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ORIGINAL ARTICLE

OBESITY DIAGNOSIS AND MORTALITY RISK BASED ON A BODY SHAPE INDEX (ABSI) AND OTHER INDICES AND ANTHROPOMETRIC PARAMETERS IN UNIVERSITY STUDENTS

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ABSTRACT

Background. Obesity is a global epidemic and belongs to major risk factors for the most prevalent diseases. Anthropometric measures are simple, inexpensive, non-invasive tools to diagnosis obesity and to assess the risk of morbidity and mortality. The most widely used are body mass index (BMI), waist circumference (WC), waist-to-hip (WHR) and waist-to-height ratios, visceral fat area (VFA), body fat (BFP) and a new body shape index (ABSI).

Objective. The aim of this study was to examine the usefulness of the ABSI in obesity diagnosis compared with other anthropometric parameters like WC, WHR, BMI, VFA, and BFP. We also compared the predictability between ABSI and above mentioned common anthropometric indices.

Material and methods. The study group was composed of 236 university students. Body height, weight, WC was measured and BMI, WHR, ABSI and ABSI z-score were calculated. The anthropometric measurements were made by using InBody 720 (Biospace Co. Ltd., Seoul, Republic of Korea). Body composition, especially VFA, BFP, FFM was diagnosed by multi-frequency bioelectrical impedance analysis. We evaluated the collected data statistically and graphically in Microsoft Office Excel 2010 (Los Angeles, CA, USA). Statistical analyses were performed using the program STATISTICA Cz version 10.

Results. The diagnosis of obesity among participants according to anthropometric measures and indices showed considerable differences. We found that obesity was diagnosed according to waist circumference in 31% of participants. According to BMI 20.3% of subjects were overweight and 5.1% obese. With increasing BMI values, the values of WC, WHR and VFA also increased linearly. According to visceral fat area 11.4% of participants were in the risk obese group and by ABSI mortality risk there were 22% of subjects with high risk (4.8% and 28.3% for men and women, respectively) and 19.1% with very high risk (11.1% and 22% for men and women, respectively). VFA and BFP values increased with increasing risk of mortality, and in men also waist circumference values. When evaluating the ABSI in relation to BMI, the U-shaped curve was confirmed and in the case of WC the J-shaped curve. The FFM evaluation showed that the very low ABSI mortality risk group reached the highest values of this parameter and the lowest values showed the average mortality risk group, not only in the study group but also in male and female groups.

Conclusions. Our findings suggest the relevance of ABSI to screen at-risk population.

Key words: *anthropometry, bioimpedance, body shape index, body mass index, BMI, visceral fat area*

INTRODUCTION

Obesity is becoming a global epidemic and belongs to major risk factors for the most prevalent diseases such as cardiovascular, metabolic, oncological and other chronic diseases and is leading cause of premature death [5, 27, 28, 31, 39]. According to the WHO, overweight and obesity are increasing in prevalence.

Anthropometric measures are simple, inexpensive, non-invasive tools to diagnosis obesity and to assess the risk of morbidity and mortality of associated diseases [15, 26, 45]. The most widely used index for measuring obesity is the Body Mass Index (BMI), which is defined by weight in kilograms divided by height in metres squared ($kg.m^{-2}$). According to WHO, obesity is defined as BMI $\geq$ 30 $kg.m^{-2}$ [43]. BMI has been one of the most widely adopted weight-related anthropometric measures [23, 32]. The disease predictability of BMI is confined as it does not distinguish between muscle and fat accumulation or distribution of adipose tissue [10, 19].

Some central obesity indices like waist circumference (WC), waist-to-hip ratio (WHR) and waist-to-height ratio (WHtR) can outperform BMI. However, there is no

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agreement on the usefulness of these mentioned measures because some studies indicate that they are strong predictors [12], whereas others contradict this [38]. Waist circumference does not help distinguishing subcutaneous from visceral fat mass, but is widely accepted as a certain measure of fat distribution. A number of epidemiologic studies have found that waist circumference predicted mortality risk better than BMI and is highly correlated with the risk of metabolic disorders [34, 37].

