Original Article

Development of muscle strenght indicators at the trunk level

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Abstract:

The aim of this study concerns how to use data obtained after evaluating the trunk muscle strength and development of force indicators that can simplify any scientific endeavour made on this line of research. They were evaluated 140 subjects age of 5-18 years, as follows: 27 subjects of 5 years old, 27 subjects of 6 years old, 26 subjects of 7 years old, 15 subjects of 12 years old, 18 subjects of 14 years old, 10 subjects of 16 years old and 17 subjects of 18 years old. They were applied 9 measuring tests for the muscular strength of the trunk, as follows: muscle strength testing on flexion from seated; muscle strength testing on left lateral tilt, from seated; muscle strength testing on extension, from seated; muscle strength testing on right lateral tilt, from seated; muscle strength testing on flexion, from standing; muscle strength testing on left lateral tilt, from standing; muscle strength testing on extension from standing; muscle strength testing on right lateral tilt from standing; lumbar muscle strength testing (classic test).

They were calculated 280 correlations between weight and general strength index of the trunk, proposed in this study ("r" values between 0.10% and 0.60 %).

It was found in this study, that it appears significant links between muscle strength and weight in the age frame of 14-18 years. The highest value belongs to the group of 14 years old (-0.60%) and is gradually decreasing towards 18 years old (-0.40%). If until the age of 14 years old the results are subject to the laws of growth and development, after this age we can discuss the individualization of somatic and anthropometric development and thus the correlation between weight and trunk muscle strength declines. It can be observed based on the average proposed force indexes, the way the balance muscle forces in the sagittal plane evolves (the front and rear plan), as aspects of laterality (foreground, left-right). The conclusions must be accepted with care, as it concerns only this group of subjects. The study would be complete, if assessed subjects would belong to different age groups and especially as adults.

Keywords: muscle strength indexes, assessing static muscular strength, muscular imbalances determination..

Introduction

This device and the method of assessing the muscle strength of the trunk was developed based on the research studies in the field (Stan, 2006). In case of the method and apparatus shown in this study, the test method involves the tractor fixed starting positions over the dynamometer, aiming that the trunk will not to use too much leverage to amplify the obtained values. It was intended to adopt a position as close to normal. It was found that tests have a significant sensitivity taking into account the differences between subjects, in this case the independent variable was the age (Stan Baștiurea, Rizescu, 2015). They were highlighted the differences between groups, but also differences between subjects in the same group.

The importance of evaluating the trunk muscle imbalances and exposing of concrete means to remedy them were described by Baștiurea, Stan and Andronic (2009). The importance of the stability of the spine and the functions in static and dynamic human torso are exposed by McGill et al (2003). It was stressed the asymmetry of the erector muscle activity in the frontal outline in 2001 (Parkin et al), studies being related to the high incidence of back pain in case of rowers. Also in 2001 Radebold et al., highlights the relationship between impaired muscle coordination and more subtle control in trunk. Functional status of the trunk and influence on lumbar pain are highlighted by Preuss and Fung (2005). Results of a 2011 study (Baștiurea, Stan Mihăilă, Crețu) outlines the influence of the mobility and trunk muscle's strength in the efficient execution of technical elements in handball. Here are just some examples of deep study of the static and dynamic spine's principles, and of the muscles that support and move all this complex gear. We believe that the development of force indicators at this important segment of the human body would complement other existing strengths indicators: *Finger flexors segmental force index*; *Segmental scapular strength index*; *Index of segmental lumbar force*. All these factors can be found in IFG - *Index of global power* (Cordon, 2009).

The development of these indicators will facilitate the systematization and processing of obtained data with the apparatus and method for evaluating the trunk muscle strength. It will enable researchers to observe the

quality issues related to the growth of this motive attribute by age (5-18 years old) and also to detect possible muscle imbalances in the sagittal and frontal plane.

Methods

Subjects

They were evaluated 140 subjects aged of 5-18 years old, as follows: 27 subjects age of 5 years old, 27 subjects age of 6 years old, 26 subjects age of 7 years old, 15 subjects age of 12 years old, 18 subjects age of 14 years old, 10 subjects age of 16 years old and 17 subjects age of 18 years old. It should be noted that three groups of 5, 6 and 7 years old are mixed; groups of 12, 14 and 16 years old are girls (athletes) and the 18 years old group is only of boys (athletes).

