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Comparison of trunk alignment and postural habits of high school adolescents and university students

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Original article

Abstract

Introduction: It is widely believed that the postural quality of adolescents is poor and this condition is blamed, at least in part, on a sedentary lifestyle and low self-awareness of body alignment and awareness of movement quality. The aim of this study was to evaluate the postural habits and trunk alignment of high school adolescents against university students with high physical activity and high awareness of the importance of postural quality for health.

Material and methods: 59 high school students and 82 university students, male and female, participated in the study. Three-dimensional trunk positioning in habitual standing was investigated using the Zebris Pointer ultrasound device. Awareness of habitual posture during various activities of daily living was assessed using a validated questionnaire. Results were analysed using Statistica v13.

Results: High school students were characterised by a greater depth of thoracic kyphosis than university students. Female high school students tended to have shallower lumbar lordosis and male high school students tended to have deeper lordosis. High school students showed worse lateral trunk inclination and greater pelvic to shoulder rotation. The most important observation regarding postural awareness was related to sitting position. Women from both groups were more likely than men to admit to sitting with a bent and rotated trunk and crossed legs.

Conclusions: It appears that higher physical activity and / or greater knowledge of university students contributes to more correct trunk positioning compared to the physically inactive high school students. Postural habits, however, are similar in both groups. Gender significantly differentiates both posture and posture-related habits.

Keywords

- faulty body posture
- postural habits
- adolescents

Contribution

A – the preparation of the research project
B – the assembly of data for the research undertaken
C – the conducting of statistical analysis
D – interpretation of results
E – manuscript preparation
F – literature review
G – revising the manuscript

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Introduction

The relationship between posture and the occurrence of musculoskeletal pain has been repeatedly demonstrated.[1–3] However, the influence of posture on mood, self-esteem or assertiveness levels is also increasingly discussed.[4–7] This knowledge is not common, and even in groups with increased awareness of the importance of posture for health (such as physiotherapy students), this knowledge does not always go hand in hand with an effort to maintain correct posture during daily activities.[8] To improve posture it is necessary to be aware of body position. It is important to recognise / feel the spatial and temporal relationship of the different parts of the body to each other in static positions (when sitting, for example) and during movement. Research shows that young people's perception of body position and movement is poor, and points to the need to use physical education lessons to increase awareness of body position and movement, e.g. awareness of body position when walking or running.[9]

The aim of the study was to compare the posture of high school and university students who, due to their chosen field of study, had an above-average knowledge of the importance of posture for health and, at the same time, were characterised by high systematic physical activity. The original plan was to divide the high school students into subgroups of low, sufficient and high physical activity. However, after analysing the questionnaires completed by the high school students, it turned out that only a few of them were physically active at a high level (these people were excluded from the study) and no one was training any sport at a club under the supervision of a coach. For this reason, four groups were finally compared: female high school students, male high school students, female university students and male university students.

In addition to an objective assessment of trunk alignment, a standardised questionnaire was conducted to establish habits related to the posture adopted in various everyday situations. The research aimed to determine whether students' self-awareness of body position and their physical activity contribute to a better quality of trunk positioning.

Material and methods

The study group consisted of a total of 141 participants, including 59 (41.8%) high school students (33 females and 26 males) aged 16–17 years and 82 (58.2%) second-, third- and fourth-year physiotherapy and physical education students aged 20–26 years (49 females and 33 males students). None of the high school students trained systemically in a sports club. Their knowledge of posture was limited to information obtained on the Internet or from their GP and was at a low level. The students' physical activity was limited to compulsory physical education lessons at school and spontaneous irregular physical activity (e.g. walking, cycling). Due to the specific type of education in the physiotherapy and physical education courses, all students surveyed were characterised by high levels of physical activity (compulsory sports classes as part of their studies and additional training for many students) and above-average knowledge of the importance of body posture for health. Physical activity level was determined using the International Physical Activity Questionnaire (IPAQ-SF).[10]

All high school and university students were informed in detail about the purpose and conduct of the study, gave written consent to participate (in the case of students under 18 years of age, consent was signed by their parents) and were informed that they could withdraw at any time during the study without giving any reason. The research was carried out to the highest ethical standards, using non-invasive methods, in conditions that ensured complete comfort. All the guidelines of the Declaration of Helsinki regarding research with human participants were followed. The study did not involve medical intervention, so additional ethics committee approval was not required.

