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COMPARATIVE ANALYSIS OF THE CORRELATIONS BETWEEN THE MUSCULAR STRENGTH EVALUATION TESTS FOR THE STUDENTS FROM THE FACULTY OF SPORTS AND PHYSICAL EDUCATION (F.E.F.S.) AND THE STUDENTS FROM THE FACULTY OF AUTOMATIC CONTROL, COMPUTER SCIENCE, ELECTRICAL AND ELECTRONICS ENGINEERING (A.C.I.E.E.)

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Abstract

The physical training of the young generation is the starting point in manifesting their physical qualities at a higher level and achieving a good potential of physical and psychical effort, essential demands of our contemporary society, characterised by dynamism on the work market and more different demands regarding the reconfiguration of the professional skills at short time intervals. The role of the muscular strength, with all its forms of manifestation and combinations with other skills is well-known concerning its favourable influences upon their movement potential, at all ages. Together with the coordinative skills, the muscular strength is considered to be the skill with the most powerful interdependence for the rest of the physical qualities; it determines the efficiency and the stability of learning, consolidating and especially applying physical qualities in different contexts.

The physical quality – strength - is, in fact, present in all elementary movements or the skills characteristic to all disciplines and sports branches. This aspect can be explained by the fact that every physical programme changes into movement only by the voluntary muscular contractions, which are an expression of the manifestation of the dynamic strength of the muscular groups responsible for producing those physical actions.

The data obtained after the planned comparative study will signal the strong, average or weak connections between the tests we used, results that allow an objective look on the favourable or less favourable influences between the different kinds of expression of the tested strength. The analysis of the calculated correlations will allow, for the next steps, an improvement of the process of physical training of the tested groups of students. This improvement – a rational selection and combination of the best methods and means – will be achieved taking into account the characteristics, the strong points and the weak points observed for each group.

Keywords: biophysical skills, muscular strength, correlations, tests, physical potential.

1. Introduction

The effort capacity of the young generation is a defining factor for high efficiency in the professional life. As students' interest in organised or independent physical activities are more and more limited, we need to identify the causes that generate these unwanted situations and the way they can be removed or at least diminished. The use of the questionnaires and of the interview on the tested batches of students allowed us to find number of factors that lead to the weak involvement of the interviewed in the physical activities: limited time because of the overloaded schedule, a sedentary life, an active social network but only on the Internet, fast food that leads to obesity, the need to work in order to have financial independence, etc.

Thus, we can distinguish the following typologies of students: those continuously involved in the performance activities (the lowest percentage of the responders), those relatively constantly involved in the daily activities who chose a healthy lifestyle, based on the physical activities, students who get involved in physical effort only occasionally and who have a sedentary life – most of them – although they are aware of the negative effects of their choice. The two batches of students don't have the same possibilities to express their forms of manifestation of the tested muscular strength. The FEFS batch of students has, from the very beginning, higher values, as a consequence of the long duration qualifying processes, favoured by the specific sports training, compared to the ACIEE batch of students where development and progress are sporadic and only the processes of body maturing together with the implication of some students in physical activities could improve the averages obtained at the tests.

The place of muscular strength in the system of physical qualities is clearly defined, being included in the sphere of conditional physical qualities that strongly consume energy in the development process, together with speed and resistance. These skills are closely connected to the coordinative and complementary ones, human motricity being

frequently a result of the combinations between them and not an effect of the action of a single physical quality. The tests used for the strength evaluation for the two batches of students have taken into consideration the main combinations with the rest of the physical qualities: strength-speed with manifestations generically gathered under the term of force, strength-resistance manifested by force-resistance, muscular resistance of short, medium and long duration, without neglecting the connections of force with the coordinative capacity and with flexibility. Figure 1 presents a synthesis of various sources regarding the qualification of physical qualities, where force has a vital role. [1,2,3,4,9,12,13,14,15,16,17,18]

