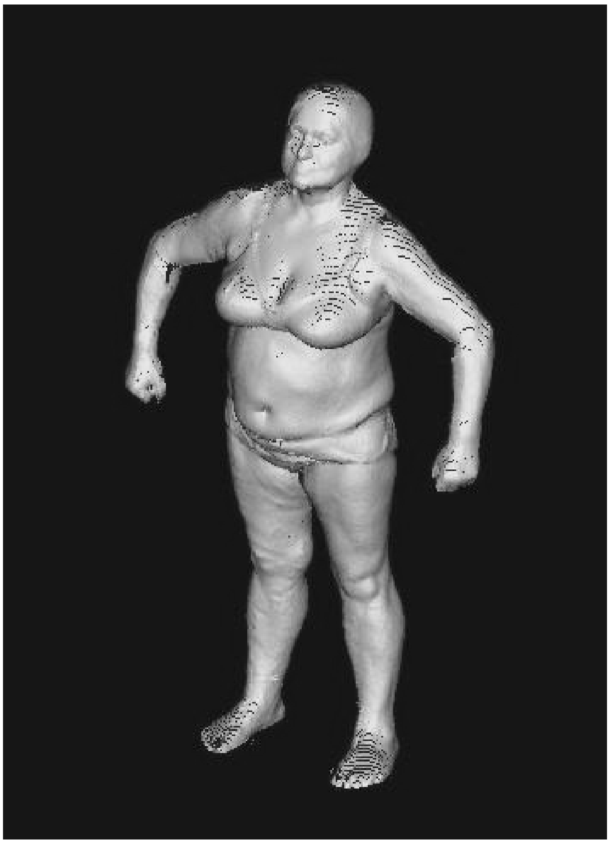

Fig. 3. Standard positioning of body in 3D body scanning.

For this reason, we selected and analyzed data from 357 subjects, between 40-56 years age category: 159 subjects were diabetics and 198 subjects were no diabetics.

Were taken into account: age, sex, diabetes, BMI and a series of 150 anthropometric measurements, including body weight, different length and girth (body length, waist circumference, hip circumference, arm circumference, hip circumference) and relationships between measurements.

We applied the body scan protocol to all subjects in the same conditions, and a qualified person did data collection.

Statistical analysis

Information obtained by scanning three-dimensional body was processed statistically using IBM Statistics SPSS 19 software. Comparison between groups was performed by analyzing the Pearson’s correlation coefficients. Statistical significance was defined as p value <0.05 and data were reported as mean ± SD (standard deviation).

We noted with one male and with two females. In addition, we noted the presence of diabetes with one and healthy individuals were marked with zero.

RESULTS AND DISCUSSIONS

In the first stage of our study were measured individually 150 body sizes. We correlated these anthropometric measurements with sex and diabetes. Direct correlation between the individual dimensions revealed a significant association between sex and diabetes subjects. As we seen in Table 1, men are more prone to disease than women are.

We associate these results with those obtained previous from an anthropometric survey of the population of Romania, showing that the risk group is aged 40–56 years. According to this study, at this risk group, obesity is higher in men.

Table 1

		Gender	Diabet	Height	Weight belly	Weight bust	Weight waist	Weight buttock	Weight upparm	Weight tight
gender	Pearson Correlation	1	-.175(**)	-.197(**)	-.031	-.341(**)	-.277(**)	-.427(**)	-.278(**)	-.383(**)
	Sig. (2-tailed)		.001	.000	.558	.000	.000	.000	.000	.000
	N	357	357	357	357	357	357	357	357	357
diabet	Pearson Correlation	-.175(**)	1	-.011	-.001	-.006	-.064	.029	.004	.103
	Sig. (2-tailed)	.001		.843	.979	.916	.230	.586	.936	.051
	N	357	357	357	357	357	357	357	357	357
height	Pearson Correlation	-.197(**)	-.011	1	.954(**)	.923(**)	.815(**)	.863(**)	.771(**)	.818(**)
	Sig. (2-tailed)	.000	.843		.000	.000	.000	.000	.000	.000
	N	357	357	357	357	357	357	357	357	357
Weight belly	Pearson Correlation	-.031	-.001	.954(**)	1	.829(**)	.708(**)	.737(**)	.656(**)	.721(**)
	Sig. (2-tailed)	.558	.979	.000		.000	.000	.000	.000	.000
	N	357	357	357	357	357	357	357	357	357
Weight bust	Pearson Correlation	-.341(**)	-.006	.923(**)	.829(**)	1	.877(**)	.847(**)	.729(**)	.772(**)
	Sig. (2-tailed)	.000	.916	.000	.000		.000	.000	.000	.000
	N	357	357	357	357	357	357	357	357	357
Weight waist	Pearson Correlation	-.277(**)	-.064	.815(**)	.708(**)	.877(**)	1	.802(**)	.662(**)	.657(**)
	Sig. (2-tailed)	.000	.230	.000	.000	.000		.000	.000	.000
	N	357	357	357	357	357	357	357	357	357
Weight buttock	Pearson Correlation	-.427(**)	.029	.863(**)	.737(**)	.847(**)	.802(**)	1	.752(**)	.841(**)
	Sig. (2-tailed)	.000	.586	.000	.000	.000	.000		.000	.000
	N	357	357	357	357	357	357	357	357	357
Weight upparm	Pearson Correlation	-.278(**)	.004	.771(**)	.656(**)	.729(**)	.662(**)	.752(**)	1	.716(**)
	Sig. (2-tailed)	.000	.936	.000	.000	.000	.000	.000		.000
	N	357	357	357	357	357	357	357	357	357
Weight tight	Pearson Correlation	-.383(**)	.103	.818(**)	.721(**)	.772(**)	.657(**)	.841(**)	.716(**)	1
	Sig. (2-tailed)	.000	.051	.000	.000	.000	.000	.000	.000	
	N	357	357	357	357	357	357	357	357	357

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

It may support the hypothesis of the correlation between diabetes and obesity

The second stage of the study involved the evaluation of correlations between different sizes combined (sum, anthropometric ratios, etc.) represented in Figure 4.

