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Original

Comparisons of summer break effect on anthropometric profile, body composition and somatotype between adolescent swimmers and less active adolescents

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ABSTRACT

Objective: The aim of this study was to compare changes in anthropometric profile, body composition, and somatotype of adolescent swimmers and less active adolescents.
Method: We selected 16 swimmers and 8 less active adolescents. The swimmers were divided based on the amount of swimming activity performed per week. A longitudinal study with repeated measures was carried out. The anthropometric profile, body composition, and somatotype were assessed before and after the summer break from swimming activity.
Results: Both groups of swimmers showed more changes in anthropometric profile, body composition, and somatotype than the less active adolescents. The very active swimmers showed a higher increase in the sum of the two central skinfolds than peripheral ones (p = 0.018). Both groups of swimmers had a great increase of the percent change in the sum of the two central skinfolds (medium active swimmers: p = 0.006, medium effect size = 0.72; very active swimmers: p = 0.001, medium effect size = 0.64).
Conclusions: The fat component seems to be more variable than the muscular and bone component during 55 – 65 days of summer break from swimming activity. The two groups of swimmers showed a preferential accumulation of central fat after the summer break compared to the less active adolescents. The suprailiac and abdominal skinfolds could be used as early predictive measurements to assess changes in body fat.
Key Words: Adolescents; Swimmers; Central fat; Dry-land exercises; Anthropometry; Skinfolds.

Comparación del efecto de las vacaciones de verano en el perfil antropométrico, la composición corporal y el somatotipo entre nadadores adolescentes y adolescentes menos activos

RESUMEN

Objetivo: El objetivo del estudio fue comparar los cambios en el perfil antropométrico, la composición corporal y el somatotipo entre nadadores adolescentes y adolescentes sedentarios.
Método: Se llevó a cabo un estudio longitudinal con medidas repetidas. Se analizó el perfil antropométrico, la composición corporal y el somatotipo antes y después del verano. Se seleccionaron 24 adolescentes: 16 nadadores y 8 sedentarios. Los nadadores se dividieron en dos grupos según los minutos de entrenamiento realizado por semana: actividad intensa = 960 minutos, actividad media = 480 minutos.
Resultados: Los nadadores mostraron mayores cambios en el perfil antropométrico, la composición corporal y el somatotipo respecto a los adolescentes sedentarios tras el verano. Ambos grupos de nadadores tuvieron un aumento en la suma de los dos pliegues centrales (nadadores de actividad media: p = 0.006, tamaño de efecto medio = 0.72; nadadores de actividad intensa: p = 0.001, tamaño de efecto medio = 0.64). Los nadadores de actividad intensa mostraron un aumento en la suma de los dos pliegues centrales frente a los periféricos (p = 0.018).
Conclusiones: En nadadores adolescentes, la grasa corporal parece ser más variable frente al componente muscular y óseo después del verano. Ambos grupos de nadadores mostraron una acumulación preferencial de grasa central después del verano frente a los adolescentes sedentarios. Los pliegues centrales podrían usarse como medidas predictivas tempranas para evaluar los cambios en la grasa corporal.
Palabras clave: Adolescentes; Nadadores; Grasa central; Ejercicios en seco; Antropometría; Pliegues cutáneos.

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Comparações do efeito das férias de verão no perfil antropométrico, composição corporal e somatótipo entre nadadores adolescentes e adolescentes menos ativos

RESUMO

Objetivo: O objetivo do estudo foi comparar as alterações no perfil antropométrico, composição corporal e somatótipo entre adolescentes nadadores e sedentários.

Método: Foi realizado um estudo longitudinal com medidas repetidas. Foram analisados o perfil antropométrico, a composição corporal e o somatótipo antes e depois do verão. Foram selecionados 24 adolescentes: 16 nadadores e 8 sedentários. Os nadadores foram divididos em dois grupos de acordo com os minutos de treinamento realizados por semana: atividade intensa = 960 minutos, atividade média = 480 minutos.