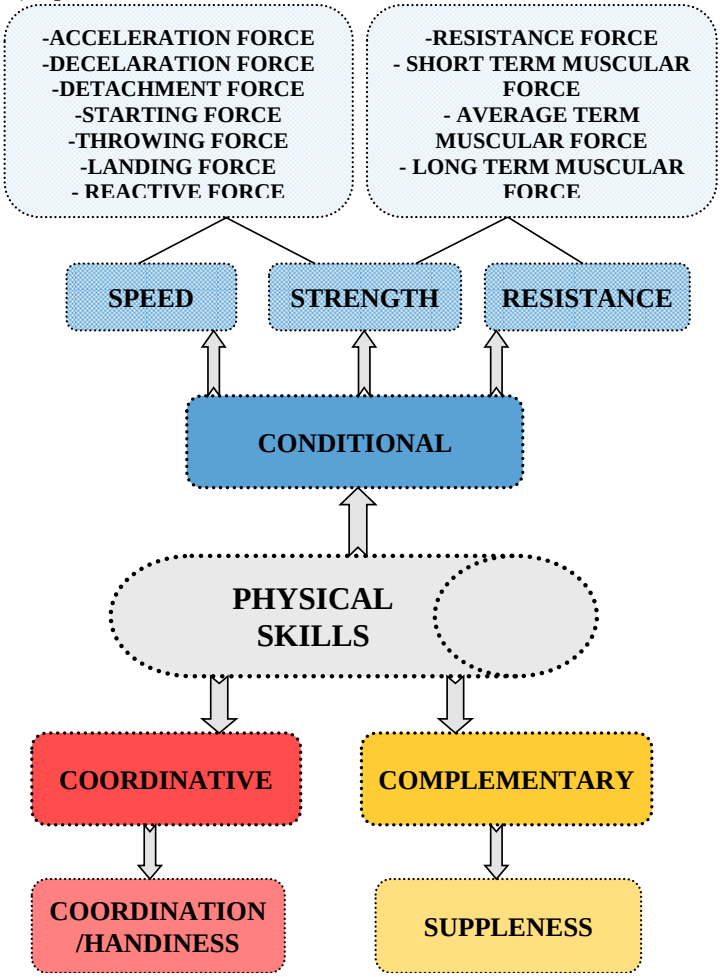

Fig. 2- The position of force in the system of physical skills

2. Problem statement

Our studies from the previous years on different batches of students from various fields of study of the "Dunarea de Jos" University of Galati showed deficiencies in their general physical skills and the active involvement of these categories in the physical activities organised and stipulated in the curriculum or in the independent ones. The limited education level of the muscular strength will have consequences on the general physical training, because of the close connections of this biometrical skill with the rest of the elements that form the physical qualities system. The exercises and the development methodology of the muscular strength are not too attractive and quickly lead to the energy depletion of the body due to the strong requests. That's why they are often avoided, although their contribution to achieving the "wellbeing" and the maximisation of the effort potential recommend them.

3. Purpose of study

Our research aimed at testing and determining the favourable or unfavourable connections between the forms of manifestation and combination of strength with other skills; they were highlighted by the value of the correlation coefficients between the tests we used, resulted from the statistical calculation, separately for the two batches of students. Comparing the number of significant correlations obtained by each study group will allow us to understand the way differences between results are generated by the specific physical training of each group. The data we obtained, allow a subsequent scientific programming of the efforts for each field of study, according to their needs, insisting on favouring the positive transfer between the forms of manifestation of strength and avoiding the interference situation.

4. **Working hypothesis**

Our study will lead to different values of the correlation coefficients calculated for the two batches of students included in the research. We suppose that the number of tests correlated positively and significantly will be higher for the ACIEE batch than for the FEFS batch. This aspect is directly influenced by the different stages of strength development on each batch – stronger for the FEFS – as a direct result of the physical experience and of the planned physical efforts.

5. Research organization and development

The present research resorted to the following methods, synthesized in the specialized literature: [5,6,7,8,10,11,19,20,21].

- *The Analysis of the specialised scientific and methodological literature* allowed us to select the fundamental aspects regarding the muscular strength education process and the age characteristics of the batches included in the research.
- *The Enquiry based on questionnaires and interviews, the Pedagogical Observation* favoured the detection of the preoccupations and the definition of the lifestyle of the young generation and the attitude of the two batches of students towards physical activities.
- *The Method of Measurements and Tests, the Statistical Mathematical Methods of result representation and interpretation* allowed us to define the tests, to gather and statistically study the obtained data and to interpret the thresholds of signification associated to the correlation coefficients.

