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Jaroslav BROĎÁNI*, Monika CZAKOVÁ**, Matúš GUZMAN***

LEVEL OF DYNAMIC POSTURAL STABILITY OF STUDENTS AT SPORTS MID-SCHOOL IN NITRA

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Poziom dynamicznej stabilności postawy uczniów Gimnazjum Sportowego w Nitrze

Streszczenie

W pracy odwołujemy się do poziomu dynamicznej stabilności postawy (DPS) u uczniów Gimnazjum Sportowego w Nitrze. Zespół badawczy składał się ze sportowców z gimnazjum sportowego w Nitrze (dziewczęta n = 21, wzrost M = 166,37, SD = 5,36; chłopcy n = 19, wzrost M = 179,05, SD = 7,57). Dynamiczną stabilność postawy mierzono za pomocą testu równowagi Star Excursion Balance Test (SEBT) przeprowadzanego w ośmiu kierunkach. Poziom dynamicznej stabilności postawy (DPS) scharakteryzowano za pomocą statystyk opisowych. Boczność między prawą i lewą stopą stojącą oceniano za pomocą testu t i „d” Cohena. Istotność statystyczną różnic oszacowano na poziomie istotności 5%.

Wyniki nie wykazały różnic w lateralności dynamicznej stabilności postawy (DPS) i złożonej stabilności postawy (CPS) u chłopców i dziewcząt pomiędzy stopą dominującą (DLS) i niedominującą (NLS) pod względem wartości średnich, maksymalnych, a nawet względnych (p = n.s). Największe zakresy ruchu pod względem wartości średnich zaobserwowano u chłopców i dziewcząt w obu stojących nogach w kierunku grzbietowym, tylno-przyśrodkowym, tylnym, tylno-bocznym, bocznym w kierunku przyśrodkowym i przednio-przyśrodkowym.

Artykuł stanowi część zadania badawczego VEGA 1/0460/23 Zdrowie postawy ciała u dzieci i młodzieży oraz możliwości wpływania na nie.

Słowa kluczowe: stabilność postawy, lateralność, chłopcy, dziewczęta, gimnastyczna sala sportowa.

* https://orcid.org/0000-0002-0126-8514; Assoc. Prof., PaedDr., PhD., Department of Physical Education and Sports, Faculty of Education, Constantine the Philosopher University in Nitra, Slovakia; email: jbrodani@ukf.sk
** https://orcid.org/0000-0002-1594-1079; Master's degree., PhD., Department of Physical Education and Sports, Faculty of Education, Constantine the Philosopher University in Nitra, Slovakia; email: mczakova@ukf.sk
*** https://orcid.org/0009-0000-8265-9201; Master's degree., Department of Physical Education and Sports, Faculty of Education, Constantine the Philosopher University in Nitra, Slovakia; email: matus.guzman@ukf.sk (corresponding author)

Abstract

At work, we refer to the level of dynamic postural stability (DPS) in students at the Sports Mid-school in Nitra. The research sample consisted of athletes from the sports mid-school in Nitra (girls n = 21, height M = 166.37, SD = 5.36; boys n = 19, height M = 179.05, SD = 7.57). Their dynamic postural stability was measured using the Star Excursion Balance Test (SEBT) carried out in eight directions. The level of dynamic postural stability (DPS) was characterized by descriptive statistics. The laterality between the right and left standing foot was assessed by a t-test and a Cohen's "d". The statistical significance of the differences was assessed at a 5% significance level.

The results did not show differences in the laterality of dynamic postural stability (DPS) and complex postural stability (CPS) in boys and girls between dominant (DLS) and non-dominant (NLS) standing foot in terms of mean, maximum and even relative values (p = n. s). The largest movement ranges in terms of average values were seen in boys and girls in both standing legs in the dorsal direction in the posteromedial, posterior, posterolateral, lateral in the medial direction and in the anteromedial front direction.

The contribution is part of the research task VEGA 1 / 0460 / 23 Postural health in children and adolescents and the possibility of influencing it.

Keywords: postural stability, laterality, boys, girls, sports mid-school.

Introduction

The students of the Sports Mid-school receive between 4 and 8 training units each in their respective fields of study. The different nature of the load, together with the uneven load due to the specific needs for sports performance in sport, may result in changes in posture and posture which may also have an impact on dynamic postural stability.

The approach chosen can be viewed from two different perspectives: balance and stability. It is important to bear in mind the correct definition of the aforementioned two concepts. Balance is the act of putting something into balance, stability is the ability to maintain balance by resisting external forces and tensions. A balanced and stable attitude, therefore, enables perfect balance to be maintained in various positions in many sports sectors, minimising the fluctuations naturally produced by our bodies and thus making it easier to make all the movements without any changes in the position itself. In addition, it increases the chance of shortening the activation time of the muscle chains involved in the technical gesture and consequently also improves the control of rebound. The ability to maintain equilibrium is crucial to everyday life. It involves complex coordination of the muscles, bones and nervous system so that the body can adapt to various internal and external influences.

