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Revisión

Somatotype tendency in Chilean adolescents from Valparaíso: review from 1979 to 2011

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Abstract

Introduction: **A good tool to determine the biotype of growing and developing subjects that has been observed is the somatotype (ST).**

Objetive: **This research study aims to describe the ST tendency in Chilean adolescents along the years.**

Methods: **The bibliographic review was carried out using data from Medline, ISI Web of Knowledge, and SciELO. The key words used for the search were: somatotype, somatotyping, adolescent (in English and Spanish). The selected articles must describe ST in Chilean adolescents between 15 and 18 years of age. The graphic representation was made through a somatochart and the series ST. To analyze the trajectory of the ST, the moving average method was used (SM), and the tendency line (lineal; TL), which expresses the data direction and projection.**

Results: **Eight articles complied with the inclusion criteria. Samples of students between 1979 and 2011 from the Regions of Valparaíso, Araucanía, and the Metropolitan region of Chile were reported. All studies correspond to transversal samples. The authors cite and/or describe the Heath-Carter anthropometric methods to assess the ST. The results showed positive TL for the endomorph component in all ages and genders. The mesomorph component maintained in male, unlike the female's component, which was negative except for the one at 18 years old. SM trajectory describes a regularity of the mesomorphic endomorph profile in female, yet with an increase in the endomorphy. In male, a change was observed from an ectomorphic mesomorph to endomorphic mesomorph.**

Conclusions: **This progressive rise of the adipose component in both genders increases the risk of suffering non-communicable diseases.**

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Key words: *Endomorphy. Anthropometry. Mesomorphy. Adiposity.*

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TENDENCIA DEL SOMATOTIPO EN ADOLESCENTES CHILENOS DE VALPARAÍSO: REVISIÓN DE 1979 AL 2011

Resumen

Introducción: **Se ha observado que el somatotipo (ST) antropométrico es un buen método para determinar el biotipo de sujetos en crecimiento y desarrollo.**

Objetivo: **Describir la tendencia del ST en adolescentes chilenos a lo largo de los años.**

Métodos: **La búsqueda bibliográfica se realizó en bases de datos Medline, ISI Web of Knowlegde y SciELO. Las palabras claves utilizadas para la búsqueda fueron: somatotipo, adolescente (tanto en inglés como español). Los artículos seleccionados debían describir el ST en adolescentes chilenos de 15 a 18 años de edad. Para la representación gráfica se utilizó la somatocarta y el ST de series, para el análisis de la trayectoria del ST se ocupó el método de medias móviles (SM) y líneas de tendencia (TL).**

Resultados: **Los artículos que cumplieron con los criterios de inclusión fueron ocho. Las muestras de estudiantes se describen desde los años 1979 hasta el 2011, en las regiones de Valparaíso, Araucanía y Metropolitana. Todos los estudios corresponden a estudios transversales. Los autores citan y/o describen el método antropométrico de Healh-Carter para evaluar el ST. Se registraron TL positivas para el componente endomorfo en todas las edades y géneros, el componente mesomorfo se mantuvo en hombres, no así en mujeres que fue negativo a excepción de los 18 años. La trayectoria SM describe una persistencia del perfil meso-endomorfo en mujeres, pero con aumento de la endomorfía. En hombres se observó el cambio de un perfil ecto-mesomorfo hacia uno meso-endomorfo.**

Conclusiones: **Este aumento progresivo del componente endomórfico en ambos géneros incrementa el riesgo de padecer enfermedades crónicas no trasmisibles.**

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Palabras Clave: *Endomorfía. Antropometría. Mesomorfía. Adiposidad.*

Introduction

In the last 30 years, Chile has experienced important socio-cultural and economic changes which have deeply modified the lifestyle of the population. Thus, at present we are in what is called post-epidemiological and nutritional transition, with practically the same characteristics as developed countries[1]. During the 1960s, Chile was characterized as a country with high prevalence of infant and maternal mortality, infectious diseases, and malnutrition. However, during the 1990s, a decrease in the infant mortality rate became apparent, moving gradually to a rise in rates of malnutrition by excess, and an increase in the rates of non- noncommunicable diseases (NCDs). Cardiovascular diseases were leading cause of death[2,3].

In Chile, malnutrition by excess represents the most relevant nutritional health issue in the population of all ages, increasingly in the school adolescent population, especially in the female gender[1,4].

Obesity in children is currently an urgent issue in the public health system[5,6], not only for this population might become obese in adulthood, but also because malnutrition by excess increases the risk of suffering psycho-social complications and NCDs, such as coronary arterial disease, metabolic syndrome in adulthood, and mellitus diabetes[7,8].

During adolescence, exogenous factors are the chief conductors in the development of obesity, which are mainly related to diet, and lack of physical activity[6,9]. Such factors have remarkably influenced the change in the result of body mass index (BMI) in child and adolescent population in the last few decades where it has increased[10].

According to a health survey carried by the Ministry of Health[11] (Chilean National Health Surveys 2010; NHS), 40.2% of 8th grade students aged 13 to 15 presented overweight, or obesity. The most alarming finding was that 90.8% of the students' performance ability or global physical condition is insufficient.

The students' nutritional assessment has been carried mainly through the BMI, whose measurement norms have been stated by the Ministry of Health's Nutrition Unit[12]. However, several researchers have characterized the students' corporeal composition through somatotype (ST)[13-16]. The ST describes biotype as of three components: endomorphy (relative adiposity), mesomorphy (muscle-skeletal robustness), and ectomorphy (lineal relation). The current concept of ST was introduced by Heath and Carter, who based on the theoretical concepts of Sheldon from 1940[17]. Samples of development and growth have been taken using this method, enabling comparison of the relative form of their components in male and female[13,15,18].

