8. Peters PG1, Alessio HM, Hagerman AE, Ashton T, Nagy S, Wiley RL. Short-term isometric exercise reduces systolic blood pressure in hypertensive adults: possible role of reactive oxygen species. Int J Cardiol. 2006 16;110(2):199-205.
9. McNulty CL1, Moody WE, Wagenmakers AJ, Fisher JP. Effect of muscle metaboreflex activation on central hemodynamics and cardiac function in humans. Appl Physiol Nutr Metab. 2014 ;39(8):861-70.

COMPARATIVE ANALYSIS OF THE DEVELOPMENT OF THE MUSCULAR STRENGTH OF 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

This paper aims at comparing the level of manifestation of the muscular strength of the university students; this period of studies coincides with the full maturity of the organism and a great improvement at all levels: morphological, physiological, psychological, regarding their personality, the education and the valorisation of their intellectual and physical qualities. The tests we used are the same for the two batches of males included in our study, a series of 11 tests that check the level of manifestation of different kinds of strength and their combination with the other physical conditioned qualities: resistance, speed, general coordination and flexibility. We have compared the results and we have analysed the significance of the performance difference between the students from the two different areas of studies and concluded that there are good premises to continuously improve the muscular strength.

The results obtained by the students of the Faculty of Sports and Physical Education (F.E.F.S.) are, for most tests, better than their colleagues' and this is due to the improvements achieved during the years of specialized sports training and not as the effect of a unique training programme conceived and applied before the tests. The students from the Faculty of Automatic Control, Computer Science, Electrical and Electronics Engineering (A.C.I.E.E.) have weaker results and only for certain tests these results are almost equal to the results of their colleagues; we consider this an accurate image of the poor level of physical training and limited concerns for an active lifestyle.

A higher level of physical education – where the muscular strength is vital – is one of the main goals of the performance sports and of the sports classes for students from other fields of study. The more they are trained in this field, the more they have favourable conditions to manifest physical qualities in various fields: performance sports, mass sports activities and loisir.

Keywords: dynamic and static muscular strength, conditional physical qualities, physical effort, physical training, fitness

1. Introduction

The muscular strength is considered a defining element of the physical capacity, also named "fitness" in English, and a major factor that allows improvement of the physical activities and represents an essential condition for a better life. For the active people of the modern society, fitness has become a way of life with great positive impact on health, effort capacity, body aspect and psychic comfort.

The sport specialists Dragnea A., Bota A./ 1999/ pages 223-224 consider the forms of manifestation of muscular strength as basic elements for the two known categories of fitness: general fitness and motor fitness, shown in figure 1. If for the general fitness its components are easily perfectible by training and a healthy person can improve them by an appropriate training, for the motor fitness [25] there are some limits imposed by the hereditary component, the combination between force and speed – also known as the explosive force, the detent or the strength – or between force and coordination – reflected in the quick change of direction or agility; they are more difficult to achieve and progress is slower.

If we analyse the elements from figure 1, we can easily conclude that strength is considered to be a vital factor of the movement capacity in every step of the individual ontogenetic development, being, in fact, the engine that allows the execution of all movements, no matter their complexity or difficulty. Thus, the process of learning and efficiently applying the elementary or specific physical abilities is strongly influenced and conditioned by the level of development of the muscular strength. This process of developing the muscular strength shouldn't be approached as a purpose itself, but as a way of improving movements and increasing the general and specific effort capacity for different kinds of sports. This physical quality shouldn't be regarded and analysed as a sole element but as an element that strongly conditions the level of manifestation of the other physical qualities like: resistance, coordination, flexibility and speed. Tudor V., Crişan D.I/ 2007, pag. 89.

