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Correlations Between Muscle Strengths Indicators Of The Trunk And The Vital Capacity

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Abstract: *Objectives. This study aims to determine the relationships between the muscle strengths indices of the trunk and the vital capacity (including VEMS and the Tiffeaneau index). Methods. We tested thirty-nine athletes divided in three age groups (who were 12, 14 and 16 years old), by measuring the waist, the weight, the vital capacity, maximum expired volume per second, and muscle strengths of the trunk. Thus, we calculated one hundred thirty-five correlations between the three groups of measured variables. Results. For the 12-year-olds group, we observed a significant correlation between CV and all values of the muscle strengths of the trunk, the correlation being negative. In the 14-year-olds group, we observed the influence of all measured strengths parameters concerning the value of the Tiffeneau index. In the 16-year-olds group, muscle strengths values no longer influence lung parameters, with significant correlations only between anthropometric and spirometry variables. Conclusions. There is a permanent change in the relationship between the large muscle strengths of the trunk and the muscles involved in the respiratory process (ensuring the CV value), depending on the age of the subjects being measured. These conclusions must be accepted with caution as they only target this group of subjects.*

Keywords: *Muscle Strength Indices, Vital Capacity, Tiffeneau Index*

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I. Introduction

There is a permanent tendency to study the relationship between strengths and elasticity of body's muscles and the ability to develop the lung function. The study of the respiratory muscles influence on pulmonary function and the reduction of fatigue due to the specific training of this muscles has permanently preoccupied many researchers [1]. It has been found that improving the strengths of the muscles involved in breathing improves pulmonary function for the athletes in wheelchairs, thus ensuring a better quality of life [2]. Other studies demonstrate the importance of developing inspiratory muscles and their influence on decreasing blood lactate concentration [3]. Due to the trunk muscle's work, improvement in performance and effort in patients with chronic obstructive pulmonary disease has been reported [4, 5, 6]. In elderly, expiratory muscle effort improves ventilatory and non-ventilatory functions, helping significant rehabilitation of the muscular decline in breathing [7].

It has been established that the intensity of muscle development of the inhaling muscles has a significant influence on pulmonary function (set at 80% of the maximum effort) [8] and results in increasing the thickness of the diaphragm that was contracted, and increasing the lung volume and exercise capacity in healthy individuals [9]. The study of the athletes shows that by improving the inhaling muscles, it is improved the recovery time for high intensity efforts [10]. If we summarize the reasons for the need to develop the muscular strengths who is participating in the stages of breathing, emphasized in the examples above, and the importance of the trunk functions in statics and dynamics of the human body [11], we note the importance of studying all possible connections between the level of muscle development and vital capacity. We have shown that, among all the motor skills, muscle strengths it most influences the execution speed, the resistance and the coordination capabilities [12]. It is known that the normal activity of a muscle is a combination of contraction and relaxation [13]. The results of a 2011 study [14] is determining the influence of trunk mobility and muscle strengths on the effective implementation of handball technical elements.

In this context, it is interesting to study the correlation between the strengths of the trunk muscle's groups that provide its basic movements (lateral tilt, flexion and extension) and the values of vital capacity, maximum expiratory force and the Tiffeneau index on different age groups. It can be seen how much the development of large trunk muscles helps or prevents the ability of the respiratory muscles to provide a big enough vital capacity according to the age.

II. Methods And Subject

2.2 Subject

We tested thirty-nine handball players divided into three age groups (who were 12, 14 and 16 years old). Please note that all athletes had a good health status to perform the tests correctly and with maximum efficiency.

2.2 Procedure

SPIROMETRY

We measured the vital capacity (CV) and the maximum expired volume per second (VEMS), by using an ALPHA spirometer. We calculated the Tiffeneau index according to the formula: VEMSx100 / CV. This index represents 80% of CV and may be increased for volleyball, basketball, handball or rugby athletes (96-100%).

MUSCULAR STRENGTH AT THE TRUNK LEVEL

For all subjects, we performed nine tests using a method and apparatus patented in Romania [15, 16] in the Table 1 there are the abbreviations used in the study for these tests: testing of the muscular strengths on flexion, from seated position; testing of the muscle strengths on the left lateral tilt, from the seated position; testing of the muscle strengths on extension from the seated position; testing of the muscle strengths on right lateral tilt from the seated position; testing of the muscle strengths on flexion, in orthostatism; testing of the muscle strengths on left lateral tilt, in orthostatism; testing of the muscle strengths on extension in orthostatism; testing of the muscle strengths on right lateral tilt, in orthostatism; testing of the lumbar muscle strengths (classic test).

