Mrozkowiak et al. BMC Musculoskeletal Disorders (2025) 26:295
https://doi.org/10.1186/s12891-025-08362-z

BMC Musculoskeletal Disorders

RESEARCH Open Access

The body postures of individuals of both sexes ranging in height from 180 to 195 cm, in the light of the mora phenomenon

Mirosław Mrozkowiak[1,2], Marta Stępień-Słodkowska[3*] and Marek Sokołowski[4]

Abstract

Background Proper muscle tension is an essential element for correct body posture and motion. It should be high enough to counteract gravity and low enough to provide smooth, selective movement and isolated activity. Improper muscle tension will disturb the correct development of the body schema. The quality of muscle tension will be dependent upon the following: genetic factors, localization and the degree of damage to the central nervous system. The aim of the study was an attempt to determine the value of features describing the body posture of women and men with a body height of 180 cm to 195 cm.

Methods The research was conducted in a group of 123 people with the body height ranging from 180 to 195 cm, coming from the entire territory of Poland. The photogrammetric method has been implemented in registering 40 features which are descriptive of body posture.

Results The research results demonstrated that the average thoracic kypnosis angle and the lumbar lordosis as well as the Alpha, Beta and Gamma angles included in the sagittal planes are located between the upper and the lower values of normative ranges for both 18 year old males and females. The size of the asymmetry of the axial locomotor system in coronal and sagittal planes and the pelvis, the height and the width of waist triangles, asymmetry of shoulder blades and shoulders in coronal and transverse planes was included between the upper and the lower extremum of normative range.

Conclusions The research material is a representative group for the analyzed body height and sex, because it was strictly selected in terms of somatic structure, body posture, physical activity and lifestyle. The sizes of the features describing the body posture of women and men with a body height of 180 cm to 195 cm fall within the ranges of the normative posture features adopted for 18-year-olds diagnosed with the use of the mora projection method.

Keywords Mora phenomenon, Body posture, Body height

*Correspondence:
Marta Stępień-Słodkowska
marta.stepien-slodkowska@usz.edu.pl
[1]Physiotherapy Practice AKTON, Warsaw, Poland
[2]Poznan Medical University, Poznan, Poland
[3]Institute of Physical Education Sciences, Faculty of Physical Education and Health, University of Szczecin, Szczecin, Poland
[4]Faculty of Sports and Defence Education, Poznań University of Physical Education, Poznań, Poland

Background

Correct body posture ensures proper functioning of the body, both motor and sensory, therefore control of postural stability plays a fundamental role for the body. A person can move efficiently or perform complex manipulative movements without losing balance. However, contrary to appearances, the desired posture is the result of complex processes occurring in the central nervous system [1].

Maintaining proper body posture and depth perception depends upon the feedback, processing and sensory interpretation of the information coming from three sources: receptors of proprioception - sensitive to stretching and tightening, balance organ receptors – providing body balance at the moment of the changing of the location of the center of gravity, and visual receptors which cause reactions which allow the maintenance of the correct body posture in relation to the external environment [2–5]. Correct body posture depends upon the cooperation and interrelationship of the individual body parts which take part in the implementation of a task, and postural stability which is to maintain the center of gravity within the confines of the supporting surface [6–9]. Proper muscle tension is an essential element for correct body posture and motion [10]. It should be high enough to counteract gravity and low enough to provide smooth. selective movement and isolated activity. Improper muscle tension will disturb the correct development of the body schema. The quality of muscle tension will be dependent upon the following: genetic factors, localization and the degree of damage to the central nervous system. Proper motor control will allow one to build active control of body posture [11]. It is based on the maintenance of a stable position of the centre of gravity, moving the centre of gravity outside the supporting surface in the opposite direction to the force applied, and stabilizing the centre of gravity in a new situation. According to the authors the main condition for proper control of body posture and control of motion is maintaining linearity. Linearity is the active arrangement of individual body segments in the axis in relation to the supporting surface and the force of gravity, as well as the relationship of the individual elements to each other, adequate to the implemented task, with the use of proper synergies and movement sequences [12]. One way to confirm linearity or its absence is to determine asymmetry in the frontal and transverse planes and the angular and linear values in the sagittal curvatures of the spine using points defining posture (characteristics of the trunk, body weight and height). Human body is at its fittest when all its components are correctly aligned in relation to each other in terms of biomechanics. In the event that one of the body parts linearity is displaced, the higher and the lower segments will aim at compensation. In the improper control of body posture the disturbances occur in the neuromuscular system and the musculoskeletal one. Coordination of mobility is improper also in terms of movement sequences. This is caused by the activation of incorrect groups of muscles (using improper synergies) which as a consequence disturb the balance. The lack of proper activity of muscles in proximal parts of the body, or their delayed activity, causes an increase of tension in distal parts of the body. In this way improper body posture is built. The sequentiality of work of groups of muscles is an essential element for their developing balance. Improper body posture is connected with an inability to adjust to the changing conditions of the surroundings and the task, which needs the quick adaptation of the correct body posture to the occurring situation. In the disturbed linearity of the musculoskeletal system the elements of the body are improperly moved in relation to each other and to the force of gravity. The center of gravity in relation to the support surface is also moved. The consequences of the aforementioned are deficiencies in terms of mobility in intercostal, glenohumeral, hip, knee and ankle joints [13].

There are many definitions of correct body posture in the literature, but only the research by Mrozkowiak (2015) [14] in a group of 3806 individuals using the photogrammetric method allowed for the description of its optimal values for each gender and the age group of 4–18.

The previous research by Mrozkowiak (2015) [14] allowed to determine them in the age group of 4–18 years. The present research in the age group of 18–23 years characterized the values describing the body posture of women and men with a body height from 180 cm to 195 cm.

In connection with the above, the aim of this study was to attempt to determine the value of features describing the body posture of women and men with a body height ranging from 180 cm to 195 cm and to assume it as correct for these individuals, as there are no similar reports in the literature on the subject. For the purposes of achieving the research objective, the following research problems were established: (1) Will the asymmetries in the frontal and transverse planes in a posture considered correct not exceed 5 mm? (2) Will the angular and linear values of the sagittal curvatures of the spine in a posture considered correct for a body height of 180–195 cm be within the normative ranges appropriate for each gender at the age of 18 and the measurement method used.

Regular assessment of body posture has broad clinical significance, including both diagnostic and therapeutic aspects. Early detection of postural abnormalities and appropriate preventive measures can significantly improve the patient's health, preventing further health problems.

As a result of the research the following research hypotheses were made: (1) Asymmetries in coronal and transverse planes will not exceed 5 mm. (2) Angular and linear sizes in sagittal spine curvatures will be included within the confines of normative ranges proper for each sex at the age of 18 and the measuring method implemented.

Materials and methods

The research was conducted in accordance with the principles included in the Helsinki Declaration [15] and for the Bioethics Committee (KEBN 2/2018. UKW in Bydgoszcz) gave consent for its implementation. The criteria for inclusion in the study were people of both sexes, people of all ages, living in rural or urban areas, with any nutritional status (BMI), height between 180 and 195 centimeters, consent to participate in the study, correct body statics and symmetry of habitual posture assessed by a physiotherapist - the author of the study, general good health assessed subjectively by the respondents, as well as physical activity at a recreational level. The criteria for exclusion from the study were height outside the range of 180–195 centimeters, lack of signed consent to participate in the study, biomechanical disorders of body statics and lack of symmetry of habitual posture assessed by a physiotherapist - the author of the study, lack of declaration of good health, a higher level of physical activity than recreational. The study was conducted in the period from 03.06.2019 to 31.10.2019 in a representative group of 123 people with a height from 180 cm to 195 cm, aged 21 to 23. All of them came from northern Poland, which made the group ethnically homogeneous (Table 1). The study participants were divided into three categories: I – people with body height ranging from 180 cm to 185 cm, II – from 186 cm to 189 cm and III – from 190 cm. The tests were conducted each time in the same conditions, at the same time of day; between 8:00 and 11:00 by the same person with over 20 years of experience in diagnosing body posture with the use of projection mora and using the same research tool. Device manufacturer: Artur Świerc, CQ Elektronik System, Kąty Wrocławskie, Poland (Sensitivity: 100%, specificity: 45%). The device has a wide range of applications in the prevention of diseases of the musculoskeletal system.