The two batches of students (56 males from FEFS and 32 males from ACIEE) were tested during the 2012/2013 university year, using 11 tests that evaluate different forms of strength manifestation on different muscular groups and chains. The study used the equipment and the installations belonging to the Faculty of Physical Education and Sport from "Dunarea de Jos" University of Galati, so, from this point of view, we had optimal conditions for conducting the research. The tests we used are:

1. *Trunk lift-ups from a back-down position 30 secs*: the initial position is back-down, palms at the back of the neck, bent knees and soles fixed by a partner or an the fixed ladder; the trunk is lifted and the elbows touch the knees, then back to the initial position. The exercise tests the dynamic abdominal strength. The number of accurate repetitions is recorded. – SNSE test.

2. *Leg lift-ups from a back-down position 30 secs:* the initial position is back-down, palms at the back of the neck; when the signal goes off the student lifts the extended legs vertically and then comes back to the original position, without touching the ground. The exercise tests dynamic abdominal strength. The number of accurate repetitions is recorded. – SNSE test.

3. Trunk extensions from a face-down position 30 secs : from a face-down position, palms at the back of the neck, ankles held by a partner, trunk extensions are performed, lifting the head above the height of the gym bench, then back to the initial position. The exercise tests the dynamic strength of the back muscles. The number of accurate repetitions is recorded. – SNSE test.

4. Simultaneous lift-ups of the arms and legs from a face-down position 30 secs: from a face-down position, strong extensions of the trunk, with the simultaneous lift-up of the extended arms and legs, above the level of the gym bench. The executions lacking the required amplitude or the accurate coordination of arms and legs are not counted. The exercise tests the dynamic strength of the back muscles, the flexibility of the muscle chains under strain and the quality of intersegment coordination.

5. Dynamometry left/right: it measures the maximum strength of the palm flexors. The subject holds the dynamometer in her palm with the forearm extended, flexing the palm with the most strength she can muster, without swinging the body or the arm tested. It is recommended to adjust the dynamometer according to the palm size of each subject taking the test. Two attempts are allowed and the best result is recorded for each palm. The following table shows the value of performance and the qualifications obtained for adult subjects /Stan Z.-2009, p.161:

Table 1: Interpretation of qualifications for the results obtained in dynamometry

Males	**Females**	**Qualification**
> 64	> 38	Excellent
56-64	34-38	Very good
52-56	30-34	Above average

48-52	26-30	Average
44-48	22-26	Below average
40-44	20-22	Weak
< 40	< 20	Very weak

6. Throwing the rounders ball with wind-up: The throw is performed on a marked spot, single-handedly, by throwing the ball over the shoulder. The exercise measures the explosive strength of the able arm. The length of the throw in metres is recorded.
7. Long jump without take-off: the tips of the feet are aligned behind a line, the soles placed at shoulder width, arm swing, doubled by the bending and extension of the legs, energetic impulse, take-off, long jump, concluded by a two-feet landing. The distance in centimetres from the starting line to the heel placed closest to it is measured and recorded. The test determines explosive strength/ lower limb impulse.
8. Maintaining the hanging position: hanging from the fixed bar irrespective of the grip – from above or from below-, a chin-up is performed, until the chin goes above the bar level, and the duration when this position is timed in seconds, until the chin goes under the level of the bar. The exercise determines the static strength in endurance regimen, especially at arm level. Eurofit and SNSE test.
9. Push-ups: From a face-down position, supported by the palms and toes, stretched out body, eyes forward; the arms are bent until the chest gets close to the ground and then the initial position is resumed. The number of successive executions is recorded, without time limit. The motion should be continuous, without interruptions, which would allow the muscles involved in the effort to recover. The test determines the dynamic strength in endurance regimen for the upper limbs muscles. SNSE test.