Resultados: Os nadadores apresentaram maiores alterações no perfil antropométrico, composição corporal e somatótipo em comparação aos adolescentes sedentários após o verão. Ambos os grupos de nadadores tiveram um aumento na soma das dois pregas centrais (nadadores de atividade média: p = 0,006, tamanho médio do efeito = 0,72; nadadores de atividade intensa: p = 0,001, tamanho médio do efeito = 0,64). A intensa atividade de nadadores mostrou um aumento na soma das dois dobras centrais em relação aos periféricos (p = 0,018).

Conclusões: Em nadadores adolescentes, a gordura corporal parece ser mais variável em comparação ao componente muscular e ósseo após o verão. Ambos os grupos de nadadores mostraram um acúmulo preferencial de gordura central após o verão em comparação com adolescentes sedentários. As dobras centrais podem ser usadas como medidas preditivas precoces para avaliar alterações na gordura corporal.

Palavras-chave: Adolescentes; Nadadores; Gordura central; Exercício seco; Antropometria; Dobras cutâneas.

Introduction

The adolescent swimmers have intense training programs during their swimming season. They usually have a break of several weeks from swimming activity during the summer. The summer break could cause detraining and a drastic reduction of daily physical activity and energy requirements of the adolescent swimmers. To date, some studies have examined the swimmers' body-composition changes over a competitive season.[1,2] There is scarce data about the effect of a drastic reduction of physical activity on anthropometric characteristics after the end of the swimming season and the research is mainly oriented to performance.[3] Previous studies have observed an increasing height,[3] weight,[4] body fat,[4] a decrease in the respiratory parameters.[5,6] Other studies have reported an unmodified resting metabolic rate[7] and reduced insulin sensitivity.[8]

We believe that the abrupt summer break from swimming training may lead to unfavorable changes in the anthropometric characteristics of the swimmers. Therefore, the aims of this study were to monitor the effects of summer break from swimming activity on anthropometric profile, body composition and somatotype of adolescent swimmers and to compare these changes to the less active adolescents.

Methods

Subject

This study was a longitudinal research part with repeated measures of several anthropometric measures. We selected the swimmers based on the amount of swimming activity performed per week. A group of seven swimmers {age 13.43 years old (y.o.); CI 95% 12.93, 13.92} trained approximately 960 minutes per week and they were classified as "very active". A group of nine swimmers (age 13.11 y.o. ; CI 95% 12.51, 13.71) trained 480 minutes per week and they were classified as "medium active". A group of eight sedentary adolescents (age 14.37 y. o.; CI 95% 13.75, 15.00) was the control group, and they were classified as "less active". The adolescents of the control group were sedentary and they did not practice any swimming or sport activity before and during the study. During the summer break, all participants performed an uncontrolled leisure activity as part of their summer holidays. No one of the participants followed up a specific diet or nutritional assessment before and during the study. All swimmers have been performing swimming for more than two years. All adolescents participated voluntarily in the study and they were informed verbally and in writing about the nature of the study. The participants and their legal guardian signed a written informed consent prior to the beginning of the study and the ethics committee of the University of Alicante granted ethical approval, according to the Declaration of Helsinki.

Procedures

The anthropometric data of the swimmers and less active adolescents were collected on the afternoon before the swimming training at the mid-July 2016 (before summer break) and 55 - 65 days later in the afternoon at the mid-September 2016 (after summer break). Participants were only wearing a textile swimsuit or underwear during all anthropometric data collections. A II level anthropometrist of the International Society for the Advancement of Kinanthropometry (ISAK) collected the anthropometric data according to ISAK's methodology.[9] The following anthropometric measurements were obtained: height, weight, eight subcutaneous skinfold thickness (bicipital, tricipital, subscapular, suprailiac, supraspinal, abdomen, front thigh, and medial calf), the circumferences included muscular girths (upper arm flexed and relaxed, upper arm flexed and tensed), waist, hip, frontal thigh, and maximum calf. Bones diameters included wrist, femur, and humerus. The body weight and the body mass index were recorded using a professional scale (Tanita BH 420MA, Tanita Corporation, Japan). It was also calculated the waist/hip ratio. For the anthropometric data collection, the following materials were used: a Rosscraft metric tape measure, narrow and inextensible (accuracy, 1 mm); diameter caliper Holtain bones (precision, 1 mm); Holtain plicometer (precision, 0.2 mm). Somatotype was calculated according to Heath-Carter´s method.[10] Body composition was calculated using the model with four components: fat mass was calculated using the equations by Withers, Carter, and Faulkner; muscle mass was calculated using the formula by Lee, and bone mass was calculated using the formula by Rocha.[11] Finally, to determine if central body fat distribution was preferentially improved by summer break, it was compared the percent change in the sum of the two central skinfolds (abdominal and suprailiac) to the percent change in the sum of the two peripheral skinfolds (thigh and tricipital).[12]