Waist circumference and WHR have been used as other markers for abdominal obesity [4]. WHR is studied but not as widely accepted measure as it was a decade ago. Visceral obesity is associated with dyslipidemia and hypertension and abdominal visceral fat is strongly associated with cardiovascular risks [11, 17].

A Body Shape Index (ABSI), based on waist circumference (in metres), weight (in kilograms) and height (in metres), defined as WC / ($BMI^{2/3}$ × $height^{1/2}$), was proposed in 2012. The goal of ABSI is to predict diseases risks that can not be readily captured by BMI [29]. ABSI z-score is used to identify the premature mortality risk level. ABSI has been developed to be independent of BMI. Song et al. [40] reported that the combination of BMI and ABSI is better in prediction for cardiovascular events than single measures. ABSI is positively correlated with visceral adiposity and has been also shown to be positively associated with visceral fat mass.

The aim of this study was to examine the usefulness of the ABSI in obesity diagnosis compared with other anthropometric parameters like waist circumference, WHR, BMI, visceral fat area and body fat percentage. We also compared the predictability between ABSI and above mentioned common anthropometric indices. Findings can be helpful in assessing the relevance of ABSI to screen at-risk population.

MATERIAL AND METHODS

The requirement for participation in the research was informed consent of volunteers with all measurement conditions which they will have to complete during the research. All participants signed written informed consent to participate in the study. Their characteristics are shown in Table 1. The study group was composed of 236 university students (Human nutrition study programme in Slovak University of Agriculture and Department of Human nutrition).

Body height was measured in a standing position without shoes on the outpatient electronical medical scales Tanita WB-300 while shoulders were in normal alignment and the data were recorded to the nearest 0.1 cm. Weight was measured in light clothing without shoes using a standard scale and recorded to the nearest 0.1 kg. Waist circumference was measured at the umbilical level and that of the hip at the maximum level over light clothing, using an upstretched tape meter, without any pressure to body surface and measurements were recorded to the nearest 0.1 cm. BMI ($kg.m^{-2}$) was calculated as weight (kg) divided by square of the height (m^2). WHR was calculated as waist circumference (cm) divided by hip circumference (cm). ABSI was defined by WC / ($BMI^{2/3}$ × $height^{1/2}$) and ABSI z-score was calculated based on the mean and standard deviations of ABSI calculated for the given age and gender. ABSI z-score formula: ABSI z-score = (ABSI – $ABSI_{mean}$) / $ABSI_{SD}$.

The anthropometric measurements were made by using InBody 720 (Biospace Co. Ltd., Seoul, Republic of Korea). Body composition, especially VFA (cm^2), BFP (%), FFM (kg) was diagnosed by multi-frequency bioelectrical impedance analysis, which measures the total impedance at frequencies of 1, 5, 50, 100, 500, 1000 kHz. Each of the participants was informed with the measurement procedure, explained the possible risks of measuring in the case of pregnancy or having an artificial pacemaker at the heart. Before the measurement, participants were asked to excrete and refrain from drinking excessive amounts of water. At the same time each participant signed informed consent for the measurement procedure and also agreed to the processing of personal data. The Lookin'Body 3.0 software was used to process the results. We focused especially on visceral fat area (VFA, cm^2), fat-free mass (FFM, kg), body fat percentage (BFP, %). Obesity was defined as BMI ≥ 30 $kg.m^{-2}$; waist circumference ≥ 85 cm and ≥ 102 cm for women and men, respectively; WHR ≥ 0.85 and ≥ 0.9 for women and men, respectively; VFA ≥ 100 cm^2; BFP ≥ 32%. ABSI z-score premature mortality risk was classified into 5 levels: very low, low, average, high and very high.