The latest researches in Chile show dominant endomorphy components in women followed by a mesomorph. In men, the mesomorph component dominates, followed by endomorph[15,19-21]. Before this high relative adiposity phenomenon, mostly in female, it becomes important to describe the trajectory of this population throughout the years as well as their projection, so that appropriate policies in public health can be originated. This research intends to describe the tendency ST has developed in late Chilean adolescents, comprehended between the ages of 15 and 18.

Materials and Methods

The review of the bibliography was carried out using the data base of Medline, ISI Web of Knowledge and SciELO (Scientific Electronic Library Online) as well as Annals of Normal Anatomy (Anales de Anatomía Normal), and Chilean Journal of Anatomy (Revista Chilena de Anatomía), being the precedent journals of the International Journal of Morphology (ISI). The review of the data base was made until October 30th 2014. The key words used were: somatotype, somatotyping, adolescent, in english and spanish. Selection criteria comprehend: publications contained in the previously mentioned data base, students in late adolescence stage between 15 and 18 years of age according to the World Health Organization (WHO), Chilean population samples, and results of publications containing the three ST components (endomorphy- mesomorphy- ectomorphy).

The exclusion criteria comprehend: individuals with diseases which modify their body composition, students out of age group subject to study and with special characteristics (sport specialties).

For the graphic presentation of the gathered data a somatochart, and the series ST were used. The former is a two-dimensional representation which contains the interrelation of the three ST components. The latter expresses the ST components.

To analyze the trajectory of the evolution of the ST, the moving average method was used, based on the variation parameter, which in this case is the years studied. This is built with the arithmetic average of consecutive values groups (pairs of values), and the curve which passes through the moving averages in the somatochart (SM)[22]. The tendency line (lineal; TL), which expresses the data direction and projection, is indicated in the representation of the series ST.

Results

After the exclusion criteria were applied, 8 researches carried out in the period between 1983 and 2013 in the region of Valparaiso (32º02' and 33º57' South latitude, and 70º and 71º West longitude) Metropolitan (32º55' and 34º19' South latitude, and 69º46' and 71º43' West longitude), and Araucanía (37º35' and 39º37' South latitude, and 70º55' West longitude until the Pacific Ocean)[23] were analyzed.

The first studies of ST in adolescents were obtained in the region of Valparaiso (Table I and II). Toro et al.[24]

Table I
Somatotypes mean adolescent male of Chile

Reference	*MY*	*n*	*Region*	*TS*	*Caliper*	*En (SD)*	*Me (SD)*	*Ec (SD)*
15 years								
Toro et al. (1983a)	1979-80	13	Valparaíso	DNR	Harpender	2.1 (*)	3.7 (*)	3.5 (*)
Toro et al. (1983b)[*]	DNR	DNR	Valparaíso	DNR	Harpender	2.3 (*)	3.9 (*)	3.4 (*)
Lizana et al. (2012)	1984-1985	17	Valparaíso	P-PS-PN	DNR	2.7 (0.8)	4.7 (1.2)	3.4 (1.3)
Almagià et al. (1986)[**]	DNR	17	Valparaíso	P-PS-PN	Harpender	5.7 (1.4)	5.1 (1.4)	3.2 (1.4)
Almagià et al. (1996)	DNR	19	Valparaíso	P-PS-PN	DNR	2.4 (0.3)	4.3 (0.7)	3.4 (1.2)
Silva et al. (2005)	DNR	DNR	Araucanía	P	Harpender	3.9 (*)	4.8 (*)	2.6 (*)
Lizana et al. (2012)	2010	21	Valparaíso	P-PS-PN	Slim Guide	3.5 (1.1)	4.5 (1.1)	2.7 (1.0)
Tapia et al. (2013)	2011	172	Metropolitana	P-PS-PN	Slim Guide	3.8 (1.9)	4.2 (1.2)	2.5 (1.3)
16 years								
Toro et al. (1983a)	1979-80	46	Valparaíso	DNR	Harpender	2.3 (*)	4.0 (*)	3.4 (*)
Toro et al. (1983b)[*]	DNR	DNR	Valparaíso	DNR	Harpender	2.0 (*)	3.8 (*)	3.5 (*)
Lizana et al. (2012)	1984-1985	29	Valparaíso	P-PS-PN	DNR	2.5 (1.1)	4.9 (1.1)	3.0 (1.1)
Almagià et al. (1986)[**]	DNR	48	Valparaíso	P-PS-PN	Harpender	4.3 (1.0)	4.6 (1.0)	3.6 (0.9)
Almagià et al. (1996)	DNR	95	Valparaíso	P-PS-PN	DNR	2.4 (0.2)	4.7 (0.6)	3.2 (1.2)
Lizana et al. (2012)	2010	27	Valparaíso	P-PS-PN	Slim Guide	4.0 (1.9)	4.4 (1.0)	2.3 (1.3)
Tapia et al. (2013)	2011	81	Metropolitana	P-PS-PN	Slim Guide	3.6 (1.9)	4.3 (1.5)	2.6 (1.4)
17 years								
Toro et al. (1983a)	1979-80	58	Valparaíso	DNR	Harpender	1.9 (*)	3.9 (*)	3.5 (*)
Toro et al. (1983b)[*]	DNR	DNR	Valparaíso	DNR	Harpender	2.7 (*)	4.1 (*)	2.5 (*)
Lizana et al. (2012)	1984-1985	24	Valparaíso	P-PS-PN	DNR	2.5 (1.2)	4.5 (1.4)	3.3 (1.4)
Almagià et al. (1986)[**]	DNR	59	Valparaíso	P-PS-PN	Harpender	4.3 (1.1)	4.7 (1.3)	3.3 (1.3)
Almagià et al. (1996)	DNR	113	Valparaíso	P-PS-PN	DNR	2.3 (0.2)	4.4 (0.6)	3.4 (1.2)
Lizana et al. (2012)	2010	22	Valparaíso	P-PS-PN	Slim Guide	3.9 (1.9)	4.3 (1.0)	2.4 (1.4)
18 years								
Toro et al. (1983a)	1979-80	29	Valparaíso	DNR	Harpender	2.2 (*)	3.8 (*)	3.4 (*)
Toro et al. (1983b)[*]	DNR	DNR	Valparaíso	DNR	Harpender	2.3 (*)	4.0 (*)	3.2 (*)
Lizana et al. (2012)	1984-1985	16	Valparaíso	P-PS-PN	DNR	3.3 (1.6)	5.0 (1.2)	2.8 (1.2)
Almagià et al. (1986)[**]	DNR	30	Valparaíso	P-PS-PN	Harpender	4.4 (0.9)	4.6 (1.1)	3.4 (1.0)
Almagià et al. (1996)	DNR	54	Valparaíso	P-PS-PN	DNR	2.3 (1.0)	4.5 (0.7)	3.2 (1.2)
Lizana et al. (2012)	2010	7	Valparaíso	P-PS-PN	Slim Guide	4.1 (2.5)	4.2 (1.4)	2.4 (1.6)