Dynamic postural stability focuses on this capability in motion, with different activities and terrain inequalities. Posterior stability is the ability to ensure upright posture and to react to changes in external and internal forces in such a way that there is no unintended or uncontrolled fall (Vařeka, 2002), or even the ability to maintain the centre of gravity (COG) projection of the support base (Lee & Lin, 2008) and to maintain stability over time (Lee & Lin, 2008). The central nervous system concentrates and selects sensory inputs from the environment to provide the most functionally useful information for maintaining stability. This ability to select important sensory stimuli is essential for the proper functioning of postural stability (Brumagne et al., 2008). Visual, vestibular and somatosensory information is important for maintaining stability. The visual system provides information about the environment, the vestibular head and body positions, and the somatosensory system includes input from proprioreceptors, thermoreceptors and nociceptors (Page et al., 2010).

In all activities, that is to say, in sport, when sportspeople come into contact with the surface, the preservation of structural stability is of crucial importance in order to achieve a successful outcome, and a high level of control is also necessary in order to ensure that movement is accurately carried out. The control unit in the form of the central nervous system concentrates primarily on maintaining equilibrium and subsequently on other activities associated with motor activity. Developing the capacity to control balance thus becomes one of the important objectives of the training process in most sports.

Methods

The research was carried out on a set of athletes from the sports mid-school in Nitra in the age range from 16 to 19 years. The sports specializations of individual probands are athletics, basketball, dance, football, handball, table tennis, floorball, hockey and fitness (girls n = 21, height M = 166.37, SD = 5.36; boys n = 19, height M = 179.05, SD = 7.57). Dynamic postural stability was measured using the eight-point Star Excursion Balance Test (SEBT). The SEBT test was performed in eight directions, i.e. posterior, posterior medial, medial, anterior medial, anterior, anterior lateral, lateral, posterior lateral on a dominant and non-dominant standing leg (Figure 1).

The output measurements of the dominant and non-dominant leg shall be assessed with respect to the maximum measured value (cm), the average of 3 attempts (cm) and the relative value (Relative – normalized distance in each direction (%) = Average distance in each direction / length of the lower limb * 100). Complex postural stability (CPS) for both legs = mean with mean values from 3 attempts of SEBT (Composit Scores) (Garrett et al., 2012; Calatayud et al., 2017).

The level of DPS was characterized by descriptive statistics (M, SD, Max, Min). The statistical significance of the differences between the dominant and the non-dominant leg was assessed by a t-test ($p < 0.05$) and the material significance of the differences was assessed by Cohen's „d" (low effect = 0.20, medium effect = 0.50, high effect = 0.80).

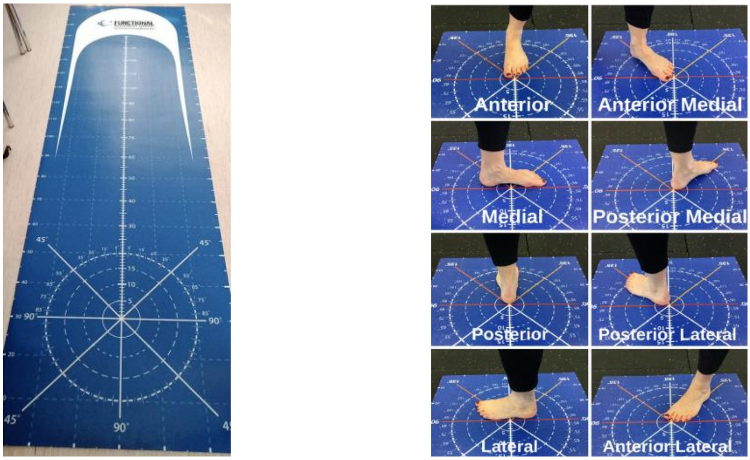

Figure 1
Eight-way Star Excursion Balance Test (SEBT)

Results

By comparing the dynamic postural stability of the students at sports mid-school, the dominant (DSL) and the non-dominant standing leg (NSL), no differentiation in the boys' lateral laterality was observed (Tab. 1 and 3) for average values t (19) = 1.59, p = 0.13, d = 0.22, maximum values t (19) = 1.49, p = 0.15, d = 0.22 and for relative values t (19) = 1.59, p = 0.13, d = 0.24.

No significant differentiation in the dominant leg (DSL) and the non-dominant standing leg (NSL) in laterality was observed in girls (Table 2 and 3) for average values t (19) = 1.71 p = 0.10, d = 0.22, maximum values t (19) = 1.48, p = 0.15, d = 0.10 and relative values t (19) = 1.59, p = 0.13, d = 0.13.

