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A BODY SHAPE INDEX - ABSI IN RELATION TO THE PREVENTION OF CIVILIZATION DISEASES IN FEMALES

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Abstract

Obesity is often quantified using the Body Mass Index (BMI). Nevertheless, the disadvantage of BMI is that it does not distinguish between the accumulation of fat and muscle mass. On the other hand, the proportion of body fat in the body does not distinguish between abdominal and peripheral fat. Abdominal fat is negatively associated with the onset of cardiometabolic diseases. The aim of this research was to evaluate changes in the parameters of anthropometry and body composition - risk values of civilization, especially cardiometabolic diseases. The specific objective was to compare the novel index - A Body Shape Index (ABSI) and the conventional Body Mass Index (BMI), as well as their relationship to other parameters.

Anthropometry and body composition measurements were performed in a group of 198 randomly selected females (university students) aged 20 to 25 years (average age 21.73 ± 0.88 years) from the Slovak University of Agriculture in Nitra. Body composition parameters were determined using a Bodystat Quadscan 4000 (Bodystat Ltd, Doubles, Isle of Man, UK) based on the multifrequency method of bioelectrical impedance. For statistical evaluation we used: T-test, χ2-test, ANOVA, Tukey's post-hoc test and nonparametric correlation analysis (Spearman's coefficient) using the statistical software Statistica Cz 10 (Dell Statistica, USA).

In the second repeated measurement after 21 calendar months and evaluation, we observed an increase in hip circumference of 1.41 cm ($p < 0.001$), an increase in body area of 0.01 m^2 ($p < 0.001$) and a decrease in anhydrous active body mass increased by 0.93 kg ($p < 0.01$) with increasing age. The BMI was significantly lower by 0.22 kg x m^{-2} ($p < 0.05$), while ABSI increased slightly by 0.001 ($p > 0.05$). The waist to hip ratio (WHR) was significantly lower by 0.01 ($p < 0.01$) in the second measurement, the waist to height ratio (WHtR) did not change significantly.

Our results point to the potential use of ABSI in a group of young females in clinical decisions and to correlate with lifestyle and other health risk factors.

***Key words**: A body shape index (ABSI), Body mass index (BMI), Body composition, Females, Risk factors, Cardiometabolic diseases.*

1. Introduction

Obesity is considered to be one of the leading causes of premature death worldwide. The prevalence of obesity has risen significantly in numerous European countries, while on the other hand, this increase is often accompanied by a simultaneous rise in chronic non-communicable diseases [1]. Worldwide, the incidence of obesity has almost tripled between 1975 and 2016. According to the World Health Organization (WHO), more than 1.9 trillion adults aged 18 and over were overweight, and out of these, more than 650 million were obese in 2016. The majority of the world's population lives in countries where overweight and obesity cause a higher mortality in comparison to underweight [2].

According to current data published by the Organization for Economic Co-operation and Development (OECD), the global incidence of overweight or obesity is 56%. Out of these statistics, 51.5% of the Slovak population is overweight or obese in comparison to 55% in the Czech Republic [3]. Furthermore, the current demographic development in Europe with a higher proportion of the elderly population suggests that investments in medical and preventive care will continue to increase (National action plan for obesity prevention 2015 - 2025) [4].

Obesity is traditionally quantified using the Body Mass Index (BMI). The disadvantage of BMI lies in its inability in distinguishing between the accumulation of fat and muscle mass. Moreover, the proportion of body fat in the body does not distinguish between abdominal fat (central fat) and fat located in a different area of the body figure (peripheral area). In the case of BMI, the risk is also affected by the shape of the body (body figure), serving as a marker of abdominal fat deposition [5]. What is more, the WHO report states that the waist circumference (WC) could be an important indicator of disease risk and a better alternative to BMI [6].

In 2012, Krakauer and Krakauer, [5], developed a new index - ABSI (A Body Shape Index), which, in addition to body weight (BW) and height (BH), also takes the circumference of the waist (WC, waist circumference) into account. The ABSI index was designed within the National Health and Nutrition Examination Survey (NHANES) in 1999 - 2004. The development of this index was based on the assessment of the US population of 14,105 adults aged 18 years and older, followed by a mortality evaluation for an average of 5 years (828 deaths). The survey indicated that the WC was higher than expected when a given height and weight were assessed, and corresponds more to a central concentration of body volume. Body shape, as reported using the ABSI index and calculated from basal clinical measurements, may be a significant risk factor for premature mortality in a population.