Table 1. Abbreviations used for the testing of the muscle strengths of the trunk.

Abbreviations	Testing of the muscle strengths of the trunk (kgf)
T1	Testing of the muscle strengths on flexion, from the seated position
T2	Testing of the muscle strengths on the left lateral tilt, from the seated position
T3	Testing of the muscle strengths on extension from the seated position
T4	Testing of the muscle strengths on right lateral tilt from the seated position
T5	Testing of the muscle strengths on flexion, in orthostatism;
T6	Testing of the muscle strengths on left lateral tilt, in orthostatism
T7	Testing of the muscle strengths on extension in orthostatism
T8	Testing of the muscle strengths on right lateral tilt, in orthostatism
T9	Testing of the lumbar muscle strengths *(classic test)*

With the testing values obtained with this device, we calculated the strengths indexes for the anterior, posterior and lateral side of the trunk [17] detailed in Table 2.

Table 2. Abbreviations used for the proposed muscle strengths indexes

Abbreviations	The description of the strengths proposed indexes
IFTSA	The average of the T1 and T5 test values based on weight (muscle strengths measured on the front of the trunk)
IFTSP	The average of T3 and T7 test values relative to weight (muscle strengths measured on the back of the trunk without T9)
IFTFS	The average of T2 and T6 test values based on weight (muscle strengths measured on the left side of the trunk)
IFTFD	The average of T4 and T8 test values based on weight (muscle strengths measured on the right side of the trunk)
IGFT	The mean T1-T8 test values relative to weight (total trunk's muscle strengths measured without T9)

2.3. Data Analysis

We were processing the collected data by using SPSS v. 20 for Windows. The Table 3 shows the results by age groups, anthropometric tests (waist and weight) and results of the spirometry test (CV and Tiffeneau).

Table 3. The values of the anthropometric and spirometry tests by age groups															
AGE: 12 YEARS OLDS						AGE: 14 YEARS OLDS					AGE: 16 YEARS OLDS				
Nr.	G	VEMS	WAIST	CV	TIFENEAU	G	VEMS	WAIST	CV	TIFENEAU	G	VEMS	WAIST	CV	TIFENEAU
1	51	2,19	161	2,51	87,25	60	1,8	162	3,4	52,94	44	1,8	152	2,7	66,67
2	33	1,4	147	2,4	58,33	59	3,6	166	3,8	94,74	76	3,7	171	4,2	88,1
3	50	1,73	156	2,19	79	38,5	2,2	161	2,8	78,57	60	3,1	172	3,6	86,11
4	54	2,3	161	2,7	85,19	41	3,1	157	3,7	83,78	46,5	2,96	162	3,1	95,48
5	44	1,76	150	2.26	0,00	50,3	2,8	166	3,7	75,68	44,6	2,68	160	2,84	94,37
6	38	2,5	157	2,7	92,59	87,7	2,5	169	3,9	64,1	74,5	3,51	167	4,41	79,59
7	44	2,59	157	2,68	96,64	47,5	2	161	3	66,67	50	3,28	155	3,58	91,62
8	47	1,97	152	2,29	86,03	50,5	3	159	3,1	96,77	57,3	2,43	170	3,34	72,75
9	50,5	3,2	157	4	80,00	69	3,1	174	4,6	67,39	51,5	3,2	160	3,18	100,6
10	33	2,1	147	2,25	93,33	49	2,9	156	4,2	69,05	60,4	2,25	168	4	56,25
11	39	1,9	150	2,4	79,17	42	2,6	154	3,1	83,87	63	2,73	166	4,57	59,74
12	31	1,9	146	2	95,00	63	2	164	3,2	62,5	56	2,47	153	3,06	80,72
13	29	1,78	142	1,87	95,19	60	1,9	178	4,4	43,18	58	3,79	163	4,02	94,28

The Table 4 shows the results of tests to measure muscle strengths of the trunk by age group. From those one hundred thirty-five correlations between these variables, forty-eight of them were ≥40% (40% - 91%). The confidence coefficient for statistical significance is 95%.

