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ANALYSIS OF THE RELATIONSHIP OF BIPEDAL DYNAMIC BALANCE INDICES IN PERFORMANCE SAMBO ATHLETES

Gheorghe Cristian BODÎRLĂU[1]

Abstract: *The study examines the relationship between dynamic balance and postural deviations in performance Sambo athletes. The research involved 13 athletes aged 14-17, trained at the "Steaua" Army Sports Club. The evaluation was conducted using the Sensamove miniboard, with a bipedal test lasting 20 seconds and a maximum tilting of 10.00 degrees. Results show better vertical balance performance (85.38%) compared to lateral balance (78.31%). The coefficient of variation indicates greater homogeneity in lateral balance (8.59%) than vertical balance (12.25%). Postural deviations are more pronounced in the front and back, with higher values for EDV (Front Inside = 45.23%, Back Inside = 40.07%). Correlations highlight a significant association between lateral balance and lateral deviations (R = 0.510). The t-test does not show significant differences (p > 0.05), with a trend towards significance for lateral deviations (p = 0.075). Conclusions emphasize the need for specific interventions to improve lateral balance and reduce postural deviations.*

Key words: *dynamic balance, postural deviations, lateral balance, vertical balance, performance.*

1. Introduction

Balance is a fundamental component of athletic performance, particularly in combat sports such as Sambo, where rapid changes in posture, dynamic movement and stability are critical for success [1], [6]. The ability to maintain postural control during dynamic actions directly impacts an athlete's effectiveness in executing techniques, evading attacks and sustaining performance throughout a match [8], [15]. Among the various types of balance, bipedal dynamic balance plays a key role in ensuring stability during movement, transitions between offensive and defensive positions and adaptability to the actions of opponents [2], [4], [9].

Recent studies have highlighted the importance of balance and coordination in Sambo athletes, linking these attributes to overall performance and injury prevention

[1] PhD. student, Institute of Physical Education and Sport of Moldova State University, Chisinau, Republic of Moldova; Independent Service for Interventions and Special Actions, General Inspectorate of the Romanian Police

[11], [12], [16]. For instance, research by Cherepov et al. (2021) focused on the relationship between coordination abilities and postural balance in martial arts athletes, underscoring the necessity of specialized training to enhance these skills [5]. Similarly, Romanenko et al. (2019) examined the interrelations of psychophysiological and physiological indicators in martial artists, indicating that balance control is closely tied to neural and muscular efficiency [10]. Moreover, Vedernikova et al. (2023) explored the psychophysiological particularities of adolescent athletes across different sports specializations, showing the balance training role in sports development [13].

Other studies on sensorimotor reactions in Sambo athletes have demonstrated that keeping the balance is a dynamic process requiring continuous neuromuscular adaptation [3]. The educational and training framework proposed by Vorozheikin et al. (2024) further reinforces the significance of systematic balance training, particularly during the preparatory phase for young athletes [14]. Additionally, Osipov et al. (2020) emphasized the importance of special physical fitness in female Sambo athletes, linking it to enhanced balance and coordination [7]. These findings suggest that developing bipedal dynamic balance is not only essential for competitive performance but also for long-term athletic development.

Given the growing body of research on postural stability and balance in combat sports, this study aims to analyze the relationship between bipedal dynamic balance indices in performance Sambo athletes. By evaluating balance metrics and their correlation with specific performance factors, this research seeks to provide insights into optimizing training methodologies and enhancing competitive efficiency. The findings will contribute to a deeper understanding of how balance capacities influence high-level Sambo performance and enable evidence-based approaches for athlete development.

The aim of this study is to analyze the relationship between dynamic balance and postural deviations in performance Sambo athletes.

2. Method

The study included 13 athletes aged 14-17, trained at the “Steaua” Army Sports Club. The tests were conducted by means of the Sensamove miniboard, using a 20-second bipedal test with a maximum tilt of 10.00 degrees. The assessment focused on lateral dynamic balance (LDB) and vertical dynamic balance (VDB). The recorded parameters encompassed performance, front and back deviations for LDB, left and right deviations for VDB, as well as the average left and right deviations.

The statistical indicators were calculated using the KyPlot 6.0 software (KyensLab Inc). An analysis of the relationship between the measured indices was conducted using the Pearson correlation coefficient. Statistical significance was established at $p < 0.05$.

3. Results

The results highlight significant differences between lateral dynamic balance (EDL) and vertical dynamic balance (VDB) in terms of both performance (Table 1) and average balance deviation (Table 2) in performance Sambo athletes.