Obesity is a preventable disease. The Vienna Declaration on nutrition and non-communicable diseases in the context of the EU Health 2020 Strategy Paper emphasizes that the involvement of the society as a whole and a subsequent implementation of health approaches in all policies is crucial [7].

The aim of this research was to evaluate changes in the parameters of anthropometry and body composition which may be considered as risk values of civilization, especially in the case of cardiometabolic diseases. The specific objective was to compare the novel A Body Shape Index (ABSI) and the conventional Body Mass Index (BMI), as well as to evaluate their relationship to other parameters.

2. Materials and Methods

The study involved 198 randomly selected adult women, with a mean age of 21.73 ± 0.88 years (ranging from 20 to 25 years). The selection of participants reflected a wide spectrum of BMI in the assessed population of young adult women (ranging from 15.24 to 34.14 kg/m^2). We evaluated the parameters of the body composition of the subjects as a component of the health and nutritional status. The measurement of health and nutritional parameters (anthropometric markers and body composition) were repeatedly performed after 1.75 years (21 calendar months), under the same conditions, instrumentation and methodology. During the second (repetitive) measurement, the mean age of the participants was 23.36 ± 0.73 years (ranging from 22 to 27 years).

In case of the anthropometric parameters, the body weight was assessed with a Brutus Tanita HD-351 digital personal scale (Tanita Europe, Hoofddorp, Netherlands) with an accuracy of 0.1 kg, while the body height was recorded using a Bodyson ultrasonic body height meter (ADE GmbH & Co., Hamburg, Germany) with an accuracy of 0.5 cm. The waist circumference and the hip circumference were measured using a tape measure to the nearest 0.1 cm. The measured data served to calculate the following somatic indices: Body Mass Index (BMI; kg/m^2); A Body Shape Index (ABSI); Waist to Hip Ratio (WHR) - centrality index; and Waist to Height ratio (WHtR). Furthermore, the body surface area - BSA (m^2), and the body adiposity index - BAI (%) were determined. BAI was calculated from height and hip circumference data [(hip circumference (cm))/(height (m)$^{3/2}$)-18] [8]. ABSI was determined from the data on the body weight, height and waist circumference (WC) : WC/(BMI$^{2/3}$ x Height$^{1/2}$), where the height and WC were given in meters [5].

The selected parameters were assessed according to the criteria given in Table 2. We evaluated the occurrence of risk values of the waist/height ratio in the case of a milder criterion (≥ 0.60). Furthermore, the occurrence of risk values was also observed using a stricter criterion (> 0.50) for a better evaluation of the results. WHO data (2020) [9] were used to evaluate BMI.

Body composition parameters were determined using a Bodystat Quadscan 4000 (Bodystat Ltd, Doubles, Isle of Man, UK) based on the principle of a multifrequency method of bioelectrical impedance with measurements at 4 frequencies (5 kHz, 50 kHz, 100 kHz, 200 kHz). The following parameters of body composition were evaluated: body fat (%, kg), fat free mass (FFM) (%, kg) and dry lean mass (DLM) (kg). We also determined the level of physical activity as a factor affecting the body composition, the overall health and nutritional status of individuals, using a range of degrees (1 to 5) according to the methodology of the Bodystat Quadscan 4000 device. Prior to each measurement, the subjects were informed in advance about the methodological procedure and signed an informed consent.

The collected data were statistically evaluated using descriptive statistics, paired T-test and χ^2-test. We tested the differences between the groups stratified on the basis of ABSI using the analysis of variance (ANOVA) and Tukey's post-hoc test to identify pairs in which the mean values of the examined parameters and indices differed significantly at the significance level of 0.05. In order to determine the interrelationships between the measured parameters, we subjected the obtained data to a nonparametric correlation analysis (Spearman's coefficient). Statistica Cz 10 (Dell Statistica, USA) program was used for the statistical evaluation.

3. Results and Discussion

Within the group of young healthy women, we examined the proportion of individual body components, selected health and nutritional parameters (including somatic indices), as well as changes that occurred over time.