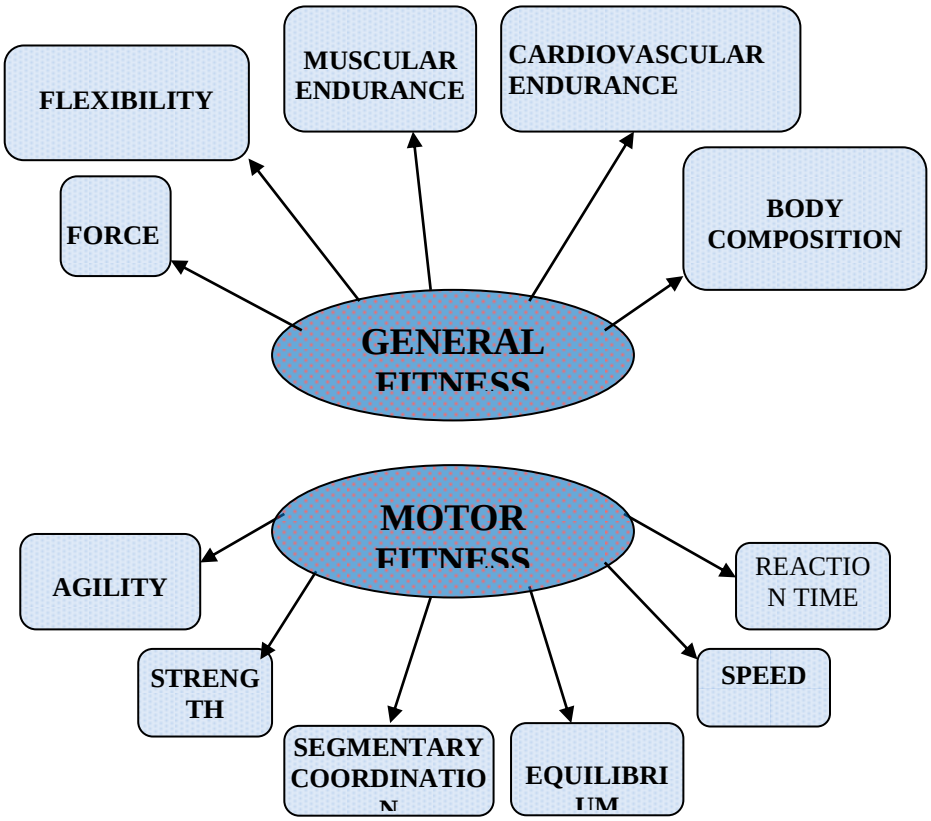

Figure 1 – Categories of fitness and types of muscular strength

The last decades have brought into attention important results of the scientific research that lead to the optimization of the work methodology by specific procedures and means adapted to each form of manifestation and combinations of the strength with other physical qualities, by studying the effects of each type of muscular contraction or by the combination of the different regimes of muscular contractions: concentric, eccentric, isometric, auxotonic, isokinetic. [1,2,3,4,5,16,17,22]

Beside the appropriate work methodology, the process of strength development can be favoured or limited by different morphological, physiological, biochemical and psychological factors or by different factors: the type of muscular fibre, the muscular thickness in section, the quality of the intramuscular and intermuscular coordination, the duration and the intensity of the muscular contraction, the dominant constitutional type, the energetic supplies and the muscular sanguine irrigation, fatigue, age and sex, the level and period of training, the articular angle and the type of lever according to the movement, the circadian rhythm, the number of muscular fibres involved according to the load, the frequency and the intensity of trainings, the muscular elasticity, concentration and motivation etc. [11,19,20,21]

For students, the motivation to execute strength exercises has many aspects: a good physical training, achieving harmony, proportionality and muscular definition, achieving some compensation effects of the deficiencies and of the deficient attitudes of the spine or other body segments, developing the frequently used muscular batches and chains or, on the contrary, of the less used ones, restoring the physical and psychical strength after intense and prolonged intellectual efforts. The maturing of the major body systems and functions offers the advantage of superior values on muscle strength indices that can be touched, being annulled the restrictions related to the charge value or the limitation of using some methods from the previous stages. The age interval 20 – 30 years old allows to obtain better result in manifesting all of the types of muscular strength, results that will decrease with age.

2. Problem statement

The level of development of the muscular strength highly influences the quality of the physical skills of the students, no matter their field of study and physical training level. Objectively determining the values of manifestation of this metrical aptitude constitutes a starting point for further specific training programmes, in order to remedy the physical training weaknesses identified in both physical education classes and sports training. Following the research regarding the components of the physical ability, carried out in the previous years on batches of students from different fields of study, we could observe a poor degree of training for all the tested elements. This reduction of the physical possibilities has multiple causes: less hours of physical education in high school but also at university, a chaotic life style, poor nutrition, sedentary habits, lack of a strong motivation for sports, overloaded school schedule, student involvement in

other activities for financial self-sustainability, the failure to acknowledge the negative effects of the lack of movement on long-term health.

