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EFFECTS OF TRADITIONAL AND REVERSE PERIODIZATION ON BODY-COMPOSITION AND SWIM PERFORMANCE

Abstract. The primary purpose of this research was to compare changes in 100m swim performance (t100c) and Body-composition values after 10 weeks of training traditional periodization (control) and reverse periodization (treatment). The Reverse periodization group indicates successful results in competition performance, and Traditional periodization group is a preferred option to improve body composition values.

Keywords: swimming, training zones, periodization, taper.

INTRODUCTION

Periodization of training is a process which including variations of volume, intensity and frequency of training to improve athletes' sports performances.[1,2,3] A goal of periodization programs is to optimize training in both short and long training periods (e.g., weeks, months, years).

A traditional program of periodization (TP) usually starts by workout of aerobic training in a preparatory period and gradually altering the preparation by reducing volume and increasing intensity to a competitive period. This program often concludes with a tapering period of reduction volume previously to main

competition.[1,4,5,6] In some sports training, different models of periodization have been suggested in which training loads are concentrated in short periods of time to increase the number of peak performances per year by following the same progression – first a volume training period, followed by a period of intensity. Examples of this training include the Block Training System of Verkhosansky[7] and Block Periodization of Issurin.[8] Reverse periodization (RP) introduced a paradigm that is completely opposite to the TP.

The RP was studied in strength training, starting preparation with high-intensity/low-volume and gradually increasing volume and reducing intensity. In fact, RP was studied in weight-training[2,3] and to date poorly studied in the swimming training context.[6,9]

Moreover, these processes of sport periodization Is followed by changes in body composition.[10] In some cases anthropometric measures may be related to performance[11] in other cases reports in a previous study it was concluded that lean body mass appears to influence swimming performance, while body fatness is relatively unimportant.[12]

The purpose of this research is compares change in 100m swim performance and body composition values, after 10 weeks of training traditional periodization and reverse periodization.

MATERIAL AND METHODS.

The participants were recruited by college program of sport sciences students with average 3 years of experience training for a competition

Volume and intensity were controlled for both groups throughout the training program to avoid attributing any outcomes to the differences in periodization; in the same way that all participants received nutritional information and were required for each of they don’t eat food supplements during of the study. An attempt was made to control physical activity outside of the training program.

Twenty subjects (men) were recruited from Castilla-La Mancha University. The participants were selected in accordance with the following criteria: a minimum of 3 years and maximum of 4 years of previous experience in swimming competition

before the beginning of the study; subjects also did not report any characteristics that would impede their participation in high-intensity or high-volume swimming training. Each participant was informed of all possible risks before the investigation and signed an informed consent document approved by Castilla-La Mancha University's ethics research committee. All procedures were in accordance with the Declaration of Helsinki. Four subjects withdrew voluntarily before the start of the program, because their main races were endurance long distances races of competitions in national events and they preferred to focus on their typical training programs. This resulted in a total of sixteen young swimming with characteristics (19.02±0.6 yrs. 165.3±3.8 cm 58.3±6.4 kg) divided into two groups: Traditional periodization (TP) and reverse periodization (RP) with main objective to prepare over a 10-week period their best performance in the 100m crawl and evaluated four times during the study.

Evaluations were conducted before the beginning of the program (T1), at the 4th week after the beginning of the swimming training (T2), at the 8th week (T3) and at the 10th week (T4).

Subjects performed a familiarization with the various test and assessment tools two days before the first test. They made the following evaluation.

TEST OF BODY COMPOSITION

We used a segmental multifrequency bioimpedance analyzer (InBody 720, Biospace Co. Ltd., Seoul, South Korea) to assess body composition and measurements. The "InBody 720" is a multifrequency impedance plethysmograph body composition analyzer, which takes readings from the body using an 8-point tactile electrode method, measuring resistance at 5 specific frequencies (1, 50, 250, 500 kHz, and 1 MHz) and reactance at 3 specific frequencies (5, 50, and 250 kHz) on each of 5 segments (right arm, left arm, trunk, right leg, and left leg).

Participants were instructed not to do any type of physical activity for 24 hours before testing. They were also told not to eat any food for 4 hours before the test to maintain a good hydration status, and then 30 minutes before beginning the tests, they were asked not to drink anything, not to urinate, and or defecate.

The participants stood barefoot in an upright position on foot electrodes on the instrument platform; both arms and legs were widely separated from each other. Four foot electrodes were used (2 oval-shaped electrodes and 2 heel-shaped electrodes), and participants were asked to grip the 2 palm-and-thumb electrodes (2 thumb and 2 palm electrodes per athlete). They did this barefoot and without any excess clothing.

The body height was measured using a commercial scale, and the skin and electrodes were cleaned and dried before testing.

