STUDY OF ANTHROPOMETRIC PARAMETERS TO SUBJECTS OVER 80 YEARS

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Abstract. Old age is associated with increased prevalence of overweight and obesity, defined as BMI > 30 kg/m^2. BMI does not differentiate muscle mass from fat and other anthropometric parameters that define abdominal adiposity have been used to properly define the concept of obesity. Obesity is a risk factor and prediction for aging associated diseases. The aim of the study is to highlight changes in anthropometric parameters and determine the health risk for elderly subjects over 80 years of age. The study was conducted on 120 subjects distributed in three age groups: A-group 80-84 years; group B 85-89 years and group C 90 years +. Body weight, height, body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR) and body adiposity index (BAI) were measured. Correlations of anthropometric parameters with the subject's age and between all anthropometric parameters were evaluated. The prevalence of health risk based on WC and the relationship between WC and BMI was assessed. There is a tendency to diminish the anthropometric parameters with the age of the subjects and a significant negative correlation of CT, RTI and BMI with age was revealed. Subjects of 90 years are normoponderal and overweight in equal proportions (38.89%) and only 11.11% with obesity. Significant changes in their anthropometric parameters with BMI increase were observed. Analyzing the prevalence of health risk, it has been observed that subjects aged 90 years and over have the highest prevalence of the "no increased risk" category and the lowest prevalence for "very high risk". Data show that anthropometric parameters are simple and useful tools for assessing health risk and targeting the therapeutic strategy of obesity, malnutrition and fragility in aging.
Key words: aging, anthropometric parameters, obesity, health risk factors

STUDIUL PARAMETRILOR ANTROPOMETRICI LA SUBIECŢI DE PESTE 80 ANI

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Rezumat. Vârsta înaintată este asociată cu creşterea prevalenţei supraponderei şi obezităţii, definită că BMI > 30 kg/m^2. BMI nu diferenţiază masă musculară de cea grasă şi alţi parametrii antropometrici care definesc adipozitatea abdominală au fost utilizaţi pentru definirea adecvată a conceptului de obezitate. Obezitatea este un factor de risc şi predicţie pentru bolile asociate procesului îmbătrânirii. Scopul studiului este să evidenţieze modificările parametrilor antropometrici şi să determine riscul pentru sănătate la subiecţii vârstnici de peste 80 ani. Studiul s-a realizat pe 120 subiecţi distribuiţi în trei grupe de vârstă: A-grupa 80-84 ani; grupa B-85-89 ani şi grupa C-90 ani +. S-au determinat greutatea corporală, înălţimea, indicele de masă corporală (BMI), circumferinţa taliei (CT), circumferinţa soldului (CS), raportul talie-sold (TSR), raportul talie-înălţime (RTI) şi indicele de adipozitate corporală (IAC). S-au evaluat corelaţiile parametrilor antropometrici cu vârstă subiecţilor şi între toţi parametrii antropometrici. S-a evaluat prevalenţa riscului pentru sănătate pe baza CT şi relaţiei dintre CT şi BMI. Există o tendinţa de diminuare a parametrilor antropometrici cu vârstă subiecţilor şi s-a

evidenţiat o corelaţie semnificativ negativă a CT, RTI şi BMI cu vârstă. Subiecţii de 90 ani sunt în proporţii egale normoponderali şi supraponderali (38,89%) şi numai 11,11% cu obezitate. S-au observat modificări semnificate ale parametrilor antropometrici acestora cu creşterea BMI. Analizând prevalenţa riscului pentru sănătate, s-a observat că subiecţii de 90 ani şi peste au cea mai mare prevalenţa a categoriei"nici un risc crescut" şi cea mai mică prevalenţa pentru "risc foarte mare". Datele arată că parametrii antropometrici sunt instrumente simple şi utile în evaluarea riscului pentru starea de sănătate şi orientarea strategiei terapeutice a obezităţii, malnutriţiei şi fragilităţii în îmbătrânire.
Cuvinte cheie: îmbătrânire, parametrii antropometrici, obezitate, factori de risc pentru sănătate

INTRODUCTION

Several factors have influence on life expectancy: heredity, lifestyle, exposure to environmental toxic chemicals, health states. Physical health is related to functional states of cardiovascular, digestive, bone and joints, muscle, respiratory, sensory (visual, hearing) systems, gait, balance, nutritional status, metabolic, hematological, immune, hormonal parameters, etc.

Anthropometric parameters such as body weight, height, body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR), waist-height ratio (WHtR), body fat index (BAI) define nutritional status, are risk factors and predict cardiovascular diseases, type 2 diabetes, metabolic syndrome, cognitive impairment, etc

Antropometric parameters change during the aging process [1]. Advancing age has been associated with increase of prevalence of obesity and overweight. Currently, obesity is defined as BMI > 30 kg/m^2. Obesity of elders has been associated with increases of morbidities such as infections, functional limitations, decrease of quality of life, gait decline and autonomy reduction. Aging- associated - changes in body composition as well as reduction in muscle mass (sarcopenia) associated with increase in fat mass (sarcopenic obesity), height decrease due to compression of vertebral bodies and cyphose, alter relationships between BMI and body fat. Uses of only body weight and BMI in order to define obesity might underestimate degree of adiposity in subjects with muscle mass loss. So, even though BMI does not change, older persons may present with an increase in visceral adipose tissue and fat areas of muscle tissue [2, 3, 4].

General obesity is a risk factor for various diseases associated or not with aging [5]: cardiovascular diseases (CVD), type 2 diabetes, functional disabilities, cognitive impairment [6, 7] but central obesity is more strongly associated with CVD risk than general obesity [8, 9].

