Analysis of the statokinetic stability of track and field athletes with mental retardation in annual sports training cycles

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PhD **T.V. Krasnoperova**[1]
PhD, Associate Professor **N.B. Lukmanova**[1]
M.V. Bystrova[1]
A.N. Beleva[1]
[1]Saint-Petersburg scientific-research institute for physical culture, Saint Petersburg

Corresponding author: tvkbox@gmail.com

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Abstract

Objective of the study is to assess the statokinetic stability of athletes with mental retardation in a year-long sports training cycle using stabilometry.

Methods and structure of the study. 8 men with mild mental retardation aged 23.3±2.1 years (four masters of sport and four candidates for master of sport) specializing in short-distance running took part in the scientific study. The study was conducted using the ST-150 stabilometric platform with STPL software. A two-phase Romberg test was performed during four periods of the annual sports training cycle. Friedman's test and Nemenski's post-hoc analysis were used to assess the reliability of the differences between the results.

Results and conclusions. In the surveyed track and field athletes with mental retardation, statokinetic stability remained at a stable and optimal level throughout the annual sports training cycle. During the competitive period, the athletes showed better coordination of the visual, proprioceptive, and vestibular analyzers, as evidenced by the lower value of the center of pressure displacement velocity. During the special preparatory and transitional periods, an increased role of vision in maintaining statokinetic stability was identified. According to the post-hoc analysis by Nemeni (p-value < 0.05, Friedman test), significant differences were found in the parameters of the sagittal axis X and the speed of movement of the center of pressure. High activity of the systems in maintaining stability in the basic stance was observed in the competitive and transition periods, as evidenced by the energy expenditure coefficient.

Keywords: *stabilometry, sports for people with mental retardation, athletics, annual cycle.*

Introduction. Studying the patterns of the body's adaptation to muscular (athletic) activity is an important task in sports physiology [11, 14]. Haghighi A.H. et.al. identify the following responses to physical exertion: adaptation of the neuromuscular apparatus (NMA), changes in the athlete's sensorimotor reactions [12], plastic functional reorganization of the NMA [6], changes in the neural structures of motor control [10], and statokinetic stability [3]. The degree of involvement of each sensory system in movement control changes as motor skills improve and depending on the tasks to be performed in different conditions of maintaining body balance [4, 8, 13].

Skilled athletes constantly improve their statokinetic stability, on which the precise execution of motor actions depends. A considerable number of studies have been devoted to the study of athletes' statokinetic stability using stabilometry. Thus, Zaicev A. and co-authors [15] found that the length and area of the statokinesiogram in athletes during the competitive period are greater than in the preparatory period, which reflects a decrease in functional capabilities.

A.S. Nazarenko and F.A. Mavliev [5] note that the sensitivity of afferent systems increases under the influence of sports activities. It has been shown that the dynamics of the average parameters of statokinetic stability reflect a higher level of long-term adaptation in athletes of situational sports than in athletes of cyclic sports [5]. In track and field athletes with mental retardation, due to the presence of organic lesions of the central nervous system, statokinetic stability integrally shows the coordination of the interaction between visual and proprioceptive analyzers [1, 2].

In highly skilled track and field athletes with mental retardation, the determination of statokinetic stability will make it possible to judge the coordination of analyzers in maintaining postural stability, and changes in it over the annual cycle will reflect the characteristics of the state of coordination function under the influence of the volume and intensity of the load. The study of individual and average stabilometric indicators of athletes obtained at different periods of the annual cycle will allow us to establish the influence of the specifics of sports activities on the statokinetic stability of athletes.

Objective of the study is to assess the statokinetic stability of athletes with mental retardation in a year-long sports training cycle using stabilometry.

Methods and structure of the study. 8 men with mild mental retardation aged 23.3±2.1 years participated in the study. Sports qualifications: four masters of sport, four candidates for master of sport. Specialization: athletics, short-distance running. The study was conducted using the ST-150 stabilometric platform with STPL software. In four periods of the annual sports training cycle (general preparation – GP, special preparation – SP, competition – CP, transition – TP), a two-phase Romberg test was performed in the basic heel-together, toes-apart stance (first phase with eyes open, second phase with eyes closed) with subsequent signal filtering (cut-off frequency 7 Hz). The parameters of the trajectory of the total center of pressure on the platform plane were recorded. Additionally, the energy expenditure coefficient and Romberg coefficient were calculated. To assess the reliability of the differences between the results in different periods, Friedman's test (due to the absence of normal distribution) and Nemeni's post-hoc analysis were used.

Results of the study and discussion. Based on the study of statokinesiogram parameters in the open-eye test: the speed of movement of the center of pressure (V, mm/s), the length (L, mm) and area (S, mm) of the statokinesiogram, the coordinates on the X-axis (mm), coordinates on the Y-axis (mm), the stable and optimal statokinetic stability of athletes with mental retardation was determined in the studied periods of the annual sports training cycle (Table 1).

