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The anthropometric profile of junior handball players (Note I)

Profilul antropometric al jucătorilor de handbal juniori (Nota I)

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Abstract

Background. Basic anthropometric parameters (height, weight, circumferences, arm span) and specific anthropometric parameters (hand span, hand grip strength) might influence performance, success in competition, training conditioning, the playing position, selection and identification of talents.

Aims. We aimed to study the anthropometric profile of junior handball players in relation to age, and the effect of maturation on general basic anthropometric parameters.

Methods. The basic anthropometric measurements determined by direct methods were: weight; height; arm span; sitting height; abdominal circumference; biacromial diameter; bitrochanteric diameter. The anthropometric parameters determined by indirect methods were: body mass index (BMI) and chest elasticity.

Results. The comparative changes of basic anthropometric parameters in the experimental groups of athletes versus the control groups show: increase of body mass at the age of 16 and 17; increase of height at the age of 15 and 16; insignificant changes of BMI, all subjects being normal weight; increase of sitting height, arm span, chest elasticity and abdominal circumference at the age of 16, 17 and 18 compared to values corresponding to 15, 16, 17 years of age; increase in bitrochanteric diameter at the age of 15 and 16.

Conclusions. The changes of basic anthropometric parameters in junior handball players can be considered as adaptive changes determined by specific physical training and maturation, and they should be taken into account for the tertiary selection of athletes.

Key words: junior handball players, basic anthropometric parameters.

Rezumat

Premize. Indicatorii antropometrici bazali (înălţime, greutate, perimetru, anvergură) şi specifici (anvergura mâinii, forţa de contracţie a flexorilor) ar putea influenţa performanţele, reuşita în competiţii, condiţionarea antrenamentului, poziţia de joc, selecţia şi identificarea talentelor.

Obiective. Ne-am propus să studiem profilul antropometric al jucătorilor juniori de handbal în raport cu vârsta şi efectul maturizării asupra indicatorilor antropometrici generali bazali.

Metode. Indicatorii antropometrici bazali determinaţi prin metode directe au fost: greutatea; talia; anvergura; înălţimea bustului; perimetrul abdominal, diametrul biacromial; diametrul bitrohanterian. Indicatorii antropometrici determinaţi prin metode indirecte au fost: indicele de masă corporală (IMC) şi elasticitatea toracică.

Rezultate. Modificările comparative ale indicatorilor antropometrici bazali la loturile experimentale de sportivi faţă de loturile de control arată: creşteri ale masei corporale la 16 şi 17 ani; creşteri ale înălţimii la 15 şi 16 ani; modificări nesemnificative ale BMI, toţi subiecţii fiind normo-ponderali; creşteri ale înălţimii bustului, anvergurii, elasticităţii toracice şi perimetrului abdominal la 16, 17 şi 18 ani, faţă de valorile corespunzătoare loturilor de la 15, 16, 17, ani; creşteri ale diametrului bitrohanterian la 15 şi la 16 ani.

Concluzii. Modificările indicatorilor antropometrici bazali la handbaliştii juniori pot fi considerate ca modificări adaptative determinate de pregătirea fizică specifică şi maturizare şi trebuie luate în considerere pentru selecţia terţiară a sportivilor.

Cuvinte cheie: jucători de handbal juniori, indicatori antropometrici bazali.

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Introduction

Handball is a team sport, which involves 7 players (one of these players is assigned the position of goalkeeper). It can be played by both male and female teams. It is for the most part a dynamic, contact sport, because it is practiced under full contact and mental pressure conditions. Players are specialized in different positions. The positions in the handball game are the following: goalkeeper, left back, right back, center, right wing, pivot, left wing. Handball players are required to possess different technical skills and fitness components (Marques & Gonzalez-Badillo, 2006; Ronglan et al., 2006; Buchheit et al., 2009; Ingebrigtsen & Jeffreys, 2012; Ingebrigtsen et al., 2013).

The specific characteristics of the handball game, implicitly of a handball team, are frequent changes in effort intensity, specific technique, full contact confrontations, mental abilities, which mainly require coordination, endurance, strength and intuition. The biomotor skills needed by a handball player are: coordination and agility/ dexterity, force/strength and resistance.

