

Original Article

Levels and Relations Between Foot and Body Postures in Primary School Pupils

Marko, Michal ^{1*}

Bendíková, Elena ²

^{1,2}Department of Physical Education and Sports, Faculty of Arts, Matej Bel University in Banská Bystrica; Tajovského 40, Banská Bystrica 974 01; Slovak Republic

DOI: 10.29081/gsjesh.2019.20.1s.01

Keywords: *Foot and body postures, period of pubescence, physical and sport education, pupils.*

Abstract

The monitored group consisted of 12 female pupils of the eighth year of primary school in B. Bystrica (age 13.42 ± 0.3 years, body height 162.6 ± 2.3 cm, body weight 49.7 ± 2.1 kg and body mass index 18.8 ± 0.9). In terms of prevention, we focused on finding the levels and relations between the foot and body postures by using standardized methods for physical and sport education (Foot posture - Plantography and method of Index and Chippaux-Šmírák; Body Posture - Method of Klein and Thomas modified by Mayer and Dynamic spine function (Tests of Schober and Stibor). By applying various physical programs in the lessons of physical and sport education, the levels of foot and body postures improve after 4 weeks (Bendíková, Marko, Rozim, & Martinský, 2019). *The listed study is the part of research project: VEGA 1/0519/19 "Physical activity as prevention of health of school population in Slovakia".*

1. Introduction

A health should be the highest social value, but the level of population health is not optimal. Many studies have discovered worsening of health in children and young people (Jančoková, 2002). The listed tendency is not only applied in general population but it also occurs in physically active children and young people (Antala et al., 2014). It cannot be obtained as given, genetic immutable condition, since the genetic basis is only the biological potential, which can be evolved in positive or negative direction.

The late prevention leads to the emergence of civilization diseases, which are known as chronic or non-communicable diseases. Their nature is not transferable to another human being. They are defined as long-term effects with relatively slow

* E-mail: michal.marko@umb.sk, tel.+421 48 446 7556

progression, as the well-known are obesity, heart attack, diabetes or cancer (Alwan, 2010).

The prevalence of civilization diseases, in our case the muscular and skeletal systems (Hruškovič, 2004) is currently manifesting in health of primary/ secondary school pupils (Kanasová, 2004; Popova et al., 2014; Walther et al., 2014; Azabagic et al., 2016; Marko, 2018).

The muscular and skeletal system provides form, stability, movement, which is visible in effective and efficient cooperation and displayed in grace and elegance, necessary for gymnastics, strength games, simply in normal human being activities, whereas absence of components of the muscular and skeletal systems may not lead to development of basic principles of nature, simply movement (Hugh, 1911).

A foot is very complicated part of human body, which is soft and flexible in children and young people and abnormal pressures (of different objective and subjective character) can easily cause foot deformations, which has become public health challenge due to increased incidence (Houghton, 2008; Malanga, & Ramirez, 2008; Menz et al., 2010; Mickle et al., 2011; Thomas et al., 2011; Rao et al., 2012). Correct foot posture is perceived by the outline of median longitudinal arch, which is divided into normal (rectus), low (planus) and high (cavus) arched foot and the harmonization of foot skeleton, in which position changes affect the foot function, thus walking (elastic, economic).

The walking is characterized by elasticity and understood as the method of primary locomotion allowing to move from place to place, in which the foot serves as certain connection with surrounding environment. The backward proprioception maintains upright body posture or adaptation to support surfaces (Klementa, 1987; Dungal, 1989; Bartošík, & Chudá, 1994; Bartik, 2003, 2005). In this context, it is very important to point out that any changes affecting the walking may affect the bones and joints of foot, blood vessels, nervous and muscular systems. It affects the shape of foot and results in diseases, disorders.

An etiology of foot is multifactorial, starting from the incorrect (inadequate) footwear, muscle imbalance or stereotyped loading of certain muscle groups, some of which are uneconomically shortening or weakening, creating conditions not only for the functional and structural changes of foot, but in relation to the body posture (Gadd, 2008; Dufour, 2009; Riskowski et al., 2011).