MY, measuring year; n, number of subjects; TS, type of school subsidy of educational establishment, Chile; SD, standard deviation; En, endomorphy; Me, mesomorphy; Ec, ectomorphy; DNR, data not reported; P, public schools; PS, private schools; PN, private nonsubsidized schools; (*), data not reported. [*], The authors classified the ages of the subjects in the following ranges: A.13.7-14.10; B.14.11-15.9; C.15.10-16.9; D.16.10-17.9; E.17.10-18.9; F.18.10-21. In the following table are shown: C, D, E, and F respectively; [**], The authors classified the ages of the subjects in the following ranges: 15.00-15.11; 16.00-16.06; 16.07-16.11(4.5-5.3-2.8); 17.00-17.06; 17.07-17.11(4.6-4.7-3.2); 18.00-18.06; 18.07-18.11(4.5-4.7-3.1), in table only the first range is shown.

Table II
Somatotypes mean adolescent female of Chile

Reference	MY	n	Region	TS	Caliper	En (SD)	Me (SD)	Ec (SD)
15 years								
Toro et al. (1983a)	1979-80	8	Valparaíso	DNR	Harpender	4.7 (*)	3.9 (*)	2.0 (*)
Lizana et al. (2012)	1984-1985	15	Valparaíso	P-PS-PN	DNR	4.6 (1.0)	5.0 (1.0)	1.8 (1.0)
Almagià et al. (1986)[*]	DNR	15	Valparaíso	P-PS-PN	Harpender	6.1 (1.0)	5.3 (0.9)	2.1 (0.9)
Almagià et al. (1996)	DNR	21	Valparaíso	P-PS-PN	DNR	4.5 (1.0)	4.8 (1.2)	2.1 (1.2)
Silva et al. (2005)	DNR	DNR	Araucanía	P	Harpender	5.6 (*)	5.2 (*)	1.8 (*)
Lizana et al. (2012)	2010	19	Valparaíso	P-PS-PN	Slim Guide	6.4 (1.7)	4.0 (1.2)	1.6 (1.2)
Tapia et al. (2013)	2011	153	Metropolitana	P-PS-PN	Slim Guide	6.0 (1.7)	4.0 (1.4)	1.5 (1.2)
16 years								
Toro et al. (1983a)	1979-80	13	Valparaíso	DNR	Harpender	5.3 (*)	4.0 (*)	1.5 (*)
Lizana et al. (2012)	1984-1985	23	Valparaíso	P-PS-PN	DNR	3.6 (1.3)	4.5 (1.6)	2.7 (1.4)
Almagià et al. (1986)	DNR	41	Valparaíso	P-PS-PN	Harpender	5.8 (1.1)	5.1 (1.6)	2.3 (1.1)
Almagià et al. (1996)	DNR	71	Valparaíso	P-PS-PN	DNR	4.5 (1.4)	4.8 (1.4)	2.1 (1.1)
Lizana et al. (2012)	2010	30	Valparaíso	P-PS-PN	Slim Guide	6.7 (1.4)	4.2 (1.3)	1.3 (1.0)
Tapia et al. (2013)	2011	109	Metropolitana	P-PS-PN	Slim Guide	5.7 (1.5)	4.0 (1.4)	1.6 (1.0)
17 years								
Toro et al. (1983a)	1979-80	34	Valparaíso	DNR	Harpender	4.5 (*)	4.0 (*)	1.9 (*)
Lizana et al. (2012)	1984-1985	22	Valparaíso	P-PS-PN	DNR	4.3 (1.3)	4.9 (1.5)	2.0 (1.0)
Almagià et al. (1986)	DNR	46	Valparaíso	P-PS-PN	Harpender	5.8 (1.2)	5.3 (1.5)	2.0 (1.0)
Almagià et al. (1996)	DNR	81	Valparaíso	P-PS-PN	DNR	4.5 (1.2)	4.9 (1.2)	1.9 (1.0)
Lizana et al. (2012)	2010	29	Valparaíso	P-PS-PN	Slim Guide	6.7 (1.4)	4.0 (1.1)	1.3 (0.9)
18 years								
Toro et al. (1983a)	1979-80	23	Valparaíso	DNR	Harpender	4.8 (*)	3.9 (*)	1.8 (*)
Lizana et al. (2012)	1984-1985	11	Valparaíso	P-PS-PN	DNR	4.4 (1.0)	4.5 (1.2)	1.9 (0.8)
Almagià et al. (1986)	DNR	35	Valparaíso	P-PS-PN	Harpender	6.2 (1.3)	5.5 (1.4)	1.6 (1.1)
Almagià et al. (1996)	DNR	51	Valparaíso	P-PS-PN	DNR	4.7 (1.4)	4.8 (1.4)	1.9 (1.2)
Lizana et al. (2012)	2010	8	Valparaíso	P-PS-PN	Slim Guide	6.7 (1.8)	4.3 (1.7)	1.3 (1.4)

