

# Determining the relation of body balance indices in middle school students

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## Abstract

**Background.** Physical education lessons must remain in the basic format without neglecting the optional, extracurricular activity because each of these activities complements the topics of its content.

**Aims.** This paper aims to investigate the balance development during physical education lessons and basketball extracurricular activity in middle school female students.

**Methods.** The research subjects were 24 schoolgirls aged 12-14 years from the “Mircea cel Bătrân” Middle School of Pitești. The study was conducted throughout the physical education lessons and basketball extracurricular activity. Static balance (SB) and lateral dynamic balance (LDB) were tested using Sensamove Sensbalance MiniBoard. Measured indices: performance; forward, backward and lateral deviations; keeping the balance.

**Results.** The analyzed results show better performance values by 2.5% at LDB, with the same share of deviations of 3.2% forward at SB and backward at LDB and at lateral deviations by 0.7% to the left at LDB and to the right at SB. Keeping the balance at LDB is better by 6.75% backward. The correlation analysis highlights 45.7% very weak connections ( $p > 0.05$ ), except for the strong connection between left, avg. deviation at SB and back, avg. deviation at LDB ( $R = 0.419$ ,  $p < 0.05$ ).

**Conclusions.** The evaluation of the development of SB and LDB in middle school students highlighted the achieved performance dynamics, the same share of the investigated balance inverse to forward-backward and left-right deviations, which influenced differently the balance keeping quality. The correlation analysis determined the degree of connection between the indices studied in the middle school students.

**Keywords:** lesson of physical education, motor skills, extracurricular activity, deviation, performance, correlation analysis.

## Introduction

As a period of transition from childhood to adolescence, the middle school age includes those moments in which the anatomical and functional transformations increase in intensity and extent. They are significant for the further development of the individual (Tohănean, 2009). The age of preadolescence, also called puberty, marks the beginning of the physical maturation of the individual. It is a period of intense formation of the personality and establishing the moral consciousness (Santi, 2020). Preadolescents start a new school cycle, with new subjects that require visual and auditory discriminative abilities as well. The spatial and temporal orientation and the tendency to interpret the meaning of perceptions are also developed (Skinner & Piek, 2001). This age is the most advantageous for the development of motor skills, also known as the age of the first performances. In parallel with the increase of the indices that define speed, skillfulness (coordination capacity) and aerobic endurance, a special attention must

be paid to mobility which, if not properly supported, can regress (Khudolii et al., 2019).

The analysis of the forms of physical exercising organization according to the subsystems of physical education leads to the conclusion that the lesson is the form encountered in all the cases. The physical education lesson must include the various points of view of the practical disciplines, which give the thematic content in terms of motor abilities and skills (Moanță et al., 2008). The structure of the lesson implies the presence of the classic links, with a variable duration. Motor skills constitute topics of lesson (speed or skillfulness as the first topic; strength or endurance as the last topic). The combination of speed, coordination and balance - called agility - is one of the most important motor skills developed throughout physical education classes in school (Acar & Eler, 2019; Szabo et al., 2020). It is important to keep in mind that all motor skills can be developed very well in this education cycle, although the emphasis is placed on speed and

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dexterity (Balcioğlu & Biçer, 2022). Any special action for developing a basic motor skill has certain effects on the improvement of the other motor skills too. Any basic motor skill can be programmed in order to be specially developed in any school semester (modules) (Doğan & Savaş, 2021).

The class of physical education must remain the basic form of physical education activity, but the optional, extracurricular activity must not be neglected either. Each of these activities has its role in the development of the students' personality (Gumay et al., 2018). Playing basketball in school requires simultaneous presence and - at the same time - develops the whole complex of motor skills (Savu & Pehoiu, 2018), namely: speed - with all its forms of manifestation (reaction, execution, movement), spring (jump height) (Alemdaroğlu, 2012); skillfulness (coordination capacity) taken to virtuosity, shown in handling the ball in different conditions of balance, with maximum speed, while facing one or more opponents (Epure & Bădău, 2021); precision of movements; the strength of lower limbs and peripheral vision is very often required indirectly (Predescu & Moanță, 2001; Cortis et al., 2011; Ciocan & Puni, 2020).

## Hypothesis

Carrying out the correlation analysis between the indices of the static and dynamic balance in the middle school students will highlight the level of development and connection between lateral, forward and backward deviations, which will influence the quality of body balance maintenance.

## Material and methods

### Research protocol

The balance measurement tool used in this research belongs to the Human Performance Research Center (H.P.R.C.) of the Physical Education and Sport Department under the University of Pitești, Romania in collaboration with Doctoral School, State University of Physical Education and Sport, Chisinau, Republic of Moldova.

