

# EFFECTS OF LINEAR AND DIARY UNDULATING PERIODIZATION ON STRENGTH, POWER AND SPEED IN YOUNGS HANDBALL TEAM PLAYERS

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## **ABSTRACT**

The purpose of the present study was to compare if significant differences exist between two different models, linear periodization (LP) and daily undulating periodization (DUP), in eliciting gains in strength, power and speed in adolescent athletes. Twenty six male handball team players of two different teams, with the same competition level in the same club, were assigned to one and another periodization group. The participants were tested for 1-RM back squat and bench press, a countermovement jump (CMJ), a triple jump with both legs, a 20-meters speed test, a standing medicine ball throw, a 7-meters standing throw and a 9-meters jumping throw. Training protocols involves 6 sessions of hypertrophy, 6 of power strength and 4 of explosive strength. There were 2 sessions per week during 8 weeks. LP group performed sessions in this order and DUP group alternated every week two different sessions. Volume and intensity were equated for each training program.

**Key Words:** weight training, power training, team sports, variation, periodization.

## **INTRODUCTION**

Periodization is one of the most important topics in strength and conditioning and can be defined as planned distribution or variation in training methods and means on a cyclic or periodic basis (19) preparing athletes to peak at the right time, avoiding plateaus in training adaptations, decreasing risk of overtraining and increasing adaptations (2, 19, 22). This occurs, as the overload principle says, mixing volume, intensity and frequency producing training adaptations (22, 23).

Periodization (PER) can be accomplished by manipulating: distribution of sessions, sets, reps, type of exercises (local to specific), number of exercises, time of rest, intensity, type of contractions performed, movement velocity and joint angle (4, 5, 20, 23). Manipulation of these variables is one of the ways coaches utilize to focus on different training objectives, such as maximum strength, hypertrophy, muscular endurance or power (24).

PER programs improve Non-Periodization (Non-PER) trainings in all populations and age (22) and should be based on the level of the athlete and the constraints of the competitive season (17, 26).

Additionally, when volume and intensity are similar, PER training elicits greater improvements than Non-PER training in strength, power, body composition and other performance variables (4, 7, 16, 23). It provides individual and appropriate metabolic conditions (20, 24) and allows the best preparation within the time allowed while athletes are concurrently required to perform high volumes of tactical/technical training, team practices and competitive matches which requires considerable planning skills (7). This is the reason because an athlete's peak performance can only be maintained for 2-3 weeks, but many sports, like team sports require a great peak performance during the 35 weeks (approximately) of the competition phase (26). Even so, in professional players, it is possible to maintain strength and power levels during the competitive season in collision sports (as handball team), and in younger players it could be increased (7). This involves long-term, intermediate, and short-term planning (21). Therefore, PER programs are widely recommended (4, 7, 11, 22, 26).

The most popular periodization is one called traditional, classical or linear periodization (LP) of Matveyev (15), in which the training loads vary from high volume and low intensity to low volume and high intensity over the mesocycles (2, 12, 16, 23).

The second important type of periodization is called flexible, undulating or nonlinear, proposed by Poliquin (19) based on the idea that volume and intensity are altered more frequently (daily, weekly or biweekly) in order to give the neuromuscular system more

frequent periods of recovery (2, 16, 19). The most common type is daily undulating periodization (DUP), in which modifications in volume and intensity are made daily (5, 21, 23).

Hence, this approach is essentially a condensed version of the traditional periodization format (7) making it the best alternative to the linear model (19) and supporting many authors who proposed that variability is key to success, because continued exposure to the same training fails to elicit further adaptation, and in time may lead to diminished performance(7).

Moreover, it has been suggested that DUP approaches are more viable when planning the training year for team sports. The rationale for this is that these methods may be better suited to maintain the athlete close to their peak throughout an extended season of regular competitions (7, 17, 26) without altering the rating of perceived exertion (6) or body composition percentages (5).