Table 1 Characteristics of the examined group in terms of body height and sex

Category	Body height (cm)	Sex	
		Male	Female
I	180–185	21	21
II	186–189	21	20
III	190 and higher	20	20
Total		62	61

Source: author's own research

40 features describing body posture in the area of torso as well as body weight and height were the subject of the research (Table 2).

The position for diagnosing body posture with the photogrammetic method consists of a computer and a card, software, a monitor and a printer, a projecting and receiving device with a camera to measure selected parameters of the spine and pelvis. The following measurement points were marked on the subjects' bodies: C7 – spinous process of the seventh cervical vertebra, KP – thoracic kyphosis, PL – spinal point of transition from kyphosis to lordosis, LL – lumbar lordosis, S1 – spinous process of the first sacral vertebra, SP – beginning of the gluteal cleft, Łl,Łp – inferior angle of the scapula (left, right), Ml, Mp – posterior, superior iliac spines (left, right), T1,T2 – left waist line, T3,T4 – right waist line B2,B4 – shoulders, B3,B4 – point of connection of the shoulder line with the neck, KS – occipital protuberance. It is possible to obtain a spatial image by displaying a line with strictly specified parameters on the back of the person being examined. Lines shown on the skin are distorted depending on the configuration of the surface. By means of a lens the image of the person being examined is received by a special optical system with a camera and then transferred to the monitor of the computer. Deformations of the image of the line registered in the computer's memory are processed by numerical algorithm into a contour map of the examined area. The aforementioned procedure was followed in order to minimize the risk of making mistakes [14].

Statistical analysis

The data were analyzed using descriptive statistics. The parameters were described using basic descriptive statistics measurements (the percentage for qualitative variables, and the mean and standard deviation, median and quartile ranges for quantitative variables). Basic analyses in terms of descriptive statistics are presented in Tables 3, 4 and 5. They included calculations of statistical order values (arithmetic mean, quartiles), dispersion parameters (standard deviation) and indicators of symmetry (coefficient of asymmetry, coefficient of concentration).

Results

Basic descriptive statistics gave a full picture of the distribution of examined features taking into consideration sex and three categories: I – measurements results for individuals with a body height ranging from 180 cm to 185 cm, II – from 186 cm to 189 cm and III – from 190 cm. The average body mass in the following categories among the men was: 80.92. 85.9 and 92.83 kg and among the women it was: 81.45, 86.3 and 93.9 kg (Table 6). The average body height among the men was

Table 2 List of registered features of the torso, body weight and height

No.	Symbol	Parameters		
		Unit	Name	Description
Sagittal plane				
1	Alpha	degree	Lumbosacral angle	
2	Beta	degree	Thoracolumbar angle	
3	Gamma	degree	Upper thoracic angle	
4	DCK	mm	Total length of the spine	Distance between points C_7 i S_1 measured in vertical axis
5	KPT	degree	Angle of extension	Defined as a deviation of the C_7-S_1 line from the vertical line in sagittal plane
6	KPT -	degree	Angle of body bent	Defined as a deviation of the C_7-S_1 line from the vertical line in sagittal plane
7	DKP	mm	Depth of thoracic kypnosis	Distance from point LL to point C_7
8	KKP	degree	Angle of thoracic kypnosis	KKP = 180 – (Beta + Gamma)
9	RKP	mm	Height of thoracic kypnosis	Distance between points C_7 and PL
10	GKP	mm	Depth of thoracic kypnosis	Distance measured horizontally between the vertical lines passing through points PL and KP
11	DLL	mm	Length of lumbar lordosis	Distance between points S_1 and KP
12	KLL	degree	Angle of lumbar lordosis	KLL = 180 – (Alpha + Beta)
13	RLL	mm	Height of lumbar lordosis	Distance between points S_1 and PL
14	GLL -	mm	Depth of lumbar lordosis	Distance measured horizontally between the vertical lines passing through points PL and LL
Coronal plane				
15	KNT -	degree	Angle of body bent to the side	Defined as a deviation of the C_7-S_1 line from the vertical line to the left in coronal plane
16	KNT	degree		Defined as a deviation of the C_7-S_1 line from the vertical line to the right in coronal plane
17	KLB	degree	Angle of shoulder line. the right one is higher	Angle between the vertical line and the line passing through points B_2 and B_4
18	KLB–	degree	Angle of shoulder line. the left one is higher	
19	UL	degree	Angle of shoulder blade line. the right shoulder blade is higher	Angle between the vertical line and the line passing through points Ł1 and Łp
20	UL -	degree	Angle of shoulder blade line. the left shoulder blade is higher	
21	OL	degree	Lower angle of the left shoulder blade is further away	Different distance between inferior angles from the spinolaminal line measured vertically on the straight lines passing throught points Łl and Łp
22	OL -	degree	Lower angle of the right shoulder blade is further away	
23	TT	mm	Left waist triangle is higher	Different distance measured vertically between points T_1 and T_2 as well as T_3 and T_4.
24	TT–	mm	Right waist triangle is higher	
25	TS	mm	Left waist triangle is wider	Different distance measured horizontally between the staight lines passing through points T_1 and T_2 as well as T_3 and T_4
26	TS -	mm	Right waist triangle is wider	
27	KNM	degree	Angle of pelvic tilt. the right wing of ilium is higher	Angle between the horizontal line and the straight line passing through points M1 and Mp
28	KNM -	degree	Angle of pelvic tilt. left wing of ilium is higher	
29	UK	mm	Maximum variation of the spinous process to the right	The biggest variation of the spinous proces from the vertical line starting from S_1. Distance measured in horizontal axis.
30	UK -	mm	Maximum variation of the spinous process to the left	
31. 32	NK. NK -		Number of vertebra which is maximally moved to the left of right	Number of vertebra which is maximally moved to the left or to the right in asymmetrical spinolaminal line. counted as number 1. starting from the 1st cervical vertebra (C_1) If the arithmetic mean takes values e.g. from 12.0 to 12.5 then it is Th_5. if from 12.6 to 12.9 then it is Th_6.
Transverse plane				

Table 2 (continued)

No.	Symbol	Parameters		
		Unit	Name	Description
33	UB–	degree	Angle of protrusion of the left inferior angle of scapula is greater than that of the right angle of scapula	Difference between agles UB_1 – UB_2. Angle UB_2 included between the line passing through point Łl and perpendicular to the horizontal axis of the camera and the line passing thorugh points Łl and Łp. Angle UB_1 included between the line passing through Łp and perpendicular to the axis of the camera and the staight line passing through points Łp and Łl.
34	UB	degree	Angle of protrusion of the right inferior angle of scapula is greater than that of the left angle of scapula	
35	KSM	degree	Pelvis rotated to the right	Angle between the line passing through point Ml and perpendicular to the axis of the camera and the straight line passing through points ML and MP
36	KSM -	degree	Pelvis rotated to the left	Angle between the line passing through point Mp and perpendicular to the axis of the camera and the straight line passing through points ML and MP
37	LL	mm	Peak of lumbar lordosis	Peak of lumbar lordosis
38	PL	mm	The border of the transition from lordosis to kyphosis	The border of the transition from lordosis to kyphosis
39	Mc	kg	Body mass	Measurements conducted by means of a digital medical scale 0.5 cm and 100 gram
40	Wc	cm	Body weight	

Source: author's own research

182.17, 186.4 and 192.58 cm, among the women: 181.6, 186.1 and 191.3 cm (Table 7).

