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METHODOLOGICAL JOURNAL<http://mentaljournal-jspu.uz/index.php/mesmj/index>ANALYSIS OF VESTIBULAR APPARATUS OSCILLATIONS IN HANDBALL
PLAYERS AT THE TRAINING STAGE USING THE “FORCEPLATFORMSMART”
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ABOUT ARTICLE

Key words: handball players, training, vestibular apparatus, ForcePlatformSmart, at the beginning of the study, exercise, oscillation, athletes, workload, body weight.

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Abstract: The levels of vestibular apparatus oscillations in the control group of handball players were determined at the beginning and end of the training sessions using the “ForcePlatformSmart” software. Based on the results obtained, relevant proposals and recommendations were developed. When examining the levels of vestibular apparatus oscillations in the control group of handball players involved in our study, using the “ForcePlatformSmart” software at the beginning and end of the training sessions, the following results were obtained. At the beginning of the study, along the X-axis, K-v A. demonstrated oscillations within the range of 13/-16 before exercise, while after exercise, the oscillation range changed to 13/-17. At the end of the study, along the X-axis, oscillations within the range of 14/-16 were observed before exercise, while after exercise, the oscillation range remained within 14/-16.

Introduction. The levels of vestibular apparatus oscillations in the control group of handball players were determined at the beginning and end of the training sessions using the “ForcePlatformSmart” software. Based on the results obtained, appropriate proposals and recommendations were developed.

Methodology.

When examining the levels of vestibular apparatus oscillations in the control group of handball players involved in our study at the beginning and end of the training sessions using the “ForcePlatformSmart” software, the following results were obtained.

At the beginning of the study, K-v A. demonstrated oscillations within the range of 13/-16 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 13/-17. At the end of the study, oscillations within the range of 14/-16 were observed along the X-axis before exercise, while after exercise, the oscillation range remained at 14/-16.

It was determined that, compared with the body position before the workload, the athlete in this weight category reduced the lateral displacement of body weight toward the left side by 6° after exercise. Along the Y-axis, the athlete demonstrated oscillations within the range of 14/-18 before exercise, which changed to 16/-18 after exercise. A reduction of 6° in the athlete’s oscillation amplitude was observed following the exercise load.

Along the Z-axis, the oscillation range was 32/38 before exercise and changed to 30/35 after the workload. Thus, the oscillation range decreased from 6 units to 5 units.

The movement range was observed within a radius of 10°, while regular movement within an accuracy radius of 20° was recorded. The duration of the accuracy point was 3/8 along the Y-axis and -4/7 along the X-axis.

These findings indicate that, in this weight category, the athlete demonstrated a relatively high level of body oscillation toward the left side. Under the influence of the exercise workload, the oscillation shifted closer to the center of the body-weight axis, indicating that the athlete tolerates and adapts well to the imposed physical workload.

At the beginning of the study, J-v O. demonstrated oscillations within the range of 13/-17 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 14/-19. At the end of the study, oscillations within the range of 14/-17 were observed along the X-axis before exercise, while after exercise, the oscillation range changed to 15/-18. It was determined that, compared with the body position before the workload, the athlete in this weight category reduced the lateral displacement of body weight toward the left side by 6° after exercise.

Along the Y-axis, the athlete demonstrated oscillations within the range of 14/-20 before exercise, which changed to 14/-18 after exercise. A reduction of 6° in the athlete’s oscillation amplitude was observed following the exercise load. Along the Z-axis, the oscillation range was 32/38 before exercise and changed to 33/39 after the workload. The oscillation range was therefore reduced from 6 units to 6 units.

The movement range was observed within a radius of 10° , while regular movement within an accuracy radius of 20° was recorded. The duration of the accuracy point was 5/8 along the Y-axis and -4/7 along the X-axis. These findings indicate that the athlete in this weight category demonstrated a relatively high level of body oscillation toward the left side. Under the influence of the workload, the oscillation shifted closer to the center of the body-weight axis, indicating that the athlete tolerated and adapted well to the imposed physical workload.

Results and Discussion. At the beginning of the study, F-v N. demonstrated oscillations within the range of 14/-18 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 12/-17. At the end of the study, oscillations within the range of 15/-18 were observed along the X-axis before exercise, while after exercise, the oscillation range changed to 13/-17. It was determined that, compared with the body position before the workload, the athlete in this weight category reduced the lateral displacement of body weight toward the left side by 6° after exercise.

