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Original

Changes of somatotype in high school students, V region, Chile: 1985-2010

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Abstract

Objective: **To determine the trend of high school students from Valparaíso Chile by means of an anthropometrical somatotype**

Material and methods: **two samples of students during the years 1984-1985 (86 men and 71 women) and 2009-2010 (77 men and 86 women) between 15 and 18 years of age have been studied. Somatotype was estimated by the Heath-Carter anthropometric method.**

Results: **significant differences were found in all the variables of the somatotype during the periods studied ($p < 0.01$), except for height ($p = 0.176$) and humeral breadth in women ($p = 0.067$). Important distinctions were also found in the endomorphic, mesomorphic and ectomorphic components ($p < 0.01$). Men measurements registered remarkable differences in all the variables ($p < 0.01$), with the exception of weight ($p = 0.156$), calf breadth ($p = 0.906$) and arm breadth in contraction ($p = 0.284$). Measurement results of endomorphic ($p<0.01$), ectomorphic ($p < 0.01$) and mesomorfic components ($p < 0.05$) revealed considerable differences.**

During the period 1984-1985, men classified as balanced mesomorph 2.7-4.8-3.1 which switched to mesomorph-endomorph 3.8-4.3-2.5 in the period 2009-2010. And the population of women in the 1984-1985 period is classified as mesomorph-endomorph 4.2-4.7-2.1 and changes to a mesomorphic-endomorph biotype 6.6-4.1-1.3 in the 2009-2010.

Conclusions: **the somatotype of the adolescent population, especially women in Valparaiso, Chile has changed to a predominant endomorphic biotype, and its mesomorphic component has decreased. A high relative adiposity contributes to increase the probability for these people to suffer non-transmissible chronic diseases and cardiovascular issues.**

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Key words: *Somatotype. Anthropometry. Adolescents. Endomorphy.*

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DESPLAZAMIENTO DEL SOMATOTIPO DE ESTUDIANTES DE ENSEÑANZA SECUNDARIA, V REGIÓN, CHILE: 1985-2010

Resumen

Objetivo: **Determinar la tendencia de una población de estudiantes de educación secundaria de Valparaíso, Chile a través del somatotipo.**

Material y métodos: **Se han estudiado dos muestras de estudiantes durante los períodos 1984-1985 (hombres 86 y mujeres 71) y 2009-2010 (hombres 77 y mujeres 86) de 15 a 18 años. Se registraron los datos antropométricos para evaluar el somatotipo antropométrico de Heath-Carter.**

Resultados: **Para todas las variables del somatotipo de Heath-Carter se encontraron diferencias significativas entre los períodos estudiados ($p < 0,01$) excepto para talla ($p = 0,176$) y diámetro humeral ($p = 0,067$) en mujeres, para los componentes endomorfo, mesomorfo y ectomorfo también se registran diferencias significativas ($p < 0,01$). En hombres, se registran diferencias significativas para todas las variables ($p < 0,01$) con excepción de peso ($p = 0,156$), perímetro de pierna ($p=906$) y perímetro de brazo en contracción ($p = 0,284$). También se observan diferencias significativas en los componentes endomorfo ($p < 0,01$), ectomorfo ($p < 0,01$) y mesomorfo ($p < 0,05$). La población de mujeres del periodo 1984-1985 se clasifica como endomorfo-mesomorfo 4,2-4,7-2,1 y cambia a un perfil endo-mesomórfico 6,6-4,1-1,3 en el 2009-2010. En los hombres en el periodo 1984-1985 se clasifica como mesomorfismo balaceado 2,7-4,8-3,1 y cambia a un endomorfo-mesomorfo 3,8-4,3-2,5 en el periodo 2009-2010.**

Conclusiones: **El somatotipo de la población de adolescentes de Valparaíso, Chile se ha desplazado hacia un biotipo predominantemente endomorfo sobre todo en mujeres y ha disminuido su componente mesomórfico. Este perfil con una alta adiposidad relativa contribuye a aumentar las probabilidades de que esta población sufra enfermedades crónicas no transmisibles y cardiovasculares.**

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Palabras clave: *Somatotipo. Antropometría. Adolescentes. Endomorfía.*

Introduction

The somatotype corresponds to the estimation of the corporeal shape and its composition, which is expressed in three numbers that correspond to the components obtained during the embryological development: endoderm, mesomoderm and ectoderm, altogether corresponding to the morphological characteristics of the subject as a whole.[1]

The somatotype has proven to be closely related to the physical condition and the identification of the physical characteristics of athletes[2,3] with health risk factors,[4,5] as well as the body composition.[6] Moreover, many investigators have recognized the value of the somatotype characteristics in population from developing countries: maturity, and sexual dimorphism.[7-11]