The following part of the chapter indicates the observed differences for selected, average values of features describing the body posture of women and men in relation to the categories. The observed differences allow for the indication of certain trends and regularities, however, these observations require further research and statistical analyses of the significance of the results found. As shown in Tables 3, 4 and 5; among the participants of the research the total spine length (DCK), the length and the height of lumbar lordosis (DLL, RLL) in the following categories of the body height increased and the angle of thoracic kyphosis and lumbar lordosis slightly fluctuated. Only in case of women the length of lumbar lordosis is the biggest in the 1st category, smaller in the 3rd category and the smallest in the 2nd category. Among the men the size of Alpha angle, the depth of thoracic kyphosis (GKP) and lumbar lordosis (GLL) increases with the body height. Beta and Gamma angles are the biggest in the 2nd category, and in the 2nd and the 3rd categories slightly smaller but at a similar level. Alpha angle among women has very similar sizes in all three categories. Beta and Gamma angles are the biggest in the 2nd category, in the other two it is slightly smaller but at a similar level. Delta angle is the biggest in the 2nd category, the smallest in the 3rd category and even smaller in the 1st category. The depth of thoracic kyphosis (GKP) and lumbar lordosis (GLL) is the smallest in the 2nd category. The depth of thoracic kyphosis is the biggest in the 1st category and slightly in the 3rd category. The depths of lumbar lordosis is the biggest in the 3rd category, and slightly smaller in the 1st category. Among the men the biggest torso asymmetry in sagittal plane (KPT-. KPT) occurs in the 1st category, the smaller in the 3rd category and the smallest in the 2nd category. Torso asymmetry (KNT-, KNT) and pelvis asymmetry (KNM-, KNM) in coronal plane increases with the body height, while asymmetry of pelvis in transverse plane (KSM-, KSM) slightly changes. Among women the biggest trunk asymmetry in sagittal plane occurs in the 1st category, in other two categories it is the same or slightly differs (KPT-, KPT). Among the examined the angle of trunk bending to the left (KNT-) in coronal plane shows slight fluctuations, the angle trunk bending to the right (KNT) increases with the increase of the body height. It is similar with the asymmetry of pelvis in transverse plane (KSM-, KSM). Asymmetry of pelvis in coronal plane (KNM-), where the left wing of ilium is higher, does not show any bigger fluctuations, however in cases where the right wing of ilium is higher (KNM) the biggest asymmetry occurs in the 1st category. In two other categories it stays at similar, lower level. Among all the examined asymmetry of shoulders (KLB-, KLB). inferior angles of scapulas (UL-, UL) and their distance from spinolaminal line (OL-, OL) in coronal plane and protrusion in transverse plane (UB-, UB) increases with the increase of the body height. Among men the asymmetry in coronal plane of the waist triangles (TT-) and their width (TT-) where the right one is higher and wider, slightly increases with the increase of body height. Among the examined who had a left waist triangle higher (WT) the asymmetry of height decreased with the height but the weight (WT) increased. Asymmetrical spinolaminal line with left protrusion (UK-) had the highest values in the 1st category, smaller in the 3rd category and the smallest in the 2nd category. The apex (NK-) was always localized between Th7 and Th9. Among the examined who had the right-side protrusion (UK), the smallest tilt

Table 3 Average sizes of the features describing body postures for men and women in the category I (n) M = 21. F = 21

Feature	Sex													
	Male							Female						
	Decriptive statistics													
	Category I													
	M	Sd	Me	Q1	Q3	A	Kr	M	Sd	Me	Q1	Q3	A	Kr
DCK	492.93	28.7	489.5	487.7	494.3	0.7	0.3	482.4	28.2	479.7	399.4	485.8	0.8	0.2
Alfa	6.56	4.0	6.52	6.2	6.8	-0.0	-0.3	8.5	7.9	8.1	7.6	9.2	-0.2	-09
Beta	9.09	3.3	8.6	8.2	11.4	0.1	-0.3	9.0	4.1	9.1	8.6	10.4	-0.3	-06
Gamma	11.77	3.2	10.4	9.6	14.8	O.5	-0.3	10.5	4.0	9.5	8.7	12.1	-0.1	0.4
Delta	27.43	7.1	25.8	24.6	29.8	0.5	-0.2	27.78	8.3	30.5	24.8	29.8	0.6	0.3
KPT-	3.31	1.7	2.4	2.5	5.6	0.4	-1.1	2.9	1.5	0.5	1.2	4.2	0.7	0.3
KPT	3.03	2.6	2.7	2.5	5.2	0.7	-0.1	4.6	3.2	2.8	6.9	7.3	0.3	-05
DKP	394.34	30.6	387.4	385.1	406.5	0.7	0.4	388.5	32.1	379.8	376.8	400.1	0.1	-01
KKP	161.34	5.4	162.3	156.8	169.8	-0.2	-0.4	164.3	4.9	158.7	157.8	169.8	0.0	-06
RKP	295.75	25.4	286.4	289.3	301.5	0.4	-0.7	294.6	23.9	290.5	287.6	301.3	0.1	-03
GKP	15.62	9.0	14.3	13.2	18.7	0.6	0.4	17.6	8.8	16.4	15.4	19.8	0.7	-01
DLL	345.05	29.1	340.2	335.4	349.9	0.5	-0.1	342.7	33.2	339.7	332.5	350.1	-0.1	-06
KLL	165.87	5.7	163.8	158.7	172.7	-0.4	-0.0	165.5	7.7	166.3	160.5	176.5	-0.7	0.3
RLL	197.18	18.7	196.1	187.6	201.5	-0.2	-0.1	195.4	17.7	187.9	183.2	203.2	-0.2	-04
GLL-	18.65	17.8	17.9	15.8	21.4	0.4	-0.2	19.7	17.8	17.6	16.6	22.7	0.6	0.3
KNT-	4.34	0.6	3.6	2.7	6.2	1.1	2.7	5.2	1.6	4.8	4.5	6.2	0.6	-07
KNT	2.38	1.4	2.1	1.8	3.8	0.5	-0.0	2.4	1.0	2.0	1.7	3.2	0.3	-07
KLB-	2.02	1.2	1.7	1.2	3.4	0.7	-0.2	1.9	0.7	1.7	1.4	2.9	0.5	-05
KLB	3.45	1.3	3.1	2.5	5.3	0.4	-0.0	2.9	1.4	2.6	2.0	3.8	0.6	-07
UL-	2.11	1.2	1.8	1.8	3.8	0.7	0.1	2.1	1.3	1.7	1.1	4.2	0.4	-05
UL	3.21	1.4	2.4	1.9	5.1	0.7	-0.3	3.3	1.3	2.4	1.4	4.9	0.7	0.3
UB-	1.43	0.8	1.1	0.4	3.6	1.0	1.2	1.1	2.4	1.3	0.3	4.1	0.3	-12
UB	2.11	2.8	3.1	0.8	4.9	0.5	0.2	3.1	3.1	3.0	1.1	4.9	0.3	-13
OL-	2.11	4.7	2.9	2.2	4.6	0.7	-0.3	1.9	4.9	1.4	5.6	3.4	0.5	-02
OL	3.67	2.6	3.8	2.7	5.1	0.5	0.2	2.9	2.2	1.8	1.5	4.1	1.1	2.1
TT-	3.11	2.4	2.1	2.0	5.4	0.7	-0.4	2.9	2.2	1.8	1.1	5.1	0.5	-03
TT	1.56	7.1	1.4	0.7	4.3	0.0	-0.2	2.7	2.1	2.0	1.9	3.8	1.0	0.5
TS-	4.23	5.9	3.8	2.4	6.5	0.3	-1.1	3.9	4.6	3.6	2.9	5.7	0.5	-03
TS	2.34	1.9	1.9	1.0	4.9	0.9	0.6	2.4	2.1	2.2	1.9	4.8	0.6	-02
KNM-	2.31	1.5	2.1	1.9	4.8	0.7	0.4	1.9	1.1	2.0	0.9	3.2	1.2	2.6
KNM	1.45	0.9	1.1	0.6	2.8	1.0	0.3	2.3	1.2	2.1	0.9	4.2	0.8	-07
KSM-	2.34	3.1	2.1	0.7	4.6	0.8	0.6	2.9	3.1	2.2	0.5	4.2	0.6	-06
KSM	3.45	3.6	3.3	2.1	5.4	0.1	-0.8	2.9	4.7	2.4	0.6	4.6	0.3	-04
UK-	3.8	2.9	3.9	2.1	4.8	0.6	-0.4	2.3	3.7	2.5	2.0	4.8	0.2	-12
NK-	7.0	14.8	15.6	5.0	10.0	0.5	-0.5	7.0	3.8	15.2	4.0	10.0	0.3	-05