Therefore, it is necessary to increase personal interest and responsible attitude of each pupil to health, with integral part of active approach, thus indicating the possibility of diversifying the content of physical and sport education in relation to the pupil's health (Bendíková, 2018).

2. Material and methods

The purpose of study was to identify the levels and relations between the foot and body postures in primary schools pupils, within lessons of physical and sport education.

In accordance with the aim of study, the monitored group consisted of 12 ($n = 12$) female pupils of the eighth year of primary school in B. Bystrica (age 13.42 ± 0.3 years, body height 162.6 ± 2.3 cm, body weight 49.7 ± 2.1 kg and body mass

index 18.8 ± 0.9). The monitored group ($n = 12$) was in period of pubescence and without any health problems. The primary characteristics of the monitored group ($n = 12$) is presented in table 1.

Table 1. *The primary characteristics of monitored group ($n = 12$)*

Measured values	Monitored group
Age [years]	13.42 ± 0.3
Body weight [kg]	49.7 ± 2.1
Body height [m]	162.6 ± 2.3
Body mass index [kg/m^2]	18.8 ± 0.9

The study was realized within intervals of 7 October 2019 - 11 October 2019. It was terrain (lessons of physical and sport education), one-group (selected group of pupils) and pedagogical (selected primary school). The evaluation of monitored group ($n = 12$) was realized within the lessons of physical and sport education (2 x 45 minutes - Monday/ Friday).

In terms of data acquisition methods, the method of studying literary sources, mainly of foreign literature, was used. It was followed by method of somatometry (Šimonek, 2000; Selekman, 2012), in which the data of age, body height and body weight were calculated to the body mass index (Hošková, Matoušová, 2005). The evaluation of foot and body postures was performed by applying the standardized methods for physical and medical practice. To evaluate the plantogram, which was the result of method of plantography (Srdečný, 1982), we applied methods of index and Chippaux-Šmírák (Klementa, 1987). While using the method of observation, a static component of body postures was evaluated by method of Klein and Thomas, modified by Mayer (Vojtaššák, 2000). However, the method of palpation was used to evaluate the dynamic spine function, mainly by the tests of Schober and Stibor (Labudová, Vajczíková, 2009; Bendíková, 2011).

The evaluation of study results was realized by qualitative and quantitative methods of data processing. To evaluate the degrees of foot and body postures, as the individual and overall levels of muscular and skeletal systems, we applied the methods of multiplicity (n), arithmetic mean (\pm) and percentage frequency analysis (%). What is more, the study consisted of methods, such as analysis and synthesis, inductive and deductive approaches, comparisons and generalizations.

3. Results and Discussions

According to the aim of study, the study results are subject to more accurate monitoring and processing, as they cannot be generalized. What is more, it is very necessary to understand them in the overall context and in relation to the health and through the prism of muscular and skeletal systems, mainly in the areas of foot and spine.

The study results are presented in tables and figures for better presentation and understanding, while the figure 1 shows the results of evaluation the foot of the monitored group ($n = 12$) of female pupils at primary school in B. Bystrica. It was evaluated by the method of index, which evaluates the longitudinal arch of foot. If

the value is less than 1.6, the arch of foot is good; otherwise it is defined as flat foot (Pes planus) (Bendíková, 2011).

Within the figure 1, the results of index method recorded alarming findings, as the flat foot was recorded in 66.6 % ($n = 8$) of the monitored group ($n = 12$). The index range ranged from 1.51 to 2.1, however the differences between left and right foot were not significant (0.02 - 0.08). One of many factors, which have influenced the formation of flat foot, has been body weight (Chen et al., 2009). It is the same case in our study, as within the monitored group ($n = 12$) the female pupils 10 - 12 ($n = 3$) had higher body weights than the rest of the monitored group ($n = 12$). But, within the monitored group ($n = 12$), we recorded good arch of foot in four female pupils 1 - 4 ($n = 4$).