MY, measuring year; n, number of subjects; TS, type of school subsidy of educational establishment, Chile; SD, standard deviation; En, endomorphy; Me, mesomorphy; Ec, ectomorphy; DNR, data not reported; P, public schools; PS, private schools; PN, private nonsubsidized schools; (*), data not reported.[*], The authors classified the ages of the subjects in the following ranges: 15.00-15.11; 16.00-16.06; 16.07-16.11(6.2-5.5-1.8); 17.00-17.06; 17.07-17.11(6.3-5.5-1.7); 18.00-18.06; 18.07-18.11(6.0-4.8-2.3), in table only the first range is shown.

registered students' STs of both sexes, finding a clear sexual dimorphism by ages, where the mesomorphic endomorph component would be characteristic of the group of women without significant variations among ages. Male have serious changes in their mesomorphy, which is statistically significant between the ages of 15 and 18. In this case, male presented an inclination toward mesomorph-ectomorph[24]. The authors of this research project, taking into account the tendency of male toward mesomorphy, specified their description in the relation between ST and age, in which it was found that only at 13.7 and 15.9 years of age a balanced mesomorph is presented, and a tendency toward ectomorphic mesomorph in groups of 15.10 to 18.9[25].

In 1986, a similar ST is described in male and female of 15 to 21 years of age with distinct dispersions between the ages of 16 and 18. However, despite the similarities, the average of subjects positioned male with an ST 4-5-4 in the mesomorph component, and female with an ST 6-6-2 in the endomorph-mesomorph[18].

In 1996, the description of ST was carried out in an important sample of the population between 6 and 23 years of age in Valparaiso, in public, private, and unsubsidized private educational institutions, finding that the endomorph component remains constant in both sexes, higher in female (Table I and II). The authors stand out that endomorph in female is characterized by doubling the one in male, and that its difference is much higher over 14 years of age. An example of this case is given at the age of 18: the researchers report an endomorphy of 2.3 in male and 4.7 in female. As regards the educational institutions, a major homogeneity was found in municipal and subsidized private schools compared to the unsubsidized schools[18].

The following search is carried in Temuco, Region of Araucanía, Chile[19]. When evaluated a private school (unsubsidized), it was observed that the values of the endomorph component at 15 years old are higher in female than in male, whose mesomorph component is predominant[19]. This predominance of the endomorph component in female over male is maintained in later studies by Lizana et al. and Tapia et al. carried out in Valparaíso and Metropolitan Region respectively[15,21].

As regards ectomorph, third component of ST, reports indicate that it has declined. Both female and male's values are in the low category (1.3 and 2.7), which indicates great volume and round shapes, characteristics of people with an increase of the relative adiposity[17]. This component in Chilean female has not have important changes throughout the studied period. However, a decrease is observed in male from 1983 until 2011 where it is considered a moderate-to-low category (3 to 5).

In male's SM (Fig. 1-4C) ectomorphic mesomorph biotype is observed moving toward mesomorphic endomorph; the projection indicates that the endomorphy rise will continue in progress, except at 15 years old when it can move to more central components. In female, SM's indicates a biotype characterized by mesomorphic endomorph in the first reported studies, and that has remained along the years, but with an increase in the endomorph component. SM projection in women indicates that it will continue to move toward endomorph components.

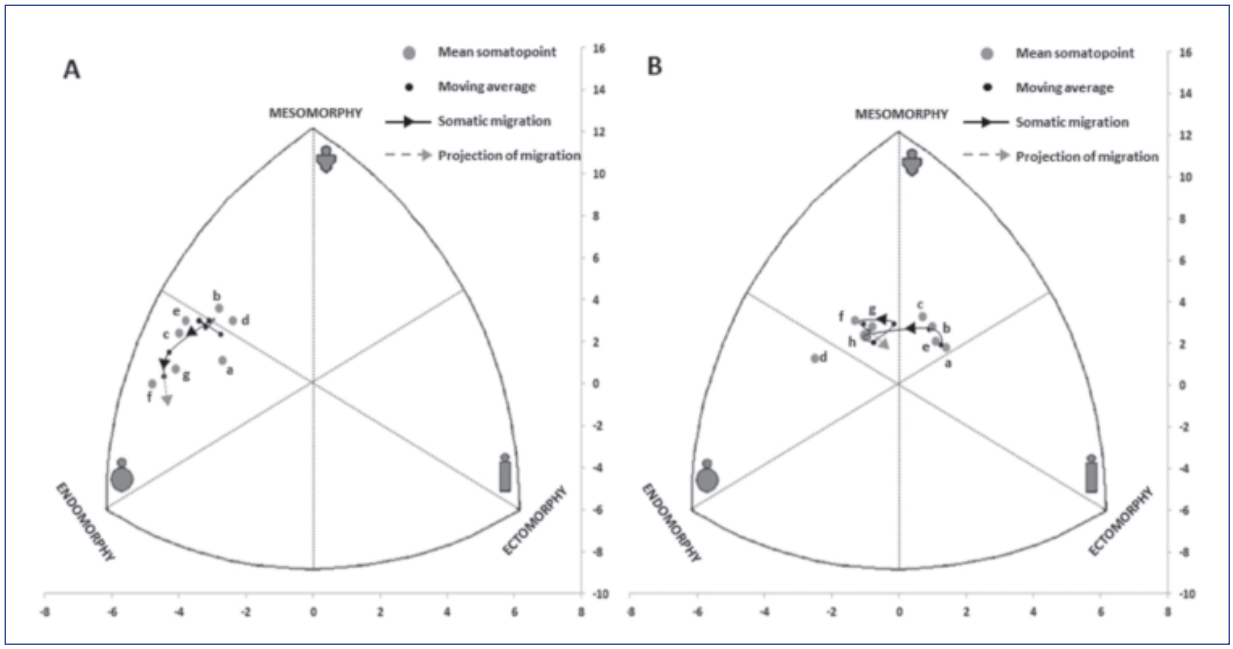

Fig. 1.—Somatic migration of mean somatopoint samples between 1979 -2011, through 15 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Silva et al., 2005); f (Lizana et al., 2012); g (Tapia et al., 2013). B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Silva et al., 2005); g (Lizana et al., 2012); h (Tapia et al., 2013).

