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# The Physical Balance of Adolescents and its Connection with Social and Emotional Balance

Rozwój fizyczny młodzieży  
oraz jej związek z równowagą  
społeczną i emocjonalną

## ABSTRACT

Today's society needs educated and competent people who are able to make use of existing knowledge and are ready for further development, which includes the idea of perfection and progressive changes. In this context, the question of educational provision for pupils with special needs is being pursued in Latvia: whether all of these pupils and in what way are they included in the general educational institution, whether a school is prepared to provide favourable conditions for the acquisition of high quality education for the pupils, what are possible pedagogical challenges and how can they be dealt with in order for pupils with special needs to socialize in a modern society, to become independent, active members of society who are also able to make decisions. The educators of the Rezekne Higher Education Institution are actively involved in finding solutions by participation in various international and national projects. One of the most significant projects in this field is the national science programme "Innovative solutions for social telerehabilitation in the schools of Latvia in the context of inclusive education (INOSOCTEREHI)". The physical balance of

## KEY WORDS

adolescents, balance disorder, development, pupil with special needs, telerehabilitation

## SŁOWA KLUCZOWE

młodzież, zaburzenia równowagi, rozwój, uczeń ze specjalnymi potrzebami, telerehabilitacja

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Case reports

Raporty z badań



12–13 old Latvian pupils and its connection with their emotional and mental balance are researched in the framework of the project.

## ABSTRAKT

Współczesne społeczeństwo potrzebuje wykształconych i kompetentnych ludzi, którzy są w stanie skorzystać z istniejącej wiedzy i są gotowi do dalszego rozwoju, obejmującego dążenie do doskonałości i pozytywnych zmian. W tym kontekście kwestia zapewnienia dobrego kształcenia uczniów ze specjalnymi potrzebami jest ciągle aktualna na Łotwie. Dlatego zasadne są pytania czy wszystkich tych uczniów obejmuje się kształceniem i w jaki sposób są oni włączani do systemu kształcenia powszechnego. Ważne jest pytanie, czy szkoła łotewska jest przygotowana do zapewnienia korzystnych warunków do nabycia wysokiej jakości kształcenia przez uczniów. Istotne jest także określenie jakie są wyzwania pedagogiczne i jak mogą być one realizowane we współczesnym społeczeństwie w odniesieniu do uczniów ze specjalnymi potrzebami, tak aby ci mogli stać się niezależnymi i aktywnymi członkami społeczeństwa, będącymi w stanie podejmować samodzielne decyzje. Pracownicy Akademii Technologicznej w Rezekne są aktywnie zaangażowani w poszukiwanie rozwiązań, poprzez udział w różnych projektach krajowych i międzynarodowych. Jednym z najbardziej znaczących projektów w tej dziedzinie jest narodowy program nauki „Innowacyjne rozwiązania dla telerehabilitacji społecznej w szkołach na Łotwie w kontekście edukacji włączającej (INOSOCETEREHI)”. W ramach prezentowanego projektu bada się istnienie związku rozwoju fizycznego z emocjonalną i psychiczną równowagą u 12- i 13-letnich uczniów łotewskich szkół.

## Analysis of Literature

Latvian statistics of health screening in 2013 show that 39% of pupils up to the age of 14 (except for pupils of Form 1) are included in the second health group (children at risk of the development of chronic diseases, acute diseases often occur with complications, etc.). 50 670 children and adolescents to the age of 14 were treated in hospital in 2013, 1400 suffered from musculoskeletal system and connective tissue diseases, 3258 suffered nervous and sensory organ diseases, 1110 were treated for different fractures, and 670 for concussion.<sup>1</sup> There is

<sup>1</sup> *Bērni Latvijā* (2014). Statistisko datu krājums, Available at: <[http://www.csb.gov.lv/sites/default/files/nr\\_12\\_berni\\_latvija\\_2014\\_14\\_00\\_lv\\_en.pdf](http://www.csb.gov.lv/sites/default/files/nr_12_berni_latvija_2014_14_00_lv_en.pdf)>.

a possibility that the pupils face difficulties due to health problems and they need support while acquiring learning content. Analysis of the literature<sup>2</sup> shows that due to various diseases or injuries children and adolescents may also have balance coordination problems that lead to discomfort, pain syndrome development and restriction of functions, as well as causing an inadequate load on the muscles, ligaments, joints, and bones.<sup>3</sup>

