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Traditional periodization upgrade sport performance and heart rate variability of experienced triathletes.

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Abstract*: 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 compares change in running and swimming performance, after 36 weeks of intervention program of 17 weeks traditional periodization (TP) followed to a 17 weeks period of Polarized training distribution(POL). The secondary purpose was to examine changes in heart rate variability. There were eight healthy well-trained triathletes, with average 9 years of experience training for a competition (36.2 ± 4.8 years; 173.5 ± 12 cm; 73.1 ± 2.6 kg). Results after 36 weeks of study showed exhibit significant ($p<0.05$) improvements in swimming, running performance and heart rate variability after completing the TP plan of 17 weeks. Otherwise, the results exhibit stagnates of swimming and running performance, during and after the intervention of POL. The results demonstrated that Traditional periodization based on endurance period, competitive and peak periods; is efficient strategy for training and improve competitive performance to experienced triathletes. Polarized training distribution is an option to maintenance performance at time to reduce volume of training.*

Keywords*: Periodization, Polarized, training-distribution high-intensity, threshold-training, heart rate variability.*

INTRODUCTION:

In the competitive sports, most of coaches and athletes, frequently organize their training program in a periodical plan to maximize performance. This preparation plan is well known it as "Periodization" and has been described as a pedagogical process in where variations in volume, intensity and frequency of training are organized to raise the level of competitive sport performance.[1]

Periodization have been used over the past decades, in the practice of training all different range of athletes from de novice to elite level. A typical program of traditional periodization (TP) starts on a basic preparatory period by building volume workload of aerobic low intensity of training (LIT); followed by gradually altering the preparation, reducing the total amount of volume at time to increasing the intensity of the exercise into a called competitive period. This competitive period is characteristic by the predominant workout of aerobic threshold (ThT) and the High-Intensive Interval Training (HIIT). [2-3]

Although the most effective periodization is yet to be determined; multiple studies show how determinant is the influence of aerobic training on competitive performance for a distance events. [3-4-5-6]

Polarized training distribution (POL) introduces a fashion planning characterized to avoid excessive training on the ThT. Recent studies examining and support the training intensity distribution of Polarized training of 80~85% LIT; 10~20% HIIT; and high tendency to abridge the training intensity between ventilatory thresholds of less than 5% ThT workload. [4-5-6]

The published reports of POL have studied effects of endurance sports as Nordic skating; route cycling, and runners with expertise of distance events. These studies suggest to the POL is good option to the preparation of athletes of disciplines of predominant requirement of endurance. [4-5-6]

Otherwise, researches comparing POL with other tendencies of training load distribution are very limited; as limited also are reports that have searching a period of study effects of POL greater than 15 weeks of intervention. [4]

The primary purpose of this research was compares change in running and swimming

performance, after 36 weeks of intervention program of 17 weeks traditional periodization followed to a 17 weeks period of Polarized training distribution. The secondary purpose was to examine changes in heart rate variability.

MATERIALS AND METHOD:

Participants

Participants were eight healthy well-trained triathletes, engaged in representative national training program, with average 9 years of experience training for a competition (36.2 ± 4.8 years; 173.5 ± 12 cm; 73.1 ± 2.6 kg) before begins the intervention, subjects practice training 109.8 ± 43.8 minutes per day, 10 ± 2 training sessions per week, and were required to them attend a medical examination. Subjects did not report any characteristics that would impede their participation in high-intensity or high-volume training. Each participant was informed about the porpoise of the study and possible risks before the investigation and signed an informed consent document. All procedures were in accordance with the Declaration of Helsinki.

Participants in this study had previous experience in training traditional periodization. Volume and intensity were strictly controlled throughout the training program; in the same way that all participants received nutritional information and were required to do not consume ergogenic supplements during the study.

Training intervention and assessment protocols

Program intervention begins performed a macrocycle of 17 weeks traditional periodization (TP); after this first procedure of the intervention, triathletes had two weeks of transition period and after that they performed a second macrocycle of 17 weeks Polarized training (POL).