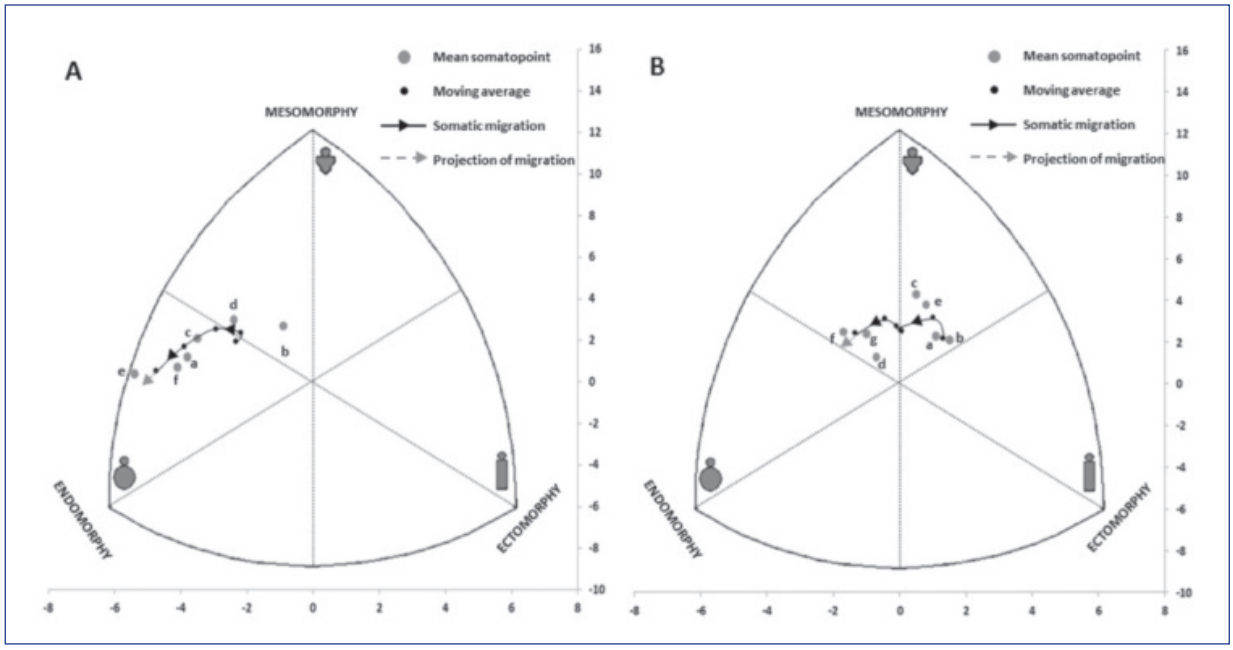

Fig. 2.—Somatic migration of mean somatopoint samples between 1979 -2011, through 16 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012); f (Tapia et al., 2013). B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012); g (Tapia et al., 2013).

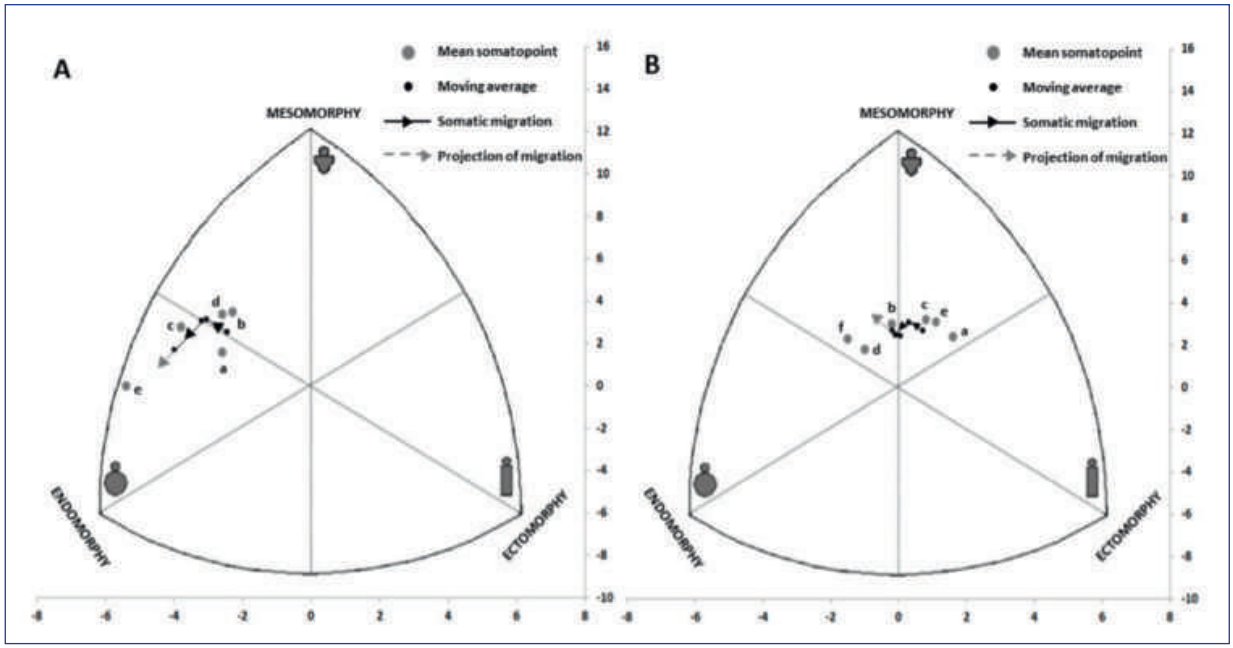

Fig. 3.—Somatic migration of mean somatopoint samples between 1979 -2010, through 17 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012). B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012).