10. Tractions from a hanging posture: From a hanging posture, arms and body stretched out, either with a forehand or underhand connection, without touching the ground with the soles of the feet. Bending the arms until the chin is above the exercise bar, then coming back to the initial posture. The number of executions is being recorded, while not allowing for any balance of the body. It determines the dynamic force in an arms endurance routine. SNSE trial.
11. Sit-ups: From a sitting position, the subject has to perform 10 successive sit-ups, coming back to the original sitting position, without using the upper limbs—the arms are crossed over the chest. The sit-up technique is freely chosen by the subject. The duration necessary for the 10 sit-ups is recorded, lower times representing superior performance, the exercise tests the muscle strength of the lower limbs, the results being also influenced by the mobility of the joints involved in the effort, and also by adopting an efficient technique.

6. Findings and results, conclusions and recommendations

All the results obtained following the specific muscular strength evaluation tests have been transferred in the calculation pages of the SPSS [Statistical Package for the Social Sciences/version 20] statistical processing program. For both batches included in our study we have observed major problems in finalizing the last test – *Sit-ups* – because of its special characteristics, seldom encountered in the physical activities and because of the execution technique. Thus 15 students from the ACIEE batch of students and 8 students from the FEFS batch couldn't finish it or abandoned it, so that all the tests have been successfully passed by 41 male students from the ACIEE and 24 male students from FEFS.

Determining the type of correlation used for the statistical calculation was done following the establishment of the distribution normality through the values presented in the Shapiro-Wilk test. The results obtained are shown in Table 1. Mention should be made that the distribution of the results is not normal if the significance thresholds have been attained. We have calculated Pearson correlations for the combinations between the tests with normal distribution and the Spearman correlations for those associations where the data distribution is not normal.

Table1 - Tests of Normality

Tests of Normality- Shapiro-Wilk						
	ACIEE students			FEFS students		
	Statistic	df	Sig.	Statistic	df	Sig.
Trunk lift-ups from a back-down position	,976	41	,543	,952	24	,300

Leg lift-ups from a back-down position	,970	41	,352	,928	24	,086
Trunk lift-ups from a face-down position	,960	41	,160	,942	24	,180
Arm and leg lift-ups from a face-down position	,958	41	,136	,933	24	,116
Dynamometry left	,941	41	**,033**	,948	24	,248
Dynamometry right	,965	41	,238	,976	24	,810
Rounders ball throw	,980	41	,678	,978	24	,864
Long jump without take-off	,959	41	,149	,909	24	**,033**
Maintaining the hanging position	,960	41	,159	,952	24	,305
Push-ups	,957	41	,121	,939	24	,155
Tractions from a hanging posture	,918	41	**,006**	,900	24	**,021**
Sit-ups	,862	41	**,000**	,944	24	,198

The types of correlations we used, the sign and the value of the correlation coefficients, the significance thresholds for the ACIEE batch of students are shown in table 2:

The statistical calculation and the interpretation of the resulted coefficients allow us to discover the differences of manifestation of the muscular strength and the interdependence between the tests we used for the students included in our study. The ACIEE batch registers many situations of significant correlations – *34 cases* – out of which 27 correlations and strongly significant, corresponding to the thresholds $P < 0,01$ and 7 of them are significant and corresponding to the thresholds $P < 0,05$. We can explain this situation as a direct effect of a limited level of physical training, where the forms of manifestation of the muscular strength and its combinations with other skills do not exclude themselves, but, on the contrary, sustain each other, even if their conditioning mechanisms and their developing methodology are different and sometimes incompatible.

If their development and manifestation level is weak, the effects of mutual support are more obvious, based on the actions of favourable transfer from one form of manifestation to another. This situation is known in the speciality literature as a positive transfer, often observed to the beginners or to those who have a low training level, when the accumulations gained for a physical skill will favour progress in the manifestation of other skills, even if their energetic mechanisms are different. For example: favourable transfer from force to speed, from force to resistance, etc.

