CULTURA, CIENCIA Y DEPORTE

# Drop sets effects on maximum dynamic strength, jumping ability and acceleration in female basketball players

## Efectos del entrenamiento de series descendentes sobre fuerza máxima dinámica, salto y aceleración en jugadoras de baloncesto

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## Abstract

The aim of this research was to quantify the effects of the inclusion of drop set training (DS) on maximum dynamic strength (1RM) in back squat, jump ability (CMJ) and speed (10 m) in female basketball players. For this purpose, 25 participants (22.59 ± 3.73 years) of two amateur teams were examined in three times: initial assessment (T0), after six weeks of traditional lower limbs strength training without DS (T1), and after an additional six weeks incorporating DS training (T2). Only the performance in the CMJ test was significantly influenced by the training program ($p$ = .001; $\eta p^2$ = .376). Post-hoc test identified statistical differences from 1RM: T0-T1 ($p$ = .001), T0-T2 ($p$ = .001) and T1-T2 ($p$ = .001). Differences were also identified in CMJ between T0-T1 ($p$ = .001) and T0-T2 ($p$ = .001), and in 10 m between T0 and T2 ($p$ = .05). These results suggest that, despite the supposed low efficacy of DS training compared to traditional training in improving performance in jumping and acceleration capacities, both can be complementary within a training program, as the effects produced are maintained.

**Key words:** Team sport, training, female, sport performance, drop sets.

## Resumen

El objetivo de esta investigación fue analizar los efectos del entrenamiento de series descendentes (DS) en fuerza máxima dinámica (1RM) en media sentadilla, capacidad de salto (CMJ) y capacidad de aceleración (10 m) en jugadoras amateur de baloncesto. Veinticinco jugadoras (22.59 ± 3.73 años) de dos equipos fueron evaluadas en tres ocasiones, siendo T0 la evaluación inicial, T1 la evaluación después de trabajar la musculatura de la extremidad inferior durante seis semanas con entrenamiento clásico de fuerza sin DS, y T2 después de otras seis semanas incluyendo DS. Únicamente el rendimiento en CMJ estuvo influenciado significativamente por el programa de entrenamiento ($p$ = .001; $\eta p^2$ = .376). Se encontraron diferencias significativas en 1RM comparando los tres tiempos: T0-T1 ($p$ = .001), T0 con T2 ($p$ = .001) y T1-T2 ($p$ = .001). También hubo diferencias en CMJ entre T0-T1 ($p$ = .001) y T0-T2 ($p$ = .001), mientras que en 10 m únicamente entre T0-T2 ($p$ = .05). Estos resultados sugieren que, a pesar de una supuesta poca eficacia del entrenamiento con DS respecto al entrenamiento tradicional en la mejora del rendimiento en acciones de salto y aceleración, ambos pueden ser complementarios dentro de una planificación al mantenerse los efectos producidos.

**Palabras clave:** Deporte de equipo, entrenamiento, mujer, rendimiento deportivo, drop sets.

## Introduction

The practice of a specific sport is characterized by specific conditional demands on athletes. In basketball, these demands are primarily related to the application of explosive strength, which influences other capacities as it enables agility with and without the ball and speed over short distances (Delextrat & Cohen, 2008; Montgomery et al., 2010), in addition to performance in technical actions inherent to the game (Alsasua et al., 2022; Izquierdo et al., 2021). In this context, the literature confirms that the application of strength is essential for proper athletic performance in basketball (Chaouachi et al., 2009). Improving strength leads to an enhancement in the ability to accelerate (Ben Abdelkrim et al., 2006) and jump (Delextrat & Cohen, 2008; San Román-Quintana et al., 2012), crucial actions for performance due to their influence during the game.

Strength training prescription involves manipulating the components of the load (volume, frequency, duration, intensity and density) to achieve the intended muscular adaptations (Kraemer & Ratamess, 2004). In fact, alternating the manipulation of these load components is recommended to avoid potential stagnation in muscular adaptations (Krzysztofik et al., 2019). In this regard, it has been speculated that manipulating training volume and relative effort (proximity to muscular failure) may have a positive impact on various training adaptations, such as muscle hypertrophy (Schoenfeld et al., 2019). This is precisely the basis for the training technique known as drop sets (DS).

DS training involves performing a set of an exercise with a specific load until momentary muscle failure. After reaching failure, the load is reduced (± 20%) and additional repetitions are performed until a new point of muscle failure is reached (Angleri et al., 2020; Krzysztofik et al., 2019). DS training increases time under tension and training density (work per unit of time) (Coleman et al., 2022; Schoenfeld & Grgic, 2018), promoting a greater accumulation of metabolites and cellular inflammation, thus favoring the growth of muscle cross-sectional area, i.e., muscle hypertrophy (Schoenfeld & Grgic, 2018; Schoenfeld et al., 2019).