Female's TL (Fig. 5-6A) show mesomorph component decreasing along time (equations, 15 years old: y=-0643x + 4.8571; 16 years old: y= -0.0343x + 4.5533). At 17 years old, it maintains stable (equation not represented dates, R^2=0; y=4.62), and at 18 a slight increase is observed (y=0.11x + 4.27; Fig. 8A). As regards endomorph component, it rises in all age ranges along the years and prevails over the rest of the components (equations, 15 years old: y=0.25x + 4.4143; 16 years old: y= 0.2857x + 4.2667; 17 years old y = 0.46x + 3.78; 18 years old: y=0.41x + 4.13). Ectomorph component shows a decrease during the observed period (TL all negative).

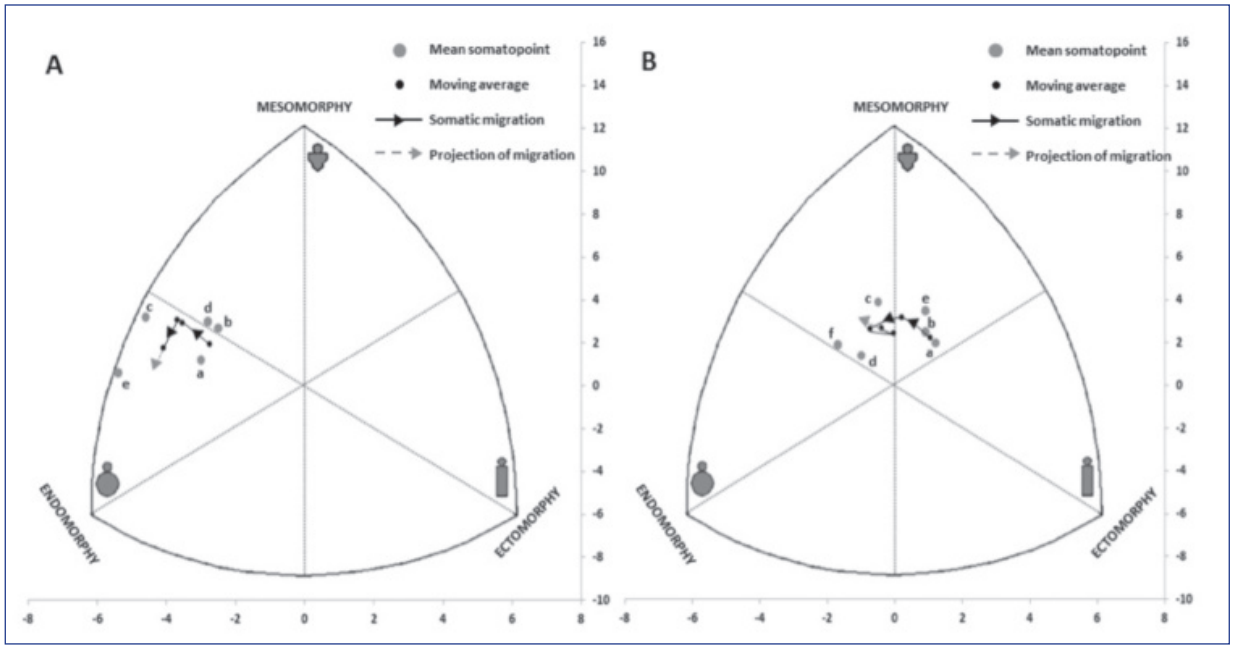

Fig. 4.—Somatic migration of mean somatopoint samples between 1979 -2010, through 18 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012). B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012).

Male's TL (Fig. 5-8B) show a dominant mesomorph component, which presents a positive TL in all ages. Even if the mesomorph component prevails over the rest, it is observed that the endomorph component increases along the years. In relation to the endomorph component, a minor predominance compared to the rest of the components during the periods 1979-85 (Fig. 5-8B). However, from 1986 this situation changes, since the endomorph component value exceeded the ectomorph component. Similarly to female, ectomorph component diminishes in the described period (negative TL).

Discussion

Results of this study show that from 1979 until 2011 an increase in the endomorph component in association to adiposity has been produced from 15 to 18 years of age, projecting a change in the corporal composition of

