Concentrated Load On A Reverse Periodization, Propel Higher Positives Effects On Track Test Performance, Than Traditional Sequence.

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Abstract: Periodization of sport training, is a systematic manipulation of parameters as volume, intensity, frequency and duration of exercise stimuli. The primary purpose of this research was compares change in Athletic Running Performance, after training block periodization and reverse periodization. The secondary purpose was to examine changes in Heart rate variability. There were 16 volunteer male participants (28.0±1.6 yrs. 1.72±5.3 cm 84.1±9.3 kg) divided in two groups. The control group participated in the Block Periodization program (BP), and the experimental group participated in the Reverse Periodization program (RP). This research lasted 10 weeks in which 4 assessments were made. They Consisted of a baseline (T1) and three post-tests: at 4th week (T2) at 8th week (T3) and last test at 10th week (T4) of intervention. Results at the end of study, show significant (p<0.05) improvements on Athletic Running Performance; favorable to Reverse periodization. Block periodization appears better related to aerobic physical fitness.

KEYWORDS: Reverse-Periodization, Athletic-training, high-intensity, Aerobic-training, threshold-training.

INTRODUCTION:

Periodization of training is a pedagogical process in where the preparation of athletes is fragmented in shorter periods with a specific target and constant variations of volume, intensity and frequency of training, to stimulate positive physical adaptation and to enhance sports performances.¹

In the competitive sports, most of coaches and athletes, from beginners to elite level of competition, frequently organize their training program in a periodical plan to maximize performance, achieved through correct balance of stress/recovery relationships.²

A program of traditional periodization (TP) usually starts on a basic preparatory period by building volume of aerobic training (VAT) and 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 High-Intensive Interval Training (HIIT).³

To date, there have been only a limited number of studies comparing different periodization models in competitive track running and most of the researches are focused to compare TP to Block periodization program (BP) which is characterized by an initial accumulation block that demands a high-volume training performed at relative low-intensity; followed by an intermediate block of transformation and followed to the last block of realization, the main characteristic of BP is a mesocycles are called blocks and are more intensive and shortened of the TP. In the scientific literature, both TP and BP model is often referred to as the “classic linear periodization model” or “block with linear increase.¹⁻⁴

The concept of reverse periodization (RP) introduced a paradigm that is conversely to the TP plan, starting the first period of preparation focus on the specific speed of competition. To achieve this goal, HIIT is the initial training tasks, and then at the next period, gradually increasing aerobic volume of training. Currently, RP was studied in weights-lifting training,⁵ in rowing training ⁶ and swimming training ¹⁻⁴ But to date no one study reports results comparing BT to RP in the track athletic training.

In the athletic training; the distances of 400 (t400m) and 1000 (t1000m) meters are both track tests usually employed to predict level of performance to the athletes. The (t400m) is a speed
endurance test and official event, that demands a capacity to maintain close to maximum speed in an effort longer than 45 seconds, that requires an appropriate training and effort distribution of strength, speed and endurance.\(^7\)

The (t100m) test is not official race of competition, however is a test frequent required to predictive performance, because it yields in a unique evaluation, with a relevant information of the both state of aerobic and anaerobic performance, furthermore, many coaches used as a test to interprets the aerobic and anaerobic thresholds to best control the workload and effects of training.\(^8\)

Heart rate variability, is one method that has been used to monitor the recovery process following strenuous exercise: Besides, these processes of periodization usually cause and are accompanied by changes in the cardiorespiratory responses.\(^9\)

The primary purpose of this research was compares change in Athletic Running Performance, after 10 weeks of training block periodization and reverse periodization. The secondary purpose was to examine changes in heart rate variability.

**MATERIALS AND METHOD:**

**Participants**

Participants were healthy well trained members of the local fire department, engaged in regional training program, with average 9 years of experience training for a competition. In this study, there were 16 volunteer male participants (28.02±1.6 yrs, 1.72±5.3 cm 84.1±9.3 kg) divided in two groups of 8 participants each group; subjects did not report any characteristics that would impede their participation in high-intensity or high-volume running 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.

The control group participated in the Block Periodization program (BP), and the experimental group participated in the Reverse Periodization program (RP), this research lasted 10 weeks in which 4 assessments were made. They Consisted of a baseline (T1) and three post-tests: at 4th week (T2) at 8th week (T3) and last test at 10th week (T4) of intervention.

**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. All subjects performed a familiarization with the various test and assessment tools, 2 days before the first test and beginning of the study.

**Track Test Performance**

In each application of the tests all participants performed a warmup that consisted of 10 minutes running at aerobic low intensity, followed by 4 repetition of 200m in a progressive demand of easy to medium intensity; once the participants were completed the warm-up they rest sited for a period of 5 to 7 minutes before the initial test. During the period of rest after warm-up; the auxiliary researchers provided each participant with a heart monitor. Heart rate was measured using Polar S810. (Polar Electro Ibérica. Barcelona), with smart breast sensor.

The initial test consists of a maximal effort running of 400 meters (t400m), performed in an official 400m track stadium. Once completed the total data related to t400m; participants practice an active recovery, running and walking for a period of 20 minutes and resting passively 3-5 minutes before reported ready to the second test consisted of running maximal effort 1000m (t1000m), at the end of each bout, was monitored heart rate (HR); alike at one minute rest; at 3 minutes, and 5 minutes after ends the respective test. Data times of t400m and t1000m, were recorded with a photocell of precision measure Newtest 300 (Newtest Oy, Oulu, Finlandia), data was directly imported to a personal laptop.

**Training and assessment protocols**

The daily workouts required or a maximum of 60 minutes of training in which the different tasks and objectives planned to the intervention. Three zones of training were required to control and quantify volume and intensity of training (Figure 1): Zone 1= Low Intensity training (LIT) <2 mM/L Zone 2 of Threshold Training (ThT) 2~4 mM/L and Zone 3 of High intensity of Training (HIT) >4mM/L.\(^{1-4}\)

Subjects trained five days per week in were warm-up and calm down were standardized for both groups as warm-up of 10 minutes running at LIT; calm down consisted on 5 minutes running HIT and 10 minutes of stretching. Three session per week were performed the specific training tasks depending of a program BP first block consisted training aerobic volume of training (AVT) of 45 minutes running at aerobic medium intensity (10-12 RPE of Borg scale). To the RP group the initial block of High-Intensive Interval Training (HIIT) for this research was selected an adaptation of the protocol 30-30\(^9\) the workout training consisted of 8 bouts of sub-maximal effort of 200m with 30 seconds of recovery among repetitions. Two day per week participants done aerobic regenerative training.
At the end of the 4th week and after taking the second data test (T2) both groups turn to same workout practice and then BP trained two times per week HIIT and sustain two practice per week AVT to avoid lost the adaptations achieved. Thereby, the RP, exercised AVT two times per week and two practice per week hold training HIIT. At the end of the 8th week and after taking the third data test (T3) both groups train same realization block consisted on one day HIIT, one day AVT, and three regenerative training practices.

### Statistical analysis

Values are presented as mean ± SD. The normality of data was checked using Shapiro-wilk’s test. All variables presented equal distribution and homoscedasticity, thus data was studied 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<0.05. farther. Table 1 show data of Track Test Performance assessments of 10 weeks intervention.

### Results

Results at the 10th week show significant (p<0.05) differences between groups per moment of T1 to T4 in variables of t400m and t1000m.

At inside-group assessments; group of BP decrease significantly (p<0.05) the performance values of t400m and t1000m in T2 comparison to T1. Inside-group assessments of RP exhibit significant (p<0.05) improvement performances to t400m in T3 and T4 compared to T1. data also show significant (p<0.05) performance improvements of t100m at the T3 and T4.

### Table 1. Summary of 10 weeks assessments on Track Test Performance.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>% Change T1 to T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>t400m (s)</td>
<td>RP</td>
<td>60.12 ± 2.79</td>
<td>58.97 ± 2.06</td>
<td>58.87 ± 1.72*</td>
<td>58.77 ± 1.99*</td>
<td>↓ 2.3</td>
</tr>
<tr>
<td></td>
<td>BP</td>
<td>59.20 ± 2.46</td>
<td>61.75 ± 2.83*</td>
<td>57.97 ± 1.94</td>
<td>58.13 ± 2.61</td>
<td>↓ 1.8</td>
</tr>
<tr>
<td>t1000m (s)</td>
<td>RP</td>
<td>209 ± 0.17</td>
<td>204 ± 0.13</td>
<td>197 ± 0.32*</td>
<td>191 ± 0.29*</td>
<td>↓ 9.4</td>
</tr>
<tr>
<td></td>
<td>BP</td>
<td>199 ± 0.09</td>
<td>206 ± 0.07*</td>
<td>196 ± 0.09</td>
<td>197 ± 0.06</td>
<td>↓ 1.0</td>
</tr>
</tbody>
</table>

*=p<0.05 vs T1; †=p<0.05 for between-group comparisons. t400m= time of 400 meters running; t1000m= time of 1000 meters running RP=Reverse periodization; BP=Block periodization. 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.

