Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity

Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es **Web**: https://revistas.udc.es

Original Article. The effect of summer holidays on body composition and respiratory muscle strength in pubescent swimmers. Vol. 9, issue 2; p. 262-283, may 2023. https://doi.org/10.17979/sportis.2023.9.2.9296

The effect of summer holidays on body composition and respiratory muscle strength in pubescent swimmers

El efecto de las vacaciones de verano sobre la composición corporal y la fuerza muscular respiratoria en nadadores púberes

Magdalena Rokicka-Hebel[1]; Grzegorz Bielec[2]

[1]Academy of Tourism and Hotel Management in Gdansk, Poland

[2]Gdansk University of Physical Education and Sport in Gdansk, Poland

Correspondence: grzegorz.bielec@awf.gda.pl

Editorial shedule: *Article received 15/09/2022 Article accepted: 06/04/2022 Article published: 01/05/2023*

https://doi.org/10.17979/sportis.2023.9.2.9296

For cite this article you must use this reference:
Rokicka-Hebel, M.; Bielec, G.. (2023). The effect of summer holidays on body composition and respiratory muscle strength in pubescent swimmers. Sportis Sci J, 9 (2), 262-283 https://doi.org/10.17979/sportis.2023.9.2.9296

Authors' specific contribution: study conception and design: M R-H; data collection: M R-H; analysis and interpretation of results: GB and MR-H; draft manuscript preparation: GB and MR-H. Both authors reviewed the results, revised the work critically for important intellectual content, and approved the final version of the manuscript.

Funding: Authors declare the study received no external funding.

Informed consent from study participants: Participants and their guardians gave their written informed consent.

Conflict of interest: Authors declare that there is no conflict of interest.

Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Original Article. The effect of summer holidays on body composition and respiratory muscle strength in pubescent swimmers. Vol. 9, issue 2; p. 262-283, may 2023. https://doi.org/10.17979/sportis.2023.9.2.9296

Abstract
Changes in daily routine and decrease in physical activity during summer holidays period, often result in body weight gain in school-age children. However, the impact of summer break on body composition in athlete children has not been thoroughly investigated. The current study was aimed at identifying possible changes in body composition and respiratory muscle strength after an 8-week summer break in age-group swimmers. Eighteen girls and fifteen boys ages 10-13 years (mean 11.6±1.0) participated in the study. The measurements were taken in June and repeated in September the same year. Body composition was assessed with an InBody 720 analyzer, and respiratory muscle strength was assessed with a MicroRPM device. A fifty-meter front-crawl test was conducted to induce respiratory muscle fatigue. All analyzed body composition parameters; i.e., body mass, body mass index, tissue, and muscle components increased substantially after the summer break ($p<0.05$). No significant changes in maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) were detected in both boys and girls after the detraining period ($p>0.05$). It can be concluded that 8-week summer break had an effect on body composition parameters in juvenile swimmers, but no effect on their respiratory muscle strength was apparent. Studies involving a greater number of participants engaged in various sports activities are needed to better understand the effect of summer break on anthropomorphic and respiratory parameters in youth athletes.
Keywords: Children; anthropometry; exercise; swimming

Resumen

Los cambios en la rutina diaria y la disminución de la actividad física durante el periodo de vacaciones de verano, suelen provocar un aumento de peso corporal en los niños en edad escolar. Sin embargo, no se ha investigado a fondo el impacto de las vacaciones de verano en la composición corporal de los niños deportistas. El presente estudio tenía como objetivo identificar los posibles cambios en la composición corporal y la fuerza muscular respiratoria tras unas vacaciones de verano de 8 semanas en nadadores jovenes. Dieciocho niñas y quince niños de 10 a 13 años (media de 11.6±1.0) participaron en el estudio . Las mediciones se realizaron en junio y se repitieron en septiembre del mismo año. Se evaluó la composición corporal con un analizador InBody 720 y la fuerza muscular respiratoria con un dispositivo MicroRPM. Se realizó una prueba de crol frontal de cincuenta metros para inducir la fatiga de los músculos respiratorios. Todos los parámetros de composición corporal analizados, es decir, la masa corporal, el índice de masa corporal, el tejido y los componentes musculares, aumentaron sustancialmente tras el descanso estival ($p<0.05$). No se detectaron cambios significativos en la presión inspiratoria máxima (MIP) ni en la presión espiratoria máxima (MEP) tanto en los chicos como en las chicas después del periodo de desentrenamiento ($p>0.05$). Se puede concluir que las vacaciones de verano de 8 semanas tuvieron un efecto sobre los parámetros de composición corporal en los nadadores juveniles, pero no se observó ningún efecto sobre su fuerza muscular respiratoria. Se necesitan estudios con un mayor número de participantes que practiquen diversas actividades deportivas para comprender mejor el efecto de las vacaciones de verano en los parámetros antropomórficos y respiratorios de los deportistas juveniles.
Palabras clave: Niños; antropometría; ejercicio; natación

Sportis Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Introduction

Summer vacation is considered as a critical period in the variation in body composition among school-age children. Body weight gain is linked to decrease of physical activity levels during summertime (Cristi-Montero et al., 2014). The other potential obesogenic behaviors (e.g. diet, screen-time, sleep patterns) are also presented by the children in the summer (Brazendale et al., 2018). Data show that children and adolescents who do not participate in extra-curricular physical activity are more likely to increase their body mass and decrease cardiorespiratory fitness in the holidays period (Aphamis et al., 2019). As for athlete children, the summer vacation is a part of training periodization. In school-age children training season usually begins in August/September and ends in June/July. The training season consists of 3 to 4 mesocycles, depending on the competition schedule. The detraining period begins after the major summer competition, and lasts 5-7 weeks or longer. The detraining period can be defined as "summer break", where children undertake unsupervised, spontaneous physical activity or present almost sedentary behaviors. Although physical activity decreases in children during summer break, this is a time for physical and mental recovery for youth sportsmen (Volmut et al., 2021). The effect of long-term training cessation on anthropometrics and the physiology of juvenile athletes has not been thoroughly investigated. Studies conducted on young adult endurance athletes (19-20 years) reveal significant increase in body mass, and body fat, along with decreases in oxygen consumption levels after a 5-week summer break (Maldonado-Martin et al., 2017, Ormsbee & Arciero, 2012). Breaks from exercise also showed decreases in other parameters. For example, a 3-week inter-semester break resulted in substantial decrease in aerobic endurance, anaerobic capacity, and vertical jump performance in 11-12-year-old female basketball players (Atay & Kayalari, 2013). Conversely, a 3-week detraining period in adolescent football players positively affected their muscle mass and free fat mass, without affecting their muscle thickness, strength, and athletic performance (Gavanda et al., 2020). Another study indicated that muscular strength did not decrease significantly after 12-week detraining period in pre-pubertal boys (Da Fontoura et al., 2004). As for swimmers, 12-year-old boys and girls improved their kinematics parameters and swimming performance during a 25-meter swim after a 10-week summer vacations (Moreira et al., 2014).