Compared to the ACIEE batch of students, we have observed less significant correlations to the FEFS one: only 13, out of which 7 correlations are strongly significant and corresponding to thresholds $P < 0,01$, while 6 correlations are significant and corresponding to thresholds $P < 0,05$. This aspect can be explained by the fact that the higher levels of specific physical training and the sports specialization lead to the phenomenon of negative transfer or interference to the physical skills level. In this case we observe a drastic decrease of the number of signalled positive correlations, each sports branch involving only certain groups and muscular chains and stressing only certain forms of force manifestation: explosive at the level of the arms or of the legs, maximal, dynamic, isometric, strength under stress, etc. These situations trigger incompatibilities in the developing process of the different forms of strength manifestation, any higher threshold attained with a certain form, not being strongly correlated with the development of another form of manifestation or combinations that involve another kind of effort: for example the maximal force of some muscular groups with force under stress of the same muscles. *To conclude, the data obtained by the statistic calculation radically change from one batch to another, confirming the working hypothesis.* This aspect reinforces the idea that the initial training stage observed and the sports diversified specializations will decisively influence the positive or negative relations between all forms of manifestation of the muscular strength, tested during the study.

Another aspect that needs to be mentioned is that of the mainly negative significant correlations that the test *Sit-ups* realizes with the rest of the tests; the explanation is that it is the only test with atypical characteristics to which high results correspond to lower performance. For example: the more the students need time to perform the 10 sit-ups, the weaker the result and vice-versa, the lower the time, the better the result. Therefore we are going to analyse the results of the correlations for this test only in absolute terms.

For the ACIEE batch of students we have calculated strong and significant positive correlations for a threshold < 0,01 for the following combinations of tests:

- *Trunk lift-ups from a back-down position* with *Leg lift-ups from a back-down position* – both tests stressing the abdominal muscles, with different execution.
- *Trunk lift-ups from a back-down position* with *Leg lift-ups from a back-down position* with: *Throwing the rounders ball with wind-up, Long jump without take-off, Maintaining the hanging position, Push-ups, Tractions from a hanging posture* – highlight the vital role that the abdominal muscles have for the throwing movements, the postural stability, the isometric stress and marinating the body balance for the last 3 tests, although it doesn't act as a triggering factor of the movements not even for one test.
- *Dynamometry left* with *Dynamometry right*, both exercises testing the maximal contraction strength of the palm flexors and where can also be manifested the crossed transfer: from one segment to the pair/homologous segment.

- *Simultaneous lift-ups of the arms and legs from a face-down position* and *Trunk extensions from a face-down position* – both testing strength and mobility of the back muscles, the second test being more complex through the more difficult actions of coordination and synchronization.

- *Trunk extensions from a face-down position* with *Maintaining the hanging position*, which proves the important role of the back muscles in the body balance and stabilization for the second test.