Therefore, other parameters that define central/abdominal obesity as determined by waist circumference (WC) and visceral adiposity index (VAI), but also various associations of anthropometric indicators such as waist-to-hip ratio (WHR), waist-to-height ratio (WHtR) and body adiposity index (BAI) have been considered as contributing to adequately defining the concept of obesity and predict better than BMI the cardiovascular disease risk [10-15].

Paradoxically, a series of literature data show that in the elderly the mortality rate is lower in overweight and obese subjects [2, 16].

On the other hand, underweight defined as BMI<18.5 kg/m^2, malnutrition and frailty are important events associated with the aging process.

The purpose of this study is to highlight changes in anthropometric parameters: body weight, height, body weight index, waist circumference, hip circumference, waist-to-hip ratio, waist-yo-height ratio and body fat index, with which to determine the risk of illness for people aged over 80 years.

MATERIAL AND METHODS

Experimental groups: In the study, 120 patients, men and women, over 80 years of age, hospitalized in INGG were included. Subjects were informed about the

assessments to be made and agreed in writing to participate in this study. Subjects were divided into 3 groups according to age: A - age group 80-84 years, B - group 85-89 years old and C - age group 90 years and over 90 years.

Determinations: Measurement of anthropometric parameters such as body weight, height, body mass index (BMI), waist circumference (WC), hip circumference (HC), waist-hip ratio (WHR), waist-height ratio (WHtR), body fat index (BAI) was performed in subjects from the three age groups. The results were expressed as mean ± standard deviation. The comparison between the two results was achieved by Student's "t" test, and the values for $p < 0.05$ were considered significant. For the calculation of "t" and the correlation coefficient r (Pearson) the program excel - Windows 2007 was used. Correlation studies of the anthropometric parameters with the age of the subjects were made, as well as correlations between all the anthropometric parameters studied. The prevalence of the risk of impairment of health was determined based on waist circumference and body mass index in subjects in the three age groups.

RESULTS

The measurements showed that there was a tendency to reduce body weight, BMI, waist and hip circumference, waist-hip ratio and waist-height ratio, but no anthropometric parameter studied significantly changed in 85-89 year-old subjects and those over 90 years compared to subjects in the age group 80-84 years (Tab. I).

Tab. I Distribution of anthropometric parameters in elderly patients over 80 years of age

Age Parameters	**A** **80 – 84 years**	**B** **85 – 89 years**	**P**	**C** **90 + years**	**P**
Age (years)	82,02 ± 1,36	86,66 ± 1,24	**< 0,001 vs A**	92,36 ± 2,26	**< 0,001 vs A** **< 0,001 vs B**
Number Sex (W/M)	**36** (33W / 3M)	**57** (37W / 20M)	-	**19** (12W / 7M)	-
Weight (kg)	65,62 ± 13,03	66,85 ± 12,46	0,357 vs A	63,00 ± 12,20	0,799 vs A 0,265 vs B
Height (cm)	156 ± 8	160 ± 10	0,07 vs A	158 ± 10	0,522 vs A 0,374 vs B
BMI (kg/m^2)	26,72 ± 4,98	26,07 ± 4,45	0,975 vs A	25,17 ± 4,11	0,855 vs A 0,533 vs B
Waist (cm)	96,91 ± 14,39	94,15 ± 12,09	0,301 vs A	90,58 ± 8,88	0,104 vs A 0,321 vs B
Hip (cm)	105,95 ± 12,89	103,97 ± 11,84	0,276 vs A	100,76 ± 8,75	0,137 vs A 0,291 vs B
Waist-Hip Ratio	0,90 ± 0,04	0,90 ± 0,05	0,951 vs A	0,89 ± 0,05	0,628 vs A 0,643 vs B
Waist-Height Ratio	0,61 ± 0,08	0,59 ± 0,07	0,376 vs A	0,57 ± 0,06	0,154 vs A 0,420 vs B
BAI (body adiposity index) (%)	35,08 ± 5,74	33,82 ± 6,87	0,348 vs A	32,98 ± 5,89	0,267 vs A 0,641 vs B

However, the calculation of correlations of anthropometric parameters with the age of the patients revealed that the waist circumference, waist-height ratio and body adiposity index (BAI) correlated significantly negatively with the age of the investigated subjects (Tab. II).

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Tab. II Correlation of anthropometric parameters with the age of the subjects

Parameter	**r**	**R^2**	**T exp.**	**P**
Weight (kg)	- 0,1064	0,01132	1,12206	> 0,05
Height (cm)	0,05251	0,00276	0,5537	> 0,05
BMI (kg/m^2)	- 0,1498	0,02244	1,5958	> 0,05
Waist circumference (cm)	**- 0,2285**	0,05219	2,1967	**< 0,05**
Hip circumference (cm)	- 0,17649	0,03115	1,6928	> 0,05
Waist-Hip Ratio	- 0,12897	0,01663	1,2245	> 0,05
Waist-Height Ratio	**- 0,20227**	0,04091	1,9601	**0,05**
BAI (body adiposity index)	**- 0,11173**	0,01248	1,07169	**< 0,05**

Obesity, defined as BMI ≥ 30 kg/m^2 is a risk factor for some pathological conditions, and is often associated with aging, as well as malnutrition and fragility. For these reasons, we evaluated the prevalence of subjects in the age groups studied: 80-84 years, 85 = 89 years and 90 and over 90 years in all BMI categories (Fig.1).