Little is known about the effect of summer holidays on respiratory muscle strength in children and adolescents. In one study, children practicing yoga demonstrated higher inspiratory and expiratory muscle strength after a 3-month summer break when compared with their normally active peers (De Souza Espindola et al., 2021). Some studies demonstrate that anthropomorphic parameters and participation in aerobic exercises are the factors influencing respiratory muscle strength in children (Dassios & Dimitriou, 2019; Patil et al., 2020). Swimming is a typical aerobic activity, thus young athlete swimmers display higher values of pulmonary parameters than non-swimmers and inactive children (Rochat et al., 2022).

To the best of our knowledge, there are only a few studies researching the effect of summer break on the anthropometric changes in pubertal children involved in regular sports activities. However, these studies do not present body composition data. Moreover, we found only two studies assessing the changes in respiratory muscle strength after long-term detraining periods in age-group swimmers. Thus, the current study was aimed at assessing the possible changes in anthropometrics, body composition, and respiratory muscle strength in 10-13-year-old swimmers after an 8-week summer break. We hypothesized that (1) muscle and fat components would increase after summer vacations, and (2) the detraining period would not affect respiratory muscle strength.

Methods

Study design

This is a one-group observational design. Non-random sampling method was used in the current study. The study was split into two stages. The first stage of the study was conducted at the end of June, immediately after the completion of the children's training macro-cycle. Assessment included: (i) anthropomorphic measurements, (ii) respiratory muscle strength, and (iii) swim test. After the assessment children participated in daily training sessions till the beginning of summer break (ca 4-5 days). Trainings loads were low

Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

with minimal intensity. The second stage took place after the 8-week summer break - in the second week of September. Children started a new training macro-cycle 6 days before the exams took place. During the second stage the same measurements were repeated (Figure 1). Anthropomorphic measurements were taken on a weekday in the morning. The following morning, a swim test and respiratory muscle strength assessment was conducted. Participants were asked to maintain their nutritional habits during the summer. No instructions on physical activity were given to the participants.

Participants

The inclusion criteria for the study were as follows: (i) minimum of 3 years of systematic swim training, (ii) an age category labeled (youngster), (iii) good state of health, no training abstinence in the last six weeks, and (iv) willingness to participate in the study. Thirty eight swimmers, 18 girls and 20 boys, ages 10 to 13 years (mean 11.9±1.2 years), took part in the first stage of the study in June. Girls and boys were the members of the same club team located in the city of Gdansk, Poland. Girls and boys followed the same training program. The mean training experience of the study group was 5.0±1.8 years. The subjects trained annually for 38 weeks. At the time of the study the swimmers trained 18-22 hours per week (including 12-18 hours of training in water). All swimmers were trained mainly for short and medium distances (between 50m and 200m). All of the participants were licensed with the national swimming federation. According to the federation rules, participants are examined by a sports medicine physician twice a year (in spring and in autumn) to determine their good health status. Then, the level of biological maturation is also assessed. During the study participants were healthy, with no inflammation and infectious diseases. Participants spent the summer break without swimming training. Spontaneous holiday physical activity (lake or sea bathing, cycling or sports games) was not intense enough to be considered as sports training and was excluded from this study. At the end of a summer break five boys decided not to continue swimming training in the following school year because of medical (2 boys) and personal (3 boys) reasons. These boys did not participate in measurements taken in September. Thus, the results of 18 girls and 15 boys were analyzed in the current study (see

Figure 1). Basic demographic and anthropomorphic data of participants are presented in Table 1.

The study was conducted in accordance with the Declaration of Helsinki. The parents of all subjects gave written consent for their child to participate in the study. Each participant of the study also gave his/her written consent. The protocol was approved by the local Institutional Review Board (KB-18/17).

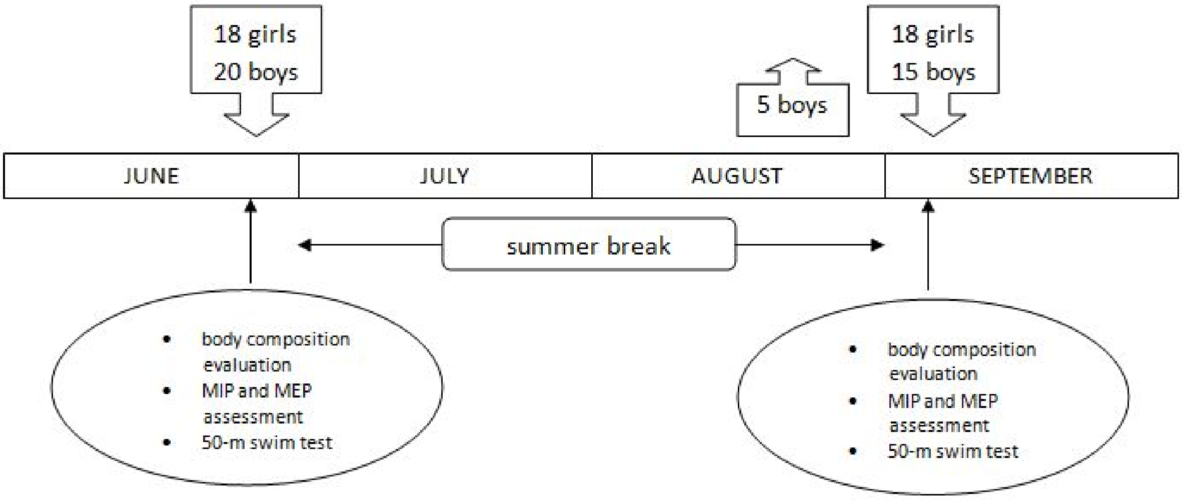


Figure 1. Study design and participants. MIP - maximum inspiratory pressure, MEP - maximum expiratory pressure.