In case of the anthropometric markers, the second measurement revealed a significant increase in the hip circumference ($p < 0.001$) and body surface area ($p < 0.001$) corresponding to an increasing age. On the other hand, a significant decrease in the dry lean mass ($p < 0.01$) was recorded (Table 1).

Within the assessed indices and ratios, the BMI was significantly lower in the repetitive assessment ($p < 0.05$), while the ABSI increased slightly ($p > 0.05$). WHR was significantly lower in the second measurement ($p < 0.01$), however WHtR did not change significantly.

The waist circumference, which makes it possible to determine the increased risk of possible complications of obesity, did not increased significantly with age. A significant increase in the hip circumference and the waist/hip ratio, as well as a decrease in active body mass expressed without water content are related to the physical activity, the values of which remained well below a medium degree in the group. These observations were evaluated negatively, as an adverse phenomenon in terms of an increased risk of civilization diseases, in the prevention of non-infectious health complications of civilization, including cardiometabolic diseases.

In case of the individual parameters, we evaluated the proportion of women with possible risk values. In terms of the prevalence of risk factors, a high proportion of body fat in the sample was observed, which corresponded to more than a quarter of women in both measurements (26.3% and 27.8%). By evaluating body fat, we found that the proportion of women with high fat content did not differ significantly in the first and second measurement. In the second measurement, more women had risk values for systolic blood pressure (7.1% versus 3.5%). Repeated measurements significantly increased the number of cases with a high diastolic pressure (from 1.5% to 13.6%, $p < 0.001$).

Table 1. Characteristics and comparison of parameters in the studied set of female volunteers

Risk factor	1st measurement (N = 198)	2nd measurement (N = 198)	T-test	
Level of physical activity	2.42 ± 0.61	2.44 ± 0.60	0.786	NS
Anthropometric parameters				
Age (years)	21.73 ± 0.90	23.36 ± 0.77	0.000	+++
Weight - w (kg)	60.28 ± 8.85	60.48 ± 9.14	0.390	NS
Height - Ht (cm)	166.02 ± 5.44	-	-	n
Waist circumference - WC (cm)	70.81 ± 6.71	70.91 ± 7.42	0.757	NS
Hip circumference - HC (cm)	97.92 ± 6.37	99.33 ± 6.95	0.000047	+++
Body constitution parameters assessed by the BIA method				
Body fat - BF (%)	21.91 ± 6.08	21.54 ± 6.37	0.400	NS
Body fat - BF (kg)	13.37 ± 5.50	13.38 ± 5.35	0.979	NS
Fat free mass - FFM (%)	78.09 ± 6.08	78.46 ± 6.37	0.400	NS
Fat free mass - FFM (kg)	46.91 ± 6.62	47.11 ± 6.53	0.603	NS
Dry lean mass - DLM (kg)	14.90 ± 5.28	13.97 ± 2.74	0.006	++
Somatic indices				
Body mass index - BMI (kg/m^2)	21.86 ± 2.95	21.64 ± 3.15	0.014	+
Body shape index - ABSI	0.070 ± 0.003	0.071 ± 0.003	0.246	NS
Waist/hip ratio - WHR	0.72 ± 0.04	0.71 ± 0.05	0.004	++
Waist/height ratio - WHtR	0.43 ± 0.04	0.42 ± 0.04	0.187	NS
Body surface area - BSA (m^2)	1.67 ± 0.12	1.68 ± 0.12	0.0003	+++

Legend: Values are expressed as mean ± SD; NS ($p \geq 0.05$); + ($p < 0.05$); ++ ($p < 0.01$); +++ ($p < 0.001$), n - not tested.

This observation was also reflected in an increased proportion of women with unfavorable systolic and/or diastolic blood pressure at a later examination, which was observed in 16.2% of women in comparison to 3.5% gathered from a previous examination ($p < 0.001$) (Table 2).

Almost a fifth of the group had unfavorable BMI values without a significant difference in comparison to the later evaluation (17.2% and 12.6%). According to the centrality index in the cohort, there was no high-risk WHR ratio (≥ 0.85), considered to be an android health risk, however 8.1% and 6.6% of women, respectively, had a high waist circumference accompanied by an increased risk of metabolic and cardiovascular complications. 6.6% of the group had an unfavorably high waist/height ratio (> 0.50) during both examinations. We did not observe the occurrence of a risk waist/height ratio using a less stringent criterion (≥ 0.60), which is why we may assume that one of the reasons for this observation may lie in a young age of the examined group.