### Period and place of the research

The research was conducted in March 2023, during the classes of physical education and the basketball extracurricular activity. This scientific approach led to the realization of a confirmatory (but also correlation) study carried out in the "Mircea cel Bătrân" Middle School of Pitești, Romania.

### Subjects and groups

The subjects of the research ( $n = 24$ ) were middle school female students aged 12-14 years, body weight  $48.38 \pm 8.64$  kg, height  $1.62 \text{ m} \pm 0.07$  m and body mass index (BMI) –  $18.4 \pm 2.26$  kg/m<sup>2</sup>; all participants had normal mass consistent with their age. It must be mentioned that 12 schoolgirls are members of the representative team of the school. The subjects were informed referring to their participation in the research and gave their consent, as per the Declaration of Helsinki.

### Applied tests

The measurement of the static and dynamic balance was performed by means of the Sensamove Sensbalance MiniBoard (Fig. 1), tilting the platform at 10 degrees.

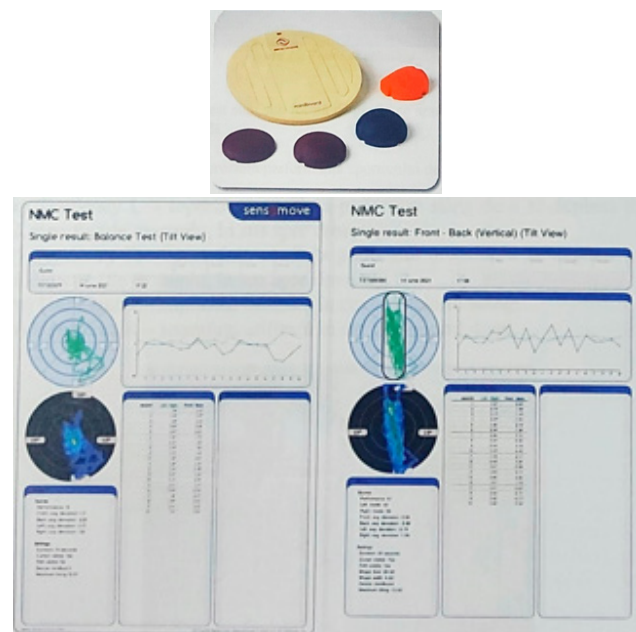


Fig. 1 – Results of the balance test (Sensamove Sensbalance MiniBoard).

*Test 1:* static balance was determined as follows: the schoolgirls stood on both feet on the balance board, with the toes at the same level and the arms crossed over shoulders. Subjects had to keep the balance on the board for 20 sec., while following a fixed point of the computer screen. The results of this test are presented in graphical form, showing forward-backward and left-right deviations per sec.

### Parameters obtained:

- Performance (%) – balance keeping performance, expressed in %;
- Front, avg. deviation – average forward deviation, expressed in degrees;
- Back, avg. deviation – average backward deviation, expressed in degrees;
- Left, avg. deviation – average deviation to the left, expressed in degrees;
- Right, avg. deviation – average deviation to the right, expressed in degrees.

*Test 2:* dynamic lateral balance was determined keeping the same position, but this time the schoolgirls had to perform a left-right "swinging" movement on both legs, staying inside a space displayed on the computer screen. The test results are presented in graphical form showing the performance of keeping in front and at the back of the space, also the forward-backward and left-right deviations per second.

### Parameters obtained:

- Performance - it shows the performance of the student to keep the balance, expressed in %.
- Front, inside - keeping in the front space, expressed in %.
- Back, inside - keeping at the back of the space, expressed in %.
- Front, avg. deviation - average forward deviation, expressed in degrees.
- Back, avg. deviation - average backward deviation, expressed in degrees.

- Left, avg. deviation - average deviation to the left, expressed in degrees.

- Right, avg. deviation - average deviation to the right, expressed in degrees.

*Statistical processing*

Statistical analysis was done using the KyPlot 6.0 (KyensLab Inc) software to calculate the usual descriptive indices: mean, SD – standard deviation, Cv % - coefficient of variation (minimum and maximum). Correlation analysis was performed by means of Pearson coefficient, between the indices of the static and dynamic balance and the size of the effect (the coefficient of determination R<sup>2</sup>). Significant data were reported at p<0.05.

**Results**

The results of determining the indices of static and dynamic balance development in the 12-14-year-old schoolgirls are listed in Tables I and Table II.