Purpose of study: It targets the testing and interpretation of the results obtained by the two batches of students from FEFS and ACIEE at the tests for determining the degree of evolution of the types of muscular strength and of its combinations with other physical aptitudes. The calculation of the differences between the averages of the two batches and then the statistical analysis of these differences allows us to appreciate the way in which the physical trainings and the scientifically planned physical effort in the previous years – for the FEFS students – lead to significant progress compared to the ACIEE students. Thus, we can notice the forms of manifestation of strength where we don't have to insist anymore but also those forms or combinations where training is deficient and we should intervene by new stimulus and specific training methods.

Working hypothesis: We left from the premise that we are going to obtain major differences between the levels of manifestation of strength for the two batches of students, at all tests, and that these differences will be confirmed as significant following the statistic calculation.

3. Research organization and development

The scientific research, was based on different methods, observing the instructions and regulations stipulated in the specialized literature [7,8,9,10,13,14,23,24]: the analysis of the specialized scientific and methodical literature, the survey based on the questionnaire and on the interview, the guided pedagogical observation, measuring and testing, statistical and mathematical methods of graphical representation and interpretation of the results.

The batches of students (32 males from FEFS and 56 males from ACIEE) were tested during the 2012/2013 university year. We have used the material basis and the equipment from the Faculty of Sports and Physical Education and the Research Centre for Human Performance. The set of tests consisted of 11 tests that investigated the development level of the different forms of manifestation and combinations of the muscular strength. The tests are as follows:

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 strength in an arms endurance routine. SNSE test.
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.

4. Findings and results

The data obtained have been transferred and analysed with the SPSS [Statistical Package for the Social Sciences]. Figure 2 graphically shows the dynamics of the performances of the batches of students.