Test Procedure

They were applied 9 measuring tests of the muscle strength at the trunk level (Mark, Stan, Baștiurea, Chiculiță, 2008), as follows: muscle strength testing on flexion from seated; muscle strength testing on left lateral tilt, from seated; muscle strength testing on extension, from seated; muscle strength testing on right lateral tilt, from seated; muscle strength testing on flexion, from standing; muscle strength testing on left lateral tilt, from standing; muscle strength testing on extension from standing; muscle strength testing on right lateral tilt from standing; lumbar muscle strength testing (classic test).

Applied abbreviations tests can be analyzed in Table 1.

Table 1. Abbreviations used for testing muscle strength at the trunk level

<i>Abbreviations</i>	<i>Testing the muscle strength at the trunk level (kgf)</i>
G	<i>Weight</i>
T1	<i>Muscle strength testing on flexion from seated</i>
T2	<i>Muscle strength testing on left lateral tilt, from seated</i>
T3	<i>Muscle strength testing on extension, from seated</i>
T4	<i>Muscle strength testing on right lateral tilt, from seated</i>
T5	<i>Muscle strength testing on flexion, from standing</i>
T6	<i>Muscle strength testing on left lateral tilt, from standing</i>
T7	<i>Muscle strength testing on extension from standing</i>
T8	<i>Muscle strength testing on right lateral tilt from standing</i>
T9	<i>Lumbar muscle strength testing (classic test)</i>

The methodology of drafting the proposed indexes

With the respect of the method used to calculate the overall strength index (IFG). Abbreviations and formulas for segmentation indexes and global strength index are described in Table 2.

Table 2. Abbreviations and formulas used to calculate indexes of force and global segmentations

<i>Abbreviations</i>	<i>Testing of the muscle strength at the trunk level</i>	<i>Formula</i>
G	<i>Weight</i>	-
F1	<i>The force of the flexor muscles of the right hand</i>	-
F2	<i>The force of the flexor muscles of the left hand</i>	-
F3	<i>The force of the scapular muscles area</i>	-
F4	<i>The force of the lumbar muscles area</i>	-
IFD	<i>The segmental force index of the fingers flexors</i>	$[(F1+F2)/2]/G \times 100$
IFS	<i>Segmental scapular strength index</i>	$(F3/G) \times 100$
IFL	<i>Segmental lumbar strength index</i>	$(F4/G) \times 100$
IFG	<i>Global strength index</i>	$[(F1+F2+F3+F4)/4]/G \times 100$

With the respect of the principle of value reporting muscle strength measured by weight. Table 3 describes the abbreviations for proposed force indexes in this document.

Table 3. Abbreviations used for muscular force indexes

<i>Abbreviations</i>	<i>The description of the proposed strength indexes</i>
IFTSA	Average values of the T1 and T5 tests by weight (<i>muscle strength measured at the front of the trunk</i>)
IFTSP	Average values of the T3 and T7 tests by weight (<i>muscle strength measured at the back of the trunk, without T9</i>)
IFTSP9	Average values of the T3, T7 and T9 tests by weight (<i>muscle strength measured at the back of the trunk, with the addition of classical test T9</i>)
IFTFS	Average values of the T2 and T6 tests by weight (<i>muscle strength measured at the left side of the trunk</i>)
IFTFD	Average values of the T4 and T8 tests by weight (<i>muscle strength measured at the right side of trunk</i>)
IGFT	Average values of the T1-T8 tests by weight (<i>general muscle strength at the trunk level measured without T9</i>)
IGFT9	Average values of the T1-T9 tests by weight (<i>general muscle strength at the trunk level, measured with the addition of the classic T9 test</i>)

The formulas developed in this study are specified in the Table 4.