	Trunk lift-ups from a back-down position	Leg lift-ups from a back-down position	Trunk lift-ups from a face-down position	Arm and leg lift0ups from a face-down position	Dynamometry left	Dynamometry right	Rounders ball throw	Long jump without take-off	Maintaining the hanging position	Push-ups	Tractions from a hanging posture	Sit-ups
Trunk lift-ups from a back-down position	-	**Prs ,602** Sig. ,000 N=56**	**Prs ,305* Sig. ,022 N=56**	**Prs ,229 Sig. ,089 N=56**	**Spr -,061 Sig. ,657 N=56**	**Prs ,047 Sig. ,737 N=56**	**Prs ,529** Sig. ,000 N=56**	**Prs ,634** Sig. ,000 N=56**	**Prs ,418** Sig. ,001 N=56**	**Prs ,574** Sig. ,000 N=56**	**Spr ,515** Sig. ,018 N=56**	**Spr -,328* Sig. ,036 N=41**
Leg lift-ups from a back-down position		-	**Prs ,264* Sig. ,049 N=56**	**Prs ,157* Sig. ,249 N=56**	**Sprm -,035 Sig. ,796 N=56**	**Prs ,063 Sig. ,646 N=56**	**Prs ,390** Sig. ,003 N=56**	**Prs ,415** Sig. ,001 N=56**	**Prs ,378** Sig. ,004 N=56**	**Prs ,488** Sig. ,000 N=56**	**Spr ,564** Sig. ,000 N=56**	**Spr -,266 Sig. ,093 N=41**
Trunk lift-ups from a face-down position			-	**Prs ,626** Sig. ,000 N=56**	**Spr -,029 Sig. ,833 N=56**	**Prs -,138 Sig. ,310 N=56**	**Prs ,170 Sig. ,210 N=56**	**Prs ,323* Sig. ,015 N=56**	**Prs ,371** Sig. ,005 N=56**	**Prs ,224 Sig. ,097 N=56**	**Spr ,099 Sig. ,466 N=56**	**Spr -,153 Sig. ,340 N=41**
Arm and leg lift-ups from a face-down position				-	**Spr -,186 Sig. ,171 N=56**	**Prs -,193 Sig. ,155 N=56**	**Prs ,073 Sig. ,595 N=56**	**Prs ,156 Sig. ,252 N=56**	**Prs ,299* Sig. ,025 N=56**	**Prs ,174 Sig. ,199 N=56**	**Spr ,121 Sig. ,373 N=56**	**Spr -,226 Sig. ,156 N=41**
Dynamometry left					-	**Spr ,755** Sig. ,000 N=56**	**Spr ,114 Sig. ,404 N=56**	**Spr ,100 Sig. ,462 N=56**	**Sprm ,019 Sig. ,891 N=56**	**Sprm ,047 Sig. ,732 N=56**	**Spr ,023 Sig. ,866 N=56**	**Spr ,326* Sig. ,038 N=41**
Dynamometry right						-	**Prs ,142 Sig. ,297 N=56**	**Prs ,078 Sig. ,569 N=56**	**Prs ,041 Sig. ,765 N=56**	**Prs ,205 Sig. ,130 N=56**	**Spr ,151 Sig. ,268 N=56**	**Spr ,247 Sig. ,120 N=41**
Rounders ball throw							-	**Prs ,525** Sig. ,000 N=56**	**Prs ,427** Sig. ,001 N=56**	**Prs ,493** Sig. ,000 N=56**	**Spr ,481** Sig. ,000 N=56**	**Spr -,418** Sig. ,007 N=41**
Long jump without take-off								-	**Prs ,575** Sig. ,000 N=56**	**Prs ,617** Sig. ,000 N=56**	**Spr ,619** Sig. ,000 N=56**	**Spr -,422** Sig. ,006 N=41**
Maintaining the hanging position									-	**Prs ,574** Sig. ,000 N=56**	**Spr ,612** Sig. ,000 N=56**	**Spr -,427** Sig. ,005 N=41**

Push-ups										-	**Spr ,846** Sig. ,000 N=56**	**Spr -,321* Sig. ,041 N=41**
Tractions from a hanging posture												**Spr -,284 Sig. ,072 N=41**
Sit-ups												-

Table 2: The value of the correlation coefficients for the strength tests, the signification threshold and the number of cases / ACIEE batch of male students

Note: ***** Correlation is significant at the 0.05 level (2-tailed).
****** Correlation is significant at the 0.01 level (2-tailed).
Spr – Spearman Correlation Coefficient
Prs – Pearson Correlation Coefficient