Ostrihoňová *et al.*, [10], studied a large cohort of 45,216 women (aged 25 and over), and recorded high values for the waist circumference (80 cm and more) in more than a half (58.84%) of women. The authors found a significantly higher proportion of women with a waist circumference within the morbidity risk zone starting from the group of 25 years to the age category of 65 years and older. In case of this study, we evaluated a younger age category of women (from 20 to 25 years).

We also focused on the level of physical activity of women due to its expected effect on body composition. Within the individual levels of physical activity (Table 3), the representation of women in the first and second measurements decreased in the order: low/medium > medium > medium/high > very low activity. Overall, we can state that the largest share of the studied set of volunteers (more than half) was characterized by a low/medium activity (occasional recreational physical activity) and more than a third exhibited medium activity (regular physical activity mostly over the weekend). Very high activity (5th degree) did not occur in the studied subjects, the women did not perform demanding or competitive sport activities. Levels of the physical activity from the 1st to 4th degree, respectively, did not differ significantly when comparing the first and the second measurement, i.e. following 1.75 years.

Table 2. Prevalence of cardiometabolic health risks in the studied set of female volunteers

Risk factor	**1 st measurement** (N = 198)		**2nd measurement** (N = 198)		**p-value**	**χ^2-test**
	N	**%**	**N**	**%**		
Body fat - BF **> 25 %**	52	**26.3**	55	**27.8**	0.98995	NS
Body mass index - BMI **≥ 25 kg/m^2**	34	**17.2**	25	**12.6**	0.65639	NS
Waist circumference - WC **> 80 cm**	16	**8.1**	13	**6.6**	0.95334	NS
Waist/height ratio - WHtR **> 0.50**	13	**6.6**	13	**6.6**	1.00000	NS
Systolic blood pressure - sBP **> 140 mmHg**	7	**3.5**	14	**7.1**	0.48183	NS
Diastolic blood pressure - dBP **> 90 mmHg**	3	**1.5**	27	**13.6**	0.00012	+++
Systolic and diastolic blood pressure* **sBP > 140 mmHg and dBP > 90 mmHg**	3	**1.5**	9	**4.5**	0.37740	NS
Systolic and/or diastolic blood pressure ** **sBP >140 mmHg and/or dBP > 90 mmHg**	7	**3.5**	32	**16.2**	0.00049	+++

Legend: * 2 risk factors present (high systolic and diastolic blood pressure), i.e. present 2 risk factors simultaneously; ** at least 1 risk factor present (high systolic and/or diastolic blood pressure), i.e. present 1 or 2 risk factors simultaneously; Explanations different to Table 1.

Table 3. Level of physical activity in the studied set of female volunteers

Level of physical activity	**1st measurement** (N = 198)		**2nd measurement** (N = 198)		**p-value**	**χ^2-test**
	N	**%**	**N**	**%**		
1 - Very low	3	**1.5**	2	**1.0**	n	n
2 - Low/medium	117	**59.1**	116	**58.6**	0.99972	NS
3 - Medium	69	**34.8**	71	**35.9**	0.99756	NS
4 - Medium/high	9	**4.5**	9	**4.5**	1.00000	NS

NS (p ≥ 0.05), n - not tested.

The cumulative evaluation of activity levels showed that the performance of physical activity at the level of 1 to 2 slightly predominated in the group, without statistical significance (60.6% at the initial and 59.6% at the subsequent measurement). This is an unfavorable finding as subjects with a higher degree of activity were less frequent in the first (39.3%) as well as in the later measurement (40.4%).

Subsequently, we performed an adjustment to the body shape index ABSI (Table 4) in order to evaluate changes in other monitored parameters of cardiometabolic health risk with an increasing ABSI value, as ABSI has the potential to improve the clinical evaluation beyond commonly used procedures.

BMI values decreased significantly with increasing ABSI values ($p < 0.05$). Higher ABSI values, which may indicate an increased risk for metabolic diseases, were also distributed at low BMI values, indicating a reduction in BMI as a predictor of morbidity in young adult women, and at the same time probably due to interindividual variability in ABSI. Bouchi *et al.*, [11], considered ABSI as a BMI-independent marker of visceral adiposity when they confirmed a significant positive correlation between ABSI and visceral fat area (VFA) ($r = 0.138$, $p = 0.001$) and a negative correlation with BMI ($r = -0.085$, $p = 0.037$) in a cross-sectional study of 607 patients with type 2 diabetes mellitus.