Handball is one of the sports games with the highest physical demands. The categories of movement specific to the handball game are the following: jumping, sprinting, throwing, blocking and pushing (Gorostiaga et al., 2006). In order to plan a high quality of sports training, anthropometric measurements and evaluations of the players' morphofunctional status are needed. For an effective training process, it is essential to know the current anthropometric characteristics and the morphofunctional characteristics of players in different positions (Srhoj et al., 2002). Analyses have shown that handball players perform various movement activities depending on their playing position. During the game, wing players cover the greatest distance, by sprinting, while the backs cover the gate. The specific anthropometric characteristics (height, weight, palm length and width) are the main criteria for the selection of handball players in different positions (Zapartidis et al., 2009a; Zapartidis et al., 2009b; Srhoj et al., 2002).

Many studies have aimed to establish the anthropometric profile of handball players depending on:

a) age in juniors and seniors (Bon et al., 2015; Silva et al., 2013; Vieira et al., 2013; Hassan et al., 2007; Matthys et al., 2012; Wagner et al., 2014; Vishapuu & Jürimäe, 2009; Ingebrigtsen et al., 2013; Nikolaidis & Ingebrigsten, 2013; Debanne & Laffaye, 2011; Mohamed et al., 2009; Milanese et al., 2011)

b) sex (Bon et al., 2015; Sekulic et al, 2013; Wagner et al., 2014)

c) somatotype (Bon et al., 2015; Raschka & Wolthausen, 2007; Nikolaidis et al., 2015)

d) morphological profile (Bon et al., 2015; Ghobadi et al., 2013; Vieira et al., 2013; Moss et al., 2015; Massuça & Fragoso, 2015; Matthys et al., 2013; Krüger et al., 2014; Moncef et al., 2012; Srhoj et al., 2002; Chaouachi et al., 2009; Lidor et al., 2005; Ziv & Lidor, 2009; Ingebrigsten et al., 2013)

e) playing position in the team (Bon et al., 2015; Ghobadi et al., 2013; Michalsik et al., 2015; Sibila & Pori, 2009; Vila et al., 2012; Silva et al., 2013; Nikolaidis et al., 2015; Nikolaidis & Ingebrigsten, 2013; Krüger et al., 2014; Rousanoglou et al., 2014; Haugen et al., 2016; Matthys et al., 2013; Hassan et al., 2007)

f) level of training for elite and non-elite players (Ghobadi et al., 2013; Michalsik et al., 2015; Vieira et al., 2013; Moss et al., 2015; Rousanoglou et al., 2014)

g) nutrition status (Waly et al., 2013)

h) technical profile (Michalsik et al., 2015)

i) experience in sport (Vila et al., 2012; Wagner et al., 2016)

Hypothesis

The junior period spans between the age of 13 and 18 years. The categories of juniors III, II and I in handball cover the pubertal, postpubertal and adolescent periods: 13-14, 15-16 and 17-18 years.

Considering that basic anthropometric parameters (height, weight, abdominal circumference, arm span) and specific anthropometric parameters (hand span, hand grip strength) might influence performance, success in competition, training conditioning, the playing position, selection and identification of talents, we aimed to study the anthropometric profile of junior handball players in relation to age, and the effect of maturation on general basic anthropometric parameters.

Material and methods

The research was conducted with the approval of the Cluj County School Inspectorate, the subjects' informed consent, the consent obtained from the subjects' parents, and the approval of the sports medicine doctor at the *George Coşbuc* National College in Cluj-Napoca.

Research protocol

a) Period and place of the research

The determinations of anthropometric parameters in athletes of the experimental groups and in the control groups were performed for each group at two times: time T1 - October 2014, and time T2 - October 2015.

Studies were carried out at the school medical office of the *George Coşbuc* National College in Cluj-Napoca and at the medical office of the Sports High School in Cluj.

b) Subjects and groups

The research was conducted in 6 groups of subjects, each consisting of 10 subjects.

The experimental groups (E) included professional athletes from the Sports High School Cluj and the Potaissa Handbal Club Association Turda, while the control groups (C) comprised pupils from the *George Coşbuc* National College in Cluj-Napoca, as follows:

C1 – subjects born in 1997, aged 17.77 ± 0.26 at time T1

C2 – subjects born in 1998, aged 16.57 ± 0.19 at time T1

C3 – subjects born in 1999, aged 15.88 ± 0.25 at time T1

E1 – subjects born in 1997, aged 17.72 ± 0.26 at time T1

E2 – subjects born in 1998, aged 16.24 ± 0.38 at time T1

E3 – subjects born in 1999, aged 15.47 ± 0.17 at time T1

We mention that at time T2, the groups were one year older.

