

SENSOMOTOR COORDINATION, THEORETICAL AND PHYSICAL (MOTOR) PREPAREDNESS OF FIRST YEAR STUDENTS OF HIGHER EDUCATIONAL INSTITUTIONS OF PHYSICAL EDUCATION AND SPORT

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Annotation.. Purpose - to examine the degree of relationship and interaction performance of semantic structure of motor action (level of theoretical preparation) and indicators of sensomotor coordination (level of physical - motor - preparedness) of students. The study involved 233 students (142 boys, 91 female) aged 17 - 18 years. Were determined for sensory-motor coordination and academic performance of students, the factorial structure of the relationship indicators of theoretical and practical courses. It is established that the development of exercise training programs, sports and educational disciplines depends on the semantic structure of the motor action. It is noted that the semantic structure of the motor action is based on theoretical knowledge. Also - on perfecting the mechanisms of psychomotor and sensory-motor coordination. The parameters of the factor structure: the level of development of the vestibular apparatus - 25%; coordination abilities of - 18 %, static-dynamic stability of the body - 16%; proprioceptive sensitivity - 13%.

Keywords: student, physical education, gymnastics, sports, sensomotor, coordination, tests, theory, practice, factors.

Introduction

Problem definition. "Coordination" is nothing but overcoming of our organs' of movement excessive degree of freedom, i.e. their transformation in controlled systems. We call ... introducing of continuous corrections in movement on the base of our sense organs' signals a principle of sensor corrections" [2, pg. 54].

The simplest human motion reflexes, ensuring normal process of more complex movements are conditioned by functioning of lower sectors of central nervous system. More complex reflexes of body are regulated by midbrain's and vestibular apparatus's functioning, which, in their turn, subordinate to cerebellum's regulating influence, which coordinates movements' adequacy. Enrichment of afferent processes results in complicating of movements. Functioning of visual afferent processes ensures preciseness of movements in space. The part of space, in which movement takes place, is divided in sensor and motor fields. Motor field – is a part of space in which movement takes place. Sensor field is wider than motor one. Owing to eyesight and hearing we consider characteristics of space, in which we move. More complex movements, the so-called subjective, take place as a results of functioning of highly organized sectors of cortex, front brain sectors, functioning of right and left brains. Movements acquire sense; they become targeted. [5].

"Sensor" (from Latin) means relating to sensitivity, basing on sensitivity. Authors Cr. Hannaford [9], V. Maas [10], W. Petryński [11] think that sensorimotor coordination is development, control, regulation, correction of movements with the help of sense organs (sensor systems): visual, motional, vestibular, hearing, tactile, proprioceptive and inter-receptive systems and sense of smell.

Free movements appear as result of realization of programs, which are formed in motion functional systems of CNS (central nervous system). N.A. Bernstein [1] marked out the following stages of execution of correct movement: 1 stage – perception of situation and its appraisal, self appraisal as a being, involved in this situation; 2 stage – determination of motion task, i.e. creation of image of desired situation's progressing; 3 stage programming of task's solution, i.e. determination of target and content of the movement as well as motion means, which at disposal of individual, with the help of which he intends to solve the motion task; 4 stage – actual execution of movement: individual overcomes excessive freedom of his organs of movement, turns them in controlled systems and executes required targeted movement. It is possible only if there are instincts, corresponding to motion task, bents to mastering of coordination, which is a central condition of movement, which ensures preciseness, adequacy and smoothness of its execution. Coordination abilities are foundation of sportsman's motion functioning.

There are determined coordination abilities to execution of static and dynamic balances, to balancing in system if interacting bodies, to evaluation of proprioceptive signals in upright and reverse positions, to vestibular stability and sensitivity, to estimation of space and time on support and without support, to differentiating of motion's parameters, evaluation of movement's stability and watching an object, to manifestation and changing of movements' rhythm and temp, to responsiveness of movements by the time of motion response, to manifestation of movements' frequency, symmetry and asymmetry , to coordination of movements with music. These abilities are intrinsic to all, who practice kinds of sports with complex coordination structure of movements and condition effectiveness of movements.

