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Changes Manifest Motor Abilities under the Influence Applications of Isometric and Isotonics of Operators

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Abstract The basic aim of this research is to changes and difference in changes of manifested motor abilities under influence of application of isometric and isotonic operators. On the samples of 216 male examinees 15 years of age, which were sorted into groups A, B and C kinesiologic contents operators were applied. In group A, applied were isometric operators, in group B isotonic operators and in group C which were control group, applied were poly-structural operators of complex motion. In course of three months research, examinee shad weekly three trainings and other days remained for rest. Duration of one training were 60 min. Operating context in experimental group were identical in biomechanics base structure. Form of work which were used were cells system and circle working method. Volume end distribution of applied operators were individually programmed based on initial state, taking 70% of maximal duration valuation or repeating number in each operator. Progressive discontinued duration or operators performance numbers were programmed from initial state through transitive until final state. Examinees motor abilities were determined by use of measuring instruments. Measuring were effected at the beginning, middle and end of examination and were than analysed. Groups of first, second and third measure were analysed through variance analyse and according to importance of group differences, tests were made of differences of arithmetic centres. Motor abilities initial state had very important changes, depending on type of applied operators. Applied isometric operators, in comparison to applied isotonic operators under identical conditions were more important in development of motor abilities, static strength, speed, flexibility and coordination.

Keywords Motor abilities, Transformation process, Isometric operators, Isotonic operators, Basic statistics, Alterations

1. Introduction

Human body is moved by contractions of muscle fibres that transfer force via tendon ends on bone levers. The activation of muscles causes the release of mechanical energy used to produce force. The components of mechanical energy are force and displacement. Force is necessary to keep the existing position or to resist a stronger force, i.e. gravitation. Isotonic contraction occurs when muscle force is greater than the exterior force. When they are equal isometric contraction occurs, and when the muscle force is smaller than the exterior force plyometric contraction occurs. Studies results (Bass, R.I., (1939), Hettinger, T., (1972, 1975), Dodig, M., 1979, 1983, 1998, 2002, 2007), Jansen, R.K., (1976) show the advantages of isometric exercises in respect to isotonic. On the other side Berger, R.A., (1962, 1964), Rasch, J.P., & Burke, R.K., (1968) imply that isotonic exercises are in advantage. But researches that were done by Asmussen, E., Hansen, O., Lammert, O., (1954), Dennison, J.D., Howell, M.L., & Morford, W.R., (1961) show that there are no considerable differences in the increase of strength when applying isometric and isotonic trainings.

It is important to emphasize the exploration of the relationship among Isometric, Isotonic, and Isokinetic Concentric and Eccentric Components. Anderson, M.A., Gieck, J.H., Perrin, D.H., Weltman, A., Rutt, R., & Denegar, C. (1991). In addition, effects of maximal isometric and isokinetic resistance training on strength and functional mobility in older adults, confirmed the significant impact of process. Symons, T.B., Vandervoort, A.A., Rice, C.L., Overend, T.J. & Marsh. G.D, (2005). There are different research results probably due to different means, methods, intensities and duration of training. Researches so far have not examined the influence of isometric and isotonic trainings on motor abilities in whole, and especially not when isometric and isotonic operators varied in duration. Researches of isometric (Brunner, J.A., (1967), Hermansen, L., (1981), and isotonic trainings (Hellebrandt, F.A., Houtz, S.J., (1956) with varied duration and intensity of exercises so far were mostly achieved in laboratory conditions. The aim of this research is to establish the level of influence and the difference in influence of isometric and isotonic operators on development of manifest motor abilities, while the main aim is to comprehend the changes of manifest motor abilities

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under the influence of application of isometric and isotonic operators, as well as their importance. Isometric and isotonic operators with equal kinetic structure were applied. The type of stimulus of corresponding intensity and duration was varied. In this sense an experimental drawing was done which defined optimal conditions necessary to vary only the type of muscle work.

2. Methods

2.1. Participants

The population from which the sample for this research was defined consisted of 216 male examiners, of 15 years of age. The choice of sample was random since the operations of forming and sorting into groups A, B and C were done independently of this type of research. Groups were taken as already administratively formed classes of secondary schools, and therefore the sample can be considered random. On the day when measurement was done, due to the nature of group and research, examinees had to fulfill, except general conditions, the condition not to interrupt the continuity of exercise more than three times and not to do other types of exercise during this experiment. The effective of the sample was planned in order to enable that many degrees of freedom so that P.01 = 1.98 and P.05 = 1.98 differences could be statistically relevant 72 examinees were necessary in each group. In such a way the total effective of the sample was 216 examinees. 240 examinees were included, 80 in each group. Some were eliminated for not having fulfilled the research conditions. In accordance with intentional measuring subject, a battery of 24 motor tests was constructed, which brought information in many tests so far. Performed validation tests they gave satisfactory reliability test Dodig, M., (2007). Full name, cipher and ordinal number used in text and tables are mentioned in each test. For each motor ability three tests were applied:

(1) EXPLOSIVE STRENGTH; 1.long jump without running (MDM), 2. throwing medicine ball while lying down (MBMP), 3. hop, skip and jump without running (MTRS)

(2) REPETITIVE STRENGTH; 1. jump upon a small bench with one third of weight (MNK), 2. trunk erection – on Swedish crate (MITS), 3. mixed crossbar body lifting (MMZ)

(3) STATIC STRENGTH; 1.maintenance in crossbar body lifting (MIZG), 2. maintenance in half knee-bend with one half of body weight (MIZP), 3. maintenance on parallel bars (MIZS)

(4) PRECISION; 1. darts (MPIK), 2. aiming at vertical target with leg (MGAN), 3. aiming at horizontal target with arm (MGAR)

(5) FLEXIBILITY; 1. inversion with stick (MISP), 2. sitting inversion (MPS), 3. side string (MSPA)

(6) SPEED; 1. hand tapping (MTAR), 2. leg tapping on the wall (MTAN), 3. trunk lifting in 30 seconds (MD30)

(7) COORDINATION; dexterity with stick (MKOP), 2. slalom with three balls (MS3M), 3. dexterity in air (MOZ)

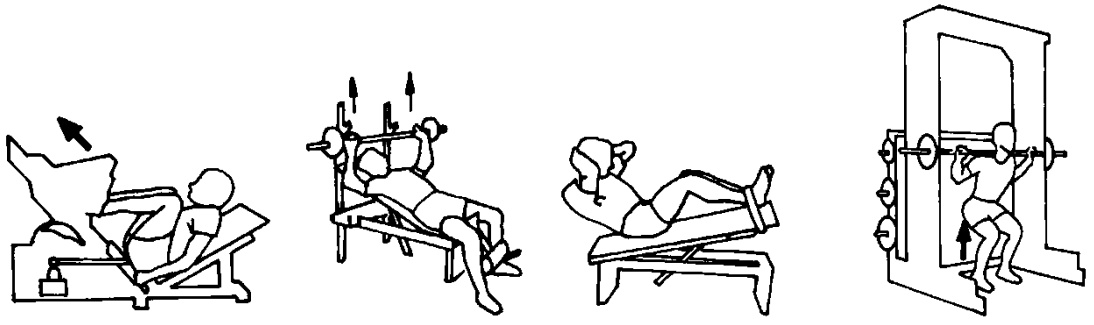
(8) BALANCE; 1. standing on one foot with closed eyes (MSZO), 2.cross standing on a low bench (MPSG), 3. standing on turned bench for balance (MSOK)

2.2. Procedure

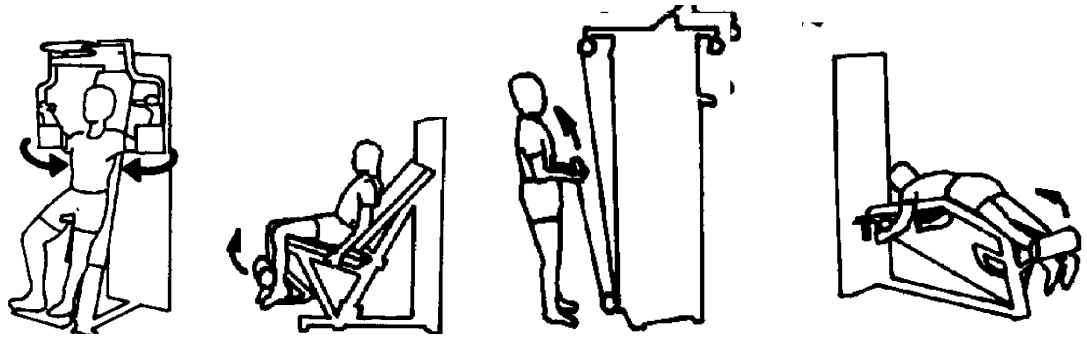
The research was done in two phases; preparation and realization phase.

Preparation phase – research planning was done as well as the battery of measuring instruments chosen. The place and time of research was fixed. The operator content in experimental groups was defined; it was based on kinetic structures that fulfill the requirements of this research, and are directed towards changing the motor abilities. The operator content consisted of kinetic structures that are realized due to resistance of own body and in form of weightlifting exercises. The choice of operator content was defined topologically according to particular muscle regions – arms and shoulder region, trunk and legs (Picture 1.)

