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REVIEWS
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The importance of medical selection and orientation in sports
Importanţa selecţiei şi orientării medico-sportive

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Abstract

Sports selection, followed by sports orientation, tends to start from increasingly early ages, individually, based on the sports branch in question and the following selection criteria: genetic, morphological, functional, neuropsychological, biochemical. These criteria can be correctly assessed only by a close collaboration between the physician, coach and physical trainer, as well as including a good knowledge of scientific assessment criteria. First of all, a detailed general anamnesis is made, to which an initial, as well as periodic, sports medical anamnesis will be added. This is followed by the somatometric examination, which comprises the clinical, aesthetic, anthropometric and somatometric exams. The somatoscopic exam and the one assessing individual physical qualities complete the medical sports assessment. All these must be performed in order to achieve a complete and complex sports medical picture and to reach the final goal of scientifically based medical sports orientation for the individual, as well as to obtain performance at the highest levels.

Keywords: medical sports orientation, selection criteria.

Rezumat

Selecţia în sport, urmată de orientarea sportivă, tinde să înceapă la vârste din ce în ce mai timpurii, individual, în funcţie de ramura sportivă vizată, pe baza următoarelor criterii de selecţie: genetic, morfologic, funcţional, neuropsihic, biochimic. Aceste criterii pot fi apreciate corect doar printr-o strânsă colaborare medic-antrenor-preparator fizic şi printr-o bună cunoaştere a criteriilor ştiinţifice de evaluare. Se începe cu o anamneză amănunţită generală, la care se adaugă anamneza medico-sportivă, ce va fi atât iniţială, cât şi periodică. Se continuă cu examenul somatometric ce va cuprinde examenul clinic, examenul estetic, examenul antropometric şi examenul somatometric. Examenul somatoscopic şi cel prin care se face aprecierea calităţilor fizice individuale vin să completeze evaluarea medico-sportivă, pentru a reuşi să se efectueze o completă şi totodată complexă evaluare medico-sportivă, pentru a atinge scopul final de orientare medico-sportivă pe criterii ştiinţifice a individului şi a obţinerii de performanţe sportive la cele mai înalte niveluri.

Cuvinte cheie: orientare medico-sportivă, criterii de selecţie.

The importance of orientation and selection in sports

Biological selection and medical orientation in sports are important in order to obtain, though science, performance at the highest competitive levels. Sports selection starts early, depending on the sports branch, as early as the age of 5-6 years in gymnastics, swimming and skating. In other branches (most of them), the selection starts at the age of 10-11 years. In sports branches such as heavy athletics, boxing, rowing, the selection starts around the age of 12-13 years. In order to increase the predictability of selection, this should be based on a minimum of 3 scientific criteria: biomedical (or medico-biological, or medical), psychological and motor.

Sports orientation is a subsequent selection stage, based on the same scientific criteria, and the capacity of understanding sports competitiveness is not generally achieved before the age of 9 (Patel et al., 2002; Daniels, 2007; White et al., 1998).

Only starting with the age of 12 are most children neuro-psychologically developed enough in order to understand the complex sports tasks, as well as physically and mentally prepared to take part in competitive sports, under appropriate supervision (Patel et al., 2002; Daniels, 2007; White et al., 1998).

In Romania, because of the lack of an actual national data register and guides on how to record the students'

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sports qualities, only the motor component is usually taken into consideration, which leads to a very low predictability percentage of this selection stage.

In order to increase the predictability of selection, this should be based on scientific criteria.

Thus, medical orientation should go through several stages: sports medical anamnesis, somatometric exam, somatoscopic exam, physical quality assessment. Only in this way, is a favorable medical biological selection possible for proper sports orientation (White et al., 1998).

a) *Anamnesis*

It represents the starting point of any medical exam, therefore of the sports medical exam as well, being important in setting the sports medical diagnosis, as well as in making the initial sports selection, which could also undergo modifications along the way. Sports medical anamnesis has two components: general anamnesis and special anamnesis, which is specific for sports. Sports anamnesis is both initial and periodic. Initial anamnesis comprises the child's medical history, potential illnesses, as well as organic and/or functional sequelae, the child's motivation for sports, the parents' motivation, if the family had or has performance athletes. A separate talk with the parents is necessary in order to identify any element that might influence the athlete's future activity (White et al., 2004; Avramescu et al., 2006; Drăgan, 1989). The periodic sports medical anamnesis focuses on just two aspects: the medical evolution from the last checkup until the current day and the sports evolution (down to the smallest details) in the same time frame (an association of sports and medical evolution, through the athlete's vision) (Avramescu et al., 2006; Drăgan, 1989).

The assessment of physical development is done by the somatometric exam (paraclinical method of assessing physical development and nutrition status based on anthropometric measurements) and the somatoscopic exam (visual observation of the subject in order to assess composure, the general nutrition state, distribution of adipose tissue, muscle mass development, bone structure development, the presence of physical defects).

b) *The somatoscopic exam*

It consists of the frontal, dorsal and profile visual inspection of the subject's body, with the methodical inspection of global and segmental characteristics, statically and dynamically. Although subjective in its essence, somatoscopy, as it is predominantly carried out through the examiner's senses, has an outstanding importance in sports medicine, being the first component of the clinical exam. Rich in information, it allows a global and segmental assessment, despite not being expressed in concrete measurement units. Its results contribute to the individual's health status diagnosis, as well as physical and biomotor development (Avramescu et al., 2006; Drăgan, 1989).

The diagnosis of satisfactory, good or very good orthostatic, normotonic posture must be done according to the correctness of ratios between the segments, the body's balance in space according to the support polygon and gravitation line, represented by the line at the 0 (zero) point of the anthropometric frame. The qualities of orthostatic posture are: optimal, economical, esthetically vertical, ability for stato-kinetic and telekinetic practical performance (Avramescu et al., 2006; Drăgan, 1989).

c) *The somatometric exam*

It provides objective data on development, by direct measurement of the body size, through relatively simple measurements, with handy equipment (tape line, goniometer, mobility ladder, height and weight scales, dynamometer, myotonometer) and it allows to draw valuable conclusions. A quantified expression of the data can be carried out and, through statistical and mathematical processing, development standards are created (Avramescu et al., 2006; Drăgan, 1989).

