

RESTING HORMONE ALTERATIONS AND INJURIES: BLOCK VS “DAILY UNDULATING PERIODIZATION” WEIGHT-TRAINING AMONG D-1 TRACK AND FIELD ATHLETES

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INTRODUCTION: The development of “periodized” resistance training programs has resulted in several programming models of training each purporting to produce advances over more traditional models. “Daily undulating periodization” (DUP) programming models have been developed using daily changes in repetitions (and work). Heavy and light days are believed to be accomplished as a result of using loading differences (intensity) associated with different repetition schemes being used from day to day. It is thought that this type of alteration produces enhanced variation such that superior gains in strength and power, and overall performance are accomplished (Rhea et al. 2002). Block periodization (Block) consist of stages containing three “blocks”, Accumulation, Transmutation and Realization. Typically, each block last 3-4 weeks. Block depends upon “Phase Potentiation”, in which each individual block theoretically potentiates the next through residual effects. During accumulation, the focus is on higher volume and less specific training; alterations in aspects such as body composition work capacity, and basic strength are emphasized. Transmutation moves to more specific exercises with lower volume and somewhat higher intensities and can result in substantial increases in maximum strength for specific exercises. For strength-power athletes, Realization typically deals with power oriented task-specific exercises and typically involves a taper to reduce accumulated fatigue. Often a planned over-reaching phase is used in conjunction with the taper (Painter et al. 2012). A primary purpose of this study was to assess alterations in resting T, C, and the T:C ratio. Additionally, we assessed injuries across the 10-week training period in relation to the previously presented volume, intensity, and training efficiency data.

METHODS:

Athletes: Prior to initiation, sport medicine staff carried out health screenings. If injury occurred, the sport medicine staff examined the athlete and documented type and extent of injury before continuing. **Exclusion criteria:** missing 3 training sessions, missing any testing session, protocol non-compliance or physical training outside prescribed training sessions. Four athletes (1 Block; 3 DUP) were excluded. Demographic data: Block (n = 10), Ht = 1.81 ± 0.10 m, age = 20.1 ± 1.3 yr, Mass = 93.2 ± 32.6 kg, % fat = 15.7 ± 11.6; DUP (n = 9) Ht = 1.79 ± 0.47 m, age = 19.2 ± 0.7 yr, Mass = 86.0 ± 17.9, % fat = 16.3 ± 7.5.

Experimental Design: Study used a randomized counter-balanced design in which Division-I collegiate track and field athletes were divided into two groups, performing either a Block programming model or a DUP programming model for 10-weeks. Additional training (e.g. sprint, event practice etc.) was identical for each group. Measurements occurred at 0 wks (T1), 4 wks (T2), 8 wks (T3) and 11 wks (T4).

Training: Programs were developed after an exhaustive literature review and, before initiation, were reviewed by multiple strength coaches to assure that the program models were being applied appropriately. Exercises primarily consisted of squats, pulling movements and pressing movements.

Estimated Work: Estimates of strength training work were based on volume load (VL: repetitions x load x sets). Coaches recorded the loads and repetitions completed for each set. VL and training intensity were calculated using custom Excel spreadsheets. Athletes were surveyed throughout the study concerning additional exercise performed outside of normal training. Once each daily VL was determined, each microcycle volume load was summed. To calculate training monotony, the average volume load per microcycle was determined and then divided by the microcycle's standard deviation:

Monotony (a.u.)= (mean volume load)/(standard deviation); strain (a.u.)= monotony x volume load **Outside (non-resistance) work:** including practice was monitored for accuracy and verified with the sport coaching staff. Coaches ranked each element of practice on a subjective Likert-like scale from 1-10 (1 = lowest and 10 = highest loading day). Coaches included their estimate of volume and intensity in the rating producing assessment of the relative work performed by the athletes. Both groups performed the same outside training depending upon their event. Each element of non-strength training was rated. Elements were summed to form an overall picture of relative training load (volume) for non-resistance exercise training.