Table 4. Formulas for calculating proposed force indexes

<i>Abbreviations</i>	<i>The proposed calculation formula</i>
IFTSA	$[(T1+T5)/2]/G \times 100$
IFTSP	$[(T3+T7)/2]/G \times 100$
IFTSP9	$[(T3+T7+T9)/3]/G \times 100$
IFTFS	$[(T2+T6)/2]/G \times 100$
IFTFD	$[(T4+T8)/2]/G \times 100$
IGFT	$[(T1+T2+T3+T4+T5+T6+T7+T8)/8]/G \times 100$
IGFT9	$[(T1+T2+T3+T4+T5+T6+T7+T8+T9)/9]/G \times 100$

Data analysis

The data collected was processed using SPSS v. 20 for Windows. They were calculated all force indicators proposed for all age group subjects, as follows: Table 5 for 5 years old subjects, Table 6 for 6 years old subjects, Table 7 for 7 years old subjects, Table 8 for 12 years old subjects, Table 9 for 14 years old subjects, Table 10 for 16 years old subjects, and Table 11 for 18 years old subjects.

A correlation was conducted to examine the relationship between weight and IGFT for all age groups

Table 5. Strength indexes values calculated for 5 years old subjects

<i>Age group: 5 years old</i>							
NR.	IFTSA (kgf)	IFTSP (kgf)	IFTSP9 (kgf)	IFTFS (kgf)	IFTFD (kgf)	IGFT (kgf)	IGFT9 (kgf)
1	31.58	34.21	43.86	18.42	23.68	26.97	30.99
2	31.58	39.47	52.63	18.42	18.42	26.97	32.75
3	20.00	25.00	41.67	25.00	27.50	24.38	30.00
4	25.00	30.56	57.41	36.11	25.00	29.17	38.27
5	30.00	50.00	82.22	50.00	40.00	42.50	54.07
6	27.27	25.00	37.88	29.55	15.91	24.43	28.79
7	34.21	36.84	49.12	34.21	26.32	32.89	37.43
8	40.63	50.00	72.92	43.75	46.88	45.31	53.47
9	38.24	35.29	45.10	35.29	41.18	37.50	40.52
10	34.09	31.82	34.85	34.09	34.09	33.52	34.34
11	31.82	27.27	42.42	27.27	31.82	29.55	34.34
12	27.27	40.91	54.55	34.09	34.09	34.09	39.39
13	23.81	26.19	38.10	21.43	16.67	22.02	26.46
14	23.68	23.68	38.60	34.21	28.95	27.63	32.16
15	38.24	35.29	64.71	38.24	29.41	35.29	45.10
16	29.41	35.29	52.94	38.24	32.35	33.82	39.87
17	31.58	34.21	40.35	34.21	31.58	32.89	35.09
18	22.22	30.56	38.89	19.44	19.44	22.92	26.54
19	28.57	40.48	55.56	30.95	28.57	32.14	38.10
20	26.32	39.47	49.12	26.32	28.95	30.26	34.50
21	20.83	29.17	40.28	25.00	31.25	26.56	30.56
22	25.00	30.00	50.00	27.50	30.00	28.13	35.00
23	27.78	38.89	51.85	30.56	30.56	31.94	37.04
24	21.43	45.24	53.97	40.48	42.86	37.50	41.27
25	19.44	33.33	55.56	27.78	30.56	27.78	35.80
26	31.58	50.00	71.93	28.95	34.21	36.18	45.03
27	27.50	22.50	30.00	30.00	35.00	28.75	30.56

* **IFTSA** - Average test values for T3 and T7 tests by weight, **IFTSP** - Average test values for T3 and T7 tests by weight, **IFTSP9** - Average test values for T3, T7 and T9 tests by weight, **IFTFS** - Average test values for T2 and T6 tests by weight, **IFTFD** - Average test values for T4 and T8 tests by weight, **IGFT** - Average test values for T1-T8 tests by weight, **IGFT9** - Average test values for T1-T9 tests by weight