Table 3 (continued)

Feature	Sex													
	Male							Female						
	Decriptive statistics													
	Category I													
	M	Sd	Me	Q1	Q3	A	Kr	M	Sd	Me	Q1	Q3	A	Kr
UK	2.47	3.0	2.1	1.3	4.3	0.7	-0.5	2.1	3.9	2.3	1.0	4.2	0.1	-1.1
NK	9.0	14.0	14.2	6.0	11.0	0.4	-0.6	8.0	3.1	16.3	5.0	11.0	0.2	-0.6

Source: author's own research; *A* - coefficient of asymmetry, *Kr* - coefficient of concentration

was detected in the 1st category, in the 2nd and the 3rd categories it was bigger and with similar value. The apex (NK) was always localized between Th8 and Th9. Among the women who had a higher left waist triangle (TT) the asymmetry decreased with the height and increased with the width (TT). In women who had the right waist triangle higher (TT-) it was the greatest in the 1st category, smaller in the 3rd category and the smallest in the 2nd category. The biggest width occurred in the 2nd category, smaller in the 3rd category and the smallest in the 1st category. Asymmetrical spinolaminal line with left protrusion (UK-) had the biggest values in the 3rd category, smaller in the 1st category and the smallest in the 2nd category. The apex (NK-) was always localized between Th7 and Th8. The examined that had a right-side protrusion (UK) the size of tilt decreased with the increased body height. The apex (NK) was always localized between Th6 and Th10.

The values presented as an arithmetic mean show an average level of the phenomenon's frequency of occurrence. Localization of the unit out of this value does not mean that the posture is incorrect – it is just different than the one found in other people of the same sex and body height, domiciled in this region. The average size of the angle of thoracic kyphosis and lumbar lordosis and the Alpha, Beta and gamma angles included in sagittal plane are located between the upper and the lower size of normative ranges specified by Mrozkowiak [14] for both sizes aged 18. Also the size of asymmetry of the axial system in coronal and sagittal planes. in pelvic plane, the height and width of waist triangles, the asymmetry of shoulder blades and shoulders in coronal and transverse planes is included between the upper and the lower extremum of normative range.

Discussion

The aim of this study was to attempt to determine the value of features describing the body posture of women and men with a body height ranging from 180 cm to 195 cm and to assume it as correct for these individuals.

The analyses of the values of the features describing the body posture of women and men between 180 and 195 cm in height obtained by the study allowed us to assume that it is correct, in particular it should be noted that there are no similar scientific reports in the literature on the subject, which additionally gives rise to the possibility of confrontation and establishing normative ranges for other available research groups. The authors, examining apparently healthy people in a specialist assessment of body posture and the musculoskeletal system, assumed the limit of asymmetry in the frontal and transverse planes not exceeding 5 mm and also assumed that the angular and linear values of the sagittal curvatures of the spine in these people would be within the normative

Table 4 Average sizes of the features describing body postures for men and women in the category II (n) M = 21. F = 20

Feature	Sex													
	Male							Female						
	Descriptive statistics													
	Category II													
	M	Sd	Me	Q1	Q3	A	Kr	M	Sd	Me	Q1	Q3	A	Kr
DCK	532.47	28.7	530.6	502.7	542.1	0.7	0.4	527.6	32.7	521.7	511.4	531.4	0.3	-02
Alfa	7.1	4.1	7.0	5.8	9.4	-0.1	-0.2	8.6	4.6	8.9	6.2	10.7	-0.3	-08
Beta	9.79	3.3	11.5	7.6	13.2	0.1	-0.3	11.5	4.1	12.8	9.8	13.9	0.3	-06
Gamma	12.48	3.2	13.7	10.4	14.8	0.5	-0.3	12.7	4.1	13.2	10.5	14.3	-0.1	0.5
Delta	29.37	7.1	27.9	24.8	32.8	0.4	-0.3	32.6	8.5	31.9	25.9	37.9	0.5	0.3
KPT-	2.31	1.9	2.1	1.5	3.8	0.5	-1.2	2.1	1.8	0.9	1.8	4.3	0.7	0.2
KPT	1.93	2.3	1.87	1.1	2.7	0.7	-0.1	2.5	3.1	2.4	2.0	3.7	0.4	-05
DKP	425.97	32.4	428.7	421.2	435.2	-0.3	-0.4	412.6	34.8	409.7	402.8	421.5	0.2	0.3
KKP	160.65	5.1	156.9	155.4	169.8	0.1	-0.4	164.3	3.2	163.8	160.2	169.8	0.0	-05
RKP	319.48	25.8	318.7	310.5	327.8	-0.4	-0.4	310.4	23.1	308.5	302.4	316.7	0.1	-02
GKP	16.43	8.5	15.9	15.4	18.5	0.5	22.1	15.7	6.4	20.3	13.9	17.6	0.1	0.2
DLL	372.73	28.7	370.6	367.8	378.7	0.3	-0.6	370.6	32.6	368.9	361.3	376.9	0.3	-02
KLL	164.32	4.5	163.1	160.2	169.8	-0.1	-0.5	162.6	4.8	161.7	158.7	169.8	-0.2	-04
RLL	212.99	21.2	214.1	207.8	221.1	0.1	-0.8	210.5	25.0	212.6	208.7	219.8	0.0	-1.1
GLL-	19.32	8.2	17.6	17.6	22.6	0.3	-0.4	18.5	6.4	18.6	14.7	23.3	-0.1	-04
KNT-	4.58	0.6	3.8	0.7	6.2	0.4	-1.2	5.1	0.7	4.9	4.1	7.3	-0.0	-09
KNT	3.11	0.5	3.1	2.6	5.4	0.5	-1.3	3.2	0.4	3.1	2.2	4.3	0.4	-13
KLB-	2.43	0.8	2.4	1.9	3.7	0.2	-0.9	2.1	0.5	2.0	1.2	3.4	2.2	-13
KLB	4.01	0.7	3.9	3.5	6.5	0.6	-0.4	5.1	0.7	5.0	4.3	6.7	0.2	-13
UL-	2.45	1.1	1.9	1.3	4.2	0.5	0.1	3.1	2.2	2.6	2.1	5.2	0.6	-07
UL	3.32	1.2	3.1	2.3	4.7	0.6	-0.0	3.4	1.8	3.2	2.4	4.6	0.7	-04
UB-	1.69	1.6	1.6	0.7	2.9	0.4	-0.4	2.3	4.1	2.3	2.1	3.7	0.5	-03
UB	2.87	0.8	2.6	1.1	4.3	0.9	1.4	3.2	0.7	2.3	2.1	4.6	0.8	3.1
OL-	2.98	5.2	4.1	1.4	5.1	0.5	-0.3	3.6	5.8	3.2	2.1	4.7	0.7	-00
OL	4.21	2.1	3.8	3.1	6.3	0.5	-1.4	4.0	1.5	1.9	3.1	5.9	0.3	-05
TT-	3.2	3.8	3.1	1.1	4.9	0.3	-1.9	2.1	2.8	2.2	1.0	4.8	0.9	04
TT	1.21	3.7	1.1	0.4	2.9	0.8	-0.2	1.1	3.2	1.1	0.5	2.7	0.4	0.0
TS-	4.45	4.7	4.5	3.1	6.2	-0.2	-1.3	5.3	6.1	5.4	4.1	7.2	0.8	-01
TS	2.79	4.1	2.8	1.6	4.8	0.8	0.0	3.1	4.5	4.6	2.4	5.7	0.1	-05
KNM-	2.56	1.6	2.4	1.7	5.2	0.7	3.7	2.2	0.7	2.5	0.7	4.3	-0.3	-1.7
KNM	1.56	1.1	1.6	0.7	3.5	0.8	-0.1	1.6	0.8	1.5	0.8	3.1	-0.1	-1.6
KSM-	2.31	2.4	2.3	0.8	3.8	0.2	-0.3	3.1	2.3	3.1	0.7	4.8	0.3	0.2
KSM	3.44	0.6	3.3	2.1	4.8	0.2	-3.1	4.3	2.7	2.6	2.1	5.0	0.6	-04
UK-	2.8	5.4	3.1	1.3	3.9	0.5	-0.4	2.1	2.8	2.2	0.7	4.6	0.7	-02
NK-	9.0	2.9	3.2	5.0	11	-0.3	-1.1	7.0	2.7	2.8	5.0	11	0.5	-01