We evaluated the collected data from the anthropometric measurements statistically and graphically in Microsoft Office Excel 2010 (Los Angeles, CA, USA). Statistical analyses were performed using the program STATISTICA Cz version 10. The levels of statistical significance were set at $P<0.05$ (*), $P<0.01$ (**), $P<0.001$ (***). The data were presented as mean±standard deviation (SD). Differences among anthropometric data were tested with a one-way analysis of variance (ANOVA) and were compared using Tukey's Post Hoc Test.

RESULTS AND DISCUSSION

Among the participants, the diagnosis of obesity showed considerable differences according to anthropometric measures and indices. The basic participants´ characteristics are shown in Table 1.

Table 1. The basic characteristics and results of measurements of the study group

Parameters	mean±SD	max	min	med	mod
Age (years)	20.5±1.8	38	18	20	20
Height (cm)	170.7±8.1	195	153	170	168
Weight (kg)	68.1±15.4	182.8	43.0	64.7	64.7
Waist circumference, WC (cm)	82.5±10.6	153.5	65.5	80.5	80.1
Waist-to-hip ratio, WHR	0.86±0.05	1.1	0.75	0.85	0.85
Body mass index, BMI (kg.m^{-2})	23.2±3.9	51.7	16.8	22.6	23.6
Visceral fat area, VFA (cm^2)	67.9±29.8	233.9	5.0	63.7	66.2
Body fat percentage, BFP (%)	24.8±8.5	49.3	3.0	25.2	31.7
Fat-free mass, FFM (kg)	51.1±12.5	99.4	32.8	46.3	44.9

Abbreviations: ±SD – standard deviation; max – maximum value; min – minimum value; med – the median value of a range of values; mod – the value that appears most often

We evaluated the waist circumference differently by gender. We found that there were 25.4% of women and 6.3% of men with a waist circumference greater than 85 cm and 102 cm, respectively (Table 2). This represents 31% of obese people in the study group. BMI, VFA, BFP and FFM values increased linearly in both genders with increasing waist circumference. Waist circumference reflects more or less central obesity but is sensitive to body size. Waist circumference and waist-to-hip ratio were reported to have similar associations with incident diabetes as BMI [42] and together with waist-to-height ratio were reported to better discriminate cardiovascular diseases risks than BMI [2]. Waist circumference was strongly correlated with BMI according to results of different studies [4, 8, 41]. Sato et al. [36] confirm strong correlation between BMI and waist circumference and body weight, but not with height. By evaluating the WHR we found 53.2% of women with values above 0.85 and 14.3% of men with values above 0.9 (67% of those at obesity risk; Table 3). Also in this case, the values of the waist circumference, VFA and BFP increased linearly with increasing WHR values. Among the different categories of WHR we found significant differences in the values of the monitored parameters, both in male and female groups.

Table 2. Representation of participants according to waist circumference categories differentiated by gender

WC (cm) – women	n = 173	%	mean	BMI (kg.m^{-2})	VFA (cm^2)	BFP (%)	FFM (kg)
< 80	91	52.6	74.3	20.2^a	54.1^a	23.6^a	76.4^c
80-85	38	22.0	91.6	22.9^b	75.4^b	29.2^b	70.8^b
> 85	44	25.4	93.4	26.5^c	106.9^c	35.8^c	64.2^a
WC (cm) – men	n = 63	%	mean	BMI (kg.m^{-2})	VFA (cm^2)	BFP (%)	FFM (kg)
< 94	50	79.4	82.6	24.0^a	42.9^a	13.6^a	86.4^c
94-102	9	14.3	96.7	28.6^b	84.6^b	21.0^b	79.0^b
> 102	4	6.3	122.5	36.1^c	155.6^c	33.3^c	66.7^a

Abbreviations: n – number of participants; WC – waist circumference; BMI – body mass index; VFA – visceral fat area; BFM – body fat mass; FFM – fat-free mass; ^{abc} – different symbols in the column mean statistically significant differences in mean values