Analysis of the literature shows that balance disorders may also occur because of a variety of other reasons, for example:

(1) moderate or severe balance disturbances occur as secondary to children with primary visual impairments<sup>4</sup>;

(2) they are often associated with behavioural disorders—coordination or balance disorders are observed in 45% of cases of children with behavioural disorders<sup>5</sup>;

(3) the greater the weight, the greater balance disturbances; it requires greater muscular and skeletal strength to maintain balance in the case of increased weight<sup>6</sup>;

(4) tall individuals are characterized by greater postural sway<sup>7</sup>.

<sup>2</sup> Y. Agrawal, J.P. Carey, C.C. Della Santina, M.C. Schubert, L.B. Minor, “Disorders of balance and vestibular function in US adults: data from the National Health and Nutrition Examination Survey, 2001–2004”, *Archives of Internal Medicine* 2009, vol. 69, no. 10, p. 938–944; J.M. Greve, M. Cuğ, D. Dülgeroğlu, G.C. Brech, A.C. Alonso, “Relationship between Anthropometric Factors, Gender, and Balance under Unstable Conditions in Young Adults” *BioMed Research International* 2013, Available at: <<http://www.hindawi.com/journals/bmri/2013/850424/>>; C.V. Portfors-Yeomans, C.L. Riach, “Frequency characteristics of postural control of children with and without visual impairment”, *Developmental Medicine & Child Neurology* 1995 vol. 37, no. 5, p. 456–463.

<sup>3</sup> D. Šmite, *Fiziskā funkcionālā stāvokļa izmeklēšana fizioterapijā*, 2013, Available at: <<http://www.vmnvd.gov.lv>>.

<sup>4</sup> C.V. Portfors-Yeomans, C.L. Riach, “Frequency characteristics of postural control of children with and without visual impairment”, op. cit.

<sup>5</sup> W.J. Harvey, G., Reid, “Attention-Deficit/Hyperactivity disorder: APA Research Challenges”, *Adapted Physical Activities Quarterly* 2005, vol. 22, no. 1, p. 1–20.

<sup>6</sup> J.M. Greve et al., “Relationship between Anthropometric Factors, Gender, and Balance under Unstable Conditions in Young Adults”, op. cit.; B. McGraw, B.A. McClenaghan, H.G. Williams, J. Dickerson, D.S. Ward, “Gait and postural stability in obese and nonobese prepubertal boys”, *Archives of Physical Medicine and Rehabilitation* 2000 vol. 81, no. 4, p. 484–489; R. Moликova, M. Bezdicikova, K. Langova et al., “The relationship between morphological indicators of human body and posture”, *Biomedical Papers of the Medical Faculty of the University Palacký* 2006, vol. 150, no. 2, p. 261–265.

<sup>7</sup> P. Kejonen, *Body movements during postural stabilization. Measurements with a motion analysis system.* (Academic Dissertation, 2002), Available at: <<http://>



There is research<sup>8</sup> showing that even minor balance disturbances diminish an individual's mobility and affect his/her physical activity (for example, reduce the ability to perform their daily activities) and psychosocial functioning (for example, reduced social activity which in severe cases even leads to social isolation). Consequently, these disorders become a problem not only for the child and adolescent, his/her family, medical personnel, but also of society, including an educational institution, that needs to be solved.<sup>9</sup>

To date no research has been carried out in Latvia concerning adolescents' balance problems and the connection of the disorders with psycho-emotional state, impact of balance disorders on learning activities and personal development in general. Thus, a pilot was carried out in the beginning with the aim of examining the spread/frequency of balance problems within the context of 12–13 year-old adolescents in Latvia and to identify possible regularities of a pupil's physical and psycho-emotional balance and learning activities.

### Organization of Research

A piece of portable equipment for balance testing, BIOSWAY, was used in the physical balance testing phase. The facility enables to capture movements connected with balance and provides an objective assessment of neuromuscular control and somatosensory operation.<sup>10</sup> The following tests were accomplished for data acquisition:

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herkules.oulu.fi/isbn9514267931/html/b1336.html>; A.J.Y. Lee, W.H. Lin, "The influence of gender and somatotype on single-leg upright standing postural stability in children", *Journal of Applied Biomechanics* 2007, vol. 23, no. 3, p. 173–179.