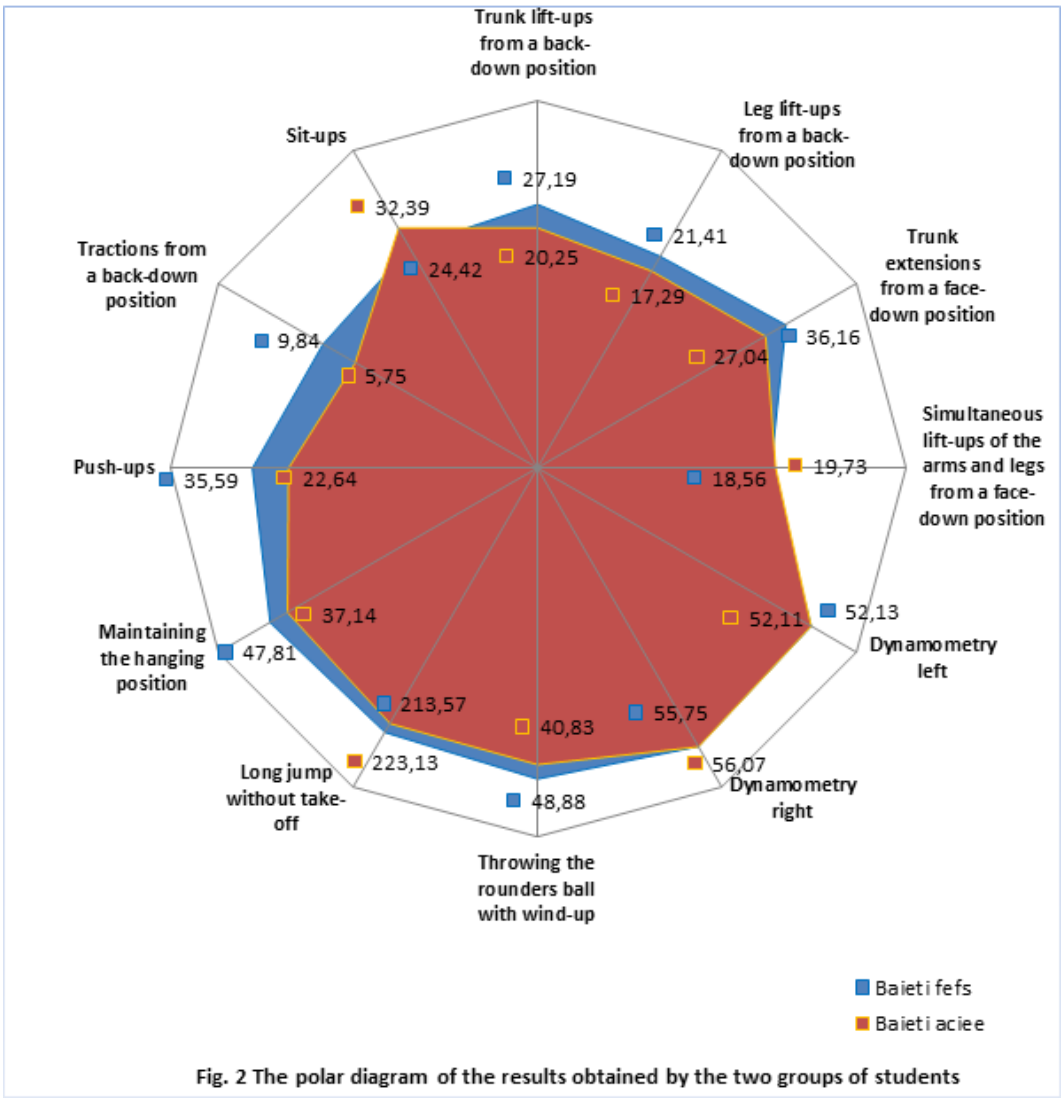

Fig. 2 The polar diagram of the results obtained by the two groups of students

The results obtained, the average values for the two batches of students –FEFS and ACIEE- and the significance of the recorded differences are shown in Table 2. We can easily notice that at 8 of the 12 tests that we used, the recorded differences between the average values of the two batches are significant, aspects confirmed by the statistical calculations, concretized in the values of **t** and the related thresholds of significance / **P/Sig.** Except for the last test –where students from both batches abandoned the exercise or were unable to finish it – to all the other tests the number of students stayed the same during testing.

Table 2 – Main statistical indicators for the batches of males tested for strength

No.	Test	Batch type/no. of cases	Average	Average difference	Std. error average	Std. deviation	t	P/Sig. 2 tailed
1	**Trunk lift-ups from a back-down position**	Males FEFS (32) Males ACIEE (56)	27,19 20,25	6,938	,723 ,615	4,091 4,605	7,305	**,000*****
2	**Leg lift-ups from a back-down position**	Males FEFS (32) Males ACIEE (56)	21,41 17,29	4,121	,751 ,440	4,249 3,290	4,734	**,000*****
3	**Trunk lift-ups from a face-down position**	Males FEFS (32) Males ACIEE (56)	36,13 27,04	9,121	,671 ,980	3,794 7,336	7,679	**,000*****
4	**Arm and leg lift-ups from a face-down**	Males FEFS (32) Males ACIEE	18,56 19,73	-1,170	1,849 ,995	10,460 7,448	-,557	**,580**

	position	(56)						
5	**Dynamometry left**	Males FEFS (32) Males ACIEE (56)	52,13 52,11	,018	1,995 ,915	11,287 6,851	,008	**,994**
6	**Dynamometry right**	Males FEFS (32) Males ACIEE (56)	55,75 56,07	-,321	1,894 ,988	10,716 7,390	-,150	**,881**
7	**Rounders ball throw**	Males FEFS (32) Males ACIEE (56)	48,88 40,83	8,045	1,441 1,067	8,151 7,988	4,486	**,000*****
8	**Long jump without take-off**	Males FEFS (32) Males ACIEE (56)	223,13 213,57	9,554	3,604 3,637	20,389 27,215	1,866	**,066**
9	**Maintaining the hanging position**	Males FEFS (32) Males ACIEE (56)	47,81 37,14	10,672	3,481 2,799	19,693 20,950	2,389	**,020***
10	**Push-ups**	Males FEFS (32) Males ACIEE (56)	35,59 22,64	12,951	2,667 1,487	15,089 11,131	4,241	**,000*****
11	**Tractions from a back-down position**	Males FEFS (32) Males ACIEE (56)	9,84 5,75	4,094	1,079 ,585	6,102 4,375	3,337	**,002****
12	**Sit-ups**	Males FEFS (24) Males ACIEE (41)	24,42 32,39	-7,967	1,360 1,728	6,666 11,067	-3,622	**,001*****

*(P<0,05) ; **(P≤0,01) ; ***(P≤0,001)

In the test *Trunk lift-ups from a back-down position* we obtained a difference between the average values of the two batches of 6,938 repetitions in favour of the batch of males from FEFS. This result corresponds to a **t**= 7,305, corresponding to a threshold of significance P=,000, value < ,001, so *the difference that we obtained is considerable*. As most of the sport branches strongly involve the abdominal muscles, the difference between the performances obtained for the two batches is normal.