Table 6. Strength indexes values calculated for 6 years old subjects

<i>Age group: 6 years old</i>							
NR.	IFTSA (kgf)	IFTSP (kgf)	IFTSP9 (kgf)	IFTFS (kgf)	IFTFD (kgf)	IGFT (kgf)	IGFT9 (kgf)
1	22.73	43.18	60.61	29.55	29.55	31.25	38.38
2	36.96	30.43	53.62	36.96	32.61	34.24	41.55
3	26.47	47.06	84.31	41.18	38.24	38.24	51.63
4	47.50	45.00	78.33	52.50	42.50	46.88	57.78
5	17.50	22.50	43.33	22.50	22.50	21.25	28.33
6	42.11	55.26	80.70	44.74	44.74	46.71	56.14
7	37.50	52.50	71.67	40.00	47.50	44.38	51.67
8	41.18	32.35	54.90	41.18	26.47	35.29	42.48
9	21.15	21.15	37.18	13.46	19.23	18.75	24.36
10	42.00	32.00	53.33	32.00	30.00	34.00	40.89
11	28.26	30.43	44.93	32.61	32.61	30.98	35.75
12	37.50	32.50	53.33	32.50	27.50	32.50	39.44
13	37.50	35.00	55.00	32.50	32.50	34.38	41.11
14	34.09	52.27	65.15	52.27	38.64	44.32	49.49
15	12.00	18.00	25.33	14.00	10.00	13.50	16.44
16	47.62	50.00	77.78	45.24	47.62	47.62	57.14
17	38.64	40.91	60.61	38.64	36.36	38.64	45.45
18	22.73	34.09	42.42	22.73	18.18	24.43	28.28
19	38.64	47.73	77.27	31.82	29.55	36.93	47.98
20	40.00	42.00	65.33	38.00	40.00	40.00	48.00
21	52.38	66.67	90.48	47.62	52.38	54.76	64.02
22	31.82	40.91	63.64	27.27	34.09	33.52	41.92
23	26.32	23.68	47.37	18.42	13.16	20.39	28.65
24	50.00	47.22	68.52	33.33	36.11	41.67	49.38
25	36.36	36.36	57.58	36.36	31.82	35.23	42.42
26	50.00	68.18	89.39	45.45	43.18	51.70	60.61
27	41.30	47.83	71.01	34.78	43.48	41.85	50.24

* IFTA - Average test values for T3 and T7 tests by weight, IFTSP - Average test values for T3 and T7 tests by weight, IFTSP9 - Average test values for T3, T7 and T9 tests by weight, IFTFS - Average test values for T2 and T6 tests by weight, IFTFD - Average test values for T4 and T8 tests by weight, IGFT - Average test values for T1-T8 tests by weight, IGFT9 - Average test values for T1-T9 tests by weight

Table 7. Strength indexes values calculated for 7 years old subjects

<i>Age group: 7 years old</i>							
NR.	IFTSA (kgf)	IFTSP (kgf)	IFTSP9 (kgf)	IFTFS (kgf)	IFTFD (kgf)	IGFT (kgf)	IGFT9 (kgf)
1	31.82	31.82	50.00	40.91	45.45	37.50	42.93
2	23.33	20.00	36.67	31.67	26.67	25.42	30.37
3	42.00	26.00	49.33	32.00	26.00	31.50	38.67
4	40.00	48.33	65.56	30.00	40.00	39.58	46.30
5	36.96	43.48	60.87	41.30	26.09	36.96	43.48
6	42.86	46.43	65.48	46.43	39.29	43.75	50.40
7	35.42	52.08	73.61	37.50	37.50	40.63	49.07
8	27.08	37.50	50.00	37.50	27.08	32.29	37.04

9	50.00	50.00	60.00	46.00	48.00	48.50	52.00
10	20.45	25.00	37.88	18.18	20.45	21.02	25.76
11	26.67	28.33	50.00	28.33	33.33	29.17	36.30
12	30.88	39.71	65.69	27.94	32.35	32.72	42.16
13	23.44	20.31	33.33	20.31	20.31	21.09	25.35
14	43.75	56.25	76.39	47.92	50.00	49.48	56.94
15	38.00	42.00	65.33	36.00	36.00	38.00	46.22
16	58.70	43.48	72.46	50.00	41.30	48.37	57.49
17	42.59	44.44	80.25	38.89	40.74	41.67	53.91
18	40.38	44.23	62.82	28.85	40.38	38.46	45.30
19	39.66	51.72	72.41	46.55	44.83	45.69	53.26
20	36.67	43.33	56.67	30.00	30.00	35.00	40.37
21	60.71	60.71	58.33	48.21	39.29	52.23	52.38
22	37.50	43.75	72.22	39.58	45.83	41.67	51.39
23	43.75	54.17	70.83	41.67	35.42	43.75	50.46
24	36.54	50.00	70.51	61.54	46.15	48.56	55.56
25	38.64	38.64	71.21	43.18	59.09	44.89	55.05
26	24.00	22.00	30.67	28.00	26.00	25.00	27.56