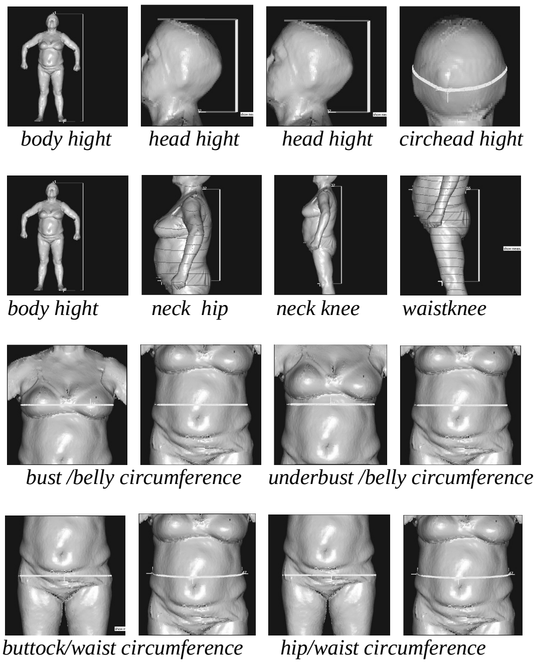

Fig. 4. Ratios between different anthropometric measurements.

As we can see in Table 2 there is a very low correlation (0.005) between diabetes and BMI, which leads to the conclusion that weight is not relevant at the moment when the diabetic manifests the disease. The studies suggest that more important for triggering diabetes diseases could be the evolution of weight gain over the life course[12].

To verify this hypothesis we need additional data about weight evolution of people in our study group.

There were no significant statistically correlations between "peripheral" accumulation of adipose tissue (diameter arms and thighs) and diabetes. Instead the ratio hip/waist is negatively correlated ($p \leq 0.05$) with diabetes.

These differentiated results support the hypothesis that accumulation by adipose tissue mainly in the abdominal region may be an indicator of risk for onset diabetes.

This tendency is manifested mainly in the male population.

Table 2

		Gender	Diabet	BMI
gender	Pearson Correlation	1	-.175 (**)	.127(*)
	Sig. (2-tailed)		.001	.014
	N	357	357	357
diabet	Pearson Correlation	-.175 (**)	1	.005
	Sig. (2-tailed)	.001		.925
	N	357	357	357
Body headhight	Pearson Correlation	-.363(**)	.069	.128(*)
	Sig. (2-tailed)	.000	.187	.014
	N	357	357	357
headcirch eadhight	Pearson Correlation	.071	.054	.101
	Sig. (2-tailed)	.173	.302	.051
	N	357	357	357
neckkneen eckhip	Pearson Correlation	-.061	-.069	.069
	Sig. (2-tailed)	.239	.182	.183
	N	357	357	357
neckknee waistknee	Pearson Correlation	.442(**)	.039	.147(**)
	Sig. (2-tailed)	.000	.454	.005
	N	357	357	357
bustbelly	Pearson Correlation	.345(**)	.015	.841(**)
	Sig. (2-tailed)	.000	.771	.000
	N	357	357	357
underbust belly	Pearson Correlation	.089	.076	.873(**)
	Sig. (2-tailed)	.087	.143	.000
	N	357	357	357
buttockwa ist	Pearson Correlation	.297(**)	-.129(*)	-.228(**)
	Sig. (2-tailed)	.000	.013	.000
	N	357	357	357
hipwaist	Pearson Correlation	.200(**)	-.105(*)	-.140(**)
	Sig. (2-tailed)	.000	.044	.007
	N	357	357	357
BMI	Pearson Correlation	.127(*)	.005	1
	Sig. (2-tailed)	.014	.925	
	N	357	357	357

* Correlation is significant at the 0.05 level (2-tailed).

CONCLUSIONS AND PERSPECTIVES

Anthropometric data were acquired from a 1848 subjects of which were retained for statistical processing 357 subjects (159 diabetic and 198 nondiabetic). That was considered: age, sex, and a series of 150 anthropometric measurements including body weight, BMI, various lengths and circumferences and ratios and amounts.

Pearson correlation's coefficients showed a poor correlation of diabetes:

• Negative by sex,
• Positive with body weight and BMI,
• Negative with hip / waist ratio.

Final conclusion is that diabetes is correlated with weight gain occurred during life, conclusion to be verified by obtaining and processing data on the evolution supplementary weight for people in our group.

Further aims of this study are to increase the relevance of the results by extending the study group and anthropometric data correlation with other parameters (blood pressure, glucose, lipids, uric acid, paraoxonase, etc.) We desire to use the 3D body scanning technology for setting up a protocol for early detection of diabetes risk.

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