The somatometric exam brings the following information of high practical utility:

- *Size* is 10 times more strongly influenced by heredity than by the environment. Generally, stature characterizes rather well the individual's development and it is the measurement to which all other anthropometric measurements can be compared. The scale of normal size spans between 135-190 cm, with variation in very tall statures, higher than 200 cm and very small ones, under 120 cm. In sports, the requirements are extremely different, from small statures in gymnastics to very high ones in basketball and high jump. It is important to know in which category the athlete fits at the time of selection. For this purpose, charts were created regarding the stature and weight based on age and gender, to help give the required answer, primarily taking into account the parents' statures.

- *The bust* represents the distance between the buttocks support plan and the top of the head, in the seated subject, back pressed against the height and weight scale rod. On an average, the bust represents 52% of the stature in males and 53% in females, with variations between 54.5-55% in both genders. Practically, the Adrian Ionescu index is used, as the following ratio: bust – stature/2, which in males is 5-6 cm, and in females 3-4 cm. The bust/stature ratio is very important in various athlete categories, where tall individuals must also have long lower limbs (high jumpers, 800-1500 m runners), or shorter lower limbs, with a lower center of gravity, for a higher stability in technical execution (hammer throwers, weightlifters) (Avramescu et al., 2006; Drăgan, 1989).

- *The arm span* is the distance between the right and left middle fingers, arms extended on the side at clavicle level. It is used in high performance sports, in direct connection with finalizing the sports effort. Its size must be at least equal with the stature, the characterization being: short, medium and long arms (exceptional values were recorded, up to +14 cm in comparison with the stature).

- *The biacromial width* represents the distance between the distal points of the acromion's outer edge. A high biacromial width is 39 cm in females and 43 cm in males, highly valued in body building and American football.

- *The bitrochanteric diameter* assesses the width of the pelvis and is measured in transverse plane on the antero-external edge of the greater trochanters. It could be slightly more difficult to measure in females, as the adipose tissue may mask it. It is generally 4-5 cm smaller than the biacromial width, though variations could be quite large. By comparing the 2 diameters, the athletic allure results (wide thorax, narrow pelvis), which is so much appreciated

in athletes; the maximal values are +10-12 cm and the hydrodynamic index (very valuable in swimming): J x 100 / stature, J being the ratio value (biacromial width + bitrochanteric diameter) / 2.

- *The thoracic circumference* is measured in antero-posterior and transversal plane and it assesses the individual's robustness. The transverse diameter is measured at the sternum and 4th rib level, dynamically, meaning in prolonged inspiration and expiration, in order to record an as great as possible differential. The antero-posterior diameter is also assessed dynamically, at sternum and anterior correspondence level. The transverse diameter value has to be at least 8 cm higher than the antero-posterior diameter; otherwise, it would be the case of a flat or cylindrical thorax.

- *The arm circumference*, of the left and right arms with the highest size, relaxed and in contraction, *the forearm circumference* under the elbow joint and with closed fist (for the upper limb) and *thigh circumference* relaxed and in contraction, *calf circumference* and *ankle circumference* also provide important anthropometric data, such as: data interpretation is done by estimating the absolute values (an arm with a circumference of 35 cm in women and 45 cm in men is a well-developed one, while a thigh with a 60 cm circumference is a strong one); it is also done through the relaxed-contracted difference, which should be as high as possible (differences as high as 8-10 cm were noted in bodybuilders). The thorax-stature circumference ratio is expressed by *the Erissman harmony index* (thoracic circumference – stature/2), which, in an adult, should have positive values. In children, the index has negative values, it is close to 0 around the age of 16-18 and it becomes positive in adult life. Generally, a negative Erissman index indicates an insufficiently developed thorax for an adult, while a high index could also be due to excessive adipose tissue on the torso (Avramescu et al., 2006; Drăgan, 1989).

- *Bone development* is assessed by measuring the fist circumference at the radial and cubital epiphysis, the knee circumference at the middle of the patella, the ankle circumference above the malleoli. The sum of these circumferences, compared to stature, results in an index of 45 in males and 44 in females, which allows the classification of individuals in 3 classes: small bone structure, with a bone index under 43, medium bone structure with an index between 43.5-45, strong bone structure with an index over 45.

- *The individual's weight* is easy to measure and it also provides information on the health status. The complete weighing of the individual is done in the morning, before eating, the subject being completely undressed. Assessing the weight status in an adult is done by calculating the body mass index, BMI = weight (kg)/height (m²) (Alexescu et al., 2009; Tsigos et al., 2008) (Table I). In a young adult weighing 60 kg, the fixed part is approximately 20 kg and the variable part is approximately 40 kg (30 kg muscle mass and 10 kg fat) (Avramescu et al., 2006; Drăgan, 1989).

Table I

International classification of adult body weight according to BMI.

Classification	BMI (kg/m²)
Underweight	<18.50
Normal weight	18.50 - 24.99
Overweight	25.00 - 29.99
Obesity	≥30.00
I degree obesity	30.00 - 34-99
II degree obesity	35.00 - 39.99
III degree obesity	≥40.00

(Alexescu et al., 2009; Tsigos et al., 2008)

- The calculation method of the *adipose tissue percentage* (AT%) is based on measuring 5 skin folds located on the abdomen, flank, back (under the scapula angle), brachial triceps and the anterior extremity of the thigh, all on the right side of the body. The calculation formula is the following:

AT (%) = (sum of 5 skin folds x 0.15) + 5.8 + BS (body surface)

Normally, the combined skin fold values should not go beyond +15 - +20 mm. In performance sports, the skin fold size can be: 2 mm for bodybuilders, 4-5 mm in gymnastics, 15-20 mm in weight and hammer throwers. The optimal value of adipose tissue is 11%-12%. We must take into account the fact that for an adult, 2 mm adipose tissue represent 1 kg weight (Avramescu et al., 2006; Drăgan, 1989).

We consider as very useful for specialists in sports medicine, school medicine, family medicine, etc. the presentation of tables with average data and normality indexes for height and weight in Romanian urban and rural environment (Tables I-IV) (Vlaicu, 2000).

Table I

Average data and normality indexes - Romania 1992, urban environment, height (cm).