Along the Y-axis, the athlete demonstrated oscillations within the range of 12/-18 before exercise, which changed to 13/-18 after exercise. A reduction of 6° in the athlete's oscillation amplitude was observed following the exercise load. Along the Z-axis, the oscillation range was 36/42 before exercise and changed to 38/43 after the workload. Thus, the oscillation range decreased from 6 units to 5 units.

The movement range was observed within a radius of 10° , while regular movement within an accuracy radius of 20° was recorded. The duration of the accuracy point was 4/8 along the Y-axis and -4/7 along the X-axis. These findings indicate that the athlete in this weight category demonstrated a relatively high level of body oscillation toward the left side. Under the influence of the workload, the oscillation shifted closer to the center of the body-weight axis, indicating that the athlete tolerated and adapted well to the imposed physical workload.

At the beginning of the study, N-v A. demonstrated oscillations within the range of 12/-19 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 14/-20. At the end of the study, oscillations within the range of 13/-18 were observed along the X-axis before exercise, while after exercise, the oscillation range changed to 14/-17.

It was determined that, compared with the body position before the workload, the athlete in this weight category reduced the lateral displacement of body weight toward the left side by 6° after exercise. Along the Y-axis, the athlete demonstrated oscillations within the range of 12/-19 before exercise, which changed to 15/-20 after exercise. A reduction of 6° in the athlete's oscillation amplitude was observed following the exercise load.

Along the Z-axis, the oscillation range was 36/39 before exercise and changed to 38/40 after the workload. Thus, the oscillation range decreased from 3 units to 2 units.

The movement range was observed within a radius of 10° , while regular movement within an accuracy radius of 20° was recorded. The duration of the accuracy point was 4/7 along the Y-axis and -5/7 along the X-axis.

These findings indicate that the athlete in this weight category demonstrated a relatively high level of body oscillation toward the left side. Under the influence of the workload, the oscillation shifted closer to the center of the body-weight axis, indicating that the athlete tolerated and adapted well to the imposed physical workload.

At the beginning of the study, K-v N. demonstrated oscillations within the range of 12/-18 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 13/-19. At the end of the study, oscillations within the range of 11/-16 were observed along the X-axis before exercise, while after exercise, the oscillation range changed to 14/-19.

It was determined that, compared with the body position before the workload, the athlete in this weight category reduced the lateral displacement of body weight toward the left side by 6° after exercise. Along the Y-axis, the athlete demonstrated oscillations within the range of 13/-18 before exercise, which changed to 14/-17 after exercise. A reduction of 6° in the athlete's oscillation amplitude was observed following the exercise load.

Along the Z-axis, the oscillation range was 45/48 before exercise and changed to 40/42 after the workload. Thus, the oscillation range decreased from 3 units to 2 units.

The movement range was observed within a radius of 20° , while regular movement within an accuracy radius of 20° was recorded. The duration of the accuracy point was 4/7 along the Y-axis and -4/7 along the X-axis.

At the beginning of the study, T-v F. demonstrated oscillations within the range of 12/-19 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 13/-19. At the end of the study, oscillations within the range of 11/-17 were observed along the X-axis before exercise, while after exercise, the oscillation range changed to 13/-16.

It was determined that, compared with the body position before the workload, the athlete in this weight category reduced the lateral displacement of body weight toward the left side by 6° after exercise. Along the Y-axis, the athlete demonstrated oscillations within the range of 12/-18 before exercise, which changed to 15/-20 after exercise. A reduction of 6° in the athlete's oscillation amplitude was observed following the exercise load.

Along the Z-axis, the oscillation range was 48/45 before exercise and changed to 49/51 after the workload. Thus, the oscillation range decreased from 3 units to 2 units.

The movement range was observed within a radius of 20° , while regular movement within an accuracy radius of 30° was recorded. The duration of the accuracy point was 4/7 along the Y-axis and -4/8 along the X-axis.