Table 4 (continued)

Feature	Sex													
	Male							Female						
	Descriptive statistics													
	Category II													
	M	**Sd**	**Me**	**Q1**	**Q3**	**A**	**Kr**	**M**	**Sd**	**Me**	**Q1**	**Q3**	**A**	**Kr**
UK	3.26	0.8	3.1	2.6	4.8	-0.2	-1.0	4.0	2.1	4.1	2.8	5.0	0.1	-1.0
NK	8.0	2.8	3.3	6.0	10	0.8	-0.1	6.0	2.6	3.1	4.0	10	0.5	-0.1

Source: author's own research; *A* - coefficient of asymmetry, *Kr* - coefficient of concentration

ranges. The study of anthropometric features using designated points defining the features of the body gave very specific and accurate values thanks to the use of projection moiré. Their determination contributed to the conclusion that the linearity of the posture was maintained in the group assessed by the specialist study.

In a study of healthy men aged 51 to 60 years, 23 parameters of upper body posture were analyzed in 102 healthy men aged 51–60 (55.36 ± 2.78) years. The mean height was 180.76 ± 7.81 cm with a weight of 88.22 ± 14.57 kg. The calculated BMI was 26.96 ± 3.92 kg/m2. In the usual upright position, the naked upper body was scanned three-dimensionally using video-raster stereography. For all parameters, mean or median values, confidence intervals, tolerance ranges and group comparisons were calculated, as well as correlations of BMI with physical activity. Spine parameters showed good exploration of the frontal plane in the usual standing position. In the sagittal plane, a slight ventral trunk tilt was observed with an increased angle of thoracic spine kyphosis and an increased angle of thoracic flexion. Pelvic parameters showed a clear symmetry with deviations from the 0° axis within the measurement error of 1 mm/1°. Scapula height together with scapula angles on the right and left side described a slightly elevated position of the left shoulder compared to the right side. The upper body posture was shown to be influenced by parameters such as age, height, weight and BMI [16].

Studies of adults aged 19–29 years using the analysis of the occurrence of spatial pelvic asymmetry were conducted based on the authors' original clinical classification and the significance of body mass and height for the analyzed asymmetries. Inclinometric measurements of selected landmarks of the pelvic girdle were performed in a sample of 300 young individuals. Then, the occurrence of spatial pelvic asymmetry was analyzed based on the authors' own clinical classification, assuming the symmetry of the alignment of the iliac crests, anterior superior iliac spines and greater trochanters as the criterion. All examined individuals with asymmetry < 1 degree were treated as having a symmetrical pelvis. Asymmetries in the pelvic region were observed in less than three-quarters of the studied population. A skewed pelvis was found in less than one-quarter of women and in more than one-third of men with dominant structural asymmetry. Pelvic rotation was observed in more than one-third of women and men with dominant functional asymmetries. No linear correlations were found between body weight, height and angle of asymmetry [17].

Due to the great variety of factors that shape body posture, it was not possible to take them all into account [18]. They occur in different sets, acting in a similar manner or in a completely different manner so that it is difficult to determine which the decisive factors were. It is not very

Table 5 Average sizes of the features describing body postures for men and women in the category III (n) M = 20. F = 20

Feature	Sex													
	Male							Female						
	Descriptive statistics													
	Category III													
	M	Sd	Me	Q1	Q3	A	Kr	M	Sd	Me	Q1	Q3	A	Kr
DCK	575.92	38.4	576.8	568.9	582.1	-0.1	-0.1	568.7	37.9	567.9	564.8	570.3	0.1	-1.1
Alfa	7.25	3.3	7.2	4.2	8.9	-0.1	9.2	8.9	4.2	8.8	5.4	12.5	0.1	-0.2
Beta	9.25	3.2	8.7	7.9	11.7	0.3	-0.5	8.9	2.5	8.6	7.8	12.3	-0.2	-0.6
Gamma	11.56	3.2	12.2	8.9	13.8	0.1	-0.3	9.7	2.0	9.9	8.3	12.4	-0.2	-0.0
Delta	28.07	5.7	27.7	24.8	31.1	0.1	0.4	28.8	5.5	28.9	27.1	31.2	-0.3	-0.5
KPT-	2.58	2.3	1.6	0.8	3.5	0.6	-0.5	2.1	1.4	1.7	0.7	2.9	0.6	0.4
KPT	2.38	1.8	1.8	1.0	3.8	1.0	0.1	3.1	1.8	3.0	2.1	4.7	0.2	-1.2
DKP	460.73	33.5	461.1	457.8	469.8	-0.3	-0.5	451.4	35.1	448.9	442.1	461.2	0.2	0.2
KKP	159.87	4.8	156.9	155.4	162.1	0.1	-0.5	161.6	3.2	161.2	157.6	163.1	0.0	-0.4
RKP	345.55	26.7	342.6	340.1	352.1	-0.4	-0.3	344.2	23.5	343.8	339.7	354.7	0.1	-0.1
GKP	17.11	7.6	16.9	15.7	26.4	0.5	-0.5	16.5	5.7	15.2	13.9	18.7	0.1	0.1
DLL	403.14	31.1	402.1	387.9	412.5	0.3	-0.5	391.1	31.6	388.7	387.3	410.2	0.3	-0.2
KLL	163.76	4.3	163.1	165.8	171.1	-0.1	-0.3	161.1	4.6	160.4	154.9	164.2	-0.1	-0.5
RLL	230.37	21.4	232.1	125.4	141.2	0.1	-0.7	227.6	24.3	226.9	220.1	238.7	0.1	-1.2
GLL-	20.36	8.8	19.7	17.9	24.3	0.2	-0.3	21.2	5.8	21.2	19.9	24.3	-0.1	-0.3
KNT-	4.89	0.9	4.2	3.7	6.3	0.3	-1.3	5.1	0.7	5.2	1.8	6.3	-0.0	-0.9
KNT	3.76	0.7	3.8	3.2	5.4	0.3	-1.3	4.2	0.3	0.8	3.2	6.4	0.4	-1.2
KLB-	2.49	0.7	2.5	1.6	4.2	0.3	-0.8	2.3	0.7	2.2	0.7	3.7	0.4	-1.2
KLB	4.11	0.8	4.0	3.1	5.8	0.7	-0.5	3.8	0.7	3.9	2.7	5.1	0.2	-1.2
UL-	2.79	1.1	2.5	1.8	3.9	0.7	0.2	3.2	2.2	3.1	2.8	4.6	0.5	-0.6
UL	3.58	1.3	3.6	2.5	5.2	0.8	-0.0	4.2	1.8	4.1	3.7	5.7	0.9	-0.5
UB-	2.11	1.7	2.2	1.1	3.4	0.4	-0.5	3.2	2.3	3.1	1.6	4.7	0.5	-0.4
UB	3.22	0.6	2.8	1.3	4.9	0.8	1.4	4.1	0.6	3.8	2.4	5.9	0.6	3.2
OL-	3.01	4.8	3.2	2.4	5.1	0.6	-0.3	4.7	6.5	4.2	3.1	6.2	0.7	-0.1
OL	4.79	2.1	2.1	1.8	3.7	0.3	-1.3	1.9	1.5	2.0	1.3	3.2	0.3	-0.5
TT-	3.25	12.1	3.2	2.6	5.0	0.2	-1.8	2.4	6.3	2.3	1.3	4.8	0.9	0.5
TT	1.03	8.9	1.0	0.3	2.4	0.7	-0.3	1.0	5.8	0.9	0.4	2.7	0.6	-0.1
TS-	4.58	3.1	4.4	3.1	7.1	-0.3	-1.2	4.4	4.4	4.5	3.1	5.7	0.7	-0.2
TS	3.01	4.9	2.5	1.1	4.9	0.7	0.1	3.8	4.6	4.6	2.1	4.9	0.2	-0.6
KNM-	2.67	1.8	2.1	1.4	3.6	0.6	3.5	2.1	0.6	2.6	1.0	3.1	-0.2	-1.6
KNM	1.69	1.2	1.3	1.0	3.1	0.7	-0.3	1.7	0.9	1.6	0.4	3.1	-0.2	-1.5
KSM-	2.35	2.2	2.4	1.1	3.8	0.3	-0.4	3.8	2.5	3.9	2.1	4.8	0.3	0.3
KSM	3.45	0.6	3.3	2.1	5.0	0.3	-3.0	4.8	6.8	3.2	2.1	6.8	0.7	-0.5
UK-	3.4	3.1	2.9	1.2	4.9	0.6	-0.5	2.9	2.7	2.2	1.2	4.8	0.6	-0.2
NK-	7.0	2.7	3.5	5.0	9.0	0.6	-0.4	8.0	2.8	3.1	5.0	11.0	0.7	-0.3