Regarding the scientific literature comparing the LP and DUP models, we found studies where there is no significance in the strength measures at the post between groups, as occurs in Bufford et al. (2), where 28 men and women recreationally trained for 9 weeks (3 days-per-week) without changes in the bench press or squat at the end, or in Rhea et al. (20), with 16 to 17 years hockey players, training 2 days-per-week for 12 weeks. Both groups significantly improved their performance relative to the beginning but there are no differences between both of them at the end. This lack of significance between the two methodologies also occurs in Hartmann et al. (8), Hoffman et al. (10), Kok et al. (14) and Shankaralingam and Kok (24). However, in other studies the DUP model obtains better performances (21, 23). There is only one study where the performance of the LP group were better than DUP (amateur men who trained 3 days a week for 12 weeks) (13).

Looking at the population used, studies which compare one model periodization against the other we can find different works comparing: amateur or recreational men (13, 25), amateur women (14, 20) a mix of men and women trained recreationally (2, 23) and experienced men (10, 21). Naturally, a factor that needs to be considered when examining the efficacy of periodized training is that untrained subjects obtained more profits than trained population due to strength gains by neural factors (4).

Furthermore, in terms of training days for DUP, ACSM (1) cited in Shankaralingam and Kok (24) has been suggested that twice a week training frequency is adequate for inducing muscular strength. It would be enough for the regular season of team sports too (7, 26). But in many studies we have found comparing both periodization methodologies, not always use athletes

and their training programs vary from 2 times per week (23, 24, 25), 3 times a week (2, 8, 13, 14, 20) or even 4 days in split routines (10, 16, 21). Although the split routines programs tend to decrease the specificity of the strength exercises which may reduce the degree of transference of the strength gains to sports skills (16).

Finally, the aim of this study was to compare the evolution of the strength, power and speed in a young handball team players population, manipulating the periodization model (LP versus DUP) for 8 weeks of equated volume and intensity training, with 2 sessions of strength weekly.

## **METHOD**

### ***EXPERIMENTAL APPROACH TO THE PROBLEM***

This present study attempted to investigate the efficacy of LP and DUP models for developing performance gains. To our knowledge, this is the first study to compare LP and DUP in young handball team players. Total volume and intensity were equated for both groups through the 8 weeks. Maximal bench press and leg press, twenty meters speed, triple jump, CMJ, seven meters standing shot, nine meters moving shot and medicine ball overhead throw were tested. These measurements allow us to evaluate upper and lower-body strength in a young handball team players population because these skills are required in their competition.

### ***PARTICIPANTS***

The participants (n= 26) were male adolescent handball team players from a sport club in Elche C.B. (Spain), aged 15 and 16 years old who have 1 year-experience in resistance training. Participants were volunteers, and parents or tutors were informed and gave their informed consent accordance to Miguel Hernández ethic committee.

Subjects did not realize any additional resistance training during the study but continued with normal handball team training. The characteristics of the participants who completed the study are shown in Table 1.

**Table 1.** Characteristics of the participants.

	<b>DUP Group</b>	<b>LP Group</b>
	<b><i>Average ± SD</i></b>	<b><i>Average ± SD</i></b>
Age (years)	15,58 ± 0,51	15,50 ± 0,51
Height (cm)	176,83 ± 7,89	176,14 ± 6,85
Weight (kg)	72,06 ± 12,35	66,98 ± 12,36

## **TESTING**

All subjects participated in strength and power assessments that were performed before the training program (Pre) and at the end of the 8-week training program (Post). All testing was conducted by the same researcher and all conditions were standardized. Finally, all subjects were required to perform power testing before maximal strength assessments and performed a specific warm-up before the testing.

### *Maximal dynamic strength*

The 1-RM maximal dynamic strength was assessed using a previously established protocol (3), which requires that subjects progressively increase resistance across attempts until the 1-RM is achieved. Rest period between trials was at least 5 minutes.

For the bench press, participants began by lying horizontally with the buttock, lower back, upper back, and head firmly planted on the bench, with elbows fully extended and gripping the bar. Subjects lowered the bar until the chest was slightly touched, approximately 3 cm superior to the xiphoid process. The elbows were extended equally with the head and hips remaining in contact with the bench, and the feet in contact with the floor throughout the lift. No bouncing or arching of the back was allowed.

The 1-RM squat was performed to the parallel position, which was achieved when the greater trochanter of the femur was lowered to the same level as the knee. In this position, when the upper thigh was parallel to the floor (knee is in 90° of flexion), the participant must performed the concentric phase of the parallel squat.