<sup>8</sup> F.J.A. Deconinck, G.J.P. Savelsbergh, D. Clercq, M. Lenoir, "Balance problems during obstacle crossing in children with Developmental Coordination Disorder", *Gait & Posture* 2010, vol. 32, no. 3 (July 2010), p. 327–331; A. Zijlstra, M. Mancini, L. Chiari, W. Zijlstra, "Biofeedback for training balance and mobility tasks in older populations: a systematic review", *Journal of NeuroEngineering and Rehabilitation* 2010, Available at: <<http://www.biomedcentral.com/content/pdf/1743-0003-7-58.pdf>>.

<sup>9</sup> S. Ušča, V. Ļubkina, "Līdzsvara problēmu identificēšanas pamatojums un iespējas skolā", in: *Izglītības reforma vispārīzglītojošā skolā: izglītības satura pētījumi un ieviešanas problēmas. 2014. gada zinātnisko rakstu krājums*, Rēzekne 2014, p. 114–122.

<sup>10</sup> Cf. V. Ļubkina, A. Kaupušs, S. Ušča, L. Riņakova, A. Ciukmacis, *Neiromu-*

- Postural stability test to determine the adolescent's ability to maintain the center of balance;
- Stability limit test to determine what is the maximum angle which an adolescent is able to reach in a vertical position without losing balance, how well he/she controls the center of gravity;
- Sensory organization balance test to determine the sway index in four different positions and to identify potential problems.

300 adolescents of the age 12–13 years from 22 schools in Latvia participated in balance testing with BIOSWAY. Parallel to testing with BIOSWAY, a questionnaire took place. Answers were collected from 353 parents of 12–13 year-old adolescents from 22 schools in Latvia; educators from 6 schools in Latvia; 89 adolescents aged from 12 to 13 years from 7 schools in Latvia. The obtained data was coded and processed by the program IBM SPSS Statistics 22.

## Results of Pilot Research

### 1. Results of testing with the equipment BIOSWAY

The results of the postural stability test show that nearly every fourth 12–13-year-old adolescent's overall postural stability index is below normal. This indicates the need for additional examination because postural balance characterizes the adolescent's ability to maintain the centre of gravity above the support area in the rest position; it is also essential for starting and stopping a movement.<sup>11</sup> Significant differences ( $p = 0,050$ ) were detected in the analysis of Mann-Whitney test results concerning the ability to maintain the centre of balance (deviation) depending on the adolescents' sex: deviation for girls was higher than for boys.

Stability limit test identifies in which direction balance control has bigger problems. The Standards of Stability limit test of the

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*skulārās sistēmas, līdzsvara testēšanas un trenēšanas un vibromasāžas tehnoloģija un ieviešanas metodika, Rēzekne 2013.*

<sup>11</sup> A. De Kegel, I. Dhooge, W. Peersman, J. Rijckaert, T. Baetens, D. Cambier et al., "Construct validity of the assessment of balance in children who are developing typically and in children with hearing impairments", *Physical Therapy* 2010, vol. 90, no. 12, p. 1783–1794.



BIOSWAY equipment determines that the total ratio is over 65. Analysis of the results reveals that the overall result is only good for 9.4% of adolescents, it is below the norm in other cases.

The sensory organization balance test is designed for identification of balance problems and determination of the sway index in four different positions. A variable surface (hard and soft) and visual conditions (eyes closed, eyes open) were used in order to test investment of visual, vestibular, somatosensory functions and to determine to what extent an adolescent is able to keep his/her balance through the senses, when and which of the senses is disrupted.

Normal balance includes the ability to stand still in different situations regardless of circumstances or activities. This ability is characterized by the result of the centre of gravity sway. The higher the sway index, the more unstable an adolescent.<sup>12</sup> A summary of the obtained data is shown in Table 1.

Table 1  
Compliance  
of sensory organization balance  
test results with the  
established norms

Position	Normative data	Adolescents whose results do not comply with norm (% and cases)
on hard surface, eyes open	0,21–0,48	25% or 75
on hard surface, eyes closed	0,48–0,99	16% or 48
on soft surface, eyes open	0,38–0,71	48% or 144
on soft surface, eyes closed	1,07–2,22	21,3% or 64

The analysis of the results showed differences depending on the adolescent's place of residence and sex.