The muscular adaptations of the lower extremities promoted by DS training have been underexplored in athletes. University students showed significant increases in dynamic one-repetition maximum (1RM) in leg press through this method by performing five sets with loads at 50% of 1RM compared to a traditional single-set configuration (Goto et al., 2004). However, in bodybuilders, no significant differences were observed between DS training (two sets with a 20% load reduction) and traditional training (three to five sets of six to twelve repetitions with a two-minute rest interval between sets), despite both types of training promoted significant increases in muscle strength and hypertrophy (Angleri et al., 2017). Raeder et al. (2016) compared the effects of various training types, including DS training, over six days in soccer and handball players. Their results did not show significant improvements in jump capacity, and the authors suggested the need for a multi-day adaptation period to produce the necessary gains. Only one study has analyzed the effects of DS training in basketball players (Drinkwater et al., 2007). After a six-week training period with different DS training types (G1: 12x3; G2: 4x6 G3: 8x3; all with a 60% 1RM load), there were no significant differences between groups in muscle hypertrophy or 1RM. With these precedents, there is a significant gap in the scientific literature regarding the effect of DS training on jump capacity and acceleration ability in sports in general, and in basketball in particular.

This research may provide new evidence regarding a type of strength training that has not been sufficiently analyzed in female basketball players and its potential effects on crucial capacities such as dynamic maximum strength, jumping, and acceleration (Mancha-Triguero et al., 2020). Therefore, the objective of this study was to analyze the effects of incorporating DS training on the dynamic maximum strength of the lower extremities, jumping ability, and acceleration capacity in amateur female basketball players. Based on the available literature, it can be hypothesized that DS training may not increase the magnitude of neuromuscular effects produced by traditional strength training, but it might help to maintain the effects achieved with it.

## Methods

### *Sample*

Twenty-five players (age: 22.59 ± 3.73 years; body mass: 66.37 ± 8.21 kg; height: 170.13 ± 10.44 cm; federated experience: 10.45 ± 3.00 years) from two amateur senior teams of the same club participated in this study. Both teams competed at national and regional levels, respectively.

The inclusion criteria for the participants were as follows: a) age between 18 and 30 years; b) minimum relative strength in deep squat with a barbell of 1.25 times body mass; c) at least 2 years of experience in strength training; d) no consumption of creatine supplements, anti-inflammatory drugs, anabolic androgenic steroids or other substances that could affect muscular adaptations during the training period and 4 weeks before the study; and e) adherence to the assigned strength program three days a week throughout the intervention period. Sixty-eight percent (17 players) were assessed during the follicular phase of the menstrual cycle in one of the three measurable assessments, and 40% (10 players) used oral contraceptives.

This research was approved by the ethics committee of the corresponding University (ULE-022-2021). All procedures were conducted in accordance with the Helsinki Declaration. All participants were informed about the aim and procedures and signed an informed consent before voluntarily participating in the study.

## *Design*

The present study has a quasi-experimental design, as there is no control group, and all participants underwent the same intervention. The intervention took place over 14 weeks, starting in the first week of the competitive period after all players had completed a five-week preseason. The training load for both teams was relatively identical during both the preparatory and competitive periods: three weekly training sessions plus four friendly matches during the preparatory period, and three weekly training sessions plus one official league match every weekend during the competitive period. Furthermore, the planning and design regarding the load of training tasks and exercises were the same and carried out by the same individual (in the role of a fitness coach) for both teams, along with supervision by the coaches.

During the competitive period, training sessions had a relatively similar design: activation and warm-up (15 min), tasks focused on improving conditioning aspects (30 min), technical-tactical tasks (45 min) and cool-down (10 min). Two days prior to the initial measurement (T0), a familiarization session was conducted to explain the protocol and technical standards for each test: 1RM in half squat, countermovement jump (CMJ), and 10-meter linear acceleration (10 m).

On measurement days (T0, T1, and T2), for obtaining the 1RM, a specific standardized warm-up was performed consisting of five half squats with a bar and light loads, and two submaximal repetitions in half squat with a bar and a high load selected by the players (Enes et al., 2021). The warm-up for measuring jump capacity and acceleration included 5 min of continuous running at 6 km/h, five repetitions of CMJ, and three repetitions of 10 m acceleration (Enes et al., 2021).

The order of the tests evaluated in each measurement was as follows: 1RM test in half squat with a bar (Tuesday) and, 48 hours later (Thursday), CMJ and 10-m test. This sequencing ensured a 48-hour recovery period after the last competitive match. After the initial evaluation (T0), the participants began a six-week traditional strength training program conducted twice a week (12 training sessions in total). Once this period was completed, the same tests as in the initial assessment were conducted in the following week to evaluate the effects of traditional training (T1). Subsequently, another six-week period with 12 sessions of the same strength training was initiated, but with the addition of DS. After this training period, the tests were repeated to assess the potential effects of including DS training (T2). The study timeline, with the measurement weeks and training periods, can be observed in Figure 1.

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | T0 | Traditional training | | | | | | T1 | DS training | | | | | | T2 |
| Period | Pre-season | | | | | Competitive | | | | | | | | | | | | | |
| Week | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| Month | August | | | | September | | | | October | | | | November | | | | December | | |

**Figure 1.** Timeline in the study design

**Notes:** T0, initial assessment; T1, traditional training assessment; T2, drop set (DS) training assessment.

The strength training programs were integrated at the beginning of the session, before the technical-tactical training, on Tuesdays and Thursdays of each week, at the same time. The warm-up consisted of running for 5 min at 6 km/h around the playing court and performing 2 sets of 8 and 3 repetitions of half squat with a bar with an estimated load of 10% and 60% of 1RM, respectively (Enes et al., 2021).

Both traditional strength training and DS training included the same contents and were performed in the same order. Both are shown in Table 1, which also includes the training loads applied in each of them (Enes et al., 2021; Schoenfeld et al., 2019).

**Table 1.** