Does an In-Season Detraining Period Affect the Shoulder Rotator Cuff Strength and Balance of Young Swimmers?

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ABSTRACT

Batalha, NM, Raimundo, AM, Tomas-Carus, P, Marques, MAC, and Silva, AJ. Does an in-season detraining period affect the shoulder rotator cuff strength and balance of young swimmers? J Strength Cond Res 28(7): 2054–2062, 2014—Imbalance in shoulder rotator muscles is a well-documented problem in swimmers, and it is important to implement land-based strength training programs. Meanwhile, the effects of a detraining period on swimmers’ shoulder rotator muscles are unknown. The purpose of this study was to analyze the effects of a strength training program and detraining on the strength and balance of shoulder rotator cuff muscles in young swimmers, despite the continuity of usual water training. An experimental group (n = 20) and a control group (n = 20) of young male swimmers with the same characteristics (age, body mass, height, training volume, and maturational state) were evaluated. In both groups, the peak torques of shoulder internal (IR) and external (ER) rotators were assessed during preseason, midseason (16 weeks), and postseason (32 weeks). The experimental group underwent a strength training regimen from baseline to 16 weeks and a detraining period from 16 to 32 weeks. Concentric action at 60°·s⁻¹ and 180°·s⁻¹ was measured using an isokinetic dynamometer. The ER/IR strength ratios were obtained. At 60°·s⁻¹, there were significant increments in IR strength and the ER/IR ratio in both shoulders. This trend was the same throughout the competitive season. The tendency was the same at 180°·s⁻¹ because training effects were noted primarily in IR and ER/IR ratios. Moreover, the absence of land-based strength training, from 16 to 32 weeks, revealed a reduction in the ER/IR ratio values in both shoulders. Our findings suggest that young swimmers’ coaches should use dry-land strength training protocols, and that it is recommended that these should be conducted on a regular basis (during the whole season).

KEY WORDS swimming, isokinetic strength, muscle balance, shoulder joint

INTRODUCTION

In competitive swimming, the upper-body force needed to move the swimmer through the water, especially in the execution of 3 of the 4 strokes (freestyle, butterfly, and backstroke), derives primarily from shoulder adduction and internal rotation (IR) (12,20). Thus, shoulder internal rotators and adductors become stronger and hypertrophied relative to their antagonist muscle groups (24,25). This can lead to agonist-antagonist muscle imbalance, which is documented in competitive swimming (1,22), and might also be related to future shoulder injury (4,5). Regarding this concern, several authors (12,22) recognize the importance of the implementation of an early intervention strength training program aimed at reducing such imbalances, and functioning as a preventive factor. Some studies have produced significant findings regarding strength gain in the shoulder rotator muscles (3,8,11). Others also identify benefits in shoulder rotator balance with strength training programs (16,18). However, particularly with swimmers, past studies were mainly conducted in a clinical context, analyzing the effects of a strength training program on posture (15) and the incidence of shoulder pain (23).

Interruptions in training sessions due to illness, injury, holidays, the postseason break, or other factors are normal occurrences for any sport. One study (10) found that after 6 weeks of detraining (dry-land strength for upper and lower limbs), although strength parameters remained stable, swimming performance still improved. Unfortunately, there is a lack of data regarding the impact that a respite from training may have on shoulder musculature, particularly with regard to the effects of detraining. To the best of our knowledge, only 1 study has examined the effects of strength
training and reduced training on rotator cuff musculature (17). However, in this study, which examined non-athletes, it was found that a training frequency of 1 session per week maintains rotator cuff strength gains in previously untrained subjects. Furthermore, eccentric strength may be more susceptible to detraining. Thus, because little is known about this subject in relation to swimming, the detraining period was also investigated in this study.

The aim of this study was to assess the effects of a strength training and detraining program on the strength and balance of shoulder rotator cuff muscles in young swimmers, despite the continuity of usual water training. It was hypothesized that (a) a compensatory strength training program would promote an increase in shoulder rotator muscle strength and balance, (b) despite the continuity of usual water training, the absence of specific shoulder rotator strength training (detraining) would produce a decrease in strength and balance.

**METHODS**

Experimental Approach to the Problem

A longitudinal design was used, in which the swimmer’s isokinetic internal and external concentric rotational shoulder muscle strength was examined. Peak torque (PT) measurements obtained at angular velocities of 60°·s⁻¹ and 180°·s⁻¹ defined rotational strength.

A 3 × 2 × 2 repeated-measure data analysis was conducted on dependent variables (PT and ER/IR ratios). The independent variables selected were time (examined at 3 levels: preseason, midseason, and postseason); angular velocity (examined at 2 levels: 60°·s⁻¹ and 180°·s⁻¹); and direction (examined at 2 levels: internal rotation and external rotation).

**Subjects**

Forty national level young male swimmers aged between 14 and 15 years gave their written consent to participate in the study after being informed about the experimental procedures. After an initial evaluation, subjects were randomly divided into 2 groups, an experimental group and a control group. Baseline characteristics of the subjects are presented in Table 1.

As inclusion criteria, it was considered that swimmers should (a) not have any clinical history of upper limb disorders, (b) have qualified to compete in the national championships, (c) undergo a minimum of 8 hours of training per week, (d) be aged between 14 and 15 years, and (e) not undergo any previous dry-land training. The main goals of the study were explained to all the participants and their legal guardians, who signed a consent form before testing. This study was approved by the institutional review board of the hosting university (proceeding 09002/2008).

Moreover, research was undertaken in compliance with the

![Table 1. Baseline characteristics of the subjects.*](image-url)
Helsinki Declaration and the international principles governing research on humans and animals.

To verify whether there were differences in maturational states of the 2 groups, the percentage of predicted mature height, based on the Khamis and Roche method (14), was measured in all evaluation periods. This method uses height, body mass, and midparent stature. The calculation was made based on the following formula:

\[
\text{Predicted adult stature} = \text{intercept} + \frac{\text{height}}{\text{height coefficient}} + \frac{\text{body mass}}{\text{body mass coefficient}} + \frac{\text{height} \times \text{midparent stature}}{\text{mid-parent stature coefficient}}.
\]

The intercept and remaining coefficients values are given by Khamis and Roche (14), considering individual chronological age. The average error for the male population is 2.2 cm (14).

**Procedures**

The experimental design is represented in Figure 1. Each subject reported to our laboratory 1 week before preseason testing for familiarization with equipment and procedures (E0). One week after familiarization, baseline evaluation was conducted. Output values for internal and external rotator cuff isokinetic strength were obtained before (E1) and after (E2) the training program and after detraining (E3), during concentric actions executed on an isokinetic dynamometer (Biodex System 3; Biodex Corp., Shirley, NY, USA). Subjects were seated and stabilized using velcro straps to avoid compensatory trunk movements. They were positioned with their arms at 90° of abduction, 90° of elbow flexion, and at scapular plane, as proposed by other investigators (13). Shoulder internal and external rotation torque was evaluated through a range of motion of 90°, from neutral rotation to 90° of external rotation. Subjects' position and joint alignment were achieved in accordance with instructions defined for using the isokinetic dynamometer (26). Test procedure was explained to all subjects before the start of testing, with emphasis on exerting maximal effort within each individual's tolerance. After 15-minute warm-up, involving articular mobilization and stretching, PT with 3 repetitions at 60°·s⁻¹ and 20 repetitions at 180°·s⁻¹ was recorded. A 60°·s⁻¹ speed was first performed for each extremity, followed by a 180°·s⁻¹ speed. Two trial repetitions at each speed were performed to familiarize subjects with the testing procedure.

A 2-minute resting period was allowed for participants between each speed test. All tests were performed during the morning (with no previous training or fatigue), and standardized verbal instructions and encouragement were given to all participants during both tests. The range of motion stops was chosen according to the manufacturer's recommendations to ensure that identical ranges of motion were tested bilaterally and during follow-up.

| Elastic band color | Exercise 1 | Exercise 2 | Exercise 3 |
|--------------------|------------|------------|------------|
| Red                | 17         | 16         | 13         |
| Green              | 3          | 4          | 7          |
| Green              | 12         | 10         | 6          |
| Blue               | 8          | 4          | 7          |
| Black              | 0          | 6          | 7          |