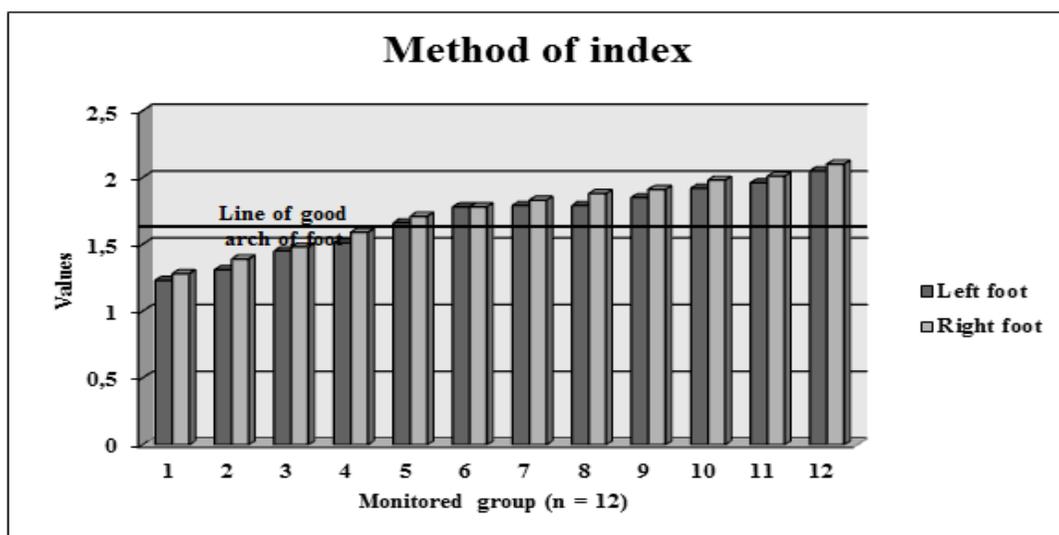


Figure 1. The method of index in monitored group ($n = 12$)

The next method (Chippaux-Šmírák) is based on evaluating construction of external positions. If the value is less than 45.0 %, it is good foot. However, if it is above 45.1 %, it is flat foot, which is divided into the slightly (45.1 % - 50.0 %), mediumly (50.1 % - 55.0 %) and strongly (60.1 % - 100.0 %) (Klementa, 1987).

Within the figure 2, in which are various index ranges, the biggest (4 x) had the good foot. Its index range ranged from the 19.2 % to 39.4 %. The slightly and strongly flat foot occurred in the monitored group ($n = 12$) equally 3 times ($n = 3$). It is difficult to find the origin of strongly flat foot, as we believe that overweight, involved in female pupils 10 - 12 ($n = 3$) was directly related to the lack of physical activities. Neither the index range of the slightly, normally and strongly flat foot showed any visible differences, as they ranged from 0.6 % to 2.8 %. Only 1 x, it occurred that the left foot had better (lower) index range values (48.3 % : 46.7 %) than the right foot. It was due to the dominance of the female pupil's lower limb ($n = 1$). Even, Pedersen et al. (1995), Nikolaidou, Boudolos (2006) and Chen (2011)

recorded higher incidence of flat foot (from > 45.1 % to > 62.7 %) in children and young people, aged from 10 to 17 years of age.