In complex postural stability (CPS), no significant differences were noted in boys between the dominant (DSL) and non-dominant standing leg (NSL) in terms of average values t (19) = 0.80, p = 0.44, maximum values t (19) = 0.51 p = 0.62 and relative values t(19) = 0.77, p = 0.45 nor for girls from the point of view of average values t (19) = 1.33, p = 0.2, maximal values t (19) = 1.04, p = 0.31 and relative values t (19) = 1.37, p = 0.18.

In terms of average values, we recorded the largest range of motion in boys and girls for both standing legs in the dorsal (spinal plane) in the posterior medial direction (M_{dsl} = 95.18, SD = 13.22 <> M_{nsl} = 92.53, SD = 11.04), in the posterior direction (M_{dsl} = 93.07, SD = 12.28 <> M_{nsl} = 92.75, SD = 12.32), in the posterior lateral direction (M_{dsl} = 90.95, SD = 10.79 <> M_{nsl} = 90.74, SD = 12.40) and laterally in the medial direction (M_{dsl} = 93.37, SD = 12.65 <> M_{nsl} = 92.09, SD = 12.02). From the perspective of the frontal plane, the greatest range of motion was in the anterior medial direction (M_{dsl} = 79.44, SD = 8.48 <> M_{nsl} = 78.39, SD = 8.50).

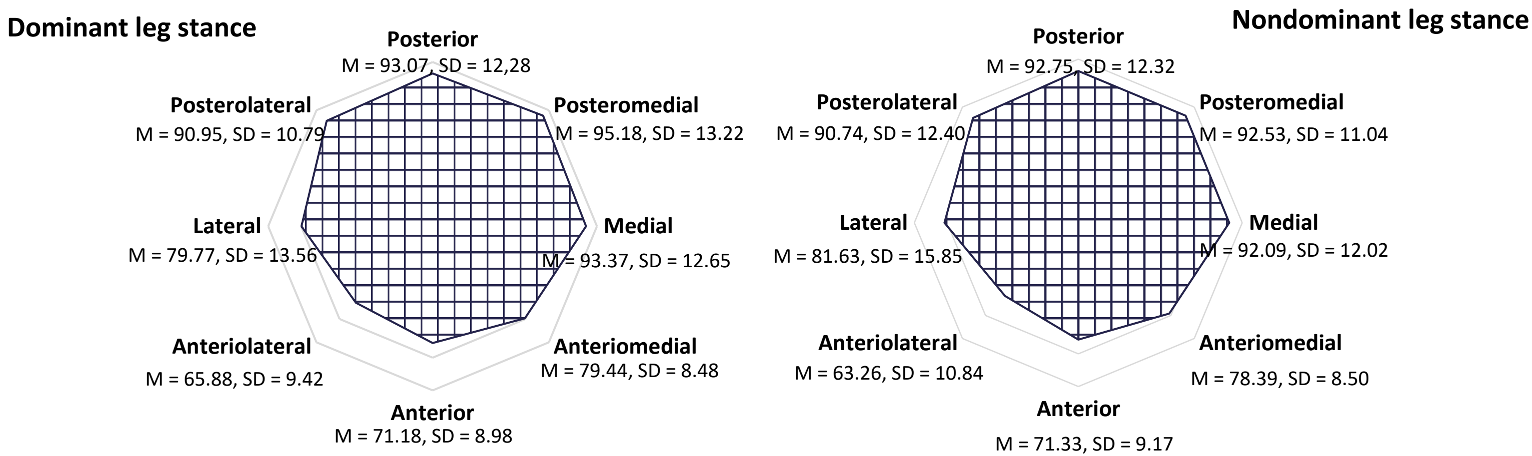

Figure 1

Postural stability of the dominant and non-dominant leg of girls and boys (Mean values)