The analysis of the statistical calculations of the static balance indices evaluation reveals 58.3% above-average performances, with values ranging from 62 to 96%. The weight of the deviations related to the center is 49% to the front and 51% to the back while the lateral deviations are 48.2% to the left and 51.8% to the right (Table I).

Analyzing the statistical calculations of the results of the lateral dynamic balance indices evaluation highlights 50% performances above the average, with values between 67 and 100%, keeping within the space above the average by 54.2% forward and 29,2% backward, weight of the deviations by 45.8% forward and 54.2% backward. In terms of lateral deviations, the following values were found out: 48.9% to the left and 51.1% to the right (Table II).

In order to point out the relationship between static and lateral dynamic indices in the 12-14-year-old schoolgirls, a correlation analysis was performed. The results are shown in Fig. 2.

**Table I**

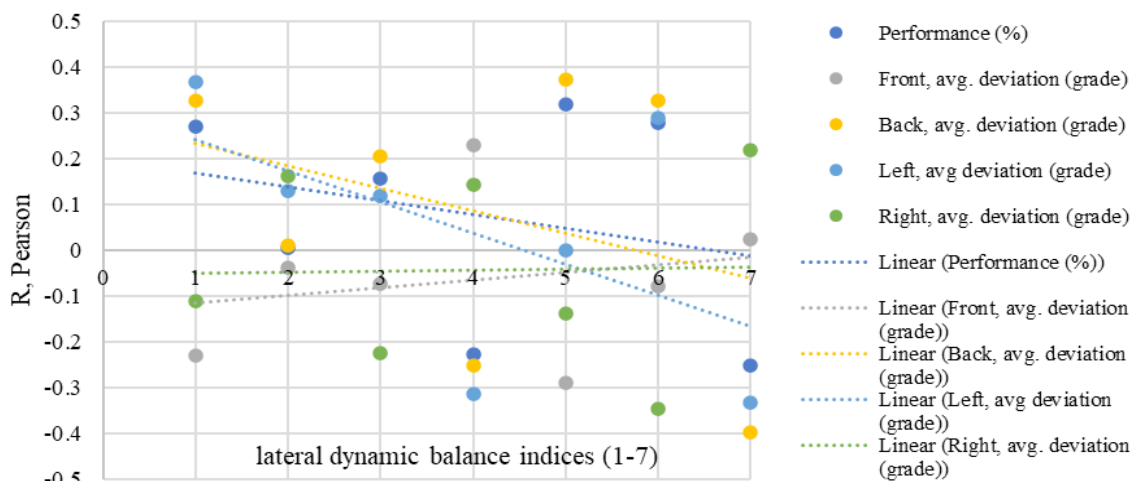
Results of the descriptive statistical indices –static balance in the middle school students (12-14 yrs.), n=24.

Indices	Descriptive Statistics				
	Mean	±S.D.	CV (%)	Min	Max
Performance (%)	86.29	7,78	9,02	62	96
Front, avg. deviation (deg.)	0.81	0.55	68.1	0.05	2.15
Back, avg. deviation (deg.)	-0.84	0.69	-82.2	-2.99	0.00
Left, avg. deviation (deg.)	-0.67	0.45	-67.2	-2.09	-0.17
Right, avg. deviation (deg.)	0.72	0.38	53.32	0.22	1.7

**Table II**

Results of the descriptive statistical indices-lateral dynamic balance in the middle school students (12-14 yrs.), n=24.

Indices	Descriptive Statistics				
	Mean	±S.D.	CV (%)	Min	Max
Performance (%)	88.79	9.09	10.24	67	100
Front, inside (%)	41.17	13.87	33.69	15	66
Back, inside (%)	47.92	14.23	29.71	31	84
Front, avg. deviation (deg.)	1.09	0.31	28.73	0.53	1.72
Back, avg. deviation (deg.)	-1.29	0.45	-34.95	-2.24	-0.6
Left, avg. deviation (deg.)	-3.75	0.97	-25.80	-5.25	-2.06
Right, avg. deviation (deg.)	3.92	0.97	24.81	2.37	5.56



**Fig. 2** – Correlation analysis between static and lateral dynamic balance indices in students aged 12-14 yrs.

The results of the correlation analysis show 35 connections (57% positive and 43% negative). In the case of the correlations between the static and lateral dynamic balance indices, one can observe very weak connections (45.7%) and non-existent ones (54.3%) with a range of  $-0.25 < R < 0.25$  la  $p > 0.05$ , excepting the strong connection ( $R = 0.419$ ) at  $p < 0.05$  between Left, avg. deviation (degrees) at static balance and Back, avg. deviation (degrees) at lateral dynamic balance. As for the intervals of the correlations between indices, the correlations are very poor:  $R$  ranging from  $-0.25$  to  $0.32$  (in the performance case);  $R$  between  $-0.289$  and  $-0.397$  (Front and Back, avg. deviation, Left and Right, avg. deviation). The size of the effect (coefficient of determination  $R^2$ ) ranges from the value  $0.00$  and  $0.176$ , which reflects a very weak, even non-existent connection between variables (Predoiu, 2020). Regarding the confidence limits, it must be stated that the value  $0$  is present in the confidence interval (95%).