Statistical analysis

The data was classified based on the number of minutes of swimming training per week. The mean and standard error (SD) were calculated for all parameters. Not being able to guarantee normal statistical distribution a non-parametric Wilcoxon test was performed to analyze the changes of each group after the summer break. Moreover, it was used to compare among percentages of changes between central and peripheral fat. To compare and analyze the differences among the groups an U-test de Mann-Whitney was carried out. To assess the percentages of change in the sum of the two central skinfolds and the two peripheral skinfolds, a binomial test was performed (median = 0). A p-value of less than 0.05 was considered significant. The effect size was calculated to determine the smallest worthwhile differences in the measurements. We calculated the Cliff's Delta effect size. The Cliff's Delta statistic is a non-parametric effect size measure that quantifies the amount of difference between two groups of observations beyond p-values interpretation. The effect size was classified as trivial (0-0.19) small (0.2-0.49), medium (0.5-0.79) and large (0.8 and greater).[13] The SPSS 15.0 (IBM, U.S.A) was used to perform this analysis.

Results

The anthropometric data of the groups are presented in the Table 1. All the changes are referred to after the summer break. The less active adolescents reduced the following measurements: a lower body mass index (Δ= -0.53, p = 0.05, trivial effect size = 0.18) and a lower circumference of upper arm flexed and tensed (Δ = -0.46 mm, p = 0.05, trivial effect size = 0.06). The medium active swimmers showed the following changes: an increase in the weight (Δ= +1.33 kg, p = 0.01, trivial effect size = 0.16), the abdominal skinfold (Δ= +2.44 mm, p = 0.01, small effect size = 0.24), the front thigh skinfold (Δ= +2 mm, p = 0.01, small effect size = 0.28), and the medial calf skinfold (Δ = +1.64 mm, p = 0.01, small effect size = 0.22). Moreover, they showed a decrease in the waist/hip ratio (Δ= -0.01, p = 0.02, trivial effect size = 0.11). The very active swimmers showed the following changes: an increase in the suprailiac skinfold (Δ= +3.5 mm, p = 0.03, medium effect size = 0.61), the supraspinal skinfold (Δ= +1.46 mm, p = 0.05, small effect size = 0.44), the abdominal skinfold (Δ= +3.61 mm, p = 0.03, medium effect size = 0.55), the front tight skinfold (Δ= +2.43 mm, p = 0.05, small effect size = 0.24), the sum of eight skinfolds (Δ = +13.5 mm, p = 0.04, small effect size = 0.34), and in the circumference of the medial calf (Δ = +0.46 mm, p = 0.04, trivial effect size = 0.12).

When we compared the differences among the groups we found that both groups of swimmers gained weight showing significant differences compared to the less active adolescents (medium active swimmers: p = 0.01, medium effect size = 0.72; very active swimmers p = 0.03, medium effect size = 0.66). Both groups of swimmers showed a greater increase in the sum of the eight

Table 1. Overall Results of Anthropometric Measurements before and after the Summer Break

Anthropometric measurements	*Less active (leisure activity)*		*Medium active (480min/week)*		*Very active (960 min/week)*		*Differences between groups (U de Mann-Whitney)*		
	Before summer break	*After summer break*	*Before summer break*	*After summer break*	*Before summer break*	*After summer break*	*Less active vs medium active p (ES)*	*Less active vs very active p (ES)*	*Medium active vs very active p (ES)*
Weight (kg)	58.31 ± 12.45	57.86 ± 11.91	51.11 ± 7.22	52.44 ± 7.39**	50.74 ± 3.2	52.31 ± 4.48	0.01 (0.72)	0.03 (0.66)	0.68 (0.12)
Height (cm)	163.25 ± 10.30	164.69 ± 9.86*	163.44 ± 9.2	166.67 ± 8.39**	164.5 ± 2.66	165.92 ±3.58*	0.04 (0.58)	0.87 (0.07)	0.07 (0.54)
Body mass index	21.65 ± 2.07	21.12 ± 1.93*	19.10 ± 1.81	18.84 ± 1.81	18.73 ± 1.03	18.98 ± 1.21	0.28 (0.33)	0.04 (0.64)	0.21 (0.39)
Waist/hip ratio	0.75 ± 0.05	0.76 ± 0.05	0.77 ± 0.39	0.75 ± 0.03*	0.78 ± 0.03	0.77 ± 0.03	0.09 (0.5)	0.19 (0.42)	0.84 (0.08)
Skinfolds									
Subscapular	8.14 ± 2.49	7.00 ± 1.16	5.94 ± 2.17	6.44 ± 2.32	6.50 ± 1.22	6.43 ± 1.59	0.03 (0.64)	0.23 (0.37)	0.17 (0.42)
Tricipital	10.81 ± 3.8	10.31 ± 3.9	8.39 ± 4.05	8.72 ± 4.16	8.29 ± 2.37	8.86 ± 2.65	0.32 (0.3)	0.19 (0.41)	1.00 (0.00)
Bicipital	5.25 ± 2.22	5.69 ± 2.89	5.00 ± 3.16	5.50 ± 4.3	4.79 ± 1.46	4.64 ± 2.07	0.74 (0.09)	0.46 (0.25)	0.92 (0.05)
Suprailiac	12.75 ± 5.03	11.12 ± 3.75	9.11 ± 4.22	10.33 ± 5.75	8.71 ± 2.19	12.21 ± 3.3*	0.04 (0.61)	0.002 (0.89)	0.11 (0.49)
Supraspinal	7.37 ± 2.96	7.50 ± 3.51	5.92 ± 2.78	6.39 ± 2.57	6.46 ± 1.37	7.93 ± 2.22*	0.81 (0.08)	0.23 (0.39)	0.07 (0.55)
Abdominal	11.43 ± 4.37	10.94 ± 4.45	9.00 ± 4.78	11.44 ± 5.21**	9.04 ± 2.82	12.64 ± 4.89*	0.002 (0.91)	0.001 (0.91)	0.41 (0.26)
Front thigh	18.43 ± 6.37	18.69 ± 7.5	15.78 ± 7.39	17.78 ± 8.22**	13.57 ± 3.78	16 ± 4.92*	0.1 (0.41)	0.07 (0.57)	0.76 (0.09)
Medial calf	10.43 ± 4.2	10.06 ± 3.46	10.03 ± 4.8	11.67 ± 5.65**	10.43 ± 2.38	11.14 ± 2.95	0.02 (0.66)	0.15 (0.44)	0.25 (0.36)
Sum 8 skinfolds	84.62 ± 28.45	81.31 ± 27.8	69.17 ± 31.74	78.27 ± 35.29	66.36 ± 18.94	79.86 ± 23*	0.01 (0.72)	0.02 (0.71)	0.30 (0.11)
Circumferences									
Upper arm flexed and relaxed	27.58 ± 1.94	27.19 ± 1.71	25.01 ± 2.4	24.81 ± 1.95	25.07 ± 1.08	24.83 ± 1.28	0.54 (0.18)	0.61 (0.17)	0.84 (0.06)
Upper arm flexed and tensed	28.71 ± 2.39	28.25 ± 2.15*	26.86 ± 2.86	26.28 ± 1.62	26.11 ± 1,34	26.13 ± 1.58	0.61 (0.16)	0.09 (0.57)	0.35 (0.30)
Front thigh	49.63 ± 4.62	49.48 ± 4.38	45.62 ± 3.73	47.43 ± 7.44	44.73 ± 2.28	45.17 ± 3.08	0.37 (0.26)	0.40 (0.28)	0.92 (0.08)
Medial calf	35.00 ± 2.43	34.75 ± 2.55	33.12 ± 2.55	32.93 ± 2.93	31.97 ± 1.63	32.43 ± 1.71*	1.00 (0.02)	0.004 (0.85)	0.01 (0.80)
Waist	69.61 ± 7.28	69.09 ± 6.97	65.12 ± 4.67	64.90 ± 3.91	66.26 ± 2.13	67.07 ± 1.99	0.74 (0.11)	0.15 (0.46)	0.30 (0.33)
Hip	92.39 ± 7.22	91.10 ± 6.07	85.14 ± 6.11	86.04 ± 5.22	85.13 ± 2.95	87.20 ± 3.82	0.01 (0.72)	0.01 (0.78)	0.17 (0.41)
Diameter bones									
Humerus/Elbow	6.35 ± 0.41	6.40 ± 0.39	6.44 ± 0.24	6.48 ± 0.27	6.29 ± 0.54	6.34 ± 0.35	0.96 (0.04)	0.78 (0.10)	0.92 (0.31)
Wrist	5.04 ± 0.43	5.11 ± 0.40	5.17 ± 0.2	5.21 ± 0.22	5.04 ± 0.44	4.96 ± 0.33	0.96 (0.02)	0.07 (0.57)	0.14 (0.44)
Femur/knee	8.96 ± 0.65	9.04 ± 0.62	8.78 ± 0.33	8.92 ± 0.26	8.50 ± 0.52	8.61 ± 0.47	0.48 (0.16)	0.40 (0.19)	1.00 (0.00)