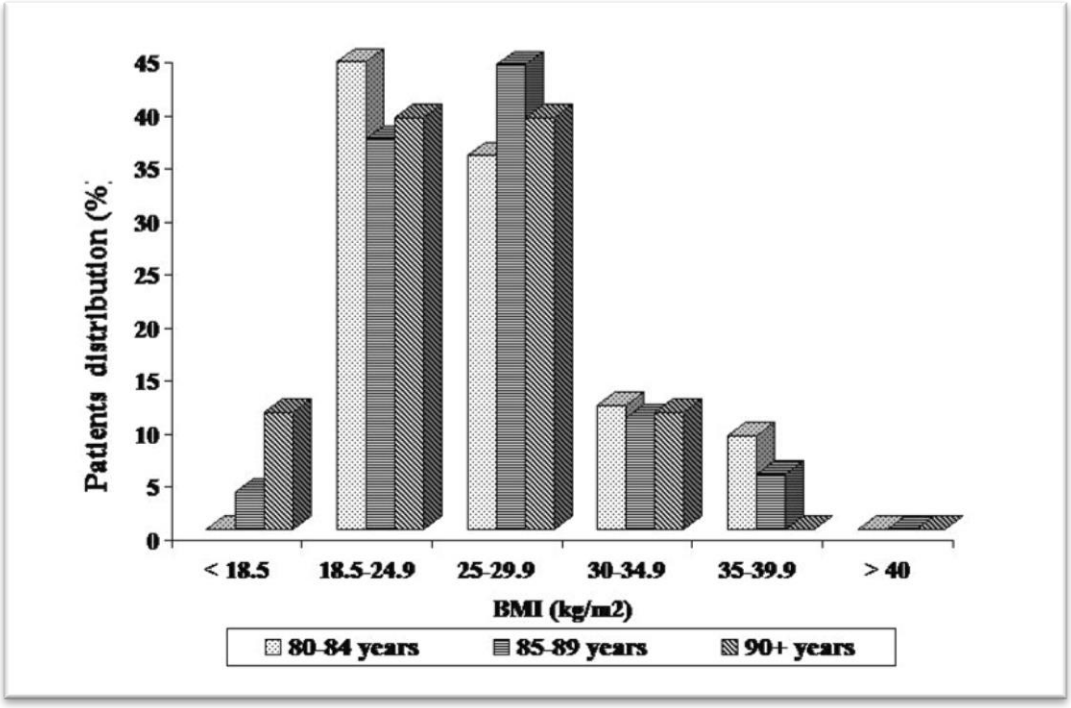

Fig. 1 Distribution of subjects by BMI in the three age groups (%)

Thus, only 3.51% of subjects aged 85-89 years and 11.11% of subjects over 90 years of age were underweight (BMI <18.5 kg/m^2 (Fig.1). 44,12% of subjects aged 80-84 years, 36,84% of those aged 85-89 years and 38,89% of subjects over 90 years of age are normoponderal (BMI = 18,5-24, 9 kg/m^2. Overweight (BMI: 25-29.9 kg/m^2 is 35.29% of subjects aged 80-84 years, 43.86% aged 85-89 years and 38.89% over 90 years of age . Fewer subjects have grade I obesity (BMI: 30-34.9 kg/m^2: 11.76% subjects aged 80-84 years, 10.53% subjects aged 85-89 years and 11.11 % of subjects over the age of 90. With obesity grade II (BMI: 35-39.9 kg/m^2 were 8.83%

of 80-84 year-old subjects and 5.26% of subjects aged 85-89 years. Note that no subject in the 80-84 age group is underweight, no subject over the age of 90 is not with obesity grade II, and no age group has morbid obesity (BMI> 40 kg/m^2) (Fig. 1). Synthesizing, in the age group 80-84 years, most subjects are normoponderal (44,12%) and overweight (35,29%) and 20,36% are obese; in the 85-89 age group most subjects are overweight (43.86%) and normoponderal (36.84%) and 15.79% are obese, and subjects over 90 years old are in equal proportion (38, 89%) normoponderal and overweight and only 11.11% with obesity.

As the aging process takes place changes in body composition in the sense of reducing muscle mass and increasing fat mass, but also a reduction in height that alters the relationship between BMI and body fat, we have further evaluated the relationship between BMI and the other anthropometric parameters (Tab. III) for all age groups.

I. Changes in anthropometric parameters according to the BMI category

In the *80-84 age group*, overweight patients showed a significant increase in waist circumference (p = 0.05) and hip circumference (p = 0.0256) versus normoponderals. Subjects with obesity gr. I have a significant reduction in height (p = 0.037) and a significant increase in waist-to-height ratio (p = 0.039) and body adiposity index (p = 0.028) compared to normoponderal. Subjects with obesity gr. I have a significant reduction in height (p = 0.037) and a significant increase in waist-to-height ratio (p = 0.039) and body adiposity index (p = 0.028) compared to normoponderal. Subjects with obesity gr. II have a significant increase in waist circumference compared to normoponderal (p = 0.037), overweight (p = 0.003) and obesity gr. I (p = 0.05); of the hip circumference compared to normoponderal (p <0.001), overweight (p <0.01) and obesity gr. I (p = 0.05); of the waist-to-height ratio compared to overweight (p <0.001) and obesity gr. I (p = 0.05) and body adiposity index (BAI) versus normoponderal (p = 0.005) and overweight (p = 0.008) (Tab. III).

In the *age range of 85-89 years***,** overweight subjects showed a significant increase in waist and hip circumference, waist-hip and waist-height ratios, and body adiposity index (BAI) versus underweight and normoponderal. Subjects with obesity gr.I showed a significant increase in waist circumference, hip circumference, and waist-to-height ratio compared to underweight and normoponderal, and a significant increase in BAI compared to underweight, normoponderal and overweight. In subjects with obesity gr. II significant reduction in height was noted compared to overweight subjects, signify-cant increase in waist circumference compared to normoponderal and overweight, hip circumference compared to underweight, normoponderal and overweight, waist-hip ratio compared to obesity gr. I, waist-height ratio compared to underweight, normoponderal, overweight and obesity gr. I., and BAI compared to underweight, normoponderal and overweight (Tab. III).