The objective of this study is to determine the tendency that the somatotype of the adolescent population between 15 and 18 years of age from the V region of Valparaíso, Chile has followed, contributing with a precedent in the country, since there are no existing studies of a somatotype monitoring in students, whereas internationally, a high value in the comprehension of the effects of their changes in terms of diet, growth, development, physical exercise and diseases has been given.[12,13]

Subjects and methods

Two transversal and random samples from both genders have been taken in the periods of 1984-1985 and 2009-2010. The population comprehends 15 to 18-year-old students from 1st to 4th grade of High school. The participants belonged to the cities of Valparaíso, Viña del Mar and Concón, V region, Chile and were registered in different schools of those cities. Parents, students and the schools consents had to be signed, which had been previously approved by the Committee on Ethics of the Pontificia Universidad Católica de Valparaíso, Chile, according to the policies of the Declaration of Helsinki.[14]

In order to register the athropometrical somatotype by Heath-Carter [12]data of height, body weight, skinfold thickness, triceps skin, subscapular, subspinal and calf breadth, as well as the humeral and femoral biepicondylar breadth, flexed arm and maximum tension breadth, and maximum calf breadth was collected, through standardized procedures.[12,15,16]

Weight was registered with precision scales (SECA™) of 100 grams sensibility. Height was registered using a stadiometer (SECA™) of 0.1 cm sensibility. Breadths were taken with a flexible and inextensible metric tape (Lufkin™). Girths were evaluated through a small sliding caliper Campbell 10 and the skinfolds with a Slim Guide caliper (both from the anthropometrical Gaucho pro kit with Rosscraft license).

Evaluations were made in bipedestation, barefooted and in light clothes. All measurements were taken three times, having the average of them as a final result.

The study was made in the educational institutions during the morning. Anthropometric measurements were taken at the right hemibody and were assessed by the first (PL) and second authors (AA) of the present study.

The somatotype calculation comprehends: a) somatotype mean, b) the three components of somatotype (endomorphy, ectomorphy, and mesomorphy) and c) the somatotype attitudinal mean (SAM), which is the average of the distance of individual somatotypes about their mean somatotype in three dimensions and a measure of

Table I
Variables of the anthropometrical somatotype per gender 1984-1985/2009-2010

	1984-1985				*2009-2010*			
	Female		*Male*		*Female*		*Male*	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Variable								
Height(cm)	158.35	6.09	172.36§	6.34	159.66	5.96	170.00§	6.28
Weight(kg)	54.34	6.28	64.00§	9.16	62.55	10.44	66.62*	14.03
Skinfold								
Triceps(mm)	12.26	6.09	8.00§	3.93	26.19	6.44	15.27§	7.81
Subescapular(mm)	13.34	4.79	11.54 NS	9.74	21.84	7.91	13.54§	8.74
Supraspinale(mm)	12.65	4.12	14.29§	4.43	18.47	7.38	10.94§	6.49
Medial calf(mm)	11.37	5.79	8.07‡	5.97	22.84	7.60	12.65§	7.33
Diameters								
Humerus(cm)	5.94	0.44	6.77§	0.45	5.82	0.38	6.56§	0.36
Femur(cm)	9.61	0.87	9.94†	0.48	9.01	0.51	9.57§	0.58
Perimeters								
Upper arm tensed(cm)	26.66	2.13	29.64§	2.55	27.91	2.82	29.20†	2.65
Calf(cm)	34.26	2.65	35.76§	2.30	35.64	3.33	35.71 NS	2.89

SD: Standard deviation; *$p < 0.05$; †$p < 0.01$; ‡$p < 0.001$; §$p<0.0001$; NS: No significance.

Table II
Descriptive statistics in somatotype components of the female-male, 1984-1985

	N	Endomorphy		Mesomorphy		Ectomorphy		Components		SAM	SD
		Mean	SD	Mean	SD	Mean	SD	X	Y		
					Female						
Age (yrs)											
15	15	4.62	0.98	5.03	0.99	1.82	1.02	-2.80	3.62	2.08	1.03
16	23	3.57	1.29	4.47	1.60	2.69	1.43	-0.88	2.67	2.97	1.43
17	22	4.31	1.30	4.92	1.45	1.95	1.02	-2.35	3.57	2.43	1.47
18	11	4.42	0.95	4.52	1.20	1.89	0.76	-2.53	2.72	1.96	0.87
Mean	71	4.23	1.13	4.73	1.31	2.09	1.06	-2.14	3.15		
					Male						
Age (yrs)											
15	17	2.73	0.83	4.67	1.21	3.35	1.32	0.62	3.25	1.91	1.22
16	29	2.49	1.13	4.85	1.08	3.00	1.10	0.51	4.21	2.26	1.04
17	24	2.49	1.18	4.53	1.38	3.27	1.41	0.78	3.30	2.33	1.63
18	16	3.26	1.63	4.97	1.23	2.76	1.18	-0.50	3.92	2.61	2.18
Mean	86	2.74	1.19	4.75	1.23	3.10	1.25	0.35	3.67		

