THE POSTURE OF THE TRUNK IN THE SAGITTAL PLANE AND THE SHAPE OF FEET IN OLDER WOMEN WITH NORMAL AND EXCESSIVE BODY WEIGHT

Katarzyna Wódka, Eliza Smoła, Marta Bibro, Małgorzata Łaczek-Wójtowicz, Agnieszka Jankowicz-Szymańska

University of Applied Sciences in Tarnow, Faculty of Health Sciences, Poland

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Abstract

The aim of this study has been to determine the relationship between the shape of the thoracic kyphosis, lumbar lordosis and sagittal trunk inclination, and the longitudinal and transverse arches of the feet, the position of the hallux and the fifth toe in women with normal and excessive body weight.

Material and methods: Eighty nine women aged from 57 to 84 were studied. The shape of the spine was examined using the Zebris pointer ultrasound system, and the shape of feet was evaluated with a podoscope with a 3D scanner. The data analysis was performed using the Statistica v13 software, frequency tables, descriptive statistics, the Kruskal-Wallis test, the post hoc Tukey test, and Spearman's rank-order correlations coefficient.

Obesity has been reported to increase thoracic kyphosis, increase the forward lean of the trunk and flatten the longitudinal arch of the feet. It was found that there is a relationship between the forward lean of the body and the reduction in the longitudinal and transverse arch of the feet and the valgus position of the hallux, and between the degree of thoracic kyphosis and the valgus position of the hallux. Excess body weight, to a greater extent than age, influences the position of the trunk and the shape of feet in older women.

A feature of the body posture that is characteristic of older women is the progression of thoracic kyphosis and lumbar lordosis, the forward lean of the body and the lowering of the arch of the feet.

Keywords*: body weight status, feet arching, posture, elderly*

Introduction

Medical care for the elderly involves maintaining their quality of life at the highest possible level. As some factors that reduce the quality of life cannot be eliminated, it is even more important to study the influence of those areas of health and fitness that can be modified on the comfort of life of the elderly. Body posture seems to be one of them. It is unique, individual and changeable for every human being. This variability is determined by many factors, including one's health, stage of life, and the intensity and quality of the processes which occur in the human body. Body posture changes throughout a person's life. In the first stages of ontogenesis, these are progressive changes, while between the ages of 40 and 50, regressive modifications begin, which increase in intensity over the age of 60. The aging process results in changes in the locomotor system: both in the ligamentous and the muscular structures. The observed decrease in muscle mass and strength, and the increase in adipose tissue volume combined with reduced physical activity may significantly affect the quality of body posture (W. Jack Rejeski & Mihalko, 2001; Acree et al., 2006; Martin, Sebastien Francois Ferriolli, Chastin Eduardo Stephens et al., 2012). These processes change the shape of the curvature of the spine resulting from balancing the weight of the body with supporting structures. For these reasons, taking into account the support-bearing function of the foot, its architecture changes throughout a person's life in a unique manner for every person (Puszczałowska-Lizis, 2011). High BMI indicative of overweight or obesity may contribute to the aggravation of involuntary changes in the feet and other body parts (Jankowicz-Szymańska et al., 2018).

Problem and aim

The goal of this study was to assess the position of the trunk and the shape of the feet in older women with different body weight status. The researchers searched for the relationship between the degree of curvatures, the balance of the trunk in the sagittal plane, the longitudinal and transverse arches of the feet, the position of the hallux and the fifth toe, and BMI. As the study group included people in both early and late old age, the correlation between age and the examined features of body posture was also estimated. The available literature lacks research on such dependencies, and these may provide knowledge that is important for more effective improvement of the quality of everyday functioning of older women in physical therapy.

Methods

Using an ad on Facebook and in a local newspaper, women aged 55 and over were invited to participate in the study. The recruitment lasted about one month. One hundred and six women volunteered. Seventeen women were excluded from the study due to having undergone ankle and foot joint surgery, suffering from neurological diseases, RA, AS, psoriasis, and recent lower limb trauma (up to 2 months prior). Ultimately, 89 women aged 57 to 84 (68.16 ± 6.26) were qualified to participate in the study. All participants were informed in detail about the course of the study and signed an informed consent to participate in it. The research was conducted in accordance with high scientific and ethical standards. Local ethics committee approval was obtained (No. 4/0177/2016).

Body height was measured using a calibrated anthropometer (ZPH Alumet No 010208, Warsaw, Poland) from the Basis point to the Vertex point with an accuracy of 0.01 m. The body weight was tested on a TANITA scale (body composition analyser bf-350; Tanita Corporation of America, Inc., Arlington Heights, Illinois) with an accuracy of 0.1 kg. Using the standard formula, the BMI value was calculated with BMI ≥25 kg/m2 indicating overweight, and BMI ≥30 kg/m2 indicating obesity.

The inclination of the trunk was tested using the Zebris pointer ultrasonic system (Zebris Medical GmbH Company, Germany), whose reliability was confirmed with tests (Kowalski et al., 2013; Takács et al., 2018). This system consists of a measuring sensor mounted on a tripod with built-in microphones, an ultrasonic indicator with two transmitters and a reference marker attached with a belt on the hips of the participant. During the examination, which lasted about two minutes, the participant stood in a habitual position, with arms hanging freely along the trunk and looked straight ahead, barefoot, in a bra and shorts pulled slightly down below the ilium. The degree of thoracic kyphosis was calculated as the sum of the angles of all thoracic vertebrae; and the lumbar lordosis - as the sum of the angles of all lumbar vertebrae. The values are given in degrees assuming that the normal value of thoracic kyphosis for women ranges between 21o and 32o and of lumbar lordosis – between 28o and 34o. Sagittal trunk inclination is given in degrees as the angle between the vertical plane and the plane passing through the C7 spinous process and the L5/S1 junction. Values lower than 2o indicated excessive backwards tilt of the trunk while values greater than 11o indicated excessive forward tilt of the trunk. Normative data provided by the manufacturer were used to assess the curvature of the spine and the inclination of the torso (Zebris Medical & WinSpine, 2009).

The shape of the feet was examined on a podoscope with a 3D scanner (CQ Elektronik System, Czernica, Poland) and described using selected parameters: Clarke's angle index which describes the measure of the longitudinal arch (CA, norm 42o-54o) (Jankowicz-Szymanska et al., 2017; Walicka-Cuprys K., Rachwał M.,& Paczesniak-Jost A, 2013), the Wejsflog index (WI, norm 2.55-3.00) (Rykała et al., 2013; Plaskiewicz et al., 2015) and the heel angle (γ, norm 14o-18o,) (Szczepanowska-Wolowiec et al., 2019; Rykała et al., 2013), both showing the transverse arch, the hallux valgus angle (α, norm 0o-9o) (Szczepanowska-Wolowiec et al., 2019), and the varus fifth toe angle (β, norm 0o-5o) (Szczepanowska-Wolowiec et al., 2019) (Fig. 1).

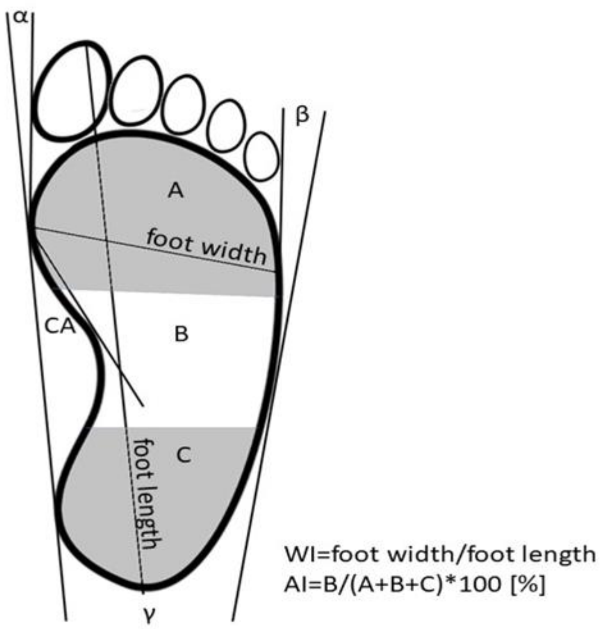

Figure 1. Foot shape assessment indices.

Additionally, the Arch Index values (AI, norm 21-28%) were analysed (Jankowicz-Szymańska et al., 2018) on the baroresistive P-walk platform (BTS Bioengineering, Milano, Italy). This index is used to characterise the longitudinal arch (proportion of the medial surface area of the footprint to the area of the entire footprint without toes). The usefulness of both devices for scientific research is confirmed by the publications of numerous scholars (Drzał-Grabiec et al., 2014; Truszczyńska-Baszak et al., 2017; Domagalska-Szopa & Szopa, 2014; Kumari et al., 2018; Caravaggi et al., 2018).

Statistical analysis was performed in the Statistica v13 software. Frequency tables and basic descriptive statistics were used. The Shapiro-Wilk test was used to check the hypothesis of normal distribution. As most of the variables were not normally distributed, the significance of intergroup differences was tested using the Kruskal-Wallis test and Tukey's post hoc test. Spearman's rank-order correlations were employed to assess the relationship between the variables, assuming that R <0.4 means a weak relationship, R within the range 0.4-0.69 means a moderate relationship, and R = or> 0.7 means a strong relationship (Schober et al., 2018; Akoglu, 2018). Differences and correlations were considered statistically significant at the significance level of p <0.05.

Results and discussion

The body weight of the studies women was 71.39 ± 10.19 kg and ranged from 53.80 kg to 92.90 kg. The body height of the subjects was 1.59 ± 0.06 m and ranged from 1.44 m to 1.78 m. Their BMI was 28.36 ± 3.89 kg/m2 and ranged from 20.50 kg/m2 up to 37.48 kg/m2. Among the participants of the study, 20 (22.5%) had normal body weight, 37 (41.5%) were overweight and 32 (36.0%) were obese.

The mean values of thoracic kyphosis and lumbar lordosis worsened in each of the groups along with the growing body weight status. However, the highest degree of both curves was recorded in women with obesity. In the case of lumbar lordosis, these were slight differences, but the degree of thoracic kyphosis was statistically significantly greater in women with obesity compared to those with normal body weight. The sagittal trunk inclination angle was significantly larger (greater inclination of the body forward) in women with obesity as compared to overweight women and women with normal body weight. However, the mean values of this parameter were within the normal range in each group (Tab. 1).

Table. 1. Comparison of thoracic kyphosis, lumbar lordosis and sagittal trunk inclination in women with normal body weight, overweight and obesity

Variable	Weight status	$\bar{x}$	Me	Min-Max	SD	P
Thoracic kyphosis [°]	normal	43.36	43.00	15.20-70.00	14.03	normal vs overweight p= 0.97
	overweight	42.55	43.10	14.90-70.00	14.53	normal vs obesity p= 0.03*
	obesity	50.86	50.95	30.10-70.0	11.27	overweight vs obesity p= 0.13
Lumbar lordosis [°]	normal	25.30	23.30	4.30-47.10	11.22	normal vs overweight p= 0.83
	overweight	26.93	24.90	6.20-50.00	10.60	normal vs obesity p= 0.85
	obesity	28.27	28.90	12.70-47.30	9.31	overweight vs obesity p = 0.57
Sagittal trunk inclination [°]	normal	4.13	4.25	0.40-9.10	2.18	normal vs overweight p= 0.99
	overweight	4.13	3.70	0.20-12.10	2.84	normal vs obesity p= 0.00*
	obesity	6.95	6.40	0.40-15.80	3.76	overweight vs obesity p= 0.00*

* - statistically significant difference

The most distinctive characteristic of the studied women, regardless of their body weight status, was the concurrence of increased thoracic kyphosis and lumbar lordosis (almost half of the participant with normal body weight and two thirds of the participants with excess body weight). A correct shape of both curves was observed in every third participant with normal body weight and every fourth participant with excess body weight (Tab. 2).

Table 2. The quality of the thoracic and lumbar spine setting in the examined women.