In the *age group of 90 years and over*, normoponderal subjects had a significant increase in hip circumference and BAI compared to underweight subjects. Overweight subjects had a significant increase in waist and hip circumference, waist-height ratio compared to underweight and normoponderal and a significant increase in BAI compared to underweight. Patients with grade I obesity had a significant increase in waist and hip circumference and waist-to-height ratio compared to normoponderal, and BAI versus underweight and normoponderal. Summarizing, in all studied age groups there were significant changes in the anthropometric parameters that accompany the increase of body mass index (BMI).

Tab. III Distribution of anthropometric parameters by BMI and age groups

Age (years)	Anthropometric parameters	< 18,5 Under weight **A**	18,5 – 24,9 Normalweight **B**	25 – 29,9 Overweight **C**	30 – 34,9 Obesity gr. I **D**	35 – 39,9 Obesity gr. II **E**
80 – 84 N = 36	Weight (kg)	-	55,00 ± 8, 21	70,33 ± 6,84 **P < 0,001 vs B**	74,50 ± 1,91 **P = 0,0002 vs B**	88,00 ± 13,45 **P < 0,001 vs B** **P = 0,005 vs C**
	Height (cm)	-	155,73 ± 8,53	160,25 ± 6,62	152,00 ± 4,32 **P = 0,0370 vs C**	153,00 ± 8,54
	BMI (kg/m^2)	-	22,55 ± 1,76	27,37 ± 1,61 **P < 0,001 vs B**	32,30 ± 1,72 **P < 0,001 vs B** **P < 0,001 vsC**	37,40 ± 1,60 **P < 0,001 vs B** **P < 0,001 vs C** **P = 0,010 vs D**
	Waist circumference (cm)	-	89,63 ± 16,39	100,85 ± 4,05 **P = 0,0512 vs B**	100,00 ± 4,35	118,50 ± 9,19 **P=0,037 vs B** **P=0,003 vs C** **P=0,05 0 vs D**
	Hip circunference (cm)	-	99,00 ± 14,60	110,85 ± 4,18 **P = 0,0256 vs B**	108,33 ± 4,93	123,50 ± 6,36 **P < 0,001 vs B** **P = 0,010 vs C** **P = 0,055 vs D**
	Waist-Hip Ratio	-	0,89 ± 0,04	0,90 ± 0,03	0,92 ± 0,01	0,95 ± 0,02
	Waist-Height Ratio	-	0,56 ± 0,08	0,61 ± 0,02	0,65 ± 0,04 **P = 0,039 vs B** **P = 0,054 vs C**	0,75 ± 0,02 **P < 0,001 vs C** **P = 0,051 vs D**
	BAI (%)	-	32,02 ± 4,97	35,04 ± 3,61	39,91 ± 4,36 **P = 0,028 vs B**	44,78 ± 1,01 **P = 0,005 vs B** **P = 0,008 vs C**
85 -89 N = 57	Weight (kg)	42,00 ± 4,24	59,28 ± 9,52 **P = 0,021 vs A**	70,80 ± 9,50 **P < 0,001 vs A** **P < 0,001 vs B**	78,08 ± 8,45 **P = 0,011 vs A** **P = 0,001 vs B**	81,00 ± 9,00 **P = 0,011 vs A** **P = 0,001 vs B**
	Height (cm)	157,00 ± 2,82	160,90 ± 10,99	161,64 ± 9,32	156,83 ± 9,86	148,00 ± 9,00 **P = 0,023 vs C**
	BMI (kg/m^2)	17,01 ± 1,10	22,70 ± 1,97 **P < 0,001 vsA**	26,97 ± 1,42 **P < 0,001 vs A** **P < 0,001 vs B**	31,72 ± 1,71 **P < 0,001 vsA** **P < 0,001 vs B** **P < 0,001 vs C**	36,92 ± 9,16 **P < 0,001 vs A** **P < 0,001 vs B** **P < 0,001 vs C** **P = 0,002 vs D**
	Waist circumference (cm)	76,00 ± 14,14	86,10 ± 6,74	100,23 ± 7,57 **P < 0,001 vs A** **P < 0,001 vs B**	103,50 ± 9,57 **P = 0,043 vs A** **P < 0,001 vsB**	118,50 ± 4,94 **P < 0,001 vs B** **P = 0,004 vs C**
	Hip circumference (cm)	89,50 ± 7,77	96,89 ± 9,52	108,58 ± 7,04 **P = 0,002 vs A** **P < 0,001 vs B**	114,25 ± 11,78 **P = 0,049 vs A** **P = 0,004 vs B**	126,00 ± 2,82 **P = 0,024 vs A** **P < 0,001 vs B** **P = 0,003 vs C**
	Waist-Hip Ratio	0,84 ± 0,08	0,89 ± 0,04	0,92 ± 0,04 **P = 0,032 vs A**	0,90 ± 0,01	0,94 ± 0,02 **P = 0,037 vs D**
	Waist-Height Ratio	0,48 ± 0,08	0,53 ± 0,03	0,62 ± 0,04 **p<0,001 vs A** **p<0,001 vs B**	0,66 ±0,06 **P < 0,001 vs B**	0,77 ± 0,01 **P = 0,036 vs A** **P < 0,001 vs B** **P < 0,001 vs C** **P = 0,032 vs D**
	BAI (%)	27,45 ± 2,72	29,58 ± 4,73	35,68 ± 4,21 **P = 0,016 vs A** **P < 0,001 vs B**	41,40 ± 6,53 **P = 0,021 vs A** **P < 0,001 vs B** **P = 0,039 vs C**	49,37 ± 4,13 **P = 0,024 vs A** **P < 0,001 vs B** **P < 0,001 vs C**
90 + N = 18	Weight (kg)	43,50 ± 0,70	60,07 ± 6,84 **P < 0,001 vsA**	67.58 ± 10,32 **P = 0,016 vs A**	79,00 ± 1,41 **P < 0,001 vsA** **P = 0,007 vs B** **P = 0,026 vs C**	-
	Height (cm)	157,00 ± 7,07	159,28 ± 10,12	156,28 ± 11,78	158,50 ± 4,94	-
	BMI (kg/m^2)	17,63 ± 1,23	23,63 ± 0,92 **P < 0,001 vsA**	27,48 ± 1,44 **P < 0,001 vs A** **P < 0,001 vs B**	31,47 ± 1,40 **P = 0,008 vs A** **P < 0,001 vsB** **P = 0,011 vs C**	-
	Waist circumference (cm)	80,50 ± 10,60	85,85 ± 2,79	97,71 ± 4,15 ***** **P = 0,015 vs A** **P < 0,001 vs B**	104,50 ± 12,02 ¶ **P = 0,002 vs B**	-
	Hip circumference (cm)	88,00 ± 5,65	97,42 ± 3,25 **P = 0,015 vs A**	104,00 ± 3,87 **P = 0,002 vs A** **P = 0,004 vs B**	115,00 ± 12,72 **P = 0,006 vs B** **P = 0,053 vs C**	-
	Waist-Hip Ratio	0,92 ± 0,17	0,88 ± 0,03	0,91 ± 0,02	0,91 ± 0,003	-
	Waist-Height Ratio	0,50 ± 0,08	0,54 ± 0,03	0,61 ± 0,04 **P = 0,037 vs A** **P = 0,003 vs B**	0,65 ± 0,05 **P = 0,003 vs B**	-
	BAI (%)	26,07 ± 0,77	30,74 ± 4,50 **P = 0,035 vs A**	35,72 ± 5,16 **P = 0,040 vs A**	39,53 ± 3,67 **P = 0,036 vs A** **P = 0,041 vs B**	-