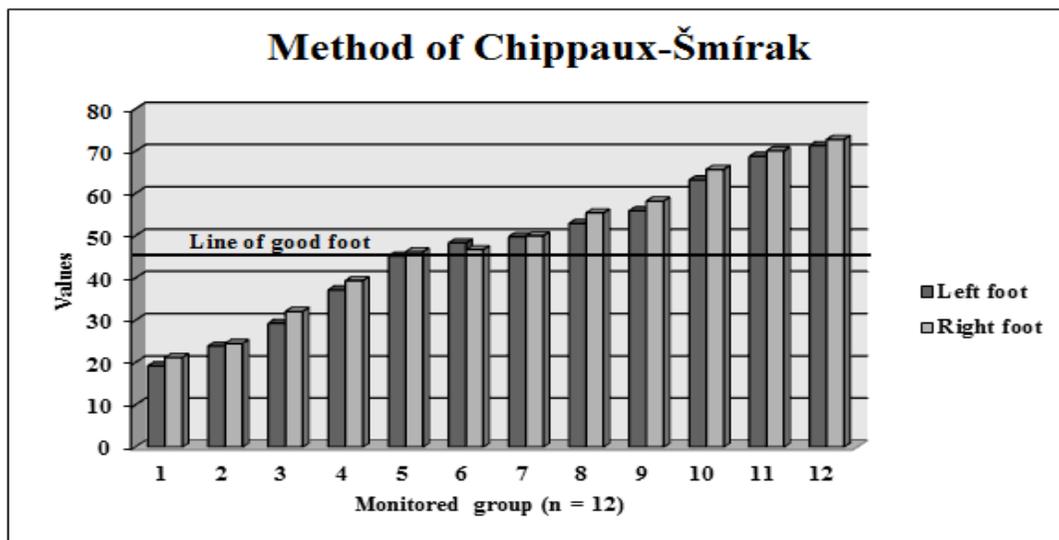


Figure 2. The method of Chippaux-Šmírák in monitored group (n = 12)

The static component of body postures was evaluated by Klein and Thomas, modified by Mayer (Vojtaššák, 2000), which is based on body components (I. - V.) and to which are given values (1 - 4). The overall body posture consists of head and neck posture, shape of chest, shape of abdomen and pelvic inclination, curvature of spine (overall) and height of shoulders and position of scapulas. As it is showed in figure 3, the correct body posture is up to 5, good body posture is between 6 and 10 points, bad body posture is between 11 and 15 points and incorrect body posture is between 16 and 20 points.

Within the figure 3, the correct body posture was recorded in 2 female pupils (n = 2) who had also good foot and arch of foot. However, the correlation between the flat foot and changes of body posture (rotation of tibia and femur, anteversion of iliac bones, thoracic hyperkyphosis, cervical hyperlordosis and lumbar lordosis) (Bricot, 2001; Borges, 2013) was also recorded in the monitored group (n = 12), as good body posture was 5 female pupils (n = 2), bad body posture in 4 female pupils (n = 4) and incorrect body posture in 1 female pupil (n = 1). Many findings of bad and incorrect body postures have been discussed (Bendíková, 2012, 2015; Marko, 2018, 2019), e.g. in children and young people, Kratěnová (2005) experienced the bad and incorrect body postures in 33.0 % at the age of 7, 40.8 % at the age of 11 and 40.6 % at the age of 15.

The most common deviations of body postures are recorded (Véle, 2006) in areas of head and neck posture, shape of abdomen and pelvic inclination and height of shoulders and position of scapulas. The worse level of head and neck posture in monitored group (n = 12) was mainly because of the ergonomic solutions of school

environment, muscle imbalance, weakness of deep neck flexors (Bendíková, 2012). The increased body weight in abdominal regions causes the pelvis to lean forward and which is resulting in wrong fixation of vertebrae and the formation of enlarged lumbar lordosis. The listed causes of bad and incorrect body postures are defined as weakening of scapular muscles, which belongs to dominance of stronger muscles (Pectoral muscles) and they stretches them (Bendíková, 2011).