Body height was measured with a calibrated anthropometer to the nearest 0.01 m, while body weight was measured with a TANITA scale to the nearest 0.1 kg. Using these data, BMI was calculated and body mass status was estimated.

The quality of trunk alignment was examined with the Zebris Pointer ultrasound system in the habitual standing position.[11,12] The participant stood with her back to the device at a distance of 80 cm from it; the examiner marked selected skeletal points on the participant's body with an ultrasonic pointer: acromion processes, inferior angles of the scapulae, anterior superior and posterior superior iliac spines, peaks of the iliac plates, spinous processes from C7 to S2 and the thoracolumbar junction. Based on the information thus entered, a three-dimensional image of the torso alignment and numerical values showing: depth of thoracic kyphosis and lumbar lordosis, alignment of the spine in the frontal plane with the magnitude of any lateral curvature, inclination of the sacrum in the sagittal plane, inclination of the trunk in the sagittal and frontal planes, difference in the distance of the right and left scapula from the plane of the back, alignment of the pelvis in the frontal and transverse planes, alignment of

the shoulders in the frontal plane and inclination and rotation of the shoulders relative to the pelvis.

Selected torso alignment characteristics were presented as qualitative data. Normative data developed by the manufacturer were used to categorise the results.[13] Normal thoracic kyphosis was assumed to be 21–32° in women and 33–43° in men; normal lumbar lordosis was assumed to be 28–34° in women and 22–28° in men; normal sagittal trunk inclination was assumed to be 2–11° in both sexes; normal sacral inclination was assumed to be 18–27° in women and 12–19° in men. For the other variables, the optimal value is 0° or 0 mm.

The posture test was always performed by the same experienced person using the same measuring device. The same testing conditions (room, time of day) were also maintained for all participants.

Awareness of habitual posture was assessed using the *Questionnaire on body awareness of postural habits in young people* consisting of 35 questions, divided into 4 parts, concerning posture habits: in the classroom (11 questions), at home (17 questions), when lifting and carrying objects / backpack / bag (4 questions) and teacher behaviour (3 questions). The questionnaire used a Likert scale, with 5 possible answers: never, rarely, often, always, don't know / don't remember.[14]

The collected data were processed in Statistica v13. Basic descriptive statistics, the Shapiro-Wilk and Brown-Forsythe tests (to determine the quality of the distribution and homogeneity of variance), one-way ANOVA and post hoc Tukey test (to test the significance of intergroup differences), frequency tables (to summarise qualitative data) were used. Differences were assumed to be significant at $p < 0.05$.

Results

The body weight of female and male high school students was significantly lower than that of female and male university students (Table 1). Body height did not differ significantly between high school and university students of the same sex. Female high school students had the lowest BMI, male high school students had a slightly higher BMI and female and male university students had a significantly higher BMI.

A greater depth of thoracic kyphosis was observed in high school students than in university students. For female high school students, these differences were statistically significant. Comparison to norms indicated a greater tendency for excessive thoracic flexion in women (round back) (Table 2). The greatest depth of lumbar lordosis and the greatest sacral slope were found in female university students and high school male students. Consistent with the norms, female high school students tended to have a significantly shallower lumbar lordosis and male high school students tended to have a deeper lumbar lordosis.