II. Changes in anthropometric parameters by age within the same BMI category

Subponderal subjects (BMI <18.5 kg/m^2) were only in the 85-89 and 90+ years of age groups (Tab. III). Normal subjects (BMI: 19.5-24.9 kg/m^2) of these age groups did not show significant changes in the anthropometric parameters studied compared to the underweight subjects (Tab. III). Overweight subjects (BMI: 25-29.9 kg/m^2) of 85-89 years did not show significant changes in anthropometric parameters compared to subjects 80-84 years. In 90+ years, there was a significant reduction in waist circumference compared to subjects 80-84 years ($p = 0.016$) and 85-89 years ($p = 0.033$). Subjects with grade I obesity (BMI: 30-34.9 kg/m^2) aged 85-89 did not show significant changes in anthropometric parameters compared to subjects 80-84 years. Subjects aged 90 years and over had only a significant increase in waist circumference compared to 80-84 year olds ($p = 0.007$) and those aged 85-89 years ($p = 0.05$). Subjects with grade II obesity (BMI: 35-39.9 kg/m^2) of 85-89 years did not show significant changes in anthropometric parameters compared to subjects aged 80-84 years. In the 90+ age group there is no subject with grade II obesity.

Summarizing the analysis of the anthropometric parameters variation according to the age of the subjects, within the same BMI category, we found that only waist circumference (abdominal obesity) underwent significant changes in subjects aged 90+, overweight and obese grade I, compared to subjects between 80-84 years and 85-89 years of age, from the same BMI categories.

Starting from significant changes in anthropometric parameters by BMI, we calculated the Pearson correlation coefficient and its significance in all subjects participating in the study in order to highlight the possible link between changes in all anthropometric parameters.

The results showed that BMI correlated significantly positively with body weight, waist and hip circumference, waist-hip and waist-height ratio and BAI (Tab. IV). The Body Adiposity Index (BAI) correlated significantly positively with body weight, BMI, waist and hip circumference, waist-height ratio and significantly negative with patient height.

Tab. IV Correlations between anthropometric parameters in subjects over 80 years of age

Parameters	BMI		BAI		Waist circumference		Waist-Hip Ratio		Waist-Height Ratio	
	r	p	r	p	r	p	r	p	r	p
Weight (kg)	0,7844	**<0,001**	0,3725	**<0,001**	0,7948	**<0,001**	0,3050	**<0,01**	0,5824	**<0,001**
Height (cm)	-0,1376	> 0,05	-0,4639	**<0,001**	0,2453	**< 0,05**	0,0499	> 0,05	-0,2112	**<0,05**
BMI (kg/m^2)	1		0,7436	**<0,001**	0,7360	**<0,001**	0,2974	**<0,01**	0,8035	**<0,001**
Waist circum-ference (cm)	0,7360	**<0,001**	0,6684	**<0,001**	1		0,4805	**<0,001**	0,8935	**<0,001**
Hip circumference (cm)	0,7043	**<0,001**	0,7148	**<0,001**	0,9177	**<0,001**	0,1028	> 0,05	0,7993	**<0,001**
Waist-Hip Ratio	0,2974	**<0,01**	0,0802	> 0,05	0,4805	**<0,001**	1		0,4601	**<0,001**
Waist-Height Ratio	0,8035	**<0,001**	0,8916	**<0,001**	0,8935	**<0,001**	0,4601	**<0,001**	1	
BAI (body adiposity index)	0,7436	**<0,001**	1		0,6684	**<0,001**	0,0801	> 0,05	0,8916	**<0,001**

The waist circumference significantly correlated with all analyzed anthropometric parameters. The waist-to-hip ratio significantly correlated with body weight, BMI, waist circumference, and waist-to-height ratio. The waist-height ratio correlated significantly positively with body weight, BMI, waist and hip circumference, waist-to-hip ratio and body adiposity index (BAI) and significantly negative with the height of the subjects.