Depending on the adolescents' place of residence (urban or rural), very significant differences were found in the measurements on a hard platform, eyes open ( $p = 0,003$ ) and on a soft surface, eyes open ( $p = 0,002$ ). Unlike the previous tests, this time in both cases adolescents living in a city had a bigger sway angle from the center (Mean Rank 164,06 and 165,32) than those living in rural areas

<sup>12</sup> V. Ļubkina et al. "Neiromuskulārās sistēmas, līdzsvara testēšanas un trenēšanas un vibromasāžas tehnoloģija un ieviešanas metodika", op. cit.

(Mean Rank 135,61 and 134,23). Since lower results reflect slight movements (the more stable an adolescent, the less he/she swings), and it is better than a high score, it is concluded that adolescents living in rural areas had better control balance when one of the senses is disrupted. The following was detected depending on sex:

(1) most significant differences ( $p = 0,000$ ) in the measurements when an adolescent stands on a hard surface, eyes open;

(2) very significant differences in the measurements when an adolescent stands on a soft surface, eyes open ( $p = 0,004$ );

(3) significant differences in the measurements when an adolescent stands on a hard surface, eyes closed ( $p = 0,028$ ).

In all cases, the average value of ranking is higher for boys than girls. It means that girls are better able to maintain their balance.

## 2. Comparative analysis of results gained after questionnaire and testing with BIOSWAY

In order to identify possible correlations, the results of parents, pupils and teachers questionnaire were compared with the results of testing with BIOSWAY.

### Questionnaire of parents

The comparative analysis of the results of parents' questionnaires and pupils' testing was carried out. The results of variables correlation were calculated using the correlation coefficient formula by Spearman. It shows that the total deviation negatively correlates with visual impairment ( $r = -0,238$ ,  $p = 0,005$ ). After the test of stability boundaries, the Spearman correlation results reveal that the total stability indicator correlates with visual impairment ( $r = -0,145$ ,  $p = 0,016$ ), the parental opinion that an adolescent is inattentive ( $r = -0,126$ ,  $p = 0,038$ ), the parental opinion that an adolescent often worries even about little things ( $r = 0,142$ ,  $p = 0,019$ ), he/she has friends among classmates ( $r = 0,216$ ,  $p = 0,000$ ).

The Spearman correlation results of sensory organization balance measurements show that the performance on a hard surface, eyes closed has a negative correlation with the parents' opinion that an adolescent has visual impairment ( $r = -0,214$ ,  $p = 0,003$ ) and language disorders ( $r = -0,163$ ,  $p = 0,027$ ). In turn, the parents' opinion that



an adolescent has behavioural disorders correlates with the measurements in a position on a soft surface, eyes open ( $r = 0,192, p = 0,009$ ) and in a position on a soft surface, eyes closed ( $r = 0,182, p = 0,013$ ).

Although the observed correlations are weak or even very weak, the significance ( $p \leq 0,050$ ) indicates a statistical essentiality and suggests that visual impairment, hearing impairment, language disorders, behavioural disorders and an adolescent's psycho-emotional state can affect physical balance, but further studies, additional results, and analysis of the particular cases are needed to confirm this assumption.

#### Questionnaire of teachers

Teachers' answers were correlated with the described adolescents' individual testing results with BOISWAY for a more precise understanding of the situation. The Spearman correlation results show the following:

- the adolescents' ability to maintain balance and the total deviation from the centre (Postural stability test) correlates with learning difficulties ( $r = - 0,424, p = 0,001$ ): the more often a pupil faces learning difficulties, the bigger is the deviation from the centre. It points to an instability of the adolescent's physical balance. A correlation with learning difficulties is also found in deviation forward – back ( $r = - 0,308, p = 0,015$ ) and in deviation left – right ( $r = - 0,383, p = 0,002$ );
- the adolescents' dynamic stability, the ability to control the centre of gravity (the results of the stability limit test) correlate with learning difficulties ( $r = - 0,263, p = 0,039$ ) and posture disorders or scoliosis ( $r = - 0,262, p = 0,039$ ).