The weekly training program of groups C consisted of general physical training 1-2 hours/week, while the weekly training of groups E consisted of specific physical training 2-3 hours/day, 5 days/week.

c) Tests applied

The basic anthropometric parameters determined by direct methods were the following (Cordun, 2009; Neagu, 2014):

- weight, expressed in kg, measured with a digital balance;
- height, expressed in cm, measured with a stadiometer;
- arm span, expressed in cm, measured with a centimeter tape;
- sitting height, measured with a stadiometer;
- biacromial diameter, expressed in cm, measured with an anthropometric compass;
- bitrochanteric diameter, expressed in cm, measured with an anthropometric compass.

The anthropometric parameters determined by indirect methods were:

- body mass index (BMI), expressed in kg/m^2
- chest elasticity, expressed in cm.

d) Statistical processing

Statistical processing was performed with the Excel application (Microsoft Office 2010) and the StatsDirect v.2.7.2 software. The results were graphically represented using the Excel application (Microsoft Office 2010).

Results

a) Body mass (Table I)

The statistical analysis of the values of *body mass for unpaired samples* showed: at time T1, statistically significant differences between groups E2-E3 ($p < 0.05$) and between groups C2-E2 ($p < 0.05$); at time T2, statistically significant differences between groups C2-E2 ($p < 0.05$).

The statistical analysis of the values of *body mass for paired samples,* between the two times, evidenced: in groups C – statistically significant differences in groups C1, C2 and C3 ($p < 0.001$), and in groups E – statistically significant differences in groups E1 and E3 ($p < 0.05$).

b) Height (Table II)

The statistical analysis of the values of *height*, *considering all six groups*, revealed statistically significant differences between at least two of the groups, both at time T1 and at time T2 ($p < 0.01$).

The statistical analysis of the values of *height for unpaired samples* showed, at T1 and T2, statistically significant differences between groups C3-E3 ($p < 0.05$).

The statistical analysis of the values of *height for paired samples,* between the two times, evidenced: in groups C – statistically significant differences in groups C1 and C2 ($p < 0.001$), in group C3 ($p < 0.01$), and in groups E – statistically significant differences in groups E2 and E3 ($p < 0.01$).

c) Body mass index (Table III)

The statistical analysis of the values of the *body mass index (BMI), considering all six groups*, indicated no statistically significant differences between the groups at time T1 or at time T2 ($p > 0.05$).

The statistical analysis of BMI values, *considering all groups C,* showed no statistically significant differences between the groups at T1 or at T2 ($p > 0.05$).

The statistical analysis of BMI values, *considering all groups E*, demonstrated no statistically significant differences between the groups at T1 or at T2 ($p > 0.05$).

The statistical analysis of BMI values *for unpaired samples* revealed: at time T1 – no statistically significant differences between any two groups ($p > 0.05$); at time T2 – no statistically significant differences between any two groups ($p > 0.05$).

Table I

Comparative analysis of *body mass* values (kg) in the studied groups and statistical significance.

Time	Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)				
T1	C1	75.90	2.9343	73.50	9.2790	58	90	C+E	0.0777	E1-E2	0.7538	C1 (T1-T2)
	C2	72.50	3.6492	74.00	11.5398	53	89	C1-C2-C3	0.7269	E1-E3	0.1816	**5.64×10^{-5}**
	C3	72.30	4.0140	73.00	12.6934	48	88	E1-E2-E3	0.1003	E2-E3	**0.0213**	C2 (T1-T2)
	E1	84.15	5.3182	82.25	16.8177	57.5	109	C1-C2	0.4777	C1-E1	0.1959	**0.0001**
	E2	87.10	4.4258	83.50	13.9956	67	120	C1-C3	0.4795	C2-E2	**0.0104**	C3 (T1-T2)
	E3	76.05	2.0823	76.50	6.5847	64	86	C2-C3	0.9710	C3-E3	0.4209	**0.0005**
T2	C1	79.80	2.9695	78.50	9.3903	60	95	C+E	0.0583	E1-E2	0.7246	E1 (T1-T2)
	C2	75.20	3.8000	76.00	12.0167	55	91	C1-C2-C3	0.4892	E1-E3	0.0991	**0.0194**
	C3	73.90	4.0012	75.00	12.6531	50	90	E1-E2-E3	0.0998	E2-E3	0.0536	E2 (T1-T2)
	E1	90.15	5.9685	88.00	18.8739	61.5	122	C1-C2	0.3535	C1-E1	0.1445	0.4961
	E2	87.40	4.0585	85.50	12.8340	69	118	C1-C3	0.2527	C2-E2	**0.0489**	E3 (T1-T2)
	E3	78.70	2.1861	79.00	6.9130	66	90	C2-C3	0.8164	C3-E3	0.3103	**0.021**