At the beginning of the study, X-v I. demonstrated oscillations within the range of 14/-18 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 14/-20. At the end of the study, oscillations within the range of 15/-17 were observed along the X-axis before exercise, while after exercise, the oscillation range changed to 15/-16. It was determined that, compared with the body position before the workload, the athlete in this weight category reduced the lateral displacement of body weight toward the left side by 6° after exercise. Along the Y-axis, the athlete demonstrated oscillations within the range of 12/-18 before exercise, which changed to 15/-20 after exercise. A reduction of 6° in the athlete's oscillation amplitude was observed following the exercise load.

Along the Z-axis, the oscillation range was 51/46 before exercise and changed to 52/55 after the workload. Thus, the oscillation range decreased from 4 units to 3 units. The movement range was observed within a radius of 20° , while regular movement within an accuracy radius of 30° was recorded. The duration of the accuracy point was 4/7 along the Y-axis and -5/7 along the X-axis.

At the beginning of the study, G-v A. demonstrated oscillations within the range of 13/-19 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 14/-18. At the end of the study, oscillations within the range of 14/-16 were observed along the X-axis before exercise, while after exercise, the oscillation range changed to 13/-16. It was determined that, compared with the body position before the workload, the athlete in this weight category reduced the lateral displacement of body weight toward the left side by 6° after exercise. Along the Y-axis, the athlete demonstrated oscillations within the range of 12/-20 before exercise, which changed to 13/-20 after exercise. A reduction of 6° in the athlete's oscillation amplitude was observed following the exercise load.

Along the Z-axis, the oscillation range was 65/63 before exercise and changed to 61/66 after the workload. Thus, the oscillation range decreased from 5 units to 2 units. The movement range was observed within a radius of 20° , while regular movement within an accuracy radius of 30° was recorded. The duration of the accuracy point was 4/7 along the Y-axis and -5/8 along the X-axis. These findings indicate that the athlete in this weight category demonstrated a relatively high level of body oscillation toward the left side. Under the influence of the workload, the oscillation shifted closer to the center of the body-weight axis, indicating that the athlete tolerated and adapted well to the imposed physical workload. During the exercises, it was

determined that the athlete in this weight category maintained body balance at a very good level.

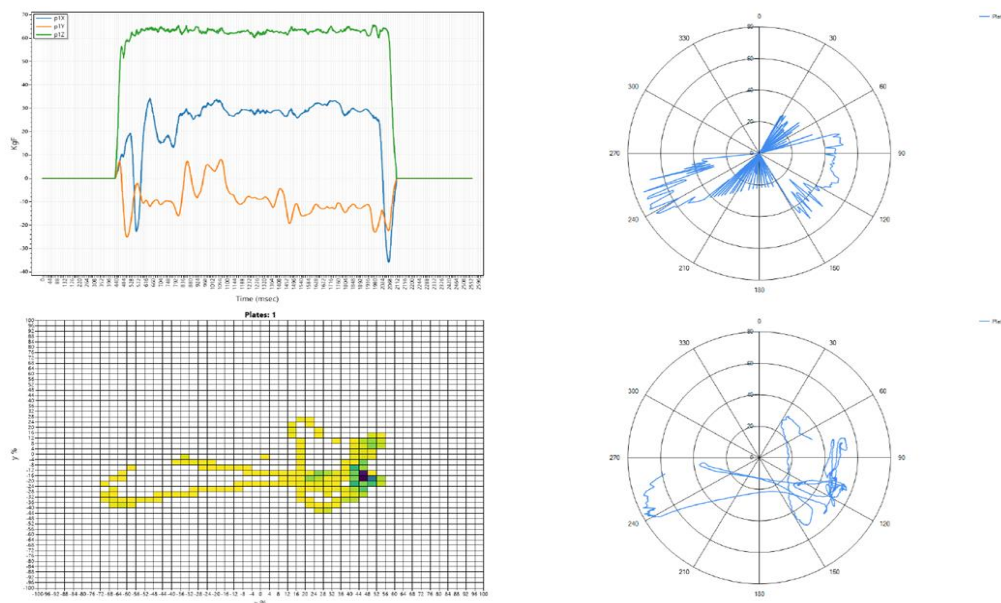


Figure 4.2. Note: Diagram of vestibular apparatus oscillations in the handball players of the control group at the end of the study.

When examining the levels of vestibular apparatus oscillations in the experimental group of handball players involved in the study at the beginning and end of the training sessions using the “ForcePlatformSmart” software, the following results were obtained.