In experimental procedure the model was based on application of equal kinetic structures, with only the type of muscle work varied. With isotonic operators movements were done with complete amplitude, while with isometric operators the position was taken under angle, so that the greatest force pushed on muscles. In such a way the influence of different kinetic structures was eliminated. The experiment was planned to last three months, and the examinees had three trainings weekly per 60 minutes. Personnel trained in measuring technique with gauges did the measurements and tests.



1. Pushing 30 kg with legs
2. Pushing 20 kg with arms
3. Inversion of body
4. Lifting 30 kg from kneet bend



5. Forward pushing of 20 kg with arms

6. Forward pushing of 30 kg with legs

7. Pulling 20 kg with arms

8. Backward pushing of 20 kg with legs

Picture 1. Survey of kinetic structures that were applied as isometric and isotonic operators in experimental procedure

Realization phase – testing was done at the beginning, in the middle and at the end of experiment. The total number of tests was divided into two, while the measuring was done in two days. The order of tests was organized in such a way that there was minimum influence of the preceding test on the results of the next one. Prior to application, examinees were divided into three groups of 80 examinees each in accordance with the type of operator. Before the beginning of research the examinees were acquainted with the complete programme and plan, as well as the way of following up and running personal administration. Examinees' maximal abilities in each operator were measured, while in experimental groups according to operator type. The volume and operator distribution in experimental groups were individually programmed, on basis of initial state of examinee, and depending on content, pattern and model of operator. The burden volume is defined by force and speed components, which were constant during the whole experiment, and only the duration component varied. The constancy of force and speed components enabled the parameter of burden duration to be representative, on basis of which the burden volume was programmed.

On basis of these results the intensity and volume of applied operators was defined for each examinee. The intensity and volume of applied operators at the beginning of training amounted to 70% of maximum of each operator. The operators were progressively–discontinuously applied so that in the middle of training they amounted to 90%, and at the end to 120% of the starting maximum. In the course of three months of training, examinees had three trainings weekly and rested for the rest of the week. The duration of training was 60 minutes. Circle cells system working method was used, as well as group working method. The programme was adjusted according to individually gauged burden, so that all examinees could overcome it. Operator application was initiated in such a direction that volume and burden distribution follow the general curve of burden, which is progressively–discontinuous. Therefore, operator application in process segments contains discontinuous volume, and follows the inclination degree of volume according to general progressive curve.

The research was organized by dividing examinees into three groups. For each different treatment was applied:

(A) Experimental procedure (GROUP - A) – examinees train under special treatment of isometric operators, which are constructed according to the contents, patterns, methods and operator volume.

(B) Experimental procedure (GROUP - B) – examinees train under special treatment of isotonic operators, which are constructed according to the contents, patterns, methods and operator volume.

(C) Control procedure (GROUP - C) – examinees train under special treatment with no intervention of experimenter and in accordance with sport games demands (basketball and football).

2.3. Data Processing Methods

Transformation, condensation and statistic data processing methods were chosen in accordance with the demands of data analysis. The central and dispersion parameters of particular variables were calculated; for the first, second and third measurement for each group. The differences between groups in each particular variable for estimation of motor abilities in initial, transitive and final state were tested in accordance with the univariant analysis of variance. The F-test and probability Q was calculated, so there was no group difference. Considerable group differences in some variables were tested with the T-test for two independent groups with significance level P.01 = 2.62, which was marked ++, and significance level P.05 = 1.98, marked with +.

3. Results

The results are presented as requested by easy reference and logic to prove the set hypothesis. The presentation of results and discussion was divided into the initial, transitive

and final examinee's state, as well as into transformation states depending on operator application.

Analysis of the initial state - the differences between groups in applied variables were analysed with variance analysis. In Table 1, the following values are stated: arithmetic mean of each group (XA, XB, XC) for each variable; standard deviation (SA, SB, SC); F- test and probability Q that between arithmetic means (calculated with 2 and 213 degrees of freedom) there are no differences.

During the first measurement or initial state of examinee, the differences of arithmetic means in particular variables are not great, which might have been expected because examinees belong to the same population. The probability that arithmetic means of groups are equal in particular measuring instruments is very high. This does not apply only to three variables, these being: MITS, MGAR and MD30, where differences are statistically confirmed. Variability measured with standard deviation is satisfactory, with this that it is slightly appointed at some variables, probably due to some low or high results, which affect the extent of result range. Analysing disperse parameters, a higher homogeneity of variable results can be noticed in group C, less in group A, and the least in group B. The significance of differences of arithmetic means for each particular variable was tested by the F– test. By inspection of Table 1 it can be noted that values F and Q permit a conclusion that between arithmetic means of particular examinee's groups there is no considerable statistical difference on the level from P=. 01 and P =. 05 in all treated variables. This data indicates that the hypothesis to be accepted is the following: in the first measurement between groups there is no considerable statistical difference, which means that groups in their initial state behave in a similar way in respect to their motor abilities. This similarity and alignment of groups enables group differences to be more clearly visible in the process of operator application.