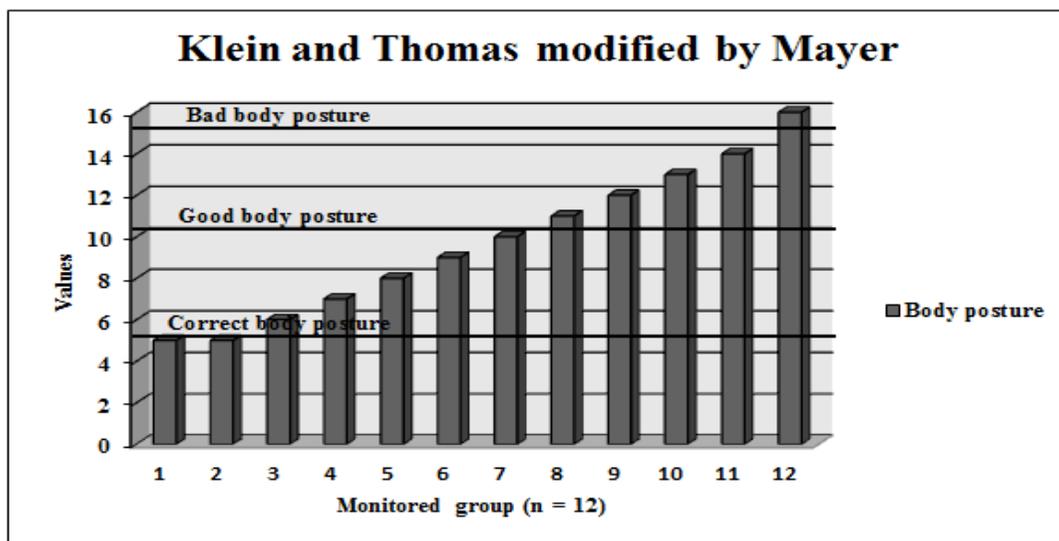


Figure 3. *The method of Klein and Thomas modified by Mayer in monitored group (n = 12)*

The next method (Dynamic spine function) is based on evaluating the spine bending. It consists of 5 tests, however according to various studies (Marko, 2019), the most visible changes are in tests of Schober (Norm of 4 - 6) and Stibor (Norm of 7.5 - 10). If it is less than norm, it is defined as decreased flexibility (Labudová, & Vajcziková, 2009).

While bending forward in test of Schober, the 5th lumbar vertebra, which was marked up by 10 cm, recorded the norm in 4 female pupils (n = 4) (Figure 4), as the next 6 female pupils (n = 6) was recorded with decreased flexibility of spine. It was due to having the values in range from 2.0 to 3.8, which is not considered as the norm, however in 2 female pupils (n = 2), the values were recorded above the norm (6.3/ 6.5), which showed increased flexibility of spine, within the monitored group (n = 12). Our findings are matching with the reached findings of Kanasová (2006) and Majerík (2009).

While evaluating the distance of the 7th cervical vertebra and the 5th lumbar vertebra, the test of Schober showed similar results as the previous test, within the dynamic spine function. The values, within norm were recorded in 4 female pupils (n = 4), as they ranged from 7.8 to 9.8. The lumbar/ cervical flexibility was reached in 4 female pupils (n = 4), within the monitored group (n = 12), however decreased flexibility was recorded in 6 female pupils (n = 6), as the values ranged from 7.4 to

4.4 (Figure 4). Within monitored group (n = 12), there was also recorded increased flexibility of spine in female pupils 11 - 12 (n = 2). Similar results are recorded in study of Bendíková, and Stackeová (2015).