SWIMMING PERFORMANCE TEST

In each application of the tests all swimmers performed a warm-up that consisted of 600m swim followed by rest period of 5 to 7 minutes before the test. The test consisted in a maximal 100m front crawl, performed in an indoor 25m swimming pool. Data times of 100m crawl (t100c), were recorded with a Colorado Timing System (Loveland, CO, USA) consisting in Infinity Start System INF-SSM; Aqua grip touchpad (188.5 x 90 cm) TP-188.5G and System 6 timing Console SYS6, and data was imported to a personal laptop with the Meet-Manager program of competition. Races was video-recorded with a digital video-camera JVC GR-D740. Of this test, we obtained data of 100m crawl (t100c), stroke frequency of 100m (SF) and stroke length (SL).

Training protocols, as described above, subjects were randomly assigned to treatment groups TP and RP (eight swimmers in each group). Statistical analyses showed no significant baseline differences in swimming performance or body composition.

The participants initiated the study after four weeks of summer period without training. Both groups performed identical volume and intensity of training but in different periodization models. The TP group began its training program performing aerobic low-intensity training (LIT) and aerobic threshold training (ThT) from week 1 to 4, and changing to high-intensive interval training (HIIT) and (ThT) in weeks 5 to 8. The RLP group began its program in HIIT and ThT from week 1 to 4 and changed to LIT and ThT from weeks 5 to 8. Both groups performed identical programs of training reduction (Taper), HIIT and LIT (Figure 1).

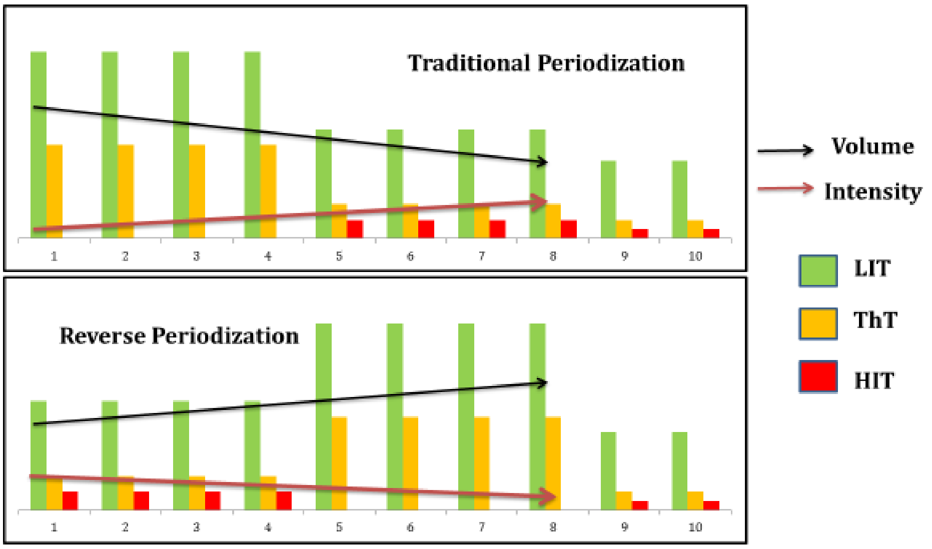

Figure 1.- Tendency of load distributions. Represents by total weekly volume in each period; A=accumulation; T=transformation; R=realization; LIT=low-intensity training; ThT= aerobic threshold training; HIT= high-intensive interval training.

Statistical analysis

Values are presented as mean ± SD. The normality of data was checked using Shapiro-wilk´s test. All variables presented normal distribution and homoscedasticity, and data was analyzed using analysis of variance for repeated measures (ANOVA) and between-group per moment comparisons with Tukey´s post hoc test. Significance level was accepted at $p \leq 0.05$ (table 1).

RESULTS

Results show how RP decreased significantly ($p<0.05$) t100c by significant increases ($p<0.05$) in SF at same time and reduced significantly ($p<0.05$) SL in T2; only RLP decreased significantly ($p<0.05$) time in t100c after 10 weeks of training. The rest of the assessment parameters of swimming performance did not change significantly in each group. Otherwise, body composition data show how TP increased significantly ($p<0.05$) FFM in T2, while reducing significantly ($p<0.05$) values in FM since T2 to T4 and reduced significantly ($p<0.05$) BF% in T2 to T4 assessment. RP has not significantly changed body composition values (table I).