In the test *Leg lift-ups from a back-down position* we obtained an average difference of 4,121 repetitions in favour of the students from FEFS, compared to the results of the students from ACIEE. The obtained value is associated to a **t**= 4,734, corresponding to a threshold of significance P=,000, value < ,001, so, for this test, too, *the difference between the average performances of the two batches is considerable.*

Still, both batches of students have obtained lower average values than the previous test, although the two tests concern the education degree of the abdominal muscular strength. A justification of this lower average number can be given by a characteristic of the execution technique at this test, more difficult than in the first variant, involving dynamic muscular contractions but also static / isometric strength for keeping the legs stretched, especially at the last part of the movement.

In the test *Trunk lift-ups from a face-down position* we obtained a difference of 9,121 repetitions in favour of the students from the FEFS. The value of the difference corresponds to a **t**= 7,679, corresponding to a threshold of significance P=,000, value < ,001, so *the difference that we obtained in this test, too, is considerable.* The explanation of this difference is that most of the students from FEFS are very familiar to the execution technique of this test which is frequently used in the training periods for educating and testing the muscular strength of the back, with favourable direct effects on the flexibility in the lumbar region.

In the test *Arm and leg lift-ups from a face-down position* the difference between the two batches of students - FEFS and ACIEE – is of -1,170 repetitions. ***It is one of the very few tests where the average values of the ACIEE batch of students are slightly superior to the average values of the FEFS batch; this is a surprising result.*** Although the recorded difference corresponds to a **t**= -,557, corresponding to a threshold of significance P =,580, value > ,05, so *the difference is not considerable in this test.* The average values of the two batches of students are lower compared to the previous test, even if both tests check the dynamic strength of the back muscles. A possible explanation may be the

increased difficulty and complexity of the analysed test, which involves not only dynamic strength but also mobility, together with the coordination and the synchronization of the upper and lower limbs in the ascending and descending steps in order to ensure fluency and fluidity of the movement.

In the test *Dynamometry left* we have observed and recorded differences of only ,018 kg-strength in favour of the FEFS batch, so we can easily conclude that the results are equal for the two batches of students. The result corresponds to a **t**=,008, corresponding to a threshold of significance P=,994, value > ,05, ***so this is another test where the difference is not significant.*** The average values of the two batches -52,13 kg-strength for the FEFS students and 52,11 kg-strength for the ACIEE students correspond to the rating *above average*, by reporting the performances to the annexed table where we have described the tests. As the left arm is usually less dexterous and less used in the physical activity, the similarity of the values obtained by the two batches is thus explained.

The results in the test *Dynamometry right* are ***surprising.*** The difference between the average of the FEFS batch and the ACIEE one is of -,321 kg-strength, so the result of the ACIEE batch is slightly superior to the result of the FEFS batch of students. This value of the difference that corresponds to a **t**= -,150, corresponding to a threshold of significance P= ,881, value > ,05, so the difference obtained is non-significant. The average value of the FEFS batch of 55,75 kg-strength corresponds to the rating *above average*, while the average of the ACIEE batch of 56,07 kg-strength corresponds to the rating *very good*. Both batches obtain in the *Dynamometry right* test better results than in the *Dynamometry left*, a normal result taking into account that the right arm is more frequently used in physical activities.

The test *Rounders ball throw* presents a difference of 8,045 m between the two batches of students, in favour of the students from FEFS. This value corresponds to a **t**= 4,486, a value corresponding to a threshold of significance P =,000, result < ,001, the recorded difference being significant. The obtained values and differences are normal, taking into account that the explosive force of the upper limbs is frequently used and developed in the athletic throws, martial arts, basketball, volleyball etc.

In the test *Long jump without take-off* we obtained an average difference of 9,554 cm in favour of the FEFS batch. The result corresponds to a **t**= 1,866, a value corresponding to a threshold of significance P=,066, a value that is > ,05, and the *difference obtained is non-significant* in this test, too. This aspect implies that for the FEFS batch, for the lower limbs, the combination strength-speed/expansion is not as developed as for the upper limbs. It is the last test in which the analysed differences are non-significant from a statistical point of view.