The waist circumference (cm) increased significantly between the quartiles from an average of 67.15 cm at the lowest ABSI in quartile Q1 to 73.79 cm at the highest ABSI in quartile Q4 ($p < 0.001$). To quantify visceral obesity, WC has the advantage of being simple to measure, requiring only a tape measure. The increased interest in WC and its preference for clinical measurements are understandable in terms of limiting the availability and high costs of more demanding assessments (such as biochemical, imaging or genetic examinations). WC, height, and weight are values that enter the ABSI determination; body shape index may contribute to a better assessment of the risk associated with obesity and body composition that is not revealed by BMI [12]. The centrality index (WHR) and WHtR also increased with growing ABSI values ($p < 0.001$).

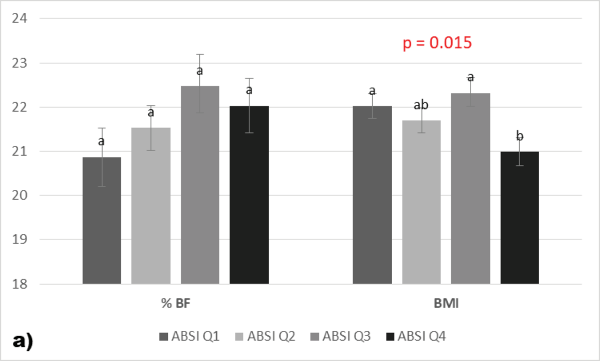
We observed a slight increase in the body fat (% BF) in parallel with an increased ABSI by 1.16% ($p = 0.309$) (Figure 1a). With increasing ABSI value in the examined group of young healthy women waist circumference increased by 0.07 m, WHR by 0.09 (Figure 1b) and WHtR by 0.03. Inversely, BMI values decreased significantly with increasing ABSI values (Table 4, Figure 1a), systolic blood pressure values decreased significantly, while a slight diastolic blood pressure values slightly decreased with an increasing ABSI index without statistical significance (Table 4).

Table 5 shows the correlation between anthropometric markers of body composition (height, weight, BMI, WC, WHR and ABSI), direct measurement of visceral and subcutaneous fat - BF (%, kg), systolic and diastolic blood pressure (sBP and dBP). ABSI correlated slightly with WC ($r = 0.389$, $p < 0.001$), WHR ($r = 0.567$, $p < 0.001$) and WHtR ($r = 0.333$, $p < 0.001$). In contrast, ABSI negatively correlated with weight ($r = -0.033$, $p =$

Table 4. Anthropometric parameters after adjustment for ABSI (mean ± SD) in set of female volunteers (N = 396)