Table 1. Basic somatic features of the participants

Variable	Group	Sex	Mean	Median	Min.	Max.	St. dev.	Intergroup comparisons
Body weight [kg]	High school	Women	53.59	53.40	41.10	73.20	6.78	**HSWa & HSMb $p < 0.001$***
		Men	67.06	65.60	46.50	115.10	17.52	**HSW & UWc $p = 0.023$***
	University	Women	61.68	58.60	44.70	131.00	13.20	**HSW & UMd $p < 0.001$***
		Men	83.50	82.40	59.60	102.80	11.71	HSM & UW $p = 0.296$
								HSM & UM $p < 0.001$*
								UW & UM $p < 0.001$*
Body height [cm]	High school	Women	162.52	164.00	153.00	174.00	6.40	**HSW & HSM $p < 0.001$***
		Men	176.58	179.50	159.00	196.00	8.24	HSW & UW $p = 0.513$
	University	Women	164.58	164.00	154.00	175.00	6.00	**HSW & UM $p < 0.001$***
		Men	181.06	180.00	169.00	193.00	6.46	**HSM & UW $p < 0.001$***
								HSM & UM $p = 0.050$
								UW & UM $p < 0.001$*
BMI [kg/m^2]	High school	Women	20.33	20.37	16.16	25.62	2.60	HSW & HSM $p = 0.752$
		Men	21.27	21.13	16.51	33.90	4.50	**HSW & UW $p = 0.017$***
	University	Women	22.71	22.40	16.80	43.80	4.07	**HSW & UM $p < 0.001$***
		Men	25.39	25.50	18.60	31.40	2.75	HSM & UW $p = 0.348$
								HSM & UM $p < 0.001$*
								UW & UM $p = 0.004$*

[a]HSW – high school women; [b]HSM – high school men; [c]UW – university women; [d]UM – university men; * – statistically significant difference

Table 2. Position of the trunk in the sagittal plane in the studied group

Variable	Group	Sex	Mean	Median	Min.	Max.	St. dev.	Intergroup comparisons
Thoracic kyphosis [°]	High school	Women	43.99	42.70	19.00	62.10	10.33	HSW[a] & HSM[b] $p = 0.890$ **HSW & UWc $p = 0.010$*** **HSW & UMd $p = 0.013$*** HSM & UW $p = 0.148$ HSM & UM $p = 0.146$ UW & UM $p = 0.997$
		Men	41.97	41.15	23.80	56.80	8.13	
	University	Women	36.44	35.30	6.00	58.00	11.79	
		Men	35.98	36.50	9.90	62.70	11.38	
Lumbar lordosis [°]	High school	Women	22.64	23.20	3.10	41.90	9.88	**HSW & HSM $p = 0.038$*** **HSW & UW $p = 0.003$*** HSW & UM $p = 0.962$ HSM & UW $p = 0.987$ **HSM & UM $p = 0.009$*** **UW & UM $p < 0.001$***
		Men	29.80	30.80	8.70	46.10	9.07	
	University	Women	30.64	31.60	0.00	50.00	11.21	
		Men	21.41	20.50	0.00	50.00	10.04	
Scapula distance difference [mm]	High school	Women	11.24	9.00	1.00	40.00	9.21	HSW & HSM $p = 0.269$ HSW & UW $p = 0.969$ HSW & UM $p = 0.466$ HSM & UW $p = 0.417$ HSM & UM $p = 0.970$ UW & UM $p = 0.667$
		Men	16.38	15.50	1.00	57.00	12.78	
	University	Women	12.35	10.00	0.00	56.00	10.18	
		Men	15.12	13.00	1.00	47.00	11.66	
Sagittal trunk inclination [°]	High school	Women	3.94	3.60	0.80	7.90	2.03	HSW & HSM $p = 0.984$ HSW & UW $p = 0.127$ HSW & UM $p = 0.936$ HSM & UW $p = 0.074$ HSM & UM $p = 0.802$ UW & UM $p = 0.409$
		Men	4.13	4.20	1.10	9.50	1.84	
	University	Women	2.89	2.40	0.00	11.60	2.33	
		Men	3.63	3.80	0.30	8.40	2.11	
Sacral angle [°]	High school	Women	16.65	15.40	0.00	46.90	12.08	HSW & HSM p = 0.053 **HSW & UW $p = 0.009$*** HSW & UM p = 0.978 HSM & UW $p = 0.998$ **HSM & UM $p = 0.018$*** **UW & UM $p = 0.002$***
		Men	22.98	24.60	8.90	35.60	8.58	
	University	Women	23.36	24.80	0.50	37.40	8.24	
		Men	15.72	15.30	0.00	43.70	9.04	