Measurements by Swimming Activity (Mean ± SD); min: minutes; ES: effect size; Difference after the summer break measurement * Significance ≤ 0.05;** Significance ≤ 0.01

skinfolds (medium active swimmers: p = 0.01, medium effect size = 0.72; very active swimmers: p = 0.02, medium effect size = 0.71), the abdominal skinfold (medium active swimmers: p = 0.002, large effect size = 0.91; very active swimmers: p = 0.001, large effect size = 0.91), and the hip circumference than the less active adolescents (medium active swimmers: p = 0.01, medium effect size = 0.72; very active swimmers: p = 0.011, medium effect size = 0.78).

The very active swimmers showed a greater change in the circumference of the medial calf compared to the medium active swimmers (p = 0.01, large effect size = 0.8) and compared to the less active adolescents (p = 0.004, large effect size = 0.85). Furthermore, the mean suprailiac skinfold of the very active swimmers increased by 40.1 % with a significant difference compared to the less active adolescents (p = 0.002, large effect size = 0.89). Other minor differences among the groups in the anthropometric profile are reported in Table 1.

The mean values of the four components of body composition are presented in Table 2. All the changes are referred to after the summer break.

The very active swimmers showed an increase of relative fat mass with two of three formulas used (Withers: Δ = +1.48 %, p = 0.06, small effect size = 0.22, Faulkner: Δ = +0.85 %, p = 0.04 small effect size = 0.40 and Carter: Δ = +0.92 %, p = 0.04, small effect size = 0.30). When we analysed the differences among the groups, we found that there was a greater increase of relative fat mass of the medium active and very active swimmers compared to the less active adolescents (Medium active swimmers: Withers: p = 0.015, medium effect size = 0.69, Faulkner: p = 0.008 medium effect size = 0.73 and Carter p = 0.004, medium effect size = 0.77; Very active swimmers: Withers: p = 0.054, medium effect size = 0.60, Faulkner: p = 0.009, medium effect size = 0.76 and Carter p = 0.021, medium effect size = 0.71). As shown in Figure 1 the very active swimmers showed a higher increase of central skinfolds than the peripheral ones. On average, the mean increase of the percent change in the sum of the two central skinfolds of the very active swimmers was 39.4%, while the peripheral ones increased by 14.1%. We found that both groups of swimmers showed a greater increase in the percent change in the sum of the two central skinfolds than less active adolescents (medium active swimmers: p = 0.006, medium effect size = 0.72; very active swimmers: p = 0.001, medium effect size = 0.64). The mean somatotypes before the summer break are shown in Figure 2A. The less active adolescents had a mesomorphic-endomorphic somatotype. This indicates the relative dominance of the muscular component with a tendency towards the fat component. The medium active swimmers had an ecto-mesomorphic somatotype. This indicates a streamlined body shape of them with a prevalence of muscular component on the fat component. The very active swimmers had a balanced ectomorphic somatotype with a very streamlined body and equal values of fat and muscular component. Figure 2B shows the somatograms after the summer break. The less active adolescents turned to a balanced mesomorphic somatotype. Both groups of swimmers showed a similar balanced ectomorphic somatotype.

