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J J. Arroyo-Toledo

Universidad de Castilla-La Mancha

Vicente J. Clemente

Universidad de Castilla-La Mancha

Jose M. Gonzalez-Rave

Universidad de Castilla-La Mancha

Domingo J. Ramos Campo

Universidad de Castilla-La Mancha

Andrew Sortwell

University of Wollongong, as259@uowmail.edu.au

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Keywords

specific, comparison, strength, between, values, traditional, reverse, periodization, swimming, performance

Disciplines

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COMPARISON BETWEEN TRADITIONAL AND REVERSE PERIODIZATION: SWIMMING PERFORMANCE AND SPECIFIC STRENGTH VALUES.

J. Jaime Arroyo-Toledo¹, Vicente J. Clemente¹, José María González-Rave¹ Domingo J. Ramos Campo² & Andrew D. Sortwell³.

Affiliations:

- ¹ Laboratory of Sport Training, Faculty of Sport Sciences. University of Castilla-La Mancha. Toledo, Esp.
 - ² Laboratory of Performance and Physical Rehabilitation, University of Castilla-La Mancha; Toledo, Spain.
 - ³ PhD Candidate at School of Education, University of Wollongong; Wollongong, Australia.
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Abstract

International Journal of Swimming Kinetics 2(1): 87-96, 2013. Periodization of athletic training is conceptualized as a pedagogical process, which involves varying volume, intensity and frequency of training in attempt to optimize sporting performance. The primary purpose of this research was to compare changes in 100m swim performance (t100c), specific swim power output (SSP) and maximum drag charge (MDC), after 14 weeks of training traditional periodization (control) and reverse periodization (treatment). There were 26 volunteer swimmers (16.02±0.6 yrs. 1.72±9.3 cm 64.1±9.3 kg) divided in two groups traditional periodization (TP) and reverse periodization (RP). Results at the 14th week showed significant improvements (p<0.05) in values of t100c (6.9%), SSP (20.9%) and MDC (10.0%) by RP above TP values. The results demonstrated that reverse periodization is specific and an efficient strategy of training for sprinters at time to reduce significantly load volume.

KEYWORDS: Reverse periodization, high-intensity, high-volume, threshold-training.

Corresponding author:

J. Jaime Arroyo-Toledo. Ph.D.

Section: Laboratory of Sport Training

Department: Faculty of Sports Sciences

Institution: University of Castilla-La Mancha

Address: Avenida Carlos III S/n. Zip Code 45004; Toledo.

Country: Spain. E-mail: dr.arroyotoledo@gmail.com

Fourteen weeks reducing load volume in a reverse periodization

INTRODUCTION

Since the popularization of sport form concept by Matveyev, (1977) traditional periodization is frequently used by many coaches in different a range of sports. In swimming training the traditional periodization adapted by Maglischo, Costill and Richardson (1992) includes four periods designated as follows: general endurance; specific endurance, competitive period and a taper period.

One of the characteristics of this traditional periodization often discussed is the high volume of workload used in the general and specific endurance periods to prepare different distances of competition, what includes training of sprinters. At this respect Costill, et al. (1991) reflects... *Since the majority of the competitive swimming events last less than 3 min, it is difficult to understand how training at speeds that are markedly slower than competitive pace for 3-4 hr/day will prepare the swimmer for the supramaximal efforts of competition.*

Swimming races being decided by only fractions of a second, many different training methods have been devised to improve performance. Currently it is known that short periods of high intensity training, with adequate resting time, it can produce similar initial adaptations to high volume of traditional endurance training (Gibala, et al. 2006). In swimming training there are different versions of high-intensive interval training (HIT) which has become popular; for example ultra short training (UST). Billat, (2001) explains how 10 seconds of work can be very easily balanced by rest periods of 10-20 seconds maintaining the specific speed of sprint races for more time than endurance training. Additionally, studies have demonstrated that high volume of swimming training has similar benefits and adaptations to high intensity training (Faude, et al. 2008; Sperlich, et al. 2010).

The development of specific strength and power qualities for swimming is commonly used training systems and elements that increase the resistance to displacement. In previous research, Girold, et al. (2006) have demonstrated that assisted and resisted swimming training using elastic tubes, is a better method to prepare sprinters of 100m than traditional training. Moreover Wright, et al. (2009) demonstrates in 5 weeks how competitive swimmers performing sets tethered to external loads obtain similar improvements in distance per stroke than endurance training. However tethered training is included in the training periodization at the competitive period, after the swimmers have swam several kilometres in the general and specific endurance periods; it can be concluded from the evidence of the research that endurance training may be partially substituted for high intensity training.