Quartile	**Q1**	**Q2**	**Q3**	**Q4**
ABSI interval	≤ 0.0684	0.0685 - 0.0704	0.0705 - 0.0727	≥ 0.0728
N	98 (24.75%)	100 (25.25%)	97 (24.49%)	101 (25.51%)
ABSI	0.067 ± 0.002^{a}	0.069 ± 0.001^{b}	0.072 ± 0.001^{c}	0.075 ± 0.002^{d}
Age (roky)	22.44 ± 1.25	22.49 ± 1.33	22.69 ± 1.29	22.79 ± 1.07
Ht (m)	1.66 ± 0.05^{a}	1.66 ± 0.06^{a}	1.66 ± 0.05^{a}	1.69 ± 0.06^{b}
WC (cm)	67.15 ± 5.08^{a}	69.42 ± 5.54^{b}	73.01 ± 7.40^{c}	73.79 ± 7.76^{c}
HC (cm)	98.28 ± 6.53^{ab}	97.46 ± 6.53^{a}	99.34 ± 7.06^{b}	99.45 ± 7.39^{b}
BMI (kg/m^{2})	22.02 ± 2.77^{a}	21.70 ± 2.83^{ab}	22.32 ± 3.32^{a}	20.99 ± 3.14^{b}
w (kg)	60.46 ± 7.81	59.64 ± 7.75	61.74 ± 10.58	59.73 ± 9.50
WHR	0.68 ± 0.04^{a}	0.71 ± 0.03^{b}	0.73 ± 0.03^{c}	0.74 ± 0.05^{c}
WHtR	0.41 ± 0.03^{a}	0.42 ± 0.04^{b}	0.44 ± 0.04^{c}	0.44 ± 0.04^{c}
BF (%)	20.87 ± 6.49	21.53 ± 5.13	22.48 ± 7.02	22.03 ± 6.10
BF (kg)	12.64 ± 5.35^{a}	12.95 ± 4.34^{ab}	14.26 ± 6.03^{b}	13.65 ± 5.74^{ab}
FFM (%)	79.23 ± 6.22	78.26 ± 5.11	77.95 ± 7.00	77.61 ± 6.17
FFM (kg)	47.65 ± 6.21	46.63 ± 6.75	47.54 ± 7.02	46.15 ± 6.23
DLM (kg)	15.23 ± 5.15^{a}	14.14 ± 5.43^{ab}	14.35 ± 2.47^{ab}	13.99 ± 2.89^{b}
BSA (m^{2})	1.67 ± 0.11^{a}	1.76 ± 0.58^{b}	1.68 ± 0.14^{ab}	1.68 ± 0.13^{ab}
BAI (%)	28.10 ± 3.23	27.69 ± 3.15	28.41 ± 3.10	27.51 ± 4.24
sBP (mmHg)	122.12 ± 15.13^{a}	119.52 ± 13.37^{ab}	119.46 ± 13.87^{ab}	117.24 ± 13.15^{b}
dBP (mmHg)	77.19 ± 10.38	75.90 ± 8.08	75.41 ± 9.18	77.64 ± 8.82

Legend: ^{abc} different symbols in a line mean significant differences ($p < 0.05$). BAI - body adiposity index. Explanations different to Table 1.



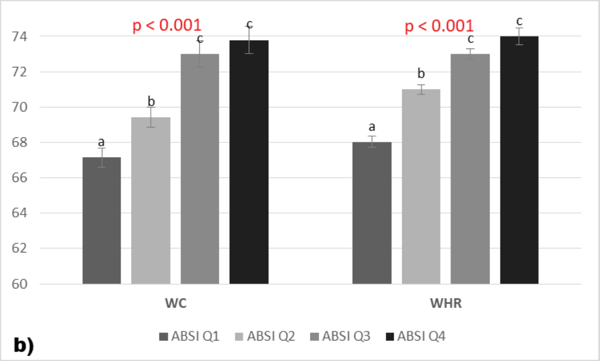


Figure 1 a) Percentage of body fat (% BF) and body mass index (BMI) according to the quartiles of A Body Shape Index (ABSI) in young women (N = 396)

Figure 1 b) Percentage of waist circumference (WC) and waist to hip ratio multiplied by 100 (WHR x 100) levels according to the quartiles of A Body Shape Index (ABSI) in young women (N = 396)

p-values by one-way analysis of variance (ANOVA)

0.508) and BMI (r = -0.116, p = 0.021). We found a weak correlation without statistical significance between ABSI and the body fat fraction (BF (%) r = 0.066, p = 0.188 and BF (kg) r = 0.061, p = 0.222).

The weak correlation between ABSI and BF suggests other mechanisms that could lead to an association between high ABSI and obesity unspecified for visceral, as the BF parameter speaks of the proportion of fat - subcutaneous and visceral. According to Biolo *et al.*, [13], ABSI may inversely reflect the muscle mass independently of BMI, and being associated with FFM (%) as determined by the bioelectrical impedance (BIA) analysis (r = -0.068, p = 0.176), FFM (kg) (r = -0,0986, p = 0.0499), DLM (kg) (r = -0.0965, p = 0.0549). High ABSI could reflect low skeletal muscle mass with an increased visceral abdominal adiposity. Within the group of young women (n = 198) we recorded that only about a quarter of subjects (26.3 and 27.8%, respectively), had a risk proportion of body fat (> 25%) in both measurements, which can be considered as one of the probable causes of a weak negative correlation between ABSI and FFM or DLM. After adjusting to ABSI, we observed a significant decrease in DLM with increasing ABSI (Table 4).