### *Power Performance*

A countermovement vertical jump (CMJ) and a standing triple jump test were performed. For both tests each participant performed two maximal jumps trials and the highest one was used for the statistical analyses. The CMJ were performed on a contact platform (Globus, Italy). To be valid, subjects had to be hands held in place on the hips and a self-selected countermovement depth was chosen by the participants. For the standing triple jump test, the start position must be with only one support. The participants could land on the last support with one or both legs. The measurement was made with the heel mark. The assessment was in both legs.

### *Speed Assessment*

Players performed 2 maximal-effort 20-m sprints and only the better one was used for the statistical analyses. Rest period between trials was at least 5 minutes. Two photocells (Globus® Chrono Control with a resolution of 1/100 s) were used to measure the 20-m speed. Participants had to stay one meter behind the first photocell to start the measure.

### *Medicine Ball Throw*

A 5-kg medicine ball throw test for maximum distance was used to assess sequential leg-hip-torso-arm. Participants had to hold the medicine ball at their back shoulder height with 2 hands behind a white taped line. They were then asked to throw the medicine ball for maximum distance. They could not pass the taped line after the throw.

### *Throwing Velocity*

Finally, throwing velocity was measured using a portable radar (Stalker sport 2, Applied Concepts Inc, USA) with an accuracy of 0.1 km·h<sup>-1</sup>. After 10 minutes of warm-up consisting of jogging, dynamic stretches and technical skills (passes and throws at a submaximal velocities), each subject performed 2 maximal velocity throws attempts from both 7 m (standing throw) and 9 m (jumping throw). The standing and the jumping throw have been described previously in (9).

## **TRAINING PROTOCOLS**

The strength training program for each group can be seen in Table 2. At the end of the training program, the same exercises were performed for each group, and volume and intensity were equated too. The intensity to performed, were individual and each subject knew his intensity before the session. It was calculated based on the initial tests. All exercise sessions were supervised by members of the research.

The LP group followed a traditional linear periodized program (2, 12, 16, 23), applied to the team sports. The training cycle was divided into several mesocycles. Each mesocycle differed in the intensity and volume of training. Subjects performed a 3-weeks hypertrophy phase, a 3-weeks power strength phase and a final 2-weeks explosive strength phase.

The DUP group performed a daily change workout to workout (19). The first 4 weeks, a daily change between hypertrophy and power strength was performed. In the second phase, changes between hypertrophy and explosive strength were developed. And finally, for the last 2 weeks, the changes were between power strength and explosive strength.

In every workout it was performed three exercises, a traction, a pushing and a leg exercise. Traction exercises were: pull-ups, row and throw row. Pushing exercises were: bench press, bench press throw, push-ups, push-ups throw, military press and military press throw. For leg

exercises were performed: squats, squat jumps, lunges, lunges jumps, step up lunge and step up jump lunge.

**Table 2.** Linear periodized and daily undulating periodized training program.

Week	Training Session	LP Training group Rep x Sets (%RM)	Resting Time (min.)	DUP Training group Rep x Sets (%RM)	Resting Time (min.)
Week 1	1	10x4 (70%)	1-2	10x4 (70%)	1-2
	2	10x4 (70%)	1-2	8x4 (50%)	2-3
Week 2	3	10x4 (75%)	1-2	10x4 (70%)	1-2
	4	10x4 (75%)	1-2	8x4 (50%)	2-3
Week 3	5	10x5 (80%)	1-2	10x4 (75%)	1-2
	6	10x5 (80%)	1-2	8x4 (50%)	2-3
Week 4	7	8x4 (50%)	2-3	10x4 (75%)	1-2
	8	8x4 (50%)	2-3	8x4 (40%)	2-3
Week 5	9	8x4 (50%)	2-3	10x5 (80%)	1-2
	10	8x4 (50%)	2-3	6x6 (30%)	3
Week 6	11	8x4 (40%)	2-3	10x5 (80%)	1-2
	12	8x4 (40%)	2-3	6x6 (30%)	3
Week 7	13	6x6 (30%)	3	8x4 (40%)	2-3
	14	6x6 (30%)	3	6x6 (30%)	3
Week 8	15	6x6 (30%)	3	8x4 (40%)	2-3
	16	6x6 (30%)	3	6x6 (30%)	3

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