Anthropomorphic measurements

Evaluation of body composition was assessed using the bioelectric impedance method (BIA). As a research tool, the In Body 720 body composition analyzer (Biospace Co., Beverly Hills, CA, USA) with a closed hand-foot electrode system was utilized. Body height was assessed with a Seca 213 stadiometer (Seca GmbH&Co., Hamburg, Germany). The measurements were taken in the morning, before the training sessions. Participants wore light clothes and were barefoot. The measurements were conducted by an experienced investigator in the Laboratory of Physical Effort and Genetics in Sport in the local university.

Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Respiratory muscle strength

Respiratory muscle strength was measured using a MicroRPM device (Micro Medical, Hoechberg, Germany). This device measures maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) through the mouth. CareFusion's Respiratory Pressure Meter is designed for the rapid assessment of respiratory muscle strength. The result of each measurement is presented in cm H2O on a liquid crystal display (Soudon et al., 2008).

Respiratory muscle strength was assessed in the swimming pool before and immediately after the swim test. Before the swim test, the subjects were familiarized with the equipment and were instructed on how the measurements would be done. Participants exercised with five breaths before each test, and then proceeded to the expiratory and inspiratory tests. Each exercise was performed twice with 2-minute pauses. A nose clip was worn by the participants during the test. Sufficient rest periods were provided between the attempts (approx. 2 min) and the swimmers were verbally encouraged to reach maximal strength (Larson et al., 1993). The measurements were taken in a sitting position. After completing the swimming test, the participant immediately got out of the water and sat in the chair to repeat the measurements. Previous studies show that the MicroRPM device reliably measures MIP and MEP in sitting and standing positions (Dimitriadis et al., 2011).

Swim test

The swim test was performed in 25-meter indoor swimming pool with standardized water and air temperature (27°C, and 28°C respectively). Participants performed a 15-minute warm-up on land (flexibility exercises), and a 600 meter warm-up in water. The warm-up in water consisted of a 250 m easy-pace front crawl, a 200 m front-crawl (as 50-m pull/swim), a 2x25 m front crawl with increasing speed, and a 100 m backstroke. After a 5-minute rest period in the sitting position, respiratory muscle strength was assessed (see "Respiratory muscle strength" paragraph above). After completing the measurements, the participant rested in the sitting position for five minutes. Following the rest period, the participants performed a 50-meter front-crawl test with maximal velocity. Starting points were marked with starting blocks. A whistle was used as the starting signal following World Swimming Federation

Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

(FINA) guidelines. The time of the trial was recorded by an experienced swimming coach with a Seiko S061 stopwatch (Seiko, Tokyo, Japan). Immediately after the swim test, the participants underwent the second measurement of respiratory muscle strength.

Statistics

The sample size was calculated *a priori* with web-based ClinCalc calculator (ClinCalc LCC, Indianapolis, IN, USA), that is commonly used in clinical research (Sfondrini et al., 2020). Our calculations were based on study of Chainok et al. (2021) where eighteen female and male swimmers ages 11-12 years had their body composition and anthropomorphic variables measured. Statistical significance was assumed with p=0.05 and a test power value of 80%. The recommended sample size was 10 boys and 12 girls.

Statistical calculations were performed using Statistica for Windows v. 13.1 program (StatSoft, Tulsa, OK, USA). Distribution of data was normal according to the Shapiro-Wilk test. Differences between anthropomorphic measurements taken before and after summer break were assessed with a Students' t-test for dependent samples. Cohen's d for the paired t-test was used to calculate the effect size. The d value varied from 0.48 to 0.64 which shows a moderate effect size. An ANOVA analysis for repeated measures and a post-hoc Tukey test were utilized to detect the differences between respiratory muscle strength (MIP and MEP) in rest and fatigue conditions before and after summer break. The relationship between respiratory muscle strength and the swim performance was assessed with Pearson's correlation. Statistical significance was set at $p<0.05$.

Results

Table 1 presents basic demographic and anthropometric data of examined swimmers before and after the summer break. Body height increased substantially both in girls and boys during summertime. Body mass and body mass index also increased substantially in examined swimmers.

Sportis. Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Table 1. Demographic and anthropometric variables in examined swimmers before and after the detraining period. Data is presented as mean values ± standard deviation.

		June	September
Age [years]	Overall (n=33)	11.67±1.06	11.92±1.07*
	Girls (n=18)	11.96±0.92	12.21±0.91*
	Boys (n=15)	11.33±1.15	11.58±1.18*
Body height [cm]	Overall (n=33)	153.68±8.06	155.24±8.18*
	Girls (n=18)	155.19±7.11	156.78±7.11*
	Boys (n=15)	151.87±8.97	153.40±9.21*
Body mass [kg]	Overall (n=33)	42.77±8.26	44.55±8.64*
	Girls (n=18)	43.49±7.97	45.30±8.15*
	Boys (n=15)	41.90±8.80	43.62±9.40*
Body Mass Index [kg/m^2]	Overall (n=33)	18,00±2.48	18.37±2.59*
	Girls (n=18)	17.95±2.25	18.33±2.32*
	Boys (n=15)	18.06±2.80	18.42±3.00*

* p<0.05 between June and September measurements

Changes in tissue components as well as in muscle and fat components are presented in Table 2. Water-based components, i.e., intracellular water, extracellular water, and overall body water increased significantly in boys and girls. The other tissue components, i.e., soft lean mass and fat free mass also increased substantially in boys and girls during summer break. A substantial increase in body fat mass, body fat percentage, and in visceral fat area was observed in girls and boys. However, skeletal muscle mass also increased during summer break in examined swimmers.

Sportis Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity

Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Table 2. Tissue components, muscle components and fat components in examined swimmers before and after the detraining period. Data is presented as mean values ± standard deviation.