* **IFSA** - Average test values for T3 and T7 tests by weight, **IFTSP** - Average test values for T3 and T7 tests by weight, **IFTSP9** - Average test values for T3, T7 and T9 tests by weight, **IFTFS** - Average test values for T2 and T6 tests by weight, **IFTFD** - Average test values for T4 and T8 tests by weight, **IGFT** - Average test values for T1-T8 tests by weight, **IGFT9** - Average test values for T1-T9 tests by weight

Table 8. Strength indexes values calculated for 12 years old subjects

<i>Age group: 12 years old</i>							
NR.	IFTSA (kgf)	IFTSP (kgf)	IFTSP9 (kgf)	IFTFS (kgf)	IFTFD (kgf)	IGFT (kgf)	IGFT9 (kgf)
1	54.55	51.52	72.73	48.48	45.45	50.00	57.24
2	42.16	50.98	77.78	31.37	35.29	39.95	50.11
3	60.00	71.25	98.33	36.25	33.75	50.31	61.67
4	35.48	48.39	78.49	33.87	33.87	37.90	49.10
5	45.19	53.85	73.08	35.58	36.54	42.79	50.43
6	30.77	43.59	66.67	28.21	29.49	33.01	41.88
7	42.59	52.78	71.60	38.89	40.74	43.75	51.03
8	40.20	56.86	70.59	30.39	28.43	38.97	45.53
9	42.42	60.61	75.76	30.30	36.36	42.42	49.49
10	37.50	48.44	73.96	34.38	37.50	39.45	48.96
11	40.20	56.86	64.05	39.22	33.33	42.40	46.41
12	56.14	60.53	92.40	47.37	42.11	51.54	63.16
13	57.95	76.14	100.00	45.45	51.14	57.67	67.68
14	38.78	48.98	62.59	37.76	31.63	39.29	44.90
15	33.33	62.50	75.69	28.13	32.29	39.06	46.06

* **IFSA** - Average test values for T3 and T7 tests by weight, **IFTSP** - Average test values for T3 and T7 tests by weight, **IFTSP9** - Average test values for T3, T7 and T9 tests by weight, **IFTFS** - Average test values for T2 and T6 tests by weight, **IFTFD** - Average test values for T4 and T8 tests by weight, **IGFT** - Average test values for T1-T8 tests by weight, **IGFT9** - Average test values for T1-T9 tests by weight

Table 9. Strength indexes values calculated for 14 years old subjects

<i>Age group: 14 years old</i>							
NR.	IFTSA (kgf)	IFTSP (kgf)	IFTSP9 (kgf)	IFTFS (kgf)	IFTFD (kgf)	IGFT (kgf)	IGFT9 (kgf)
1	29.17	49.17	72.78	36.67	38.33	38.33	47.41
2	37.50	58.33	69.44	34.17	35.00	41.25	46.85
3	57.32	73.17	100.81	42.68	42.68	53.96	65.31
4	43.90	58.54	84.55	41.46	42.68	46.65	56.64
5	50.00	73.00	103.33	48.00	51.00	55.50	67.56
6	28.74	52.87	58.62	33.33	30.46	36.35	40.10
7	46.88	50.00	63.19	39.58	34.38	42.71	47.92
8	50.98	62.75	92.81	46.08	41.18	50.25	61.66
9	40.00	48.57	74.76	36.43	37.86	40.71	50.32
10	47.00	52.00	70.00	40.00	38.00	44.25	51.11
11	46.43	66.67	88.89	50.00	51.19	53.57	62.43
12	52.44	67.07	106.50	47.56	46.34	53.35	68.02
13	38.71	57.26	76.34	26.61	30.65	38.31	46.77
14	44.17	55.00	74.44	37.50	43.33	45.00	52.59
15	47.83	68.48	108.70	42.39	43.48	50.54	65.94
16	40.79	61.84	88.16	35.53	32.89	42.76	53.65
17	45.00	66.67	87.22	45.83	40.83	49.58	58.33
18	39.02	53.66	74.80	35.37	32.93	40.24	48.78