Table 5 (continued)

Feature	Sex													
	Male							Female						
	Descriptive statistics													
	Category III													
	M	Sd	Me	Q1	Q3	A	Kr	M	Sd	Me	Q1	Q3	A	Kr
UK	3.31	0.8	3.4	1.1	4.2	-0.3	-1.1	5.0	2.2	5.6	3.1	6.8	0.1	-1.1
NK	9.0	2.8	2.9	7.0	12.0	0.7	-0.3	10	2.7	2.8	8.0	12.0	0.6	-0.2

Source: author's own research; *A* - coefficient of asymmetry, *Kr* - coefficient of concentration

realistic to specify accurate criteria for correct posture, taking into consideration all the somatic, psychological and environmental conditions of postural development. An additional variable is the fact that the examinations of posture the actual state was analyzed without taking into account the recommended factors which had an impact on its shape [19].

A precise border between anatomic variations of angles of spine curvature accepted as physiological and individual cases of their sizes which could be treated as incorrect has not so far been specified in a satisfying manner. It was accepted that correctly shaped spine curvatures should be not so large and balanced and their deformation should be noticeable [20, 21]. This statement is too general and not precise enough to be satisfactory for arbitrary diagnosis in cases which are on the border between norms and defects. The subject of consideration is very complicated and difficult to be defined. There is no consensus between evaluations of the features describing the spine in the sagittal plane. This refers to evaluations of the existing features of populations and trends in their changes which result in detecting individual cases requiring more detailed clinical research [22]. In the coronal plane this is not a problem because the spinolaminal line which is deviated from the plumb line, the difference in the height of shoulders, inferior angles of scapulas, asymmetry of waist triangles and the pelvis will always be treated as a pathological condition but in the transverse plane the shape of antero-posterior curvatures there is a dilemma, in particular in terms of norm-defects. Evaluation of curvatures with a visual assessment does not disqualify the appropriateness of the evaluation, however, in order to control the state of improvement or deterioration a measurable value is required.

Obtaining high credibility of diagnostic indicators despite their statistical analysis in the selected population requires also taking into consideration physical aspects of the spine and standardization and formalization of the research procedures implemented. The variety of techniques, methodology and research instruments implemented for specifying geometrical features describing habitual posture led to the promotion of various concepts for creating norms describing physiological curvatures of the spine. In the last few years there were at least a few ranges for thoracic kyphosis and lumbar lordosis. However, no uniform standards have been published. The reasons for this situation are different techniques of measurement implemented and concepts of adjusting anthropometric points which specify the features measured. Normative ranges for children and youths proposed by Mrozkowiak [14] constitute an attempt to standardize the process of measurement and uniforming anthropometric points proper for the method implemented. This will allow the creation of a common basis for implementing

Table 6 Descriptive statistics of average body mass for the number of the examined people taking into consideration their sexes; M = 62. F = 61

Categories	Sex													
	Male							Female						
	Descriptive statistics													
	M	Sd	Me	Q1	Q3	A	Kr	M	Sd	Me	Q1	Q3	A	Kr
I	80.92	8.9	81.2	79.6	84.3	0.3	0.2	81.45	5.6	82.7	78.9	85.7	0.2	0.0
II	85.9	8.8	87.4	83.7	88.5	0.4	0.2	86.3	5.3	88.4	82.1	88.9	0.3	0.0
III	92.83	8.9	93.8	94.3	97.2	0.3	0.2	93.9	5.7	96.5	93.5	979.2	0.4	0.1

Source: author's own research; *A* - coefficient of asymmetry, *Kr* - coefficient of concentration

comparative analysis of the results obtained in various research centers. At the same time the author claims that in biology and medicine the term norm includes also a frame of reference which can be e.g. a numeric characteristic of population in the form of positional values and measures of volatility. Limits of norms despite the appearances of objectivity are always set up in an arbitrary way [23], therefore they cannot have features of a norm or a pathology. Permanent breaching norms are connected with evolution of life systems. It is protected by a stabilizing form of natural selection and the directional selection changes, breaching the previous one and forming a new one. Things which are normal for one system can constitute an anomaly for another. Transition from a norm to a pathology is continuous. It is a continuum. Evaluation of results has to depend from out-of statistical criteria. Statistics presents only a certain scale which shows if there is more or less of something than on average in a population but does not specify confrontation of a norm to pathology. Lack of norms in reference to the discussed angles can be seen in the form of a distortion of the biomechanical stability of an organ with all the consequences which result from it. However, variations in their sizes which rarely appear in the process of ontogenesis do not have to have negative results for the functioning of an organ. One example of the aforementioned can be acceptable (up to 10 mm) variations from the spinolaminal line which are located in a limit of physiological volatility approved as a value x +-3 S which limits and closes the area of normality.