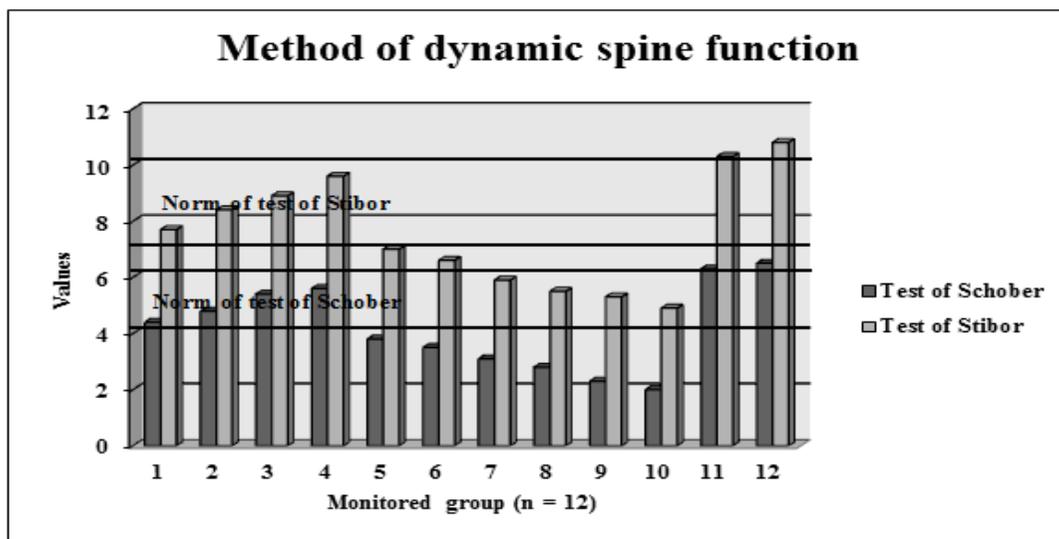


Figure 4. The method of dynamic spine function in monitored group (n = 12)

4. Conclusions

The study results have confirmed the increasing prevalence of muscular and skeletal disorders, which have doubled, not in the long period of time (1996 - 2008) (Bendíková, 2012). The spine and its parts are the most affected (negatively) within the muscular and skeletal systems (Mitova, 2015; Bendíková, 2016; Marko, 2018), while there is conclusive presumption of alarming findings associated with various disorders, which are based on functions of foot (Bird, & Payne, 1999; Cibulka, 1999; Bendíková, & Marko, 2018; Marko, 2019).

Based on the study results, the widening of knowledge about the disorders of muscular and skeletal systems is not enough and sufficient, as well the active way of life (physical activity) (Labudová, 2012) which is decreasing through the passive (non)participation in lessons of physical and sport educations (Boreham, & Riddoch, 2001; Harris, 2015). Therefore, the diversification of physical and sport educations, in forms of physical programs (Hand, 1964; Novotná et al., 2009; Ahmad, & Akthar, 2014; Bendíková et al., 2015), which are aimed at effecting foot and body postures, would not only help the muscular and skeletal systems, but also with participation in the lessons of physical and sport educations (Bendíková, 2018).

References

1. AHMAD, I., & AKTHAR, N. (2014). Comparison of Effect of Weight Bearing and NonWeight Bearing Exercise on Gait Parameters in Flexible Flatfoot Children, *The International Journal of Orthopaedics and*

- Physiotherapy*, 1(1), 6-10.
2. ALWAN, A. (2010). Monitoring and Surveillance of Chronic Noncommunicable Diseases, *The Lancet*, 376(9755), 1861-1868.
 3. ANTALA, B. et al. (2014). *Telesná a športová výchova a súčasná škola*, Bratislava : Uk, Sr.
 4. AZABAGIC, S. et al. (2016). An Epidemiology of the Musculoskeletal Disorders in Primary School Children, *Materia Socio-Medica*, 28(3), 164-167.
 5. BARTÍK, P. (2003). *Zdravotná telesná výchova*, Banská Bystrica : Pf, Sr.
 6. BARTÍK, P. (2005). *Zdravotná telesná výchova*, Banská Bystrica : Pf, Sr.
 7. BARTOŠÍK, J., & CHUDÁ, B. (1994). *Teória a didaktika zdravotnej a nápravnej telesnej výchovy*, Nitra: VšpN, Sr.
 8. BENDÍKOVÁ, E. (2011). *Oporný a pohybový systém, jeho funkcie, diagnostika a prevencia porúch*, Banská Bystrica : Umb, Sr.
 9. BENDÍKOVÁ, E. (2012). *Oslabený oporný a pohybový systém žien a jeho úprava pohybovým programom*, banská Bystrica: Fhv, Sr.
 10. BENDÍKOVÁ, E. (2015). Vplyv pohybového programu v rámci telesnej, športovej výchovy na vybrané posturálne svalové skupiny žiačok, *Telesná výchova a šport v živote človeka*, 1(2), 99-110.
 11. BENDÍKOVÁ, E., & STACKEOVÁ, D. (2015). Vplyv pohybových programov s kompenzačným zameraním na pohyblivosť chrbtice u žiakov stredných škôl, *The Hygiene*, 60(1), s. 4-9.
 12. BENDÍKOVÁ, E. (2016). Effects of Fitness Ball Exercise Programme on Female Student's Posture, *Slovak Journal of Sport Science*, 1(1), 70-77.
 13. BENDÍKOVÁ, E., & MARKO, M. (2018). Pohybové program, funkčnosť chodidla vo vzťahu k postúre žiakov, *Aktuálne problémy telesnej výchovy a športu*, 1(1), 54-64.
 14. BENDÍKOVÁ, E., MARKO, M., ROZIM, R., & MARTINSKÝ, L. (2019). Effect of 4 Week Physical Programme on Musculoskeletal System Changes in Adolescent Sport Class Students with Focus on Ice Hockey, *Physical Activity Review*, 7 (1), 63 -70.
 15. BIRD, R., & PAYNE, S. (1999). Foot Function and Low Back Pain, *The Foot*, 9(1), 175-180.
 16. BOREHAM, C., & RIDDOCH, C. (2001). Physical Activity, Fitness and Health of Children, *Journal of Sports Sciences*, 19(12), 915-929.
 17. BORGES, C. (2013). Relationship Between Lumbar Changes and Modifications in Plantar Arch in Women with Low Back Pain, *Acta Ortop*, 21(3), s. 135-138.
 18. BRICOT, B. (2001). Sistema Tónico Postural, *Posturologia*, 1(2), s. 49-76.
 19. CIBULKA, M. (1999). Low Back Pain and its Relation to Hip and Foot, *Journal of Orthopaedic and Sports Physical Therapy*, 29(10), 595-601.
 20. CHEN, C. et al. (2009). Flat Foot Prevalence and Foot Dimensions of 5 to 13 Year Old Children in Taiwan, *Foot and Ankle*, 30(1), s. 326-330.
 21. CHEN, C. (2011). Relevant Factors Influence Flat Foot in Preschool Age
-

