CHARACTERISTICS OF ONE MODEL OF MUSCLE ACTIVITY MEASUREMENT

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Abstract:

Research was conducted on 101 female students from the Faculty of Agriculture, University of Zagreb, with the aim to evaluate a performance time for 60 proposed tests of muscle activity and with the aim to determine the latent structure of the group of motor manifestations, which are under control and dominant influence of the mechanism for the regulation of excitation duration.

In view of the research issue the exploratory and the confirmatory factor analyses were applied. Besides the existence of the general factor of power, the difference between dynamic power and static endurance was confirmed, which has rarely been the case in research so far.

Key words: *muscle power, static endurance, female students, maximum likelihood method, factor analysis.*

DIE EIGENSCHAFTEN EINES MODELLS DER KRAFTBEWERTUNG

Zusammenfassung:

Eine Untersuchung wurde an 101 Studentinnen der Landwirtschaftsfakultät Zagreber Universität durchgeführt, mit dem Ziel, die Aufführungszeit für 60 vorgeschlagenen Krafttests zu bewerten, sowie die latente Struktur einer Gruppe motorischer Manifestationen festzustellen, die durch den Mechanismus für die Regulation der Aufregungsdauer kontrolliert und überwiegend beeinflusst sind. Die explorative und konfirmative Faktorenanalysen wurden angewendet.

Neben einem allgemeinen Kraftfaktor, wurde der Unterschied zwischen der Schnellkraft und Kraft bestätigt, was in bisherigen Untersuchungen selten der Fall war.

Schlüsselwörter: *Muskelkraft, Ausdauer, Studentinnen, Methode der maximalen Wahrscheinlichkeit, Faktorenanalyse*

Introduction

In the early studies of the body power structures the most frequently observed latent dimension identified was the dynamic power (Metheny, 1938; Larson 1940; 1941; McCrow, 1949; Hampel & Fleishman, 1955; McCloy. 1956). In most of the studies this factor was defined by the values of the relative arm power and the power of the shoulder area and less by the activities which require the trunk muscles.

The factor known as static endurance occurred less frequently (Carpenter, 1941; Harris, 1937; Larson, 1940; 1941; Henry, 1960). In all the studies the factor was defined by manifestations of the dynamometric type.

Nicks and Fleshman (1960) suggested another model of the latent body power structure. According to their model the factors are differentiated, according to an action criterion in the first place, into the factors of explosive dynamic power and static endurance. These authors have also assumed that within the factor of the dynamic power there exists a topological differentiation. Both models are the result of the analysis of the previous study.

There are just a few and unsystematic investigations of motor skills in Croatia (Hofman et al., 1985; Dragaš, 1980; Dodig, 1999;) especially those of power segment in women. The reason for this can be explained by the problem which is present in every test, namely, maximum energy mobilization in one exercise, which makes it impossible for the subject to repeat the exercise. Therefore, the tests of physical power space take a long time and the accuracy of the achieved results is questionable.

Šturm (1975), using a battery of 15 tests extracted two dimensions interpreted as the mechanism for the regulation of intensity excitation of the central and peripheral neuromuscular system and the mechanism for the regulation of excitation duration in the same segments. The first is responsible for the magnitude of the muscular force exercises of the dynamic and static muscular work.

The findings of the investigations by Invergo et al. (1991), Jackson et al. (1994), Rutherford and Corbin (1994), Knudson and Johnston (1995), Kuramoto & Payne (1995), Webster & Harackiewicz (1996) are reliable and valid of some common and modified fitness and power tests.

The purpose of the research was to determine the latent structure of the group of motor manifestations, which are under control and dominant influence of the mechanism for the regulation of excitation duration. The basic aim was to determine the existing factors of power of a single muscle group. Therefore, the tests were constructed that represented the primary subject of measurement:

1. elbow extension in dynamic and static performance
2. chest press in dynamic and static performance
3. partial curl-up in dynamic and static performance
4. trunk twister in dynamic and static performance
5. back extension in dynamic and static performance
6. knee extension in dynamic and static performance
7. plantar flexion in dynamic and static performance
8. hip adduction in dynamic and static performance
9. hip abduction in dynamic and static performance
10. calf raises in dynamic and static performance.

Methods

Subjects

Measurements were carried out on 101 female students aged 19-22 years at the Faculty of Agriculture, University of Zagreb. The tested female students were in the stationary growth phase, healthy, without any locomotion dysfunctions with an average body height of 165.98 cm (± 6.69 SD) and body weight of 59.70 kg (± 7.71 SD). They regularly attended physical education classes during the academic year 1998/99.

Variables

The applied variables were selected from different fitness programs carried out with the aim to determine the latent structure of the group of motor manifestations, which are under control and dominant influence of the mechanism for regulation of excitation duration. Its manifestation characteristics are dynamic and static way of performance (work) and overcoming of the resistance, which is determined by the total body mass or the mass of a part of the body. The students were measured by 60 tests: 30 tests for dynamic power and 30 tests for static endurance (Table 1.). The tests had the following characteristics:

- they were suitable for the assessment of the female students' abilities
- the complexity of conducting the tests was as low as possible
- a small number of necessary instruments (tools) and persons carrying out the tests.

The result in the tests for measuring the dynamic power is the number of repetitions per minute. For each static way of performance we recorded for how long (in seconds) a subject held the correct position. Maximum duration of each exercise was limited at 300 seconds to restrict the duration of the whole experiment. This resulted in some censored measurements (that would have lasted longer than 300 seconds if there were no time limits).

Table 1. Abbreviations and descriptions of the tests applied in the muscle activity measurements.

Statistical analysis

The basic descriptive statistics was computed. The mean value and standard deviation for the tests of static endurance with more than 3 limited measurements were calculated by the maximum likelihood method assuming the lognormal distribution model.

The exploratory factor analysis was carried out in real standard metrics by an orthoblique rotation and the number of factors defined by the GK-criterion.

Results and discussion

Characteristics of the tests of the dynamic power

Table 2 shows the basic descriptive parameters of dynamic power on the basis of which it is possible to make conclusions referring to the sensitivity and applicability of the tests applied. One of the criteria of the sensitivity of the tests is the range of results; the measure was derived from the difference between the maximum and minimum

Table 2. Basic descriptive statistics of performance values for dynamic power tests (number of repetitions).

VARIABLES	$\overline{X}$	SD	MIN.	MAX.	SKEW.	KURT.
1. ELBEXT 1	42.1	11.1	21.5	75.5	.565	.291
2. ELBEXT 2	43.1	7.4	20.0	68.5	-.178	1.244
3. ELBEXT 3	36.0	9.4	10.5	63.0	-.103	.349
4. CURLUP 1	47.8	10.7	20.5	75.5	.052	-.120
5. CURLUP 2	45.2	8.9	23.0	68.5	.215	-.067
6. CURLUP 3	41.6	10.0	14.5	71.0	.232	.495
7. CHESTP 1	18.8	7.6	4.0	43.5	.700	.306
8. CHESTP 2	48.0	9.6	20.5	78.0	.205	.374
9. CHESTP 3	39.5	11.0	20.0	74.0	.729	.460
10. TRUNKT 1	41.2	8.5	20.0	62.5	-.182	-.140
11. TRUNKT 2	39.7	8.3	15.5	59.0	-.174	-.376
12. TRUNKT 3	44.7	9.32	21.5	74.5	.140	.147
13. BACKEX 1	46.9	11.5	21.0	73.0	-.019	-.569
14. BACKEX 2	45.3	12.9	18.5	79.5	.140	-.519
15. BACKEX 3	36.8	9.6	17.5	60.0	.109	-.483
16. KNEEEX 1	39.3	9.0	17.5	69.5	.047	.852
17. KNEEEX 2	38.2	9.5	16.5	59.5	.025	-.293
18. KNEEEX 3	42.3	8.2	23.5	69.5	.234	.695
19. PLFLEX 1	34.2	14.6	10.0	69.0	.439	.606
20. PLFLEX 2	57.6	14.5	25.0	94.0	.150	-.129
21. PLFLEX 3	63.5	14.2	28.0	94.0	-.102	-.206
22. ADDHIP 1	48.7	15.0	15.0	96.0	.570	.617
23. ADDHIP 2	64.4	14.5	20.5	92.0	-.602	.299
24. ADDHIP 3	58.5	14.6	21.5	96.0	.087	-.205
25. ABDHIP 1	52.1	11.7	25.5	78.5	.064	-.636
26. ABDHIP 2	68.1	11.3	33.0	91.0	-.400	-.015
27. ABDHIP 3	59.3	15.1	28.0	97.0	.051	-.262
28. CALRAI 1	67.9	11.2	28.5	97.5	-.131	.601
29. CALRAI 2	53.2	15.4	23.5	94.0	.483	.138
30. CALRAI 3	63.0	13.7	32.0	97.0	.198	-.528

results. The wide range of results on the entire sample of tests of dynamic power suggests a very good sensitivity.

The minimum time was above zero for all exercises, thus they were appropriate (i.e. not too strenuous) for young adult female subjects.

Distribution of the results does not substantially deviate from the normal Gauss distribution, which satisfies the condition of the suitability of the exercise to the testees, since their differentiation is both in the zone of low and high results.

Characteristics of the tests of static endurance

The static endurance tests were limited because the performance time was set at exactly 300 seconds (5 minutes). For some tests there was a large number of subjects who achieved the maximum results.

The basic descriptive statistics (maximum likelihood estimates $\overline{x}$ and SD transformed back into original units, frequency of limited observations, minimum and maximum) are presented in Table 3. The 99^{th} percentile of the lognormal distribution with estimated parameters is given in the last column.

The largest frequency of limited observations was found for the tests related to flexor forces and body rotators. Estimates of the 99^{th} percentiles for some of these tests exceed 1000 seconds (more than triple the allotted time). These tests should be improved.

For the tests of static endurance related to the upper arm adductor extensor and plantar flexor, the allotted time should be slightly adjusted according to the estimates of the 99^{th} percentile.

The minimum time was above zero for all exercises; thus they were regarded as appropriate (i.e. not too strenuous) for young adult female subjects.

Table 3. Basic descriptive statistics of performance values: maximum likelihood estimates $\overline{x}$ and SD transformed into original units, frequency of censored observations, minimum, maximum (for uncensored variables), conditional expectation of values above 300 seconds (for censored variables) and 99th percentile (observed for the uncensored and estimated for the censored variables).