When assessing the ability of adolescents to use sensory functions to support balance in the cases of shortage of compensator capacity, the results of sensory organization balance test correlate with teachers' replies, and the following emerged:

- the results in the normal position when three sensory systems (visual, vestibular, and somatosensory) have accurate information (the position of eyes open, stable surface) correlate with learning difficulties ( $r = 0,331, p = 0,009$ );
- the results in the position when the visual function is primary, but the vestibular function is secondary (the position of eyes open,



unstable surface) correlate with attention ( $r = 0,255$ ,  $p = 0,046$ ) and posture disorders or scoliosis ( $r = 0,376$ ,  $p = 0,003$ ).

Analysis of the teachers' survey results and their correlation with adolescents' balance testing with BIOSWAY suggest that there is a connection between the balance results that are below the norm and indicates possible balance disorders and adolescents' learning and attention difficulties. The following conclusion leads to the assumption that balance disorders affect adolescents' learning activities, but their correction and prevention could have a positive impact on adolescents' learning achievements.

#### Questionnaire of adolescents

Adolescents' replies were also correlated with the results of their individual testing with BIOSWAY. The Spearman correlation results show that the adolescents' ability to maintain balance and deviation right – left (Postural stability test) correlate with the fact of whether an adolescent has friends in class ( $r = 0,255$ ,  $p = 0,018$ ), but the dynamic stability, the ability to control the centre of gravity (Stability limit test) correlates with attention ( $r = 0,251$ ,  $p = 0,020$ ).

When assessing the ability of the adolescents to use sensory functions to support balance in the cases of shortage of compensator capacity, the results of sensory organization balance test correlate with adolescents' replies, and the following was discovered:

- the results in the normal position when three sensory systems (visual, vestibular, and somatosensory) have accurate information (the position of eyes open, stable surface) correlate with adolescents' knowledge that they have lack of self-control, they get angry fast ( $r = - 0,221$ ,  $p = 0,041$ ): riotous adolescents have greater balance problems;
- the results in the position when the eyes are closed, the surface is stable, and an adolescent has to rely on somatosensory and vestibular functions, when the somatosensory function is the main sensory function, correlate with the adolescents' knowledge that they have lack of self-control, they get angry fast ( $r = - 0,245$ ,  $p = 0,023$ ), suggesting that the results deteriorate when the level of rudeness increases: increasing the amplitude of oscillation suggests problems with the somatosensory system;



- the results in the position when the visual function is primary, but the vestibular function is secondary (the position of eyes open, unstable surface) correlate with adolescent knowledge that they have lack of self-control, they get angry fast ( $r = -0,218$ ,  $p = 0,044$ );
- the results in the position eyes closed, unstable surface when the somatosensory system is being tested by an unstable surface, focus on the vestibular function, correlate with learning difficulties ( $r = -0,253$ ,  $p = 0,019$ ).

Analysis of the adolescents' questionnaire results and their correlation with adolescents' balance testing with BIOSWAY suggest that there is a connection between the balance results, adolescents' learning difficulties, and their ability to control themselves. The connection was established also after summarizing questionnaires of teachers and parents. So it can be concluded that there is a connection between learning difficulties/achievements and the ability to control emotions and physical balance.

## Conclusions

(1) A large proportion of 12–13 year old adolescents are found to have a deviation of postural balance which is not considered to be a disturbance but could lead to problems in the future if ignored.

(2) The results of the pilot research suggest that there is a connection between the 12 to 13-year-old adolescents physical balance control and emotional self-control. It shows that the better an adolescent controls his/her body, the better he/she controls their emotions. And vice versa—physical balance improves after controlling own emotions with the effort of will. However, taking into consideration the peculiarities of adolescent development, this connection tends to be individually different. Further research is required for testing the connections.

(3) The identified correlations between the balance readings and assessment of attention allow the assumption that balance problems affect 12–13 years old adolescents' emotional state (nervousness, lack of self-control, communication with peers in a classroom and outside of it). However, further research is necessary for the approval of this assumption.

(4) Since the responses of parents, teachers, and pupils showed a correlation between learning difficulties and balance readings below

normal, it can be concluded that physical balance affects adolescents' learning achievements.

(5) The obtained data shows that 12–13-year-olds need specific pedagogical support in the field of physical, emotional, and social balance. The support must be based on complex and successive research of pupil's developmental needs, provision of corrections and/or rehabilitation measures, focusing on the individual case in order to help each adolescent to overcome development challenges in a changing social environment.

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