Table II

Comparative analysis of *height* values (cm) in the studied groups and statistical significance

Time	Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)				
T1	C1	181.00	2.1654	181.50	6.8475	169	190	C+E	**0.0046**	E1-E2	0.5766	C1 (T1-T2)
	C2	177.50	1.4004	178.00	4.4284	169	183	C1-C2-C3	0.2670	E1-E3	0.5870	**0.0003**
	C3	176.30	1.9267	179.00	6.0928	163	182	E1-E2-E3	0.5141	E2-E3	0.2208	C2 (T1-T2)
	E1	185.55	2.7187	185.75	8.5973	171	197	C1-C2	0.1948	C1-E1	0.2079	**0.0002**
	E2	187.65	2.4989	189.75	7.9024	172	196	C1-C3	0.1472	C2-E2	0.1378	C3 (T1-T2)
	E3	183.75	1.7674	183.00	5.5889	176	192	C2-C3	0.8387	C3-E3	**0.0154**	**0.002**
T2	C1	182.50	2.1512	182.50	6.8028	170	192	C+E	**0.0028**	E1-E2	0.5841	E1 (T1-T2)
	C2	178.80	1.4205	179.00	4.4920	170	185	C1-C2-C3	0.2610	E1-E3	0.4232	0.2138
	C3	177.80	1.9310	180.00	6.1065	164	184	E1-E2-E3	0.4350	E2-E3	0.2273	E2 (T1-T2)
	E1	187.00	1.9134	185.50	6.0507	178	197	C1-C2	0.1705	C1-E1	0.1355	**0.0026**
	E2	188.80	2.5972	191.50	8.2131	173	199	C1-C3	0.1573	C2-E2	0.1432	E3 (T1-T2)
	E3	184.90	1.7042	184.50	5.3893	177	193	C2-C3	0.8968	C3-E3	**0.0107**	**0.0026**

The statistical analysis of BMI values *for paired samples*, between the two times, showed no statistically significant differences for any of the groups ($p > 0.05$).

d) Sitting height (Table IV)

The statistical analysis of the values of *sitting height*, *considering all six groups*, showed statistically significant differences between at least two of the groups both at T1 and T2 ($p < 0.001$).

The statistical analysis of the values of *sitting height*, *considering all groups C*, evidenced statistically significant differences between at least two of the groups at time T2 ($p < 0.05$).

The statistical analysis of the values of *sitting height for unpaired samples* revealed: at time T1, statistically significant differences between groups C2-C3 ($p < 0.05$) and groups C1-E1, C2-E2 and C3-E3 ($p < 0.001$).

At T2, statistically significant differences were observed between groups C1-C2 and C2-C3 ($p < 0.05$) and between groups C1-E1, C2-E2 and C3-E3 ($p < 0.01$).

The statistical analysis of the values of *sitting height for paired samples,* between the two times, showed: in groups C - statistically significant differences in groups C2 and C3 ($p < 0.01$) and in groups E – statistically significant differences in groups E2 and E3 ($p < 0.01$).

e) Arm span (Table V)

The statistical analysis of the values of *arm span*, *considering all six groups*, demonstrated statistically significant differences between at least two groups both at T1 and T2 ($p < 0.001$).

The statistical analysis of the values of *arm span for unpaired samples* showed: at time T1, statistically significant differences between groups C2-E2 ($p < 0.001$), groups C3-E3 ($p < 0.01$) and groups C1-E2 ($p < 0.05$); at time T2, statistically significant differences betewen groups C2-E2 ($p < 0.001$), groups C3-E3 ($p < 0.01$) and groups C1-E2 ($p < 0.05$).

The statistical analysis of the values of *arm span for paired samples,* between the two times, evidenced: in groups C – statistically significant differences in group C1 ($p < 0.001$), groups C2 and C3 ($p < 0.01$), and in groups E – statistically significant differences in group E2 ($p < 0.05$).

f) Chest elasticity (Table VI)

The statistical analysis of the values of *chest elasticity*, *considering all six groups*, showed statistically significant differences between at least two of the groups both at T1 and T2 ($p < 0.001$).

Table III

Comparative analysis of *BMI* values (kg/m^2) in the studied groups and statistical significance.