**Figure 2.** Exercises of the strength training program. Initial position (A); final position (B).
### Table 3. Comparative training effects on the peak torques (N·m) of IR and ER and ER/IR ratios (%) of both shoulders at 60°·s⁻¹ across the competitive season.*†

|                        | Dominant shoulder—60°·s⁻¹ | Non-dominant shoulder—60°·s⁻¹ |
|------------------------|---------------------------|-------------------------------|
|                        | Experimental (N = 20)     | Control (N = 20)              | Experimental (N = 20)     | Control (N = 20)              |
| Baseline, mean ± SD    | ER 28.61 ± 5.86           | 26.36 ± 4.56                  | 25.57 ± 5.10              | 24.83 ± 4.49                  |
|                        | IR 35.90 ± 7.71           | 33.20 ± 8.13                  | 35.47 ± 8.63              | 33.30 ± 10.46                 |
|                        | Ratio 79.69 ± 12.76        | 79.39 ± 15.40                 | 72.09 ± 7.82              | 74.56 ± 18.66                 |
| Changes from baseline to 16 wk, mean (95% CI) | ER 3.89 (2.14 to 5.64)§ | 0.97 (−3.13 to 2.08)        | 4.34 (2.92 to 5.75)§     | 1.11 (−0.49 to 2.12)         |
|                        | IR 2.63 (−0.78 to 6.03)§ | 6.36 (2.76 to 8.97)§         | 2.15 (−0.59 to 4.90)§     | 4.41 (0.5 to 7.81)§         |
|                        | Ratio 4.66 (−2.34 to 11.66)§ | −5.65 (−12.43 to 1.13)§    | 7.39 (−2.58 to 17.37)§   | −5.77 (−12.93 to 2.38)§     |
| Changes from 16 to 32 wk, mean (95% CI) | ER −0.45 (−2.39 to 1.82) | 3.07 (1.89 to 5.38)§        | −0.77 (−2.4 to 0.87)     | 3.50 (0.23 to 6.43)§        |
|                        | IR 3.29 (0.45 to 7.02)§  | 2.97 (1.27 to 5.03)§         | 4.14 (2.06 to 6.73)§      | 2.15 (−0.06 to 4.62)         |
|                        | Ratio −7.69 (−13.26 to 1.82)§ | −2.28 (−6.45 to 3.24)§     | −9.70 (−17.76 to 1.35)§  | 5.05 (−4.3 to 12.79)        |

| Baseline-16 wk | p | ES | 16–32 wk | p | ES | Baseline-16 wk | p | ES |
|----------------|---|----|----------|---|----|----------------|---|----|
| Training effects, mean (95% CI) | ER 2.93 (0.10 to 5.76) | 0.008 0.117 | −3.51 (−6.28 to 1.45) | 0.793 0.039 | 3.23 (1.55 to 4.91) | 0.015 0.247 | −4.26 (−7.39 to 1.14) | 0.540 0.029 |
|                        | IR −3.73 (−8.42 to 0.96) | 0.421 0.080 | 0.32 (−3.10 to 4.04) | 1.000 0.004 | −2.26 (−6.56 to 2.05) | 0.931 0.028 | 1.99 (−2.28 to 5.35) | 1.000 0.003 |
|                        | Ratio 10.31 (0.34 to 20.29) | 0.001 0.271 | −5.41 (−13.11 to 1.87) | 0.994 0.021 | 10.31 (0.34 to 20.29) | 0.036 0.222 | −14.25 (−22.21 to 4.20) | 0.391 0.015 |

*ER = external rotation; IR = internal rotation; ES = effect size; CI = confidence interval.
†Outcomes at baseline and changes at 16 and 32 wk.
‡p values for differences between groups.
§Within-group differences.
testing. Preseason testing occurred in the first week of the competitive swim season so that baseline measurements could be obtained. All posttesting procedures were the same as those used during the preseason session.

To characterize the strength values of shoulder rotator muscles, PT was used, defined as the maximum torque produced by the shoulder at any point on the range of motion (21). To analyze shoulder rotator strength balance, the ER/IR ratio—the quotient between PT values of the ER and the IR multiplied by 100 ([ER/IR] × 100) (6,19)—was calculated.

The experimental group, alongside with the aquatic training, completed a specific strength training program lasting 16 weeks, with special emphasis on the external rotator muscles and shoulder stabilizers. For this purpose, Thera-Bands elastic bands were used. Training program sessions were held 3 times a week and consisted of 3 different exercises (Figure 2).

Exercise 1: The subjects initiated the exercise in an anatomical reference position with slightly higher upper limb abduction and with the elastic band in tension. After this start position, an additional upper limb abduction and external rotation was required, until an angle of 50–60° was achieved between the arms and the trunk.