	variables	$\overline{x}$	SD	freq.	Min.	Max.	Skew.	Kurt.	x300	P99
1.	I 1 ELBEXT	111.1	68.3	4	35.5	358.6	1.932	4.042	362	325
2.	I 2 ELBEXT	234.8	132.6	4	41.0	448.0	.388	-1.199	389	369
3.	I 3 ELBEXT	44.9	25.2	-	14.6	205.0	2.860	15.186	-	-
4.	I 1 CURLUP	235.8	130.6	29	54.9	441.9	.463	-1.285	475	1102
5.	I 2 CURLUP	164.9	106.3	19	37.4	399.0	1.189	.241	408	600
6.	I 3 CURLUP	166.6	21.4	8	29.0	372.2	1.708	2.487	380	416
7.	I 1 CHESTP	117.6	50.2	-	32.9	300.0	1.166	1.596		
8.	I 2 CHESTP	94.6	64.0	13	30.4	300.0	1.505	1.781	380	462
9.	I 3 CHESTP	103.2	54.7	-	26.4	300.0	1.848	4.202	-	-
10.	I 1 TRUNKT	154.2	115.8	33	21.2	425.5	1.105	-.232	454	968
11.	I 2 TRUNKT	92.4	64.7	32	14.1	341.8	2.198	6.164	486	1173
12.	I 3 TRUNKT	163.6	107.8	21	50.9	394.7	1.242	.120	406	626
13.	I 1 BACKEX	149.6	90.0	14	44.7	372.4	1.503	1.131	403	577
14.	I 2 BACKEX	227.3	133.9	-	33.9	442.4	.519	-1.316	-	302
15.	I 3 BACKEX	108.0	51.3	13	26.4	300.0	1.657	4.193	380	447
16.	I 1 KNEEEX	74.0	30.9	-	14.1	159.3	.783	.180	-	-
17.	I 2 KNEEEX	59.3	37.7	-	14.2	202.4	1.726	3.514	-	-
18.	I 3 KNEEEX	146.8	92.2	-	22.3	391.3	1.374	1.048	-	-
19.	I 1 PLFLEX	151.3	73.9	-	62.4	332.7	1.302	.848	-	-
20.	I 2 PLFLEX	109.9	64.2	-	28.3	330.8	1.779	3.025	-	-
21.	I 3 PLFLEX	37.3	16.0	5	11.6	94.8	1.356	2.169	358	343
22.	I 1 ADDHIP	127.7	79.1	-	26.9	372.2	1.708	2.487	-	-
23.	I 2 ADDHIP	92.05	40.0	12	40.0	227.4	1.582	2.546	404	559
24.	I 3 ADDHIP	178.8	100.7	8	49.7	390.3	.986	-.341	377	395
25.	I 1 ABDHIP	140.6	84.1	-	54.7	372.7	1.537	1.554	-	-
26.	I 2 ABDHIP	61.04	25.6	11	24.5	167.4	1.427	2.732	369	423
27.	I 3 ABDHIP	125.2	66.6	4	39.9	328.0	1.491	1.677	366	346
28.	I 1 CALRAI	123.6	81.8	19	37.9	370.2	1.819	2.800	460	850
29.	I 2 CALRAI	114.6	59.3	4	24.5	331.1	1.540	2.950	365	330
30.	I 3 CALRAI	136.2	84.9	12	22.3	348.0	1.268	.757	403	534

Results of the exploratory factor analysis

The structure of the principal components isolated from the complete correlation matrix is presented in Table 4. The principal components exhaust 74.5% of the entire system deviation while the rest of 25.5 % can be considered as an error component. According to the applied Guttman-Kaiser criterion, 12 characteristic roots were regarded as important, so the manifestation space can be reduced to this number of latent dimensions.

The first principal component exhausted 40.3% of the total deviation. The structure of the first principal component is made up of all the tests of static endurance. The significant and positive projections of all the tests of static endurance lead to the conclusion that the first principal component can be considered as the measure of the general power factor.

The second component explains 7.9% of the total variability. The component is bipolar; on the positive pole there are projections of tests of static endurance, while the negative pole is defined as statistically significant but with small projections of tests of dynamic power of different primary objects of measurement. The data suggest that the real level of matrix intercorrelations is lower and that the applied criterion ($\lambda \geq 1$) proclaimed those components as significant, which is not the case.

Table 4. The structure of principal components

variables	H1	H2	H12	h	variables	H1	H2	h
1. ELBEXT 1	.73	-.23	-.06	.69	31. I1 ELBEXT	**.66**	.29	.65
2. ELBEXT 2	.67	-.26	.03	.77	32. I2 ELBEXT	**.53**	.35	.73
3. ELBEXT 3	.57	-.18	-.07	.74	33. I3 ELBEXT	**.62**	-.00	.65
4. CURLUP 1	.72	-.19	.04	.75	34. I1 CURLUP	**.45**	.21	.67
5. CURLUP 2	.66	-.31	-.02	.76	35. I2 CURLUP	**.54**	.26	.72
6. CURLUP 3	.76	-.16	-.15	.82	36. I3 CURLUP	**.60**	.22	.76
7. CHESTP 1	.60	-.08	.10	.66	37. I1 CHESTP	**.41**	.13	.73
8. CHESTP 2	.68	-.44	-.04	.80	38. I2 CHESTP	**.56**	.37	.75
9. CHESTP 3	.71	-.17	-.11	.82	39. I3 CHESTP	**.64**	.29	.76
10. TRUNKT 1	.65	-.34	-.05	.72	40. I1 TRUNKT	**.60**	.23	.79
11. TRUNKT 2	.66	-.28	.03	.64	41. I2 TRUNKT	**.49**	.35	.77
12. TRUNKT 3	.78	-.14	-.16	.80	42. I3 TRUNKT	**.70**	.27	.72
13. BACKEX 1	.76	-.12	.08	.72	43. I1 BACKEX	**.57**	.18	.81
14. BACKEX 2	.66	-.21	.16	.71	44. I2 BACKEX	**.66**	.31	.66
15. BACKEX 3	.70	-.21	.00	.82	45. I3 BACKEX	**.67**	.28	.64
16. KNEEEX 1	.53	-.07	-.27	.76	46. I1 KNEEEX	**.57**	.15	.64
17. KNEEEX 2	.63	-.27	.17	.58	47. I2 KNEEEX	**.57**	.21	.68
18. KNEEEX 3	.61	-.18	-.24	.78	48. I3 KNEEEX	**.57**	.22	.70
19. PLFLEX 1	.63	-.21	-.06	.68	49. I1 PLFLEX	**.55**	.31	.76
20. PLFLEX 2	.65	-.42	.07	.74	50. I2 PLFLEX	**.41**	.06	.73
21. PLFLEX 3	.75	-.19	-.18	.75	51. I3 PLFLEX	**.71**	.23	.79
22. ADDHIP 1	.63	-.27	.31	.75	52. I1 ADDHIP	**.54**	.47	.77
23. ADDHIP2	.62	-.39	.05	.78	53. I2 ADDHIP	**.65**	.30	.80
24. ADDHIP 3	.82	-.13	-.04	.84	54. I3 ADDHIP	**.71**	.18	.79
25. ABDHIP 1	.67	-.33	.07	.73	55. I1 ABDHIP	**.56**	.44	.81
26. ABD HIP 2	.63	-.42	.02	.79	56. I2 ABDHIP	**.53**	.54	.74
27. ABD HIP 3	.73	-.25	-.13	.73	57. I3 ABDHIP	**.69**	.08	.77
28. CALRAI 1	.61	-.13	.00	.82	58. I1 CALRAI	**.49**	.29	.76
29. CALRAI 2	.60	-.33	.23	.78	59. I2 CALRAI	**.49**	.47	.77
30. CALRAI 3	.76	-.01	-.05	.73	60. I3 CALRAI	**.54**	.40	.63

H - principal components; h - communality

Further analysis of the latent contents of strength comprises the space of orthoblique rotation by the application of the factor structure after the Harris-Kaiser rotation method. Twelve significant factors were extracted. The fourth (19.85) and the eighth (19.66) are the highest value of the explicable deviation of the entire space, while the ninth factor is the lowest (2.51). *The fourth orthoblique factor* predominantly determines the tests of the dynamic power of the partial curl-up and the trunk twister, which therefore could be interpreted as the factor of *dynamic power of the trunk.*

The eighth orthoblique factor is determined by all the tests of dynamic power of the chest press (CHESTP 1; push-ups, on the knees, CHESTP 2; push-ups, on the left side with wide support, CHESTP 3; push-ups, legs supported on the Scott bench) and tests of the primary object of measurement of the back extension (BACKEX 1; extension, arms on the back, BACKEX 2; extension, arms below the chin BACKEX 3; extension, holding arms raised upwards and backwards). The eighth orthoblique factor could be termed as the factor of dynamic power *of the chest press and back extension.*

The next factor, according to the percentage of the explicable deviation, is the twelfth orthoblique factor, which is characterized by the high projections of the dynamic power of legs. Comparable projections of tests of dynamic power of lower leg extensor (KNEEEX 2; lunge, PLFLEX 2; kneeling position on one knee, right leg curls, ADDHIP 1; side support, inner right leg lifts, knee bent, ABDHIP 1; lying on the side, lift leg extended forwards) make it possible to interpret this factor as the *factor of the dynamic power of legs.*

Regarding the projections of the tests of strength of different primary object of measurement, the third orthoblique factor can be interpreted as the *factor of static endurance of lower extremities.*

The ability of long-lasting isometric performance of large body muscle groups defines the seventh orthoblique factor. Therefore this factor can be interpreted as the factor of the *static endurance of the body.*

The sixth orthoblique factor is predominantly defined by the tests of dynamic power of the lower leg extensor (KNEEX 1; half-squat, KNEEEX 3; forward straddle). Slightly lower on the projections of the dynamic power of upper arm adductor are: (CHESTP 1; push-ups on the knees, CHESTP 2; push-ups on the left side with wide support, CHESTP 3; push-ups, legs supported on the Scott bench). Upon the realization of the above mentioned tests the inseparability of the local sub-mechanisms responsible for the regulation of energy of *low and upper extremities* has been confirmed.

The tests of static endurance define the eleventh orthoblique factor. High values of the correlations of tests with different primary objects of static endurance measurements confirm the total common variability of the entire space and the impossibility to isolate a specific muscle segment.

The tests of static endurance with different primary measurement object explain the tenth orthoblique factor. The tests of static endurance of the upper hip adductor have very high projections: (I2 ADDHIP – left leg, hold, knee bent, side support, I2 CHESTP – push-up, hold on the left side with the wide support). Besides the tests of adductor strength, the projections of tests of plantar flexion (I2 CALRAI – standing on the toes hold, support on the wall) and trunk twister (I2 TRUNKT – trunk twister hold to the left) are significant, too. The common characteristic of these tests is probably the cause of the complexity of the tests taking into account the position of the body during the performance. The results of the research so far (Rynkiewicz and Starosta, 1999; Dodig, 1999) make it possible to determine the tenth orthoblique factor as the *unilateral factor of static endurance.*

The first orthoblique factor suggests the complexity of the motor space of the unselected sample of women, where a range of various regulation mechanisms takes part in the realization of movements. With reservations, this factor could be interpreted as the *single factor of the dynamic power of the upper arm extensor.*

The second orthoblique factor is explained by the tests of power of upper legs flexor in dynamic (PLFLEX 1 prone position, legs curls lifted, PLFLEX 2; kneeling position on one knee, right leg curls lifted) and in the static positions (I2 PLFLEX – prone position hold legs curls lifted, I1 PLFLEX – hold in the kneeling position, right knee bent. Because of considerably lower projections of other tests this factor can be interpreted as the *factor of the power of the lower leg flexor.*

The fifth orthoblique factor is determined by the projections of the tests of static endurance of chest press (13 CHESTP – push-up, hold legs supported on the Scott bench and 13 KNEEEX – hold in forward straddle) Šturm, 1975; Invergo et al., 1991), emphasize all the difficulties in the estimation of endurance or repetition of push-ups. The authors of the aforementioned research emphasize the contamination of incorrect execution of push-ups since it is very difficult to perform the set movement structure and/or keep it for a longer time at all the set angles. The projections of tests on the fifth orthoblique factor suggest that this factor could be interpreted as the factor of the *static endurance of arms.*

Considering the projections of a very homogenous block of calf raise on the ninth orthoblique factor in the dynamic way of performance, in our opinion this factor can be interpreted as the *factor of the dynamic power of calf raise,* and further analyses will confirm or deny the possibility of the existence of this factor in one of the applied ways of performance.

The correlations of orthoblique factors (Table 8) are within the range between .05 and .77 and have a positive (+) sign. The fourth and the eighth factors, which are defined by the tests of dynamic power, have the highest correlation.

Conclusion

At the first level of factor analysis of power it is possible to predict the existence of primary factors of power divided according to the way of performance into dynamic power and static endurance with the possibility to isolate the factor of topologically near muscle groups. The isolated factors are interpreted as:

1. single factor of dynamic power of upper arm extensor
2. factor of power of lower leg flexor
3. factor of static endurance of lower extremities

4. factor of dynamic power of body
5. factor of static endurance of arms
6. factor of dynamic power of upper and lower extremities
7. factor of static endurance of the body
8. factor of dynamic power of upper chest press and back extension
9. factor of dynamic power of calf raise
10. factor of static endurance of unilateral muscle groups
11. factor of static endurance
12. factor of dynamic power of legs.

Table 6. The pattern of orthoblique factor.

VARIABLES	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
1. ELBEXT 1	.26	**.28**	-.15	.20	-.03	.11	-.09	.09	-.01	-.01	.21	.15
2. ELBEXT 2	.17	-.12	.06	-.15	-.18	**.41**	-.05	.40	-.16	.27	-.22	.23
3. ELBEXT 3	**.80**	-.14	-.02	.09	.11	.04	.05	-.06	-.00	.04	.00	.00
4. CURLUP 1	.03	-.12	-.06	**.71**	.02	-.09	-.03	.18	.19	.24	-.09	-.03
5. CURLUP 2	-.03	-.11	-.06	**.92**	.11	-.05	.18	.00	.07	.01	-.35	.06
6. CURLUP 3	.14	.00	.09	.47	-.00	-.03	.20	**.66**	.09	-.11	-.15	-.46
7. CHESTP 1	.08	-.06	-.17	-.34	.18	.42	.07	**.49**	-.06	.27	-.05	.04
8. CHESTP 2	.17	-.06	-.03	.00	-.17	.42	.00	**.45**	-.11	.03	-.24	.20
9. CHESTP 3	.17	-.05	-.07	-.09	-.07	.53	-.19	**.53**	-.01	.02	.31	-.14
10. TRUNKT 1	-.09	-.01	-.26	**.82**	.04	.18	-.17	-.14	.19	.04	.16	.15
11. TRUNKT 2	-.01	-.10	-.06	**.58**	-.14	-.05	.02	.20	.13	.14	-.11	.14
12. TRUNKT 3	.11	-.07	-.00	**.76**	-.01	.09	-.01	.37	-.01	.02	.00	-.40
13. BACKEX 1	.12	.01	-.15	.23	-.04	-.08	-.13	**.65**	.00	.19	.19	-.10
14. BACKEX 2	-.11	-.00	-.16	.02	-.07	-.20	.03	**1.03**	.08	.00	.08	-.02
15. BACKEX 3	-.14	.21	-.04	.01	.01	.13	-.13	**.92**	-.15	-.18	.12	-.10
16. KNEEEX 1	.02	.05	.04	-.01	.24	**.86**	.19	-.20	.16	-.06	-.03	-.13
17. KNEEEX 2	-.07	-.06	.17	.00	-.01	.05	-.09	.25	.09	.00	-.11	**.54**
18. KNEEEX 3	-.07	-.03	.09	.12	-.05	**.86**	-.06	-.08	-.12	-.08	.05	.09
19. PLFLEX 1	.24	**.53**	.15	.07	.01	-.06	-.10	.17	-.08	-.13	-.08	.13
20. PLFLEX 2	-.04	.31	-.05	.13	-.20	.02	-.17	.23	.09	-.00	.00	**.49**
21. PLFLEX 3	-.06	.01	.08	**.60**	-.30	.24	-.00	-.02	.06	.00	.11	.10
22. ADDHIP 1	.03	-.13	-.04	-.10	.00	-.06	-.02	-.01	-.03	.02	.09	**1.00**