The antero-posterior features of spines identified by the author are equal to specifying postures within the limits of a norm as a proper posture and out of the norm as improper posture. In the literature on the subject extremely different opinions have been presented. Some people like Minskij [24], Wolański et al. [25], Iwanowski [26], Zeyland-Malawka [21], Łubkowska [27] decided to write about them. The others like Krawański [28] reject them claiming that '… the shape of a human body reflects the state of human posture but it is not diagnostic in terms of categories such as a norm-defect'. He also points of the illusiveness of hope for establishing normative ranges because research done into this direction demonstrates only that the natural state encompasses a great variety of the shape of a silhouette in each population. Ślężyński and Kasperczyk [29] claim that '(…) achieving a real state of body posture in a population of children and youths, in particular its more significant elements would make developmental norms easier. It is recommended to aim for this and normative ranges should specify the limits which occur in the majority of the healthy population, without developmental deviations is included'. Olszewska [30] thinks that specifying limits for individual

Table 7 Descriptive statistics of average body height in approved categories for the number of the examined people taking into consideration their sexes; M = 62. F = 61

Categories	Sex													
	Male							Female						
	Descriptive statistics													
	M	S	Me	Q1	Q3	A	Kr	M	S	Me	Q1	Q3	A	Kr
I	182.17	7.6	183.9	180.2	184.5	0.2	0.4	181.6	7.7	183.2	180.3	184.6	0.3	0.4
II	186.4	6.8	187.7	186.2	188.5	0.6	0.2	186.1	6.9	187.7	186.4	188.6	0.2	0.5
III	192.58	7.3	192.6	190.2	193.3	0.5	0.5	191.3	7.6	191.9	190.2	193.1	0.4	0.5

Source: author's own research; *A* - coefficient of asymmetry, *Kr* - coefficient of concentration

groups, in which an individual should be placed is at best questionable.

The author thinks that precise specification of the proper sizes and limits of variations with reference to physiological curvatures is impossible because the transfer from proper values to the improper ones is smooth. Due to this fact it will be impossible to obtain one objective and reliable angular size. The sizes provided refer to protrusion (kyphosis) or intrusion (lordosis) of the spine in sagittal plane which are not always circular segments. and the degree of flexure of their upper and lower parts can be different. Therefore, in the diagnostics of body posture and its possible correction, the gradient term gradient of individual sections of the spine (Alpha, Beta and Gamma angles) is more useful. It is noted by numerous authors such as Iwanowski [26], Przybylski [31], Skolimowski [32], Śliwa [33], Wolański [34] and Wójcik [35]. Most often these tilts are described as angles included between lines connecting conventional points on apexes of the curve and the vertical plumb line. This is a simplification because the straight line and the curved line of the spine can be different.

In order to describe more accurate name for the antro-posterior shape of the spine the sizes of the analyzed sections of the spine should be provided (DKP, RKP, DLL and RLL) which is mentioned by Wójcik [36] and Zeyland-Malawka [19]. It must be believed that the total length of the spine (TLS) is the size which completes the set of normative ranges for a full body posture evaluation.

It was hypothetically approved that all 'partial' angles which are included in the angle of thoracic kyphosis or lumbar lordosis are normal when they guarantee proper functioning of the entire spine and they occur most frequently. The sizes of angles of thoracic kyphosis and lumbar lordosis provided for both sexes are not constant and do not clearly specify the limits because it is impossible to establish them. There were described as sizes of analyzed features with division into sex and body height.

The sizes of features provided on the basis of the measurements collected refer to the examined group domiciled in Poland. The research done for another group can give different sizes for the same features. An example of the aforementioned can be different body postures determined as correct for the individual age categories and sexes provided by Wolański [36] in the measurements made in 1957[34], 1959[36] and 1975[25]. Establishing norms on the basis of continuous examination does not solve the problem either because as Wolański [37] claims they would have to last even several dozen years; however, due to the existing tendency of secular trends they would become obsolete.

Approving one imaginary model for proper body posture. taking into account as a criteria health and fitness is obviously a theoretical assumption which is not supported by experimental research and which results only from the knowledge of pathological symptoms, co-existing with features of improper body posture. For instance: big head sticking to the front and deep cervical lordosis causing pressure on blood vessels deteriorates vascularization of brain and can cause pain and dizziness. Pressure on nerve roots can cause pain, numbness and paresis of arms. Head weight on the posterior wall of the chest makes work of the respiratory system difficult. Moreover, irregular burdening of cervical vertebrae leads to degenerative changes. Similar instances can be listed for extreme thoracic kyphosis and extreme lumbar lordosis, while back flatness means a risk of creating scoliosis. Starosta [38] writes about the need for a model (…)' correction of body posture is impossible without any knowledge about it'. Zeyland-Malawaka and Prętkiewicz-Abacjew [19] supply the statement by saying that first of all it is impossible to diagnose it. Nowotny [39] takes into consideration also a need of reference to one model for proper body posture.

The applied fragmentary method allows for determining the values of anthropometric features for women and men. Maintaining balance and motor coordination in a standing position is the basis of motor development [40, 41]. Proper stability in adults is the basic condition for motor skills in old age. The vertical positioning of the body axis in relation to the support surface is a characteristic feature of body posture. Maintaining an upright standing position requires effective control with the involvement of the sensory and musculoskeletal systems [42–46].

Conclusions

It can be assumed that the research material consisting of 123 people is a representative group for the analyzed body height and sex, because it was strictly selected in terms of somatic structure, body posture, physical activity and lifestyle. The sizes of the features describing the body posture of women and men with a body height of 180 cm to 195 cm fall within the ranges of the normative posture features adopted for 18-year-olds diagnosed with the use of the mora projection method. During the assessment of asymmetry in the frontal and transverse planes as well as angular and linear values in the sagittal curvatures of the spine, linearity was observed in the study group.

Studies on body posture standards are of great practical importance because they allow for the development of recommendations that can improve health and quality of life. Based on studies on body posture standards, educational and preventive programs can be developed that will help children, adolescents and adults maintain proper posture. Examples include promoting proper sitting at desks, correcting postural patterns during work, teaching ergonomics, and recommendations for physical activity that supports proper posture (e.g. exercises that strengthen postural muscles).

Acknowledgements
Not applicable.

Author contributions
M.M. was responsible for study design, data collection, statistical analysis and manuscript preparation. M.SS. was responsible for study design, manuscript preparation and funds collection. M.S. was responsible for manuscript preparation and funds collection.

Funding
The research was financed by the Institute of Physical Education Sciences, University of Szczecin.

Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The research was conducted in accordance with the principles included in the Helsinki Declaration. The study was approved by the ethics committee Komisja Bioetyczna (KEBN 2/2018. UKW w Bydgoszczy). Informed consent was obtained from all the participants.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Received: 9 June 2024 / Accepted: 28 January 2025
Published online: 25 March 2025

References

1. Montuori P. at al. (2023). Assessment on Practicing Correct Body Posture and Determinant Analyses in a Large Population of a Metropolitan Area. *Behav Sci (Basel).* Feb 8, 13(2), 144.
2. Kutzner-Kozińska M. Korekcja wad postawy. Wyd. II. Warszawa: WSiP; 1986.
3. Kröger S, Watkins B. Muscle spindle function in healthy and diseased muscle. Skelet Muscle Jan. 2021;7(1):3.
4. Ghorbani M, Yaali R, Sadeghi H, Luczak T. The effect of foot posture on static balance, ankle and knee proprioception in 18-to-25-year-old female student: a cross-sectional study. BMC Musculoskelet Disord Jul. 2023;4(1):547.
5. De Blasiis P, Caravaggi P, Fullin A, Leardini A, Lucariello A, Perna A, Guerra G, De Luca A. Postural stability and plantar pressure parameters in healthy subjects: variability, correlation analysis and differences under open and closed eye conditions. Front Bioeng Biotechnol Jul. 2023;20:11, 1198120.
6. Shumwey-Cook A, Woollacott MH. Motor control: theory and practical applications. Baltimore: Lippincott Williams & Wilkins; 2001.
7. Zwierko T, Lesiakowski P, Redondo B, Vera J. (2022). Examining the ability to track multiple moving targets as a function of postural stability: a comparison between team sports players and sedentary individuals. PeerJ Sep 2, 10, e13964.
8. Madle K, Svoboda P, Stribrny M, Novak J, Kolar P, Busch A, Kobesova A, Bitnar P. Abdominal wall tension increases using dynamic neuromuscular stabilization principles in different postural positions. Musculoskelet Sci Pract Dec. 2022;62:102655.
9. Dash R, Palanthandalam-Madapusi HJ. Change in task conditions leads to changes in intermittency in intermittent feedback control employed by CNS in control of human stance. Biol Cybern Aug. 2022;116(4):447–59.
10. Kaminishi K, Chiba R, Takakusaki K, Ota J. Investigation of the effect of tonus on the change in postural control strategy using musculoskeletal simulation. Gait Posture Feb. 2020;76:298–304.