Analysis of the transitional state - in the second measurement or in the transitional state of examinees, certain changes in motor abilities might have been expected under the influence of operator application. Movement of results of arithmetic means shows that certain changes took place in examinees' motor abilities (Table 2).

Table 1. Central Parametres, Dispersive Parametres and F Scores of Groups in the First Measurement

VARIABLES	PARAMETRES							
	XA	XB	XC	SA	SB	SC	F1	Q1
1. MDM	197.82	197.07	197.00	19.29	22.05	23.61	.03	.97
2. MBMP	363.54	361.06	363.00	64.15	63.42	53.80	.03	.97
3. MTRS	576.28	573.58	579.00	55.05	73.83	50.53	.14	.86
4. MNK	14.46	16.49	15.28	8.48	10.96	7.94	.88	.42
5. MITS	28.72	27.37	26.11	11.72	11.93	8.97	1.02	.36
6. MMZ	24.61	23.31	23.60	7.31	9.04	7.11	.55	.58
7. MIZG	59.58	59.29	58.54	23.23	23.52	20.24	.04	.96
8. MIZP	38.50	37.10	37.26	24.77	26.78	24.36	.07	.94
9. MIZS	22.67	21.46	22.10	13.49	13.48	15.32	.15	.86
10. MPIK	18.51	17.99	18.67	6.70	6.44	5.98	.23	.80
11. MGAN	11.17	10.71	11.18	5.24	5.19	4.05	.22	.80
12. MGAR	26.08	27.44	26.78	5.55	5.22	5.51	1.13	.32
13. MISP	109.65	110.97	108.76	17.71	19.87	20.08	.24	.77
14. MPS	19.08	19.10	19.36	7.77	7.28	7.38	.03	.97
15. MSPA	159.22	158.14	158.07	12.74	11.78	10.59	.22	.80
16. MTAR	44.21	43.37	43.56	6.56	5.99	4.90	.40	.67
17. MTAN	21.17	20.94	20.86	2.70	2.73	2.90	.23	.80
18. MD30	19.50	20.11	19.14	3.85	3.81	3.97	1.16	.31
19. MKII	124.65	123.47	124.67	31.52	24.51	31.73	.04	.96
20. MS3M	592.49	598.56	604.81	111.91	116.77	127.06	.19	.82
21. MOZ	143.56	144.35	142.86	21.82	19.66	17.73	.10	.90
22. MSZO	46.03	46.99	47.53	28.13	37.57	40.25	.03	.97
23. MPSG	146.07	143.54	147.74	86.25	87.87	78.51	.05	.95
24. MSOK	38.51	39.03	42.25	20.61	29.43	34.28	.36	.70

Legend:
MDM - long jump without running; MBMP - throwing medicine ball while lying down; MTRS - hop, skip and jump without running; MNK - jump upon a small bench with one third of weight; MITS - trunk erection – on Swedish crate; MMZ mixed crossbar body lifting; MIZG - maintenance in crossbar body lifting; MIZP - maintenance in half knee-bend with one half of body weight; MIZS - maintenance on parallel bars; MPIK – darts; MGAN - aiming at vertical target with leg; MGAR - aiming at horizontal target with arm; MISP - inversion with stick; MPS - sitting inversion; MSPA - side string; MTAR - hand tapping; MTAN - leg tapping on the wall; MD30 - trunk lifting in 30 seconds; MKOP - dexterity with stick; MS3M - slalom with three balls; MOZ - dexterity in air; MSZO - standing on one foot with closed eyes; MSG - cross standing on a low bench; MSOK - standing on turned bench for balance
XA - arithmetic mean group A; SA - standard deviation group A; XB - arithmetic mean group B; SB - standard deviation group B; XC - arithmetic mean group C; SC - standard deviation group C
F1 - F - value
Q1 – probability F - value

Table 2. Central Parametres, Dispersive Parametres and F Scores of Groups in the Second Measurement