23. ADDHIP 2	.03	.09	.23	.28	.02	-.01	.15	-.22	.12	-.16	-.38	**.68**
24. ADDHIP 3	.29	.20	.18	**.50**	.02	-.12	-.13	-.10	-.07	-.05	.08	.22
25. ABDHIP 1	-.11	.05	-.27	.52	-.00	.18	-.11	-.25	.06	.09	.16	**.57**
26. ABDHIP 2	.36	.30	.01	-.10	-.10	.00	.09	.02	.09	-.05	-.20	**.52**
27. ABDHIP 3	.20	.17	.04	**.76**	.00	-.05	-.09	.01	-.11	-.08	-.07	-.03
28. CALRAI 1	-.03	-.09	.19	.17	.04	-.02	.15	.12	**.66**	-.03	.04	.08
29. CALRAI 2	-.01	.17	-.03	-.23	.23	-.20	.15	**.80**	.33	-.00	-.33	.16
30. CALRAI 3	.05	.06	**.37**	.16	.09	.04	-.04	.11	.31	-.11	.14	.06
31. I 1 ELBEXT	.11	-.05	-.00	-.01	.06	.13	.16	.10	-.03	-.00	**.56**	-.06
32. I 2 ELBEXT	.18	-.38	.34	.01	.00	-.07	-.14	.00	.12	.10	**.58**	.05
33. I 3 ELBEXT	.20	-.25	-.08	.01	**.42**	-.13	.08	.34	-.23	.09	-.02	.29
34 I 1 CURLUP	.10	.04	-.26	-.01	.02	-.02	**.85**	-.06	.12	.03	.12	-.06
35. I 2 CURLUP	-.13	-.12	.50	-.24	-.18	.17	**.62**	.22	.17	.04	-.22	-.02
36. I 3 CURLUP	-.35	-.07	-.01	.39	-.05	.12	**.80**	.03	.00	.03	-.10	-.07
37. I 1 CHESTP	.04	-.02	-.04	.09	**.82**	.10	-.05	-.04	.06	.06	.00	-.04
38. I 2 CHESTP	.05	-.01	.23	-.08	.12	.03	-.00	.12	-.26	**.71**	-.23	-.01
39. I 3 CHESTP	-.22	-.15	.11	-.22	.02	.01	.11	.16	.04	-.05	**.64**	.44
40. I 1 TRUNKT	.09	.07	-.36	-.04	.12	.04	**.60**	-.31	-.07	.22	.27	.35
41. I 2 TRUNKT	.19	.18	-.13	-.05	-.11	.05	.45	-.26	-.00	**.66**	-.00	-.07
42. I 3 TRUNKT	.00	-.13	.12	-.12	-.09	-.17	**.34**	.23	-.08	.16	.24	.32
43. I 1 BACKEX	.28	.10	.12	-.21	.01	-.10	**.70**	.14	-.10	-.37	.15	.05
44. I 2 BACKEX	-.38	-.01	.23	-.01	-.00	.02	.06	**.46**	-.01	.26	.14	.01
45. I 3 BACKEX	-.00	.12	.24	.20	-.04	-.10	.22	.11	-.03	-.15	**.37**	-.08
46. I 1 KNEEEX	-.06	.16	**.51**	-.28	.33	.15	.14	.23	-.04	-.34	-.04	.11
47. I 2 KNEEEX	-.29	.25	.00	.11	.28	-.01	-.34	.12	.07	.24	**.39**	.11
48. I 3 KNEEEX	-.11	.09	**.80**	-.05	.22	.07	-.16	.04	-.08	-.26	-.00	.18
49. I 1 PLFLEX	.01	.47	-.15	.12	-.10	.03	.27	-.16	.01	-.02	**.63**	-.16
50. I 2 PLFLEX	-.11	**.88**	.02	-.12	-.02	-.02	-.00	.10	-.01	.11	-.01	-.06
51. I 3 PLFLEX	-.25	-.02	.22	.34	-.05	.05	.21	.18	**-.40**	-.09	.15	.10
52. I 1 ADDHIP	.05	-.01	**.92**	.04	-.14	-.02	-.11	-.23	-.00	.09	.12	.01
53. I 2 ADDHIP	-.11	.15	.20	.27	-.02	.14	-.07	-.20	-.13	**.67**	-.09	.03
54. I 3 ADDHIP	-.06	-.00	**.37**	.34	-.01	-.33	.17	.31	-.37	.10	-.21	.16
55. I 1 ABDHIP	-.08	.00	**.87**	.04	-.00	.17	.06	-.27	.16	.19	-.12	-.07
56. I 2 ABDHIP	-.04	.34	**.45**	.17	.21	-.02	.18	-.27	-.07	.27	-.06	-.26
57. I 3 ABDHIP	.00	-.09	.13	**.90**	.15	-.01	.07	-.12	-.23	-.23	.19	-.13
58. I 1 CALRAI	.41	.03	**.70**	-.22	-.19	-.01	-.20	.09	.24	.19	.15	-.28
59. I 2 CALRAI	-.02	.00	-.00	-.11	.11	-.20	-.09	.08	.14	**.85**	.21	.03
60. I 3 CALRAI	.12	-.27	**.54**	.13	-.02	-.23	.05	.06	-.19	-.00	.21	.07