Table 4. Test values for measuring the muscle strengths of the trunk, by age groups														
AGE	T1	T2	T3	T4	T5	T6	T7	T8	T9	IFTSA	IFTSP	IFTFS	IFTFD	IGFT
12 YEARS OLDS	15	10	31	9	26	21	27	20	50	40,20	56,86	43,00	28,43	38,97
	9	8	12	8	27	24	22	21	38	54,55	51,52	48,48	43,94	49,62
	14	17	26	18	32	25	31	26	59	46,00	57,00	42,00	44,00	47,25
	16	12	19	11	31	25	37	27	58	43,52	51,85	34,26	35,19	41,20
	11	7	14	8	13	15	19	15	44	27,27	37,50	25,00	26,14	28,98
	19	11	26	10	29	18	31	17	61	63,16	75,00	38,16	35,53	52,96
	14	9	16	8	22	25	32	27	56	40,91	54,55	38,64	39,77	43,47
	14	17	26	18	32	25	31	26	59	48,94	60,64	44,68	46,81	50,27
	13	11	21	11	30	21	31	25	67	42,57	51,49	31,68	35,64	40,35
	10	7	17	8	18	13	23	16	35	42,42	60,61	30,30	36,36	42,42
	11	7	14	8	13	15	19	15	44	30,77	42,31	28,21	29,49	32,69
	8	6	12	5	14	15	18	16	43	35,48	48,39	33,87	33,87	37,90
	8	6	9	7	16	16	22	17	40	41,38	53,45	37,93	41,38	43,53
14 YEARS OLDS	14	14	29	14	21	30	30	32	72	29,17	49,17	36,67	38,33	38,33
	17	12	28	12	28	29	42	30	55	38,14	59,32	34,75	35,59	41,95
	20	12	27	10	27	28	33	25	64	61,04	77,92	51,95	45,45	59,09
	14	9	16	8	22	25	32	27	56	43,90	58,54	41,46	42,68	46,65
	15	13	35	16	35	35	38	35	82	49,70	72,56	47,71	50,70	55,17
	29	25	51	24	21	33	41	29	61	28,51	52,45	33,07	30,22	36,06
	17	9	19	8	28	29	29	25	43	47,37	50,53	40,00	34,74	43,16
	18	12	22	11	34	35	42	31	78	51,49	63,37	46,53	41,58	50,74
	22	18	32	17	34	33	36	36	89	40,58	49,28	36,96	38,41	41,30
	17	15	30	16	29	25	22	22	53	46,94	53,06	40,82	38,78	44,90
	13	12	24	14	26	30	32	29	56	46,43	66,67	50,00	51,19	53,57
	19	15	22	12	24	24	33	26	76	34,13	43,65	30,95	30,16	34,72
	17	12	39	11	31	21	32	27	71	40,00	59,17	27,50	31,67	39,58
16 YEARS OLDS	14	14	34	14	31	29	22	23	49	51,14	63,64	48,86	42,05	51,42
	22	19	39	18	31	34	20	33	45	34,87	38,82	34,87	33,55	35,53
	20	14	35	15	39	35	31	28	68	49,17	55,00	40,83	35,83	45,21
	12	11	17	13	36	29	46	33	67	51,61	67,74	43,01	49,46	52,96
	15	9	32	10	15	23	32	23	64	33,63	71,75	35,87	37,00	44,56
	19	15	36	18	48	35	41	33	92	44,97	51,68	33,56	34,23	41,11
	19	14	43	14	31	32	39	25	78	50,00	82,00	46,00	39,00	54,25
	20	16	26	14	36	24	30	28	56	48,87	48,87	34,90	36,65	42,32
	16	11	24	11	30	22	24	20	77	44,66	46,60	32,04	30,10	38,35
	22	18	43	20	41	34	50	37	85	52,15	76,99	43,05	47,19	54,84
	19	15	32	14	30	26	34	30	92	38,89	52,38	32,54	34,92	39,68
	14	12	25	13	20	16	17	18	65	30,36	37,50	25,00	27,68	30,13
	17	18	27	19	37	28	33	33	82	46,55	51,98	39,66	44,83	45,75

III. Results

We made correlations between all the measured parameter values. We show the values separately, by age group, in the Table 5.