The results of this study, as well as the literature, have shown that other anthropometric parameters other than BMI contribute to the definition of obesity. Thus waist circumference is a parameter that defines abdominal obesity and undergoes significant changes within the same BMI category in patients aged 90 years and over as compared to subjects 80-84 years and 85-89 years old (Tab. III). Abdominal adiposity (waist circumference) provides information on visceral and subcutaneous adiposity without differentiating them. Visceral adiposity is a risk factor for cardiovascular pathology, type 2 diabetes, atherosclerosis, etc. Under these conditions, waist circumference benchmarks have been established, based on which a risk scale for the health status of people, taking into account race (ethnicity) and sex [17]. Thus, low risk is seen for women with WC <80 cm and men with WC <94 cm; high risk shows women with WC 80-88 cm and men with WC 94-120 cm and very high risk are women with WC> 88 cm and men with WC. 102 cm [13].

Considering these criteria, the evaluation of the distribution of subjects in the 80-84 age group revealed that 13.04% of women were at low risk (WC <80 cm), 13.04% were at high risk (WC 80-88 cm) and 65.23% have a very high risk (WC> 88 cm), while 8.69% of men have a very high risk (WC> 102 cm) (Tab. V) to affect their health status.

Tab. V Distribution of subjects according to waist circumference and sex in different risk categories for health status (%)

Subjects age (years)	Low risk		High risk		Very hight risk	
	W < 80 cm	M < 94 cm	W: 80-88 cm	M: 94 -102 cm	W > 88 cm	M > 102 cm
80-84	13,04	0	13,04	0	65,23	8,69
85-89	9,09	11,36	22,73	9,09	38,64	9,09
90+	5,55	22,22	27,78	16,67	27,78	0

In the 85-89 age group, 9.09% of women have low risk (WC <80 cm), 22.73% are at high risk (WC 80-88 cm), and 38.64% very high risk (WC > 88 cm). In men 11.36% have low risk (WC <94 cm), 9.09% have a high risk (WC 94-102 cm) and 9.09% have a very high risk (WC> 102 cm).

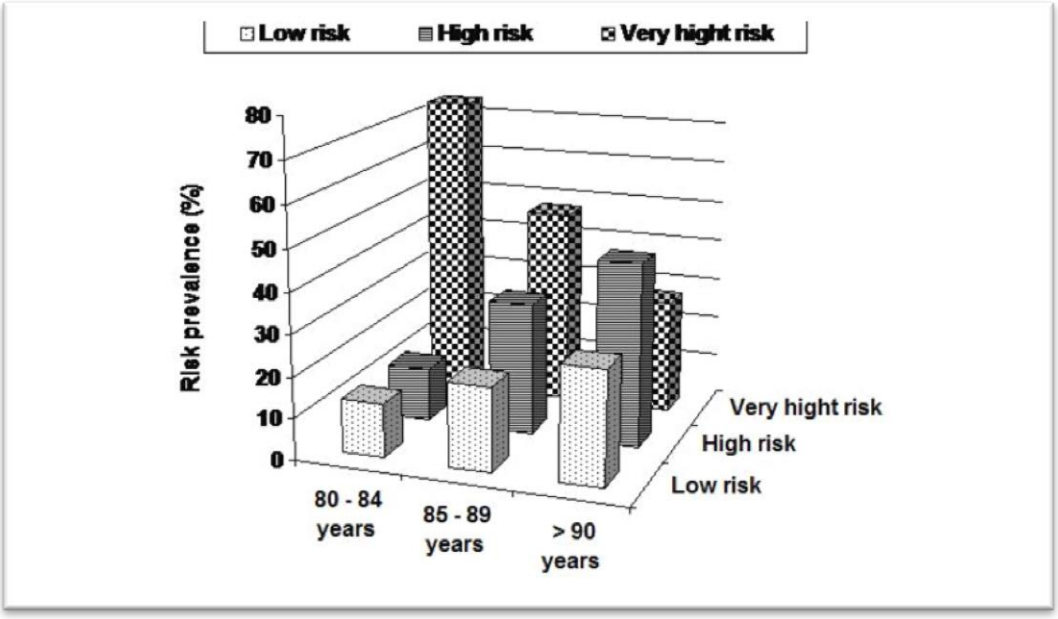

Fig. 2 Prevalence of health risk based on waist circumference

Of women aged 90 years and over 5.5% have low risk (WC <80 cm), 27.78% are at high risk (WC 80-88 cm) and 27.78% very high risk (WC> 88 cm). In the same age group, 22.22% of men have low risk (WC <94 cm), 16.67% have high risk (WC 94-102 cm) and 0% very high risk (WC>102 cm).

The analysis of the prevalence of health risk for waist circumference for women and men together revealed that subjects aged 80-84 have the highest prevalence (73.92%) of very high risk, while subjects of 90 years and over have the lowest prevalence (27.78%) of very high risk (Fig. 2). Furthermore, subjects aged 90 years and over have the highest prevalence (27.77%) of low risk for impairment of health (Fig. 2).

From the relationship of nutritional status based on BMI to waist circumference, there were several levels of risk to people's health: least risk, increased risk, high risk and very high risk [18].