The ABSI index, which was the focus of our research, correlated most closely with WHR. We have also shown its close correlation with waist circumference and WHR. We found a weaker dependence of ABSI with body height (positive correlation) as well as with BMI (negative correlation), which were significant. We did not confirm the significance of the relationship between ABSI and body fat (%, kg) as well as BSA. Hoermann *et al.*, [14]. investigated whether ABSI reflects changes in the body composition more accurately than traditional markers. The readily available anthropometric parameter ABSI reflected better the decrease of fat mass in obese men on diet and testosterone treatment than BMI or WC. Ehrampoush *et al.*, [15], confirmed that ABSI is a good predictor of body fat percentage when a cross-sectional study of 1,360 healthy individuals examined the anthropometric indices used in relation to body fat. At the same time, they confirmed that the anthropometric index WHtR (waist to height ratio) is better for the assessment of fat accumulation in the abdominal area in contrast to other indices (including BMI), and it is able to more accurately assess the percentage of body fat. Our results, similar to the authors' results, confirmed a positive correlation between WHtR and relative body fat (r = 0.597, *p* < 0.001) or absolute body fat (r = 0.701; p < 0.001) in a group of 396 young women (Table 5).

The cardiovascular and overall mortality in relation to various anthropometric parameters of obesity have been studied in many studies. Some anthropometric indicators of abdominal obesity had a linear relationship to the cardiovascular mortality, while others demonstrated the relationship to overall mortality as shown by the J-curve. Meeuwsen *et al.*, [16], reported that the association between BMI and fat percentage (% fat) was neither linear, not strong, especially with an unfavorable BMI range, and that BMI was affected by age. The body composition was measured with a Bodystat bio-impedance device in a sufficiently robust set of 23,627 English adults aged 18-99 years (99% were aged 70 years or less). BMI progressively increased with age in women. At a given BMI, the body fat increased with age (1.9 kg per decade) as well as % of fat mass (1.1 - 1.4% per decade).

Song *et al.*, [17], showed a J-curve dependence with both cardiovascular and overall mortality in the case of BMI. The authors monitored anthropometric indicators of obesity and mortality by examining the body mass index (BMI), waist circumference (WC), waist/hip ratio (WHR), waist/height ratio (WHtR), body shape index (ABSI), and waist to hip to height ratio (WHHR) in a cohort of 46,651 European men and women aged 24 - 99 years.

Table 5. Spearman correlations between values of markers of health and nutritional status of women (N = 396)

	Ht	WC	w	BMI	WHR	WHtR	BF (%)	BF (kg)	ABSI	BSA	BPs	BPd
Ht		0.004	< 0.001	0.038	0.937	< 0.001	0.003	0.894	< 0.001	0.001	0.015	0.006
WC	0.143		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
w	0.336	0.873		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.508	< 0.001	< 0.001	< 0.001
BMI	-0.104	0.855	0.901		< 0.001	< 0.001	< 0.001	< 0.001	0.021	< 0.001	< 0.001	< 0.001
WHR	0.004	0.741	0.478	0.504		< 0.001	< 0.001	< 0.001	< 0.001	0.224	0.004	0.212
WHtR	-0.184	0.946	0.756	0.882	0.734		< 0.001	< 0.001	< 0.001	0.003	< 0.001	< 0.001
BF (%)	-0.147	0.551	0.480	0.581	0.313	0.597		< 0.001	0.188	0.100	0.049	0.011
BF (kg)	0.007	0.707	0.688	0.726	0.405	0.701	0.942		0.222	0.002	< 0.001	< 0.001
ABSI	0.166	0.389	-0.033	-0.116	0.567	0.333	0.066	0.061		0.354	0.053	0.386
BSA	0.171	0.208	0.281	0.215	0.613	0.149	0.083	0.157	-0.047		0.657	0.995
BPs	0.122	0.290	0.384	0.348	0.145	0.248	0.099	0.202	-0.097	0.022		< 0.001
BPd	0.138	0.242	0.275	0.226	0.063	0.199	0.128	0.199	0.044	-0.003	0.623	

Legend: The right side (above the diagonal) shows the correlation of the *p* value; the left side (below the diagonal) shows the r Spearman correlation coefficient. Explanations different to Table 1.