Table5. Correlations between anthropometric parameters, spirometry data and muscular strengths values

Age	Variable	IFTSA	IFTSP	IFTFS	IFTFD	IGFT	CV	VEMS	Tiffeneau	WAIST
12	**TIFF**	0,38	0,60	0,33	0,37	0,49	-0,91	0,34	-	0,12
12	**CV**	-0,50	-0,53	-0,50	-0,50	-0,58	-	-0,22	-0,37	-0,13
12	**G**	-0,05	-0,01	0,05	-0,11	-0,08	0,08	0,44	-0,12	0,87
12	**VEMS**	0,12	0,29	-0,24	-0,17	0,03	-0,22	-	0,15	0,59
12	**WAIST**	0,21	0,28	0,13	-0,18	0,10	-0,13	-0,03	0,12	-
14	**TIFF**	0,48	0,47	0,62	0,51	0,57	-0,37	0,75	-	-0,54
14	**CV**	-0,38	-0,32	-0,55	-0,31	-0,43	-	0,32	-0,37	0,63
14	**G**	-0,79	-0,57	-0,71	-0,68	-0,75	0,50	-0,05	-0,42	0,65
14	**VEMS**	0,17	0,19	0,22	0,28	0,23	0,32	-	0,75	-0,13
14	**WAIST**	-0,38	-0,20	-0,66	-0,51	-0,46	0,63	-0,76	-0,54	-
16	**TIFF**	-0,30	-0,09	-0,09	-0,13	-0,12	-0,31	0,64	-	-0,16
16	**CV**	-0,03	-0,19	-0,18	-0,03	-0,14	-	0,53	-0,31	0,62
16	**G**	-0,24	-0,52	-0,40	-0,32	-0,46	0,84	0,51	-0,22	0,68
16	**VEMS**	-0,13	-0,26	-0,18	-0,13	-0,22	0,53	-	0,64	0,35
16	**WAIST**	0,11	-0,23	-0,12	0,04	-0,09	0,62	0,35	-0,16	-

After studying the values in the above tables, we can review the following results:
In the 12-years-olds, there is a significant correlation between the CV and all the muscle strengths values of the trunk.

The correlation is negative, so the lower is the muscular strengths involved in the trunk movements, the higher is the CV. There is also a strong correlation between VEMS and waist. The Tiffeneau Index is significantly influenced by the development of the strength of the posterior trunk muscles (60%).

In the 14-years-olds, we observed the influence of all measured strengths parameters on the value of the Tiffeneau index (especially with the muscular strengths measured on the left side of the trunk). At this age the waist significantly influences CV and TIFF and the weight is in a tight relationship with all measured strengths parameters.

In the 16-years-olds, we observed that the muscle strengths values no longer influence lung parameters, with significant correlations only between anthropometric and spirometry variables.

IV. Discussion

Although other authors found that there was no correlation between the body mass index and the vital capacity [18], we found in this study a significant relationship (r = 0.50% at 14 years and r = 0.84% at 16 years) between weight and CV. We advise in this study also the calculation of this index. Recent studies suggest that specific respiratory muscle training can improve the general strengths and the strengths of respiratory muscles in healthy people. Even though the effects of this type of exercise on performance remain controversial [19], we can see in this study that in the 16-years-olds CV and VEMS have given values of independent muscular respiratory muscles responsive to the trunk movements. This could mean that at this age respiratory capacity can influence motive performance and exercise capacity.

V. Conclusion

As the result of the study of the correlations between the strength of the trunk muscle groups that provide its basic movements (lateral tilt, flexion and extension) and the values of the vital capacity, the maximum exponential strengths and the Tiffeneau index on different age groups, we are noticing that in the 12-

year-olds the muscles involved in the breathing movements are much weaker than the muscles that make the trunk movements. For this reason, CV and TIFF have higher values only if this muscle group has low values. It is important that the muscles influence the extension of the trunk on the value of the Tiffeneau index (r = 60%) while at 16-year-olds this connection is insignificant and negative (r = 0.09%). At 14-year-olds, muscle strengths is favoured by weight loss and the Tiffeneau index is in a significant positive correlation with all measured strength parameters. At 16-year-olds, the muscle group that favours breathing is no longer influenced by the large muscle groups that respond to the trunk's basic movements. There is a permanent change in the relationship between the large muscle strengths of the trunk and the muscles involved in the respiratory process (ensuring the CV value), depending on the age of the subjects being measured.

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References

[1]. T. Vasconcelos, A. Hall., R. Viana, The influence of inspiratory muscle training on lung function in female basketball players – a randomized controlled trial, *Porto Biomedical Journal, Volume 2, Issue 3*, May–June 2017, 86-89.

[2]. V. Goosey-Tolfrey, E. Foden, C. Perret, H. Degens, Effects of inspiratory muscle training on respiratory function and repetitive sprint performance in wheelchair basketball players, *British Association of Sport and Medicine, 2010, Jul;44(9)*:665-8.