At the beginning of the study, K-v N., an athlete from the experimental group, demonstrated oscillations within the range of 14/-19 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 12/-17. At the end of the study, oscillations within the range of 16/-18 were observed along the X-axis before exercise, while after exercise, the oscillation range changed to 13/-16.

It was determined that, compared with the body position before the workload, the athletes in this weight category reduced the lateral displacement of their body weight toward the left side by 6° after exercise. Along the Y-axis, the athlete demonstrated oscillations within the range of 12/-16 before exercise, which changed to 15/-18 after exercise. A reduction of 6° in the athlete’s oscillation amplitude was observed following the exercise load.

Along the Z-axis, the oscillation range was 33/37 before exercise and changed to 34/38 after the workload. Thus, the oscillation range remained at 4 units.

The movement range was observed within a radius of 10°, while regular movement within an accuracy radius of 20° was recorded. The duration of the accuracy point was 4/7 along the Y-axis and -4/6 along the X-axis.

These findings indicate that the athlete in this weight category demonstrated a relatively high level of body oscillation toward the left side. Under the influence of the workload, the oscillation shifted closer to the center of the body-weight axis, indicating that the athlete tolerated and adapted well to the imposed physical workload.

At the beginning of the study, T-v D. demonstrated oscillations within the range of 15/-19 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 12/-16. At the end of the study, oscillations within the range of 16/-18 were observed along the X-axis before exercise, while after exercise, the oscillation range changed to 13/-15.

It was determined that, compared with the body position before the workload, the athlete in this weight category reduced the lateral displacement of body weight toward the left side by 6° after exercise. Along the Y-axis, the athlete demonstrated oscillations within the range of 14/-18 before exercise, which changed to 15/-19 after exercise. A reduction of 6° in the athlete's oscillation amplitude was observed following the exercise load.

Along the Z-axis, the oscillation range was 31/37 before exercise and changed to 33/36 after the workload. Thus, the oscillation range decreased from 6 units to 3 units.

The movement range was observed within a radius of 10°, while regular movement within an accuracy radius of 20° was recorded. The duration of the accuracy point was 4/7 along the Y-axis and 5/8 along the X-axis.

These findings indicate that the athlete in this weight category demonstrated a relatively high level of body oscillation toward the left side. Under the influence of the workload, the oscillation shifted closer to the center of the body-weight axis, indicating that the athlete tolerated and adapted well to the imposed physical workload.

At the beginning of the study, M-v D. demonstrated oscillations within the range of 12/-17 along the X-axis before exercise, whereas after exercise, the oscillation range changed to 12/-16. At the end of the study, oscillations within the range of 14/-16 were observed along the X-axis before exercise, while after exercise, the oscillation range changed to 13/-16.

It was determined that, compared with the body position before the workload, the athlete in this weight category reduced the lateral displacement of body weight toward the left side by 6° after exercise. Along the Y-axis, the athlete demonstrated oscillations within the range of 14/-18 before exercise, which changed to 13/-15 after exercise. A reduction of 6° in the athlete's oscillation amplitude was observed following the exercise load.

Along the Z-axis, the oscillation range was 39/44 before exercise and changed to 37/40 after the workload. Thus, the oscillation range decreased from 5 units to 3 units.

The movement range was observed within a radius of 10° , while regular movement within an accuracy radius of 20° was recorded. The duration of the accuracy point was $4/7$ along the Y-axis and $-5/7$ along the X-axis.

These findings indicate that the athlete in this weight category demonstrated a relatively high level of body oscillation toward the left side. Under the influence of the workload, the oscillation shifted closer to the center of the body-weight axis, indicating that the athlete tolerated and adapted well to the imposed physical workload.

We believe that the process of physical preparation of handball players for high-level sport should include a methodology for developing general physical qualities through specialized exercises, as well as non-traditional exercises aimed at further improving the physical qualities and physical abilities necessary for enhancing performance indicators.

Thus, the results of our study clearly demonstrated that the research model developed, implemented, and applied for the experimental group had a positive effect on the effectiveness of the educational and training process during the physical preparation of handball players for sports training and competitive activities. The obtained results provide evidence that the methodology developed for the experimental group, aimed at developing physical qualities through specialized exercises within the educational and training process, can be considered the most appropriate and effective approach.