The complementary purpose of this study, was to examine changes in heart rate variability (HR). table 2, show summary data of the heart variations immediately after ends the bouts of running performance; at one minute after, at 3 minutes after and 5 minutes of recovery.

No significant modifications were registered in the monitorization of HR; the highest HR to RP group.
was asset at the end of t400m in T3. In case of BP group the highest HR were registered at the end of t400m on baseline assessment. Both groups exhibit semi complete recovery (<120 Beats per minute) at the 5 minutes recovery (HR\textsuperscript{4-5R}) after t400m and after 3 minutes recovery (HR\textsuperscript{M-3R}) after t1000m.

### Table 2. Summary of Heart Rate Variability.

<table>
<thead>
<tr>
<th>Group / TTP</th>
<th>Variable</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP / t400m</td>
<td>HR\textsuperscript{400m}</td>
<td>160.00 ± 05.22</td>
<td>167.00 ± 06.16</td>
<td>171.33 ± 08.55</td>
<td>165.33 ± 08.26</td>
</tr>
<tr>
<td></td>
<td>HR\textsuperscript{4-1R}</td>
<td>138.50 ± 10.39</td>
<td>132.83 ± 16.08</td>
<td>142.83 ± 10.13</td>
<td>136.67 ± 07.76</td>
</tr>
<tr>
<td></td>
<td>HR\textsuperscript{4-3R}</td>
<td>127.33 ± 17.60</td>
<td>127.33 ± 14.62</td>
<td>126.33 ± 13.05</td>
<td>129.33 ± 09.61</td>
</tr>
<tr>
<td></td>
<td>HR\textsuperscript{M-1R}</td>
<td>112.33 ± 24.74</td>
<td>112.67 ± 17.05</td>
<td>115.65 ± 13.65</td>
<td>115.00 ± 09.94</td>
</tr>
<tr>
<td>RP / t1000m</td>
<td>HR\textsuperscript{1000m}</td>
<td>168.00 ± 09.80</td>
<td>167.67 ± 09.67</td>
<td>168.50 ± 15.36</td>
<td>162.00 ± 15.18</td>
</tr>
<tr>
<td></td>
<td>HR\textsuperscript{M-1R}</td>
<td>125.50 ± 16.99</td>
<td>126.00 ± 16.20</td>
<td>122.00 ± 14.97</td>
<td>122.00 ± 19.06</td>
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<tr>
<td></td>
<td>HR\textsuperscript{M-3R}</td>
<td>124.17 ± 11.46</td>
<td>119.50 ± 12.80</td>
<td>117.50 ± 12.49</td>
<td>117.20 ± 15.97</td>
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<tr>
<td></td>
<td>HR\textsuperscript{M-5R}</td>
<td>111.50 ± 9.95</td>
<td>114.00 ± 16.05</td>
<td>112.00 ± 16.73</td>
<td>114.40 ± 15.45</td>
</tr>
<tr>
<td>BP / t400m</td>
<td>HR\textsuperscript{400m}</td>
<td>169.00 ± 13.09</td>
<td>164.40 ± 08.05</td>
<td>161.33 ± 07.97</td>
<td>157.33 ± 06.11</td>
</tr>
<tr>
<td></td>
<td>HR\textsuperscript{4-1R}</td>
<td>144.50 ± 16.99</td>
<td>141.40 ± 11.48</td>
<td>146.33 ± 09.16</td>
<td>146.67 ± 02.31</td>
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<tr>
<td></td>
<td>HR\textsuperscript{4-3R}</td>
<td>129.67 ± 10.52</td>
<td>131.20 ± 13.68</td>
<td>133.33 ± 08.55</td>
<td>130.00 ± 04.00</td>
</tr>
<tr>
<td></td>
<td>HR\textsuperscript{M-1R}</td>
<td>117.83 ± 02.40</td>
<td>117.60 ± 11.52</td>
<td>117.33 ± 06.53</td>
<td>115.33 ± 07.02</td>
</tr>
<tr>
<td>BP / t1000m</td>
<td>HR\textsuperscript{1000m}</td>
<td>164.18 ± 12.40</td>
<td>166.50 ± 12.52</td>
<td>161.50 ± 04.46</td>
<td>166.67 ± 05.03</td>
</tr>
<tr>
<td></td>
<td>HR\textsuperscript{M-1R}</td>
<td>132.67 ± 06.41</td>
<td>132.83 ± 17.60</td>
<td>129.83 ± 09.68</td>
<td>130.67 ± 10.07</td>
</tr>
<tr>
<td></td>
<td>HR\textsuperscript{M-3R}</td>
<td>115.50 ± 04.55</td>
<td>115.00 ± 15.15</td>
<td>115.83 ± 05.31</td>
<td>116.67 ± 06.11</td>
</tr>
<tr>
<td></td>
<td>HR\textsuperscript{M-5R}</td>
<td>112.33 ± 03.88</td>
<td>113.17 ± 14.91</td>
<td>111.00 ± 07.54</td>
<td>110.67 ± 03.06</td>
</tr>
</tbody>
</table>