- Children, *European Journal of Paediatr*, 2(3), s. 931-936.
22. DUFOUR, B. (2009). Foot Pain, *Arthritis and Rheumatology*, 61(10), 1352-1358.
 23. DUNGL, P. (1989). *Otopedie a traumatology nohy*, Praha : Avicenum, ČR.
 24. GADD, A. (2008). *Nohy*, Bratislava : Eugenika, Sr.
 25. HAND, B. (1964). *Effect of Corrective Exercise Program on Ninth Grade Boy with Foot Deviations*, Ellensburg: Cwu, USA.
 26. HARRIS, S. (2015). One in Three Primary Pupils' Hate Exercise, *Daily Mail*, 1(1), 13-14.
 27. HOŠKOVÁ, B., & MATOUŠOVÁ, M. (2005). *Didaktika zdravotní tělesné výchovy pro studující FtvS Uk*, Praha : Karolinum, ČR.
 28. HOUGHTON, K. (2008). Review for Generalist, *Pediatric Rheumatology Online Journal*, 6(6), 134-139.
 29. HRUŠKOVIC, B. (20004). Alergia a astma v Európe, *Via Practica*, 2(1), 78-80.
 30. HUGH, C. (1911). *Encycloædia Britannica*, New York: Encycloædia Britannica Company, USA.
 31. JANČOKOVÁ, Ľ. (2002). Telesný, resp. funkčný rozvoj žiakov základných škôl v Banskobystrickom kraji, *Zborník výstupov grantovej výskumnej úlohy*, 1(1), 7-22.
 32. KANASOVÁ, J. (2004). *Funkčné svalové poruchy u 10-12 ročných žiakov a ich ovplyvnenie v rámci školskej telesnej výchovy*, Bratislava : Ftvš, Sr.
 33. KANASOVÁ, J. (2006). *Držanie tela u 10 až 12 ročných žiakov, jeho ovplyvnenie v rámci školskej telesnej výchovy*, Nitra : Peem, Sr.
 34. KLEMENTA, J. (1987). *Somatometrie nohy*, Praha : Spn, ČR.
 35. KRATĚNOVÁ, J. (2005). Rizikové faktory a prevalence vadného držení těla u dětí školního věku, *Praktický lékař*, 85(11), 629-634.
 36. LABUDOVÁ, J. (2012). *Teória a podpora zdravia*, Bratislava : Uk, Sr.
 37. LABUDOVÁ, J., & VAJCZIKOVÁ, S. (2009). *Športová činnosť pri poruchách orgánov opory a pohybu*, Bratislava : Slovenský zväz rekreačnej telesnej výchovy a športu, Sr.
 38. MAJERÍK, J. (2009). Svalová nerovnováha, držanie tela 16 - 17 ročných z hľadiska športovania, *Telesná výchova a šport*, 19(1), s. 18-25.
 39. MALANGA, G., & RAMIREZ, J. (2008). Common Injuries of Foot and Ankle in Childhood and Adolescence Athlete, *Physical Medicine and Rehabilitation Clinics of North America*, 19(2), 3447-371.
 40. MARKO, M. (2018). Level of Posture Depending on Impact of the School Bag and Footwear in Elementary School Pupils, *Zborník prác z fakultného kola študentskej vedeckej aktivity 2018*, 1(1), 25-37.
 41. MARKO, M. (2019). Changes of the Body Posture in Elementary School Pupils by Applying Propriofoot Concept in the Physical and Sport Education, *Zborník prác z fakultného kola študentskej vedeckej aktivity 2019*, 1(1), 20-31.
 42. MENZ, H. et al. (2010). Foot and Ankle Risk Factors for Fall in Older