The model of reverse periodization previously investigated by, Arroyo-Toledo et al. (2013) shows that even if the workload is equal at the total of the periodization program, the directions of volume and intensity affects improvement in performance of swimming in different moments of total period of training. Despite this, there was no other study to compares the effects of traditional periodization program and reverse periodization.

The primary purpose of this research was compares change in 100m swim performance after 14 weeks of training traditional periodization and reverse periodization. The secondary purpose was to examine changes in stroke values, specific swimm power output and maximum drag charge tethered to external loads.

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MATERIALS AND METHODS

Participants

The participants were recruited by regional competitive program with average 5 years of training for a competition. In this study there were 26 volunteer swimmers (16.02 ± 0.6 yrs. 1.72 ± 9.3 cm 64.1 ± 9.3 kg) divided in two groups of 13 swimmer (5 women 7 men each group); subjects did not report any characteristics that would impede their participation in high-intensity or high-volume swimming training. Each participant and his parents were 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. The control group participated in the traditional periodization program (TP) and the experimental group participated in the reverse periodization program (RP). The main objective was to prepare over a 14-weeks period to do their best performance in the 100m crawl, which was evaluated five times during the study.

TESTING PROTOCOLS

Volume and intensity were strictly controlled for both groups throughout the training program; in the same way that all participants received nutritional information and were required to do not eat food supplements during the study. An attempt was made to control physical activity outside of the training program. All subjects performed a familiarization with the various test and assessment tools, 2 days before the first test and beginning of the study.

(a) Swimming Performance

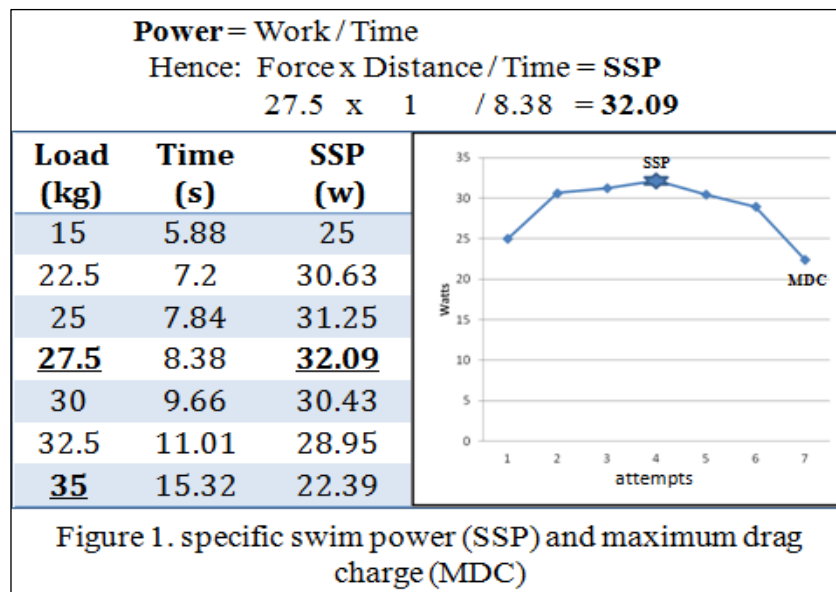
In each application of the tests all swimmers performed a warmup that consisted of 600m swim followed by rest period of 5 to 7 minutes before the test. The test consisted in a maximal 100m front crawl, performed in an indoor 25m swimming pool. Data times of 100m crawl (t_{100c}), were recorded with a 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. In the 100m crawl swim test, stroke rate (SR) was measured between 55 and 70 meters, using a chronometer Geonaute Trt'L 900 (China), distance per stroke (DPS) was calculated from time and the number of strokes in the last stretch of 25m.

(b) Tethered swimming to external loads.

To obtain the variables of specific swim power output (SSP) and maximum drag charge (MDC) was required a concentric tool of tethered swimming training named *Power-rack*. The test's protocol follows the next procedure previously described by Patnott et al. (2003) and Wright et al. (2009). Each participant used a belt connected to external weights load by non elastic cable, The swimmer should start into the pool in a supine position, without any force applied to the wall they swimm 10 m maximum effort starting with the less load (15kg) and increasing load (10kg) in each try, participants resting in passive form almost 4 minutes between each repetition until is able to complete the distance test (10m) in attempt to swimm attached to the maximal external load as possible. Two photocells of precision measure *Newtest 300* (Newtest Oy, Oulu, Finlandia) attached at the arms of *power-rack* tool register time in a Palm Zire tablet, 1 m between photocells equivalent to 7 m. MDC is expressed from the highest kg mobilized and complete the distance of each swimmer. SSP is obtained from the time,

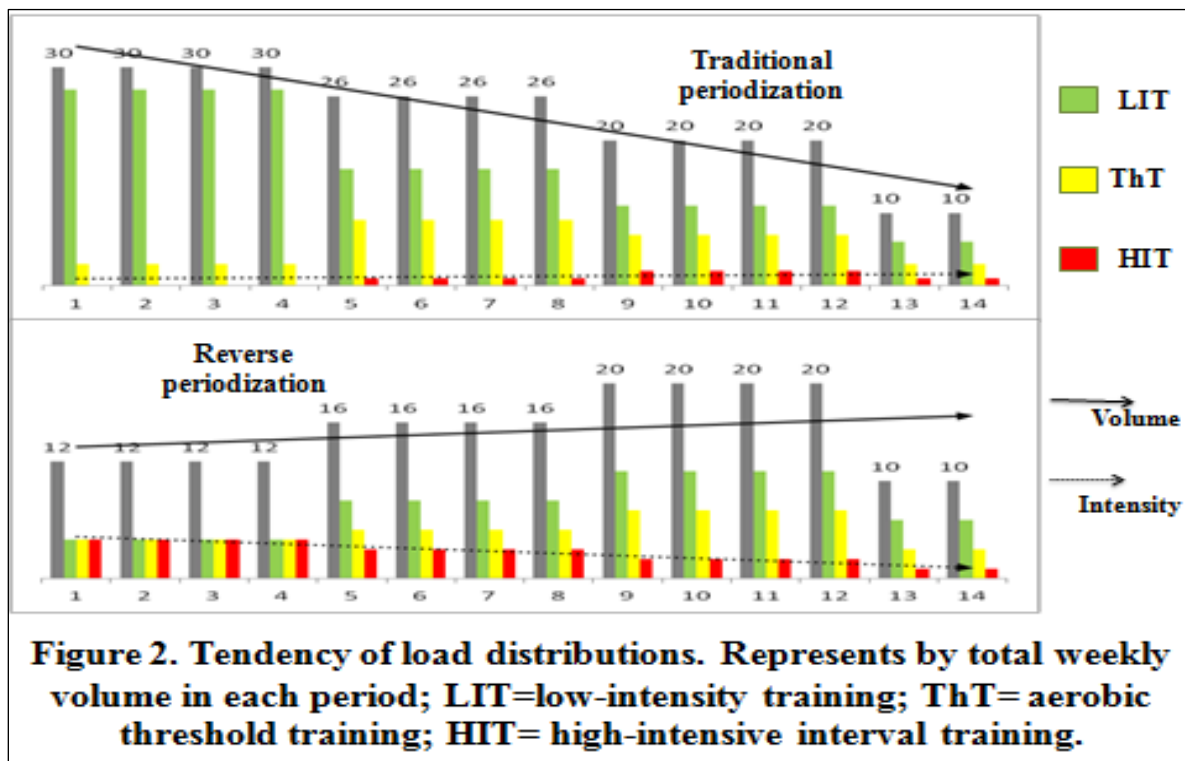
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distance between photocells of precision and kg completed in each attempt and calculated by the procedure expressed in figure 1.



TRAINING AND ASSESSMENT PROTOCOLS

The participants commenced the study after summer period without training. Group of TP began its training program with aerobic general phase and then aerobic specific periods. Group of RP began its program with a high intensity period which used: tethered training and Ultra-short training. Both groups perform identical volume and intensity during competitive and taper periods (figure 2). During the 14 weeks of training five evaluations were applied. They Consisted of a baseline (T1) and four post-tests: at 4th week (T2) at 8th week (T3) at 12th week (T4) and at 14th (T5).



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Subjects trained six days per week, in the initial period three sessions training was performed the main target of the period and three sessions performing complementary regenerative training; when they initiated the next periods, the participants maintained one day per week training of the past period to avoid lost the precedent stimulation. Three zones of training were required to control and quantify volume and intensity of training (Laursen, 2010), Zone 1=LIT<2 mM/l. Zone 2= ThT 2~4 mM/l. and Zone 3=HIT>4mM/l. Traditional periodization group swam in the 14 weeks a total of 324 km from that volume, the final distribution was 228 km to LIT; 82 km to ThT; and 14 km to HIT. Reverse periodization group complete 212 km of total volume from that, 104 km are swam to LIT; 70 km to ThT; and 38 km to HIT (Table 1).

Table 1. Training distribution, tests and typical series by period.

Group	Weeks 1-4		Weeks 5-8	Weeks 9-12	Weeks 12-14
TP	LIT (5-6 x 800m)		ThT (10-12 x 200m)	HIT (5 x25m) ThT (3 x 200m)	HIT (5 x25m) ThT (3 x 200m)
Period	General endurance 30 km/week		Specific endurance 26 km/week	Competitive 20 km/week	Taper 10 km/week
RP	(6-16 x 10m)		UST (6 x 20m)	HIT (5 x25m) ThT (3 x 200m)	HIT (5 x25m) ThT (3 x 200m)
Period	Tethered training 12 km/week		Ultra-short training 16 km/week	Competitive 20 km/week	Taper 10 km/week
Tests	T1	T2	T3	T4	T5

TP=Traditional periodization; RP=reverse linear periodization; T1=baseline valuation; T2=evaluation after 4 weeks of training; T3=evaluation after 8 weeks of training; T4=evaluation after 12 weeks of training; T5= evaluation after 14 weeks of training.

STATISTICAL ANALYSIS

Values are presented as mean \pm 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 $p \leq 0.05$.

RESULTS

Results at the 14th week show significant ($p < 0.05$) differences between groups per moment in variables of: t100c; SSP and MDC.

At inside-group assessments; traditional periodization decrease significantly ($p < 0.05$) values of SSP in T2 compared to T1; and increase significantly ($p < 0.05$) in T3, T4 and T5 compared to T2. The rest of assessment parameter did not change significantly in this group.

Inside-group assessments of reverse periodization show four times significant ($p < 0.05$) decreases in t100c, first one T2 compared to T1; second and third one T3 and T4 compared to T1 and T2; and finally T5 compared respectively to T1, T2 and T3.

Values of SSP increase significantly ($p < 0.05$) in T3, T4 and T5 compared to T1 and T2. Results in MDC increase significantly ($p < 0.05$) in T4 and T5 compared to T1 and T2.

Values of SF and DPS did not change significantly for each group (table 2).

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Table 2. Summary of assessments to 14 weeks.

Group	Variable	T1	T2	T3	T4	T5	% Change T1-T5
TP	t100c (s)	61.6 ± 1.1	61.3 ± 1.0	61.2 ± 1.0	61.2 ± 1.1	61.3 ± 1.2	↓ 0.4
	SR (s/m)	44.78 ± 2.3	46.58 ± 2.1	46.20 ± 2.6	46.26 ± 2.3	46.09 ± 2.2	↑ 2.9
	DPS (m)	1.37 ± 0.04	1.31 ± 0.03	1.32 ± 0.05	1.32 ± 0.04	1.33 ± 0.04	↓ 3.0
	SSP (w)	43.2 ± 4.7	39.2 ± 4.2*	44.8 ± 4.4‡	45.4 ± 4.1‡	45.7 ± 3.9‡	↑ 5,7
	MDC(Kg)	49.7 ± 4.3	47.9 ± 4.3	49.5 ± 4.2	50.8 ± 4.1	51.4 ± 3.7	↑ 3,4
RP	t100c (s)	62.7 ± 1.5	60.9 ± 1.4*	59.1 ± 1.2**	58.6 ± 1.5**	58.6 ± 1.3**†	↓ 6.9 †
	SR (s/m)	48.71 ± 3.1	47.56 ± 2.5	47.98 ± 2.3	49.57 ± 2.7‡	46.88 ± 2.8	↓ 3.9
	DPS (m)	1.28 ± 0.04	1.28 ± 0.03	1.23 ± 0.02	1.18 ± 0.03‡	1.25 ± 0.03	↓ 2.4
	SSP (w)	41.0 ± 3.7	40.6 ± 3.1	46.0 ± 3.5**	47.6 ± 4.2**	49.6 ± 4.7**	↑ 20.9 †
	MDC Kg)	45.7 ± 3.9	46.1 ± 3.9	49.6 ± 4.2	49.6 ± 3.4*	50.3 ± 3.9**	↑ 10.0 †