		June	September
Intracellular Water (ICW) [l]	Overall (n=33)	16.12±2.64	16.46±2.78*
	Girls (n=18)	16.41±2.50	16.76±2.52*
	Boys (n=15)	15.77±2.84	16.11±3.11*
Extracellular Water (ECW) [l]	Overall (n=33)	9.96±1.61	10.17±1.75*
	Girls (n=18)	10.12±1.51	10.36±1.56*
	Boys (n=15)	9.76±1.76	9.95±1.98*
Overall Body Water (TBW) [l]	Overall (n=33)	26.08±4.24	26.63±4.53*
	Girls (n=18)	26.53±4.01	27.12±4.08*
	Boys (n=15)	25.53±4.59	26.05±5.09*
Soft Lean Mass (SFT) [kg]	Overall (n=33)	33.48±5.46	34.19±5.81*
	Girls (n=18)	34.07±5.18	34.81±5.24*
	Boys (n=15)	32.77±5.89	33.44±6.54*
Fat Free Mass (FFM) [kg]	Overall (n=33)	34.68±6.17	35.40±6.89*
	Girls (n=18)	36.08±5.48	36.89±5.55*
	Boys (n=15)	34.68±6.17	35.40±6.89*
Skeletal Muscle Mass (SMM) [kg]	Overall (n=33)	19.03±3.45	19.48±3.64*
	Girls (n=18)	19.40±3.28	19.87±3.30*
	Boys (n=15)	18.58±3.70	19.01±4.07*
Body Fat Mass (BFM) [kg]	Overall (n=33)	7.32±3.87	8.32±3.93*
	Girls (n=18)	7.41±3.51	8.41±3.43*
	Boys (n=15)	7.22±4.39	8.22±4.58*
Percent Body Fat	Overall (n=33)	16.49±6.20	18.13±5.98*

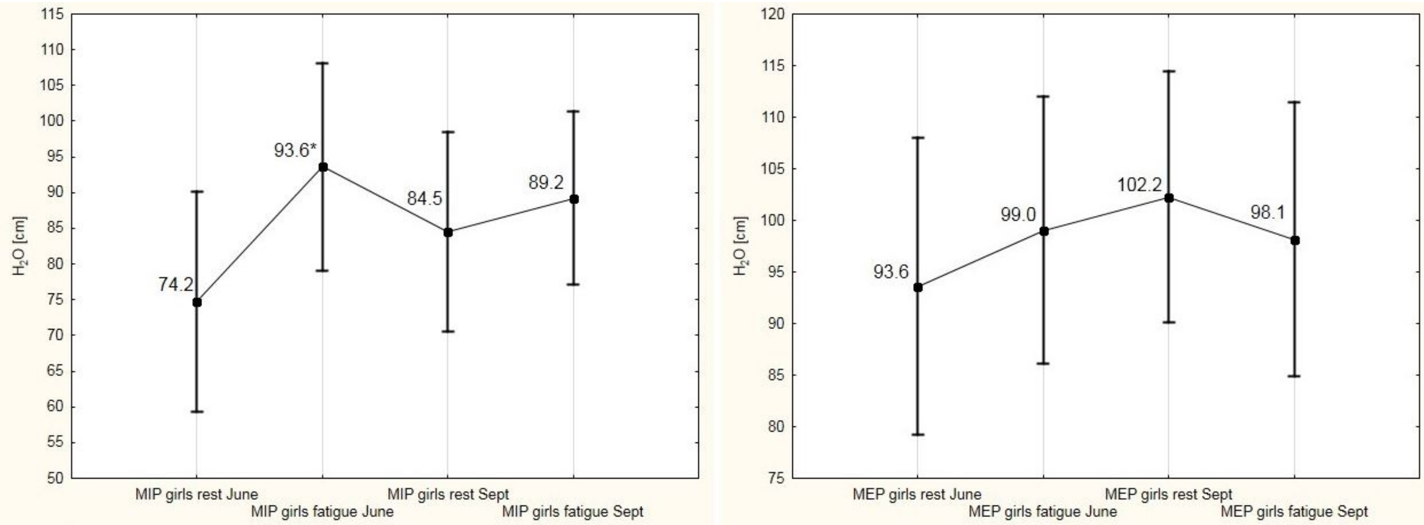
(PBF) [%]	Girls (n=18)	16.48±5.36	18.04±4.94*
	Boys (n=15)	16.49±7.29	18.23±7.21*
Visceral Fat Area	Overall (n=33)	30.01±16.35	34.16±16.99*
(VFA) [cm^2]	Girls (n=18)	30.98±15.20	35.19±15.06*
	Boys (n=15)	28.91±18.04	33.00±19.43*

* p<0.05 between June and September measurements

Figure 2 (A for girls, and B for boys) represents the strength of subjects' respiratory muscles before and after the summer break. After 8 weeks of summer break, boys and girls demonstrated higher values of MEP measured at rest, but the differences were not statistically significant. Expiratory muscle strength measured in fatigue conditions (after the swim test) slightly increased in boys, and slightly decreased in girls. However, the changes were statistically insignificant. Although MIP values measured at rest increased in girls by almost 10 cm H20 after the summer break, these changes were not statistically significant. In boys, MIP at rest decreased slightly after the summer break. Insignificant increase in MIP and MEP values, measured after the swim test, was observed in boys both in June and September Post-hoc test revealed that in June, girls demonstrated substantially higher values of MIP after the swim test when compared with resting conditions.

Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Original Article. The effect of summer holidays on body composition and respiratory muscle strength in pubescent swimmers. Vol. 9, issue 2; p. 262-283, may 2023. https://doi.org/10.17979/sportis.2023.9.2.9296



* $p<0.05$ between pre-test and post-test measurements

Figure 2A. Respiratory muscle strength variations in girls. Data is presented as mean value and 0.95 confidence intervals.