* **IFTSA** - Average test values for T3 and T7 tests by weight, **IFTSP** - Average test values for T3 and T7 tests by weight, **IFTSP9** - Average test values for T3, T7 and T9 tests by weight, **IFTFS** - Average test values for T2 and T6 tests by weight, **IFTFD** - Average test values for T4 and T8 tests by weight, **IGFT** - Average test values for T1-T8 tests by weight, **IGFT9** - Average test values for T1-T9 tests by weight

Table 10. Strength indexes values calculated for 16 years old subjects

<i>Age group: 16 years old</i>							
NR.	IFTSA (kgf)	IFTSP (kgf)	IFTSP9 (kgf)	IFTFS (kgf)	IFTFD (kgf)	IGFT (kgf)	IGFT9 (kgf)
1	42.86	56.25	77.38	35.71	41.07	43.97	52.38
2	31.25	66.67	88.89	33.33	34.38	41.41	51.62
3	58.77	67.54	98.83	43.86	44.74	53.73	65.69
4	49.02	80.39	104.58	45.10	38.24	53.19	64.27
5	48.28	48.28	64.37	34.48	36.21	41.81	47.89
6	44.23	46.15	80.13	31.73	29.81	37.98	50.21
7	50.00	73.81	94.18	42.06	45.24	52.78	61.90
8	43.75	58.93	94.05	36.61	39.29	44.64	57.94
9	36.17	44.68	75.89	29.79	32.98	35.90	47.28
10	51.92	57.69	91.03	44.23	50.00	50.96	62.82

* **IFTSA** - Average test values for T3 and T7 tests by weight, **IFTSP** - Average test values for T3 and T7 tests by weight, **IFTSP9** - Average test values for T3, T7 and T9 tests by weight, **IFTFS** - Average test values for T2 and T6 tests by weight, **IFTFD** - Average test values for T4 and T8 tests by weight, **IGFT** - Average test values for T1-T8 tests by weight, **IGFT9** - Average test values for T1-T9 tests by weight

Table 11. Strength indexes values calculated for 18 years old subjects

<i>Age group: 18 years old</i>							
NR.	IFTSA (kgf)	IFTSP (kgf)	IFTSP9 (kgf)	IFTFS (kgf)	IFTFD (kgf)	IGFT (kgf)	IGFT9 (kgf)
1	43.18	37.12	93.43	35.61	34.09	37.50	56.23
2	53.45	50.57	84.29	47.70	41.38	48.28	59.77
3	27.22	36.08	71.73	27.85	33.54	31.17	43.60
4	38.31	33.77	70.13	31.17	29.87	33.28	45.45
5	49.40	52.41	91.97	44.58	42.77	47.29	61.04
6	56.34	52.11	92.02	41.55	42.25	48.06	61.82
7	26.86	30.17	56.75	24.79	28.51	27.58	36.73
8	48.08	48.72	87.18	42.31	46.15	46.31	59.40
9	34.52	34.52	70.63	35.71	34.52	34.82	46.83
10	51.69	46.07	80.90	33.71	39.33	42.70	54.68
11	43.15	56.85	84.93	45.89	40.41	46.58	57.08
12	45.00	48.75	80.00	35.00	37.50	41.56	52.78
13	48.41	54.76	93.12	46.83	46.03	49.01	62.43
14	48.77	61.73	100.82	38.27	46.91	48.92	63.37
15	51.39	41.67	92.59	38.89	39.58	42.88	59.72
16	46.71	37.50	73.68	36.84	38.16	39.80	51.61
17	56.17	66.67	104.53	48.15	44.44	53.86	67.90