SD: Standard deviation; SAM: Somatotype attitudinal mean.

their scatter or dispersion. The higher the value of the SAM, the lower is the homogeneity of the group. Variations are defined as high (SAM ≥ 1.0), moderate (SAM between 0.80-0.99) and low (SAM ≤ 0.79).[12]

A somatochart was used to present the samples studied and thirteen categories established by Carter 1980 were applied for the age distribution. The samples were simplified into four categories (endomorphy, mesomorphy, endomorphy and central) so as to be compared.

The statistical analysis was carried out with the program Medcalc 11.6.1.0 for Windows and SPSS program version 15.00 for Windows XP 2002. A $p < 0.05$ was considered significant.

Results

In table I, the ten anthropometrical variables of the Heath-Carter anthropometrical somatotype are registered. When comparing these variables according to gender in each period, important differences are found between the years 1984-1985 in all variables, except for the subscapular skin fold thickness ($p = 0.158$), and during the years 2009-2010 only the maximum calf breadth reaches a significant difference ($p = 0.881$). When comparing the anthropometrical somatotype variables between periods (1984-1985 *vs* 2009-2010) in women, all of them, excepting height ($p = 0.176$) and

Table III
Descriptive statistics in somatotype components of the female-male, 2009-2010

	N	Endomorphy		Mesomorphy		Ectomorphy		Components		SAM	SD
		Mean	SD	Mean	SD	Mean	SD	X	Y		
					Female						
Age (yrs)											
15	19	6.44	1.72	4.00	1.19	1.59	1.16	-4.85	-0.03	2.92	1.65
16	30	6.67	1.41	4.21	1.33	1.32	1.04	-5.35	0.43	2.53	1.50
17	29	6.67	1.44	4.03	1.10	1.28	0.89	-5.39	0.12	2.35	1.60
18	8	6.72	1.83	4.33	1.71	1.26	1.44	-5.45	0.69	3.35	1.53
Mean	86	6.62	1.60	4.14	1.33	1.36	1.13	-5.26	0.30		
					Male						
Age (yrs)											
15	21	3.47	1.14	4.51	1.12	2.68	1.01	-0.79	2.87	2.37	1.86
16	27	4.02	1.91	4.36	1.00	2.34	1.27	-1.68	2.37	3.13	2.07
17	22	3.94	1.89	4.29	1.00	2.41	1.42	-1.54	1.11	3.01	2.07
18	7	4.06	2.51	4.20	1.40	2.40	1.62	-1.66	1.94	3.46	3.11
Mean	77	3.87	1.86	4.34	1.13	2.45	1.33	-1.42	2.35		

SD: Standard deviation; SAM: Somatotype attitudinal mean.

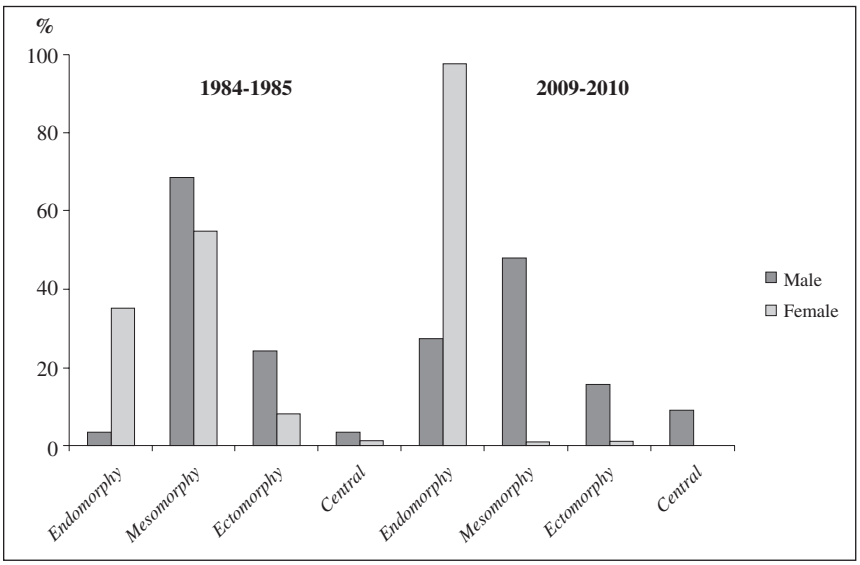

Fig. 1.—Percentage distribution of the somatotypes by category of the samples 1984-1985/2009-2010 per gender.