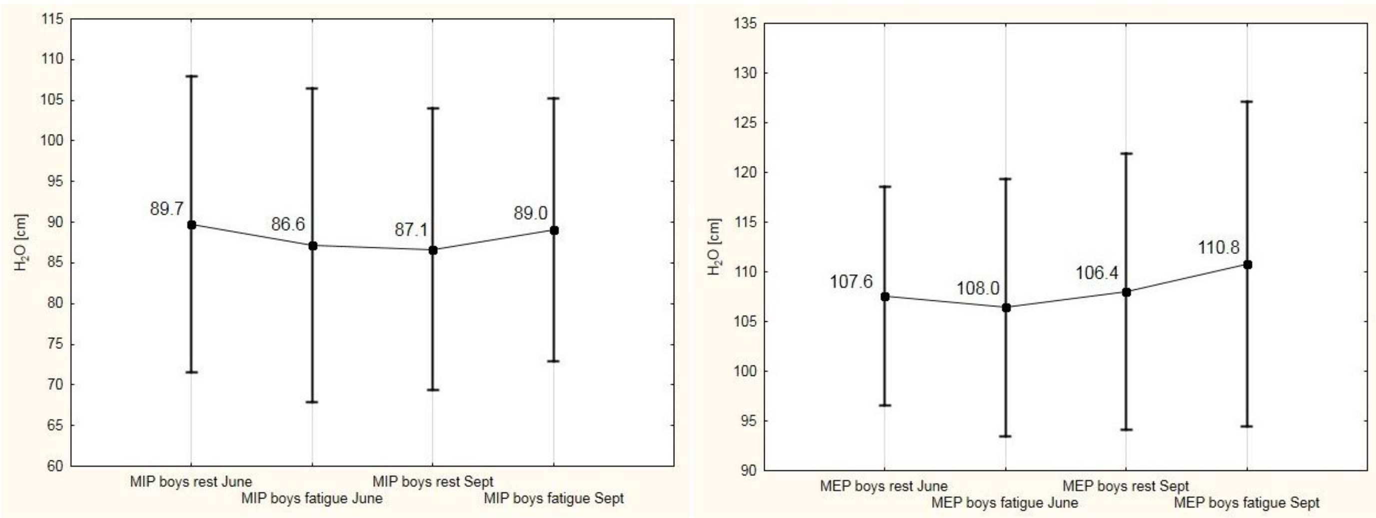


Figure 2B. Respiratory muscle strength variations in boys. Data is presented as mean value and 0.95 confidence intervals.

Sportis
Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Table 3 represents the results of 50-m front crawl test performed before and after summer vacations. Both girls and boys showed substantial improvements in their measurements. A moderate significant correlation between swim test and inspiratory muscle strength was found only in boys during June trial ($r=-0.52$, $p<0.05$). In other trials the relationships between swim performance and respiratory muscle strength were weak and insignificant.

Table 3. Fifty-meter front crawl test performance in examined swimmers before and after the detraining period. Data is presented in seconds as mean value ± standard deviation.

	50-m front crawl June	50-m front crawl Sept
Overall (n=33)	35.78±3.85	34.72±3.68*
Girls (n=18)	34.81±2.94	33.97±2.78*
Boys (n=15)	36.94±4.57	35.63±4.46*

* p<0.05 between June and September measurements

Discussion

The aim of this study was to assess the possible changes in anthropomorphic variables and respiratory muscle strength after an 8-week detraining period in age-group swimmers. Confirming our hypothesis (1), all anthropomorphic and body composition parameters increased substantially after summer break in our studied group. Although the phenomenon of weight gain and body mass index increases in children during summertime is commonly described in the literature (Brusseau & Burns, 2018, Tanskey et al., 2018), it seems that children involved in school-based regular sports activities are not likely to follow that trend. For example, thirteen years old girls who practiced regular resistance training did not markedly increase their body height, body weight, and body mass index after 12 weeks of summer holidays (Santos et al., 2011). As for swimmers, Altavilla et al. (2020) reported non-significant increases in body mass and body mass index in thirteen year old swimmers after an 8-week summer break. However, body height increased substantially in their swimmers. Moreira et al. (2014) also reported significant increases in body height in twelve year old swimmers after a 10-week summer break. Similarly, body height increased significantly in a

Sportis. Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

group of fourteen year old swimmers after a 4-week detraining period (Zacca et al., 2019). In that study summer break had no effect on swimmers' body mass index, however their body mass increased substantially. The increase in all anthropometric parameters in our children cannot be explained unequivocally. The literature presents a variety of possible determinants of the children's body composition changes during summer break. For example, daily routine is less-structured during summertime when compared to the school-year period (Tanskey et al., 2019). Due to this, both negative and positive health consequences are observed in children. On one hand, some children eat more unhealthy food, increase their screen and media use, and display unbalanced sleep patterns. These negative behavioral changes influence the child's metabolism and may cause the increase of body fat, and body mass index. On the other hand, some children spend more time on unsupervised outdoor physical activity and eat more fruit and vegetables. An increase in skeletal muscle mass may be an effect of these positive behavioral changes. Drenowatz et al. (2021) concluded that children's cardio-respiratory endurance and muscular fitness raise during summer vacation due to increased outdoor sports activities. This relationship is more visible in changing climate countries, where weather conditions determinate the possibility of performing outdoor sports and recreational activities. Similarly, findings presented by Moreno et al. (2022) suggest that children's height and weight gain during summertime occurs more often in healthy-weight subjects. We suppose that changes in body composition parameters in our children may have been caused by the maturation effect. Children in our group were younger than participants in aforementioned studies, so their physical development was in the earlier stage. According to national data, girls usually have their first menstrual cycle later, i.e. at the age of 12.0-12.5, so the pubertal growth of our female participants was still dynamic (Kulik-Rechberger & Kozlowska, 2017). However, many other factors influence growth in a child’s body size during pubescence (Burt Solorzano & McCartney, 2010; Siervogel et al., 2003). It is plausible that during summertime our swimmers might have been in very rapid phase of development. It should be noted that all analyzed anthropomorphic parameters were within the national norms for this age group.