The requirements, developed in kinds of sports with complex coordination structure of movements to sportsmen, were the basis of systemizing [3, 8].

In 1947 N.A. Bernstein [1] used terms "sense structure" and "motion composition" of subjective action. He offered quite new method of movement's controlling – principle of sensor corrections. N.A. Bernstein assumed that final target of a movement can be achieved only is corrections would be continuously introduced in it. He developed theory of levels of movements' building and marked out five main levels of movements' organization.

Level A – the level of kinetic regulation, the lowest and, considering its phylogeny, the most ancient. In human organism it has no independent significance, but it controls very important aspect of every movement – muscular tonus. This level receives signals from muscular proprioceptors, which inform about degree of muscular strain, and from organs of balance.

Level B – “level of synergies” is thalamus related level. On this level signals from muscular-joint receptors are processed, which inform about mutual position and motion of parts of body. This level is parted from outside space and is sufficiently aware of what happens in space of body. It takes important role in organization of higher levels and takes upon itself inner coordination of complex movements (ensemble of movements).

Level C – the level of “space field”. It receives signals from eyesight, hearing, tactile senses, i.e. all information about outside space that is why on this level movements, adjusted to space properties of objects- their shape, position, length, weight and etc, are built. This level includes all travelling movements: walking, climbing, run, jumps, acrobatic exercises, and exercises on gymnastic apparatuses; movements of pianist’s hands, hands of typist, ballistic movements in tennis; pointing at target and other. Lower sub-level of space field C1 is responsible for evaluation of movements’ directions and force’s dozing in movement. The upper sub-level C2 ensures maximal targeted preciseness.

Level D – level of “subjective actions”, is sinciput, pre-motor, cortex level, which is responsible for organization of actions with objects. Practically completely belongs to an individual. Characteristic peculiarity of this level’s movements is that they are coordinated with logic of an object. They have no fixed motion content; they have only final subjective result.

Level E – is a level of “intellectual movements”: speech and writing movements, movements of symbolic or coded speech – deaf-and-dumb gestures, dot-and-dash code and other. This level’s movements are determined by abstractive, verbal sense instead of subjective one.

Organization of complex movements involves, as a rule, simultaneously several levels – the level, on which this movement is built (leading level) and all lower levels.

D.D. Donskoy writes [4], – that “sense projecting” results in sportsman’s own inner “vision” of his action. There happens selection and processing of scientific data about actions from descriptive model into model training, model of project. Such model is a mean of projecting for sportsmen.

Sense structure of movement is enriched with accumulation of knowledge and motion skills by means of realization of theoretical, physical (motional) and other kinds of sportsman’s fitness’s elements (V.N. Platonov, 2004). Theoretical education of sportsmen is carried out on all stages of many years sport perfection. On every of them there are used specific means and methods of training. The program of theoretical training shall be constructive, reflect main principles of physical education system, prospects of sports for all and elite sports, of sportsman’s education [7]. In the process of theoretical training there is given a theoretical ground and analysis of technique and tactic in the chosen kind of sports; trainee is familiarized with methodic of sport technique’s training and ways of its improvement; system of sports training is explained completely and its general principles.

Sportsman shall know the tasks, which he faces; be aware of means and methods of strength’s, quickness’s, endurance, flexibility’s and dexterity’s training, be able to plan trainings, to know how to fulfill periodization of sport training, its contents; to plan many years training; to know the role of sport competitions and their variants; to know peculiarities of direct pre-competitions training and participation in them; to keep record of trainings and control them; to analyze sport and functional indicators; to keep diary of trainings [www.superinf.ru].

In higher educational establishments of physical education and sports the following subjects play important role in theoretical training: theory and methodic of physical education, theory of sports, anatomy, bio-mechanics, physiology, pedagogic, psychology, bio-chemistry and other disciplines. Comprehensive motion training of students, which is ensured by methodic and practical classes on track and fields, swimming, outdoor games, gymnastics and other sport-pedagogic disciplines, is extremely important. Theoretical knowledge and motion resources ensure students’ successful professional training at higher educational establishments of physical education and sports.