Table 7. The structure of orthoblique factor.

VARIABLES	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
1. ELBEXT 1	.61	.60	.37	**.69**	.25	.54	.39	.67	.07	.34	.45	.67
2. ELBEXT 2	.56	.29	.41	.56	.09	**.72**	.33	.69	.09	.49	.19	.62
3. ELBEXT 3	**.84**	.19	.33	.52	.23	.42	.37	.50	.16	.33	.27	.48
4. CURLUP 1	.51	.27	.46	**.80**	.21	.45	.39	.67	.36	.51	.31	.57
5. CURLUP 2	.45	.29	.35	**.80**	.22	.42	.41	.60	.25	.33	.15	.61
6. CURLUP 3	.57	.37	.51	.76	.25	.49	.52	**.81**	.26	.38	.35	.49
7. CHESTP 1	.43	.31	.34	.42	.40	**.68**	.37	.64	.05	.48	.30	.46
8. CHESTP 2	.60	.33	.32	.62	.07	.73	.32	**.74**	.15	.32	.14	.68
9. CHESTP 3	.54	.33	.45	.58	.29	**.79**	.28	.76	.14	.40	.49	.51
10. TRUNKT 1	.40	.33	.30	**.77**	.23	.54	.23	.57	.31	.32	.33	.61
11. TRUNKT 2	.46	.26	.37	**.73**	.05	.42	.37	.63	.31	.39	.23	.61
12. TRUNKT 3	.55	.34	.51	**.83**	.28	.57	.42	.76	.17	.46	.43	.51
13. BACKEX 1	.54	.41	.46	.71	.26	.49	.41	**.79**	.14	.49	.50	.57
14. BACKEX 2	.38	.35	.35	.59	.17	.37	.41	**.80**	.20	.30	.38	.55
15. BACKEX 3	.34	.56	.40	.61	.35	.58	.31	**.82**	-.04	.23	.44	.55
16. KNEEEX 1	.34	.30	.37	.41	.44	**.81**	.30	.45	.21	.34	.26	.35
17. KNEEEX 2	.40	.30	.44	.58	.18	.49	.27	.63	.25	.29	.24	**.70**
18. KNEEEX 3	.34	.32	.41	.53	.26	**.85**	.23	.55	.02	.32	.31	.52
19. PLFLEX 1	.51	**.71**	.39	.58	.25	.40	.32	.60	-.02	.23	.30	.60
20. PLFLEX 2	.45	.57	.31	.65	.04	.48	.26	.66	.22	.24	.24	**.76**
21. PLFLEX3	.46	.39	.50	**.79**	.03	.58	.41	.66	.22	.42	.41	.66
22. ADDHIP 1	.47	.31	.34	.57	.17	.39	.36	.57	.09	.25	.33	**.85**
23. ADDHIP 2	.49	.40	.38	.65	.12	.42	.37	.53	.27	.19	.08	**.79**
24. ADDHIP 3	.66	.58	.58	**.83**	.31	.46	.44	.68	.04	.40	.50	.75
25. ABDHIP 1	.40	.43	.29	.73	.21	.54	.30	.56	.16	.33	.35	**.75**
26. ABDHIP 2	.68	.55	.29	.58	.06	.46	.39	.60	.22	.23	.14	**.77**
27. ABDHIP 3	.57	.52	.43	**.81**	.24	.45	.36	.64	.04	.32	.34	.63
28. CALRAI 1	.40	.15	.50	.57	.17	.40	.38	.57	**.72**	.34	.30	.50
29. CALRAI 2	.43	.42	.31	.50	.31	.39	.37	**.73**	.42	.25	.12	.58
30. CALRAI 3	.48	.38	.68	**.68**	.37	.52	.40	.68	.38	.40	.51	.59
31. I 1 ELBEXT	.39	.31	.54	.50	.39	.41	.56	.54	-.04	.45	**.75**	.40
32. I 2 ELBEXT	.35	-.03	.64	.41	.27	.25	.33	.40	.16	.45	**.68**	.31
33. I 3 ELBEXT	.48	.24	.40	.53	.55	.37	.44	**.60**	-.11	.37	.41	.55
34. I 1 CURLUP	.33	.28	.24	.34	.15	.16	**.78**	.33	.05	.36	.40	.29
35. I 2 CURLUP	.24	.14	.60	.35	.05	.36	**.65**	.46	.25	.47	.30	.33
36. I 3 CURLUP	.15	.29	.44	.54	.17	.33	**.79**	.47	.01	.47	.40	.39
37. I 1 CHESTP	.21	.22	.34	.33	**.84**	.38	.19	.33	.02	.30	.33	.23
38. I 2 CHESTP	.28	.29	.58	.39	.37	.39	.42	.42	-.16	**.80**	.34	.29
39. I 3 CHESTP	.20	.26	.59	.46	.35	.34	.52	.54	.00	.38	**.78**	.54
40. I 1 TRUNKT	.38	.44	.32	.46	.32	.30	**.77**	.40	-.13	.51	.57	.51
41. I 2 TRUNKT	.36	.37	.38	.35	.10	.27	**.65**	.29	-.02	**.75**	.37	.26
42. I 3 TRUNKT	.39	.30	.59	.54	.20	.28	**.70**	.59	-.03	.54	.63	.57
43. I 1 BACKEX	.48	.41	.42	.40	.22	.20	**.78**	.74	-.12	.19	.53	.46
44. I 2 BACKEX	.11	.33	**.65**	.50	.33	.41	.48	.60	.01	.59	.57	.40
45. I 3 BACKEX	.32	.43	.61	.57	.29	.27	.59	.54	-.05	.38	**.69**	.43
46. I 1 KNEEEX	.24	.43	**.59**	.38	.55	.44	.39	.52	-.04	.21	.43	.43
47. I 2 KNEEEX	.08	.48	.49	.47	.54	.37	.21	.47	.00	.47	**.59**	.39
48. I 3 KNEEEX	.18	.35	**.73**	.43	.48	.39	.24	.46	-.04	.27	.45	.43
49. I 1 PLFLEX	.25	.61	.39	.44	.23	.24	.59	.38	-.13	.38	**.72**	.32
50. I 2 PLFLEX	.12	**.83**	.27	.30	.21	.25	.30	.35	-.12	.31	.27	.30
51. I 3 PLFLEX	.21	.43	.60	**.63**	.32	.39	.59	.59	-.33	.41	.63	.53
52. I 1 ADDHIP	.23	.19	**.84**	.40	.18	.25	.34	.32	.04	.52	.52	.29
53. I 2 ADDHIP	.24	.44	.62	.56	.29	.47	.42	.43	-.06	**.82**	.42	.40
54. I 3 ADDHIP	.33	.43	.64	**.65**	.27	.24	.59	.61	-.24	.49	.45	.57
55. I 1 ABDHIP	.19	.20	**.84**	.41	.28	.39	.39	.34	.20	.61	.41	.27
56. I 2 ABDHIP	.15	.49	**.66**	.40	.47	.25	.50	.30	-.15	.62	.49	.20
57. I 3 ABDHIP	.37	.34	.54	**.76**	.42	.36	.46	.54	-.15	.30	.58	.49
58. I 1 CALRAI	.46	.13	**.69**	.32	.08	.29	.25	.38	.32	.51	.41	.20
59. I 2 CALRAI	.19	.22	.52	.34	.32	.18	.39	.34	.11	**.82**	.50	.22
60. I 3 CALRAI	.31	.09	**.68**	.44	.24	.14	.45	.40	-.12	.41	.58	.35
	10.54	9.24	15.14	19.85	5.69	12.27	12.40	19.66	2.51	11.50	11.84	16.49

Table 8: Correlation of orthoblique factors in real space with the GK- criterion.