*=p<0.05 vs T1; ‡=p<0.05 vs T2; †= p<0.05 vs T3; ‡=p<0.05 for between-group comparisons. TP=Traditional periodization; RP=Reverse periodization; t100c=time 100m crawl; SR=stroke rate; DPS=distance per stroke; SSP= Specific swim power; MDC=Maximal drag charge: T1=baseline valuation; T2=evaluation after 4 weeks of training; T3=evaluation after 8 weeks of training; T4= evaluation after 12 weeks of training; T5= evaluation after 14 weeks of training. The values were expressed by mean ± standard error of the mean.

DISCUSSION

The aim of this study was compares change in 100m swim performance after 14 weeks of training traditional periodization and reverse periodization. Results show that reverse periodization produced highest improvements in 100m swim performance than traditional periodization. To our knowledge this is the first study to compare TP and RP in swimming training. Similar to previous study (Arroyo-Toledo et al. 2013), the present study confirms the effectiveness of RP to improve performance for sprinters 100 m.

An important finding in the present research is the high reduction of volume-load by side of RP (212 km to RP vs 324 km to TP); the total volume of experimental group (RP) is even less than the total volume performed by the traditional periodization group in the training zone of low intensity.

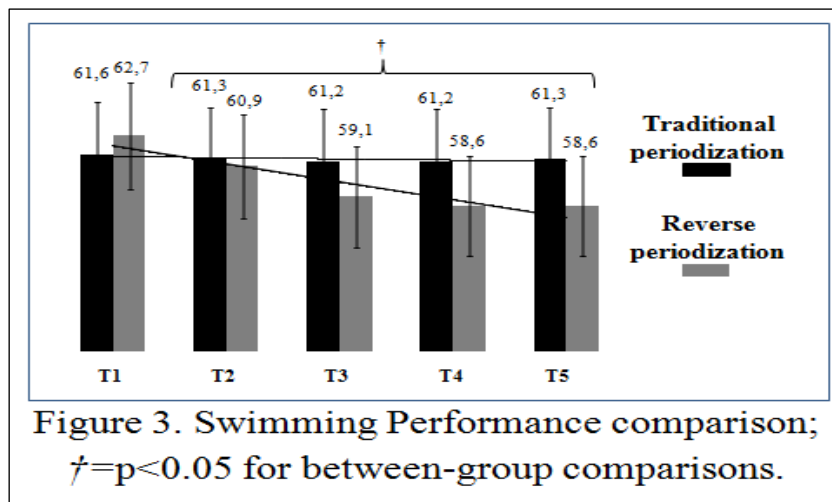
Swimming Performance

During the course of the study, the participants included in this investigation did not receive information as to the values obtained in each test, except their personal 100 m time. This was done in order to avoid involuntary alterations in swimming technique.

Analyzing data on the performance in t100c between T1 to T5, we can see how the final results for both groups were highly influenced by the first period of training. The data show how the main differences between groups were registered among the first eight weeks of training; such as TP register reduction of 0.4% in T2, and 0.1% between T2 to T3 during the periods of general and specific endurance. Otherwise RP in the first 8 weeks reduces significantly (p<0.05) 2.9% in T2 and 3.0% in T3 at the respectively period of tethered training to external loads and ultra-short training.

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In the (T4) competitive period, TP shows no significant changes while RP reduce significantly ($p<0.05$) 0.8%. In the last taper period (T5), TP increased not significant 0.1%, at moment RP show no changes (figure 3).



Apparently the high volume of training performed in the general and specific endurance periods could be exhaustive for the TP group; that is a probably factor due to the increases in time at the final assessment (T5).

Thomas, et al. (2008) consider that is beneficial for the swimming performance increase the volume of training previously to the taper reduction but at same time is required more time of taper period (21-28 days) to express the benefits by the overload work; at this respect we can see by the results how the strategy of volume modulation for TP was exhaustive and apparently the moderate volume of RP was better option. Most of swimming training programs based on a high volume of work-load expect improvements after the taper period, Our study, and previous studies, show that aerobic volume of training does not always result in improved competitive performances after reducing the workload period.