Testing: Testing occurred Monday and Tuesday, on weeks one (T1), four (T2), eight (T3), and eleven (T4). All testing dates corresponded to the start of a new block of training for the Block group. Each athlete was familiarized with the testing and training protocols on multiple occasions several weeks prior to the T1 and the beginning of the program. All of the returners (non-freshman) previously performed the tests prior to the familiarization phase, as they were part of an ongoing sport-monitoring program.

Tests consisted of hydration status, blood draws for resting T:C ratio, body composition, 1 RM parallel squat and isometric mid-thigh pulls. Testing took the place of the training session for that testing day and no other activity that day was permitted. Primary testing was conducted on Monday of each testing week (testing 1 RM squats took place on Tuesday).

Strength and Power Measures: Methodology for maximum strength and power (jumping) evaluations has been reported in the first part of this study, (Painter et al. 2012).

Blood collection/Testosterone and Cortisol: Fasting blood was collected by certified personnel and stored using standard methods. Samples were analyzed in one data. Total Testosterone (T) and Cortisol (C) were measure by ELISA the intra assay CV was 3.8 % for T and 4.5 % for C.

Monitoring Injuries: Injury may relate to the type of training protocol and fatigue management. Injury surveillance was supervised by the ETSU Sport Medicine Department. Injuries were evaluated and recorded by certified athletic trainers and later analyzed to determine injury incidences. Athlete training time was modified depending upon the severity of injury as evaluated by the sport medicine staff.

Statistical Analyses: Multiple 2 x 4 repeated ANOVA were used to determine if statistical differences existed between the training interventions and the measurement times. A 2 x 10 ANOVA was used for analysis of the volume load over the 10 weeks of training. Follow-up one-way ANOVA's were performed to determine where statistical differences existed. Correlations were calculated (critical $r = 0.38$). Effect sizes (Cohen's d) were calculated.

RESULTS:

Maximum Strength: Alterations in maximum strength followed the same general pattern as previously noted (Painter et al. 2012).

Training Volume Load, Intensity and Efficiency: Repetitions and VL were calculated weekly and for the duration of this study. The DUP group performed ($p < 0.001$, $ES = 5.09$ 95%, $CI = 3.07$ to 6.65) more repetitions ($+1,274.2$, $+49.8\%$) than the Block group (Figure 1). Additionally, the DUP group performed statistically ($p < 0.001$, $ES = 2.11$, 95%, $CI = 0.91$ to 3.13) more work by volume load ($+100,455.8$ kg, $+60.3\%$) (Figure 2) than the Block training group.

There were no statistical differences ($p > 0.05$) between the DUP and Block groups for weekly training intensity or overall average training intensity (DUP = 70.4 ± 11.1 kg; Block = 66.5 ± 9.8 kg; $p = 0.43$, $ES = 0.50$, 95%, $CI = -0.44$ to 1.40). A large statistical difference in training efficiency between the two groups was noted. **Monotony and Strain:** DUP exhibited statistically higher average monotony ($p = 0.037$, $ES = 0.98$, 95%, $CI = 0.01$ to 1.87) and strain