Weight status	Spine shape	Normal lumbar lordosis	Round lumbar lordosis	Flat lumbar lordosis	Row total
Normal	Normal thoracic kyphosis	3 37.50%	3 37.50%	2 25.00%	8
	Round thoracic kyphosis	2 22.22%	4 44.44%	3 33.33%	9
	Flat thoracic kyphosis	0 0.00%	0 0.00%	3 100.00%	3
Overweight	Normal thoracic kyphosis	3 25.00%	4 33.33%	5 41.67%	12
	Round thoracic kyphosis	3 20.00%	10 66.67%	2 13.33%	15
	Flat thoracic kyphosis	1 10.00%	1 10.00%	8 80.00%	10

Obesity	Normal thoracic kyphosis	2 25.00%	3 37.50%	3 37.50%	8
	Round thoracic kyphosis	4 18.18%	14 63.64%	4 18.18%	22
	Flat thoracic kyphosis	0 0.00%	0 0.00%	2 100.00%	2
Column total		18	39	32	89

The mean values of the α angle indicate the valgus position of the hallux of the right and left foot in each group (normal, overweight, obesity). The β angle also indicates the varus position of the fifth toe irrespective of the body weight status. The values of the γ angle and the WI point to a decrease in the transverse arch of the feet in the examined women. This tendency is only slightly greater in women with obesity (highest values of the γ angle and lowest values of WI). Significant differences were observed in the values of the Clarke angle and the AI between the participants with obesity and the overweight and normal weight women. Participants with obesity had significantly lower Clarke's angle values and higher AI values, which shows a lower longitudinal arch of the feet (Tab. 3).

Table 3. Selected foot shape indices and the body weight status in the examined women.

Variable	Weight status	Right foot					Left foot				
		$\bar{x}$	Me	Min-Max	SD	p	$\bar{x}$	Me	Min-Max	SD	p
α [°]	normal	20.82	19.30	-2.70-54.50	15.55	N vs Ov p=0.83	19.45	18.20	-0.40-50.90	15.03	N vs Ov p=0.93
	overweight	22.96	23.00	4.50-43.80	12.13	N vs Ob p=0.98	20.74	22.40	3.50-41.80	11.82	N vs Ov p=0.53
	obesity	20.25	18.55	4.20-46.20	12.93	Ov vs Ob p=0.67	23.49	25.15	3.80-52.70	13.47	Ov vs Ob p=0.66
β [°]	normal	15.74	17.35	4.30-26.20	6.37	N vs Ov p=0.98	16.71	17.20	4.30-41.90	7.99	N vs Ov p=0.83
	overweight	15.46	15.10	1.40-27.40	6.27	N vs Ob p=0.88	15.64	15.10	1.40-26.30	6.58	N vs Ov p=0.83
	obesity	16.55	16.20	4.50-28.90	5.99	Ov vs Ob p=0.74	15.62	16.25	0.40-25.60	5.88	Ov vs Ob p=0.99
γ [°]	normal	20.24	19.95	13.60-26.10	3.69	N vs Ov p=0.99	19.87	20.35	14.20-27.70	3.94	N vs Ov p=0.94
	overweight	20.16	19.70	14.20-27.30	3.58	N vs Ob p=0.95	19.50	19.90	12.40-27.70	3.55	N vs Ob p=0.91
	obesity	20.55	20.75	14.10-28.30	3.90	Ov vs Ob p=0.90	20.33	20.75	11.30-28.30	4.61	Ov vs Ob p=0.66
WI [proportion of length to width of the foot]	normal	2.29	2.27	1.97-2.71	0.18	N vs Ov p=0.90	2.33	2.36	1.98-2.64	0.20	N vs Ov p=0.96
	overweight	2.27	2.28	1.95-2.55	0.15	N vs Ob p=0.66	2.31	2.29	2.02-2.70	0.18	N vs Ob p=0.34
	obesity	2.24	2.26	1.93-2.51	0.17	Ov vs Ob p=0.85	2.24	2.20	1.89-2.80	0.22	Ov vs Ob p=0.37
CA [°]	normal	48.06	50.00	28.00-57.20	6.81	N vs Ov p=0.88	48.38	48.30	39.40-59.40	5.61	N vs Ov p=0.98
	overweight	47.12	47.50	25.70-62.50	7.44	N vs Ob p=0.03*	48.11	48.20	40.40.58.80	4.67	N vs Ob p<0.01*
	obesity	42.75	43.20	29.60-54.20	7.27	Ov vs Ob p=0.03*	41.67	41.05	19.3-60.00	8.70	Ov vs Ob p<0.01*
AI [%]	normal	23.46	22.39	16.91-30.81	3.91	N vs Ov p=0.60	22.29	24.44	6.44-30.91	6.80	N vs Ov p= 0,99
	overweight	24.59	24.56	12.13-32.67	4.68	N vs Ob p<0.01*	24.31	24.35	10.16-31.64	4.23	N vs Ob p<0.01*
	obesity	27.01	26.75	18.00-34.65	4.32	Ov vs Ob p=0.13	28.19	28.19	20.39-36.64	4.05	Ov vs Ob p<0.01*