Performance and Inside values of the dynamic balance Table 1

Statistical indicators	Performance (%)		Inside (%)			
			front	left	back	right
	EDL	VDB	EDL	VDB	EDL	VDB
Mean	78.31	85.38	34.15	45.23	44.00	40.07
SD	6.72	10.46	9.91	11.23	11.34	12.68
Cv%	8.59	12.25	29.03	24.82	25.77	31.65
Min	66.00	69.00	22.00	27.00	23.00	23.00
Max	89.00	96.00	56.00	62.00	61.00	60.00
Median	79.00	89.00	31.00	46.00	46.00	38.00
Skewness	-0.30	-0.57	0.87	-0.11	-0.39	0.19
Kurtosis	-0.61	-1.23	-0.11	-1.23	-0.91	-1.05
CLM (0.95)	4.06	6.32	5.99	6.78	6.85	7.66
Quartile Range	8.00	17.00	12.00	16	17.00	11.00
R2	0.051		0.109		0.153	
R	0.226		0.331		0.391	
t	0.77		1.16		1.41	
P	0.458		0.268		0.186	

Test of lateral dynamic balance (LDB) and Test of vertical dynamic balance (VDB)

Average deviation of the dynamic balance Table 2

	Front (degrees)		Back (degrees)		Left (degrees)		Right (degrees)	
	EDL	VDB	EDL	VDB	EDL	VDB	EDL	VDB
Mean	1.29	4.69	-1.76	-5.03	-4.35	-1.35	4.40	1.30
SD	0.27	0.71	0.36	0.99	1.35	0.49	0.91	0.38
Cv%	21.34	15.24	20.47	19.81	31.13	36.96	20.65	29.59
Min	0.8	3.35	-2.51	-7.54	-6.65	-2.32	3.19	0.84
Max	1.83	5.86	-1.07	-3.87	-3.07	-0.71	6.00	2.13
Median	1.25	4.57	-1.81	-4.97	-3.61	-1.33	4.39	1.21
Skewness	0.36	-0.03	0.01	-1.24	-0.71	-0.49	0.28	0.64
Kurtosis	-0.16	-0.69	0.24	1.59	-1.16	-0.84	-0.98	-0.46
CLM (0.95)	0.43	0.43	0.22	0.60	0.82	0.30	0.55	0.23
Quartile Range	0.29	1.16	0.31	0.89	2.37	0.71	1.10	0.59
R2	0.049		0.057		0.096		0.260	
R	-0.223		0.240		0.311		0.510	
t	0.76		0.82		1.08		1.97	
P	0.463		0.429		0.301		0.075	

The results show superior performance in vertical dynamic balance (VDB) compared to lateral dynamic balance (EDL), with an average of 85.38% for VDB and 78.31% for LDB. The coefficient of variation (Cv%) suggests greater homogeneity in lateral balance (8.59%) compared to vertical balance (12.25%), indicating higher variability in stability in the vertical position. Data distribution analysis reveals a slight negative asymmetry for both parameters. Postural

deviations point out notable differences between directions; they are more pronounced in the forward direction (Front Inside LDB = 34.15%, VDB = 45.23%) and backward direction (Back Inside LDB = 44.00%, VDB = 40.07%). Also, angular deviations are greater in vertical balance, particularly in the posterior and left directions, which may indicate more challenging stability control in these areas. Statistical analysis shows low R^2 values, while correlation coefficients (R) indicate a stronger association between lateral balance and lateral deviations (R = 0.510), suggesting a significant influence of lateral balance on postural control. The t-test and p-values do not indicate statistically significant differences for most parameters ($p > 0.05$), except for a trend toward significance ($p = 0.075$) in the correlation between lateral deviations.

4. Discussions

The results obtained in this study confirm previous findings regarding the influence of balance type on postural stability in martial arts athletes (Sambo), highlighting greater variability in vertical dynamic balance compared to lateral balance. Specialists such as Andreeva et al. (2021) emphasize that direction influences postural stability [2], while Zemková & Zapletalová (2022) focused on the importance of neuromuscular control in maintaining balance and functional performance [15]. Furthermore, Cherepov et al. (2021) demonstrated that athletes with superior coordination exhibit more efficient balance control, thus supporting the trends observed in our analysis regarding the correlations between postural deviations and dynamic balance performance [5].

5. Conclusions

Vertical dynamic balance reveals superior performance compared to lateral balance, but also greater variability, indicating individual differences in postural control.

The largest postural deviations occur in the backward direction for VDB and lateral-left for LDB, suggesting increased instability in these areas.

The correlations between balance deviation and performance are weak to moderate, indicating that other factors, such as strength and proprioception, play a significant role in balance control.

It is recommended to integrate specific lateral and vertical stabilization exercises to improve balance control, with progress monitoring throughout the training.

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