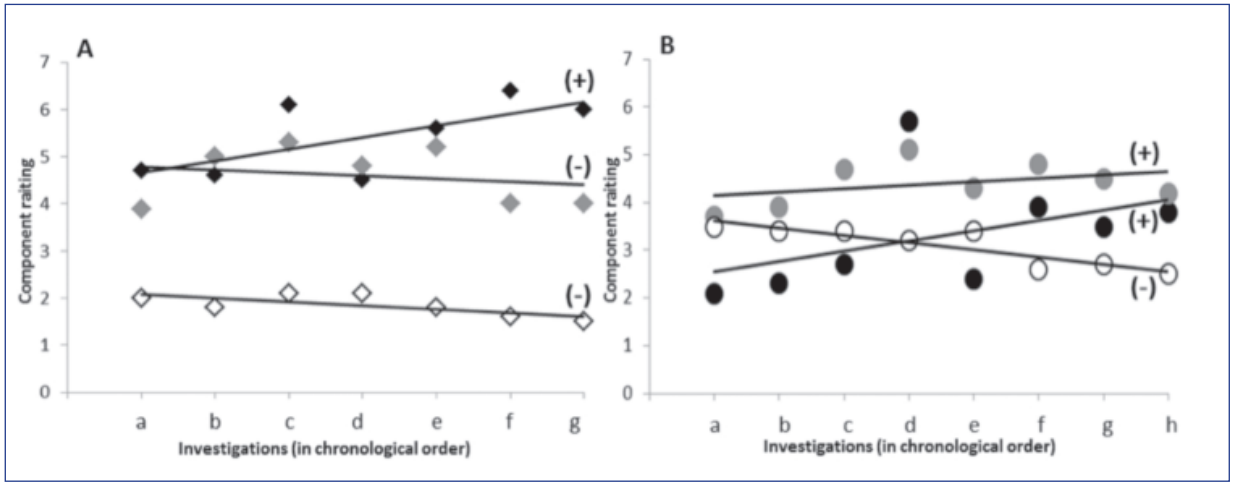

Fig. 5.—Somatotype component rating of samples between 1979 -2011, through 15 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Silva et al., 2005); f (Lizana et al., 2012); g (Tapia et al., 2013); black diamond =endomorph component; gray diamond = mesomorph component; white diamond = ectomorph component. B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Silva et al., 2005); g (Lizana et al., 2012); h (Tapia et al., 2013); black circle =endomorph component; gray circle = mesomorph component; white circle = ectomorph component. (+); (-), indicate direction of trend line.

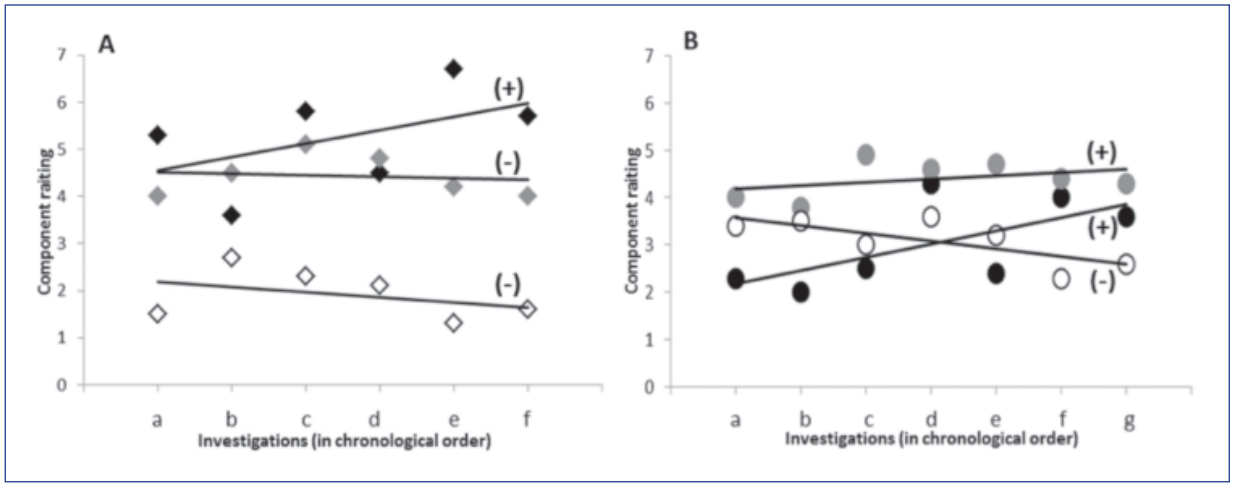

Fig. 6.—Somatotype component rating of samples between 1979 -2011, through 16 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012); f (Tapia et al., 2013); black diamond =endomorph component; gray diamond = mesomorph component; white diamond = ectomorph component. B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012); g (Tapia et al., 2013); black circle =endomorph component; gray circle = mesomorph component; white circle = ectomorph component.(+); (-), indicate direction of trend line.

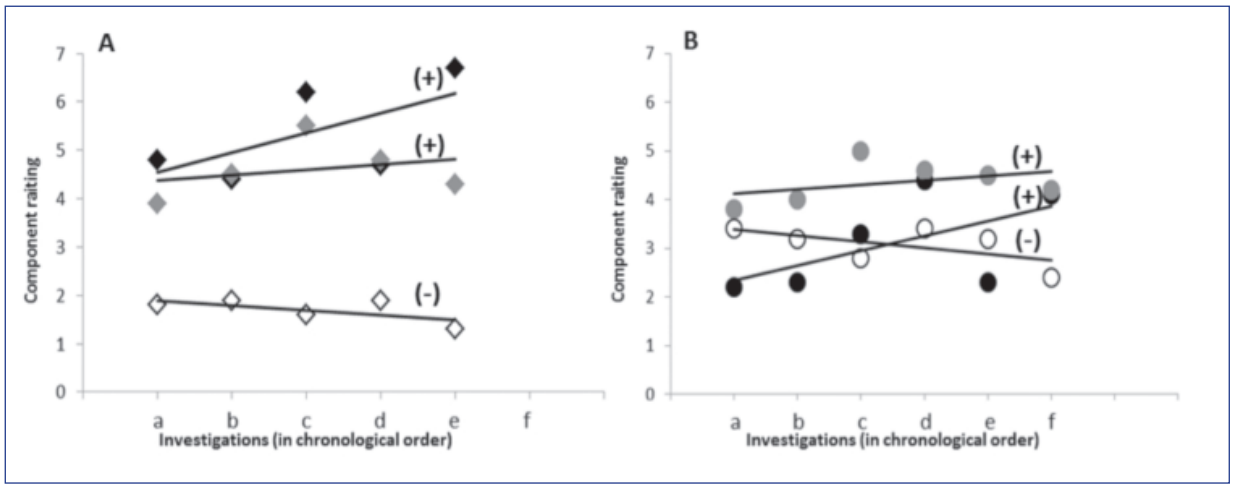

Fig. 7.—Somatotype component rating of samples between 1979 -2010, through 17 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012); black diamond =endomorph component; gray diamond = mesomorph component; white diamond = ectomorph component. B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012); black circle =endomorph component; gray circle = mesomorph component; white circle = ectomorph component. (+); (-), indicate direction of trend line.

both sexes along the years. The tendency of the female population is presenting a mesomorphic endomorph somatotype. A predominant endomorph component is described in both genders, which indicates the existence of a high component of adipose tissue.