11. Bazanova OM, Kovaleva AV. Psychophysiological Indicators of Postural Control. Contribution of the Russian Scientific School. Part I Hum Physiol. 2022;48(2):207–28.
12. Shumwey-Cook A, Horak FB. Balance rehabilitation in the neurological patient: course syllabus. Seattle: Neuroscience Education and Research Associates; 1992.
13. Szwiling Z. (2010). Wprowadzenie do terapii NDT-Bobath dla dzieci. Praktyczna Fizjoterapia i Rehabilitacja, 23–8.
14. Mrozkowiak M. Modulation, impact and relationships of selected parameters of body posture in children and adolescents aged 4 to 18 in the light of the mora projection. Bydgoszcz: University Press of Kazimierz Wielki University; 2015.
15. Deutsch E. (2000). The Declaration of Helsinki revised by the World Medical Organisation Edinburgh.
16. Ohlendorf D, et al. Standard reference values of the upper body posture in healthy male adults aged between 51 and 60 years in Germany. Sci Rep Apr. 2022;28(1):6961.
17. Bibrowicz K, Szurmik T, Ogrodzka-Ciechanowicz K, Hudakova Z, Gąsienica-Walczak B, Kurzeja P. Asymmetry of the pelvis in Polish young adults. Front Psychol. Mar 2023;22:14.
18. Wang R, et al. Risk factors associated with the prevalence of neck and shoulder pain among high school students: a cross-sectional survey in China. BMC Musculoskelet Disord Aug. 2024;9(1):641.
19. Zeyland – Malawka E, Prętkiewicz –, Abacjew E. (2005). Idealny wzorzec postawy – irrealizm czy element strategii w batalii o zdrowie dziecka. In: K. Górniak, editors, *Korektywa i kompensacja zaburzeń w rozwoju fizycznym dzieci i młodzieży* (pp. 9–13), AWF Warszawa, ZW WF Biała Podlaska, t. II.
20. Kużdżał A, Szczygieł A, Ćwirlej A. Porównanie parametrów krzywizn kręgosłupa w płaszczyźnie strzałkowej mierzonych metodą antropostereometryczną i inklinometryczną. Postępy Rehabilitacji. 2004;18(4):11–4.
21. Zeyland - Malawka E. Wyniki pomiarów Krzywizn kręgosłupa Jako układ Odniesienia w badaniu postawy ciała. Fizjoterapia. 2003;11(3):5–12.
22. Borek R, Sereda M, Stec W, Walicka-Cupryś K, Wilk G. Ocena wpływu niepewności danych pomiarowych na rezultat wnioskowania statystycznego o rozkładzie mierzonych -cech antropometrycznych. Zeszyty Naukowe Politechniki Rzeszowskiej. 2006;233(29):81–8.
23. Malinowski A, Bożiłow W. Podstawy Antropometrii. Łódź: PWN; 1997.
24. Minskij IA. (1972). Pribor Dla opredielenija naczalnych form naruszenija osanki z graficzeskim izobrażenijem linii oscistych otrostkov pozwonczika. Gig i Sanitarija, 7.
25. Wolański N, Niemiec S, Pyżuk M. Antropometria inżynieryjna. Warszawa: Książka i Wiedza; 1975.
26. Iwanowski W. Kształtowanie się fizjologicznych krzywizn kręgosłupa człowieka, Studia oparte na badaniach dzieci i młodzieży Wrocławia, Studia i Monografie. Wrocław: AWF Wrocław; 1982.
27. Łubkowska W. Ocena fizjologicznych krzywizn kręgosłupa i jej znaczenie w praktyce szkolnego wychowania fizycznego. Rozprawa doktorska, AWF Gdańsk; 2003.
28. Krawański A. (1992). Dylemat poprawności kształtu ludzkiego ciała, In: J. Ślężyński, editors, *Postawa ciała człowieka i metody jej oceny*. Katowice.
29. Ślężyński J, Kasperczyk T. Ewolucja metod oceny postawy ciała człowieka. In: Nowotny J, editor. Dysfunkcje kręgosłupa – diagnostyka, terapia. Katowice: AWF Katowice; 1993.
30. Olszewska E. Przegląd metod badania i oceny postawy ciała. In: Kutzner-Kozińska M, editor. Proces Korygowania Wsad postawy. Warszawa: AWF; 2001. pp. 50–73.
31. Przybylski J. Postawa ciała i metody jej oceny, konferencja okrągłego stołu o postawie ciała człowieka. Katowice: AWF; 1965. p. 290.
32. Skolimowski T. (1986). Kształtowanie się parametrów czynnościowych narządu ruchu w przebiegu idiopatycznych bocznych skrzywień kręgosłupa. Studia i Monografie, AWF Wrocław, (12).
33. Śliwa W. „Posturometr S – urządzenie do oceny postawy ciała. In: Nowotny J, editor. Dysfunkcje kręgosłupa. Diagnostyka i terapia. Katowice: AWF Katowice; 1993. pp. 7–9. 2.
34. Wolański N. Typy postawy ciała człowieka i ich określenie. Kultura Fizyczna. 1957;11(7):520–9.
35. Wójcik M. Kształt Krzywizn kręgosłupa w płaszczyźnie strzałkowej a siła mięśni antygrawitacyjnych u 11 – letnich dziewcząt. Rozprawy Naukowe. 1984;18:197–259.
36. Wolański N. Kształtowanie się Postawy ciała człowieka. Pediatria Polska. 1959;9:1203–16.
37. Wolański N. (1994). Zagadnienie normalności i prawidłowości w rozwoju dziecka, In: S. Gołąb, editors, *Normy rozwojowe. Aspekty teoretyczne, implikacje praktyczne* (pp. 1–18), Zeszyt Naukowy 15, Kraków: AWF Kraków.
38. Starosta J. Kształt kręgosłupa z punktu Widzenia motoryki człowieka i motoryki sportowej. Postępy Rehabilitacji. 1993;7(4):19–32.
39. Nowotny J. Ćwiczenia Korekcyjne w systemie stacyjnym. Katowice: AWF Katowice; 2001.
40. Clark JE, Metcalfe JS. The mountain of motor development: a metaphor. In: Clark JE, Humphrey J, editors. Motor development: research and reviews. Volume 2. Reston, VA: NASPE; 2002. pp. 163–90.
41. Stodden D, Goodway J, Langendorfer S, Roberton M, Rudisill M, Garcia C, et al. A developmental perspective on the role of motor skill competence in physical activity: an emergent relationship. Quest. 2008;60(2):290–306.
42. Huxham FE, Goldie PA, Patla AE. Theoretical considerations in balance assessment. Australian J Physiotherapy. 2001;4:89–100.
43. Maurer C, Mergner T, Peterka RJ. Multisensory control of human upright stance. Exp Brain Res. 2006;171:231–50.
44. Nolan L, Grigorenko A, Thorstensson A. Balance control: sex and age differences in 9- to 16-year-olds. Dev Med Child Neurol. 2005;47:449–54.
45. Barozzi S, Socci M, Soi D, Di Berardino F, Fabio G, Forti S, et al. Reliability of postural control measures in children and young adolescents. Eur Arch Otorhinolaryngol. 2014;271:2069–77.
46. Moein E, Movaseghi F. Relationship between some anthropometric indices with dynamic and static balance in sedentary female college students. Turkish J Sport Exerc. 2016;18(1):45–9.

Publisher's note