TTP= Track Test Performance; t400m= time of 400 meters running; t1000m= time of 1000 meters running
RP=Reverse periodization; BP=Block periodization. HR\textsuperscript{400m}=heart rate at end of t400m; HR\textsuperscript{4-1R}=after one minute recovery; HR\textsuperscript{4-3R}=after 3 minutes recovery; HR\textsuperscript{M-1R}=after 5 minutes recovery. HR\textsuperscript{M-3R}=heart rate at end of t1000m; HR\textsuperscript{M-5R}=after one minute recovery; HR\textsuperscript{M-3R}=after 3 minutes recovery; HR\textsuperscript{M-5R}=after 5 minutes recovery. 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 primary purpose of this research was compares change in 400m (t400m) and 1000m (t1000m) Track Test Performance; after 10 weeks of training block periodization and reverse periodization. The table 1, show summary data of 10 weeks of intervention study.

Significant increases of performance were registered to the ten weeks intervention, on the group per moment comparison of statistical analysis, at the variables t400m (p=0.01) and t1000m (p=0.001) favorable to the RP (experimental group) above the BP (comparison group). This results exhibit effectiveness of RP to improve performance for runners of the distances between 400 and 1000 meters.

In the daily monitorization of training programs studied here; RP was trained 22 sessions of HIIT for a total of 35.2k performed at the Zone 3= high Intensive training (HIT), and 10 practices of AVT with a total of 100k on the Zone 2= Threshold Training (ThT). BP group performed a total of 10 practices of HIIT completing a total of 16k on the HIT zone and 22 practices of AVT for a total of 220k on the ThT. Both groups completed the same 24 practices of total 144k performed on the recovery Zone 1= Low Intensity training (LIT).

1st Block (T1 to T2).

RP group obtained better results for both distances tested in this research, mainly attributed by two reasons: the strategy of began the program from the HIT, and the total HIIT amount of 120% higher than (28.8k to RP vs 16k to BP) the BP group performed at the high intensity of training; even when BP were trained total of 120% (220k to BP vs 100k to RP) more at the AVT.

To the BP group the data of the T2 exhibit significant (p<0.05) performance worsening, attributed to the lack of AVT to stimulate responses to the high demanding activities as t400m and t1000m. in the other side the RP group reach significant (p<0.05) performance worsening, attributed to the lack of AVT to stimulate responses to the high demanding activities as t400m and t1000m. in the other side the RP group reach significant (p<0.05) performance worsening.
workout to obtain benefits around 2~4% improvements of performance; these statements coincide for RP in the mesocycles of HIIT at the current study.

The HIIT, is the recommended workout training for improving the two aerobic and anaerobic metabolic functions as well as muscle buffering capacity and lactate tolerance, [1-10] Were the first stage of adaptation is a neural reorganization of physical resources, which translates into improvements in speed of movement in the training activity. This “reorganization” is represented in the brain and muscle fibers as a new pattern of movement. 11

These 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; these is the main explain the improvements of the Track Test Performance for the RP group. 12

Two concepts are the core support of the Block periodization, they are the concept of Concentrated loads (CL) 13 instead of disseminated multi-task loads. The second basic concept is the Long Term Delayed Training Effects (LTDTE). 14

CL statement, holds the argument that the selective-target concentration load, is a better choice than the diversification of multiple tasks in one single block or mesocycle. The LTDTE express that, the CL has positive effects to remain improved performance, and even carry on higher adaptations after cessation of the CL block stimulations. [13-14-15]

The understanding and proper handling of these concepts would represent, the timely intervention to enhance competitive sports preparation. In this study, the CL of HIIT at the initial block of training; and the LTDTE of HIIT at the second and third blocks of training, represent the better strategy to improve the Track Test Performance variables to RP group.

2nd Block (T2 to T3)

The data obtained at the T3 for BP group exhibit improvements with tendency but not significant (p=0.09); that was when the group reach the first stimulations of the HIIT. In case of RP group the improvements are significant (p=0.05) at T3.