Age	Sex	Mean	σ	Indices					
				Very low	Low	Medium		High	Very high
				M-3σ	M-2σ	M-σ	M+σ	M+2σ	M+3σ
New born	M	51.17	2.01	45.1	47.2	49.2	53.2	55.2	57.2
	F	50.63	2.04	44.5	46.6	48.6	52.7	54.7	56.8
1 year	M	74.31	3.52	63.8	67.3	70.8	77.8	81.4	84.9
	F	73.6	3.54	63.0	66.5	70.1	77.1	80.7	84.2
2 years	M	85.1	4.51	71.6	76.1	80.6	89.6	94.1	98.6
	F	84.14	4.44	70.8	75.3	79.7	88.6	93.0	97.5
3 years	M	94.01	5.26	78.2	83.5	88.8	99.3	104.5	109.8
	F	93.1	5.02	78.0	83.1	88.1	98.1	103.1	108.2
4 years	M	102.18	5.62	85.3	90.9	96.6	107.8	113.4	119.0
	F	101.09	5.63	84.2	89.8	95.5	106.7	112.4	118.0
5 years	M	108.68	5.64	91.8	97.4	103.0	114.3	120.0	125.6
	F	107.91	5.68	90.9	96.6	102.2	113.6	119.3	125.0
6 years	M	115.23	5.86	97.7	103.5	109.4	121.1	127.0	132.8
	F	114.26	5.91	96.5	102.4	108.4	120.2	126.1	132.0
7 years	M	122.04	6.29	103.2	109.5	115.8	128.3	134.6	140.9
	F	121.33	6.18	102.8	109.0	115.2	127.5	133.7	139.9
8 years	M	126.83	6.01	108.8	114.8	120.8	132.8	138.9	144.9-
	F	125.94	6.1	107.6	113.7	119.8	132.0	138.1	144.2
9 years	M	132.02	6.37	112.9	119.3	125.7	138.4	144.8	151.1
	F	131.56	6.76	111.3	118.0	124.8	138.3	145.1	151.8
10 years	M	137.51	6.89	116.8	123.7	130.6	144.4	151.3	158.2
	F	137.43	7.43	115.1	122.6	130.0	144.9	152.3	159.7
11 years	M	142.02	7.18	120.5	127.7	134.8	149.2	156.4	163.6
	F	142.74	7.94	118.9	126.9	134.8	150.7	158.6	166.6
12 years	M	147.52	7.53	124.9	132.5	140.0	155.1	162.6	170.1
	F	149.71	7.83	126.2	134.1	141.9	157.5	165.4	173.2
13 years	M	154.46	9	127.5	136.5	145.5	163.5	172.5	181.5
	F	155.39	7.59	132.6	140.2	147.8	163.0	170.6	178.2
14 years	M	161.97	9.08	134.7	143.8	152.9	171.1	180.1	189.2
	F	160.12	6.62	140.3	146.9	153.5	166.7	173.4	180.0
15 years	M	169.26	8.32	144.3	152.6	160.9	177.6	185.9	194.2
	F	161.77	6.31	142.8	149.2	155.5	168.1	174.4	180.7
16 years	M	172.81	7.19	151.2	158.4	165.6	180.0	187.2	194.4
	F	162.79	5.93	145.0	150.9	156.9	168.7	174.7	180.6
17 years	M	174.82	6.69	154.8	161.4	168.1	181.5	188.2	194.9
	F	163.15	5.96	145.3	151.2	157.2	169.1	175.1	181.0
18 years	M	176.21	6.52	156.7	163.2	169.7	182.7	189.3	195.8
	F	163.34	6.52	143.8	150.3	156.8	169.9	176.4	182.9

Table II

Average data and normality indexes - Romania 1992, urban environment, weight (kg).

Age	Sex	Mean	σ	Indices					
				Very low	Low	Medium		High	Very high
				M-3σ	M-2σ	M-σ	M+σ	M+2σ	M+3σ
New born	M	3.36	0.77	1.1	1.8	2.6	4.1	4.9	5.7
	F	3.21	0.41	2.0	2.4	2.8	3.6	4.0	4.4
1 year	M	9.9	1.08	6.7	7.7	8.8	11.0	12.1	13.1
	F	9.57	1.08	6.3	7.4	8.5	10.7	11.7	12.8
2 years	M	12.42	1.34	8.4	9.7	11.1	13.8	15.1	16.4
	F	11.97	1.32	8.0	9.3	10.7	13.3	14.6	15.9
3 years	M	14.27	1.6	9.5	11.1	12.7	15.9	17.5	19.1
	F	13.80	1.56	9:2	10.3	12.3	15.5	17.0	18.6
4 years	M	16.22	2.01	10.2	12.2	14.2	18.2	20.2	22.3
	F	15.78	2.02	9.7	11.7	13.8	17.8	19.8	21.8
5 years	M	18.12	2.32	11.0	13.5	15.8	20.4	22.8	25.1
	F	17.63	2.35	10.6	12.9	15.3	20.0	22.3	24.7
6 years	M	20.42	2.82	12.0	14,8	17.6	23.2	26.1	28.9
	F	19.77	2.81	11.3	14.2	17.0	22.6	25.4	28.2
7 years	M	23.07	3.55	12,4	16.0	19.5	26.6	30.2	33.7
	F	22.44	3.58	11.7	15.3	18.9	26.0	29.6	33.2
8 years	M	25.15	4.15	12.7	16.9	21.0	29.3	33.5	37.6
	F	24.31	4.07	12.1	16.2	20.2	26.4	32.5	36.5
9 years	M	27.92	4.83	13.4	18.3	23.1	32.8	37.6	42.4
	F	27.25	4.98	12.3	17.3	22.3	32.2	37.2	42.2
10 years	M	31.2	5.78	13.9	19.6	25.4	37.0	42.8	48.5
	F	30.83	6.31	11.9	18.2	24.5	37.1	43.5	49.8
11 years	M	33.98	6.36	14.9	21.3	27.6	40.3	46.7	53.1
	F	34.26	6.91	13.5	20.4	27.4	41.2	48.1	55.0
12 years	M	37.88	7.38	15.7	23.1	30.5	45.3	52.6	60.0
	F	39.05	7.66	16.1	23.7	31.4	6.7	54.4	62.0
13 years	M	43.05	8.81	16.6	25.4	34.2	51.9	60.7	69.5
	F	44.07	8.11	19.7	27.9	36.0	52.2	60.3	68.4
14 years	M	48.87	9.69	19.8	29.5	39.2	58.6	68.3	77.9
	F	48.8	7.88	25.2	33,0	40.9	56.7	64.6	72.4
15 years	M	54.85	9.53	26.3	35.8	45.3	64.4	73.9	83.4
	F	51.54	7.58	28.8	36.4	44.0	59.1	66.7	74.3
16 years	M	60.16	8.87	33.6	42.4	51.3	69.0	77.9	86.8
	F	53.39	7.03	32.3	39.3	46.4	60.4	67.5	74.5
17 years	M	63.16	8.59	37.4	46.0	54.6	71.8	80.3	88.9
	F	54.09	7.01	33.1	40.1	47.1	61.1	68.1	75.1
18 years	M	65.58	8.15	41.1	49.3	57.4	73.7	81.9	90.0
	F	55.01	7.22	33.4	40.6	47.8	62.2	69.5	76.7