	Trunk lift-ups from a back-down position	Leg lift-ups from a back-down position	Trunk lift-ups from a face-down position	Arm and leg lift0ups from a face-down position	Dynamometry left	Dynamometry right	Rounders ball throw	Long jump without take-off	Maintaining the hanging position	Push-ups	Tractions from a hanging posture	Sit-ups
Trunk lift-ups from a back-down position	-	**Prs ,587** Sig. ,000 N=32**	**Prs ,299 Sig. ,096 N=32**	**Prs ,539** Sig. ,001 N=32**	**Prs -,029 Sig. ,874 N=32**	**Prs ,075 Sig. ,685 N=32**	**Prs ,008 Sig. ,967 N=32**	**Spr -,074 Sig. ,688 N=32**	**Prs ,048 Sig. ,793 N=32**	**Prs ,268 Sig. ,138 N=32**	**Spr ,132 Sig. ,470 N=32**	**Prs -,286 Sig. ,175 N=24**
Leg lift-ups from a back-down position		-	**Prs ,206 Sig. ,258 N=32**	**Prs ,610** Sig. ,000 N=32**	**Prs ,280 Sig. ,121 N=32**	**Prs ,294 Sig. ,102 N=32**	**Prs ,302 Sig. ,093 N=32**	**Spr ,160 Sig. ,381 N=32**	**Prs ,288 Sig. ,110 N=32**	**Prs ,213 Sig. ,242 N=32**	**Spr ,358* Sig. ,044 N=32**	**Prs -,061 Sig. ,776 N=24**
Trunk lift-ups from a face-down position			-	**Prs ,116 Sig. ,526 N=32**	**Prs ,064 Sig. ,727 N=32**	**Prs ,065 Sig. ,623 N=32**	**Prs -,090 Sig. ,625 N=32**	**Spr ,012 Sig. ,948 N=32**	**Prs ,278 Sig. ,124 N=32**	**Prs ,219 Sig. ,229 N=32**	**Spr ,292 Sig. ,105 N=32**	**Prs -,300 Sig. ,155 N=24**
Arm and leg lift-ups from a face-down position				-	**Prs -044 Sig. 811 N=32**	**Prs ,027 Sig. 885 N=32**	**Prs ,094 Sig. ,610 N=32**	**Spr ,069 Sig. ,608 N=32**	**Prs ,194 Sig. ,287 N=32**	**Prs ,136 Sig. ,457 N=32**	**Spr ,228 Sig. ,209 N=32**	**Prs -,495* Sig. ,014 N=24**
Dynamometry left					-	**Prs ,850****	**Prs ,484****	**Spr ,262 Sig. ,148**	**Prs ,097 Sig. ,597**	**Prs ,288**	**Spr ,317 Sig. ,077**	**Prs ,017 Sig. ,936**

						Sig. ,000 N=32	**Sig. ,005 N=32**	**N=32**	**N=32**	**Sig. ,110 N=32**	**N=32**	**N=24**
Dynamometry right						-	**Prs ,413* Sig. ,019 N=32**	**Spr ,245 Sig. ,177 N=32**	**Prs ,113 Sig. ,536 N=32**	**Prs ,314 Sig. ,080 N=32**	**Spr ,359* Sig. ,044 N=32**	**Prs -,124 Sig. ,563 N=24**
Rounders ball throw							-	**Spr ,573** Sig. ,001 N=32**	**Prs ,105 Sig. ,567 N=32**	**Prs ,324 Sig. ,070 N=32**	**Spr ,329 Sig. ,066 N=32**	**Prs ,238 Sig. ,263 N=24**
Long jump without take-off								-	**Spr ,313 Sig. ,082 N=32**	**Spr ,353* Sig. ,048 N=32**	**Spr ,506** Sig. ,003 N=32**	**Spr -,013 Sig. ,951 N=24**
Maintaining the hanging position									-	**Prs ,169 Sig. ,355 N=32**	**Spr ,408* Sig. ,020 N=32**	**Prs -,267 Sig. ,207 N=24**
Push-ups										-	**Spr ,808** Sig. ,000 N=32**	**Prs ,083 Sig. ,699 N=24**
Tractions from a hanging posture												**Spr -,008 Sig. ,969 N=24**
Sit-ups												-

Table 3: The value of the correlation coefficients for the strength tests, the signification threshold and the number of cases / FEFS batch of male students

Note: ***** Correlation is significant at the 0.05 level (2-tailed).
****** Correlation is significant at the 0.01 level (2-tailed).
Spr – Spearman Correlation Coefficient
Prs – Pearson Correlation Coefficient

- *Throwing the rounders ball* with *Long jump without take-off* – as a possible transfer of the explosive force in the lower limbs – but also with *Maintaining the hanging position*, *Push-ups*, *Tractions from a hanging posture* and *Sit-ups*, the last 4 tests supposing strength manifestation under stress; the strong correlations can only be explained as an effect of a deficient training.
- *Long jump without take-off* with: *Maintaining the hanging position*, *Push-ups*, *Tractions from a hanging posture* and *Sit-ups* –in this last case being possible the transfer of the explosion of the movement in the impulsion stage at the level of the lower limbs, in order to favour the *Sit-ups*.
- *Maintaining the hanging position* with: *Push-ups*, *Tractions from a hanging posture* and *Sit-ups* – justifies the transfer from the static strength manifested in the upper-limbs to the dynamic strength of the same body areas but also to the dynamic strength of the lower limbs.
- *Push-ups* with *Tractions from a hanging posture*, where we have one of the highest indicators of the correlation coefficient, almost unitary (,846). Both tests measure the dynamic strength under stress of the arms and of the upper part of the body, but for different groups of muscles different as an action agonist/antagonist.