* **IFTSA** - Average test values for T3 and T7 tests by weight, **IFTSP** - Average test values for T3 and T7 tests by weight, **IFTSP9** - Average test values for T3, T7 and T9 tests by weight, **IFTFS** - Average test values for T2 and T6 tests by weight, **IFTFD** - Average test values for T4 and T8 tests by weight, **IGFT** - Average test values for T1-T8 tests by weight, **IGFT9** - Average test values for T1-T9 tests by weight

Results

After statistical processing the results can highlight the evolution IGFT by age (Table 12). Average IGFT value for each age group rises to a peak at 14-16 years old IFTFS and IFTFD values are equal, in this case, from the age of 12 years old. Imbalances in the sagittal plane are kept at all age groups. The best correlation between IGFT and weight are observed in the group of 14 years old (-60%).

Table 12. Average strength values by age groups

<i>Proposed strength indexes</i>	Age						
	5 years old	6 years old	7 years old	12 years old	14 years old	16 years old	18 years old
IGFT (kgf)	31.15	36.00	38.00	43.00	46.00	46.00	43.00
IFTFS (kgf)	31.00	35.00	38.00	36.00	40.00	38.00	39.00
IFTFD (kgf)	30.00	33.00	37.00	36.00	40.00	39.00	39.00
IFTSA (kgf)	28.00	36.00	37.00	44.00	44.00	46.00	45.00
IFTSP (kgf)	35.00	41.00	41.00	56.00	60.00	60.00	46.00
COREL (%)	-0.50%	-0.30%	-0.20%	0.10%	-0.60%	0.50%	-0.40%

* **IGFT** - Average overall strength index at the trunk level, age range of 5-18 years, **IFTFS** - Average strength index on the left side of the trunk at the age range of 5-18 years, **IFTFD** - Average strength index on the right torso, age range 5-18 years, **IFTSA** - Average strength index on the front of the torso, age range of 5-18 years, **IFTSP** - Average strength index on the rear of the trunk, age range of 5-18 years, **CORREL** - correlation coefficient Pearson's ($r = [-1,1]$) between parameters and proposed strength indices by weight to each of the age groups between 5-18 years old

Discussions

It is noted that, although different ages (13 years apart), composition and occupation of subjects within the groups is different, there is not a great difference in the value of muscle forces manifested in the trunk

(12 kgf between 5 to 18 years old). Reporting muscle strength to weight values keeps roughly the proportion regardless to age.

Previous studies (Firell, Crain, 1996; Nag, Desai, 2003) shows that size affects the muscular anatomy, in this case, correlations between IGFT and weight are significant at 5, 14, 16 and 18 years old. The best correlation in this study reveals the age of 14 years old (-60%). The correlation is negative, so with decreasing weight from the trunk the strength index rises. The only positive correlations are observed to 12 years old (insignificant) and 16 years old (significant).

IFTFS and IFTFD indices show at young ages (5, 6 and 7 years old) imbalances in the foreground, i.e. higher values on the left because most subjects are right-handed. From 12 years old the index values are equal, a maximum results occurring throughout the group of 14 years old (40 kgf).

If we analyze the results of IFTS and IFTSP indexes, we notice that the strength values are kept higher for dorsal area, regardless of age. The group of 18 years old values are close, but observing the low index values IGFT we conclude that this group would have to work more to develop muscle strength on extension.

The biggest difference in the sagittal plane is observed also for the group of 14 years old. Based on the results noted above we can say that the group of 14 years old stands out in all areas.

Conclusion

It was found in this study that proposed strength index simplifies observation of certain peculiarities of the individuals at certain ages. You can see some muscle imbalances at group level, but especially at the subject level. These imbalances may indicate the presence of a physical disability attitude (attitude kyphotic, lordotic and scoliotic), and from an early age may indicate the formation of muscle imbalances during growth.

For example, the group of 6 years old, the subject 14 have the following index values: IFTFS = IFTFD = 52.27 and 38.64. The difference of 15 kgf will identify a scoliotic attitude. These findings should be accepted carefully, as it concerns only this group of subjects.

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