At the beginning of the study, for Q-v T., oscillations along the X-axis were observed within the range of $12/-18$ before exercise, while after exercise, the oscillation range changed to $13/-17$. At the end of the study, oscillations along the X-axis were observed within the range of $14/-17$ before exercise and changed to $13/-17$ after exercise. It was determined that, compared with the athlete's body position before the exercise load, the body sway toward the left side decreased by 6° after training in this weight category. For these athletes, oscillations along the Y-axis were observed within the range of $11/-17$ before exercise and changed to $14/18$ after exercise. A 6° reduction in body sway was identified following the exercise load. Along the Z-axis, the oscillation range was $61/65$ before exercise and changed to $57/60$ after the exercise load. Thus, the amplitude of oscillation decreased from an interval of 4° to 3° . The range of movement was observed within a 20° radius, while movement accuracy was maintained consistently within 30° . The duration of the accuracy point was recorded as $Y = 4/7$ and $X = -5/8$.

Conclusion. These findings indicate that the athlete in this weight category demonstrated a relatively high degree of body sway toward the left side. Under the influence of the exercise load, the shift in body sway toward the center of the gravity axis indicates that this

athlete tolerates the training loads well. During the exercises, it was determined that the athlete in this weight category was in a very good condition for maintaining body balance.

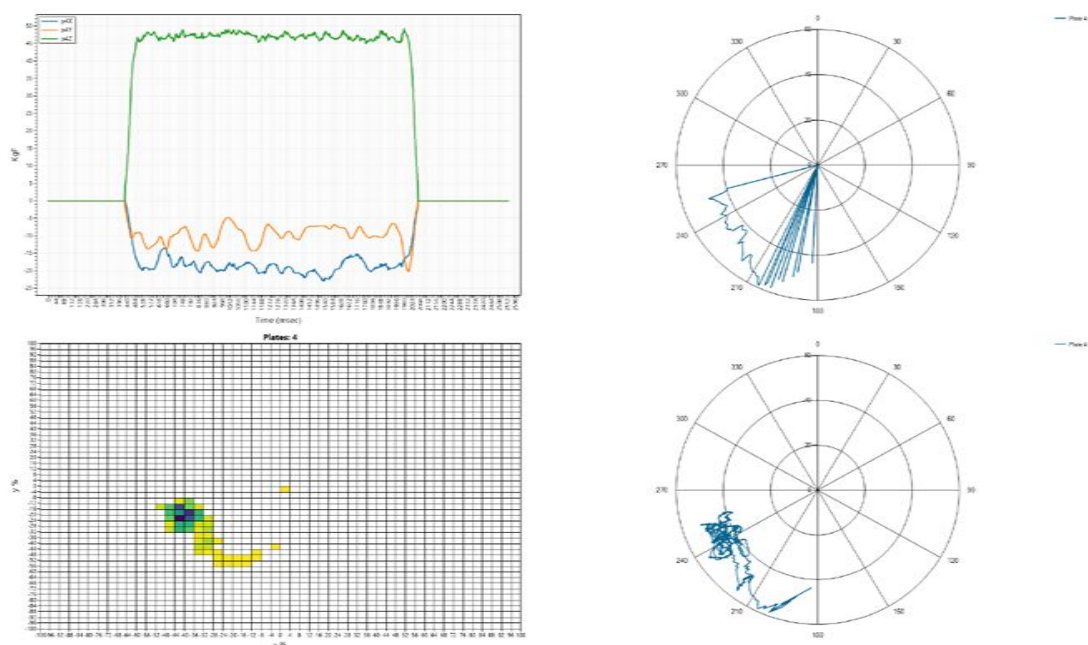


Figure 4.3. Oscillation diagram of the vestibular apparatus of the handball players in the experimental group at the end of the study.

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Table 4.2

Determination of Vestibular Apparatus Oscillation Levels in the Control Group of Handball Players at the Beginning and End of Training Using the “ForcePlatformSmart” Software