f	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
F1	1.00											
F2	.29	1.00										
F3	.33	.32	1.00									
F4	.56	.48	.56	1.00								
F5	.15	.27	.37	.29	1.00							
F6	.44	.36	.41	.56	.32	1.00						
F7	.37	.38	.50	.50	.23	.28	1.00					
F8	.57	.48	.56	.77	.33	.64	.51	1.00				
F9	19	-.09	.07	.17	-.08	.16	-.02	.18	1.00			
F10	.31	.31	.59	.48	.28	.40	.50	.44	.05	1.00		
F11	.26	.34	.61	.47	.39	.29	.53	.48	-.10	.46	1.00	
F12	.56	.48	.45	.74	.22	.54	.45	.72	.15	.33	.37	1.00

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OBILJEŽJA JEDNOG MODELA MJERENJA MIŠIĆNE AKTIVNOSTI

Sažetak

Istraživanje je provedeno s ciljem da se utvrdi latentna struktura skupa motoričkih manifestacija koje su pod kontrolom i dominatnim utjecajem mehanizma za regulaciju trajanja ekscitacije.

Primjenom šezdeset mjernih instrumenata relativne tjelesne snage željelo se utvrditi postoje li faktori relativne tjelesne snage lokalnih izoliranih mišićnih skupina. Radi toga su konstruirani mjerni instrumenti za procjenu relativne snage čiji je primarni predmet mjerenja: 1. ekstenzija podlaktice u dinamičnom i statičnom načinu rada; 2. adukcija nadlaktice u dinamičnom i statičnom načinu rada; 3. fleksija trupa u dinamičnom i statičnom načinu rada; 4. rotacija trupa u dinamičnom i statičnom načinu rada; 5. ekstenzija trupa u dinamičnom i statičnom načinu rada; 6. ekstenzija potkoljenice u dinamičnom i statičnom načinu rada; 7. fleksija potkoljenice u dinamičnom i statičnom načinu rada; 8. adukcija natkoljenice u dinamičnom i statičnom načinu rada; 9. abdukcija natkoljenice u dinamičnom i statičnom načinu rada i 10. fleksija stopala u dinamičnom i statičnom načinu rada.

Izmjerena je 101 studentica prve i druge godine dodiplomskog studija Agronomskog fakulteta Sveučilišta u Zagrebu. Uzorak je imao slijedeće karakteristike: ispitanice su u stacionarnoj fazi razvoja, dakle u dobi od 19 godina i starije, zdrave su i bez lokomotornih oštećenja, a nastavu tjelesne i zdravstvene kulture redovito su pohađale.

Za istraživanje je izabran uzorak osoba ženskog spola iz više razloga: (a) nedovoljan je broj broj mjernih instrumenata za procjenu relativne snage koji su prilagođeni osobama ženskog spola; (b) želio se dati doprinos malobrojnim istraživanjima o motoričkom prostoru u žena, osobito o segmentu relativne tjelesne snage i (c) autorici je taj uzorak bio dostupan.

Primijenjena je eksplorativna faktorska analiza. Broj značajnih dimenzija u prostoru u kojemu su varijance standardizirane određen je primjenom Guttman–Kaiserova kriterija, prema kojemu je značajna svaka ona glavna komponenta čija je varijanca jednaka ili veća od jedan.

Ustanovljene su osnovne metrijske karakteristike mjernih instrumenata za procjenu repetitivne snage i statičke izdržljivosti. S obzirom da su mjerni instrumenti statičke izdržljivosti cenzurirane varijable, provedena je analiza interkorelacija mjernih instrumenata statičke izdržljivosti odvojeno za necenzurirane i cenzurirane rezultate.

U ukupnom prostoru primijenjenih mjernih instrumenata za procjenu repetitivne snage i statičke izdržljivosti analizirani su osnovni centralni i disperzijski parametri. Primijenjeni mjernih instrumenata, namijenjeni procjeni snage, zadovoljavajuće su osjetljivosti, primjerenosti i pouzdanosti. Posljedica cenzuriranja rezultata za mjerne instrumente statičke izdržljivosti očituje se u višim vrijednostima korelacijskih koeficijenata nego u necenzuriranim rezultatima. Dobiveni su pozitivni, značajni korelacijski koeficijenti u ukupnmo prostoru primijenjenih varijabli koji se kreću u rasponu od ,23 do ,64.

Eksplorativnom faktorskom analizom, pod Guttman-Kaiserovim kriterijem, dobiveno je dvanaest faktora koji iscrpljuju 74,5% zajedničke varijance. Prva glavna komponenta iscrpljuje 40,3% ukupne varijance. Značajne, pozitivne projekcije svih mjernih instrumenata snage na prvu glavnu komponentu definiraju je kao *generalni faktor snage.* Druga komponenta je bipolarna i mjerne instrumente repetitivne snage razlikuje od mjernih instrumenata statičke izdržljivosti. Primjenom Guttman-Kaiserova kriterija iz ukupnoga je prostora izlučeno 12 dimenzija, koje su u kosoj projekciji interpretirane kao: 1. singl faktor repetitivne snage ekstenzora nadlaktice; 2. snaga fleksora potkoljenice; 3. statička izdržljivost donjih ekstremiteta; 4. repetitivna snaga trupa; 5. statička izdržljivost ruku; 6. repetitivna snaga gornjih i donjih ekstremiteta; 7. statička izdržljivost trupa; repetitivna snaga aduktora nadlaktice i ekstenzora trupa; 8. repetitivna snaga fleksora stopala; 9. statička izdržljivost unilateralnih mišićnih skupina; 10. statička izdržljivost i 11. repetitivna snaga donjih ekstremiteta.

Ključne riječi: *mišićna snaga, statička izdržljivost, studentice, metoda najveće vjerojatnosti, faktorska analiza.*