N – normal body weight; Ov – overweight; Ob – obesity; WI – Wejsflog Index; CA – Clark angle; AI – Arch Index * - statistically significant difference

There was a statistically significant, albeit weak, relationship between the BMI and the degree of thoracic kyphosis and a slightly stronger (on the verge of moderate correlation) relationship between the BMI and the sagittal trunk inclination, Clarke's angle and the AI of both feet, as well as the α angle and WI of the left foot. The age of the participants significantly correlated with the right foot valgus angle and the indicators measuring the right foot's transverse arching (γ angle and WI index) (Tab. 4).

Table 4. Relationships between the setting of the trunk, feet shape and the value of the BMI index and age in examined women.

Variable	vs BMI			vs Age		
	R^2	R	p	R^2	R	p
Thoracic kyphosis [°]	0,05	0,22	0,03*	0,01	0,06	0,60
Lumbar lordosis [°]	0,01	0,15	0,17	0,04	-0,20	0,06
Sagittal trunk inclination	0,16	0,37	<0,01*	0,02	0,11	0,33
α right foot [°]	0,01	0,07	0,51	0,16	0,38	<0,01*
β right foot [°]	0,00	0,05	0,66	<0,01	0,11	0,29
γ right foot [°]	0,03	0,13	0,24	0,11	0,34	<0,01*
WI right foot	0,07	-0,19	0,08	0,14	-0,37	<0,01*
CA right foot [°]	0,13	-0,32	<0,01*	0,01	0,06	0,56
AI right foot [%]	0,16	0,39	<0,01*	<0,01	0,03	0,79
α left foot [°]	0,05	0,22	0,04*	0,04	0,16	0,13
β left foot [°]	0,00	0,02	0,86	0,01	0,06	0,58
γ left foot [°]	0,05	0,19	0,08	0,04	0,20	0,06
WI left foot	0,10	-0,30	<0,01*	0,04	-0,21	0,05
CA left foot [°]	0,20	-0,39	<0,01*	<0,01	-0,04	0,72
AI left foot [%]	0,24	0,47	<0,01*	<0,01	0,01	0,90

WI – Wejsflog Index; CA – Clark angle; AI – Arch Index * - statistically significant correlation

The relationships between the studied variables describing the position of the trunk in the sagittal plane and the shape of the feet were also analysed (due to the large amount of data, they were not included in the table). There were found statistically significant, but weak correlations between the inclination of the body in the sagittal plane and the α angle of the left foot (p = 0.03; R = 0.26; R2= 0.09), with the WI of the left foot (p = 0.03; R = -0.23; R.2= 0.08) and the Clarke angle of the left foot (p = 0.02; R = -0.26; R.2= 0.05) and also between the degree of thoracic kyphosis and the α angle (p = 0.03; R = -0.24; R2= 0.04).