[3]. P.I. Brown, G.R. Sharpe, M.A. Johnson, Inspiratory muscle training reduces blood lactate concentration during volitional hyperpnoea, *European Journal of Applied Physiology, 2008 Sep;104(1)*:111-7.

[4]. P. Weiner, R. Magadle, M. Beckerman, M. Weiner, N. Berar-Yanay, Maintenance of inspiratory muscle training in COPD patients: one year follow-up, *European Respiratory Journal, 2004 Jan;23(1)*:61-5.

[5]. J. A. Guenette, R. C. Chin, J. M. Cory, K. A. Webb, and D. E. O'Donnell, Inspiratory Capacity during Exercise: Measurement, Analysis, and Interpretation, *Pulmonary Medicine Volume 2013*, Article ID 956081, 13 pages.

[6]. S. Swati, N. Pradeep, V. Savita & S. Sundeep, Upper limb muscle strength & endurance in chronic obstructive pulmonary disease, *Indian Journal of Medical Research 138, October 2013*, pp 492-496.

[7]. J. Kim, C. M. Sapienza, Implications of expiratory muscle strength training for rehabilitation of the elderly: Tutorial, Journal of rehabilitation Research&Development, *Volume 42 Number 2, March/April 2005*, Pages 211 - 224.

[8]. T.K. Tong, F.H. Fu, P.K. Chung, The effect of inspiratory muscle training on high-intensity, intermittent running performance to exhaustion. *Applied Physiology, Nutrition, and Metabolism, 2008, 33:*671- 681.

[9]. S.J. Enright, V.B. Unnithan, C. Heward, L. Withnall, D.H. Davies, Effect of high-intensity inspiratory muscle training on lung volumes, diaphragm thickness, and exercise capacity in subjects who are healthy, *Physical Therapy, 2006 Mar;86(3)*:345-354.

[10]. L.M. Romer, A.K. McConnell, D.A. Jones, Effects of inspiratory muscle training upon recovery time during high intensity, repetitive sprint activity, *International Journal of Sports Medicine, 2002 Jul;23(5)*:353-360.

[11]. S. McGill, S. Grenier, N. Kavcic, J. Cholewicki, Coordination of muscle activity to assure stability of the lumbar spine, *Journal of Electromyography and Kinesiology*, 2003 13, 353-9.

[12]. C. E. Peper, J. B. Betteco, J. P. Harjo, J. B. Peter, Interlimb coupling strength scales with movement amplitude. *Journal of Neuroscience Letters, 2008, 437*, 10 – 14.

[13]. B. Reijo, N. Caroline, V. K. Paavo, & L. Vesa, Adaptive changes in motor control of rhythmic movement after maximal eccentric actions. *Journal of Electromyography and Kinesiology*, 2009, 19 (2), 347-356.

[14]. E. Baştiurea, Stan,Z., I. Mihăilă, N.Creţu, The influence of anthropometric parameters and of muscle-joint mobility on the speed of execution in the handball game, *Journal of Physical Education and Sport - Citius Altius Fortius, 2011, 11(1),* 94-101.

[15]. V. Marcu, Z. Stan, E. Baştiurea, C. Chiculiţă, C., *Determining the muscle imbalances in the torso - method and apparatus*(Academica Publisher, Galati, Romania, 2008).

[16]. Z. Stan, E. Baştiurea, C. Rizescu, Sensitivity testing study proposed by method and apparatus for determining muscle imbalances at the trunk level. *Ovidius University Annals. Series Physical Education and Sport/ Science, Movement and Health,* 2015, 14(1), 62-69.

[17]. Z. Stan,E. Baştiurea I. Mihăilă, Development of muscle strength indicators at the trunk level, *Journal of Physical Education and Sport, 2015 Vol. 15, ISSUE 4,* 871-878.

[18]. L. Peng, Y. Ziliang, L. Haili, L. Jingjing, H. Liqian, G. Jiangu., D. Qiongying and L. Xu, Association between body mass index (BMI) and vital capacity of college students of Zhuang nationality in China: a cross-section study, *Oncotarget. 2017 Oct 6; 8(46)*: 80923–80933.

[19]. A.W. Sheel, Respiratory muscle training in healthy individuals: physiological rationale and implications for exercise performance, *Sports Medicine 2002, 32(9)*:567-81.

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