VARIABLES	PARAMETRES							
	XA	XB	XC	SA	SB	SC	F1	Q1
1. MDM	205.81	199.87	197.57	20.46	21.63	18.54	**3.17**	**.04**
2. MBMP	373.24	373.92	373.53	68.05	44.77	58.12	.02	.99
3. MTRS	591.65	586.06	604.79	57.54	74.17	44.22	11.86	.16
4. MNK	28.18	27.18	18.40	14.19	15.12	8.22	**12.56**	**.00**
5. MITS	40.24	37.11	24.56	10.55	14.74	9.52	**35.47**	**.00**
6. MMZ	26.62	25.76	17.67	7.42	8.59	5.66	**32.79**	**.00**
7. MIZG	60.37	57.00	39.42	22.28	22.34	18.83	**20.25**	**.00**
8. MIZP	92.07	74.54	41.36	36.44	37.06	27.04	**41.73**	**.00**
9. MIZS	25.56	22.06	16.03	11.94	11.21	10.58	**13.20**	**.00**
10. MPIK	19.14	18.85	19.29	5.73	6.39	6.35	.10	.90
11. MGAN	12.85	13.18	11.03	5.52	5.01	4.87	**3.66**	**.03**
12. MGAR	27.45	27.28	24.94	5.72	5.59	6.43	**4.01**	**.02**
13. MISP	97.47	103.99	99.26	15.94	19.40	17.32	2.63	.07
14. MPS	21.32	19.90	21.93	7.36	6.69	7.80	1.46	.23
15. MSPA	159.58	158.75	156.11	12.55	11.35	9.93	1.84	.16
16. MTAR	48.07	46.49	45.78	6.25	6.15	5.58	2.75	.06
17. MTAN	24.36	23.92	22.42	3.05	3.54	2.47	**8.02**	**.00**
18. MD30	22.36	21.88	18.50	3.60	3.93	4.57	**19.40**	**.00**
19. MKII	110.54	110.47	128.43	19.16	16.51	25.22	**18.13**	**.00**
20. MS3M	557.97	586.94	582.49	109.10	100.94	113.08	1.51	.22
21. MOZ	129.57	129.71	131.47	16.90	21.46	16.16	.24	.78
22. MSZO	68.15	58.83	73.92	51.00	46.72	51.99	1.67	.19
23. MPSG	141.39	115.35	109.74	98.35	67.41	93.22	2.69	.07
24. MSOK	52.64	48.61	58.22	42.02	32.08	56.90	.83	.43

Legend (see Table 1)

Arithmetic means of examinees in particular variables from group A, are bigger in relation to values of arithmetic means from group B and C, while the values of arithmetic means from group B are bigger than arithmetic means from group C. During this period of operator appliance, better results of some motor abilities were obtained in groups A and B, with emphasis on group A. The values of arithmetic means of group C remained similar to their values in the initial state. By analysing disperse parameters it can be noticed that homogeneity of the results is greater in the variables of group C, smaller in group A, and the smallest in group B. This can be explained by relatively high result dispersion in experimental groups, which is obvious from large standard deviations. It can be noticed that in certain variables of groups A and B some alterations appeared in the second measurement that influenced the homogeneity of the group. The values group less around central value. This speaks on behalf of the expected and noticed phenomenon that those examinees who had this level on a higher point at the beginning, developed better motor abilities. This resulted in the increase of range of obtained results, and with this on the increase of standard deviation. By inspection of data in Table 2, in the part where F– tests are mentioned, it is possible to notice that the value of the F– test permits the conclusion that the central parameters of groups differ in particular variables. On basis of this data, hypothesis that can be accepted is that statistically considerable differences exist in the second measurement between groups, and that groups differ.

Table 3. T–Test for Significant Differences between Groups in the Transitional State

VARIABLES	A – B	A – C	B – C
1. MDM	1.69	**2.53+**	0.69
2. MBMP	-	-	-
3. MTRS	-	-	-
4. MNK	0.41	**5.08++**	**4.32++**
5. MITS	1.46	**9.40++**	**6.06++**
6. MMZ	0.64	**8.17++**	**6.68++**
7. MIZG	0.90	**6.09++**	**5.11++**
8. MIZP	**3.02++**	**9.48++**	**5.95++**
9. MIZS	1.81	**5.07++**	**3.31++**
10. MPIK	-	-	-
11. MGAN	0.37	**2.09+**	**2.62++**
12. MGAR	0.17	**2.50+**	**2.31+**
13. MISP	-	-	-
14. MPS	-	-	-
15. MSPA	-	-	-
16. MTAR	-	-	-
17. MTAN	0.80	**4.21++**	**2.94++**
18. MD30	0.77	**5.59++**	**4.76++**
19. MKII	0.00	**4.79++**	**5.06++**
20. MS3M	-	-	-
21. MOZ	-	-	-
22. MSZO	-	-	-
23. MPSG	-	-	-
24. MSOK	-	-	-

A – B - T – test group A, B
A – C - T – test group A, C
B – C - T – test group B, C
Significant differences between groups Tp.01 = 2.62++ and Tp.o5 = 1.98+

The probability that central parameters in groups A, B and C in manifest motor variables are not equal is high in variables MDM, MNK, MITS, MMZ, MIZG, MIZP, MIZS, MGAN, MGAR, MTAN, MD30 and MKII. Therefore, the significance in these variables shows that applied operators have a different effect. Differences between groups occurred in gauges, which were mostly meant for measurement of motor abilities, manifested as repetitive strength, static strength, speed and less strongly as precision, coordination and explosive strength (Table 3).