Sportis Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

Results of our study show that an 8-week summer break had little impact on respiratory muscle strength in examined swimmers, therefore our hypothesis (2) was confirmed. As we mentioned before, only two studies that we found describe the changes in pulmonary parameters in pubertal swimmers after summer break. In these studies, the rates of respiratory parameters showed a decrease, particularly in children that were not engaged in any regular physical activity during the summertime (Sambanis et al., 2006, Sambanis, 2006). However, the pulmonary function parameters in these studies were expressed in vital capacity (VC) and forced vital capacity (FVC), so their results cannot be compared to our findings. Comparisons of MIP and MEP values assessed before and after the 50m front-crawl test revealed no significant differences in boys, both in June and September test sessions. In contrast, girls presented substantially higher MIP values after the swim test in June. However, the other respiratory muscle strength parameters did not change substantially in girls in both assessment sessions. We found no significant correlations between respiratory muscle strength and 50-m front crawl performance. Our results correspond to those, presented in the study of Santos et al. (2011). In their study, adolescent swimmers had MIP and MEP measured before and after a 1200m freestyle test. No significant differences were noted in MIP and MEP results between pre- and post-test measurements, however, MIP values slightly increased in girls after the swim test. In our study, girls also presented greater values of inspiratory muscle strength in fatigue conditions. It is possible, that girls were more motivated to perform respiratory maneuvers after the effort, as motivational factors may affect respiratory measurements in children (Pawar et al., 2021). On the other hand, the lack of significant differences in respiratory muscle strength after the swim-specific effort can be explained by probable high muscle adaptation. Studies looking at adult swimmers and runners confirm the positive effect of endurance training on athletes' lung function (Cordain et al., 1990).

Based on a literature review, Verma et al. (2019) concluded that in healthy children MEP values are greater than MIP values regardless of subjects' gender. Moreover, MIP and MEP values are greater in boys than in girls. The same was found for children who are engaged in sports activities (Bostanci et al., 2021). This phenomenon is explained by an

Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

increased capability for male muscles to generate maximum power output. Our study confirms these findings, except for the MIP values measured in the exercise condition before detraining period. The literature presents a wide range of MIP and MEP results in healthy pubescent children. For example, Hulzebos et al. (2018) took MIP and MEP measurements in large cohorts of Dutch healthy children in different age groups. They noted MIP values of 96±25 cm H2O and 118±27 cm H2O for 12 year old girls and boys, respectively. Consequently, measured MEP values were 116±28 cm H2O for girls, and 132±26 cm H2O for boys. Our children presented distinctly lower rates of respiratory muscle strength. On the other hand, Cox et al. (2012) reported lower values of respiratory muscle strength in 11-12-year-old Caucasian children from Australia. In their study children (boys and girls together) presented 77.3±26.2 cm H2O and 85.3±32.9 cm H2O of MIP and MEP, respectively. As for Korean children, the values for 12 years old pupils were even lower. Korean girls presented 43.1±15.8 cm H2O and 45.9±19.2 cm H2O for MIP and MEP respectively. Korean boys had 56.0±16.9 cm H2O of MIP and 50.5±13.2 cm H2O of MEP (Woo Hyuk et al., 2017). Delgado et al. (2015) compared the MIP and MEP results of pre- and early pubertal Brazilian children with those presented in other studies. They concluded that reference values for MIP and MEP demonstrate a wide diversity within studied age groups, and that ethnical specificity possibly influences maximum respiratory pressure values in children. Additionally, Heinzmann-Filho et al. (2012) noticed that body height and body mass may also affect respiratory muscle strength in healthy school children. Thus, it is difficult to conclude which position our swimmers take among their peers in terms of respiratory muscle strength, as no current national reference values were developed.

There are some limitations that should be taken into consideration when assessing the results of our study. First, we decided not to create a control group as previous studies show that anthropomorphic variables differentiate pubertal swimmers and their non-swimming peers (McKenna et al., 2012; Rufo et al., 2018). Moreover, the literature shows that physically active children present higher values of MIP and MEP than their inactive peers (Dassios & Dimitriou, 2019; De Souza Espindola et al., 2021). Second, a 50m front-crawl tests as a factor activating respiratory muscles is an experimental design. When reviewing the literature, we

Original Article. The effect of summer holidays on body composition and respiratory muscle strength in pubescent swimmers. Vol. 9, issue 2; p. 262-283, may 2023. https://doi.org/10.17979/sportis.2023.9.2.9296

did not find any recommendation of exercise frequency and duration to cause fatigue of the respiratory muscles in children. Therefore, we are not sure if short-term, intense effort could affect the respiratory muscle strength in our participants. Third, we did not control the actual levels of physical activity of our participants during summertime. Thus, the frequency and duration of undertaken physical activity may have affected the results of our study. On the other hand, our results provide an interesting basis for comparisons with other studies concerning the effect of holiday-based detraining periods in young athletes. Additionally, we present the analysis of body composition in age-group swimmers as an effect of summer break. These findings have not been presented in the literature so far, and we believe this is a strength of our study.

Conclusions

This study demonstrated that an 8-week training cessation associated with summer break had an effect on body composition parameters and anthropomorphic variables in pubertal swimmers. When comparing data from pre-, and post-holidays time periods, respiratory muscle strength did not show substantial alternation. A longitudinal assessment of respiratory muscle strength is advised in order to evaluate the level of physiological adaptation in juvenile swimmers. Moreover, these conclusions should be confirmed with studies involving larger groups of youth athletes practicing various sports.

References

1. Altavilla, C., Sellez-Perez, S., Comino-Comino, I., Comeche-Guijarro, J.M., Caballero-Perez, P. & Tuells, J. (2020). Comparisons of summer break effect on anthropometric profile, body composition and somatotype between adolescent swimmers and less active adolescents. Revista Andaluza de Medicina del Deporte, 13 (3), 134-139.
2. Aphamis, G., Ioannou, Y. & Giannaki, C.D. (2019). Physical fitness and obesity levels during an academic year followed by summer holidays: an issue of insufficient time for physical activity. International Journal of Adolescent Medicine and Health, 31(1), 20160137. https://doi.org/10.1515/ijamh-2016-0137

Sportis. Revista Técnico-Científica del Deporte Escolar, Educación Física y Psicomotricidad
Scientific Technical Journal of School Sport, Physical Education and Psychomotricity
Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