Time	Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)				
T1	C1	23.10	0.5949	22.85	1.8813	20.31	26.20	C+E	0.7071	E1-E2	0.7394	C1 (T1-T2)
	C2	22.98	1.0961	22.76	3.4663	18.56	28.73	C1-C2-C3	0.9883	E1-E3	0.2034	0.3485
	C3	23.19	1.1690	22.78	3.6966	18.07	29.40	E1-E2-E3	0.2570	E2-E3	0.1051	C2 (T1-T2)
	E1	24.28	1.1639	22.66	3.6806	19.21	31.34	C1-C2	0.9209	C1-E1	0.3856	0.7507
	E2	24.65	0.9065	24.04	2.8665	21.79	31.24	C1-C3	0.9484	C2-E2	0.7359	C3 (T1-T2)
	E3	22.53	0.5873	22.28	1.8572	20.42	26.11	C2-C3	0.8959	C3-E3	0.6228	0.9439
T2	C1	23.89	0.5584	23.57	1.7659	20.76	26.60	C+E	0.5872	E1-E2	0.5648	E1 (T1-T2)
	C2	23.48	1.1071	23.02	3.5008	19.03	29.05	C1-C2-C3	0.9095	E1-E3	0.1117	0.4675
	C3	23.31	1.1328	22.95	3.5823	18.59	29.39	E1-E2-E3	0.2365	E2-E3	0.2101	E2 (T1-T2)
	E1	25.64	1.4106	24.32	4.4606	19.41	32.42	C1-C2	0.7469	C1-E1	0.2719	0.6953
	E2	24.47	0.8707	23.46	2.7533	22.22	30.72	C1-C3	0.6521	C2-E2	0.6694	E3 (T1-T2)
	E3	23.02	0.5803	23.18	1.8350	20.67	26.87	C2-C3	0.9137	C3-E3	0.8244	0.1323

Table IV

Comparative analysis of *sitting height* values (cm) in the studied groups and statistical significance

Time	Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)				
T1	C1	87.00	2.2706	89.00	7.1802	69	96	C+E	**< 0.0001**	E1-E2	0.2535	C1 (T1-T2)
	C2	90.60	1.0562	91.50	3.3400	82	94	C1-C2-C3	0.0594	E1-E3	0.2533	0.0625
	C3	88.40	1.2311	89.50	3.8930	78	91	E1-E2-E3	0.3294	E2-E3	0.3998	C2 (T1-T2)
	E1	96.65	1.1082	98.25	3.5044	90	100	C1-C2	0.0621	C1-E1	**0.0002**	**0.0039**
	E2	95.85	0.8884	96.50	2.8092	89	99	C1-C3	0.5641	C2-E2	**0.0009**	C3 (T1-T2)
	E3	94.85	1.0751	95.50	3.3998	90	100	C2-C3	**0.0339**	C3-E3	**0.0009**	**0.002**
T2	C1	87.70	2.4132	89.50	7.6311	69	98	C+E	**< 0.0001**	E1-E2	0.7548	E1 (T1-T2)
	C2	92.00	1.0954	92.50	3.4641	83	96	C1-C2-C3	**0.0393**	E1-E3	0.9494	0.25
	C3	89.60	1.1662	90.50	3.6878	80	93	E1-E2-E3	0.9220	E2-E3	0.7513	E2 (T1-T2)
	E1	96.30	1.0520	97.00	3.3267	90	100	C1-C2	**0.0445**	C1-E1	**0.0014**	**0.0078**
	E2	96.90	0.9363	98.00	2.9609	90	100	C1-C3	0.4227	C2-E2	**0.0018**	E3 (T1-T2)
	E3	96.40	1.1446	97.25	3.6194	90	101	C2-C3	**0.0184**	C3-E3	**0.0020**	**0.0044**

Table V

Comparative analysis of *arm span* values (cm) in the studied groups and statistical significance.

Time	Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)				
T1	C1	177.00	2.0276	177.50	6.4118	166	186	C+E	**< 0.0001**	E1-E2	0.2133	C1 (T1-T2)
	C2	174.90	1.3860	176.00	4.3830	166	180	C1-C2-C3	0.5219	E1-E3	0.5146	**0.0007**
	C3	174.20	1.8785	176.00	5.9404	162	180	E1-E2-E3	0.2982	E2-E3	0.1265	C2 (T1-T2)
	E1	186.30	2.5951	188.00	8.2064	172	200	C1-C2	0.4052	C1-E1	0.0117	**0.0039**
	E2	191.00	2.5560	191.00	8.0829	180	201	C1-C3	0.3245	C2-E2	**7.32 x 10^{-5}**	C3 (T1-T2)
	E3	184.20	1.9709	187.00	6.2325	173	190	C2-C3	0.7679	C3-E3	**0.0031**	**0.0078**
T2	C1	179.00	2.0923	179.50	6.6165	167	188	C+E	**< 0.0001**	E1-E2	0.1200	E1 (T1-T2)
	C2	175.80	1.4591	177.00	4.6140	167	182	C1-C2-C3	0.4197	E1-E3	0.9087	0.5554
	C3	176.10	1.8883	178.50	5.9712	163	182	E1-E2-E3	0.1509	E2-E3	0.0990	E2 (T1-T2)
	E1	186.50	2.4370	188.00	7.7064	172	200	C1-C2	0.2277	C1-E1	**0.0313**	**0.025**
	E2	192.70	2.8985	193.00	9.1658	181	206	C1-C3	0.3422	C2-E2	**0.0002**	E3 (T1-T2)
	E3	186.10	2.4288	189.00	7.6804	173	199	C2-C3	0.6426	C3-E3	**0.0080**	0.4886