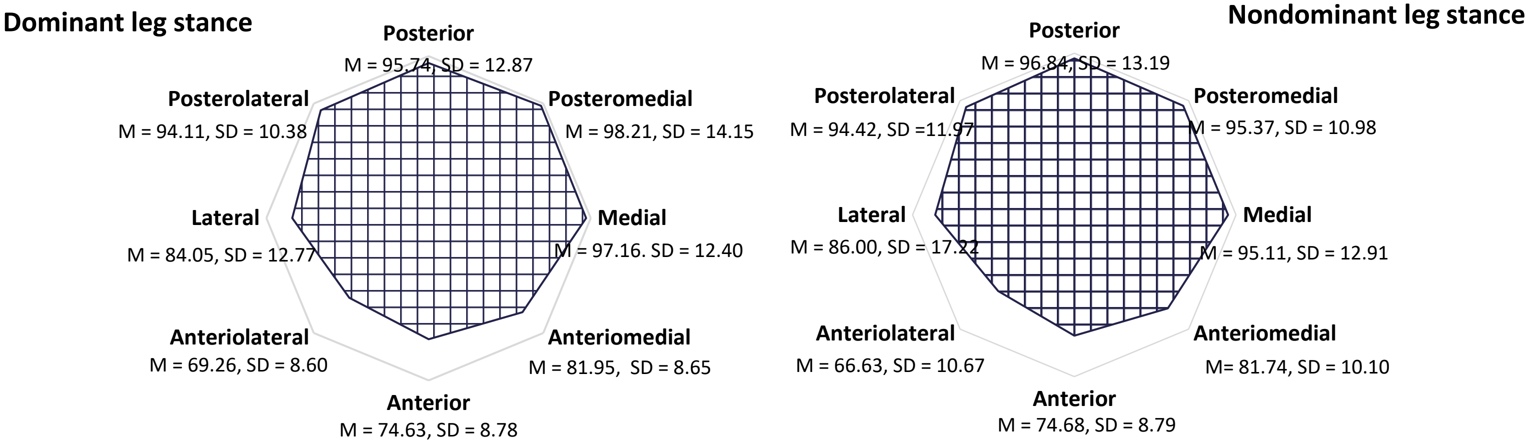

Figure 2

Postural stability of the dominant and non-dominant leg of girls and boys (Maximum values)

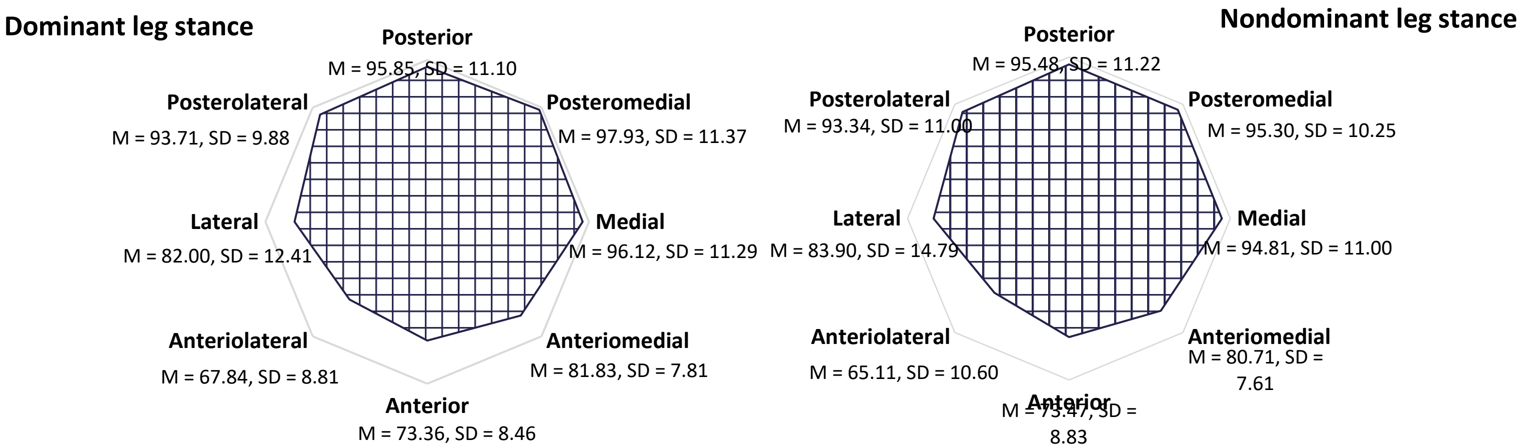

Figure 3

Postural stability of the dominant and non-dominant leg of boys (Relative values)

Table 1

Postural stability of the dominant and non-dominant leg of boys from the point of view of maximum, average and relative values

	Average values				Maximum values				Relative values			
	Dominant		Nondomimant		Dominant		Nondomimant		Dominant		Nondomimant	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Anterior (cm)	93.07	12.28	92.75	12.32	95.74	12.87	96.84	13.19	95.85	11.10	95.48	11.22
AnteroLateral (cm)	95.18	13.22	92.53	11.04	98.21	14.15	95.37	10.98	97.93	11.37	95.30	10.25
Lateral (cm)	93.37	12.65	92.09	12.02	97.16	12.40	95.11	12.91	96.12	11.29	94.81	11.00
PosteroLateral (cm)	79.44	8.84	78.39	8.50	81.95	8.65	81.74	10.10	81.83	7.81	80.71	7.61
Posterior (cm)	71.18	8.98	71.33	9.17	74.63	8.78	74.68	8.79	73.36	8.46	73.47	8.83
PosteroMedial (cm)	65.88	9.42	63.26	10.84	69.26	8.60	66.63	10.67	67.84	8.81	65.11	10.60
Medial (cm)	79.77	13.56	81.63	15.85	84.05	12.77	86.00	17.22	82.00	12.41	83.90	14.79
Anteromedial (cm)	90.95	10.79	90.74	12.40	94.11	10.38	94.42	11.97	93.71	9.88	93.34	11.00