Discussion

The most important findings of the present study was that both groups of swimmers showed an accumulation of total and central fat, whereas there was no accumulation in the less active adolescents.

After the summer break, all participants were taller. The participants were adolescents, thus it is probable that this data was a result of their biological growth. The study did not only focus on body mass and body mass index mainly because the adolescents could change their body mass or body mass index rapidly due to biological growth. Moreover, a fuller view of anthropometric characteristics is advisable because the anthropometric changes may not necessarily reflect weight status or body mass index. A warning is provided for those swimmers or coaches who depend on body mass or body mass index measurement for body fat status monitoring.

The data before the summer break (the differences among the two groups of swimmers and less active adolescents) and the increase of central fat after the summer break (only in both groups of swimmers) suggest a protective role of swimming preventing fat gain.[2,14] We focused our study not only on the anthropometric profile but also on the body composition and the somatotype, thus giving to our results additional sport clinical relevance. The results showed that 55 to 65 days of summer break from swimming activity was sufficient period to observe a general increase of anthropometric measurements related to fatness in both groups of swimmers, meanwhile the less active adolescents maintained them. A possible explanation could be that the swimmers reduced physical activity and daily energy expenditure. Therefore, the fatness gain of the swimmers could indicate that they were in sustained positive energy balance during the summer break.[15,16]

Moreover, the decrease of physical activity could create a favorable physiological condition to fat issue storage.[17] It was reported a remarkable increase in the suprailiac and abdominal skinfolds of both groups of swimmers. According to our results, previous studies have shown that two months detraining reduced insulin sensitivity and increased abdominal fatness.[4,8] An uncontrolled accumulation of fat, especially central fat, is a risk factor associated with different no-transmittable diseases such as diabetes mellitus type 2, hypertension, metabolic syndrome, etc.[18] Fat gain and detraining during the summer break could be the main factors that influence performance during the first part of the following swimming season. However, detraining and the fat gain are "temporary states" if the swimmers resume a new season.

Table 2. Overall Results of Body Composition before and after the Summer Break

Body composition's formulas	*Less active (leisure activity) n = 8*		*Medium active(480min/week) n = 9*		*Very active (960 min/week) n = 7*		*Differences between groups U de Mann-Whitney*		
	Before summer break	*After summer break)*	*Before summer break*	*After summer break*	*Before summer break*	*After summer break*	*Less active vs medium active p*	*Less active vs very active p*	*Medium active vs very active p*
% fat mass (Withers)	12.62±4.22	12.33±4.22	10.60±4.74	11.96±5.18	10.40±2.43	11.88±3.43	0.015	0.054	0.75
% fat mass (Faulkner)	11.55± 1.93	11.25±1.83	10.25±2.04	10.83±2.11	10.42±1.12	11.27±1.66*	0.008	0.009	0.53
% fat mass (Carter)	9.58±2.37	9.36±2.31	8.37±2.58	9.14±2.77	8.29±1.36	9.20±1.9*	0.004	0.02	0.67
% muscle mass (Lee)	44.22±3.99	44.33±3.38	46.32±5.2	45.19±5.44	44.82±4.52	43.43±4.57	0.11	0.15	0.75
% bone Mass (Rocha)	16.07±1.09	16.66±1.22*	18.34±1.67	18.74±2.03	17.78±1.42	17.43±1.35	0.32	0.006	0.07
% residual	27.07±1.7	26.66±2.09	24.72±2.46	24.09±3.44	26.99±3.76	27.24±3.52	0.88	0.28	0.40