[a]HSW – high school women; [b]HSM – high school men; [c]UW – university women; [d]UM – university men; * – statistically significant difference

Table 3. Position of the trunk in the frontal plane in the studied groups

Variable	Group	Sex	Mean	Median	Min.	Max.	St. dev.	Intergroup comparisons
Pelvic obliquity [°]	High school	Women	1.98	1.20	0.00	5.80	1.54	HSW[a] & HSM[b] $p = 0.925$ HSW & UW[c] $p = 0.999$ HSW & UM[d] $p = 0.0997$ HSM & UW $p = 0.935$ HSM & UM $p = 0.972$ UW & UM $p = 0.999$
		Men	1.73	1.10	0.10	6.40	1.67	
	University	Women	1.95	1.60	0.00	6.90	1.55	
		Men	1.90	1.70	0.00	5.00	1.46	
Pelvic / shoulder obliquity [°]	High school	Women	1.82	1.50	0.10	5.50	1.47	HSW & HSM $p = 0.814$ HSW & UW $p = 0.544$ HSW & UM $p = 0.899$ HSM & UW $p = 0.992$ HSM & UM $p = 0.999$ UW & UM $p < 0.940$
		Men	2.21	1.95	0.40	5.90	1.38	
	University	Women	2.32	1.70	0.10	8.80	1.99	
		Men	2.11	1.30	0.00	4.90	1.61	

Variable	Group	Sex	Mean	Median	Min.	Max.	St. dev.	Intergroup comparisons
Pelvic hight difference [mm]	High school	Women	7.09	4.70	0.00	18.30	5.27	HSW & HSM $p = 0.956$ HSW & UW $p = 0.678$ HSW & UM $p = 0.719$ HSM & UW $p = 0.383$ HSM & UM $p = 0.437$ UW & UM $p = 0.999$
		Men	6.20	3.45	0.30	22.70	6.43	
	University	Women	8.76	7.00	0.10	31.10	7.52	
		Men	8.81	7.70	0.10	20.70	6.54	
Shoulder hight difference [mm]	High school	Women	6.99	6.20	1.60	17.40	4.94	HSW & HSM $p = 0.995$ HSW & UW $p = 0.837$ HSW & UM $p = 0.428$ HSM & UW $p = 0.955$ HSM & UM $p = 0.639$ UW & UM $p = 0.845$
		Men	7.37	7.20	0.00	22.90	5.47	
	University	Women	8.11	7.40	0.20	21.50	5.59	
		Men	9.20	8.50	0.00	28.20	7.47	
Lateral trunk inclination [°]	High school	Women	1.53	1.60	0.00	2.70	0.64	HSW & HSM $p = 0.558$ HSW & UW $p = 0.115$ HSW & UM $p = 0.050$ **HSM & UW $p = 0.002$*** **HSM & UM $p = 0.001$*** UW & UM $p = 0.938$
		Men	1.79	1.80	0.50	5.10	0.97	
	University	Women	1.14	1.20	0.00	3.60	0.71	
		Men	1.05	0.80	0.00	3.70	0.77	
Scoliosis deformation [°]	High school	Women	1.77	0.00	0.00	11.60	3.42	**HSW & HSM $p = 0.029$*** HSW & UW $p = 0.999$ HSW & UM $p = 0.997$ **HSM & UW $p = 0.016$*** **HSM & UM $p = 0.048$*** UW & UM $p = 0.997$
		Men	4.69	3.45	0.00	17.80	5.21	
	University	Women	1.78	0.00	0.00	20.50	3.85	
		Men	1.95	0.00	0.00	13.20	3.87	

[a]HSW – high school women; [b]HSM – high school men; [c]UW – university women; [d]UM – university men; * – statistically significant difference

Participants did not differ significantly in pelvic and shoulder alignment in the frontal plane (Table 3). Female and male high school students had worse lateral trunk inclination than university students, and male high school students had a significantly greater tendency for lateral bending of the spine compared to the other study groups.