Table III

Average data and normality indexes - Romania 1992, rural environment, height (cm).

Age	Sex	Mean	σ	Indices					
				Very low	Low	Medium		High	Very high
				M-3σ	M-2σ	M-σ	M+σ	M+2σ	M+3σ
New born	M	51.30	2.13	44.9	47.0	49.2	53.4	55.6	57.7
	F	50.44	2.32	43.5	45.8	48.1	52.8	55.1	57.4
1 year	M	74.52	4.63	60.6	65.3	69.9	79.2	83.8	88.4
	F	73.06	4.38	59.9	64.3	68.7	77.4	81.8	86.2
2 years	M	84.89	5.41	68.7	74.1	79.5	90.3	95.7	101.1
	F	83.83	5.49	67.4	72.9	78.3	89.3	94.8	100.3
3 years	M	93.80	6.03	75.7	81.7	. 87.8	99.8	105.9	111.9
	F	92.70	5.40	76.5	81.9	87.3	98.1	103.5	108.9
4 years	M	101.25	6.56	81.6	88.1	94.7	107.8	114.4	120.9
	F	100.03	6.67	80.0	86.7	93.4	106.7	113.4	120.0
5 years	M	107.22	6.27	88.4	94.7	101.0	113.5	119.8	126.0
	F	105.03	6.42	85.8	92.2	98.6	111.5	117.9	124.3
6 years	M	113.28	6.46	93.9	100.4	106.8	119.7	126.2	132.7
	F	112.21	6.77	91.9	98.7	105.4	119.0	125.8	132.5
7 years	M	119.35	6.25	100.6	106.9	113.1	125.6	131.9	138.1
	F	118.17	6.30	99.3	105.6	111.9	124.5	130.8	137.1
8 years	M	124.30	6.25	105.6	111.8	118.1	130.6	136.8	143.1
	F	123.25	6.50	103.8	110.3	116.8	129.8	136.3	142.8
9 years	M	129.26	6.46	109.9	116.3	122.8	135.7	142.2	148.6
	F	128.70	6.83	108.2	115.0	121.9	135.5	142.4	149.2
10 years	M	134.44	6.70	114.3	121.0	127.7	141.1	147.8	154.5
	F	133.87	6.99	112.9	119.9	126.9	140.9	147.9	154.8
11 years	M	139.38	7.18	117.8	125.0	132.0	146.6	153.7	160.9
	F	139.54	7.77	116.2	124.0	131.8	147.3	155.1	162.9
12 years	M	144.39	7.63	121.5	129.1	136:8	152.0	159.7	167.3
	F	145.94	8.09	121.7	129.8	137.9	154.0	162.1	170.2
13 years	M	150.03	8.34	125.0	133.4	141.7	158.4	166.7	175.1
	F	152.04	7.92	128.3	136.2	144.1	160.0	167.9	175.8
14 years	M	156.17	9.06	129.0	138.1	147.1	165.2	174.3	183.4
	F	156.06	7.24	134.3	141.6	148.8	163.3	170.5	177.8
15 years	M	160.75	8.68	134.7	143.4	152.1	169.4	178.1	186.8
	F	157.99	6.61	138.2	144.8	151.4	164.6	171.2	177.8
16 years	M	165.26	7.81	141.8	149.6	157.5	173.1	180.9	188.7
	F	160.23	6.16	141.8	147.9	154.1	166.4	172.6	178.7
17 years	M	167.31	7.37	145.2	152.6	159.9	174.7	182.1	189.4
	F	161.49	5.97	143.6	149.6	155.5	167.5	173.4	179.4
18 years	M	169.05	7.46	146.7	154.1	161.6	176.5	184.0	191.4
	F	162.15	6.06	144.0	150.0	156.1	168.2	174.3	180.3

Table IV

Average data and normality indexes - Romania 1992, rural environment, weight (kg).

Age	Sex	Mean	σ	Indices					
				Very low	Low	Medium		High	Very high
				M-3σ	M-2σ	M-σ	M+σ	M+2σ	M+3σ
New born	M	3.27	0.43	2.0	2.4	2.8	3.7	4.1	4.6
	F	3.25	0.65	1.3	2.0	2.6	3.9	4.6	5.2
1 year	M	9.75	1.20	6.2	7.4	8.6	11.0	12.2	13.4
	F	9.41	1.17	5.9	7.1	8.2	10.6	11..8	12.9
2 years	M	12.26	1.54	7.6	9.2	10.7	13.8	15.3	16.9
	F	11.89	1.42	7.6	9.1	10.5	13.3	14.7	16.2
3 years	M	13.98	1.73	8.8	10.5	12.3	15.7	17.4	19.2
	F	13.53	1.75	8.3	10.0	11.8	15.3	17.0	18.8
4 years	M	15.67	2.10	9.4	11.5	13.6	17.8	19.9	22.0
	F	15.34	2.18	8.8	11.0	13.2	17.5	19.7	21.9
5 years	M	17.38	2.54	9.8	12.3	14.8	19.9	22.5	25.0
	F	16.89	2.43	9.6	12.0	14.5	19.3	21.8	24.2
6 years	M	19.39	2.75	11.1	13.9	16.6	22.1	24.9	27.6
	F	18.77	2.93	10.0	12.9	15.8	21.7	24.6	27.6
7 years	M	21.71	3.18	12.2	15.4	18.5	24.9	28.1	31.3
	F	20.95	3.19	11.4	14.6	17.8	24.1	27.3	30.5
8 years	M	23.88	3.48	13.4	16.9	20.4	27.4	30.8	34.3
	F	23.05	3.55	12.4	16.0	19.5	26.6	30.2	33.7
9 years	M	26.32	3.99	14.4	18.3	22.3	30.3	34.3	38.3
	F	25.62	4.47	12.2	16.7	21.2	30.1	34.6	39.0
10 years	M	26.32	4.52	12.8	17.3	21.8	30.8	35.4	39.9
	F	28.25	4.84	13.7	18.6	23.4	33.1	37.9	42.8
11 years	M	31.97	5.30	16.1	21.4	26.7	37.3	42.6	47.9
	F	31.68	5.93	13.9	19.8	25.8	67.6	43.5	49.5
12 years	M	35.12	5.82	17.7	23.5	29.3	40.9	46.8	52.6
	F	36.28	6.94	15.5	22.4	29.3	43.2	50.2	57.1
13 years	M	39.55	7.05	18.4	25.5	32.5	46.6	53.7	60.7
	F	41.63	7.55	19.0	26.5	34.1	49.2	56.7	64.3
14 years	M	44.59	8.10	20.3	28.4	36.5	52.7	60.8	68.9
	F	46.03	7.79	22.7	30.5	38.2	53.8	61.6	69.4
15 years	M	49.67	8.38	24.5	32.9	41.3	58.1	66.4	74.8
	F	49.45	7.42	27.4	34.6	42.0	56.9	64.3	71.7
16 years	M	55.41	7.54	32.8	40.3	47.9	63.0	70.5	78.0
	F	52.96	6.64	33.0	39.7	46.3	59.6	66.2	72.9
17 years	M	58.68	7.34	36.7	44.0	51.3	66.0	73.4	80.7
	F	54.72	6.61	34.9	41.5	48.1	61.3	67.9	74.6
18 years	M	61.66	7.35	39.6	47.0	54.3	69.0	76.4	83.7
	F	56.03	6.72	35.9	42.6	49.3	62.8	69.5	76.2

Physical qualities

The physical (motor) qualities are assessed using specific methods.

Muscular strength – measured with dynamometers. It is expressed in kgf and it records the finger flexor strength, the pectoral arch strength and lumbar strength. The segmental strength index is calculated with the formulae:

- [(F1dr. + F1stg./2)]/Gx 100 for finger flexor strength, which is 60-70 in males and 50 in females;
- [F.sc./G] x 100 for pectoral arch strength, which is 50-60 in males and 40 in females;
- [F.lomb./G] x 100 for lumbar strength, which is 180 - 200 in males and 120-140 in females (Avramescu et al., 2006; Drăgan, 1989).

Mobility, tested with the mobility ladder, which emphasizes the anterior mobility of the lumbar spine. Muscular elasticity results from the difference of muscular circumferences in relaxed and contracted state in the upper and lower limbs, the differences in the thorax circumference while inhaling and exhaling, as well as at abdomen level (Avramescu et al., 2006; Drăgan, 1989).

Muscle tone is assessed at the level of larger limb muscle mass, while resting and in maximum contraction. The Szimayer myotonometer records values of 60-70 in relaxation and 140-150 in contraction (Avramescu et al., 2006; Drăgan, 1989).

Joint mobility is assessed in each of the big joints with the goniometer; in athletes it can have very good values, but it generally diminishes with age. We must also make a difference between joint mobility and joint laxity (Avramescu et al., 2006; Drăgan, 1989), a quality which is

very appreciated in rhythmic gymnastics.

The speed of an individual mostly depends on heredity, and it can only be "educated" to a very small extent. Speed, measured with the chronometer, can be characterized through several qualities: reaction, execution, repetition, movement; there are several exercises for increasing these types of speed, so necessary in individual sports (athletics, judo, boxing, wrestling), and also, in team sports (football, handball, basketball) (Avramescu et al., 2006; Drăgan, 1989).

Motor coordination or *dexterity* represents the capacity to execute the necessary movements in a correct, fast manner, adapted to the situation. It is a necessary quality in any field, especially in those with practical applicability, such as performance sports. Dexterity represents a sum of qualities which interfere with all the other qualities. If by the age of 12-14 years old, an individual does not show a certain dexterity for a motor activity, it is most unlikely they will later acquire it. As it is a complex quality, dexterity has no methods, methodical procedures or special qualities and it can only be subjectively measured (Avramescu et al., 2006; Drăgan, 1989).

Endurance is the body's capacity to perform an activity for a long time without diminishing efficacy. It is assessed in three ways: long term endurance (8-10 min.), medium term endurance (between 2-8 min.), short term endurance (45 sec. – 2 min.). Endurance is a slightly perfectible motor quality, through sustained and well scientifically researched training (Avramescu et al., 2006; Drăgan, 1989).

Thus, the medical biological selection and sports orientation can be carried out based on several criteria:

- The sanogenic criterion, which must be closely abided by, especially in primary selection. The following will be excluded from selection: cardiovascular diseases (even compensated), congenital anomalies, neuroendocrine diseases with or without behavioral disorders, rheumatic diseases, tuberculosis or acute viral hepatitis, renal diseases and sequelae, blood diseases, severe hearing and vision impairments, severe physical defects etc. (Drăgan, 1989).

- The genetic criterion, based on the genetic gender diagnosis. At several Olympic Games and world championships a few cases of genetic gender were encountered in female athletes, even in the absence of transgender situations. This led to the mandatory implementation of a genetic gender exam for winners in the Olympic Games or world championships (Drăgan, 1989). Recently, in 2013, a group of Australian scientists perfected a genetic test which proves or not the presence of a variant of the ACTN3 gene (R577X variant). This gene normally produces the actinin-3 protein, which contributes to the formation of rapid contraction muscular fibers, which are precisely those fibers used in intense efforts, such as athletic sprint events or bodybuilding. An individual which has no copy of the R577X variant may well have better than average results in sprint events or force sports, such as judo. Also, through a higher percentage of rapid contraction muscle fibers, the individual might have better results in bodybuilding. On the other hand, a person with two copies of this gene should do better in endurance sports, while a person with a copy of each variant should be placed somewhere between the two extremes. For now, these tests cause a lot of ethical controversy and they should be used and interpreted in a very discerning way (1).

- The morphological criterion in the performance selection is a true indicator, which both biologists and teachers use in sports selection. A certain constitution biotype could prove unfavorable in a certain sports event, on a biological level. This is why during the medical sports examination, it is necessary to mention the relation between the constitution type, established following the investigations, and the sports event in question: constitution biotype favorable (unfavorable) for the sports event (Drăgan, 1989).

- The functional criterion reflects more the effect of training rather than the consequence of genetic factors. Motor indicators: speed, strength, endurance, mobility, which belong to the coach and the teacher. The sports physician parallels these indicators with the physiological base, which is objective. Usually, the coach carries out a pre-selection, using the chronometer, the "eye", the tape line and the weight, which then later the physician consolidates, confirming it or ruling it out, by running a complex set of tests (Avramescu et al., 2006; Drăgan, 1989).

- The neuro-psychological criterion takes into account the psychogenic type, motivation for sports, the parents' psycho-physical aspect, psycho-reactivity, focused attention, stress coping, excitability, intelligence level (IQ). (Avramescu et al., 2006; Drăgan, 1989).

- The biochemical criterion considers a biochemical profile that might be favorable for a certain sport. For instance, those with high testosterone levels lean towards strength sports (weight lifting, bodybuilding), while those with high hemoglobin levels lean towards endurance sports (marathon, semi-marathon) (Drăgan, 1989).

Discussions

Global concerns on medical orientation at increasingly younger ages towards practicing certain sports have been relatively few in the last years, Romania not having, unfortunately, a standardized system to be applied by sports physicians.

In 2001, the Sports Medicine and Fitness Committee and the School Health Committee published the guidelines of the American Academy Association of Pediatrics for optimization and safety of children and teenagers in sports practice. These guidelines show how pediatricians can assess a child's capacity of practicing sports, their availability, how to minimize risks and maximize performance.

Moreover, through standard measurements on the aforementioned anthropometric indexes applied to children, one could also establish the health status and need to practice sports at population level. In a 2010 study, carried out on a group of children aged between 7 and 15 years, the authors drew the conclusion that sedentariness was correlated with female gender, obesity and abdominal circumference (Andreasi et al., 2010; Andersen, 2009; Ruiz et al., 2006).

In a pilot study published in 2009, it is shown that gender, the type of sports and competitive level are important factors to be taken into account when studying

the ways in which athletes define their own success or failure (Hanrahan & Cerin, 2009; Hanrahan et al., 2003; Hanrahan & Biddle, 2002), providing us with a few practical conclusions: male athletes should be encouraged to define their success in terms of improving their own performances, rather than just being better than the others; athletes practicing individual sports could also need to be convinced that success should be about acquiring new skills and improving the old ones; athletes practicing team sports should want to improve their own physical and sport qualities and admit that these can contribute to the success or failure of the entire team (Hanrahan & Cerin, 2009; Hanrahan et al., 2003; Hanrahan & Biddle, 2002; Papaioannou et al., 2007; Hanrahan & Gross, 2005).

Studies regarding sports orientation are in full swing in various sports, being aimed at finding exploration and integration methods from as early as possible ages. For instance, a 2013 study's conclusion is that children under the age of 11 cannot assess curved trajectories, unlike teenagers and adults (Brunet et al., 2007; Belmonti et al., 2013; Assaiante et al., 2005). The anticipation of turning the head and assessing the trajectory is developed late during childhood, while navigation skills, such as planning the itinerary and getting from egocentric reference to allocentric reference, are acquired late in the development of the control motor system; thus, the critical age to consolidate and acquire navigation skills is around the age of 9-10 years old. However, further studies are necessary (Brunet et al., 2007; Belmonti et al., 2013; Assaiante et al., 2005; Hicheur et al., 2005).

A comparative study on several anthropometric parameters between professional triathlon athletes and Sports and Physical Education students revealed that there were no significant differences between the two groups in terms of arm circumference, length of lower limbs, abdominal circumference or thigh circumference (Brunkhorst & Kielstein, 2013; McLean & Parker, 1989; Campion et al., 2010). As expected, performance athletes had a lower heart rate and body weight that the control group. Moreover, the cyclists of this group had a higher BMI, bigger thighs and were taller than triathletes, these measurements not having a higher impact on performance than individual training (Brunkhorst & Kielstein, 2013; Landers et al., 2000; Knechtle et al., 2007).

In 2014, a group of Swiss researchers published data on gender differences regarding some anthropometric qualities of professional swimmers: the age of male freestyle swimmers is higher by 2 years than that of females, age that is rising with the event distance in females, but not in males; female swimmers seem to obtain the fastest swimming speeds on short distances earlier in their age (~ 20-21 years), in comparison with long distances (~ 25-27 years); male freestyle swimmers seem to reach the highest speed between 22-27 years; moreover, gender does not influence the swimmer's speed at various length categories of an event (Rüst et al., 2014; Buhl et al., 2013; Donato et al., 2003; Vaso et al., 2013).

USA, the country with the highest interest in individual and national health, provides us with detailed maps/charts according to age and gender, referring to the individual's harmonious physical development until the age of 20 years. The charts were put together by the Centers for disease control and prevention - CDC (2).

These charts were created in order to enable to assess the health status of the school and preschool child, but they can also be applied by sports physicians to find those individuals with the right genetic load and family medical history, with the physical qualities necessary for performance sports. For instance, if following the physical exam, a child with a height above the 90th percentile is found, the child can be directed towards sports such as basketball, high jump; if, however, the height is below the 30th percentile, the child can be directed towards rhythmic gymnastics, weight lifting, judo, according to the child's bio-psychological qualities and their desire to practice sports. For those that are interested, the site provides numerous charts regarding all of the individual's physical qualities until the age of 20, with gender differences and possibility for exhaustive interpretation, thus giving an important technical support for those interested in professional activity: school and preschool physicians, GPs, sports physicians.

The clinical charts have scaled grids (kg, cm), with units in English (lb, in). The clinical diagrams are available for boys and girls. Of all the available clinical charts, we select those on monitoring the stature, weight and BMI according to age, which target children and teenagers aged 2-20 (Fig. 5-8).

It is desirable to carry out a research to render the CDC charts compatible, with the purpose of adapting them to the Romanian population.