## Discussion

The current research intended to study the level of balance development during the physical education lessons and the extracurricular activity of basketball in the middle school female students.

The results of the research highlight the dynamics of the balance development indices both throughout the physical education lesson with basketball game topics and the extracurricular activity in the 12-14-year-old schoolgirls. The results of the evaluation of static balance indices show a performance between 62 - 96%; the weight of the deviations has intervals with the size of 2.2 degrees forward and 2.99 degrees backward, while lateral deviations of 1.47 degrees to the left and 1.92 degrees to the right are observed (Table I). In terms of lateral dynamic balance indices evaluation, one can notice performances between 67 - 100%; the balance keeping is better by 6.75% backward, the weight of the deviations with the size of intervals is 2.25 degrees forward and 2.84 degrees backward, while the lateral deviations show 7.31 degrees to the left and 7.93 degrees to the right (Table II). This research is not the only one that dealt with balance development during the physical education lessons and throughout the extracurricular activity at the middle school level, as shown above. There are also other specialists who focused on the development of physical and motor skills by basketball specific means (Savu & Pehoiu, 2018) or by using specific basketball training games within the seventh-grade physical education lesson (Ciocan & Puni, 2020). The demands of competitive basketball games and the relationship between the physical abilities of the players and game performance were studied too (Abdelkrim et al., 2010). But studies on the comparison between the anthropometric characteristics of basketball players and sprinters were less reported. Therefore, it was proposed to compare the fitness parameters of these athletes regarding the anthropometric measurements, body composition, strength, endurance and motor abilities (Daulatabad et al., 2020; Chukhlantseva et al., 2021). In the recent years, the basketball game has developed significantly worldwide, which has led to the improvement of sports performance. The continuous adaptation of training methods, the use

of high-tech auxiliary equipment and the implementation of technology in sports are factors that contributed to achieving outstanding performances (Epure & Bădău, 2021).

The results of the correlation analysis highlight 45.7% very poor connections ( $p > 0.05$ ), with the exception of the strong connection between left deviation at static balance (SB) and back deviation at lateral dynamic balance (LDB) ( $p < 0.05$ ), which justifies the mutual influence between them. There are also other concerns regarding this relationship between the motor skills and the contents of basketball game. The relations between general coordination, specific coordination and specific fitness in the male basketball players aged 8 - 17 years were investigated too. It was found out that the general coordination is highly important for improving the sport-specific skills during the development phase of these ones. Afterwards, when the sport-specific skills are mastered close to perfection, the importance of the general coordination decreases (Kamandulis et al., 2013). The layup shot is one of the important techniques in basketball game. Therefore, it is necessary to know aspects related to layup skills. A study was carried out to prove the relationship between eye-hand coordination, agility and basketball lay-up skills. This study used the quantitative descriptive approach together with the correlation method (Suryadi et al., 2023). Although many scientific papers focused on the relations between isokinetic knee strength, anaerobic performance, sprinting ability, agility and vertical jump in athletes, an insufficient number of studies were conducted on basketball players, especially those of the first division (Alemdaroğlu, 2012). Basketball players were monitored to verify whether they can maintain their performances at the end of the game. Therefore, the following elements were verified: strength (handgrip), jump (countermovement jump), sprint (10 m and 10 m bouncing the ball [10mBB]) and coordination of the limbs (synchronized hand and foot flexions and extensions). The findings show that the heavy load of the game has beneficial effects on the executive function and attentional control. It is necessary that coaches organize training sessions that combine intense physical exercises and complex coordination tasks meant to enhance the attentional capacity of the players (Cortis et al., 2011).

## Conclusions

1. The evaluation of the balance development level during the physical education lesson but also throughout the basketball extracurricular activities in the middle school students revealed the dynamics of the achieved performance. We highlighted the same weight of the investigated balance inverse to the forward-backward and left-right deviations, which differently influenced the quality of balance keeping.
2. The correlation analysis determined the degree of connection between the indices studied in the middle school girls. These data are very useful for the teachers of physical education and the basketball specialists.

## Conflict of interests

The author declares no conflict of interest.



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