The statistical analysis of the values of *chest elasticity for unpaired samples* evidenced: at time T1, statistically significant differences between groups C1-E1, C2-E2 and C3-E3 ($p < 0.001$), and at time T2, statistically significant differences between groups C1-E1, C2-E2 and C3-E3 ($p < 0.001$).

The statistical analysis of the values of *chest elasticity for paired samples*, between the two times, showed: in groups E – statistically significant differences in group E1 ($p < 0.05$).

g) Abdominal circumference (Table VII)

The statistical analysis of the values of *abdominal circumference*, *considering all six groups*, indicated statistically significant differences between at least two of the groups both at T1 and T2 ($p < 0.01$).

The statistical analysis of the values of *abdominal circumference for unpaired samples* showed: at time T1, statistically significant differences between groups E2-E3 ($p < 0.05$) and between groups C1-E1 and C2-E2 ($p < 0.01$); at time T2, statistically significant differences between groups C1-E1 ($p < 0.05$).

The statistical analysis of the values of *abdominal circumference for paired samples*, between the two times, evidenced: in groups C – statistically significant differences in group C2 ($p < 0.001$), group C1 ($p < 0.01$), and in groups E – statistically significant differences in group E1 ($p < 0.01$).

h) Biacromial diameter (Table VIII)

The statistical analysis of the values of *biacromial diameter*, *considering all six groups*, showed statistically significant differences between at least two of the groups at time T1 ($p < 0.05$).

The statistical analysis of the values of *biacromial diameter for unpaired samples* revealed: at time T1, statistically significant differences between groups C1-E1 ($p < 0.01$).

The statistical analysis of the values of *biacromial diameter for paired samples*, between the two times, showed: in groups C – statistically significant differences in groups C2 and C3 ($p < 0.001$) and in group C1 ($p < 0.05$).

i) Bitrochanteric diameter (Table IX)

The statistical analysis of the values of *bitrochanteric diameter for unpaired samples* evidenced: at time T1, statistically significant differences between groups C3-E3 ($p < 0.05$); at time T2, statistically significant differences

Table VI

Comparative analysis of *chest elasticity* values (cm) in the studied groups and statistical significance

Time	Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)				
T1	C1	4.80	0.6633	4.00	2.0976	2	8	C+E	5.16×10^{-19}	E1-E2	0.0909	C1 (T1-T2)
	C2	3.70	0.3350	3.50	1.0593	2	5	C1-C2-C3	0.2240	E1-E3	0.1605	0.0957
	C3	3.90	0.3145	4.00	0.9944	2	5	E1-E2-E3	0.1388	E2-E3	0.7304	C2 (T1-T2)
	E1	13.20	0.9522	13.50	3.0111	8	18	C1-C2	0.1626	C1-E1	**1.98×10^{-6}**	0.6193
	E2	11.20	0.5538	11.00	1.7512	9	14	C1-C3	0.2419	C2-E2	**6.96×10^{-9}**	C3 (T1-T2)
	E3	11.50	0.6540	11.00	2.0683	8	16	C2-C3	0.6685	C3-E3	**1.05×10^{-7}**	0.7804
T2	C1	4.30	0.6333	4.00	2.0028	2	8	C+E	**1.64×10^{-16}**	E1-E2	0.8024	E1 (T1-T2)
	C2	3.90	0.3786	4.00	1.1972	2	6	C1-C2-C3	0.7347	E1-E3	0.7413	**0.0491**
	C3	3.80	0.3590	4.00	1.1353	2	6	E1-E2-E3	0.9266	E2-E3	0.8995	E2 (T1-T2)
	E1	11.30	1.0440	11.00	3.3015	7	18	C1-C2	0.5957	C1-E1	**3.96×10^{-5}**	0.8049
	E2	11.00	0.5375	10.50	1.6997	8	13	C1-C3	0.5034	C2-E2	**9.32×10^{-9}**	E3 (T1-T2)
	E3	10.90	0.5667	11.00	1.7920	7	13	C2-C3	0.8502	C3-E3	**2.36×10^{-8}**	0.4754