The work has been fulfilled in compliance with combined plan of scientific & research works in the field of physical culture and sports of Ukraine for 2011-2015. Code: 2.15. Topic: “Monitoring of static-dynamic stability of sportsman’s body and systems of bodies in kinds of sports with complex coordination structure of movements”, state registration No. 0111U001726. Index УДК: 796.012.2.

Purpose, tasks of the work, material and methods

The purpose of the work is to study indicators, which characterized the levels of sensorimotor coordination, of theoretical and physical (motion) fitness of first year students of higher educational establishment; to estimate factorial structure of informative parameters, influencing on effectiveness of practical classes in gymnastics.

Tasks: 1. Studying of sensorimotor coordination parameters of first year students of physical education and sports’ higher educational establishments at practical classes on gymnastics.

2. Analysis of first year students’ progress in theoretical and practical disciplines.

3. Analysis of factorial structure of interconnections and inter-influence of theoretical and practical disciplines’ indicators on effectiveness of first year students’ mastering of academic program’s materials at higher educational establishment of physical culture and sports.

Material of the research: 233 students of NUPESU (142 boys and 91 girls) of 17-18 years old took part in the research. They specialize in the following kinds of sports: games, cyclic, sports with complex coordination, martial arts.

From them there were: masters of sports and candidate masters of sports – 63 persons, with 1st – 2nd grade – 114 persons, without sport grade – 56 persons.

Testing was carried out in three stages. At first stage (from 10th to 26th of September) – during practical classes with first year students (main gymnastics) we measured initial level of sensorimotor coordination of students of all groups.

At second stage, which continued four months, (September – December 2011) students fulfilled practical material from academic programs in gymnastics, track and fields, outdoor games in compliance with schedule of university. Most part of program was oriented on studying of theory and methodic of teaching of drill, applied exercises and exercises for general physical development. In programs there were no materials on improvement sensorimotor coordination of students. At the end of the second stage we carried out repeated pedagogic testing by all indicators, which show coordination level of the tested.

At third stage, which lasted five months, (January – May 2012) students fulfilled applied and general exercises in compliance with academic program, - vaults, acrobatic exercises, exercises in hanging and supporting positions, exercises for development of sensorimotor coordination and physical fitness (strength, flexibility, jumping ability).

At the end of the third stage we carried out final pedagogic testing by all indicators, showing coordination abilities of the tested in order to determine influence of practical trainings on coordination abilities' progressing. Alongside with it, we carried out analysis of students' progress in theoretical disciplines (history of Ukraine, anatomy, Ukrainian language, sport games, track and fields) and in practical discipline – gymnastics.

The methods of the research. They are: analysis of scientific-methodic literature, analysis of mark sheets on theoretical and practical disciplines, comparison – analogy, tests' method, mathematical statistics, factor analysis.

The tests' method. For achievement of our research's purpose we selected and systemized nine tests, indicators of which characterize coordination abilities of the tested [6]. The basis of selection and systemizing of tests for measuring and evaluation of coordination abilities (criterion of evaluation) – was specific requirements, existing in sports, sensorimotor coordination as an indicator of integral functioning of organism's systems [9, 10].

Determination of static body balance (Biriuk's test, No.1). Fulfillment of exercise: vertical posture on high tiptoes, feet are in contact with each other, arms risen upward, eyes are closed. This position shall be kept for a certain period of time (without losing contact with floor).

Determination of vestibular stability by dynamic balance indicators (Barany's test, No.2). Initial position – sitting in Barany's armchair, head bent on breast (by 30°), eyes are closed. After 10 rotations of armchair, the tested shall stand up and walk 5 meters by straight line, looking directly forward, with arms, dropped down. Mean arithmetic of six deviations to the right and to the left from the straight line was calculated in cm.

Test for static-dynamic body stability (test No.3 – forward somersaults). Initial position: squatting position with hands, resting on floor; execute five somersaults, resting on floor for 5 seconds with following execution of ten jumps on the spot to maximal height in the center of scaled circle. Jump shall be fulfilled with pressed to each other feet, hand on waist, looking forward. Mean arithmetic of three biggest deviations from center of circle was calculated.

Determination of coordination abilities' level (test No.4 for coordination; test No. 5 – for coordination in complex conditions). Initial position: general posture. 1. Left hand on waist. 2. Right hand on waist. 3. Left hand moves to shoulder. 4. Right hand moves to shoulder. 5. Left hand goes upward. 6. Right hand moves upward. 7-8. Two claps above head. 1-6. All movements to be fulfilled in reverse order. 7-8. Two claps on thighs. The exercise was evaluated by experts by 10 points scale. Every wrong movement reduced mark by 0.5 point.

Test for steady landing after jump in depth (test No.6, landing test). Exercise: Jump down from height of 3 meters in upright position, on foam rubber mats in center of circle. Quality of landing, character of mistakes were evaluated by 10 points scale: little mistake – minus 0.2 points, middle mistake – minus 0.5 points, falling down – 1 points. Mark: mean value of three attempts.

Next was testing of space orientation in conditions of relatively short-term weightlessness and proprioceptive sensitivity in changed conditions (tests 7 and 8, for space orientation). Execution of exercise: press hand dynamometer with any convenient hand with force of 200 N (for girls - 100 N). There were three attempts with visual control and three attempts without visual control, in jump from 3 meters height, in upright position of body and hanging on bent legs (girls on lower bar and boys of upper bar of gymnastic bars of different level). This exercise influences mainly on otolithic analyzer. Mark: mean value of three attempts shall not exceed 10 N.

Testing of dynamic balance by passing of polygon's perimeter (test 9, for dynamic balance). Execution of exercise: step of one of polygon's sides, put hands on waist and start movement by every polygon's side. Every step is of length, equal to one polygon's facet, eyes shall be directed forward. Movement shall be carried out up to first losing of balance (staggering of body, movements of arms, touching the rest by leg (foot)). ± The quantity of walked sides shall be considered.

Results of the research

The obtained initial balance indicators (test 1, Biriuk's test) witness that body stability of the tested is not sufficient. Mean group time of posture's keeping is $7.29 - 7.41 \pm 4.95 - 5.68$ sec. ($X \pm S$).

Results of vestibular balance testing by indicators of dynamic balance (test 2 – Barany's test) witness that most of the tested manifested disordered coordination of vertical body position in walking after rotations. When passing 5 meters segment, after rotations in Barany's armchair, the tested deflected from axial line to the right and to the left by

15-30 cm. Some sportsmen lose balance and fell down after two-three steps. Mean group value of body deviation from central line was both for girls and boys $20.83 - 18.70 \pm 8.62 - 8.17$ cm.

Vestibular load – five forward somersaults during 5 seconds – significantly worsened dynamic stability of both girls' and boys' bodies. It resulted in the fact that most of the tested (70 %) could not execute ten jumps in the center of scaled circle, crossed circumference, fell down after fulfilling of 5 somersaults. The worst indicators were registered among girls 28.65 ± 10.42 . Boys showed a little bit better results 27.81 ± 12.07 cm.

The level of coordination abilities of the tested, who fulfilled test for coordination (test 4) is characterized as middle and above middle that is in compliance with researches of Polish specialists [8]. Mean group marks for test 4 both of girls and boys are $9.39 - 9.59 \pm 0.6$ points. It witnesses that boy-students and girl-students are on the same level of coordination abilities.

With making coordination test more complex (test 5, jumping) most of the tested showed significant worsening of results. For example boys' mark for this test reduced to 8.98 ± 1.26 points.

Test 6, for landing, was fulfilled for determination of steady landing's quality after jump from 3 meters' height in upright position. In this test the tested are in conditions of short-term weightlessness, which, to certain extent, disorders coordination of nervous-muscular system. Analysis of the obtained results witnesses that most of the tested (86,5 %) fulfilled test with mistakes of steady landing. For example 20 % of the tested made little mistakes, 45 % – made rather significant mistakes and 21,5 % - made rough mistakes.

Tests 7,8 were used for determination of space orientation and proprioceptive sensitivity. Results show that the tested in most cases rendered excessive muscular efforts, which were expressed in overestimation of the required indicators. For example, mean group indicators of boys were $220 - 230 \pm 50.54$ N, and of girls – they were $120 - 140 \pm 60.17$ N, from initial indicators.