Table I

Results of swimming performance and body composition

Group Swimming performance	**TP**	**RP**	Body composition	**TP**	**RP**
t100c (s) T1	59.58 ± 1.5	60.21 ± 2.6	FFM (kg) T1	25.1 ± 1.9	26.0 ± 4.1
T2	59.24 ± 1.6	57.68 ± 2.9*	T2	26.6 ± 1.8*	25.3 ± 2.4
T3	59.18 ± 1.9	57.70 ± 1.2	T3	26.0 ± 1.8	26.9 ± 4.3
T4	59.16 ± 1.8	57.16 ± 1.7*	T4	26.3 ± 2.0	27.2 ± 5.0
% change T1-T4	↓ 0.7%	↓ 5.3%	% change T1-T4	↑ 4.7%	↑4.6%
SF (bpm) T1	45.92 ± 1.2	48.33 ± 1.1	FM (kg) T1	11.5 ± 5.0	9.7 ± 4.2
T2	45.42 ± 1.2	51.58 ± 1.3*	T2	10.4 ± 4.7*	9.9 ± 4.1
T3	45.66 ± 1.4	48.00 ± 1.3	T3	10.3 ± 5.1*	9.7 ± 4.3
T4	46.25 ± 1.1	48.58 ± 1.0	T4	10.4 ± 4.9*	9.3 ± 4.5
% change T1-T4	↑ 0.7%	↑ 0.5%	% change T1-T4	↓10.5%	↓4.3%
SL (m/stroke) T1	1.45 ± 0.11	1.38 ± 0.09	BF% T1	19.2 ± 5.5	17.1 ± 7.3
T2	1.47 ± 0.11	1.29 ± 0.09*	T2	17.4 ± 6.7*	17.7 ± 7.0
T3	1.44 ± 0.14	1.39 ± 0.12	T3	17.2 ± 6.9*	17.3 ± 7.5
T4	1.42 ± 0.09	1.39 ± 0.09	T4	17.4 ± 6.5*	16.8 ± 6.4
% change T1-T4	↓ 2.1%	↑ 0.7%	% change T1-T4	↓.10.3%	↓1.7%

*=$p \leq 0.05$ vs T1. TP = Traditional periodization; RP = Reverse periodization; t100c = time 100m crawl (s); SF = stroke frequency (bpm); SL = stroke length (m/stroke); FFM = fat-free mass (kg); FM = fat mass (kg); BF% = body fat percentage (%); T1 = baseline valuation; T2 = evaluation after 4 weeks of training; T3 = evaluation after 8 weeks of training; T4 = evaluation after 10 weeks of training. The values were expressed by mean ± standard error of the mean.

DISCUSSION

The aim of this research was to compare how the organization of TP and RP, affect performance in swimming performance with relative trained swimmers after

10 weeks of training. The results obtained show how different distributions of volume and intensity of training caused different effects in swimming performances (100m crawl) and in values in body composition.

During the study, the groups included in this investigation did not receive information as to the values obtained in each test, except their personal times over 100m. This was done to avoid involuntary alterations in swimming technique. Analyzing data on the performance of swimmers in t100c between T1 to T4, we can see how the RP reduced significantly ($p<0.05$) 5.3% of the time to complete this distance. The LP reduced slightly, 0.7% time, to perform above baseline values. In our T2 assessment, the RP increased SF and reduced SL; in other cases, the TP reduced SF and improved SL. The results in t100c and SF variables show that at the end of the study results for both groups were highly influenced by the first period of training.

The TP start program from aerobic LIT and ThT training and during this time improved SL, when the group performed HIIT and Taper. Stroke values were changed but not significantly increasing SF. The LIT featuring slow strokes proved very useful to the economy of swimming for long distances, but this is one of the main weaknesses for competitive swimming distances of 200m and less[15,16,17] and we confirm in the present study this group improved SF during HIIT and Taper period of training, not significantly.

The most important improvements from aerobic training combined LIT with ThT appear among at weeks four to six after increasing training volume; these improvements are evident in the economy of movement (length per stroke) coinciding with aerobic threshold considered between 3~4mM/l. Frequently traditional training programs based in LIT+ThT spent between 6 to 11 months per year showed no significant improvements in time of competition.[18,19,20]

Besides, elite swimming races of 200m and less are completed in less time than two minutes, nevertheless traditional programs expend 12 or 18 hours per week swimming excessive volume of training and more than 75% of this volume is expended under the lactic threshold.[13,14,15,17] Some experts believe that this low-

intensity training is the main weakness that causes extreme stroke rate reductions.[15,16,17,18]

Recent studies have shown similar results to this study where training founded on the high volume of work are not profitable compared to high- intensity training programs.[21,22] One of the objectives of the LIT is to improve the swim-efficiency index. Another is the reduction of lactate concentrations and lactate clearance.[18,19,20] Then we hypothesized that a better strategy of training would be to perform sets of speed training to lactate production, before the LIT and ThT sets,[6,11] to improve the process of lactate clearance.