3. Atay, E. & Kayalarli, G. (2013). The effects of detraining period of female basketball team players aged 10-12. Turkish Journal of Sport and Exercise, 15 (2), 51-55.
4. Bostanci, O., Kabadayi, M., Mayda, M.H., Yilmaz, A.K. & Yilmaz, C. (2021). Shooting performance and respiratory muscle strength in archers aged 9-12. Baltic Journal of Health and Physical Activity, 13(3), 31-36. https://doi.org/10.29359/BJHPA.13.3.04
5. Brazendale, K., Beets, M.W., Turner-McGrievy, G.M., Kaczynski, A.T., Pate, R.R. & Weaver, R.G. (2018). Children's obesogenic behaviors during summer versus school: a within-person comparison. Journal of School Health, 88 (12), 886-892. https://doi.org/10.1111/josh.12699
6. Brusseau, T. & Burns, R.D. (2018). Children's weight gain and cardiovascular fitness loss over the summer. International Journal of Environmental Research and Public Health, 15(12), 2770. https://doi.org/10.3390/ijerph15122770
7. Burt Solorzano, C.M. & McCartney, C.R. (2010). Obesity and the pubertal transition in girls and boys. Reproduction, 140 (3), 399-410. https://doi.org/10.1530/REP-10-0119
8. Chainok, P., Machado, L., De Jesus, K., Abraldes, A.A., Borgonovo-Santos, M., Fernandes, R. & Vilas-Boas, J.P. (2021). Backstroke to breaststroke turning performance in age-group swimmers: hydrodynamic characteristics and pull-out strategy. International Journal of Environmental Research and Public Health, 18 (4), 1858. https://doi.org/10.3390/ijerph18041858
9. Cordain, L., Tucker, A., Moon, D. & Stager J.M. (1990). Lung volumes and maximal respiratory pressures in collegiate swimmers and runners. Research Quarterly for Exercise and Sport, 61(1), 70-74. https://doi.org/10.1080/02701367.1990.10607479
10. Cox, D.W., Verheggen, M.M., Stick, S.M. & Hall, G.L. (2012). Characterization of maximal respiratory pressures in healthy children. Respiration, 84 (6), 485-491. https://doi.org/10.1159/000342298
11. Cristi-Montero, C., Bresciani, G., Alvarez, A., Arriagada, V., Beneventi, A., Canepa, V., Espinoza, P., Parraguez, M., Toledo, C., Valencia, S. & Rodriguez-Rodriguez, F. (2014). Critical periods in the variation in body composition in school children. Nutricion Hospitalaria, 30 (4), 782-786. https://doi.org/10.3305/nh.2014.30.4.7694

Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

12. Da Fontoura, A.S., Schneider, P. & Meyer, F. (2004). Effect of the muscular strength detraining in prepubertal boys. Revista Brasileira de Medicina do Esporte, 10 (4), 285-288. https://doi.org/10.1590/S1517-86922004000400005
13. Dassios, T. & Dimitriou, G. (2019). Determinants of inspiratory muscle function in healthy children. Journal of Sport and Health Science, 8 (2), 183-188. https://doi.org/10.1016/j.jshs.2016.08.002
14. de Souza Espindola, C., Minsky, R.C., Cardoso, J., de Figueiredo, I.C.X.S. & Schivinski, C.I.S. (2021). Level of physical activity and respiratory muscle force in healthy children. Fisioterapia e Pesquisa, 28(2), 179-185.
15. Delgado, R.N., Campos, T.F., de Oliveira Borja, R., de Freitas, D.A., da Silva Chaves, G.S. & de Mendonca, K.M.P.P. (2015). Maximal respiratory pressures of healthy children: comparison between obtained and predicted values. Pediatric Physical Therapy, 27, 31-37. https://doi.org/10.1097/PEP.0000000000000100
16. Dimitriadis, Z., Kapreli, E., Konstantinidou, I., Oldham, J. & Strimpakos, N. (2011). Test/retest reliability of maximum mouth pressure measurements with the MicroRPM in healthy volunteers. Respiratory Care, 56(6), 776-782. https://doi.org/10.4187/respcare.00783
17. Drenowatz, C., Ferrari, G. & Greier, K. (2021). Changes in physical fitness during summer months and the school year in Austrian elementary school children - a 4-year longitudinal study. International Journal of Environmental Research and Public Health, 18, 6920. https://doi.org/10.3390/ijerph18136920
18. D'Souza, C.D. & Avadhany, S,T. (2014). Effect of yoga training and detraining on respiratory muscle strength in pre-pubertal children: a randomized trial. International Journal of Yoga, 7, 41-47.
19. Gavanda, S., Geisler, S., Quitmann, O.J., Bauhaus, H. & Schiffer, T. (2020). Three weeks of detraining does not decrease muscle thickness, strength or sport performance in adolescent athletes. International Journal of Exercise Science, 13 (6), 633-644.
20. Heinzmann-Filho, J.P., Vasconcellos-Vidal, P.C., Jones, M.H. & Faguendes-Donadio, M.V. (2012). Normal values for respiratory muscle strength in healthy preschoolers and

Editor: University of A Coruña. A Coruña. Spain
ISSN-e 2386-8333
E-mail: sportis.journal@udc.es Web: https://revistas.udc.es

school children. Respiratory Medicine, 106 (12), 1639-1646. https://doi.org/10.1016/j.rmed.2012.08.015

21. Hulzebos, E., Takken, T., Reijneveld, E.A., Mulder, M.M.G. & Bongers, B.C. (2018). Reference values for respiratory muscle strength in children and adolescents. Respiration, 95 (4), 235-243. https://doi.org/10.1159/000485464
22. Kulik-Rechberger, B. & Kozlowska, M. (2017). Is there a further acceleration in the growth and pubertal development in girls? Pediatric Endocrinology, 16 (2), 95-100. https://doi.org/10.18544/ep-01.16.02.1666
23. Larson, J.L., Covey, M.K., Vitalo, C.A., Alex, C.G., Patel, M. & Kim, M.J. (1993). Maximal inspiratory pressure. Learning effect and test-retest reliability in patients with chronic obstructive pulmonary disease. Chest, 104 (2), 448-453. https://doi.org/10.1378/chest.104.2.448
24. Maldonado-Martin, S., Camara, J., James, D.V.B., Fernandez-Lopez, J.R. & Artetxe-Gezuraga, X. (2017). Effects of long-term training cessation in young top-level road cyclists. Journal of Sports Sciences, 35 (14), 1396-1401. https://doi.org/10.1080/02640414.2016.1215502
25. McKenna, L., Straker, L. & Smith, A. (2012). Can scapular and humeral head position predict shoulder pain in adolescent swimmers and non-swimmers? Journal of Sports Sciences, 30 (16), 1767-1776. https://doi.org/10.1080/02640414.2012.718092
26. Moreira, M.F., Morais, J.E., Marinho, D.A., Silva, A.J., Barbosa, T.M. & Costa, M.J. (2014). Growth influences biomechanical profile of talented swimmers during the summer break. Sports Biomechanics, 13(1), 62-74. https://doi.org/10.1080/14763141.2013.865139
27. Moreno, J.P., Musaad, S., Dadabhoy, H., Baranowski, T., Crowley, S.J., Thompson, D., Chen, T.A. & Johnston, C.A. (2022). Seasonality of children's height and weight and their contribution to accelerated summer weight gain. Frontiers in Physiology, 13, 793999. https://doi.org/10.3389/fphys.2022.793999
28. Ormsbee, M.J. & Arciero, P.J. (2012). Detraining increases body fat and weight and decreases VO_2 peak and metabolic rate. Journal of Strength and Conditional Research, 26 (8), 2087-2095. https://doi.org/10.1519/JSC.0b013e31823b874c