Evaluation of dynamic body balance with passing the polygon's facets in conditions of restricted support gave the following results: 50 % of the tested executed this task successfully, maintaining balance up to certain quantity of rounds (40). The other part of the tested (40 %) fulfilled 25-29 passing of facets and lost balance. Less part (10 %) lost balance after 10-15 passing of facets.

The second stage was characterized by fulfillment of practical material from academic programs on theoretical and practical disciplines:

The carried out intermediate testing showed that there were no confident changes in indicators, which characterized sensorimotor coordination. There was a trend to improvement of indicators.

After finishing of general gymnastics course, by results of tests 1-9 we registered confident improvement of indicators. For example, in test 1 the tested became to confidently better keep vertical position of body, standing on high tiptoes: from 7.29 to 15.02 ± 5.34 sec. ($p < 0.05$). The same confident improvement was manifested by girls: $7.41 - 15.35 \pm 9.97$ sec. ($p < 0.05$).

Vestibular stability with passing of 5 meters' segment (test 2) improved by 4-5 cm ($20.83 - 15.10 \pm 7.69 - 8.15$ cm ($p < 0.05$)).

The quantity of tested, who fulfilled high jumps at the spot inside 10 centimeters' scaled circle (test 3), increased up to 29%. There were no jumping out of the circle and falling down after rotational load. Mean group indicators of boys improved from 27.81 to 19.08 ± 8.71 cm. The girls' indicators improved from 28.65 to 15.72 ± 4.55 cm, comparing with initial data.

Indicators of coordination abilities' level (tests 4 and 5) increased, at the end of experiment, from 8.98 to 9.88 ± 0.22 points. It witnesses that execution of academic program on gymnastics facilitated improvement of coordination abilities of the tested and, as a result, exercises for coordination were fulfilled on higher sport-technical level.

After 1st year of studying indicators of test 6 increased by 0.3 – 0.5 points and were $9.30 - 9.61 \pm 0.4$ of girls and, accordingly, from 9.4 to 9.83 points of boys at the account of reducing of rough and middle mistakes by 15 %.

Realization of academic programs resulted at the end of researches in significant improvement of indicators of space orientation and proprioceptive sensitivity (tests 7 and 8) and reached to normative efforts, in which error must not exceed $10.42 - 10.94$ N for girls and $93 - 10.15$ N for boys ($p < 0.05$).

Indicators of dynamic balance of body in passing of polygon's sides in conditions of restricted support improved by 10 %, in comparison with initial data, obtained before experiment ($p < 0.05$).

Pedagogic analysis of 1st year students' marks in theoretical disciplines (history of Ukraine, anatomy, Ukrainian language, methodic of teaching of outdoor games and track and fields) witnesses that students' progress is on rather sufficient level. For example by the results of analysis of 1st year students' progress, the quantity of good and excellent marks at the end of academic year were: 39.4 % –good marks, 19.2 % “excellent” and 41.4 % –satisfactory marks (see fig.1)

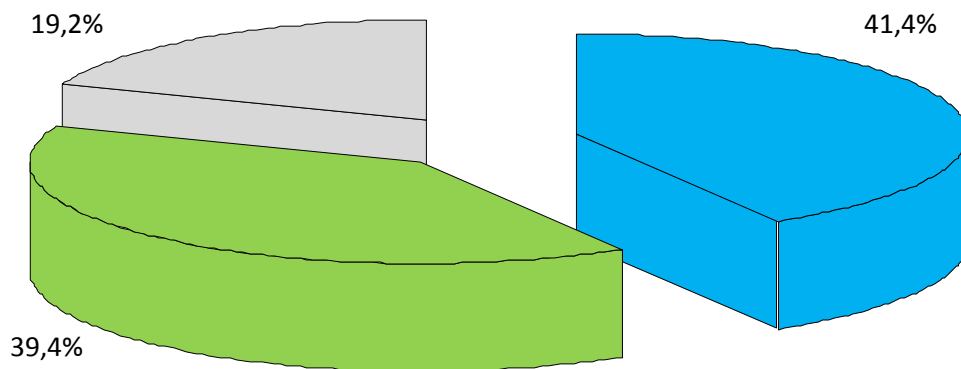


Fig.1. 1st year students' progress in theoretical disciplines

- Satisfactory mark
- Good marks
- Excellent marks

Analyzing progress in every studied theoretical subject separately, we can note that quantity of satisfactory marks belong mainly to history of Ukraine (61.3%) and anatomy (53.6%). Concerning such subjects as Ukrainian language, outdoor games and track and fields - there good and excellent marks prevail (see fig. 2)