A prospective study from Mauritius found that a higher waist circumference (WC) and a lower hip circumference (HC) correlated with a higher risk of mortality, while BMI values did not correlate with mortality [18]. The prospective study does not directly indicate whether interventions aimed at reducing ABSI would reduce the risk of mortality independent of the change of weight.

He *et al.*, [19], found in a 15-year prospective study that in middle-aged Chinese adult men, the ABSI index may not be associated with mortality, while in the US and British populations, the anthropometric parameter of ABSI is considered a major risk factor for mortality. Haghighatdoost *et al.*, [20], found that ABSI was a weak predictor of cardiovascular risk and metabolic syndrome in the Iranian adult population. They studied 9,555 individuals aged 19 years and over with a mean age of 38.7 years and a BMI of 25.7 kg/m^2.

Motamed *et al.*, [21], identified the best discriminators in the diagnosis of metabolic syndrome (MetS) in a set of 5,910 subjects of different obesity indices. The discriminant power of several indices in diagnosing at least two other MetS components present was evaluated. With the exception of BMI in women, the waist circumference (WC), waist/hip ratio (WHR), and waist/height ratio (WHtR) were good discriminators in the diagnosis of MetS. Adejumo *et al.*, [22], compared the ability of anthropometric parameters to predict MetS in healthy individuals with and without MetS. Out of all 11 evaluated anthropometric parameters in both men and women, WC was the best. Gomez-Marcos *et al.*, [23], analyzed the ability of various adiposity indices to identify individuals with MetS in people at moderate cardiovascular risk. The investigated adiposity indices (WHtR, BRI), with the exception of ABSI, showed an association with MetS and a similar ability to detect subjects with MetS among subjects with a moderate cardiovascular risk.

Haraguchi *et al.*, [24], examined the association between traditional and novel body composition indices and arterial stiffness. According to the authors, ABSI and body roundness index (BRI) could be used to identify predictors of vascular remodeling or organic vascular dysfunction. The obesity paradox suggests that people with a normal BMI may have a higher risk of mortality than people with a BMI that falls under the obesity criterion. Furthermore, the study suggests that ABSI can be used with high accuracy to evaluate fat distribution in non-obese men to predict arterial stiffness.

Yang *et al.*, [25], compared new anthropometric indices with traditional hypertension prediction parameters, and developed models of hypertension prediction in the elderly subjects in China. Significant positive associations were found between BMI, WC, WHtR, visceral adiposity index (VAI), BRI and risk of hypertension. BMI was the strongest predictor of hypertension when compared to other anthropometric indices.

It is necessary to appeal to the population through preventive and educational activities aimed at improving and strengthening health throughout life and not only when health problems appear. Preventive interventions aimed at children and young people mean a return on investment in medical-preventive care of about 6 - 10%, if the interventions are implemented at an early age [26, 27].

ABSI has the potential to improve clinical evaluation beyond commonly used measures. The comparison of anthropometric indicators should be based on a consistent methodology, including the adjustment of known covariates such as age and gender.

In this article, we respect the original designation "A body shape index" (ABSI). However, as it is not common to refer to the BMI as the "A body mass index" (ABMI), but the abbreviation BMI (body mass index) as well as the body roundness index (BRI) are being used, it is worth considering using a clear body shape index (BSI) label when introducing ABSI into routine clinical practice.

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4. Conclusions

- Accurate measurement of visceral fat multiplication - risky in terms of the development of cardiometabolic morbidity and mortality using reference methods such as DEXA, CT, MRI cannot be used in routine clinical practice or in epidemiological studies.

- Our results show that the ABSI index well reflected the trunk fat measured by the waist circumference, or the total body fat measured by the BIA method. Determination of the ABSI index could be a useful metric indicator of the amount of abdominal fat comparable to waist circumference, abdominal circumference, measurement of visceral fat by other methods, e.g. BIA.

- Our results point to the potential use of body shape index (ABSI) in a group of young women in clinical decisions and to the correlation with lifestyle and other health risk factors. We propose to shorten the designation used for the ABSI body shape index and to introduce the abbreviation BSI (instead of ABSI).

- Subsequent studies in larger cohorts differentiated on the basis of age, gender, health status, physical activity, lifestyle, diet and somatotype are needed to examine in detail the potential and possible benefits of ABSI as a clinical marker in the Slovak population to determine the risk of morbidity associated with obesity.

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