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SOMATOTYPES OF ELITE JUNIOR DIVERS: SEX AND AGE GROUP VARIATION

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Abstract: *Variation in somatotype associated with sex and age was considered in a sample of 278 elite divers, 121 males and 157 females 8.5–18.5 years of age. All were participants in the 1991 and 1992 Speedo/U.S. Diving Junior Olympic Championships. The Heath-Carter anthropometric protocol was used to estimate somatotype. Multivariate and stepwise discriminant analyses were used to compare somatotypes by sex within competitive age groups (≤13, 14–15, 16–18 years) and across competitive age groups in each sex. Within each age group, males are more mesomorphic and females are more endomorphic, though there is some variation within age groups. Somatotype differs significantly by age group among male and female divers, respectively, but subsequent pairwise comparisons indicate no significant differences between age groups for specific somatotype components in either sex. Mesomorphy is the primary discriminator of somatotype between male and female divers ≤13 years, followed by endomorphy. Endomorphy is the primary discriminator of somatotype between sexes, followed by mesomorphy and then ectomorphy in the two older age groups. Ectomorphy was the best discriminator of somatotype among the three age groups of female divers, followed by mesomorphy. There were no significant discriminators of somatotype among the three age groups of male divers. Comparisons of elite Junior Olympic divers with elite collegiate and international divers are consistent with the hypothesis that there is a physique model characteristic of successful divers which is already apparent during late childhood and early adolescence.*

Keywords: *Physique; Young athletes; Aesthetic sports; Anthropometry.*

Introduction

Physique or body build is most often quantified as somatotype, a composite based on the specific contributions of endomorphy, mesomorphy and ectomorphy. The three components together define an individual's somatotype. Although several methods are available to quantify physique, the Heath-Carter anthropometric protocol is the most commonly used for estimating somatotype (Malina et al. 2004).

Physique is a significant factor in the selection of young athletes and perhaps a major contributor to success in some sports. Data for young athletes in gymnastics, soccer, track and field, and other sports indicate that those who are successful tend to have physiques that are similar to adult athletes in the respective sports (Carter and Brallier 1988, Carter and Heath 1990, Malina 2003, 2004). The results suggest the presence of a physique model for a given sport or event within a sport that is characteristic of successful performance from beginning to Olympic levels.

The present paper considers the somatotypes of elite Junior Olympic divers 9–18 years of age from two perspectives (1) differences in somatotypes of elite male and

female divers within the same competitive age groups, and (2) differences in somatotypes of divers by competitive age groups within each sex.

Methods

The sample included 278 divers, 121 males 8.5–18.5 years and 157 females 8.9–18.5 years of age. All were participants in the 1991 and 1992 Speedo/U.S. Diving Junior Olympic Championships. These were national competitions; participants were successful in regional competitions throughout the country. Divers competed in three age groups: 13 and under, 14–15, and 16–18 years. The project was approved by United States Diving; consent of a parent and/or guardian and consent of individual divers were also obtained.

Dimensions for the Heath-Carter anthropometric protocol were taken by an experienced individual (RMM): weight (kg), height (cm), bicondylar and biepicondylar breadths (cm), flexed arm and calf circumferences (cm), and the triceps, subscapular, supraspinale and medial calf skinfolds (mm). The algorithms of Carter and Heath (1990) were used to derive a somatotype for each diver.

Descriptive statistics were calculated by sex and age group. Multivariate procedures for somatotype analysis, recommended by Cressie et al. (1986), were used to test sex differences within competitive age groups (see above) and age group differences within sex. The approach uses MANCOVA with Wilks' Lambda (Λ) as the test statistic to consider the three somatotype components together; age is a covariate in all analyses. If the comparison is significant, pairwise comparisons with a Bonferroni adjustment are used to identify which of the components contributed to the difference. Since the univariate F-test has a limitation in that it does not consider intercorrelations among components (Cressie et al. 1986), forward stepwise discriminant analyses were also conducted between sexes within age groups and among age groups within each sex. A $p<0.05$ was accepted as significant in all analyses. All analyses were done with the Statistical Package for the Social Sciences (SPSS 12.0).