In the test *Maintaining the hanging position* we recorded an average difference of 0,672 sec. in favour of the FEFS batch. All the students / males from the two batches have succeeded in finalising this test, considered to be more difficult – because of its static characteristics, the muscular tensions and the strong articular solicitations, the blocked thorax that limits the amplitude of the respiratory movements – and which led to numerous cases of failure / abandon for the same study on females from the same two fields of study. The value **t**= 2,389 corresponds to a threshold of significance P=,020, value ≤ ,05, so, in this case, the registered difference is significant.

In the test *Push-ups* we have registered an average difference between of 12,951 repetitions in favour of the FEFS students, a result that corresponds to a **t**= 4241 which means a threshold of significance P=,000, value < ,001, so, in this case, too, *the obtained difference is significant*. The big difference between the averages of the two batches proves the higher level of physical training of the FEFS students for the combination strength at the upper limbs level, being the consequence of their constant preoccupations.

The results of the test *Tractions from a back-down position* – with the palms supinated – indicates a difference between the average values of the two batches of 4,094 repetitions in favour of the FEFS students. The result corresponds to a value **t**= 3,337 that corresponds to a threshold of significance P=,002, value < ,01, that indicates a *significant difference.* Because of its difficulty, this test for the evaluation of the dynamic strength is the only one that was exclusively tested on the male batches.

The test *Sit-ups* is also the only one that hasn't been finished by members of both batches. Thus, we have recorded 8 cases of abandonment or impossibility to finalize it from the FEFS batch and 15 such cases in the ACIEE batch. A note should be made that, at this test, none of the female students from FEFS abandoned, the test being particularly difficult for males, involving muscular strength, equilibrium, coordination, techniques for a good execution and mobility. The difference between the two average values is of -7,967 sec. in favour of the FEFS batch, a value that corresponds to a **t**= -3,622, associated to a threshold of significance P=,001, value ≤ ,001, so the *difference obtained at this last test is significant*. It is the only test with atypical characteristics from the applied set of tests – the higher the result / time, the lower the performance. The high difficulty of this test is also due to its special demands that suppose the inactivity of the arms and trying to stand up using only the inferior limbs, from an uncomfortable position. Students were allowed to choose their execution technique by variants that were performed before the official testing; still, some of them have abandoned the exercise. We have observed two efficient techniques:

- standing up from a seated position with legs crossed by vigorously pushing the side of the feet, arms crossed on the chest.

- standing up from a seated position by stretching forward one of the legs, flexing the trunk in order to gather kinetic energy and change the position of the centre of gravity, then flicking the weight on the front leg while getting up.

5. Conclusions and recommendations

The male students from the FEFS obtain, in most cases, better results than the students from ACIEE, and the differences are significant. Thus, we have statistically proved higher values in both tests that involve the abdominal muscles, a test that evaluates the back muscles, a test that evaluates the explosive strength of the upper limbs, the test of static strength under stress, two tests of dynamic force of the arms and the test of functional muscular strength of the lower limbs. Thus, we can conclude that these forms of manifestation and combinations of strength with other physical qualities are adequately developed and we cannot signal deficiencies in the physical training based on these components for the FEFS batch of students.

However, there are two tests where differences are not so high: *dynamometry left* and *Long jump without take-off*, and two situations in which the difference is in favour of the ACIEE students– *dynamometry right* and *arm and leg lift-ups from a face-down position* -, although these differences are also non-significant. It follows that, for the FEFS batch, we have to insist on the dynamic strength of the lower limbs, on the training of the strength of the palmar flexors and on the diversification and even complication of the exercises, for a better adaptation to new stimuli.

The value of the performances obtained by the ACIEE batch of students – compared to the performances obtained by the FEFS batch of students – reflects a weaker training. Thus, we are confronted to the necessity to make progress through a physical training based on the elimination of the training deficiencies and downshift recovery. The bigger the differences, the higher the progress, as we all know that muscular strength can register great progress, being a perfectible physical quality, while speed and coordination depend genetically, so with certain limits in development. ***The comparison of the results obtained by the two batches of students confirms – but not entirely - the working hypothesis,*** highlighting by the differences we have obtained the chances to improve the level of manifestation of the general strength, the explosive strength, strength under tension, dynamic and static strength, etc.