Three zones of training were required to control and quantify volume and intensity of training: Zone 1= Low Intensity training (LIT) <VT1. Zone 2 of Threshold Training (ThT) VT1 ~ VT2. and Zone 3 of High intensity of Training (HIT) >VT2. TP planning consisted of: nine to ten sessions per week, where four to five was mainly trained at LIT; three ThT; and two practices at week HIT.

The participants commenced the study after summer transitory period. During the 36 weeks of study, eight evaluations were applied, it´s comprises four mesocycles per macrocycle. Data collection start before beginning the intervention plan (T1); the TP began its program by preparatory period ending at the 9th week (T2) and then the competitive period ends at the 14th week (T3) peaking period of preparation concludes at the 17th week (T4). Of the total distance of swimming training 233km was training in zone 1; 36,5km was training o the zone 2 and 14,8km was performed at the zone 3. The group train for a running a total of 1033km on zone 1; 182km at the zone 2 and 35km on the zone 3 the weekly training distribution is exhibit in the Figure 1.

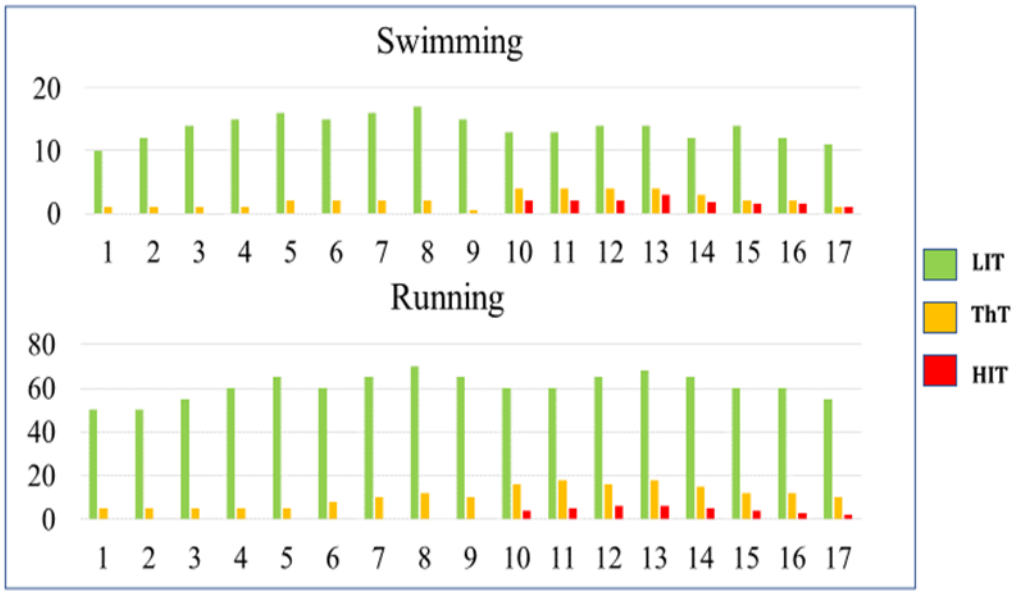

Figure 1.- Traditional Periodization Tendency of load distributions. Represents by total weekly volume. LIT=low-intensity training; ThT= aerobic threshold training; HIIT= high intensive training.

After two weeks of transition it has been made the initial test of the POL (T1POL) and at the end of the

where five was mainly trained at LIT; only one practice of ThT; and three practices at week HIT. During the POL planning training participants train for a swimming, 193km to the zone 1; 17km on the zone 2 and 26,8 on the zone 3. The running training 9th week (T2POL) at the end of the 14th week (T3POL) and at the end of the 17th week (T4POL). POL planning consisted of: nine sessions per week, preparation was a total of 873km on zone 1; 85km to zone 2 and 94km performed on zone 3. Figure 2 show the load distribution of the Polarized plan intervention.