29. Patil, P., Deodhar, A. & Jadhav, S. (2020). Respiratory muscle strength in children in age group 7-12 years: a cross-sectional observational pilot study. International Journal of Health Sciences and Research, 10 (11), 145-156.
30. Pawar, S., Narayan, A., Karnad, S.D., Alaparthi, G.K. & Bairapareddy, K.C. (2021). Respiratory muscle strength in healthy Indian children of age 7-17 years: a cross-sectional study. International Journal of General Medicine,14, 4413-4422. https://doi.org/10.2147/IJGM.S315626
31. Rochat, I., Cote, A. & Boulet, L-P. (2022). Determinants of lung function changes in athletic swimmers. A review. Acta Paediatrica, 111(2), 259-264. https://doi.org/10.1111/apa.16095
32. Rufo, J.C., Paciencia, I., Silva, D., Martins, C., Madureira, J., de Oliveira Fernandes, E., Padrao, P., Moreira, P., Delgado, L. & Moreira, A. (2018). Swimming pool exposure is associated with autonomic changes and increase airway reactivity to a beta 2-agonist in school aged children: a cross-sectional survey. PLoS One, 13 (3), e0193848. https://doi.org/10.1371/journal.pone.0193848
33. Sambanis, M., Noussios, G., Sambanis, A. & Kalogeropoulos, I. (2006). Detraining and pulmonary function in adolescent female swimmers. Minerva Pneumologica, 45(4), 221-228.
34. Sambanis, M. (2006) Effects of detraining on pulmonary function and performance in young male swimmers. Minerva Pneumologica, 45(2), 121-128.
35. Santos, A., Marinho, D.A., Costa, A.M., Izquierdo, M. & Marques, M.C. (2011). The effects of concurent resistance and endurance training follow a specific detraining cycle in young school girls. Journal of Human Kinetics, 29A: 93-103. https://doi.org/10.2478/v10078-011-0064-3
36. Santos, M.A.R.C., Pinto, M.L., Sant'Anna, C.C. & Bernhoeft, M. (2011). Maximal respiratory pressures among adolescent swimmers. Revista Portuguesa de Pneumologia, 17(2), 66-70. https://doi.org/10.1016/s2173-5115(11)70016-1
37. Sfondrini, M.F., Zampetti, P., Luscher, J., Gandini, P., Gandia-Franco, J.L. & Scribante, A. (2020). Orthodontic treatment and healthcare goals: evaluation of multibrackets treatment

Original Article. The effect of summer holidays on body composition and respiratory muscle strength in pubescent swimmers. Vol. 9, issue 2; p. 262-283, may 2023. https://doi.org/10.17979/sportis.2023.9.2.9296

results based using PAR index (Peer Assessment Rating). Healthcare, 8, 473. https://doi.org/10.3390/healthcare8040473

38. Siervogel, M,R,, Demerath, E.W., Schuber, C., Remsberg, K.E., Chumlea W.C., Sun, S., Czerwinski, S.A. & Bradford, T. (2003). Puberty and body composition. Hormone Research, 60 (suppl.1), 36-45. https://doi.org/10.1159/000071224
39. Soudon, P., Steens, M. & Toussaint, M. (2008). A comparison of invasive versus noninvasive fulltime mechanical ventilation in Duchenne muscular dystrophy. Chronic Respiratory Disease, 5(2), 87-93. https://doi.org/10.1177/1479972308088715
40. Tanskey, L.A., Goldberg, J.P., Chui, K., Must, A., Wright, C.M. & Sacheck, J.M. (2019). A qualitative exploration of potential determinants of accelerated summer weight gain among school-age children: perspectives from parents. BMC Pediatrics, 19, 438. https://doi.org/10.1186/s12887-019-1813-z
41. Tanskey, L.A., Goldberg, J., Chui, K., Must, A. & Sacheck, J. (2018). The state of the summer: a review of child summer weight gain and efforts to prevent it. Current Obesity Reports, 7 (2), 112-121. https://doi.org/10.1007/s13679-018-0305-z
42. Verma, R., Chiang, J., Qian, H. & Amin, R. (2019). Maximal static respiratory and sniff pressures in healthy children - a systematic review and meta-analysis. Annals of American Thoracic Society, 16(4), 478-487. https://doi.org/10.1513/AnnalsATS.201808-506OC
43. Volmut, T., Pisot, R., Planinsec, J. & Simunic, B. (2021). Physical activity drops during summer holidays for 6- to 9-year old children. Frontiers in Public Health, 8, 631141. https://doi.org/10.3389/fpubh.2020.631141
44. Woo Hyuk, C., Myung Jun, S., Myung Hun, J., Je Sang, L., Soo-Yeon, K., Hye-Young, K., Younghee, H., Choongrak, K. & Yong Beom, S. (2017). Maximal inspiratory pressure and maximal expiratory pressure in healthy Korean children. Annals of Rehabilitation Medicine, 41 (2), 299-305. https://doi.org/10.5535/arm.2017.41.2.299
45. Zacca, R., Toubekis, A., Freitas, L., Silva, A.F., Azevedo, R., Vilas-Boas, J.P., Pyne, D.B., Castro, F.A. & Fernandes, R.J. (2019). Effects of detraining in age-group swimmers performance, energetics and kinematics. Journal of Sports Sciences, 37(13), 1490-1498. https://doi.org/10.1080/02640414.2019.1572434