RP group obtain better results mainly attributed to the strategy of began the program from the tethered training and ultra short training, this results coinciding partially with previous researches showing how high-intensive interval training can be trained at the beginning of a cycle preparation and the assimilation occurs in less time than the aerobic period of volume of training (Faude et al. 2008; Sperlich et al. 2010) at same time than differs of cited studies about that, in the present study high-intensive interval training demonstrate higher efficacy to prepare sprinters of 100 m compared to high volume of training.

Laursen, (2010) affirm than two sessions of high-intensive interval training per week is enough work to obtain benefits between 2~4% improvements of performance, these statements coincide for RP in the periods of tethered training to external loads and ultra-short training, We believe that these extraordinary improvements may be due to the inclusion of high-intensive interval training, the best adaptations occurring during the first period of the Program when the subjects were not fatigued. This was different from the TP group, who followed high-intensive interval training after having been under stress in the aerobic periods.

Stroke values

Results in stroke values were different than in a previous study (Wakayoshi et al. 1993), in the present research TP group increase the number of strokes and reduce the distance per stroke since the T2 to T5 assessments, similar situation is observed in RP group in T4 at moment to

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increase the volume of work-load but obtaining the best results for stroke values in the T5 when the taper period was performed, that suggest than four weeks of overload increase was benefit for RP group but the eight weeks of endurance training for TP was high stressful.

This phenomenon of increase stroke rate at time to reduce distance per stroke is usually named as reduction in swimming efficiency, in case of the present research can be attributed at the controversial and not entirely clear theories of muscle damage induced by prolonged exercise, experts of physiology (Wilmore & Costill, 1988) show how in part, the continuous prolonged exhaustive exercise is responsible for the localized muscle pain, tenderness, and swelling associated with muscle soreness; also observed technical mistakes associated with overtraining and modifications in swimming technique in attempt by swimmers to keep the race pace. Besides, the low intensity training featuring slow strokes proved very useful to the economy of swimming for long distances, but some studies support the idea of this is one of the main weaknesses for competitive swimming distances of 200m and less (Costill et al. 1991; Maglischo, 2011).

Tethered swimming to external loads

Results of the variables in tethered swimming to external loads show that were affected significantly. TP decrease significantly ($p<0.05$) specific swim power output in T2 compared to T1, after the general endurance period, that can be interpreted as that the endurance training was negative for specific swim power output; data of assessments T3 to T5 show significant ($p<0.05$) improvements compared to T2 but not to T1. In this group the improvement in maximal drag charge is total not significantly 3.4% for the fourteen weeks.

RP group produced significant ($p<0.05$) improvements above TP values for both variables specific swim power and maximal drag charge. Difference between groups can be adduced to the different protocol of training (endurance low intensity training vs high intensive training); this kind of work (tethered training and Ultra short training) is the most specific form to recruit and involve in the swimming activity all individual muscle type of fibers and that represent a weakness by the endurance low intensity training, where are trained primarily slow fibers as explained by Maglischo, (2011).

Result by RP group in specific swim power is close (20.9% to 21%) of the results expressed of Patnott, et al. (2003) but differs in time period of study, 14 weeks for the present research and 21 weeks in Patnott's study, that difference can be attributed by the inclusion of tethered training since the first week of training.

In the 4th week RP reduced but not significantly 0.9% in values of specific swim power, this results match with Patnott, et al. (2003) whose show first a reduction in values of power and improvements in the second half part of the 21 weeks. At same time these results of the 4th week (T2), differs to the study performed of Wright, et al. (2009) who's found improvements of 7.6% in specific swim power after five weeks of tethered training. Probably reason of the differences between studies is the higher experience of subjects in Wright's study.

The present study coincides with the finding of Girolid, et al. (2006), in both studies tethered training results show how is better strategy to prepare sprinters of 100m than traditional training. At the same time the present research confirms how high volume of training has not advantage above high intensive interval training, similar than previous studies (Faude et al. 2008; Sperlich et al. 2010), and provide an answer of how short periods of high intensity training, with adequate resting time, produce similar and better initial adaptations than high volume of traditional endurance training, coinciding with Gibala, et al. (2006). Future studies

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would replicate the present research including a significant higher number of participants to confirm these results.

CONCLUSION

With these results is concluded: reverse periodization planning is specific and efficient strategy for training sprinters 100 m at time to reduce significantly load volume; moreover, traditional periodization of swimming training overrates effects of high volume of work-load with low specific applications for sprinters.

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