Min: minutes; Difference after the summer break measurement * Significance ≤ 0.05; ** Significance ≤ 0.01

This would explain why the swimmers decrease their body weight and related anthropometric values during the first part of the swimming season.[19] However, detraining on young swimmers should not overrated because at these ages the priorities of the coaches should focus on the continuing progression of the swimming styles, turns, starts and prevention of future injuries more than the level of training. Furthermore, it was reported that the summer rest could have beneficial effects on injury prevention, physical and mental exhaustion.[20] Despite that, many swimming coaches reduce as much as possible the summer break off training to avoid the effects of detraining.

A recent study has reported body weight gain after the sport withdrawal.[21] Post-competitive body weight gain is a common problem for former athletes. To assess central fat immediately after sport withdrawal could be an early strategy to detect possible weight gain in ex-athletes.

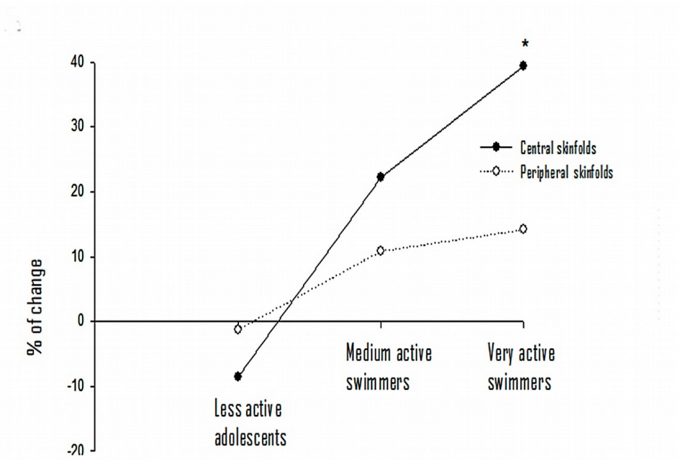

Figure 1. Body Fat Distribution. Quantification of % of changes in the sum of the two central skinfolds and the two peripheral skinfolds after the summer break (central skinfolds = black circle), (peripheral skinfolds = white circle). * p = 0.018).

The % of changes in the sum of central fat skinfolds, the body composition's formulas and the somatotype gave results according to the anthropometric profile giving to our study additional relevance to understanding the changes that occurred during the summer break.

The changes in the diameter of the bones were similar among the three groups. Thus, the anthropometric changes related to growth and bone diameters should not be influenced by the level of physical activity.[22] We did not find any measurable changes in the muscle component. The muscular component is related to strength, power and it is essential for enhancing athletic performance.[1,3] It is probable that our method of estimation, gathered the short-term studied, was insensitive to detect subtle morphological changes in muscle.

We found that the two groups of swimmers gained relative fat mass. According to our results, the fat component seemed to be the only one that had varied over 55-65 days in the swimmers.[4,8] Despite this, both groups of swimmers had a lower fat component and a healthier body composition than less active adolescents. We did not expect this clear accumulation of central fat in both groups of adolescent swimmers. The percent change in the sum of the two central skinfolds showed a possible dose-response relationship between the amount of swimming activity previously carried out and the amount of the central fat accumulated over the summer break. However, to demonstrate a clear dose-response more studies are needed.[12,23]

Our results on the percentage of relative fat mass were slightly lower than those described in other studies with swimmers.[2,24] A possible explanation is that our sample was much smaller than the other research cited above.