Table 3. Representation of participants according to waist-to-hip ratio categories differentiated by gender

WHR – women	n = 173	%	mean	WC (cm)	VFA (cm^2)	BFP (%)
< 0.85	81	46.8	0.82	74.3^a	53.9^a	23.6^a
≥ 0.85	92	53.2	0.89	86.5^b	88.3^b	31.8^b
WHR – men	n = 63	%	mean	WC (cm)	VFA (cm^2)	BFP (%)
< 0.9	54	85.7	0.84	83.6^a	45.2^a	13.9^a
≥ 0.9	9	14.3	0.98	108.7^b	121.1^b	28.3^b

Abbreviations: n – number of participants; WHR – waist-to-hip ratio; WC – waist circumference; VFA – visceral fat area; BFM – body fat mass; ^{ab} – different symbols in the column mean statistically significant differences in mean values

According to BMI, we found 20.3% of overweight participants and 5.1% of those with obesity (Table 4). When assessing the BMI in terms of individual parameters, we found linearly increase in WC, WHR and VFA values. There were significant differences between the groups. BFP increased similarly, but overweight subjects had lower BFP values compared to normal weight subjects (non-significant differences). Obese participants had significantly higher BFP values compared to other groups. BFP values of undernourished group differed significantly from those of normal weight and obesity but not overweight. When evaluating the FFM in relation to BMI, we found that the lowest values of FFM were found in the group of undernourished participants (significant differences) and the highest values were in the overweight group. This is indicated by the fact that physically active participants, whose BMI values were biased due to increased muscle mass, were included in the overweight group. Similar results have been found in another of our previous studies [18]. Several reviews found that high BMI is associated with an elevated risk of chronic civilizing diseases and all-cause mortality [3, 46]. Mortality hazard according to BMI creates the U-shaped or J-shaped curve – low and high BMI increased this risk compared to near-median BMI values. BMI does not distinguish between fat locations. Abdominal fat deposition is thought to be particularly serious [24, 25]. Higher body fat mass is associated with greater risk of premature death, higher muscle mass reduces this risk [6].

According to visceral fat area (VFA), 11.4% of participants were assigned to the risk obese group (Table 5). In relation to the other measures, we found that with increasing VFA values, both WC and BFP increased. In many cases, there were significant differences. In the case of FFM, the highest values had participants of the group with VFA above 160 cm^2 (significant differences compared to the values of other categories). The lowest FFM values were found in groups with VFA values between 40-100 cm^2.

Table 4. Representation of participants according to BMI categories

BMI ($kg.m^{-2}$)	n = 236	%	mean	WC (cm)	WHR	VFA (cm^2)	BFP (%)	FFM (kg)
Underweight	46	19.5	18.9	72.9^a	0.82^a	46.8^a	21.1^a	42.8^b
Normal weight	130	55.1	22.4	79.9^b	0.85^b	63.8^b	24.9^b	48.5^c
Overweight	48	20.3	26.9	91.3^c	0.89^c	80.9^c	24.7^{ab}	62.9^a
Obesity	12	5.1	33.8	106.8^d	0.96^d	132.4^d	37.1^c	60.2^a

Abbreviations: n – number of participants; BMI – body mass index; WC – waist circumference; WHR – waist-to-hip ratio; VFA – visceral fat area; BFM – body fat mass; FFM – fat-free mass; ^{abcd} – different symbols in the column mean statistically significant differences in mean values

Table 5. Representation of participants according to VFA categories

VFA (cm^2)	n = 236	%	mean	WC (cm)	FFM (kg)	BFP (%)
low	25	10.6	27.2	76.1^a	59.6^b	11.7^b
optimal	118	50.0	54.6	77.6^a	49.7^a	21.8^c
limit	66	28.0	82.6	85.3^b	49.2^a	29.5^d
border	18	7.6	114.1	97.2^c	50.4^{ab}	36.8^a
high	7	3.0	141.7	107.4^d	56.9^{ab}	40.2^a
extreme	2	0.8	202.5	136.2^d	80.5^c	44.1^a

Abbreviations: n – number of participants; VFA – visceral fat area; WC – waist circumference; FFM – fat-free mass; BFM – body fat mass; ^{abcd} – different symbols in the column mean statistically significant differences in mean values

ABSI data are shown in Table 6 and Table 7 and relationship to individual parameters in Figures 1-5. According to ABSI mortality risk, we found 22% of subjects with high risk (4.8% and 28.3% for men and women, respectively) and 19.1% with very high risk (11.1% and 22% for men and women, respectively). VFA and BFP values increased with increasing risk of mortality, and in men also waist circumference values. When evaluating the ABSI in relation to BMI, the U-shaped curve was confirmed and in the case of WC the J-shaped curve. Participants with very low and very high mortality risk had almost equal values, respectively the highest BMI and WC values. This finding was also confirmed for the male group (J-shaped mortality risk for BMI). The FFM evaluation showed that the very low ABSI mortality risk group reached the highest values of this parameter and the lowest values showed the average mortality risk group, not only in the study group but also in male and female groups. Initial studies reported that ABSI had a stronger association with premature mortality compared with BMI or waist circumference [30]. This result is consistent with the finding that combination of BMI and waist circumference performed better in explaining non-abdominal, abdominal subcutaneous and visceral fat than BMI or waist circumference alone [9, 21]. Based on the results of meta-analysis, Jil et al. [22] estimated the differential predictability between ABSI and BMI. The estimated increase in hypertension risk associated with a standard deviation increase in ABSI is 29% lower than that associated with a standard deviation increase in BMI, increase in diabetes risk is 14% lower than that associated with a standard deviation increase in BMI and, in contrast, an increase in all-cause mortality risk associated with a standard deviation increase in ABSI is 49% higher than that associated with a standard deviation increase in BMI [22].

Table 6. ABSI and ABSI z-score differentiated by gender

Parameters	mean±SD	max	min	med	mod
ABSI (all)	0.0778±0.0036	0.0859	0.0671	0.0778	0.0781
ABSI z-score (all)	0.0513±0.8901	2.231	-2.763	0.067	-0.037
ABSI (men)	0.0752±0.0038	0.0859	0.0671	0.0744	0.0768
ABSI z-score (men)	-0.6057±0.9956	2.231	-2.763	-0.793	ND
ABSI (women)	0.0788±0.0030	0.0856	0.0704	0.0786	0.0772
ABSI z-score (women)	0.2906±0.7137	1.941	-1.685	0.26	-0.037

Abbreviations: ±SD – standard deviation; max – maximum value; min – minimum value; med – the median value of a range of values; mod – the value that appears most often; ABSI – a body shape index

Table 7. Representation of participants according to ABSI mortality risk categories differentiated by gender