Table VII

Comparative analysis of *abdominal circumference* values (cm) in the studied groups and statistical significance

Time	Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)				
T1	C1	72.60	1.0975	71.50	3.4705	69	80	C+E	0.0033	E1-E2	0.3625	C1 (T1-T2)
	C2	73.10	1.7667	71.00	5.5867	67	82	C1-C2-C3	0.5515	E1-E3	0.3404	**0.0091**
	C3	75.40	2.5828	72.50	8.1677	67	90	E1-E2-E3	0.1030	E2-E3	**0.0231**	C2 (T1-T2)
	E1	82.50	3.5723	79.00	11.2965	71	101	C1-C2	0.8133	C1-E1	**0.0083**	**0.0003**
	E2	84.00	2.5473	81.50	8.0554	75	100	C1-C3	0.3381	C2-E2	**0.0029**	C3 (T1-T2)
	E3	76.50	1.5147	77.00	4.7900	70	83	C2-C3	0.4730	C3-E3	0.7185	0.0547
T2	C1	74.10	1.2512	73.50	3.9567	69	82	C+E	**0.0097**	E1-E2	0.2863	E1 (T1-T2)
	C2	75.50	1.9336	73.00	6.1146	68	84	C1-C2-C3	0.9531	E1-E3	0.0515	**0.0078**
	C3	76.60	2.6466	74.50	8.3693	68	92	E1-E2-E3	0.0645	E2-E3	0.0709	E2 (T1-T2)
	E1	87.30	4.1927	83.00	13.2585	71	110	C1-C2	0.5524	C1-E1	**0.0117**	> 0.9999
	E2	82.40	2.4230	80.50	7.6623	74	102	C1-C3	0.8381	C2-E2	0.0918	E3 (T1-T2)
	E3	77.60	1.4621	77.00	4.6236	72	87	C2-C3	0.9553	C3-E3	0.3813	0.1022

Table VIII

Comparative analysis of *biacromial diameter* values (cm) in the studied groups and statistical significance

Time	Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)				
T1	C1	40.00	0.7149	40.00	2.2608	36	43	C+E	**0.0182**	E1-E2	0.4320	C1 (T1-T2)
	C2	41.10	0.6046	41.00	1.9120	38	44	C1-C2-C3	0.4812	E1-E3	0.1424	**0.0313**
	C3	40.00	0.8563	40.00	2.7080	36	44	E1-E2-E3	0.2627	E2-E3	0.3231	C2 (T1-T2)
	E1	43.30	0.7895	44.00	2.4967	39	46	C1-C2	0.2554	C1-E1	**0.0062**	**0.0002**
	E2	42.40	0.7916	44.00	2.5033	38	45	C1-C3	> 0.9999	C2-E2	0.1504	C3 (T1-T2)
	E3	41.90	0.4333	42.00	1.3703	40	44	C2-C3	0.3096	C3-E3	0.0693	**4.89×10^{-5}**
T2	C1	40.90	0.7219	42.00	2.2828	36	44	C+E	0.4106	E1-E2	0.6256	E1 (T1-T2)
	C2	42.40	0.6000	42.00	1.8974	40	46	C1-C2-C3	0.4299	E1-E3	0.9159	0.3434
	C3	41.60	0.8327	42.00	2.6331	38	46	E1-E2-E3	0.9629	E2-E3	0.9842	E2 (T1-T2)
	E1	42.90	0.7219	42.50	2.2828	40	47	C1-C2	0.1991	C1-E1	0.0756	> 0.9999
	E2	42.40	0.7024	42.50	2.2211	39	46	C1-C3	0.6482	C2-E2	> 0.9999	E3 (T1-T2)
	E3	42.60	0.3399	42.50	1.0750	41	45	C2-C3	0.4471	C3-E3	0.3235	0.0781

Table IX

Comparative analysis of *bitrochanteric diameter* values (cm) in the studied groups and statistical significance