The somatotype's differences between the two groups of swimmers before the summer break could be caused by the 2-fold higher time spent on weekly swimming training by the very active swimmers. A high level of swimming training, at these ages, could lead to having very streamlined swimmers. To have a very streamlined musculature is a performance advantage but at the same time could be a risk for joint injuries in swimming.[25] Elite programs usually introduced dry-land exercises with and without equipment in early adolescence. Dry-land exercises in swimming increase strength, prevent injuries and are beneficial for performance.[1] Incorporating dry-land exercises that directly target muscle mass during the summer break may be advantageous to achieve a balanced body composition.[1]

The information displayed in the present study could be used to implement some measures to avoid the fat gain during the summer. The study could be useful for coaches, swimmers and any other person that works with swimmers.

The sample size of the study was limited. Larger cohort evaluations would provide further evidence to characterize the effect of the summer break from swimming activity. Another limitation could be that we did not collect the data on the grade of

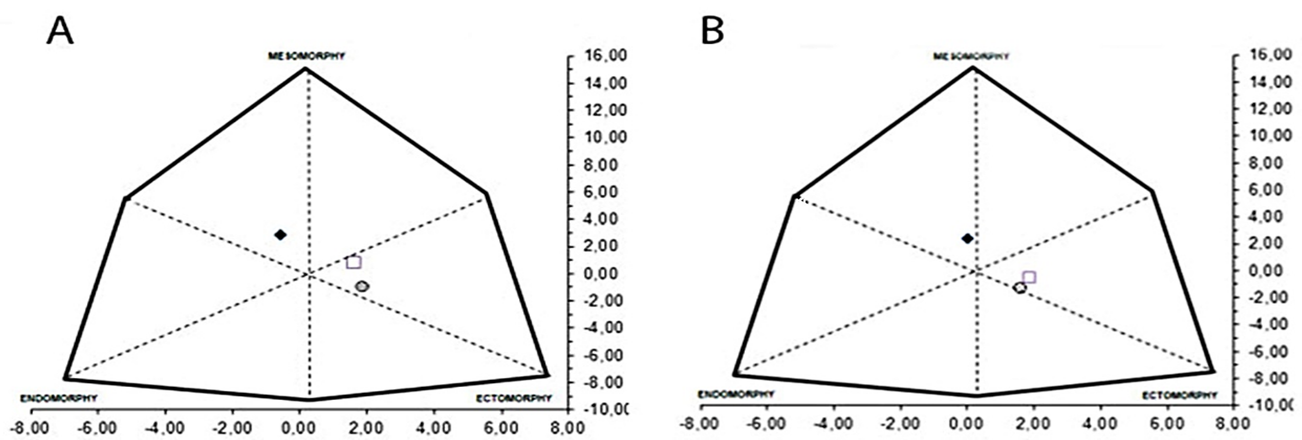

Figure 2. Somatotypes of the Three Groups of Study. Somatograms of less active adolescents (black diamond n = 8), medium active (white square n = 9) and very active swimmers (grey circle n = 7). (A) Somatogram before the summer break (B) Somatogram after the summer break. The three symbols (diamond, square and circle) are the mean values of each group.

the physical development of the participants or to estimate it. It was impossible to monitor the leisure activity of the participants carried out during their summer holidays. We make available a supplementary table with the statistical analysis based on sex in the supplementary data.

For swimmers, the possibility of gain fatness is high during a break from swimming activity. There is a high risk of priority accumulation of central fat during the summer break. Maintaining the optimal fat mass or tracking fat changes during the summer break may be helpful to start the new season in the best possible way. Monitoring central skinfolds as abdominal and suprailiac, maybe a reliable method for coaches and professionals who work with swimmers to monitor early changes in body fat mass.

Authotship. All the authors have intellectually contributed to the development of the study, assume responsibility for its content and also agree with the definitive version of the article. **Conflicts of interest.** The authors declare no conflicts of interest. **Provenance and peer review.** Not commissioned; externally peer reviewed. **Ethical Responsabilities.** *Protection of individuals and animals:* The authors declare that the conducted procedures met the ethical standards of the responsible committee on human experimentation of the World Medical Association and the Declaration of Helsinki . *Confidentiality:* The authors are responsible for following the protocols established by their respective healthcare centers for accessing data from medical records for performing this type of publication in order to conduct research/dissemination for the community. *Privacy:* The authors declare no patient data appear in this article.

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