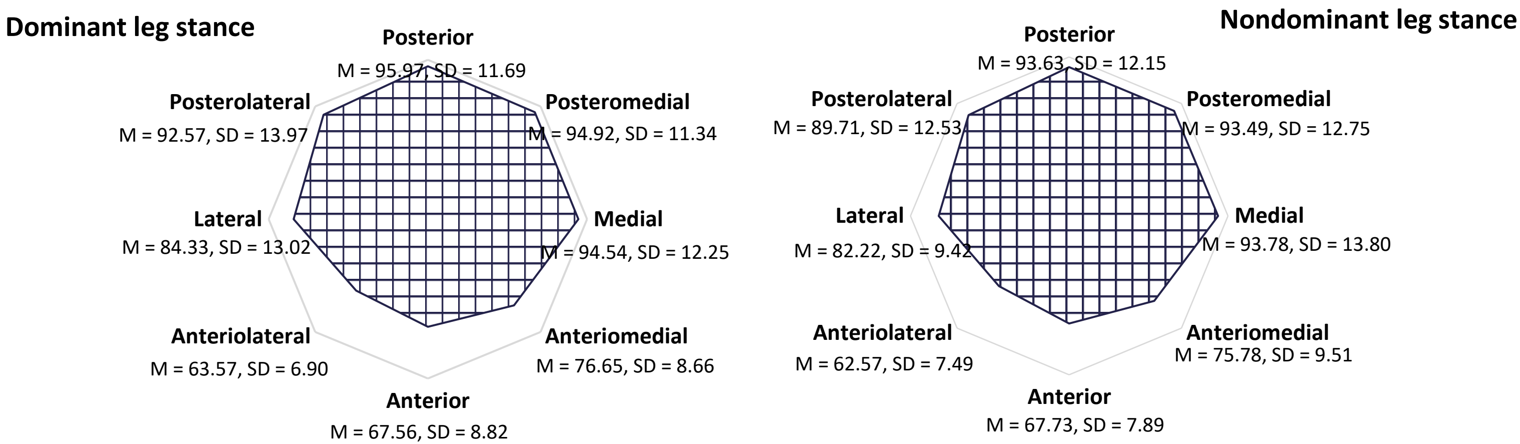

Figure 4

Postural stability of the dominant and non-dominant leg of girls (Average values)

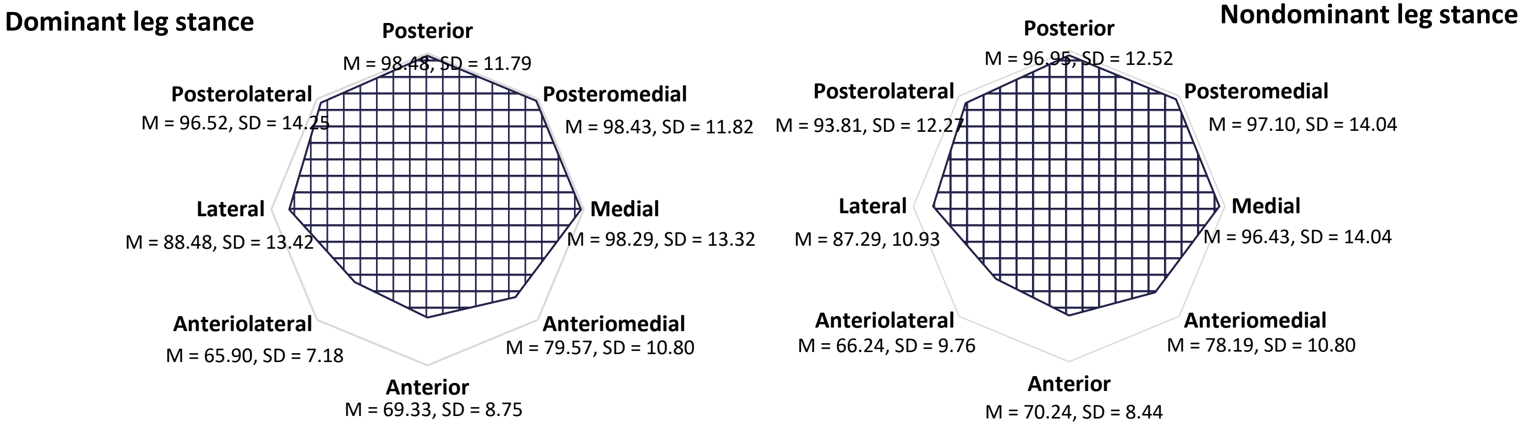

Figure 5
Postural stability of the dominant and non-dominant leg of girls (Maximum values)