Figure 1: Daily Undulating and Block Periodization Repetitions

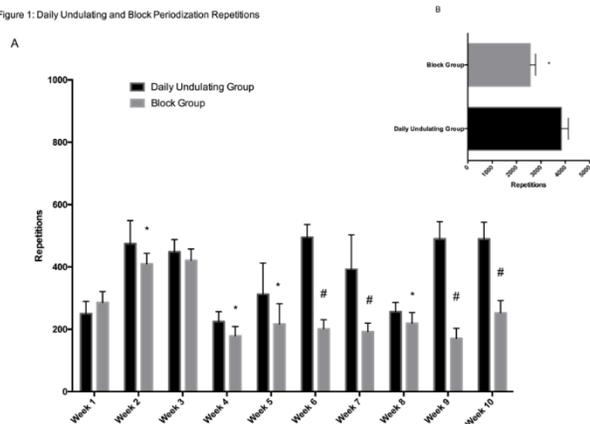


Figure 2: Daily Undulating and Block Periodization Volume Load

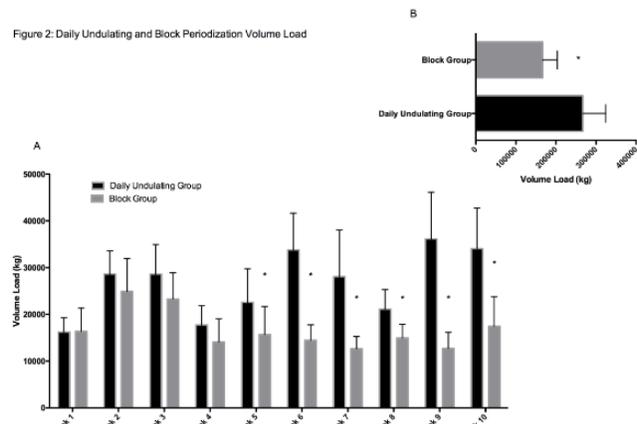


Figure 3: Daily Undulating and Block Periodization Monotony Scores

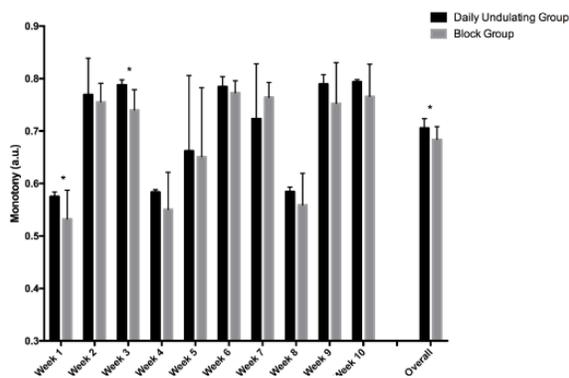
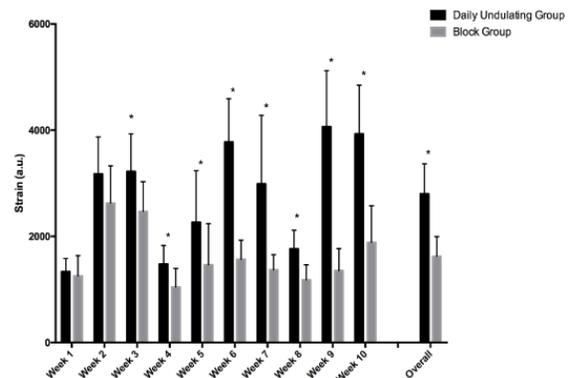


Figure 4: Daily Undulating and Block Periodization Strain Scores



($p < 0.001$, $ES = 2.50$, 95%, $CI = 1.24$ to 3.54) (Figures 3 and 4). The DUP group exhibited higher monotony scores (Figure 3) during week 1 ($p = 0.027$) and week 3 ($p = 0.002$). With the exception of week 1 and 2 ($p = 0.76$) DUP exhibited statistically higher strain scores (Figure 4) for all other weeks compared to the Block group.

The estimated volume of outside work from the coaches ranking is shown in Figure 5. Generally, the amount of outside work increased through the first seven weeks then showed a decrease.

Testosterone and /Cortisol: Block T and C generally showed fewer training related perturbations and alterations in T, C and T:C showed stronger correlations with performance gains (example T4 T:C vs Δ IPFa, DUP = 0.6 , $BI = 0.86$)

DISCUSSION/PRACTICAL APPLICATIONS:

We suggest that the Block programming resulted in superior fatigue management and produced a superior training method because:

1. Training efficiency was greater and monotony and strain were lower.
2. Relationships between T:C and maximum strength measures were consistently stronger in the Block.
3. Subtle VL induced perturbations in the T:C were generally less "negative" in the Block
4. The difference in the injury rate was quite large and may have resulted from superior fatigue management in the Block group.

Based on this data we suggest that this form of DUP programming is an inefficient method of resistance training that can result in poor fatigue management and an increased risk of injury when performed in conjunction with sport training.

REFERENCES:

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