Lower pelvic torsion was recorded in high school students (significant difference between high school females and male students), while lower pelvic to shoulder rotation was recorded in university students (significant difference between high school females and university students) (Table 4).

Table 4. Position of the trunk in the transversal plane in the studied groups

Variable	Group	Sex	Mean	Median	Min.	Max.	St. dev.	Intergroup comparisons
Pelvic torsion [°]	High school	Women	2.76	1.50	0.10	9.70	2.46	HSW & HSM $p = 0.992$ HSW & UW $p = 0.461$ **HSW & UM $p = 0.026$*** HSM & UW $p = 0.621$ HSM & UM $p = 0.060$ UW & UM $p = 0.376$
		Men	2.92	2.35	0.10	8.70	2.63	
	University	Women	4.20	3.00	0.20	32.90	5.07	
		Men	5.78	4.00	0.10	18.40	5.65	
Pelvic / shoulder rotation [°]	High school	Women	6.25	6.60	0.70	16.10	3.85	HSW & HSM $p = 0.629$ **HSW & UW $p = 0.020$*** HSW & UM $p = 0.309$ HSM & UW $p = 0.509$ HSM & UM $p = 0.974$ UW & UM $p = 0.751$
		Men	5.13	5.10	0.20	12.90	3.94	
	University	Women	3.94	3.50	0.20	15.40	3.40	
		Men	4.74	3.90	0.50	14.80	3.07	

[a]HSW – high school women; [b]HSM – high school men; [c]UW – university women; [d]UM – university men; * – statistically significant difference

Among high school students, females were more likely to declare that they did not know or could not remember what posture they take in class (Table 5). Female high school students were more likely to report sitting in class with their torso leaning forward and twisted, and more likely to sit with their legs crossed, while male high school students were more likely to indicate that they sit with both feet firmly supported on the floor. No clear differences were noted between female and male high school students in carrying objects (Table 7) or their opinion on teachers' behaviours (Table 8).

Table 5. Posture habits in the classroom in both groups of high school pupils

High school female pupils					With respect to your body posture in the CLASSROOM, do you:	High school male pupils				
Always	Frequently	Rarely	Never	Do not know / remember		Always	Frequently	Rarely	Never	Do not know / remember
1	14	10	6	2	sit with your back well supported on the backrest?	0	2	6	18	0
6	21	6	0	0	sit with your body tilted forward?	3	8	15	0	0
0	10	16	4	2	sit with your upper body twisted (with torso torsion)?	0	3	15	8	0
1	10	16	4	2	sit with your buttocks slipping forward?	0	9	9	7	1
0	12	8	2	11	sit with your buttocks well supported without slipping forward?	1	10	5	0	0
1	11	12	2	7	sit with both feet firmly on the floor?	10	7	9	0	0
1	14	10	6	0	sit with your feet unsupported?	0	2	6	18	0
1	19	8	5	0	sit cross-legged?	0	0	11	15	0
8	17	6	0	2	stand with equal support on both legs?	9	9	6	0	2
2	17	8	2	4	stand with more support on one leg?	0	7	15	4	0
9	21	0	0	3	carry out body movements (e.g. joint movements, stretching, etc.)?	3	14	9	0	0

Table 6. Posture habits at home in both groups of high school pupils

High school female pupils					With respect to your body posture at HOME, do you:	High school male pupils				
Always	Frequently	Rarely	Never	Do not know / remember		Always	Frequently	Rarely	Never	Do not know / remember
0	15	16	0	2	sit with your back well supported on the backrest?	11	9	6	0	0
2	28	3	0	0	sit with your body tilted forward?	2	5	18	1	0
1	10	6	6	10	sit with your upper body twisted (with torso torsion)?	0	2	11	13	0
3	5	21	4	0	sit with both feet firmly on the floor?	14	9	2	1	0
2	9	17	4	1	sit with your feet unsupported?	0	4	3	19	0
4	17	10	2	0	sit cross-legged?	1	5	15	5	0
0	16	8	1	8	sit with your buttocks well supported without slipping forward?	3	16	7	0	0
0	18	9	6	0	sit with your buttocks slipping forward?	0	7	12	5	2
3	8	12	9	1	lie down (to sleep) on your stomach?	0	4	2	17	3