Significant positive correlations for the ACIEE batch of males, but for a threshold < 0,05 are found to the following combinations of tests:

- *Trunk extensions from a face-down position* with *Trunk lift-ups from a back-down position* and *Leg lift-ups from a back-down position*, proves the connection between the strength of the back and of the abdominal muscles.
- *Trunk extensions from a face-down position* with *Long jump without take-off*, aspect that indicates the importance of the trunk extension while performing the second test.
- *Simultaneous lift-ups of the arms and legs from a face-down position* cu *Maintaining the hanging position*.
- *Sit-ups* cu: *Trunk lift-ups from a back-down position*, *Dynamometry left* and *Push-ups*.

The rest of the calculated correlations – positive or negative – are not significant, so the association between those tests is weak.

For the FEFS batch of students we calculated strong, positive and significant correlations for the following combinations of tests – see table 3. They are not always the same, as for the previously analysed batch of students, because the higher level of physical training and the sports specialisations do not allow us to register a high number of significant associations between tests. Positive and significant correlations for a threshold < 0,01 are to be found for the following associations of tests:

- *Trunk lift-ups from a back-down position* with *Leg lift-ups from a back-down position* –both tests involve the abdominal muscles, with a different technique and higher difficulty for the second variant.
- *Simultaneous lift-ups of the arms and legs from a face-down position* with: *Trunk extensions from a face-down position* and *Leg lift-ups from a back-down position* – highlight the strong interrelationship between the level of the abdominal and of the back muscular strength.
- *Dynamometry left* with *Dynamometry right* and *The rounders ball throw*, the positive correlation with the last test being explained by the strong stress of the upper limbs muscles with the arm perfectly stretched in order to test the maximum contraction force of the palmar flexors, even if at *The rounders ball throw* the effort is explosive and is addressed to other muscle groups and articulations, too.
- *The rounders ball throw* with *The long jump without take-off*, both involving the muscular contraction of the quick fibres in order to achieve the explosive kind of efforts.
- *Tractions from a hanging posture* with *The long jump without take-off* and *Push-ups*, the last two tests supposing the combination force – resistance.

Significant positive correlations for the FEFS batch of students – but for a threshold < 0,05- were observed for the following combinations of tests:

- *Tractions from a hanging posture* with *Leg lift-ups from a back-down position*, highlighting the role of the abdominal muscles in the execution of the first test
- *Dynamometry right* and *Maintaining the hanging position*

For the last combination, the same groups of muscles are strongly stressed and the execution position is identical, the difference consisting of the tested kind if strength: dynamic and then static under stress.

- *Dynamometry right* with *Throwing the rounders ball*
- *Push-ups* with *Long jump without take-off*
- *Sit-ups* with *Simultaneous lift-ups of the arms and legs from a face-down position*

The other correlations between the tests demonstrate that, for the FEFS batch of students, the associations are not significant; the phenomena of positive transfer are limited between the different kinds of strength, compared to the situation of the other group of students. It follows that sports specializations will develop into a strict selection of those combinations of motor skills required by the competitive effort, in the hypertrophy of the muscular chains that frequently take part in the technical procedures, in the training of those combinations of energetic systems imposed by the competitive effort. In these situations, any stresses that do not correspond to the model of strength training required by that sports branch will lead to the interferences between skills and to the performance regression, situations that need to be avoided. For example the development of the muscular resistance in sports where maximal force is not really needed.

All forms of manifestation of the muscular strength are elements of a system, with stronger or weaker connections between them, conditioned by the characteristics of physical training and the field of study of the tested batches of students. The same study, tested on the groups of female students from the two faculties showed different results between the correlated tests, compared to those registered for the male students. The positive and significant correlations observed between tests point out that those forms of manifestation or combinations support each other and can be planned in the same training process while the non-significant and the negative associations should be avoided.

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