humeral breadth (p = 0.067), show considerable differences. In men, meaningful disparity is found in all variables, except for weight (p = 0.906), maximum calf breadth (p = 0.906) and upper arm girth (p = 0.284). The SAM studied per gender in both periods shows high variations (all of them over 1.0), which indicates a low homogeneity in the group.

In tables II and III the somatotypes are presented (endomorphic, ectomorphic and mesomorphic components, X & Y and SAM) of the 1984-1985 and 2009-2010 samples respectively of men and women. When classifying the people according to the categories established by Carter,[1] the women sample of period 1984-1985 features a endomorphic-mesomorphic profile, and in the period 2009-2010 changes to a mesomorphic-endomorph (endomorphy is dominant and mesomorphy is greater than ectomorphy) biotype, both without age distinction. In men, the individuals studied during the period 1984-1985 were classified as balanced mesomorph. Nevertheless, differences were discovered in terms of age: 15, 16 and 17 year-old men are ectomorphic-mesomorph, and at the age of 18 they become balanced mesomorph, whereas the individuals from the 2009-2010 sample present an mesomorph-endomorphprofile (endomorphy and mesomorphy are equal or do not differ by more than one-half unit), excepting the 15-year-old individuals whose profile was categorized asendomorphic-mesomorph. After comparisons between periods and gender were made, significant differences were found in women for the endomorphic, mesomorphic and ectomorphic components (p < 0.01). In men, important differences were also observed in the three components: endomorphic (p < 0.01), ectomorphic (p < 0.01) and mesomorphic (p < 0.05). After comparing the endomorphic, mesomorphic and endmorphic components between genders in the period 1984-1985, only the second component (mesomorphism) does not show an important difference (p = 0.946), which continues to be a fact in the period 2009-2010 (p = 0.172).

In figure 1, the 13 categories established by Carter were divided in four groups (ectomorphism, mesomorphism, endomorphism and central),[1] in which important differences can be found in terms of the percentage distribution per category (Chi-square: p < 0,001), per gender in the same period and in different periods. Figure 2 shows a somatochart, the mean somatopoints per age, gender and studied sample.

Discussion

Significant changes have been detected in the somatotype of men and women studied, where a high increase in the endomorphic component has been observed as regards women, going from 4.22 to 6.62 this increase in a component related to the adipose tissue had already been shown by the group through the percentage of body fat with the equations established by Slaughter. [18]The concordance between the somatotype and the body composition had already been observed.[6] The tendency towards a greater relative adiposity was also registered in other demographies[19,20,21] throughout the BMI (body mass index), including Chile.[22] However, there are no studies of the somatotopic trend in the Chilean population, in spite of the fact that the somatotopic characteristics in developing countries are known, as well as their sexual dimorphism.[10,11,13,17]

In the first sample studied, the classification of men was predominantly mesomorphic, with a second ectomorphic component. Regarding this particular issue, Toro and collaborators had already described somatotypes for men, with a tendency towards ectomorphic-mesomorph.[7] A detailed description of the relationship between somatotype and age was given by the same

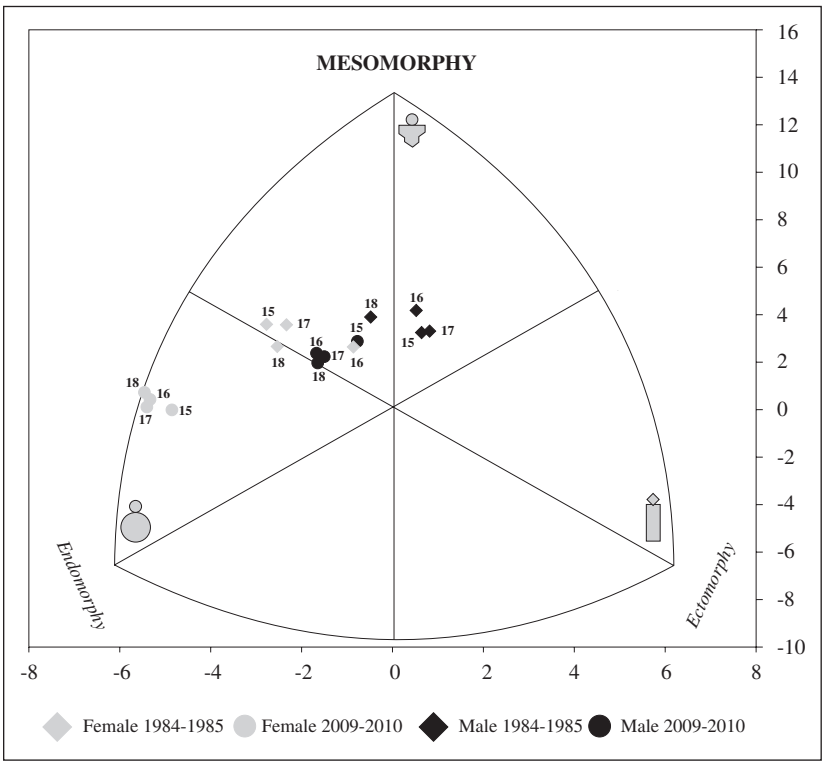

Fig. 2.—Distribution of the mean somatopoints by age, represented in a somatochart of the 1984-1985/2009-2010 samples per gender.

investigators, who discovered that,a tendency to mesomorph-ectomorph in the groups between 13 and 21 of age.[23] In the previous years of the sample registration, a trend towards the mesomorphic and ectomorphic components was being shown in male students. Whereas in women between 15 and 18 years of age an average somatotype 4.8-3.9-1.8 was registered, which evidences that in years previous to 1984-1985 the female biotype is endomorphic, followed by a mesomorphic component.[7]

In comparison to the study with populations such as the one from Londrina, Brasil (1983) where somatotypes of 4.0-3.8-2.3 and 4.0-3.4-2.6 in ages from 15.5 to 16.4 were recorded, as well as studies in Caracas, Venezuela (1985) where individuals between 15.3 and 21.3 years of age present a somatotype of 4.5-4.0-1.9, the Chilean female sample from 1984-1985 leans towards the average between the Venezuelan and the Brasilian in the endomorphic component. However, a slight rise in the ectomorphic component and a higher one in the mesomorphic component are found. 15.5-year-old Brazilian men show a somatotype of 2.1-3.7-3.5 and at the age of 16.4 of 2.2-4-0-3.3, whereas their Venezuelan peers between 15.3 and 21.3 years old present a biotype 2.7-4.4-3.0, [12]which represents a similarity in both countries with the Chilean students from the 1984-1985 sample. Even so, a higher mesomorphic component in Chilean students was found. By the year 1996, somatotypes of students from Valparaíso between 6 and 23 years of age were registered by Almagià and collaborators, determining that the endomorphic component is constant in both sexes, although higher in women. This endomorphy in women is twice higher than in men, and it increases even more over the age of 14.[9] A slight rise of 0.23 somatotopic units (US) in women is found in this study, in comparison to the 1984-1985 sample, where a tendency towards adiposity of this population starts to be evident. This sexual dimorphism is also found in other populations between 4 and 14 years of age, in which mesomorphism is predominant in men and endomorphism in women.[8] In the foothills of Temuco, Chile, an endomorphic tendency (5.6) was found in 15-year-old women,[24] component which in women of the same age from years 2009-2010 was exceeded by 0.84US. In men, a mesomorphic biotype was registered, similar to the individuals studied in this research (mesomorphy: 4.51).

If the average somatotypes of 15 to 17-year-old students from the present sample and the Bulgarian population are contrasted, a very similar mesomorphic component, but a higher endomorphic component are observed: 2.7US over in women and 1.62US over in men.[11]

Interestingly, in Temuco, Chile, the somatotypes of overweight and obese students between 16 and 18 years old were registered by Silva and collaborators[25] the results show the following: men 7.4-4.0-0.6; women 8.1-4.1-0.4, which exceeds 3.53US in men from the 2009-2010 sample. Nevertheless, the group of women has only 1.48 US difference, which confirms a sexual dimorphism as a high adiposity in adolescents. This results corroborate that the problem of overweight and obesity in Chile represents a serious issue in public health[19,26] mainly due to the changes in the population's lifestyles, such as the one into a "occidental diet", pre-

dominantly associated with fast food and a reduction of physical activity,[27] which leads to a drop in the mesomorphic component related to the musculature within time, and a tendency to an increase in the endomorphic component, mainly in women. This high adiposity-type of profile contributes to raise the probabilities for the population to suffer non-transmissible, chronic and cardiovascular issues, which may appear in adult life.[28, 29]

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