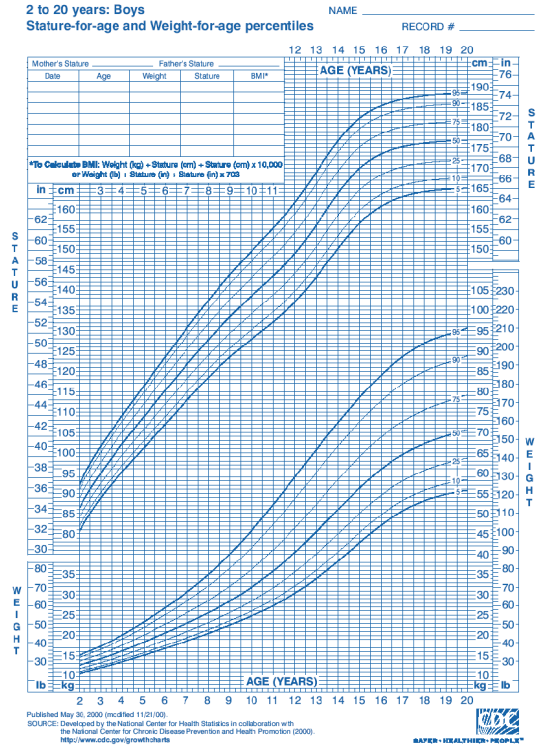

Fig. 5 – Stature according to age and weight - 2-20 year-old boys.

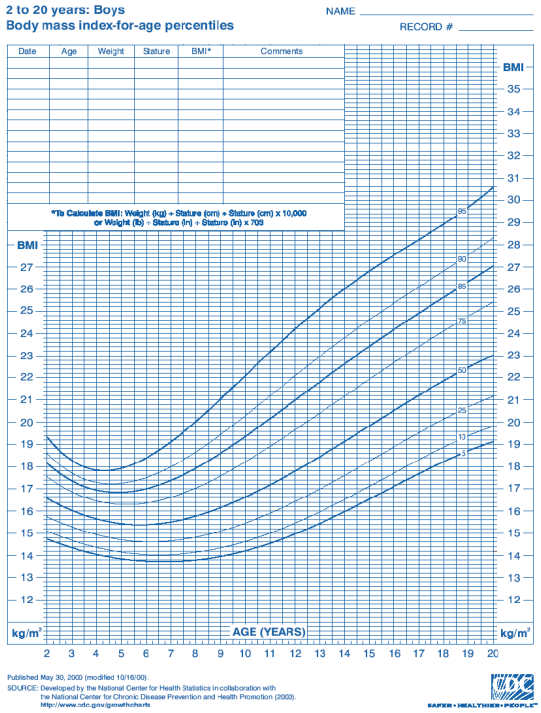

Fig. 6 – Body mass index - 2-20 year-old boys.

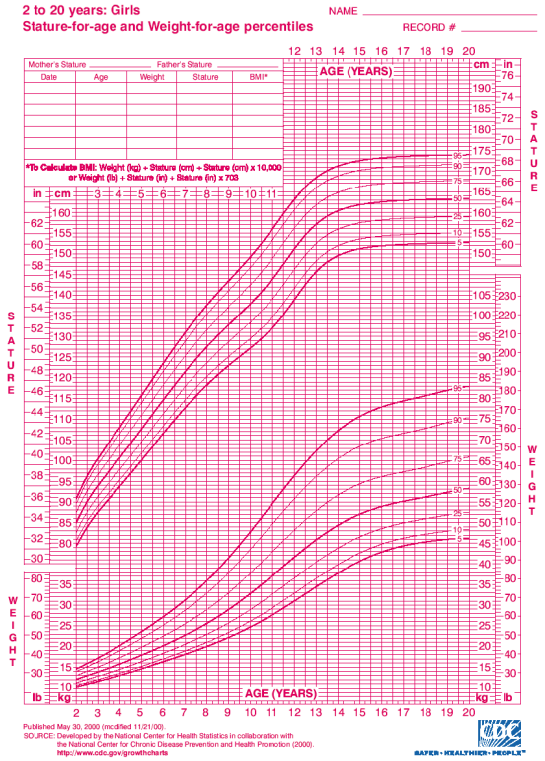

Fig. 7 – Stature according to age and weight - 2-20 year-old girls.

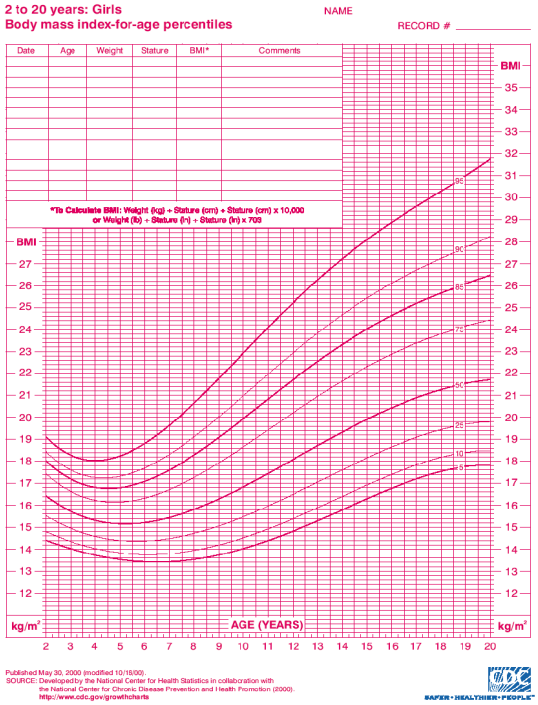

Fig. 8 – Body mass index - 2-20 year-old girls.

Conclusions

1. Sports medical orientation is a complex system that could mainly be applied to children, but can be extended to any sports age.

2. Sports medical orientation operates with objective indicators in order to emphasize that particular biological potential which, under scientific training, could lead to sports performance, under the conditions of no negative interference from growing, schooling and sanogenesis.

3. In Romania, there is no updated national register on the bio-psycho-motor qualities of school and pre-school children, which are so necessary for trainers in order to recruit future athletes on a scientific basis.

4. The lack of national guides eligible for sports physicians leads to a decrease of sports performance. In daily practice, sports physicians could turn to international guides and assess the physical qualities of an individual based on existing annexes, in order to guide them towards a certain sport.