Discussion

Along with the increase in BMI, a progression of thoracic kyphosis, a forward lean of the body, and a flattening of the longitudinal arch of both feet were observed, whereas in the left foot, an increase in the valgus of the hallux and a reduction in the transverse arch were found. Age, to a lesser extent than excessive body weight, influences the position of the trunk and feet in the participants. Our study shows that a forward lean of the body may be associated with a reduction in the longitudinal and transverse arches of the feet and hallux valgus.

Excessive body weight affects the deterioration of body posture, and it is associated with the risk of many diseases, thus reducing the quality of life and shortening of life duration (Imagama et al., 2013; Porter Starr & Bales, 2015; Błaszczyk et al., 2009; Bookwala & Boyar, 2008; Zalesin et al., 2008; Mickle & Steele, 2015). This research proves that excessive body weight, especially obesity, strongly influences the inclination of the curvatures of the spine and the position of the trunk in the sagittal plane, and its impact on the inclination of the trunk seems to be more pronounced. The deterioration of thoracic kyphosis and lumbar lordosis above the norm was more often observed in participants with excess body weight. These features may be risk factors for back pain. Vismara L. et al. (Vismara et al., 2010) compared posture and spine function in obesity participants with and without chronic back pain and found a significant correlation between back pain and round thoracic kyphosis, round lumbar lordosis, and spinal mobility. Martha R. Hinman (RHinman, 2004) compared the degree of thoracic kyphosis and the stiffness of the thoracic spine of women of different ages. She noted a significant difference between the degree of thoracic kyphosis and the possibility of active correction of the position of the thoracic spine between younger and older women. In turn, Pan et al. (Pan et al., 2018) found that obesity reduces the mobility of the chest.

The shape of the thoracic spine in older people may be associated with an increased risk of falls (Takeda et al., 2009; McDaniels-Davidson et al., 2018; Kasukawa et al., 2010; Kim et al., 2017). Research by McDaniels-Davison et al.(McDaniels-Davidson et al., 2018) showed a strong association between increased degree of thoracic kyphosis and an increased risk of falls in the elderly. There is also reliable data that confirms the relationship between the correct inclination of the body in the sagittal plane and a higher level of balance and better body posture stability. This translates into a reduced risk of falls in the elderly (Imagama et al., 2013). Similar studies were conducted by Kasukawa et al. (Kasukawa et al., 2010). They found a significant correlation between an increased angle of lumbar kyphosis (lumbar flexion), spine tilt, and postural imbalance, and a higher risk of falls in the elderly. The researchers explained this correlation with the limited compensatory mechanisms of lumbar kyphosis (lumbar flexion). Changes in the shape of the spine, which are associated with the worsening of lumbar kyphosis (lumbar flexion) and inclination of the spine in the elderly, lead to displacement of the centre of gravity, which causes imbalance and reduced movement quality while walking. Similar observations were made by Ishikawa et al. (Ishikawa et al., 2009) who assessed body posture in people with osteoporosis. They noted that lumbar kyphosis, but not thoracic kyphosis, adversely affects the inclination of the spine and postural balance and may be a risk factor for falls.

In our study, there was a tendency for increased degree of lumbar lordosis with increasing BMI values. At the same time, it was found that the observed mean values of the lumbar lordosis angle were lower than in other age groups, which indicates a tendency for a decrease in lumbar lordosis with age (Jankowicz-Szymańska, A.; Bibro et al., 2018; Walicka-Cupryś K., Drzał-Grabiec J. et al., 2012.). Therefore, the results obtained in our research seem to suggest that obesity, and not age, contributes to round lumbar lordosis. The relationship between obesity and the aggravation of lumbar lordosis is confirmed by the aforementioned studies by Vismara et al. (Vismara et al., 2010). Also, the ten-year study carried out by Takeda et al. (Takeda et al., 2009) proves that with age lumbar lordosis decreases, the angle of the sacral slope decreases and the forward lean of the trunk increases. In our research, we have also observed a forward lean of the body. Other researchers confirm the reduction in lumbar lordosis and a growing forward tilt of the trunk with age (Gelb et al., 1995; Schwab et al., 2006; Hammerberg, E. Mark; Wood, 2003).