High school female pupils					With respect to your body posture at HOME, do you:	High school male pupils				
Always	Frequently	Rarely	Never	Do not know / remember		Always	Frequently	Rarely	Never	Do not know / remember
14	13	5	1	0	lie down (to sleep) on your side?	11	10	1	1	3
3	5	5	16	4	lie down (to sleep) on your back?	1	5	15	0	5
12	19	2	0	0	carry out body movements (e.g. joint movements, stretching, etc.)?	10	10	6	0	0
4	18	8	3	0	stand with more support on one leg?	0	7	11	8	0
7	14	10	1	1	stand with equal support on both legs?	8	11	7	0	0
0	10	12	3	8	watch TV or use the computer (tablet or similar) sitting down with your back well supported on the backrest?	0	16	7	0	3
4	15	7	7	0	watch TV or use the computer lying down?	2	12	9	3	0
4	4	16	1	8	watch TV or use the computer sitting down with your back curved and your buttocks slipping forward?	0	7	11	8	0

Table 7. Posture habits related to carrying objects in both groups of high school pupils

High school female pupils					With respect to CARRYING OBJECTS, do you:	High school male pupils				
Always	Frequently	Rarely	Never	Do not know / remember		Always	Frequently	Rarely	Never	Do not know / remember
2	6	13	12	0	carry your backpack/bag on one shoulder (preferably on one side)?	0	3	14	9	0
15	13	4	1	0	carry your backpack/bag on both shoulders?	16	7	3	0	0
11	16	5	0	1	bend your knees to pick up an object from the floor?	6	14	6	0	0
6	18	7	1	1	bend your back to pick up an object from the floor?	2	10	13	1	0

Table 8. Posture habits related to teachers' behaviour in both groups of high school pupils

High school female pupils					In the classroom, do most of the TEACHERS:	High school male pupils				
Always	Frequently	Rarely	Never	Do not know / remember		Always	Frequently	Rarely	Never	Do not know / remember
11	21	0	0	1	ask the students to sit down and remain silent	11	11	4	0	0
3	2	18	7	3	allow the students movements	1	1	18	2	4
1	0	11	17	4	encourage the students to carry out movements during the class	0	1	14	9	2

Also in the university student group, women were more likely to admit to sitting with their torso twisted and leaning forward and with their legs crossed both in class (Table 9) and at home (Table 10). In the university student group, there was no difference between men and women in the frequency of sitting with both feet firmly on the floor. In this group, women were more likely to declare carrying their handbag on one shoulder than men. High school students of both sexes answered mostly that they carry their backpack on both shoulders (Table 11). In the opinion of university students, academic teachers do not encourage a change of position / movement during lessons more often than high school teachers (Table 12).

Table 9. Posture habits in the classroom in both groups of university students

UIniveristy female pupils					With respect to your body posture in the CLASSROOM, do you:	University male pupils				
Always	Frequently	Rarely	Never	Do not know / remember		Always	Frequently	Rarely	Never	Do not know / remember
2	17	20	10	0	sit with your back well supported on the backrest?	1	7	11	14	0
3	35	10	1	0	sit with your body tilted forward?	3	13	16	0	1
2	13	24	9	1	sit with your upper body twisted (with torso torsion)?	0	7	16	9	1
4	11	25	9	0	sit with your buttocks slipping forward?	2	13	12	6	0
6	13	23	2	5	sit with your buttocks well supported without slipping forward?	1	19	10	3	0
7	15	24	3	0	sit with both feet firmly on the floor?	8	12	11	1	1
2	17	20	10	0	sit with your feet unsupported?	1	7	11	14	0
1	19	21	8	0	sit cross-legged?	3	3	11	15	1
3	20	26	0	0	stand with equal support on both legs?	7	19	6	1	0
9	24	12	2	2	stand with more support on one leg?	1	9	21	2	0
20	24	5	0	0	carry out body movements (e.g. joint movements, stretching, etc.)?	10	16	6	1	0