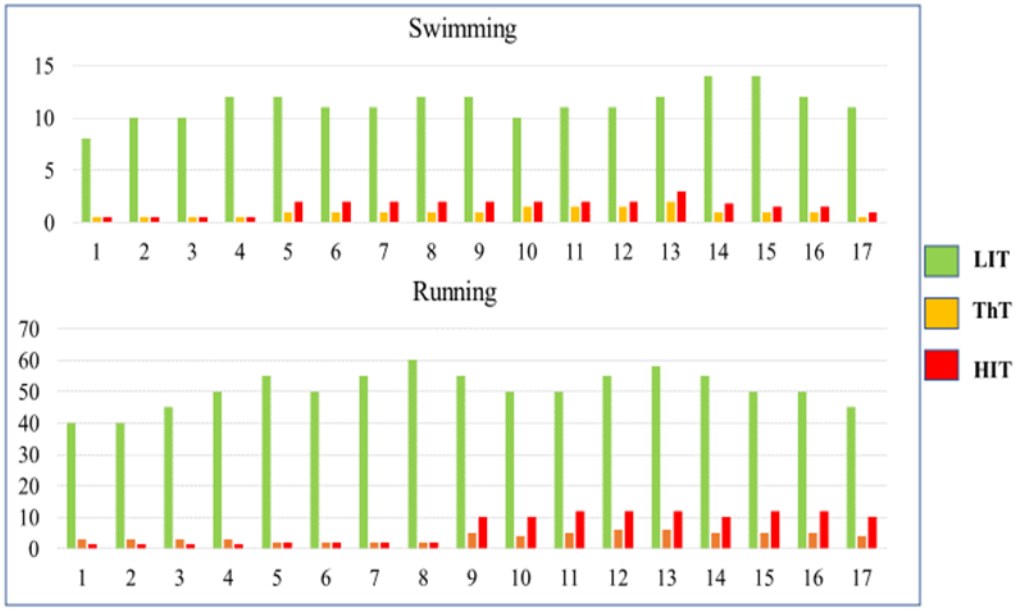

Figure 2.- Polarized Tendency of load distributions. Represents by total weekly volume. LIT=low-intensity training; ThT= aerobic threshold training; HIT= high intensive training.

Swimming Performance

The initial test evaluates swim performance. In each application of the tests, participants performed a warm-up that consisted of 800m swim followed by rest period of 5 to 7 minutes before the test. The test consisted in a 800m maximal effort front crawl divided in two repetitions of 400m with a break of one minute between repetitions, tests were performed in an indoor 25m swimming pool. Data times of 400m crawl (t400c) and the sum of both repetitions 800 meters (t800m), 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. Heart rate was measured through Polar S810. (Polar Electro Ibérica. Barcelona).

Running Performance

Running performance was evaluated after four hours of recovery break, subjects performed a warm-up of fifteen minutes of running below 140 bpm followed by rest period of 5 to 7 minutes before the test. The test consisted in evaluate time of maximal effort 3000 m (t3000r) performed in an official 400m track stadium. Data times of t3000r, were recorded with a photocell of precision measure Newtest 300 (Newtest Oy, Oulu, Finlandia), data was directly imported to a personal laptop.

Heart rate variability

Heart rate (HR), and heart rate recovery data was also collected after three ($HR^{3'recovery}$) and five minutes ($HR^{5'recovery}$) for both tests, swimming and running performance. Heart rate was measured through Polar S810. (Polar Electro Ibérica. Barcelona).

Statistical analyses

Data obtained from this research were treated statistically with the SPSS 17.0 statistical application. Values are presented as mean ± SD. Normality and homocedasticity assumptions were checked with a ShapiroWilks test.

A variance analysis and Bonferroni post hoc test were carried out on the variables that supported the normality and homocedasticity assumptions. A Wilcoxon test was performed on the variables that

did not support the normality and homocedasticity assumptions. Significance level was accepted at $p \leq 0.05$.

RESULTS

Results shown how decreased significantly ($p<0.05$) swimming performance in t400c and t800c and Heart rate recovery 3 and 5 minutes, after the Competitive (T3) and peaking (T4) periods. Data exhibit significant decrease ($p<0.05$) of t3000r, and heart rate recovery 3 and 5 minutes at the end of TP in T4. Variables records of POL didn´t change significantly. Summary of data collected is exhibit in table 1.

Table 1. Summary of assessments to 36 weeks.