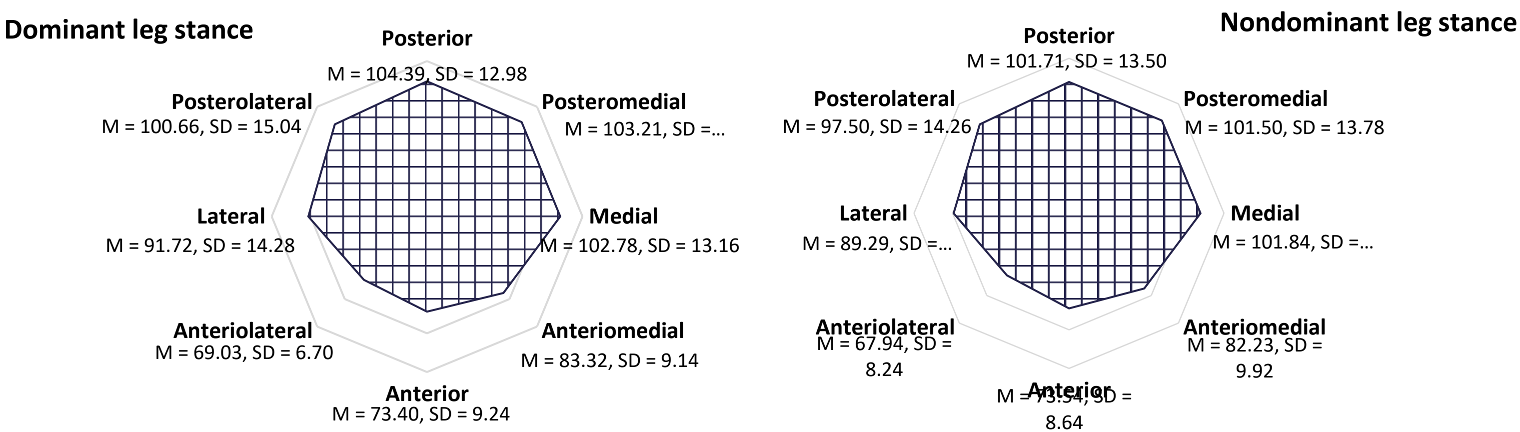

Figure 6

Postural stability of the dominant and non-dominant leg of girls (Relative values)

Table 2

Postural stability of the dominant and non-dominant leg of girls from the point of view of maximum, average and relative values

	Average values				**Maximum values**				**Relative values**			
	Dominant		**Nondomimant**		**Dominant**		**Nondomimant**		**Dominant**		**Nondomimant**	
	M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
Anterior (cm)	95.97	11.69	93.63	12.15	98.48	11.79	96.95	12.52	104.39	12.98	101.71	13.50
AnteroLateral (cm)	94.92	11.34	93.49	12.75	98.43	11.82	97.10	14.04	103.21	12.14	101.50	13.78
Lateral (cm)	94.54	12.25	93.78	13.80	98.29	13.32	96.43	14.04	102.78	13.16	101.84	15.07
PosteroLateral (cm)	76.65	8.66	75.78	9.51	79.57	10.80	78.19	10.80	83.32	9.14	82.23	9.92
Posterior (cm)	67.56	8.82	67.73	7.89	69.33	8.75	70.24	8.44	73.40	9.24	73.54	8.64
PosteroMedial (cm)	63.57	6.90	62.57	7.49	65.90	7.18	66.24	9.76	69.03	6.70	67.94	8.24
Medial (cm)	84.33	13.02	82.22	9.42	88.48	13.42	87.29	10.93	91.72	14.28	89.29	10.32
Anteromedial (cm)	92.57	13.97	89.71	12.53	96.52	14.25	93.81	12.27	100.66	15.04	97.50	14.26

Table 3

Differences in postural stability between the dominant and non-dominant leg of boys and girls

	Average values						**Maximum values**						**Relative values**					
	boys			**girls**			**boys**			**girls**			**boys**			**girls**		
	t	**p**	**d**	**t**	**p**	**d**	**t**	**p**	**d**	**t**	**p**	**d**	**t**	**p**	**d**	**t**	**p**	**d**
Anterior	0.08	0.94	0.02	0.16	0.88	0.02	0.03	0.98	0.01	0.03	0.98	0.11	0.05	0.96	0.01	0.05	0.96	0.02
AnteroLateral	1.31	0.21	0.26	0.95	0.35	0.14	1.24	0.23	0.27	1.24	0.23	0.04	1.29	0.21	0.28	1.29	0.21	0.15
Lateral	0.80	0.43	0.13	0.98	0.34	0.19	0.80	0.43	0.13	0.80	0.43	0.10	0.77	0.45	0.14	0.77	0.45	0.20
PosteroLateral	0.17	0.86	0.02	1.71	0.10	0.22	0.21	0.83	0.03	0.21	0.83	0.20	0.30	0.77	0.04	0.29	0.77	0.22
Posterior	0.23	0.82	0.03	1.45	0.16	0.20	0.80	0.43	0.08	0.80	0.43	0.13	0.27	0.79	0.03	0.27	0.79	0.20
PosteroMedial	1.59	0.13	0.22	0.84	0.41	0.12	1.49	0.15	0.22	1.48	0.15	0.10	1.59	0.13	0.24	1.59	0.13	0.13
Medial	0.61	0.55	0.10	0.55	0.59	0.06	0.93	0.36	0.16	0.93	0.36	0.14	0.62	0.55	0.12	0.62	0.55	0.07
Anteromedial	0.71	0.48	0.12	0.44	0.67	0.10	0.13	0.90	0.02	0.13	0.90	0.13	0.72	0.48	0.15	0.72	0.48	0.11