Results

Sample sizes and descriptive statistics for age and somatotype of the divers are summarized by competitive age groups and for the total sample by sex in Table 1. Results of the MANCOVA and subsequent pairwise comparisons are summarized in Table 2. Somatotype differs significantly between male and female divers within each competitive age group. Among divers ≤13 years, males are significantly more mesomorphic ($p<0.001$) and females are significantly more ectomorphic ($p<0.05$), while endomorphy does not differ significantly ($p=0.07$). Among divers 14–15 years, females are significantly more endomorphic ($p<0.001$) and males are significantly more mesomorphic ($p<0.001$), while ectomorphy does not differ significantly ($p=0.09$). Among divers 16–18 years, females are significantly more endomorphic ($p<0.001$) and males are significantly more mesomorphic ($p<0.001$) and ectomorphic ($p<0.001$).

Somatotype differs significantly by age group among male and female divers, respectively (Table 2). However, subsequent pairwise comparisons indicate no significant differences between age groups for specific somatotype components in either sex. Differences in mean somatotype components among age groups of male divers are small (Table 1), with the exception of a decline in mean ectomorphy between 14–15 and 16–18

year old divers. Among females, endomorphy increases and ectomorphy decreases across the three age groups, whereas mesomorphy increases only in later adolescence (Table 1).

Table 1. Sample size, age and somatotype of elite junior divers by age group and for the total sample of divers within sex.

Age Group	n	Age, yrs M	Age, yrs SD	Endomorphy M	Endomorphy SD	Mesomorphy M	Mesomorphy SD	Ectomorphy M	Ectomorphy SD
Males									
≤13	42	12.0	1.1	2.3	0.6	5.1	0.9	3.0	1.0
14–15	30	14.7	0.6	2.1	0.5	5.1	0.9	3.2	1.1
16–18	49	17.3	0.8	2.1	0.5	5.3	1.0	2.7	0.9
Total	121	14.8	2.5	2.2	0.6	5.2	0.9	2.9	1.0
Females									
≤13	54	12.3	1.2	2.6	0.8	4.1	0.7	3.5	0.9
14–15	48	14.7	0.6	3.0	0.7	4.1	0.8	2.8	1.0
16–18	55	17.1	0.9	3.3	0.7	4.6	0.8	2.2	0.8
Total	157	14.7	2.2	3.0	0.8	4.3	0.8	2.9	1.0

Table 2. Results of the multivariate analyses of covariance and subsequent pairwise comparisons of somatotype for sex differences within age group and for age group differences within sex.

	Λ	F	p	Endomorphy	Mesomorphy	Ectomorphy
Sex Differences						
≤ 13 yrs	0.600	20.24	<0.001	0.074	**<0.001**	**0.024**
14–15 yrs	0.290	59.62	<0.001	**<0.001**	**<0.001**	0.088
16–18 yrs	0.331	66.58	<0.001	**<0.001**	**<0.001**	**0.005**
Age Differences						
Males	0.860	3.01	< 0.01			
≤13 / 14–15 yrs				0.091	0.066	0.096
≤13 / 16–18 yrs				0.073	0.067	0.541
14–15 / 16–18 yrs				0.419	0.485	1.000
Females	0.900	2.72	< 0.05			
≤13 / 14–15 yrs				1.000	1.000	0.146
≤13 / 16–18 yrs				0.950	0.217	0.060
14–15 / 16–18 yrs				1.000	0.062	0.239

Results of the forward stepwise discriminant function analyses of somatotype by sex within age groups and by age group within sex are summarized in Table 3. Mesomorphy is the primary discriminator of somatotype between male and female divers ≤13 years, followed by endomorphy. Among the two older age groups of divers, endomorphy is the primary discriminator of somatotype between males and females, followed by

mesomorphy and then ectomorphy. Ectomorphy was the best discriminator of somatotype among the three age groups of female divers, followed by mesomorphy. On the other hand, there were no significant discriminators of somatotype among the three age groups of male divers.

Table 3. Summary of forward stepwise discriminant function analyses for the significant comparisons of somatotype between the sexes within age groups and among age groups within each sex.