Inspecting the results with T– test considerable changes among groups in the transitional state can be noticed. Generally it can be noticed that group C (control group) shows results responsible for the lower degree of change than other groups; this group made less progress than the others. Group A achieved the highest results, and these are responsible for the higher degree of change under the influence of isometric operators. The results obtained in this period of operator application show that changes in half of the variables considerably differ from the statistic point of view. From 24 variables in total, 12 variables differ considerably. But, differences in variables (MDM, MNK, MITS, MMZ, MIZG, MIZP, MIZS, MGAN, MTAN, MD30 and MKII) show also the specific quality of these changes which aren't accidental. These differences are as follows:

(1) Group A differs considerably from group B in the variable MIZP, while from group C in variables: MDM, MNK, MITS, MMZ, MIZG, MIZP, MIZS, MGAN, MTAN, MD30 and MKII.

(2) Group B statistically differs from group C in variables: MNK, MITS, MMZ, MIZG, MIZP, MIZS, MGAN, MTAN, MD30 and MKII.

Taking into consideration the intentional subject of variable measurement and the results in basic parameters of these variables even after operator application, it can be concluded in this period that:

1. Groups A and B greatly developed their motor abilities in the interval between the first and second measurement than the group C. This is noted on basis of the highest values in variables MNK, MITS and MMZ which otherwise define the capability of repetitive strength. Furthermore, it is also noted in the variables MIZG, MIZP and MIZS that define the capability of static strength, variables MD30 and MTAN that measure speed, as well as in the variables MGAN and MGAR for measuring precision. As well, the variable MKII for measuring coordination and finally the variable MDM for measuring explosive strength, show changes in these groups.

2. Group A has higher values than group B in all variables, excluding the variable MNK where the value is smaller. The only statistically considerable difference is in the variable MIZP.

3. Group C shows less developed motor abilities over this period, which is obvious from the smallest values in all variables.

Analysis of the final state - in the third measurement or the final state of experimental process, considerable changes of motor abilities might be expected under the influence of applied operators. During experimental time of operator appliance, positive movements took place, experimental groups achieved better results in some manifested motor reactions, while the results in the control group were close to initial state values. The central parameters of examinees from group A are greater in respect to values of central parameters from the preceding states, as well as in respect to values of central parameters of group B; this also applies to values in group C. The disperse parameters of groups show that the results of both experimental groups are more stable and homogeneous, while these changes are insignificant in the control group.

By inspection of data in Table 4 it can be noticed that the values of the F– test support the conclusion that central parameters of groups differ in particular variables.

On basis of these data the hypothesis that in the third measurement or the final state there are statistically considerable differences, and that the groups differ can be accepted. The central parameters in groups A, B and C are not equal in manifested variables; they are high in the variables: MDM, MBMP, MNK, MITS, MMZ, MIZG, MIZP, MIZS, MPIK, MGAN, MGAR, MSPA, MTAR, MD30, MKII, MOZ and MPSG. Therefore, the significance of the F– test in these variables shows that the operator applications had different influences.

By inspection of Table 5, where T– test (differences between groups in the final state) is presented, it can be noticed that the greatest differences during operator application appeared between group A and C, then between group B and C, while the differences between group A and B appeared only in several variables.

The obtained results are a possible consequence of the influence of isometric and isotonic operators applied in this period. The highest degree of change in motor abilities has the group where isometric operators were applied, and this group advanced greatly. The main reason for differences that happened should be in the functional operator patterns. During the complete strain of the applied isometric operators impulses are sent continuously from the centre to the periphery and from the periphery via sensory nerves to the central nervous system. When isotonic operators are used, platoons of impulses appear only during contractions, and disappear during relaxation. This is confirmed by the fact that during isometric burden the action streams appear not only in muscles at work, but also in their antagonist muscles Coob, S., Forbes, A., (1923). This continuous excitation process in the central nervous system represents the main reason for differences in favour of the isometric operators. Isotonic contractions, on the other hand, involve a coordination of antagonists and synergists. To a moving part of the body kinetic energy is given in a certain direction, and then, in order to avoid trauma, it must be terminated. Due to this, the antagonist muscles that started the shortening are deactivated immediately, and synergist muscles that hinder movement, are activated.