Labels: t-test, p – value, Cohens “d”

Table 4

Complex PS in boys and girls from the point of view of maximum, average and relative values

		Boys				Girls			
		M	**SD**	**Max**	**Min**	**M**	**SD**	**Max**	**Min**
Dominant	**Average (cm)**	83.603	8.534	97.667	67.542	84.329	8.840	103.542	70.958
	Maximum (cm)	86.888	8.273	99.875	70.250	87.500	9.200	107.125	74.375
	Relatively (cm)	86.078	6.828	98.653	72.279	91.967	9.113	111.335	78.843
Non dominant	**Average (cm)**	82.840	9.424	98.083	68.208	83.090	8.275	100.792	68.792
	Maximum (cm)	86.349	9.747	104.875	72.125	86.632	8.809	105.000	71.750
	Relatively (cm)	85.263	8.192	100.085	74.262	90.495	8.832	108.378	72.412

Table 5

Differences in CPS in boys and girls between their dominant and non-dominant leg

		Diference Boys				Diference Girls			
		d	t	p	d	d	t	p	d
CPS	**Average**	0.76	0.80	0.44	0.084	1.24	1.33	0.20	0.143
	Maximum	0.54	0.51	0.62	0.059	0.87	1.04	0.31	0.095
	Relatively	0.81	0.77	0.45	0.107	1.47	1.37	0.18	0.162

Discussion

In our research, comparing the dynamic postural stability of sports mid-school students with the dominant (DSL) and non-dominant standing leg (NSL), we did not find any differences in the laterality of the boys. Similarly, in girls, no significant differences of dominant (DSL) and non-dominant standing leg (NSL) in laterality were found.

In the level of complex postural stability (CPS), no significant differences were recorded in boys between the dominant (DSL) and non-dominant standing leg (NSL) in terms of average values $t (19) = 0.80$, $p = 0.44$, maximum values $t (19) = 0.51$ $p = 0.62$ and relative values $t (19) = 0.77$, $p = 0.45$ even in girls from the point of view of average values $t (19) = 1.33$, $p = 0.2$, maximum values $t (19) = 1.04$, $p = 0.31$ and relative values $t (19) = 1.37$, $p = 0.18$.

In terms of average values, we recorded the largest range of motion in boys and girls in both standing legs in the dorsal (spinal plane) direction in the posteromedial direction, in the posterior direction, in the posterolateral direction and in the lateral direction in the medial direction. From the perspective of the frontal plane, the greatest range of motion was in the anteromedial direction.

Hrysomallis (2011) executed a complex study, consisting of several researches, dealing with the impact of postural stability in individual areas of sport, where he found that postural stability has a significant impact on the performance of athletes in various disciplines. The results showed, for example, that the proportionality of postural stability to an athlete's performance can best be observed primarily in accuracy in shooting disciplines, for example, when shooting with a rifle or a bow. The research revealed that gymnasts showed the best balance skills, followed by soccer players, swimmers and basketball players. In sports such as shooting, football and golf, athletes have better balance than athletes in alpine skiing, surfing or judo. The author also points out that adding a balance component to the activities led to improved performance in high jump or downhill skiing. The results demonstrate a very close connection and influence of the ability to maintain balance on a range of performance indicators of athletes and support the idea that stability training can be a very useful addition to the regular training of athletes to improve some motor skills.

Postural stability can be disturbed by internal influences such as heartbeat and respiratory muscle activity (Zemková & Hamar, 2005). Molnárová (2023) states that in sport shooting, in the discipline of TRAP, one of the causes may be insufficient cardiorespiratory adaptation due to the need to hold one's breath when shooting. This statement is also confirmed by the research of Konttinen et al. (1998) who demonstrated that heart rate decreased during the launch phase in all probands, with heart rate variation greater in non-elite shooters compared to elite shooters. Applying the lower extremity dynamic balance test (SEBT) appears to us to be an interesting parameter for detecting changes when introducing an experimental factor.

In the work of the authors Pal et al. (2021) we find the effect of plyometrics and pilates on the dynamic balance of lower limbs and the strength of the center of the body of karate athletes. The authors applied 8-week experimental stimuli in two experimental and one control group. When presenting the final results, they found statistically significant positive changes in the dynamic balance of lower limbs at the 1% level of significance. The results of the authors were also supported by research conducted by Czaková (2022), who applied SEBT as a test battery, with the same (1%) level of statistical significance, after an 8-week speed-strength stimulus in karate athletes.