Exercise 2: The initial position was identical to the position described in Exercise 1, progressing to simultaneous upper limb abduction at scapular plane until the end of the range of motion, close to 160° of abduction.

Exercise 3: The initial position with the shoulder at 90° flexion at the scapular plane, the elbow in total flexion, and hands in total pronation above the shoulder girdle, progressing during the exercise to a full extension of the elbow and total shoulder flexion.

The initial training load was determined after 2 sessions of adaptation to materials and training techniques. The initial load was implemented using red elastic bands. All swimmers executed 3 sets of each exercise mentioned above with 30-second rest intervals. The 2 first sets involved 20 repetitions each, whereas the last set was executed until exhaustion. The training load progression was ensured since the last set, when swimmers reached 30 repetitions, the level of training was increased, using an elastic band indicating the next level of color/resistance. This procedure was conducted independently for each exercise in the program. Table 2 gives us an idea of the training load progression for each exercise throughout the training period.

The control group only performed the water training program during the whole season. After the initial 16-week period, the strength training program was halted for the experimental group, which performed only aquatic training until the end of the season.

Statistical Analyses
Initially, the Kolmogorov-Smirnov normality test with Lillifors correction was used to assess data normality. Differences in baseline characteristics between groups were tested using analyses of variance (ANOVAs). The training effects within and between groups were evaluated using analyses of variance for repeated measures, adjusted for the maturation values used as covariates (ANCOVA), with Bonferroni post hoc tests. Effect sizes are reported as partial eta-squared (\(\eta^2\)), with cut-off values of 0.01, 0.06, and 0.14 for small, medium, and large effects, respectively (7).

In addition to the \(p\) values, detailed statistics are provided, including the mean and 95% confidence interval, to best characterize the change within each group between evaluation periods. Changes in values between moments were defined as the increase or decrease from 1 evaluation period to the evaluation period immediately thereafter. The training effect indicates the differences between changes in the 2...
Table 4. Comparative training effects on the peak torques (N·m) of IR and ER and ER/IR ratios (%) of both shoulders at 180°·s⁻¹ across the competitive season.*†

|                          | Dominant shoulder—180°·s⁻¹ | Non dominant shoulder—180°·s⁻¹ |
|--------------------------|-----------------------------|-------------------------------|
|                          | Experimental (N = 20)       | Control (N = 20)              | Experimental (N = 20) | Control (N = 20) |
| **Baseline, mean ± SD**  |                             |                               |                             |                   |
| ER                       | 24.29 ± 4.06                | 22.98 ± 4.07                  | 22.16 ± 4.09               | 22.00 ± 3.70      |
| IR                       | 32.97 ± 7.31                | 29.83 ± 8.39                  | 34.09 ± 8.17               | 29.80 ± 8.27      |
| Ratio                    | 73.67 ± 5.86                | 77.04 ± 12.99                 | 65.00 ± 12.04              | 73.83 ± 13.68     |
| **Changes from baseline to 16 wk, mean (95% CI)** |                             |                               |                             |                   |
| ER                       | 4.60 (3.25 to 5.95)§        | 1.79 (0.17 to 4.06)           | 3.49 (2.25 to 4.74)§       | 2.98 (1.59 to 4.76)§ |
| IR                       | 4.33 (2.15 to 6.5)§         | 6.23 (2.93 to 8.13)§          | 1.41 (-0.69 to 3.51)§      | 4.03 (2.98 to 7.07)§ |
| Ratio                    | 3.80 (-2.57 to 10.16)       | -8.38 (-11.39 to -2.87)§     | 7.25 (0.48 to 13.57)       | 0.01 (-5.27 to 4.31) |
| **Changes from 16 to 32 wk, mean (95% CI)** |                             |                               |                             |                   |
| ER                       | -0.50 (-1.42 to 0.62)       | 3.46 (2.31 to 4.82)§          | 0.07 (-1.38 to 1.23)       | 0.98 (-0.27 to 2.92) |
| IR                       | 1.40 (-0.91 to 3.11)        | 2.05 (-0.19 to 4.32)          | 1.77 (-0.58 to 4.11)       | 3.24 (1.84 to 5.99)§ |
| Ratio                    | -4.09 (-9.41 to 1.83)       | 5.39 (0.07 to 9.14)§          | -3.25 (-7.29 to 0.25)      | -3.84 (-8.32 to 3.45) |