The RP group began its HIIT program by increasing SF (6.7%) during this period and decreasing similarly SL (6.9%) significantly ($p<0.05$) for both values – that means this group decreased its efficiency index in T2; in the second period of training, when the period increased in volume and after the Taper period, this group improved its swim-efficiency index with a non-significant improvement in SF (0.5% to RP vs 0.7% to TP).

The effect showed not significant difference between groups in SL, outcomes. TP showed a reduction of 2.1% and an RP improvement of 0.7%. At the end of this research (T4) the RLP group obtained better values in t100c (5.3% vs 0.7%) compared to the LP group for the 10 total weeks of study.

Comparing the results obtained in this research with previous investigations based in HIIT, the 5.3% improvement of RP for t100c is higher than the results achieved in the cited studies,[16,21,22,23] e.g. 3.4% obtained by Toussaint and Vervoorn[23] for the same training period (10 weeks) and higher also than the 2% observed in the first of the four years of study conducted by Termin and Pendergast, with high level swimmers.[16]

The improvements exhibit of RP in this research are higher than the 4% improvements suggested by Laursen,[13] since reports compiled in different sports. But all these reports were performed employing traditional training, which means HIIT after LIT or ThT periods. We believe that these extraordinary improvements may be due to the inclusion of HIIT since the beginning of training programs and the best

adaptations occurred due to the freshness with which the participants started the first period of the program, different to the TP group were the HIIT was trained after the aerobic training period.

Moreover, these high improvements can be attributed to the limited experience of the participants, coinciding these results of our study with Ebben et al,[24] who demonstrated how a similar type of training than reverse periodization (reverse step load) is better option to improve sport performance for athletes relatively untrained, and compared to linear traditional periodization. The results of the present study are in concordat to with previous researches;[21,22] where is exhibit that HIIT can be trained at the beginning of a cycle preparation and the assimilation occurs in less time than high- volume training.

Training HIIT, the first stage of adaptation is a neural reorganization of physical resources, which translates into improvements in speed movement in the training activity. This neural reorganization is represented in the brain and muscle fibers as a new pattern of movement. Some studies explain these adaptations comes from adaptations of the nervous system during speed-strength training similar to HIT and where improvements occurring in both, transmission from the central nervous system and responses such as a reflex-type level of the spinal cord with an increase of an agonist muscle activation and antagonist muscle relaxation,[15,25,26] these may explain the increases in SF and provide an option to train and maintain optimal SF at the end of races, avoiding those difficulty of maintaining optimal stroke rate in sprint races 200m and less.[15,17]

The data obtained at the taper volume reduction; represent considerably less than 3% improvement obtained in different sports, triathlon, running and swimming,[4,5,27] but most of these results are registered in endurance races (over 10 minutes) and involve high training volumes for long distance competitions – different from this study in which training volumes are moderated (adapted for a race less of 1 minute).

Most of swimming training programs are planned based on a high volume of workout expecting spectacular improvements after the taper period, This and

previous studies show that high-volume training does not always result in improved competitive performances after reducing the volume of training.[5,6,9,16]

After 10 weeks of swimming training, the TP group obtained better results in different parameters of body composition; in this group the greatest decrease in FM and BF percentage may be due primarily to the high values compared to the baseline. Despite this distribution of work in which the first period was focused on training volume following the second one which was focused in intensity, it seemed to be more effective in reducing fat mass for young swimmers than the distribution model proposed in the RP.

Values obtained in fat mass reduction of the TP group in this research are highest (10.5 vs 8.4%) than Sideraviciüte et al.[10] he difference could be attributed to the inclusion of HIIT and ThT training in this group and to training five sessions per week differently than two times per week, which is all the LIT performed in the study by Sideraviciüte.

To the FFM values, both periodization have similar results, although the TP sees a higher percentage gain than the RP (4.7% vs 4.6%) partially in concordance to the study prepared by Prestes et al.[2] who showed that traditional periodization is better option than reverse periodization to improve body composition values, although neither of the two groups studied obtained higher results (7.8%) in FFM outcome compared to that registered in Prestes' study, probably due to differences of fitness activity.

In swimming, highest values in FFM combined with high reduction of FM affect in negative swimming performance, this excessive muscle mass may increase the drag surface to water, which in some cases this gains in FFM and strength are not a compensation of the increased resistance of drag forces in water.[11,12]

CONCLUSION

With these results is concluded: reverse periodization planning is specific and efficient strategy for training sprinters 100m; moreover, 10 week of traditional periodization of swimming training, ends with a great reductions of fat mass. Farther,

aerobic volume of training. Does not always result in improved competitive performances and does not show superiority to High-Intensive Interval Training.

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