In addition to the LTDTE of HIIT, another important event can be observed in this second period of intervention: while HIIT is an excellent stimulus to improving the two aerobic and anaerobic metabolic functions as well muscle buffering capacity and lactate tolerance. AVT is the best stimulation to train the lactate clearance, exhibit in the results of RP group at the T3 and coincident to previous researches. [16-17-18]

Two reasons justify aerobic training, even in the preparation of athletes of sprint events. First, the evident fact that through the optimal aerobic training, the athletes learn to tolerate fatigue and improves the processes of physical regeneration. [19-20]

The second reason is that, aerobic training facilitates the lactate clearance, much better than low intensity training or the inactive recovery. The present research and previous studies confirm, that the best strategy to lactate manage would be: first to train the lactate tolerance and after then, the lactic clearance. [16-17-18]

3rd Block (T2 to T3).

The results at the end of the intervention (T4), in were done the reduction of volume, refereed as realization block in case of block periodization theory 3-13-14-15 differs of each program. In case of the BP group the improvements attained at the T3 exhibit detriments of performance. In opposite case of the RP, exhibit improvements of 0.1% to t400m and 3.1% to the t1000m.

These results can be interpreted as; whilst the reduction of volume affects as detraining to the case of BP group.

Thomas, et al. consider that, is beneficial to the athletes, the taper reduction of volume prior to the main competition; at time that the results are conditioned of how long the macrocycle of the athletes were lasted; the results of BP show that ten weeks of training is not enough to reach best performance after taper, manifested on effects of detraining.

In the conversely case; this reduction of volume attains positives effects to RP, and are coincident to previous researches reported by Mujika, and Padilla, 21 whose explains how: an improvement among 2 ~ 3% can be obtained in the taper, whenever to the athlete is offered enough recovery and holds training the intensity achieved before the taper. 22

Heart Rate Variability.

The HVR data obtained at the end of t400m show that: RP increase stroke rate from T1 to T3; and in case of BP the stroke rate data report reduction since T1 to T4.

The recovery at 3 minutes after t400m show constantly less stroke rate to BP and in the case of the experimental group the data show a ripple, with
initial reduction from T1 to T3; followed by increased at the end of the intervention.

These data can be interpreted as follows: in case of the BP the plan intervention stimuli effectively the aerobic adaptation even recovery after maximal effort, while those adaptations limited the increase of the heart stroke rate and consequently the arterial blood distribution.

The data compilation at the end of t100m since T1 to T3 show slight variations, that change very markedly on T3 to T4.

To BP group show stroke increases of heart stroke rate and to the case of RP group were find reductions; these two different variations, can be interpreted as mentioned in previous headings: to quicker de-training for the case of the BP group and acceptable active recovery for the case of RP group.

The recovery after 3 minutes; don’t show considerable variation to the case of BP. In the opposite case RP exhibit, constant improvement from 124 beat per minute at T1 to 115 at T4. These improvements of recovery support the effectiveness of the intervention plan to the experimental RP group.

The summary of the data of heart rate variability, reflex that: BP are better associated to aerobic adaptation related to health and wellness. Whilst RP are associated to anaerobic adaptation related to performance improvements. Anyways, the present research confirms how AVT has not advantage above HIIT, similar than previous studies. [1-8-9-10]

Despite the innumerable scientific information available; nowadays, many are the training programs that hold the perspective of "the more is better" in other words, volume as a priority above the intensity and quality of training. The evidence of this study disproves such like concept.

The results of this study, coinciding partially with previous researches on a different sport disciplines and gender participants. Ebben et al. 6 demonstrated how a similar type of training than reverse periodization (reverse step load) is apparently better option to improve endurance performance for female varsity rowers relatively untrained.

Clemente-Suarez et al. Reported, for the same period of ten weeks, higher autonomic adaption to a reverse periodization above traditional periodization on swimming training. 23

Otherwise a previous research accomplished from Arroyo-Toledo et al. 1-4-17 appear concordant to the present study displaying how reverse periodization is an optimal option to develop sport performance at time than traditional periodization in a block or linear plan, appears better option for a fitness and physical appearance values.

**Conclusion**

With these results is concluded: Concentrated load on a reverse periodization; is specific and efficient strategy to improve performance of sprint track runners among 400 to 1000m distances.

Block periodization appears better related to aerobic physical fitness. Whilst Reverse Periodization are associated to anaerobic performance improvements.

Farther, aerobic volume of training. Does not represent superiority to High-Intensive Interval Training.

**References**