| Baseline-16 wk | p  | ES | 16–32 wk | p  | ES | Baseline-16 wk | p  | ES | 16–32 wk | p  | ES |
|----------------|----|----|----------|----|----|----------------|--|----|----------|----|----|----------|
| Training effects |    |    |          |    |    |                |    |    |          |    |    |                |
| ER             | 2.81 (0.15 to 5.46) | 0.007 | 0.116 | -3.96 (-5.21 to 2.12) | 0.086 | 0.061 | 0.51 (-1.33 to 2.36) | 0.945 | 0.008 | -0.90 (-2.54 to 1.43) | 1.000 | 0.001 |
| IR             | -1.90 (-6.37 to 2.56) | 1.000 | 0.025 | -0.65 (-3.43 to 2.98) | 1.000 | 0.005 | -2.62 (-5.34 to 0.10) | 0.665 | 0.081 | -1.47 (-4.79 to 1.14) | 0.872 | 0.005 |
| Ratio          | 12.18 (3.52 to 20.84) | 0.020 | 0.235 | -9.48 (-14.15 to 3.01) | 0.932 | 0.029 | 7.24 (-1.96 to 16.45) | 0.936 | 0.008 | 0.59 (-6.53 to 8.28) | 0.928 | 0.011 |

*ER = external rotation; IR = internal rotation; ES = effect size; CI = confidence interval.
†Outcomes at baseline and changes at 16 and 32 wk.
‡p values for differences between groups.
§Within-group differences.
groups [training effect = (Δexperimental – Δcontrol)]. All analyses were performed using SPSS (version 18.0; SPSS, Inc., Chicago, IL, USA), and the significance level was set at \( p \leq 0.05 \) for all tests.

**RESULTS**

The overall characteristics of the 2 groups were similar in terms of age, body mass, training volume, and maturational status. Table 3 shows significant training effects (from baseline to 16 weeks) on ER strength \( (p = 0.008; \text{ and } p = 0.015 \text{ for the dominant shoulder [DS] and the non-dominant shoulder [NDS]}) \) and, consequently, on the ER/IR ratio \( (p = 0.001 \text{ and } p = 0.036 \text{ for DS and NDS}) \) for the assessment made at \( 60^\circ \text{s}^{-1} \) for both shoulders, also with large effect sizes \( (\eta_p^2 > 0.14) \). In Figure 3, muscle balance changes and the differences between the groups throughout the season are evident.

Moreover, it should be noted that, for both shoulders, the above-mentioned significant results regarding the training effects of the ER and ER/IR ratios were no longer recorded following the detraining period.

Regarding shoulder rotator strength results at \( 180^\circ \text{s}^{-1} \) (Table 4), the same trend held, but only for the DS, because the significant strength training effects with medium to large effect sizes occurred in the ER \( (p = 0.007; \eta_p^2 = 0.116) \) and ER/IR ratios \( (p = 0.020; \eta_p^2 = 0.235) \).

With regard to the detraining period, once more, the above-mentioned significant results were no longer recorded. This may be a consequence of the absence of training.

**DISCUSSION**

The aim of this study was to analyze the effects of a strength training program and detraining on the strength and balance of shoulder rotator cuff muscles in young swimmers. The findings confirm our initial hypotheses: (a) the compensatory strength training program produces beneficial effects in shoulder rotator muscle strength and balance, (b) despite the continuity of usual water training, the absence of the above-mentioned specific strength training produces a decrease in strength and balance.

Regarding the strength training effects, and as far as the results obtained for an angular velocity of \( 60^\circ \text{s}^{-1} \) are concerned, it should be noted that they are very similar with regard to both DS and NDS (Table 3). The ER force values for the experimental group show a marked increase (from 3.89 N·m to 4.34 N·m for DS and NDS), and tend to differ with moderate to large effect sizes, as compared with the control group. The most relevant results are a consequence of the aforementioned force value increases, which show significant differences between groups regarding ER/IR ratios (Figure 3), which are significantly higher for the experimental group. If we consider that, according to Ellenbecker and Roetert (9), unilateral ratios characterize the quality of muscular balance and also that no differences were found between the maturity levels of the different groups, it may be concluded that the strength training program conducted promotes greater muscle balance because values of ER/IR ratios in both shoulders increased with significant differences and large effect sizes between groups. However, considering the normative shoulder rotator ratio values (between 66 and 75%) (9), despite the decline seen in the control group, the ER/IR ratios did not register values below 66% at any point, which are not associated with severe imbalances and shoulder joint muscle instability.