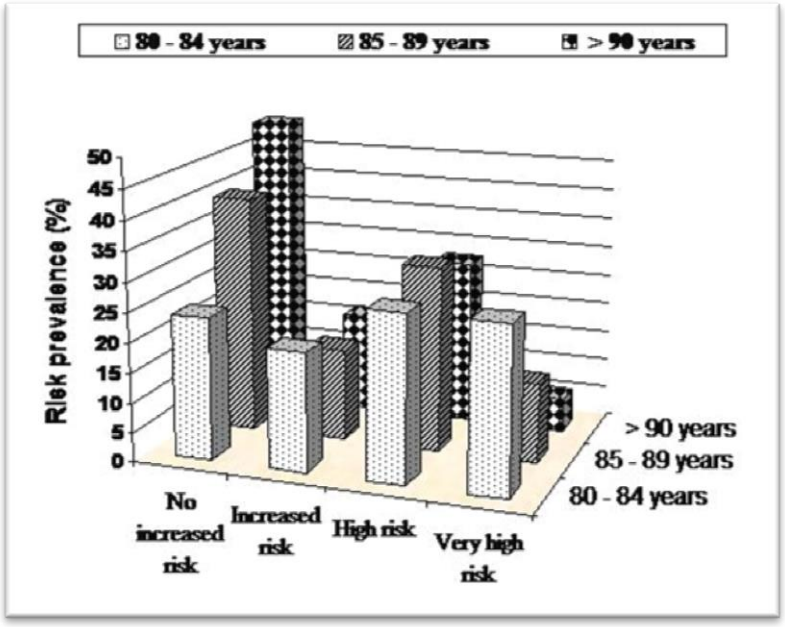

Fig. 3 Prevalence of Health Risk (%), based on waist circumference (WC) and Body Mass Index (BMI), in patients over 80 years

In the 80-84 year age group, women and men together, 24% show no increased risk, 20% increased risk, 28% high risk and 28% very high risk of harm to health. (Fig. 3). In the age range of 85-89 years, 40% of subjects are risk-free, 15.55% with increased risk, 31.12% with high risk and 13.33% with very high risk. In subjects aged 90 years and over, no increase risk is 50%, increases risk by 16.67%, high risk of 27.78% and very high risk of 5.55%. In conclusion, subjects aged 90 years and over have the highest prevalence of no increase risk and the lower prevalence of very high risk (Fig. 3).

The study of correlations between subject age and health risk based on waist circumference showed that the age-related relationship was positively correlated with low risk and high risk and significantly negative with very high risk (Tab. VI). The calculation of the correlation between subject age and health risk based on waist circumference and BMI showed that age correlated significantly positive with no increased risk, significantly negative with increased risk and very high risk, and not correlated with high risk category (Tab. VI).

Tab. VI Pearson's correlation between health risk and subjects age

Health risk	Risk category	Pearson's correlations	
		r	p
based on WC	Low risk	0,9994	< 0,001
	High risk	0,9936	< 0,001
	Very high risk	- 0,9969	< 0,001
based on WC and BMI	No increased risk	0,9912	< 0,001
	Increased risk	- 0,7193	< 0,01
	High risk	0,0059	> 0,05
	Very high risk	- 0,9846	< 0,001

DISCUSSIONS

Due to technological advances and scientific discoveries in the medical field, society is experiencing a steady and rapid increase in life expectancy in Western European countries, coupled with a major increase in population aging. And Romania is experiencing the aging phenomenon of the population. Increased life expectancy is accompanied by an increased risk of aging-related illnesses such as obesity, type 2 diabetes, atherosclerosis, cancer, and neurodegenerative diseases. These diseases represent enormous challenges, both for individuals and for society, in terms of quality of life and economic burden. Thus, aging societies have to urgently address public health issues and develop services for the elderly.

Maintaining independence, quality of life, high function, and health is crucial for the older population. So, obesity and the loss of muscle mass and muscle function (sarcopenia) are important health risk factors in old age leading to functional decline and mobility limitations [3].

Obesity is associated with increased incidence of cardiovascular disease, type 2 diabetes, dyslipidemias, metabolic syndrome, and cognitive impairment in the general population and the elderly population.

Obesity prevalence is increasing in the older population, and like sarcopenia, obesity (ie, a body mass index (BMI) >30 kg/m²) and severe obesity (ie, a BMI .35 kg/m²) have been consistently associated with several negative health outcomes, disabilities, falls, and mobility limitations. The effect of obesity on mortality by cardiovascular disease, however, is less relevant in older than in younger age groups, as obese older patients with cardiovascular disease have demonstrated

better survival rates compared with nonobese older patients (the so-called "obesity paradox" [19]. But even if mortality rates might be affected positively by obesity, the problem remains that its negative effects on function may lead to considerable disability during this extended lifetime.

Body mass index is the standard for classifying weight and is the most practical method to determine the extent of obesity. Obesity is commonly classified as BMI≥30 kg/m^2, whereas a BMI < 18.5 is classified as underweight, a BMI of 18.5–24.9 as normal weight and a BMI of 25–29.9 as overweight. This classification does not take into account sex or age. Classification of obesity by using BMI does neither differentiate between fat and fat free mass, nor between the distributions of body fat. Other parameters like waist circumference, waist to hip ratio, direct measurement of visceral body fat, or classifications which incorporate parameters of body composition, the relation between fat and fat free mass and the concept of sarcopenic obesity have been proposed to be more valid parameters for mortality risk assessment in the elderly.

A BMI in the obese range in the elderly increases the risk of frailty by 3.5 and 96% of community-dwelling subjects aged 65–80 are classified as frail. Not only increased BMI, especially sarcopenia and sarcopenic obesity are associated with frailty. Frailty in elderly subjects is associated with increased mortality. On the other hand, not only obesity, but also underweight, the other extreme on the BMI scale can be responsible for the development of frailty. This fact seems paradoxical; however, the way underweight and obesity lead to frailty follow different pathophysiological paths with only the same outcome, frailty. A good nutritional status can contribute to the prevention of frailty through the prevention of underweight and adiposity.