Even if both sexes present different SM and projections, the enfomorph component prevails and rises in both genders throughout the years. This research project has determined a sexual dimorphism which has also been reported in other populations around the world[13,26]. In the case of this study, a higher sexual dimorphism was found in women's endomorph component, whereas men have higher mesomorph component. However, it is important to remark that both genders have moved toward endomorphy. It is interesting to see how teenage women present changes at 15 years of age in their endomorph component (regardless the region they are from): 4.7 in 1983, 4.5 in 1985, 6.1 in 1986, 4.4 in 1996, 5.6 in 2005, 6.4 in 2010, and 5.7 in 2011. Figures indicate an increase of 1.8 somatotype units in 28 years, thus adiposity has changed from moderate (range between 3 and 5) to high in the last few decades (table II). At same age, male have moved to the limit of moderate and high relative adiposity (table I). These results agree with the comparison carried out by Lizana et al. (2012)[15] with adolescents from the Region of Valparai-

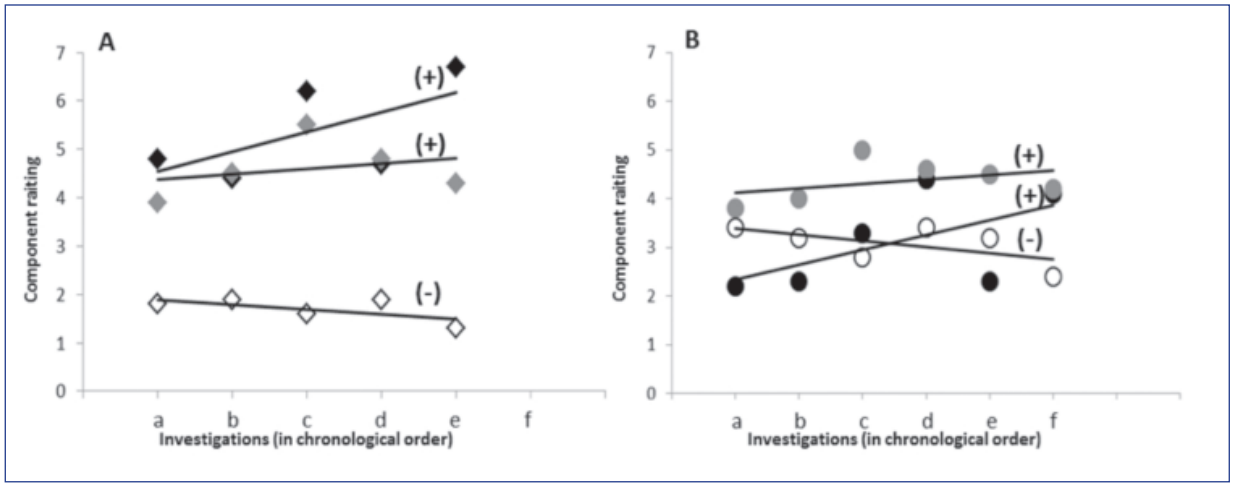

Fig. 8.—Somatotype component rating of samples between 1979 -2010, through 18 year-old of female (A) and male (B) mobile averages, Chile. Lowercase letters indicate studies: A=a (Toro et al., 1983a); b (Lizana et al., 2012); c (Almagià et al., 1986); d (Almagià et al., 1996); e (Lizana et al., 2012); black diamond =endomorph component; gray diamond = mesomorph component; white diamond = ectomorph component. B=a (Toro et al., 1983a); b (Toro et al., 1983b); c (Lizana et al., 2012); d (Almagià et al., 1986); e (Almagià et al., 1996); f (Lizana et al., 2012); black circle =endomorph component; gray circle = mesomorph component; white circle = ectomorph component. (+); (-), indicate direction of trend line.

so in 1984/1985, and 2010, resulting in a significant increase in the endomorph component, which was higher in women, in all studied ages. Results also coincide with late NHS (2003-2010), in which a rise in the prevalence of obesity has been registered, especially higher in women. Moreover, NHS data denote obesity rises as age increases, only with a drop during elderly. This rise of overweight and obesity (evaluated by BMI) has high correspondence to the endomorph component, which was described in the work of Silva's et al. (2008), who evaluated a group of overweight and obese adolescents (BMI according to WHO). An endomorph component over 7 in men, and over 8 women was obtained in the study, which corresponds to extreme categories[17].

The phenomenon is perceived in the evaluation carried out by the NHS[11](2003-2010). However, a decrease of mesomorph component was reported in our study attributed to a lack of physical activity, as several authors have reported[9,27,28]. In addition, a tendency to a rising endomorph component is observed. This type of profile with high relative adiposity contributes to increasing the probabilities for population to suffer from cardiovascular, and NCDs, even in adulthood[29].

Results interpretation is limited by methodological issues of research projects which include: instruments used, available data (3 papers did not have standard deviations data[19,24,25], and the variability of sample sizes which may be from 7 to 172 by age, type of school subsidy, and region. Such factors introduce possible biases that should not affect results systematically. The cross-cutting nature of the studies, of which there are no reports of ST cohort, limits interpretation of tendencies. However, it is interesting to observe that an endomorphism increase has been reported in independent studies in three different regions of Chile. Similar studies of a territory are scarce, since there is only one that compares subjects from a region (Valparaíso) in two different periods in order to observe changes of ST components through time[15]. In this regard, it would be important to describe particular populations such as the native peoples, whose studies has only been focused on Mapuches[16], and with the characterization of the rural school population compared to urban which has not been explored in Chile either. Additionally, comparisons with different geographical areas are neither registered. ST in Chile requires more studies in children and adolescents, incorporating variables that may modify it (physical activity, intake, among other), since it is an important evaluation tool of body shapes that must cause impact in public health guidelines.

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