Table 10. Posture habits at home in both groups of university students

University female pupils					With respect to your body posture at HOME, do you:	University male pupils				
Always	Frequently	Rarely	Never	Do not know / remember		Always	Frequently	Rarely	Never	Do not know / remember
0	15	16	0	2	sit with your back well supported on the backrest?	11	9	6	0	0
2	28	3	0	0	sit with your body tilted forward?	2	5	18	1	0
1	10	6	6	10	sit with your upper body twisted (with torso torsion)?	0	2	11	13	0
3	5	21	4	0	sit with both feet firmly on the floor?	14	9	2	1	0
2	9	17	4	1	sit with your feet unsupported?	0	4	3	19	0
4	17	10	2	0	sit cross-legged?	1	5	15	5	0
0	16	8	1	8	sit with your buttocks well supported without slipping forward?	3	16	7	0	0
0	18	9	6	0	sit with your buttocks slipping forward?	0	7	12	5	2

University female pupils					With respect to your body posture at HOME, do you:	University male pupils				
Always	Frequently	Rarely	Never	Do not know / remember		Always	Frequently	Rarely	Never	Do not know / remember
3	8	12	9	1	lie down (to sleep) on your stomach?	0	4	2	17	3
14	13	5	1	0	lie down (to sleep) on your side?	11	10	1	1	3
3	5	5	16	4	lie down (to sleep) on your back?	1	5	15	0	5
12	19	2	0	0	carry out body movements (e.g. joint movements, stretching, etc.)?	10	10	6	0	0
4	18	8	3	0	stand with more support on one leg?	0	7	11	8	0
7	14	10	1	1	stand with equal support on both legs?	8	11	7	0	0
0	10	12	3	8	watch TV or use the computer (tablet or similar) sitting down with your back well supported on the backrest?	0	16	7	0	3
4	15	7	7	0	watch TV or use the computer lying down?	2	12	9	3	0
4	4	16	1	8	watch TV or use the computer sitting down with your back curved and your buttocks slipping forward?	0	7	11	8	0

Table 11. Posture habits related to carrying objects in both groups of university students

University female pupils					With respect to CARRYING OBJECTS, do you:	University male pupils				
Always	Frequently	Rarely	Never	Do not know / remember		Always	Frequently	Rarely	Never	Do not know / remember
19	19	5	6	0	carry your backpack/bag on one shoulder (preferably on one side)?	5	5	18	5	0
10	4	25	8	2	carry your backpack/bag on both shoulders?	8	16	5	4	0
13	22	9	0	5	bend your knees to pick up an object from the floor?	16	11	6	0	0
2	18	24	4	1	bend your back to pick up an object from the floor?	5	10	16	2	0

Table 12. Posture habits related to teachers' behaviour in both groups of university students

University female pupils					In the classroom, do most of the TEACHERS:	University male pupils				
Always	Frequently	Rarely	Never	Do not know / remember		Always	Frequently	Rarely	Never	Do not know / remember
13	22	10	3	1	ask the students to sit down and remain silent	9	13	6	1	4
2	2	27	13	5	allow the students movements	3	3	12	7	8
0	2	25	21	1	encourage the students to carry out movements during the class	0	4	10	11	8

Discussion

Examination of trunk alignment showed significantly worse spinal shape in the sagittal plane in high school students. Female high school students were more likely to have excessive thoracic kyphosis and flat lumbar lordosis, while male high school students had excessive lumbar lordosis. Female high school students (of both sexes) were also more frequently diagnosed with trunk tilt in the frontal plane and male pupils additionally had more frequent lateral bending of the spine.