ABSI mortality risk (all)	n = 236	%	mean	BMI ($kg.m^{-2}$)	WC (cm)	VFA (cm^2)	FFM (kg)	BFP (%)	Age
Very low	35	14.8	0.0721	24.6^{a}	81.1^{a}	42.3^{a}	66.6^{c}	14.3^{c}	20.4
Low	47	19.9	0.0754	23.1^{ab}	79.6^{a}	57.3^{ab}	53.0^{b}	21.6^{d}	20.7
Average	57	24.2	0.0775	22.4^{ab}	79.4^{a}	64.9^{bc}	46.2^{a}	25.8^{a}	20.5
High	52	22.0	0.0798	22.2^{b}	82.1^{a}	75.0^{c}	46.3^{a}	27.8^{ab}	20.8
Very high	45	19.1	0.0828	24.4^{a}	90.8^{b}	94.4^{d}	48.9^{ab}	31.3^{b}	20.2
ABSI mortality risk (men)	n = 173	%	mean	BMI ($kg.m^{-2}$)	WC (cm)	VFA (cm^2)	FFM (kg)	BFP (%)	Age
Very low	29	46.0	0.0721	25.1^{bc}	82.8^{abc}	41.4^{a}	71.0^{b}	12.8^{c}	20.4
Low	15	23.8	0.0755	24.3^{ab}	85.4^{abc}	48.7^{ab}	69.5^{b}	14.1^{cd}	21.0
Average	9	14.3	0.0772	24.5^{abc}	86.2^{abc}	62.2^{a-d}	60.9^{c}	19.2^{bcd}	20.0
High	3	4.8	0.0807	26.4^{abc}	96.0^{bcd}	84.8^{a-e}	67.4^{bc}	21.1^{a-d}	27.3
Very high	7	11.1	0.0827	30.0^{c}	106.3^{d}	111.8^{e}	69.6^{bc}	26.4^{abe}	20.0
ABSI mortality risk (women)	n = 63	%	mean	BMI ($kg.m^{-2}$)	WC (cm)	VFA (cm^2)	FFM (kg)	BFP (%)	Age
Very low	6	3.5	0.0726	22.0^{ab}	72.6^{a}	46.5^{a-c}	45.6^{a}	21.6^{abd}	20.3
Low	32	18.5	0.0753	22.5^{ab}	76.9^{a}	61.3^{a-c}	45.3^{a}	25.2^{ab}	20.5
Average	48	27.7	0.0775	22.1^{a}	78.2^{a}	65.4^{bc}	43.5^{a}	27.0^{a}	20.5
High	49	28.3	0.0798	22.0^{a}	81.3^{ab}	74.4^{cd}	45.0^{a}	28.2^{ae}	20.4
Very high	38	22.0	0.0829	23.4^{ab}	87.9^{c}	91.2^{de}	45.1^{a}	32.2^{e}	20.2

Abbreviations: n – number of participants; ABSI – a body shape index; BMI – body mass index; WC – waist circumference; VFA – visceral fat area; FFM – fat-free mass; BFM – body fat mass; abcde – different symbols in the column mean statistically significant differences in mean values