t/ r			Along the X-axis.		Along the Y-axis.		Along the Z-axis.		Movement radius.		Movement Accuracy Radius		Duration of the Accuracy Point.	
			Before exercise.	After exercise.	Before exercise.	After exercise.	Before exercise.	After exercise.	Before exercise.	After exercise.	Before exercise.	After exercise.	Y	X
1	K-v A.	T.B	13/-16	13/-17	14/-18	13/-18	32/38	34/41	10°	20°	10°	20°	3/8	4/7
		T.O	14/-16	14/-16	16/-18	15/-17	30/35	32/40	10°	20°	10°	20°	5/8	4/7
2	J-v O.	T.B	13/-17	14/-19	14/-20	15/-20	32/38	33/39	10°	20°	20°	20°	4/7	4/8
		T.O	14/-17	15/-18	14/-18	15/-19	33/37	34/39	10°	20°	10°	20°	4/8	5/8
3	F-v N.	T.B	14/-18	12/-17	12/-18	13/-18	36/42	38/43	20°	30°	20°	30°	4/8	4/7
		T.O	15/-18	13/-17	13/-18	13/-18	32/36	35/39	10°	20°	10°	10°	4/7	5/7
4		T.B	12/-19	14/-20	12/-19	15/-20	41/46	44/42	10°	20°	10°	20°	4/7	4/7

	N- v A.	T.O	13/-18	14/-17	14/-18	16/-20	36/39	38/40	20°	30°	10°	20°	5/7	5/7
5	K- v N.	T.B	12/-18	13/-19	13/-18	14/-17	47/51	43/45	20°	20°	20°	30°	4/7	4/7
		T.O	11/-16	14/-19	12/-17	13/-16	45/48	40/42	10°	20°	10°	20°	5/7	5/7
6	T- v F.	T.B	12/-19	13/-19	12/-18	15/-20	50/46	51/47	20°	20°	20°	30°	4/7	4/8
		T.O	11/-17	13/-16	11/-17	13/-18	48/45	49/51	10°	20°	10°	20°	5/7	5/8
7	X- v I	T.B	14/-18	14/-20	12/-19	14/-20	55/59	54/58	10°	10°	20°	30°	4/7	4/8
		T.O	14/-16	13/-17	14/-19	14/-19	51/46	52/55	10°	20°	10°	20°	5/7	5/8
8	G- v A.	T.B	13/-19	14/-18	12/-20	13/-21	62/68	63/68	10°	20°	20°	30°	3/7	4/8
		T.O	15/-17	15/-16	14/-18	15/-19	65/63	61/66	10°	20°	10°	20°	5/7	5/8
9	K- v N.	T.B	13/-16	13/-17	14/-18	13/-18	32/38	34/41	10°	20°	10°	20°	3/8	4/7
		T.O	14/-16	14/-16	16/-18	15/-17	30/35	32/40	10°	20°	10°	20°	5/8	4/7
10	E- v J.	T.B	13/-17	14/-19	14/-20	15/-20	32/38	33/39	10°	20°	20°	20°	4/7	4/8
		T.O	14/-17	15/-18	14/-18	15/-19	33/37	34/39	10°	20°	10°	20°	4/8	5/8

11	K	T.B	14/-18	12/-17	12/-18	13/-18	36/42	38/43	20°	30°	20°	30°	4/8	4/7
	-v O.	T.O	15/-18	13/-17	13/-18	13/-18	32/36	35/39	10°	20°	10°	10°	4/7	5/7
12	Y	T.B	12/-18	13/-19	13/-18	14/-17	47/51	43/45	20°	20°	20°	30°	4/7	4/7
	-v A.	T.O	11/-16	14/-19	12/-17	13/-16	45/48	40/42	10°	20°	10°	20°	5/7	5/7
13	H	T.B	12/-19	13/-19	12/-18	15/-20	50/46	51/47	20°	20°	20°	30°	4/7	4/8
	-v E	T.O	11/-17	13/-16	11/-17	13/-18	48/45	49/51	10°	20°	10°	20°	5/7	5/8
14	A	T.B	14/-18	14/-20	12/-19	14/-20	55/59	54/58	10°	10°	20°	30°	4/7	4/8
	-v S.	T.O	14/-16	13/-17	14/-19	14/-19	51/46	52/55	10°	20°	10°	20°	5/7	5/8
15	C	T.B	13/-19	14/-18	12/-20	13/-21	62/68	63/68	10°	20°	20°	30°	3/7	4/8
	h -v F	T.O	15/-17	15/-16	14/-18	15/-19	65/63	61/66	10°	20°	10°	20°	5/7	5/8

Note: X, Y, and Z represent the changes in vestibular apparatus oscillations measured along the respective axes before and after exercise at the beginning and end of our study.