The study of Bakhsis (2023), Behm et al. (2005) and Chauhan et al. (2023) investigated ice hockey players in the context of the interaction between selected performance parameters and postural stability. Hockey players can develop high speed by skating, and actions during the game are characterized by sudden accelerations, decelerations and changes of direction. The observed positive interactions of agility and DPS in hockey players are also confirmed by the research of Arboix-Alió and Aguilera-Castells (2021), as hockey skating performance is significantly related to balance and sprint tests, which points to the important role of postural stability in players' skating speed.

In the work of Blanár et al. (2020), the authors investigated the dependence of skating and running performance on explosive lower limb strength and dynamic balance in ice hockey players. They used the Y-Balance Test to determine the level of dynamic balance. A significant relationship was measured between the 5-10-5 running test and Y-Balance of the left leg ($p<0.01$) and also Y-Balance of the right leg ($p<0.01$), as well as in the study of Bayraktar (2017).

Dynamic postural stability also greatly affects the health of humans. In the study of Zemkova et al. (2022), the authors examined the differences between the sexes in the strength of torso rotation at different loads in a group of gymnastics and dance sports. The force produced during torso rotation was evaluated using the FiTRO torso Premium apparatus. The results showed significantly higher average performance in the acceleration phase of the torso in men than in women at 10.5 kg (206.8 ± 22.0 W and 165.4 ± 17.8 W, $p = 0.033$), 15.5 kg (231.8 ± 27.5 W and 155.6 ± 24.4 W, $p = 0.001$) and 20 kg (196.9 ± 25.3 W and 111.4 W). Similar significant gender differences were also observed at angular velocity of ≥ 10.5 kg. Alternatively, performance and strength were greater at lower rates in men than in women. However, some women were able to produce slightly more power and strength at higher speeds, despite their lower values at lower speeds than men. This can be attributed both to genetic predispositions and to the specificities of their acrobatic and dance elements, including torso rotation at different speeds under different load conditions.

Studies by Brumagne et al. (2008), which involved 21 probands with low back pain (LBP) and 24 healthy probands with a mean age of 24.6 years, investigated the effect of different surface types (firm and unstable foam) on postural stability. On both types of surfaces, a bipedal stance was first performed with eyes open, with vision included, and the following three situations, all with eyes closed: ballistic bilateral abduction of the shoulder joint, bilateral vibration stimulus on the m. triceps surface, bilateral vibration stimulus on m. multifidus lumborum and bilateral vibration stimulus on m. tibialis anterior. All tests lasted 60 seconds. No statistically significant differences between groups were found in bipedal standing on a firm surface. However, when standing on an unstable foam surface and excluding vision, persons with LBP showed significantly greater deviations of the place of action of the resulting reaction force – center of pressure (COP) than healthy persons. The authors further highlight the fact that young adults suffering from LPB are likely to prefer the same type of postural strategy in different situations, even in those when it is not entirely appropriate (e.g., standing on an unstable surface). People with LBP appear to prefer the ankle strategy, but this is appropriate when standing on a firm, level surface. It is not as effective as other types of postural strategies on an unstable surface.

The above studies by different authors and their research show that dynamic postural stability can affect different sports sectors, age categories and individual health.

Conclusions

The aim of this paper was to evaluate the level of dynamic postural stability of the students of the Sports Mid-school in Nitra using the SEBT test. This test is easy to use in measuring dynamic postural stability, injury assessment, screening and rehabilitation.

Postural stability is one of the basic building blocks of sports performance. Athletes who have a high level of postural stability can better control their body during sports performance and handle the tense situations that sport brings with it.

However, the level of postural stability is not only related to sports performance, but also has a close connection with the health aspect of the athlete. Athletes with properly strengthened and balanced muscle fibers are less prone to back injuries, joint injuries or other problems related to posture (improper body posture).

The unrecorded significant differences in boys and girls between the dominant (DSL) and non-dominant standing leg (NSL) show us the importance of a stable and balanced stance for both legs in all directions of movement, even with the diversity of sports specialization of sports mid-school students. We believe that a stable and balanced attitude forms the basis for sports performance in young athletes, which will be necessary in their next sports specialization.

STATEMENT OF ETHICS

This study was conducted in accordance with the World Medical Association Declaration of Helsinki. The study protocol was reviewed and approved by the University of Constantine the Philosopher in Nitra, UKF/197/2024/191013:001, Nitra, Slovakia. All participants provided written informed consent to participate in this study.

DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interests with respect to the research, authorship, and/or publication of the article *Level of Dynamic Postural Stability of Students at Sports Mid-school in Nitra.*

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