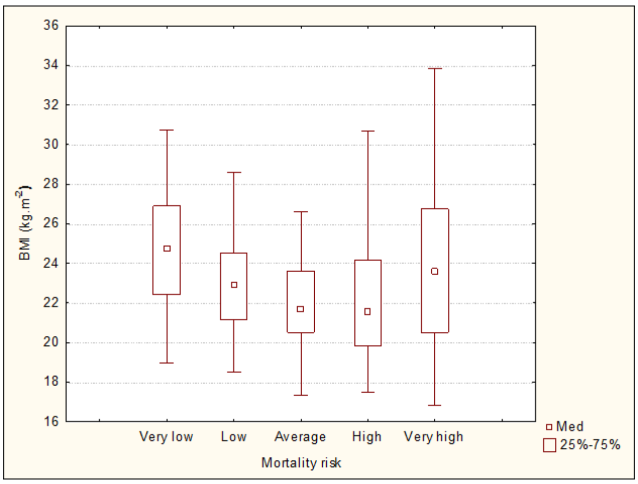

Figure 1. Mortality risk in relation to body mass index

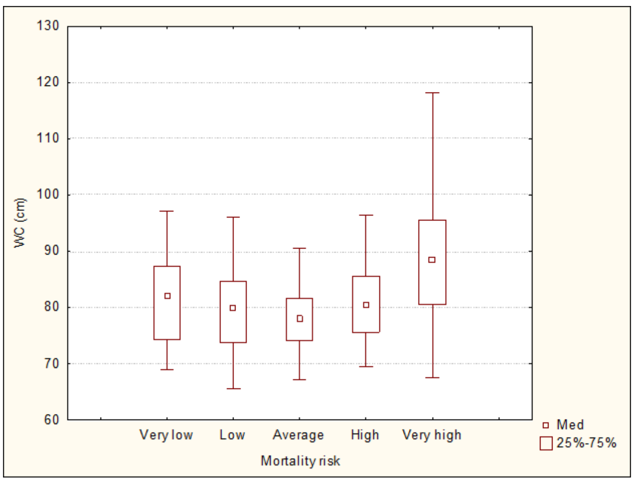

Figure 2. Mortality risk in relation to waist circumference

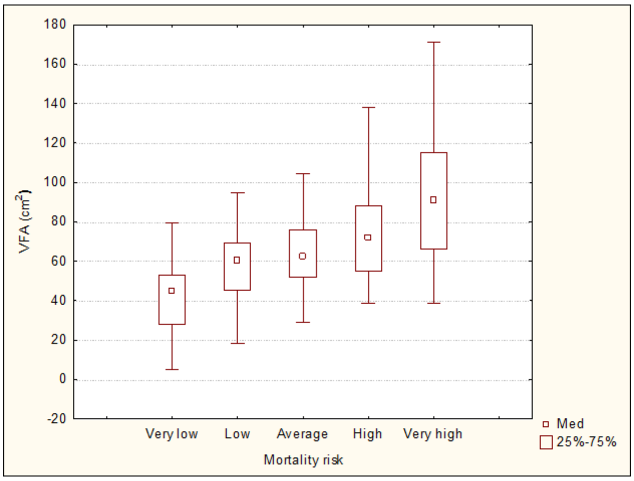

Figure 3. Mortality risk in relation to visceral fat area

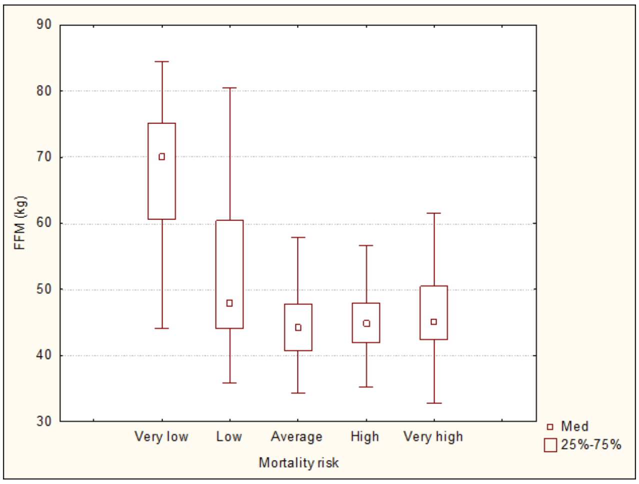

Figure 4. Mortality risk in relation to fat free mass

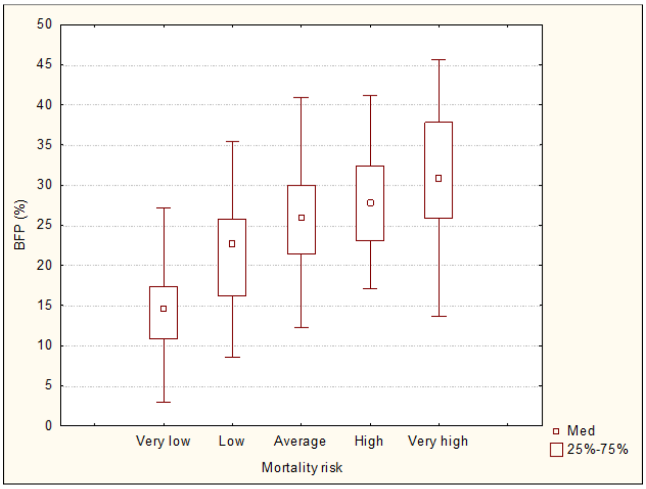

Figure 5. Mortality risk in relation to body fat percentage

High ABSI indicates that waist circumference is higher than expected for a given weight and height and forms a more central accumulation of body volume [29]. Meta-analysis of the authors *Jil* et al. [22] estimated the differential predictability between ABSI and waist circumference, too. The estimated increase in hypertension risk associated with a standard deviation increase in ABSI is 29% lower than that associated with a standard deviation increase in waist circumference and in contrast, the estimated increase in all-cause mortality risk associated with a standard deviation increase in ABSI is 34% higher than that of associated with a standard deviation increase in waist circumference [22]. The relationship between body weight status and chronic conditions is likely to differ by sex [35] and there is a relatively stronger association between ABSI and mortality because age is a key factor in the assessment of population mortality and ABSI tends to increase significantly with age [29]. Similar results were obtained by Sato et al. [36], particularly in women. BMI and waist circumference increased linearly with age in women but decreased linearly or were constant with age in men. ABSI's CVD predictability tended to vary across different age groups [16, 44]. An excess central adiposity is associated with an elevated risk of chronic diseases. ABSI, similar to BMI and waist circumference, does not differentiate fat from lean mass. Higher ABSI may correspond to a greather visceral fat area and smaller fraction of muscle mass. *Bouchi* et al. [8] in their study found that ABSI was positively correlated with visceral fat area and appears to reflect visceral adiposity independently of BMI.

Study of *Dhana* et al. [14] showed that among other anthropometric measures, ABSI had a stronger relation with total, cardiovascular and cancer mortality. *Sato* et al. [36] found that ABSI did not correlate with BMI, height and weight but showed modest correlation with waist circumference. It means that ABSI is independent from BMI. According to study of *Biolo* et al. [7] ABSI is a more direct marker of abdominal adiposity than visceral adiposity. So ABSI can be used as a practical criterion to predict adiposity-related health risks in clinical assessments. Studies have shown that ABSI is positively associated with fat mass and negatively with fat-free mass [14]. Our findings confirm this fact.