Body mass index is not only used to classify obesity but also to determine life expectancy and prevalence of obesity-related issues and comorbidities. The risk of developing a comorbid condition increases with increasing BMI [4]. Additional factors that increase disease risk in the overweight and class I and II obesity groups are large WC (>102 cm in men and >88 cm in women) and ethnicity. The rationale for measuring the WC in clinical practice is to identify metabolically obese and overweight patients whose BMI is normal and thus would not be considered for lifestyle intervention and treatment. The WC measurement has been highlighted as a key component in several recently released algorithms for overweight and obesity management.

Waist circumference is also a method often used to diagnose metabolic syndrome in overweight and obese patients. When a large WC is factored into BMI-associated disease risk, there is an increased disease risk in the overweight and class I obesity groups. The WC is less useful as an independent marker of medical risk when the BMI is greater than 39. Overall risk is independently associated with excess abdominal fat (WC > 102 cm in men and > 88 cm in women). The visceral deposition of adipose tissue is easily ascertained by measuring WC or the waist-to-hip ratio.

Waist circumference was shown to be a surrogate marker for intra-abdominal adiposity in a study conducted upon men and women. In this study, WC strongly correlated with intra-abdominal adiposity as measured using computed tomography or magnetic resonance imaging, which is considered the criterion standards for imaging adipose tissue. Waist circumference is also used in the screening of the metabolic syndrome and to establish the cardiovascular risk factors in the elderly [19]. The metabolic syndrome and its components which include excess abdominal fat, insulin-resistance, dyslipidemia, and high blood pressure are highly prevalent in older populations (NCEP, 2002). The prevalence of the metabolic syndrome increases with age and reaches a

peak in men aged 50–70 years and women aged 60– 80 years. In the adult population with age fasting plasma glucose and postprandial glucose increase by 1–2 mg/dl and 10–20 mg/dl, respectively, for each decade. Such as, the prevalence of type 2 diabetes mellitus, also increases with age and reaches a peak in women aged 85 years and older and in men aged 75–84 years [20].

Both anthropometric parameters, MBI and waist circumference were also used to assess disease risk. Thus, a stratification of the health risk was made depending on the BMI category and the waist circumference [4, 17].

In this context, the measurement of anthropometric parameters currently in the clinic, regardless of age, gender, race or pathology, allows the detection of risk factors for impairment of health and the adoption of an appropriate treatment strategy. By simple means, easy to achieve, one can predict the incidence of a disease or death.

Given the increase in life expectancy, the increase in the proportion of the elderly population globally, along with the increase in the prevalence of diseases associated with the aging process, with economic and social impact, our study has highlighted changes in anthropometric parameters: body weight, height, body weight index, hip circumference, waist-to-hip ratio, waist-yo-height ratio and body fat index, and determine the risk of illness for people aged over 80 years.

Our study revealed that no anthropometric parameter suffers significant changes in subjects over 90 years of age and those aged 85-89 years. However, the correlations studies of anthropometric parameters with of the patients age revealed that the waist circumference, waist-height ratio and body adiposity index (BAI) correlated significantly negatively with the age of the investigated subjects. Analyzing the prevalence of obesity in the three age groups, the study showed that in the age group 80-84 years, most subjects are normoponderal (44,12%) and overweight (35,29%) and 20,36% are obese; in the 85-89 age group most subjects are overweight (43.86%) and normoponderal (36.84%) and 15.79% are obese, and subjects over 90 years old are in equal proportion (38, 89%) normoponderal and overweight and only 11.11% with obesity.

The assessment of the relationship between BMI and other anthropometric parameters showed significant changes in WC, HC, WCR, WHtC, and BAI that accompany the increase of BMI in all studied age groups. The analysis of the anthropometric parameters variation according to the age of the subjects, within the same BMI category, showed that only waist circumference (abdominal obesity) underwent significant changes in subjects aged 90+, overweight and obese grade I, compared to subjects between 80-84 years and 85-89 years of age, from the same BMI categories.

Correlations between anthropometric parameters in subjects over 80 years of age highlight the possible link between changes in all anthropometric parameters.

To be highlighted as subjects over 90 years of age have a lower prevalence of high and very high risk and an increased prevalence of no increase risk and low risk for health based on BMI and WC.

Although, in general, obesity is a risk factor for CVD, type 2 diabetes, atherosclerosis, cognitive impairment, cancer, and the incidence increases with age, it is not a risk factor for mortality in the elderly, especially at those with serious pathologies. That is why we are discussing the appropriateness of indications of reducing BMI in elderly patients, targeting treatment to disease control and addressing a healthy lifestyle that includes movement/ exercise and proper nutrition.

CONCLUSIONS

Obesity is defined as BMI> 30 kg/m^2, but in the process of aging there are changes in body composition that in turn modify the

relationship between lean and fat mass. Thus, BMI does not adequately measure body adiposity and has a limited capacity to predict mortality. The concept of obesity has been complemented by the assessment of other anthropometric parameters such as WC, WH, WHR, WHtR, BAI, that provide information about fat mass and its distribution according to age and pathology.

WC, WHR and WHtR measurements allow the assessment of abdominal adiposity, which is a risk factor for cardiovascular disease, type 2 diabetes, cognitive impairment, etc.

It is known that the prevalence of overweight, obesity, abdominal obesity and adiposity is higher in the elderly, but it is not a risk factor for mortality ("obesity paradox").

Simple assessment of anthropometric parameters and their various associations was at the base of the health risk stratification and the mortality prediction.

Our study found that after the age of 80 there was a tendency to reduce the values of the anthropometric parameters studied, and the waist circumference, the waist-height ratio and the body adiposity index (BAI) correlated significantly negatively with the age of the investigated subjects. Subjects aged 90 years and over had the highest prevalence of no increase risk and the lowest prevalence of very high risk.

Measurement of anthropometric parameters allows the orientation and pursuit of a therapeutic strategy of obesity, abdominal obesity, underweight, malnutrition and fragility associated with the aging process.

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