The results of the FEFS batch of students should not be regarded as overrated as they surely need corrections or improvements. These results are a summary of specific influences of the sports branches and tests and of the recorded results on a physical, functional and morphological plan during the training years or following an independent training for the students who are not involved in performance activities. We also have to take into account that each sports branch develops only certain forms of strength manifestation and combinations. The chances to make a spectacular progress in strength training are lower for the FEFS batch of students than the ACIEE one, knowing that progress and improvement are more obvious for those who start from a more limited level of training. From this point of view, we could have a favourable evolution in the strength training for the ACIEE batch, under a scientific and rational planning of the training process.

Nevertheless, the weaker results of the male students from the ACIEE field of study are a consequence of number of factors with negative effects in the long term on the general physical status of the young generation and their attitude of indifference or rejection for the physical activity: food, obesity, smoking, sedentariness, commodity, spending their spare time in the virtual environment, lack of constant preoccupations for the relaxing, performance or sustentation physical activities, lack of interest for this kind of activities during the previous stages of their lives, less physical education classes – for the university students, only 1 hour/week – poor quality of the equipment for sports activities.

In conclusion, this paper underlines deficient aspects regarding the strength training of the university students, from different fields of study and implication in the physical effort. Following the presentation of data obtained during the research we can develop training programmes that can remedy the weaknesses highlighted in the strength training, that lead to the improvement of the level of physical training for the studied age group and that determine a different attitude of the young generation regarding the physical training.

References

1. Albu V. (1999.) Teoria educaţiei fizice şi sportului. Constanţa: Exponto, pp. 165-199
2. Achim Ş. (2002.) Planificarea în pregătirea sportivă. Bucureşti: Exponto, p.97
3. Alexe N.(1993). Antrenamentul sportiv modern. Bucureşti: Editis, pp.313-331
4. BompaT. (2001). Dezvoltarea calitatilor biomotrice. /Scoala nationala de antrenori/ Constanta: Ex Ponto, pp.5-165
5. Dragnea A., Teodorescu Mate S. (2002). Teoria sportului. Bucureşti: FEST, pp.356-360
6. Dragnea A., Bota A. (1999). Teoria activităţilor motrice. Bucureşti: EDP, pp.222-225
7. Epuran M., Marolicaru M. (2002). Metodologia cercetării activităţilor corporale. Cluj Napoca: Risoprint, 170 p.
8. Gagea A. Metodologia cercetării ştiinţifice în educaţie fizică şi sport. Bucureşti: Fundaţia România de Mâine, 1999. p. 15-342.
9. M.E.N.-Serviciul Naţional de evaluare şi examinare- Sistemul naţional şcolar de evaluare la disciplina educaţie fizicăşi sport. Bucureşti: 40p.
10. Niculescu I. I. (2006). Evaluare motrică şi somato-funcţională. Craiova: Universitaria, pp.10-90
11. Raţă G., Raţă B.C. (2006). Aptitudinile în activitatea motrică. Bacău: EduSoft, pp. 35-64
12. Săvescu I (2009). Educaţie fizică –ghid orientativ pentru titularizare şi definitivat-. Craiova: Aius Printed, 2008 pp 136-160
13. Simion G., Amzar L., (2009). Stiinta cercetarii miscarii umane. Pitesti: Universitatea din Pitesti, pp.106-231
14. Stan Z. (2009). Evaluare motrică si funcţională. Galati: Zigotto, pp.159-166
15. Tudor V. , Crişan D.I. (2007). Forţa-aptitudine motrică. Bucureşti:Bren, pp.89
16. http://ro.scribd.com/doc/99239919/Calitatile-Motrice-Si-Metodica-Dez-Lor
17. http://www.usefs.md/PDF/Cursuri%20electronice/TMAS/Teoria%20si%20metodologia%20antrenamentului%20sportiv%20%28Lectia14%29.pdf
18. http://bibliotecascolara.ro/leon_victor/Dezvoltarea_calitatilor_motrice.pdf
19. http://ro.scribd.com/doc/22573497/TEORIA-EDUCA%C5%A2IEI-FIZICE-%C5%9EI-SPORTULUI
20. http://www.slideshare.net/dragonyahoo/tefs
21. http://ro.scribd.com/doc/201404382/Forta-rezistenta-supletea