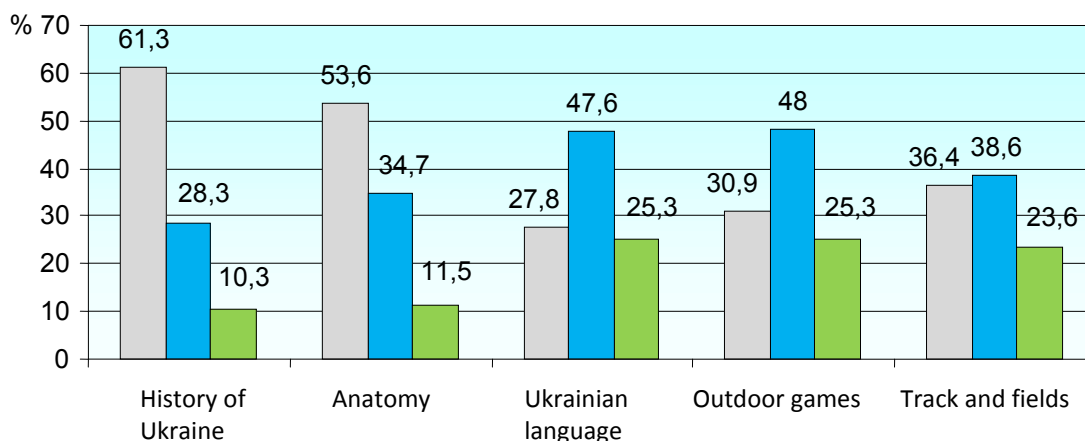


Fig.2. General diagram of 1st year students' progress on theoretical disciplines

- Satisfactory
- Good
- Excellent

Factor analysis permitted for us to fulfill complex analysis of the obtained indicators with the help of software Excel and STATISTICA 6.0.

The initial data for factor analysis were preliminary and final indicators, characterizing coordination abilities of 1st year students.

The first, the most significant factor with total dispersion of sample 25.0% included indicators, characterizing vestibular analyzer's level. The second factor with total dispersion of sample 18.0% included indicators, characterizing coordination abilities. The third factor with total sample dispersion of 16.0% characterizes static and dynamic balance. The fourth factor equals to 13.0% and characterizes proprioceptive sensitivity. The fifth factor – 10.0% - characterizes the level of theoretical knowledge. The sixth factors included indicators with total contribution in total dispersion of sample of 9.0%, which reflect anthropometrical indicators (height and weight). The seventh factor – is sportsmanship and equals to 9.0%.

The percentage of influence of different sensorimotor coordination's indicators, theoretical base and physical fitness is given in diagrams, see fig. 3 and 4. The results of our research are in compliance with data, presented in article by W. Bołoban et al. [8].

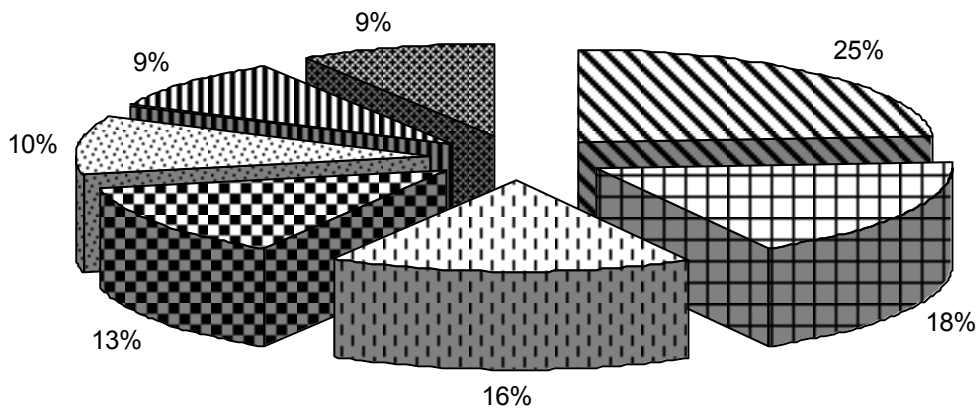


Fig. 3 Correlation of factors, which determine level of sensorimotor coordination, theoretical base and physical fitness of 1st year girl-students after finishing of 1st year of study