Periodization		Variable	T1	T2	T3	T4
	Swimming Performance					
TP		t400c (s)	354.3±21.7	352.6±39.6	344.0±42.4*	322.4±5.7*
		HR (bpm)	177.5±12.0	175.8±7.3	168.6±10.3	163.3±14.0*
		t800c (s)	780.3±14.3	752.6±10.8	691.3±9.9*	652.5±16.3*
		HR (bpm)	176.7±11.2	174.2±8.9	169.6±9.1*	170.5±8.2
		$HR^{3´recovery}$	90.3±9.3	82.5±10.6	80.2±9.3	75.2±7.1*
		$HR^{5´recovery}$	83.5±6.3	80.0±14.3	70.9±12.8*	72.5±6.5*
POL		t400c (s)	348.4±42.3	349.1±22.6	352.3±14.3	350.1±6.9
		HR (bpm)	169.6±13.3	170.0±11.4	171.3±5.9	172.5±8.2
		t800c (s)	697.9±6.8	798.6±3.1	705.3±2.8	700.9±8.6
		HR (bpm)	168.7±14.9	169.8±10.2	170.2±9.4	170.8±6.7
		$HR^{3´recovery}$	81.3±9.2	80.2±11.3	79.6±8.9	80.2±5.6
		$HR^{5´recovery}$	72.6±8.0	71.3±9.8	71.5±6.0	70.6±8.3
	Running Performance					
TP		t3000r (s)	691.0±36.8	664.0±12.7	651.6±18.2	620.3±13.4*
		HR (bpm)	179.3±22.2	169.3±9.2	167.4±14.1	169.1±15.6*
		$HR^{3´recovery}$	93.0±14.6	86.5±19.1	88.2±18.4	79.5±14.8*
		$HR^{5´recovery}$	87.0±12.6	82.0±17.1	84.5±12.0	77.0±11.3*
POL		t3000r (s)	656.3±14.9	651.0±13.9	652.9±14.6	651.0±11.2
		HR (bpm)	169.3±11.6	167.5±10.6	168.3±10.8	167.9±9.8
		$HR^{3´recovery}$	89.6±14.3	88.7±17.0	87.2±11.5	86.3±16.9
		$HR^{5´recovery}$	80.1±12.3	82.5±13.4	80.3±16.3	79.1±10.5

TP=Traditional periodization; POL=Polarized training distribution; T1=baseline valuation; T2=evaluation after 9 weeks of training; T3=evaluation after 14 weeks of training; T4= evaluation after 17 weeks of training. t400c=400m crawl; t800c=800m crawl; t3000r= 3000m running; HR= heart rate; $HR^{3´recovery}$= heart rate after 3 minutes recovery; $HR^{5´recovery}$= heart rate after 5 minutes recovery; *=$p<0.05$ contrast to T1.

Discussion

The primary purpose of this research was to compares change in running and swimming performance, after 36 weeks of intervention program of 17 weeks traditional periodization followed to a 17 weeks period of Polarized training distribution.

The results exhibit significant ($p<0.05$) improvements in swimming and running performance after completing the traditional periodization plan of 17 weeks. Otherwise, the results exhibit stagnates of swimming and running performance, during and after the intervention of Polarized training distribution.

The swimming performance of t400c and t800c was significant ($p<0.05$) at the T3 evaluation t400c, exhibit 10 seconds of improvements (2.9%); at the T4 the improvements were a total of 32 seconds (9.9%). The t800c variable has the highest improvement detected during the study; these improvements were of 1:39 minutes (12.8%) at the T3; and a total of 2:08 minutes (19.6%) improvement of swimming performance at the total of 17 weeks.

During the development of the polarized intervention; the variable t400c did not search significant variations. Were observed stagnate of performance with a frequent worsening and total deterioration of 2 seconds (0.5%). The variable t800c were also negatively affected during the POL intervention with a total deterioration of 3 seconds (0.4%).

The data of t3000r get in significant ($p<0.05$) improvements of 1:11 minutes (11.4%) for the total of 17 weeks intervention of traditional periodization.