Conflicts of interest

Nothing to declare.

References

Alexescu T, Motocu M, Negrean V, Ţărmure S, Lencu M. Obezitatea şi sindromul metabolic. Epidemiologie şi etiopatogenie. Clujul Medical, 2009; 82 (3):353-359.

Andersen LB. Physical activity in adolescents. J Pediatr (Rio J). 2009;85:281-283.

Andreasi V, Michelin E, Rinaldi AE, Burini RC. Physical fitness and associations with anthropometric measurements in 7 to 15-year-old school children. J Pediatr (Rio J). 2010;86(6):497-502.

Assaiante C, Mallau S, Viel S, Jover M, Schmitz C. Development of Postural Control in Healthy Children: a Functional

Approach. Neural Plast. 2005;12:109-118.
Avramescu ET (coord). Kinetoterapia în activităţi sportive. Vol. II. Ed. Didactică şi Pedagogică, Craiova, 2006,15-28;105-120.
Belmonti V, Cioni G, Berthoz A. Development of anticipatory orienting strategies and trajectory formation in goal-oriented locomotion. Exp Brain Res. 2013;227:131-147.
Brunet M, Chaput JP, Tremblay A.The association between low physical fitness and high body mass index or waist circumference is increasing with age in children: the 'Québec en Forme' Project. Int J Obes (Lond). 2007;31:637-643.
Brunkhorst L, Kielstein H. Comparasion of anthropometric characteristics between professional triathlets and cyclists. Biol. Sport. 2013;30:269-273.
Buhl C, Knechtle B, Rüst CA, Rosemann T, Lepers R. Women achieve peak swim performance in individual medley at earlier ages than men. Medicina Sportivă. 2013;17:54-59.
Campion F, Nevill AM, Karlsson MK et al. Bone status in professional cyclists. Int. J. Sports Med. 2010;31:511-515.
Daniels AM. Cooperation versus competition: is there really such an issue? New Dir Youth Dev. 2007;(115):43-56, 6-7.
Donato AJ, Tench K, Glueck DH, Seals DR, Eskurza I, Tanaka H. Declines in physiological functional capacity with age: a longitudinal study in peak swimming performance. J Appl Physiol. 2003;94:764-769.
Drăgan I (coord). Selecţia şi orientarea medico-sportivă. Ed . Sport Turism, Bucureşti, 1989.
Hanrahan SJ, Biddle SJH. Measurement of achievement orientations: psychometric measures, gender, and sport differences. Eur J Sport Sci. 2002;2(5):1-12.
Hanrahan SJ, Cerin E, Hartel C. Achievement goal orientations, attributional style, and motivational climate as predictors of performance and persistence. In: Proceedings of the Association for the Advancement of Applied Sport Psychology Annual Conference, 2003.
Hanrahan SJ, Cerin E. Gender, level of participation, and type of sport: Differences in achievement goal orientation and attributional style. J of Sci Med. in Sport. 2009; 12:508-512.
Hanrahan SJ, Gross J. Attributions and goal orientations in masters athletes: Performance versus outcome. Revista de Psicologia del Deporte. 2005;14(1):43-56.
Hicheur H, Vieilledent S, Berthoz A. Head motion in humans alternating between straight and curved walking path: combination of stabilizing and anticipatory orienting mechanisms. Neurosci Lett. 2005; 383:87-92.
Knechtle B, Knechtle P, Andonie JL et al. Influence of anthropometry on race performance in extreme endurance triathletes: World Challenge Deca Iron Triathlon 2006. Br. J. Sports Med. 2007;41:644-648.
Landers GJ, Blanksby BA, Ackland TR et al. Morphology and performance of world championship triathletes. Ann. Hum. Biol. 2000;27:387-400.
McLean BD, Parker AW. An anthropometric analysis of elite Australian track cyclists. J. Sports Sci. 1989;7:247-255.
Papaioannou AG, Milosis D, Kosmidou E, Tsigilis N. Motivational climate and achievement goals at the situational level of generality. J App Sport Psychol. 2007;19:38-66.
Patel DR, Pratt HD, Greydanus DE. Pediatric neurodevelopment and sports participation. When are children ready to play sports? Pediatr Clin North Am. 2002;49(3):505-531.
Ruiz JR, Rizzo NS, Hurtig-Wennlof A, Ortega FB, Warnberg J, Sjostrom M. Relations of total physical activity and intensity to fitness and fatness in children: the European Youth Heart Study. Am J Clin Nutr 2006;84:299-303.
Rüst CA, Rosemann T, Knechtle B. Sex difference in age and performance in elite Swiss freestyle swimmers competing from 50 m to 1,500 m. SpringerPlus. 2014;3:228-237.
Tsigos C, Hainer V, Basdevant A et al. Management of obesity in adults: European clinical practice guidelines. Obesity Facts, 2008;1(2):106-116.
Vaso M, Knechtle B, Rüst CA, Rosemann T, Lepers R. Age of peak swim speed and sex difference in performance in medley and freestyle swimming – a comparison between 200 m and 400 m in Swiss elite swimmers. J Hum Sport Exercise. 2013;8:954-965.
White SA, Duda JL, Keller MR.The relationship between goal orientation and perceived purposes of sport among youth sport participants. J Sport Behav, 1998;21(4):474-483.
White SA, Kavussanu M, Tank KM, Wingate JM. Perceived parental beliefs about the causes of success in sport: relationship to athletes' achievement goals and personal beliefs. Scand J Med Sci Sports. 2004;14(1):57-66.
Vlaicu, B. Elemente de iugiena copiilor şi adolescenţilor. Ed. SOLNESS. Timişoara, 2000
***. Committee on Sports Medicine and Fitness and Committee on School Health. Organized Sports for Children and Preadolescents. Pediatrics, 2001;107(6):1459-1462.
***. American Academy of Pediatrics, Committee on Sports Medicine and Fitness. Physical fitness and the schools. Pediatrics. 2000;105:1156-1157.

Websites

(1) http://www.nutritiesportiva.ro/medicina_sportiva/12testele_genetice.html, 2013. Accessed on March 2014
(2) http://www.cdc.gov/growthcharts/2000growthchart-us.pdf, 2001. Accessed on March 2014