- People, *The Journal of Gerontology*, 61(8), 866-870.
43. MICKEL, J. et al. (2011). Cross-Sectional Analysis of Foot Function, Functional Ability and Health-Related Quality of Life in Older People with Disabling Pain in Foot, *Arthritis Care and Research*, 63(11), 1592-1598.
 44. MITOVA, S. (2105). Frequency and Prevalence of Postural Disorders and Spinal Deformities in Children of Primary School Age, *Research in Kinesiology*, 43(1), 21 -24.
 45. NIKOLAIDOU, E., & BOUDOLOS, D. (2006). The Footprint-Based Approach for Rational Classification of Foot Types Young Schoolchildren, *Foot*, 4(20), s. 82-90.
 46. NOVOTNÁ, N. (2009). *Programy v pohybovom režime žiakov mladšieho školského veku bansko-bystrického regiónu ako determinant zdravia*, Banská Bystrica : Umb, Sr.
 47. PEDERSEN, B. et al. (1955). Foot Deformity, Length of Triceps Surae in Danish Children between 3 and 17 Years Old, *Journal of Pediatrics Orthopaedics*, 4(5), s. 71-73.
 48. POPOVA, D. et al. (2014). Postural Disorders and Spinal Deformities in Children and Primary School Age, *Activities in Physical Education & Sport*, 4(2), 171-177.
 49. RAO, S. et al. (2012). Musculoskeletal Conditions of the Foot and Ankle, *The Best Practice and Research*, 26(3), 345-368.
 50. RISKOWSKI, L. et al. (2011). Associations of Foot Posture and Function to Lower Extremity Pain, *Arthritis Care and Research*, 65(11), 1804-1812.
 51. SELEKMAN, J. (2012). *School Nursing*, Philadelphia: F. A. Davis Company, USA.
 52. SRDEČNÝ, B. (1982). *Tělesná výchova zdravotně oslabených*, Praha: Spn, ČR.
 53. ŠIMONEK, J. (2000). Pohybová aktivita v živote súčasného človeka, *Pohybová aktivita a šport v živote dospelých*, 1 (2), 23-65.
 54. THOMAS, J. et al. (2011). Population Prevalence of Foot and Ankle Pain in Old Age, *Pain*, 152(12), 2870-2880.
 55. VÉLE, F. (2006). *Kineziologie*, Praha: Triton, ČR.
 56. VOJTÁŠŠÁK, J. (2000). *Ortopédia*, Bratislava : Sap, Sr.
 57. WALTER, A. et al. (2014). Prevalence of Low Back Pain in Adolescence Athletes, *Journal of Sports Medicine*, 35(6), 684-689.