In the open-eye test, the initial level of statokinetic stability in GP showed that all parameters studied: the speed of movement of the center of pressure, the length and area of the statokinesiogram, and the coordinates on the X and Y axes were at an optimal level. Compared to GP, in the other periods there was a decrease in the speed of the center of pressure, length and area of the statokinesiogram. This indicates sufficient physical performance and coordination in the work of the visual, proprioceptive and vestibular analyzers. According to the post-hoc analysis by Nemeni (p-value < 0.05, Friedman test), significant differences were found in the parameters of the sagittal X-axis and the speed of movement of the center of pressure V (Fig. 1). Thus, in the open-eye test, there was a significant difference between GP and SP on the X axis and between SP and CP on the speed of movement of the center of pressure. The maximum degree of coordination of the analyzers in maintaining stability was observed in CP.

When comparing the results of the statokinesiogram in tests with open and closed eyes, the following patterns were identified. An increase in the speed of movement of the center of pressure, length and area of the statokinesiogram in GP and TP in the test with closed eyes. The shifts obtained were insignificant and reflected the influence of proprioception on the body's ability to maintain an upright posture. The indicators of the speed of movement of the center of pressure,

Table 1. Results of stabilometric testing of track and field athletes with mental retardation at different periods of the annual cycle (n=8)

Period	Eyes	V, mm/s	L, mm	S, mm	X, mm	Y, mm
GP	Opened	9,18±2,08	275,53±62,31	132,86±32,90	3,79±1,66	8,05±6,02
	Closed	11,68±1,77	350,64±52,86	159,93±35,01	1,25±1,86	6,00±5,89
SP	Opened	7,01±0,90	209,46±26,82	99,24±39,06	-2,23±1,35	10,59±6,54
	Closed	11,61±1,64	348,13±49,31	259,03±70,18	-0,31±1,61	13,01±6,24
CP	Opened	6,64±0,82	199,64±24,45	73,84±12,98	-0,14±3,52	6,68±5,38
	Closed	10,41±1,67	313,14±50,03	152,20±36,03	1,21±3,68	9,66±6,81
TP	Opened	7,64±1,07	229,30±32,14	66,30±11,92	-0,50±1,95	-1,98±3,77
	Closed	11,65±1,88	349,98±56,30	216,14±45,84	1,06±1,74	0,90±4,03

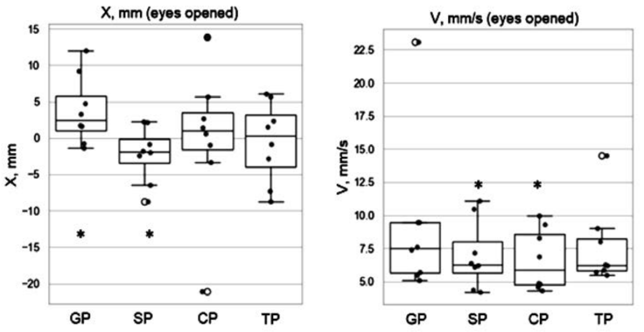

Fig. 1. Distribution of these parameters by period with confidence intervals (post-hoc analysis by Nemeni (– p-value < 0.05, Friedman test)*

length and area of the statokinesiogram in SP and CP increased by more than 60%.

The changes identified may be associated with an increase in the volume and intensity of physical activity and a significant contribution of the visual analyzer to maintaining stability. The results obtained indicate the prevalence of visual control in maintaining statokinetic balance and the absence of signs of physical fatigue.

A.B. Trembach et al. [9] showed in their work that one of the objective markers of physical fatigue is an increase in the speed of movement of the center of pressure. In their opinion, physical fatigue and psycho-emotional stress can be factors in the disruption of the functioning of the central nervous system. Analyzing the energy expenditure coefficient, we found that the greatest activity in maintaining balance in the basic stance was observed in CP and TP (Table 2). The Romberg coefficient indicated the significant role of the visual analyzer in SP and TP.

Table 2. Stabilometric coefficients in different periods of the annual cycle (u.e.)

Period	Energy consumption coefficient	Romberg's coefficient
GP	193,50±37,32	141,25±29,39
SP	187,13±3,41	314,75±85,58
CP	233,50±39,82	198,63±30,90
TP	222,13±45,17	337,50±74,09

During the remaining periods of the annual training cycle, highly skilled track and field athletes demonstrated optimal statokinetic stability. The results obtained are consistent with the data reported by Nopin S.V. et al. [7].

Conclusions. Thus, in track and field athletes with intellectual disabilities, statokinetic stability was at an optimal level during all periods of the annual training cycle. During the competitive period, track and field athletes showed coordination in the work of the visual, proprioceptive and vestibular analysers and interaction between different levels of the central nervous system. During the special preparatory and transitional periods, an increased role of vision in maintaining statokinetic stability was identified.

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