Table 4. Central Parametres, Dispersive Parametres and F Scores of Grups in the Third Measurement

VARIABLES	PARAMETRES							
	XA	XB	XC	SA	SB	SC	F1	Q1
1. MDM	212.90	207.07	198.50	18.06	19.09	18.75	**10.88**	**.00**
2. MBMP	398.01	386.89	373.49	69.62	48.59	58.59	**3.06**	**.04**
3. MTRS	592.26	589.25	604.21	58.74	66.51	42.62	1.39	.25
4. MNK	43.51	41.46	18.11	19.36	19.83	7.64	**52.05**	**.00**
5. MITS	48.04	47.36	26.28	14.84	15.42	9.85	**59.61**	**.00**
6. MMZ	34.86	32.26	18.49	10.58	10.71	5.21	**65.94**	**.00**
7. MIZG	83.47	80.44	39.46	24.84	22.40	16.45	**94.18**	**.00**
8. MIZP	122.01	95.47	46.60	49.21	41.68	30.62	**62.03**	**.00**
9. MIZS	39.00	31.10	16.54	18.03	14.77	9.47	**44.27**	**.00**
10. MPIK	19.54	19.76	17.03	5.51	6.85	5.93	**4.44**	**.01**
11. MGAN	14.24	13.83	10.50	4.74	5.53	3.74	**13.55**	**.00**
12. MGAR	29.33	28.16	25.24	5.50	5.36	6.19	**10.63**	**.00**
13. MISP	96.74	102.19	100.25	13.68	17.31	15.84	2.24	.11
14. MPS	21.21	20.67	20.12	7.97	6.33	7.33	.40	.67
15. MSPA	165.25	161.61	155.83	11.55	11.18	9.81	**13.74**	**.00**
16. MTAR	49.74	48.56	46.22	5.85	6.09	5.68	**6.67**	**.00**
17. MTAN	24.49	23.33	22.36	2.62	2.84	2.46	**11.63**	**.00**
18. MD30	24.74	24.65	18.92	3.09	3.52	4.36	**58.66**	**.00**
19. MKII	102.19	108.92	126.26	17.45	18.71	22.03	**29.23**	**.00**
20. MS3M	536.11	570.60	571.49	110.51	105.04	103.17	2.24	.09
21. MOZ	123.75	122.22	138.42	15.31	14.61	14.51	**26.23**	**.00**
22. MSZO	70.10	62.99	66.17	56.16	50.77	52.07	.32	.72
23. MPSG	144.18	123.12	102.68	93.07	85.41	74.99	**4.31**	**.01**
24. MSOK	60.29	58.24	60.07	41.77	47.25	47.63	.04	.96

Legend (see Table 1)

Table 5. T – Test for Significant Differences among the Groups in the Final State

VARIABLES	A – B	A – C	B – C
1. MDM	1.884	**0.69**++	**2.72**++
2. MBMP	1.08	**2.24**+	1.49
3. MTRS	-	-	-
4. MNK	0.63	**0.58**++	**9.32**++
5. MITS	0.27	**10.36**++	**9.76**++
6. MMZ	1.35	**11.78**++	**9.83**++
7. MIZG	0.77	**12.54**++	**12.49**++
8. MIZP	**3.49**++	**11.04**++	**8.01**++
9. MIZS	**2.87**++	**9.36**++	**7.03**++
10. MPIK	0.21	**2.64**++	**2.55**+
11. MGAN	0.48	**5.27**++	**4.21**++
12. MGAR	1.28	**4.17**++	**3.04**++
13. MISP	-	-	-
14. MPS	-	-	-
15. MSPA	2.03	**5.26**++	**3.30**++
16. MTAR	1.23	**3.37**++	**2.39**+
17. MTAN	**2.62**++	**5.07**++	**2.20**+
18. MD30	0.16	**9.24**++	**8.68**++
19. MKII	**2.23**+	**5.24**++	**7.06**++
20. MS3M	-	-	-
21. MOZ	0.61	**5.89**++	**6.67**++
22. MSZO	-	-	-
23. MPSG	1.41	**2.94**++	1.52
24. MSOK	-	-	-

Legend (see Table 3)

Therefore, it turns out that the application of isometric operators represents a more economical work, i.e. that during isometric contraction, lasting action streams cause permanent excitation, which is not the case with isotonic contractions, where coordination efficiency is expressed. The second reason is the electrical activity of the number of

motor units, or the degree of motor units activity. In earlier researches Hill, A.V., (1951, 1956) Jewell, B.R., Wilkie, D.R., (1959), Hettinger, T., (1972), Bawa, P., (1976), Dick, F.W., (1997) and others), mechanical and electrical activity, expressed by integrated EMG, was changed during movement, being the highest within the range of 70° to 120°, and decreasing out of it. The application of isometric operators was done under the 90° angle, which had influence on greater activity of motor units, while the application of isotonic operators was done within the range of 40° to 180°. Therefore, the complete duration, as well as the way of muscle activities differs in isometric and isotonic contraction. This means that these elements are the main reason for group differences in this research.