The variant of t3000r was the less affected during the POL, achieving a very slight improvement of 5 seconds (0.7%) to a total 17 weeks.

In swimming training the traditional periodization adapted by Maglischo, Costill and Richardson (1992) includes: general and specific endurance period, competitive period and a peaking period. The present study confirms how useful is this plan of preparation to enhance performance of endurance athletes. [7] Coincidentally with previous studies. [2-3] and the theory of sports performance development. [1]

The endurance training of Low Intensive Training (LIT) featuring slow strokes proved very useful to the economy of swimming training long distances. [8] Some of the relevant positive effects from aerobic training LIT and ThT, start to be evident about at the fourth to sixth week of training. Biomechanically, these improvements are evident in the economy of movement (length per stroke); [9] physiological adaptations include: reductions of blood lactate concentrations to the same step pace, increases in oxygen uptake and consequently improvements of performance. [10]

Otherwise, previous studies explain how planning of periodization based on high-volume of training, lose effectiveness to stimulate adaptations if they are maintained for prolonged periods. [11] That could partially explain the deterioration during and after the POL program.

Laursen,[13] affirms than two sessions of high-intensive interval training per week is enough workout to obtain benefits around 2~4% improvements of performance, these statements coincide for the TP but not in case of POL even though the plan of POL included one HIT session per week more than the plan to TP.

The high-intensive interval training consisted in "*repeated bouts of exercise lasting ~1 to 8 min and eliciting an oxygen demand equal to ~90 to 100 % of VO2max, separated by rest periods of 1 to 5 min"* [13] and it is of very high proven effectiveness for to training of medium and short distances of competition; but the evidence of the present and previous research exhibit how the ThT should not excluded of the preparation plan. [2-3] Billat and colleagues, [14] explored this query in a group of middle distance runners initially training six sessions per week of LIT only. And then; they found that a training intensification to four LIT sessions, one HIT session, and one ThT session resulted in improved running speed at VO2max.

The secondary purpose of this research was to examine changes in heart rate variability. Autonomic adaptations expressed at the variable of HR; and after recovery as the variables $HR^{3'recover}$ and $HR^{5'recover}$

The results show significant ($p<0.05$) improvements during effort and faster recovery after maximal effort at the end of the macrocycle of TP. Besides, the results exhibit stagnates of the to the same variables, during and after the intervention of POL.

Results of swimming performance during the intervention of TP, exhibit frequent improvements in data collection, compiled at the end of each of the three periods (preparatory, competitive and peaking) this swimming improvements were achieved at same time to decreases of HR $HR^{3'recover}$ and $HR^{5'recover}$

This adaptation represents a raise of cardiac efficacy throughout effort and at the recovery. Therefore, improved oxygen uptake; muscular oxygen delivery; and less blood lactate concentration. Supporting the findings of previous studies as Costill et al. (1991), and Wakayoshi et al. (1993). [9-10]

This HR improvements, is the ending result of a prolonged process, in which low-intensity aerobic training of LIT at the first period of endurance development, promotes gain of pillarization and increase in mitochondria.[15] And then at the second period (Competitive) the intensification of training (HIIT) stimulates and increases the performance of heart muscle. [3-5-6-9-10-12-13-14-15] Furthermore, confirms that: periodize training is the most efficient way to improve competitive performance through positive physiological adaptations. [1-2-3-7-11]

An interesting finding of this research is in relation to the reduction amount of volume training during the POL. These results suggest that once the way sports developed the peak of performance, it is possible to keep the sporting achievements with a reduced training load organized under the suggestions of the Polarized training distribution.

However, one of the potential weaknesses of this research is the impossibility of organize parallel training groups studied in equal volume and intensity to analyze in depth the performance from both programs after training.

CONCLUSION

With these results is concluded: Traditional periodization based on endurance period, competitive and peak periods; is efficient strategy for training and improve competitive performance to experienced

triathletes. Polarized training distribution is an option to maintenance performance at time to reduce volume of training. Farther, traditional periodization appears positive related to autonomic adaptations. Whilst Polarized training distribution are associated to aerobic fitness maintenance.

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