Our research shows that excess body weight significantly affects not only the position of the torso, but also the shape of the feet. Overweight and obesity appear to primarily reduce the longitudinal arch of the feet, but also affect the transverse arch and, to a lesser extent, valgus of the big toe. Similarly to this research, previous studies conducted by our team on a group of women aged 10 to 84 showed that excessive body weight, not age, is a risk factor for flattening of the arch of the feet (Jankowicz-Szymańska et al., 2018). The influence of overweight and obesity on the arch of the feet of the elderly was also studied by Aurichio et al. They observed that women with obesity had flat feet more often, and men with obesity had valgus foot more often. A study conducted among 800 people 60 years old or older in China revealed that the most common foot defects in this population were flat feet and hallux valgus which affected about half of the participants (Luo et al., 2017). The correlation between flatfoot and valgus of the first toe, but also varus of the fifth toe in the elderly population was also observed by Puszczałowska-Lizis et al.(Puszczałowska-Lizis et al., 2018). We do not know, however, whether foot disorders were correlated with BMI in the studied populations.

Excess body weight is associated with the occurrence of other disorders, including foot abnormalities. As shown by studies of other authors, people with excessive body weight more frequently report pain in the feet. Dufour et al. (Dufour et al., 2017) after evaluating 4888 feet, noted a positive correlation between BMI and reported foot pain. This is confirmed by the findings of Mickle et al. (Mickle & Steele, 2015) who analysed the impact of obesity on the structure, function and level of perceived foot pain in 312 people aged 60-90. They observed that in participants with obesity, foot pain and reduced strength of the hallux and toe flexors were more frequent than in overweight and healthy participants. In addition, they discovered that people with obesity had different time-space parameters of gait compared to overweight people and people with a normal body weight (shorter stride length, greater gait width, lower walking speed). The fact that pronation of the feet, a tendency for longitudinal flat feet, pain complaints are more frequently reported in the group with obesity was also noted by other researchers (Butterworth et al., 2015; Tománková et al., 2015). In turn, Awale et al. (Awale et al., 2017) showed a significant relationship between foot positioning, the severity of foot pain and the risk of falling. They showed that in the group of people with pronated feet position and moderate to severe pain, there was an increased likelihood of repeated falls. Gao et al. (Gao et al., 2019) when examining people aged between 60 and 82, found a relationship between obesity and dynamic gait stability and balance. As BMI increases, the dynamic stability and body balance of the elderly decreases, which in turn may have an impact on a greater risk of falling.

A comparison of the results of our research, which describes the relationship between the position of the spine and the inclination of the trunk in the sagittal plane, and the shape of the feet, with the conclusions of other authors is difficult as there are no such reports. Our study shows that the increased forward lean of the trunk related to the transfer of body weight to the forefoot, may reduce the longitudinal and transverse arches and cause the hallux valgus.

The limitations of this study include the small size of the group and the limitation of the study group only to women. In the future, we plan to extend the research by the assessment of the pelvic position, awareness of the quality of body posture and the study of the quality of life, including self-assessment of the impact of body posture and shape of the feet on everyday functioning. Despite these limitations, we believe that our findings will contribute to a better understanding of the changes accompanying aging and will be helpful in creating rehabilitation programs aimed at improving the patients' quality of life.

Conclusion

1. Increased thoracic kyphosis and lumbar lordosis, the forward lean of the body and the lowering of the arch of the feet are characteristic for older women.

2. Excessive body weight, to a greater extent than age, affects the inclination of the trunk and the shape of the feet in older women, which favours increased aggravation of thoracic kyphosis, the forward lean of the trunk and reduction of the longitudinal arch of the feet.

3. A significant, although weak, correlation between the forward lean of the body and the reduction in the longitudinal and transverse arch of the feet and the valgus position of the big toe, and between the degree of thoracic kyphosis and the valgus position of the big toe was found.

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Corresponding information:

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Correspondence to: Marta Bibro
University: University of Applied Sciences in Tarnow, 33–100 Tarnow, ul. Mickiewicza 8, Poland
Faculty: Faculty of Health Sciences
E-mail: martabibro@poczta.fm