The results of this research show that groups statistically differ in a great number of variables. Out of 24 variables in total, in 18 variables the groups considerably differ. The results for variables: MDM, MBMP, MNK, MITS, MMZ, MIZG, MIZP, MIZS, MPIK, MGAN, MGAR, MSPA, MTAR, MD30, MKII, MOZ and MPSG, indicate the specificity of these groups, depending on the applied operators, which are not accidental. The obtained differences are as follows:

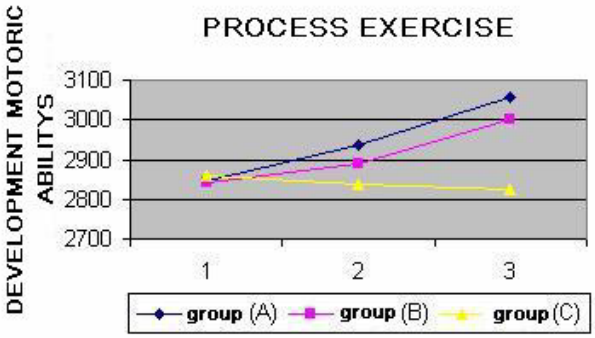
1. Group A, where isometric operators were applied, considerably statistically differs from group B, where isotonic operators were applied. The differences exist in the variables MIZP, MIZS, MSPA, MTAN and MKII. The greatest statistical differences appeared between group A and the control group C in the variables: MDM, MBMP, MNK, MITS, MMZ, MIZG, MIZP, MIZS, MPIK, MGAN, MGAR, MSPA, MTAR, MD30, MKII, MOZ and MPSG.
2. Group B, where isotonic operators were applied, considerably differs from group C in the following variables: MDM, MNK, MITS, MMZ, MIZG, MIZP, MIZS, MPIK, MGAN, MGAR, MSPA, MTAR, MTAN, MD30, MKII and MOZ.

In respect to the obtained results and the intentional object of variable measurement (with considerable statistical difference), as well as the results in basic parameters of these variables, after the application of operator in this period, the following can be stated:

1. Motor abilities developed more in group A (where isometric operators were applied):
   - than in group B on basis of central parameters of the variables which define the capability of static strength (MIZP, MIZS), flexibility (MSPA), speed (MTAN) and coordination (MKII).
   - than in group C on basis of central parameters of the variables that define the capability of explosive strength (MDM, MBMP), repetitive strength (MNK, MITS, MMZ), static strength (MIZG, MIZP, MIZS), precision (MPIK, MGAN, MGAR), flexibility (MSPA), speed (MTAR, MTAN, MD30), coordination (MKII, MOZ) and balance (MPSG).
2. Motor abilities developed more in group B (where isotonic operators were applied):
   - than in group C on basis of central parameters of variables that define the capability of explosive strength (MDM), repetitive strength (MNK, MITS, MMZ), static strength (MIZG, MIZP, MIZS), precision (MPIK, MGAR, MGAN), flexibility (MSPA), speed (MTAR, MTAN, MD30) and coordination (MKII, MOZ).

4. Discussion

On the sample of 216 male examinees of 15 years of age, sorted into groups A, B and C kinesiologic operators with corresponding content were applied. Isometric operators were applied in group A, isotonic in group B, and poly-structural operators of complex motion (basketball and football) in group C, which was the control group.



Picture 2. Presentation development motoric ability

In the course of three months research, examinees had three trainings weekly, with resting days in between. Each training lasted for 60 minutes. The contents and methods in all of experimental groups were identical in the basic biomechanical structure of operators. The cell system and circle working method were the forms of work used. Volume and distribution of operator application were individually foreseen on basis of the initial state. This was done so that 70% of maximal values of endurance or number of repetitions in single operator were taken. Progressive discontinued duration or number of operator performances was programmed. Volume and operator distribution was progressively and discontinuously programmed from the initial state of 70%, through the transitional state of 90 % and towards the final state of 120% in each operator. 24 motor tests were applied for the estimation of motor abilities of examinees. Measuring was done at the beginning, in the middle and at the end of examination, and then analysed. Group differences between the first, second and third measurement were analysed through variance analysis; and according to the significance of group differences, the differences between arithmetic means were tested (Picture 2.).

According to these tests the following conclusions can be drawn:

1. The applied isometric operators had a large influence on the development of following motor abilities: static strength, repetitive strength, precision, explosive strength, speed, coordination, flexibility and balance.

2. The applied isotonic operators had a large influence on the development of following motor abilities: repetitive strength, static strength, speed, precision, coordination, explosive strength and flexibility.

3. The applied isometric operators in comparison to the applied isotonic operators under identical conditions brought a greater development of the following motor abilities: static strength, speed, flexibility and coordination.

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