Both groups of females, more often than males, admitted to leaning their trunk forward in a sitting position, which in female high school students could be related to excessive thoracic kyphosis. Female university students did not show a worsening of thoracic kyphosis compared to males. Perhaps increased physical activity contributed to this. This negligent sitting position of female high school students (with lumbar spine in flexion) may in turn be responsible for the shallowing of the lumbar lordosis in this group. The twisted trunk position in sitting reported by women in both groups may be related to frequent sitting with legs crossed. Although female university students admitted to frequently carrying a bag on one shoulder, they were not diagnosed with a greater deviation of trunk position in the frontal plane than the other groups. Male high school students had a significantly higher incidence of lateral bending of the spine.

All university students examined in the described study were characterised by high and systematic physical activity. This was largely due to compulsory physical activity as part of the education programme. Therefore, this group is not representative and may differ from the general student population in Poland. Using the same tool (International Physical Activity Questionnaire – IPAQ-SF), Grabowska[15] examined the level of physical activity of 629 students of various faculties at the University of Wrocław, the Wrocław University of Technology and the Medical University. She recorded a high level of physical activity in 37.3% of the students, sufficient in 26.0% and low in 36.7%. The aforementioned author did not observe an effect of gender on participants' physical activity level. In contrast, Boguszewski et al. 16 found that males physiotherapy students at the Warsaw Medical University were significantly more likely to have high level of physical activity than their female counterparts. Studies conducted among high school students show that most of them present a moderate level of physical activity at this age,[17] with females more often showing deficits in physical activity.[18]

Much is said about the importance of physical activity for the quality of body posture. However, research results do not always unequivocally confirm the beneficial effects of sport on shape of the spine. Grabara 19 showed insignificant differences (concerning only selected posture parameters) between boys who practise football and those who do not. Other studies on young men have also shown that a high level of physical activity is not sufficient to ensure correct posture.[20] On the other hand, Balko et al. [21] who assessed the posture of children aged 10–11 years diagnosed significantly better body posture in pupils who were physically active three times a week compared to pupils who exercised only once a week or less frequently.

For postural control, postural awareness is crucial, which is very difficult to assess, especially on the objective dimension required in evidence-based medicine. In addition to the Questionnaire on body awareness of postural habits in young people used in this study, a number of validated tools are available to assess the level of postural awareness, e.g.:

1. Postural Awareness Scale (PAS), which consists of 12 statements answered on a 7-point scale where 1 means: absolutely disagree and 7 means: completely agree. Higher scores indicate greater postural awareness;[22,23]
2. Body Awareness Questionnaire (BAQ), which consists of 18 statements based on a seven-point scale (from 1 – not at all concerned with me to 7 – very concerned with me).[24]

Therapeutic systems aimed at increasing sensory-motor awareness are also being developed. An example of such a therapy is Basic Body Awareness Therapy (BBAT), which focuses on teaching the correct execution of everyday movements and their sensation in relation to taming and space (http://www.iatbbat.com/basic-body-awareness-therap.html). Publications on the effectiveness of BBAT therapy show promising results on the one hand, but on the other hand indicate the need for further research on this topic.[25–27]

The research presented here is only a small step on the road to understanding the importance of posture awareness. The aim was to draw attention to this important, difficult and underresearched problem. High school and university students were chosen as participants in the study to show that in these groups faulty posture is a common problem. This is also the last moment when a systemic approach (e.g. through health-promoting education and improving the quality of physical education lessons) can be attempted to address this problem.

Conclusions

1. Students who have knowledge of the importance of posture for health and are highly physically active are characterised by better trunk positioning in habitual standing compared to high school students. However, habitual posture in everyday situations is similar in both groups.
2. Women differ from men in their posture habits: they are more likely to describe their sitting position as leaning forward with trunk twisted and with their legs crossed. They are also more likely to carry a bag on one shoulder.
3. According to both high school and university students, teachers do not encourage a change in body position during lessons and lectures and prefer students to sit quietly without moving at their desks.

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