Time	Group	Mean	SE	Median	SD	Min	Max	Statistical significance (p)				
T1	C1	33.90	0.7371	33.50	2.3310	30	37	C+E	0.1511	E1-E2	0.1322	C1 (T1-T2)
	C2	34.50	0.9098	34.00	2.8771	31	40	C1-C2-C3	0.7167	E1-E3	0.0537	**0.0038**
	C3	34.50	0.4282	34.50	1.3540	32	36	E1-E2-E3	0.1327	E2-E3	0.6325	C2 (T1-T2)
	E1	34.90	0.7667	36.00	2.4244	30	38	C1-C2	0.7779	C1-E1	0.3595	**0.0078**
	E2	32.90	0.9244	32.00	2.9231	30	38	C1-C3	0.4931	C2-E2	0.0968	C3 (T1-T2)
	E3	32.90	0.5859	33.00	1.8529	31	37	C2-C3	0.4645	C3-E3	**0.0425**	**0.01**
T2	C1	34.90	0.7951	34.50	2.5144	32	39	C+E	0.0994	E1-E2	0.4184	E1 (T1-T2)
	C2	35.80	0.7572	35.00	2.3944	33	40	C1-C2-C3	0.7954	E1-E3	0.0881	0.7804
	C3	35.40	0.6000	36.00	1.8974	32	38	E1-E2-E3	0.2647	E2-E3	0.4497	E2 (T1-T2)
	E1	34.80	0.8273	35.00	2.6162	30	38	C1-C2	0.4887	C1-E1	0.9315	0.0938
	E2	33.80	0.8794	33.50	2.7809	30	38	C1-C3	0.6221	C2-E2	0.0915	E3 (T1-T2)
	E3	33.00	0.5375	33.00	1.6997	31	36	C2-C3	0.9933	C3-E3	**0.0080**	0.7263

between groups C3-E3 ($p < 0.01$).

The statistical analysis of the values of *bitrochanteric diameter for paired samples,* between the two times, showed: in groups C - statistically significant differences in groups C1 and C2 ($p < 0.01$) and in group C3 ($p < 0.05$).

Discussions

The comparative changes regarding the influence of general training and maturation on basic anthropometric parameters in control junior subjects at time T2 versus time T1 showed:

- an increase in body mass, height, arm span, abdominal circumference, biacromial diameter and bitrochanteric diameter at the age of 16, 17, 18 compared to values at the age of 15, 16, 17 corresponding to the groups;
- insignificant changes of BMI, which was within normal limits;
- an increase of sitting height at the age of 16 and 17 compared to values at the age of 15 and 16.

The comparative changes regarding the influence of specific training and maturation on basic anthropometric parameters in junior handball players at time T2 versus time T1 evidenced:

- an increase of body mass at the age of 16, 17, 18 compared to values corresponding to groups aged 15, 16, 17;
- an increase of height and sitting height at the age of 16 and 17 compared to values of groups aged 15 and 16;
- absence of significant changes in BMI, which was within normal limits;
- an increase of arm span at the age of 17 compared to values at the age of 16;
- a decrease of chest elasticity and abdominal circumference at the age of 18 compared to values at the age of 17.

The comparative changes of basic anthropometric parameters in groups E versus groups C showed:

- an increase of body mass at the age of 16 and 17;
- an increase of height at the age of 15 and 16;
- insignificant changes of BMI, all subjects being normal weight: an increase in sitting height, arm span, chest elasticity and abdominal circumference at the age of 16, 17, 18 compared to values corresponding to groups aged 15, 16, 17;
- an increase of bitrochanteric diameter at the age of 15 and 16.

Our results are in accordance with the data of other authors regarding the factors that can have a favorable influence on the anthropometric profile of junior handball players: maturation (Dias Quiterio et al., 2011; Matthys et al., 2012; Matthys et al., 2013; Vieira et al., 2013) and specific progressive training (Silva et al., 2013; Rousanoglou et al., 2014; Hermassi et al., 2015), in addition to talent (Mohamed et al., 2009; Pion et al., 2015; Moss et al., 2015; Ghobadi et al., 2013).

Conclusions

1. Biological maturation induces significant changes in body mass, height, arm span, biacromial and bitrochanteric diameters, sitting height and abdominal circumference in C juniors, with general physical training.
2. Biological maturation and specific physical training cause a significant increase of body mass, height, sitting height and arm span, and a decrease of chest elasticity and abdominal circumference in E junior handball players.
3. The increases of body mass, height, sitting height, arm span, chest elasticity and abdominal circumference are significant in E junior handball players compared to C subjects and occur at the age of 15-16.
4. The changes of basic anthropometric parameters in E junior handball players can be considered as adaptive changes induced by specific physical training and should be taken into account for the tertiary selection of athletes.

Conflicts of interests

There are no conflicts of interest.

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