The predictability of ABSI and other anthropometric parameters for chronic diseases and all-cause mortality may not be uniformly distributed across population subgroups. WHR and WtHR showed significant differences between Mexico and Colombia [33]. A study conducted among a European population showed that waist circumference and WHR are stronger predictors for cardiovascular mortality than BMI and ABSI [40]. Study conducted in a middle-age, older Indonesian population reported that ABSI was less strongly associated with incident hypertension than waist circumference and BMI [13]. ABSI was not found to be associated with mortality among Chinese male and haemodialysis patients [1, 20]. The risk for mortality was observed to increase with rising levels of ABSI [9].

CONCLUSIONS

In our study we examined the usefulness of the ABSI in obesity diagnosis compared with other anthropometric parameters like WC, WHR, BMI, VFA and BFP. We found that obesity was diagnosed according to waist circumference in 31% of participants. BMI, VFA and BFP values increased linearly in both genders with increasing waist circumference. Waist circumference reflects more or less central obesity but is sensitive to body size. According to BMI, 20.3% of subjects were overweight and 5.1% obese. With increasing BMI values, the values of WC, WHR and VFA increased linearly, too. According to visceral fat area, 11.4% of participants were in the risk obese group and by ABSI mortality risk there were 22% of subjects with high risk (4.8% and 28.3% for men and women, respectively) and 19.1% with very high risk (11.1% and 22% for men and women, respectively). VFA and BFP values increased with increasing risk of mortality, and in men also waist circumference values. When evaluating the ABSI in relation to BMI, the U-shaped curve was confirmed and in the case of WC the J-shaped curve. Participants with very low and very high mortality risk had almost equal values, respectively the highest BMI and WC values. This finding was also confirmed for the male group (J-shaped mortality risk for BMI). The FFM evaluation showed that the very low ABSI mortality risk group reached the highest values of this parameter and the lowest values showed the average mortality risk group, not only in the study group but also in male and female groups. Our findings suggest the relevance of ABSI to screen at-risk population.

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Conflict of interest

The authors declare no conflict of interest.

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