- ▣ Vestibular analyzer
- ▤ Coordination abilities
- ▥ Static and dynamic balance
- ▦ Proprioceptive sensitiveness
- ▧ Level of theoretical knowledge
- ▨ Anthropometrical data
- ▩ Sportsmanship

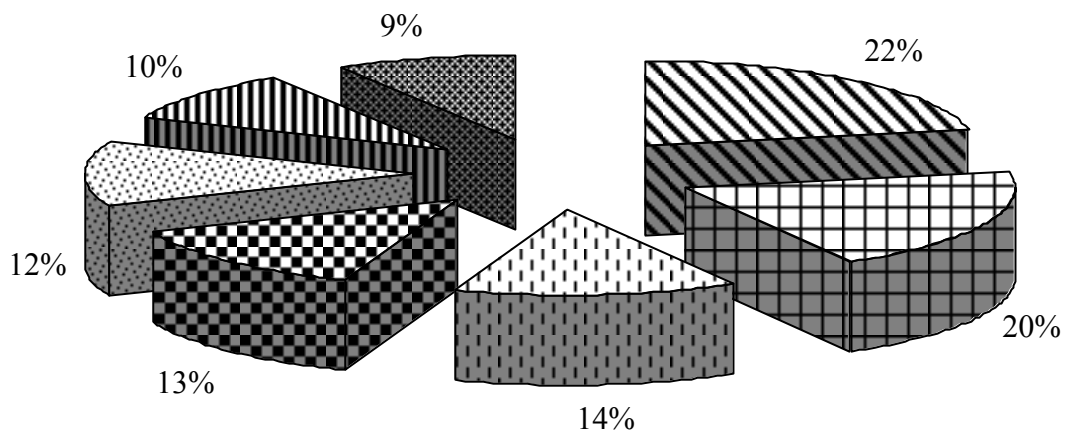


Fig.4 Correlation of factors, which determine level of sensorimotor coordination, theoretical base and physical fitness of 1st year boy-students after finishing of 1st year of study

- ▣ Vestibular analyzer
- ▤ Coordination abilities
- ▥ Static and dynamic balance
- ▦ Proprioceptive sensitiveness
- ▧ Level of theoretical knowledge
- ▨ Anthropometrical data
- ▩ Sportsmanship

Thus, positive dynamic of exercises of academic sport-pedagogic disciplines depends on sense structure of motion functioning, included in training process, which is built on the base of theoretical knowledge as well as continuously improving psycho-motor mechanisms and sensorimotor coordination as the base of physical (motion) fitness of students.

Conclusions:

1. It has been proved that realization of academic sport-pedagogic disciplines at practical classes of 1st year students is effective and form knowledge, motion skills and skills in mastering of physical and sport exercises.
2. Positive dynamic of exercises of academic sport-pedagogic disciplines depends on sense structure of motion functioning, included in training process, which is built on the base of theoretical knowledge as well as continuously improving psycho-motor mechanisms and sensorimotor coordination as the base of physical (motion) fitness of students.
3. In the content of factorial structure there have been marked out parameters, which have the following shares in achievement the purpose of the present work: factor, characterizing vestibular analyzer's level – has 25% share; factor, determining coordination abilities equals to 18.0%; factor reflecting static-dynamic balance – is 16% and factor, characterizing proprioceptive sensitivity contributes 13% to total dispersion.
- 4 Central nervous system of 1st year students is ready to receive a cycle of theoretical knowledge and skills to form firm motion abilities at practical classes with the help of realization of up-to-date didactic teaching technologies.

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