	Step 1	Step 2	Step 3	Wilks' Lamda	p
Sex Differences by Age Groups					
≤ 13 years	Mesomorphy	Endomorphy		0.618	< 0.001
14 to 15 years	Endomorphy	Mesomorphy	Ectomorphy	0.297	< 0.001
16 to 18 years	Endomorphy	Mesomorphy	Ectomorphy	0.331	< 0.001
Age Group Differences by Sex					
Females	Ectomorphy	Mesomorphy		0.634	< 0.001

Discussion

Compared to age- and sex-specific mean somatotypes of several samples of non-athletes (Malina et al. 2004), young divers are, on average, more mesomorphic and less endomorphic. The higher mesomorphy and lower endomorphy in divers compared to non-divers most likely reflect somatic characteristics which confer an advantage in performing power and acrobatic moves/movements, and highlight the importance of selection for the sport. In general, mesomorphy is positively associated with performance while endomorphy is negatively associated with performance, specifically in tasks which involve the projection of the body through space (Malina et al. 2004).

Detailed comparisons of the young divers with other samples of elite young athletes are beyond the scope of this report. Nevertheless, somatotypes of divers, on average, are generally similar to those of gymnasts of the same age, though data are more available for females (Carter and Heath 1990). Female divers 14–15 and 16–18 years tend to be slightly higher in endomorphy and mesomorphy and lower in ectomorphy compared to gymnasts of the same age. Of interest, 50% of the current sample of female divers but only 15% of male divers had their first organized sport experiences in gymnastics (Malina and Geithner 1993).

Mean somatotypes of Junior Olympic divers are compared to elite collegiate and international divers in Table 4. With few exceptions, mean somatotypes of Junior Olympic divers and international elite divers are quite similar. The data are consistent with the hypothesis that there is a physique model characteristic of successful divers which is already apparent during late childhood and early adolescence.

Table 4. Comparative somatotype data for Junior Olympic and senior level divers.

Sex/Sample	n	Age (yrs) M	Age (yrs) SD	Endomorphy M	Endomorphy SD	Mesomorphy M	Mesomorphy SD	Ectomorphy M	Ectomorphy SD
Males									
U.S. Junior Olympics, 1991–1992	42	12.0	1.1	2.3	0.6	5.1	0.9	3.0	1.0
	30	14.7	0.6	2.1	0.5	5.1	0.9	3.2	1.1
	49	17.3	0.8	2.1	0.5	5.3	1.0	2.7	0.9
Alamo Competition, 1991[1]									
U.S.	7	25.9	2.5	2.0	0.5	5.8	1.1	1.7	0.6
Russia	4	21.6	3.7	1.5	0.4	5.6	0.9	2.1	0.4
China	5	21.3	3.9	1.9	0.3	4.7	0.4	2.3	0.4
Olympics, 1968[2]	16	21.3	3.7	1.9	0.5	5.4	0.7	2.7	0.7
World Championships, 1991[3]	43	22.2	4.6	2.0	0.5	5.3	1.0	2.4	0.8
Females									
U.S. Junior Olympics, 1991–1992	54	12.3	1.2	2.6	0.8	4.1	0.7	3.5	0.9
	48	14.7	0.6	3.0	0.7	4.1	0.8	2.8	1.0
	55	17.1	0.9	3.3	0.7	4.6	0.8	2.2	0.8
U.S. Collegiate, 1985–1994[4]	19	19.5	1.6	3.5	0.9	4.2	0.7	2.4	1.0
Alamo Competition, 1991[1]									
U.S.	7	25.0	2.9	3.1	0.5	4.4	1.2	1.8	0.7
Russia	4	18.5	2.3	2.7	0.2	4.3	0.8	2.0	0.7
China	6	16.8	2.4	3.6	0.9	4.8	0.4	1.9	0.4
Olympics, 1968 & 1976[2]	8	21.1	7.0	2.9	0.7	4.1	0.7	2.9	0.5
World Championships, 1991[3]	39	20.9	3.8	2.8	0.7	3.8	1.0	2.8	0.9

[1]Geithner and Malina (unpublished), Alamo International Diving Meet, May 1991
[2]Carter and Heath (1990)
[3]Carter and Marfell-Jones (1994)
[4]Malina et al. (2002)

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