Considering the evaluations performed at \( 180^\circ \text{s}^{-1} \), DS results (Table 4) are, to a large extent, similar to those previously described, showing a significant increase in ER force values for the experimental group, and revealing significant differences in the training effects (from baseline to 16 weeks). Likewise, there are effects on the strength training carried out with marked increases in ER/IR ratios for the experimental group (3.8%) and decreases for the control group (–8.3%).

Our data, for the strength training effects for both isokinetic strength protocols performed, presented one point in common with those of a range of studies that involve compensatory training programs for shoulder rotator muscles (3,16,18,23): significant strength gains were recorded for the muscle groups involved in the exercises carried out. It should also be noted that, in some of these studies (3,16,23), unilateral ratio results decreased after interventions. The main difference lies in the kind of strength training employed, which did not clearly relate to ER. For this reason, IR force values were significantly higher as compared with their antagonists. This, together with the results presented in this study regarding ER/IR ratios, provides strong support for the proposition that compensatory strength training focused on the swimmer’s shoulder rotators should be targeted specifically at including ER strengthening and shoulder stabilization.

Moreover, despite the continuity of the water training, our findings show a clear trend associated with the absence of strength training, which reveals itself in both protocols, which is a reduction in the ER/IR ratios values. Indeed, in the experimental group at \( 60^\circ \text{s}^{-1} \), intra-group differences in the ER/IR ratio of both shoulders between 16 and 32 weeks were recorded \( (p = 0.038 \text{ and } p = 0.001 \text{ for DS and NDS, respectively}) \). Because unilateral ratios characterize the quality of muscle balance (9), it may be stated that a lack of dryland training in conjunction with water training promotes shoulder rotator muscle imbalance.

The above-mentioned differences in the ER/IR ratios of the experimental group between 16 and 32 weeks are mainly because of the significant increase in internal rotators strength and a slight reduction in or maintenance of ER values. The significant increase in the strength of internal rotators can be explained by aquatic training, which promotes the strengthening of shoulder IR and arm adduction in different proportions in relation to their antagonists (24). Regarding the slight decrease in ER strength, Wilmore...
and Costill (27) support our findings because they suggest that power and muscle strength values are reduced after a detraining period, although these reductions are relatively small during the first few months.

In the only study that we identified which was conducted with a view to evaluating the effects of training and detraining on shoulder rotator muscles, McCarrick and Kemp (17), reported that significant reductions in strength were only noted after 12 weeks when individuals completely halted training, but strength remained unchanged when the training was reduced to 2 or 1 weekly session. These results are not in accordance with our findings because ER strength decreased slightly (a decrease ranging from −0.77 to 0.07 N·m). However, it should be noted that in this study only the dry-land strength program was halted, whereas water training continued, which may account for this difference.

Moreover, McCarrick and Kemp (17) also report that there is evidence to support the notion that concentric strength training is more resistant to detraining than eccentric training. In view of the fact that the compensatory training program used in our study included mainly concentric strength, these authors’ findings may also help explain the ER results for the experimental group, which remained constant.

We believe that the main limitation of this study has to do with the isokinetic testing position. Swimmers were seated with a single arm elevated in the scapular plane, which is not a swimming-specific position. A prone testing position may be more suitable for swimmers; however, this position was not an option using this assessment tool.

**Practical Applications**

At early ages, competitive swimmers already experience a considerable increase in training volume, leading to the previously documented shoulder rotator imbalances. Compensatory strength training is essential, representing the prescribed shoulder strengthening exercises a useful compensatory training option because it lead to an increase in absolute strength values for shoulder rotators and greater muscle balance. Therefore, dry-land strength training protocols should be used, focusing specifically on strengthening the ER and stabilizers of the shoulder joint. In addition, it is recommended that young swimmers’ coaches conduct, on a regular basis (throughout the season), dry-land strength training programs, otherwise, as presented in our results, ER strength and muscle balance may be negatively impacted by the detraining process, despite the continuance of usual water training.

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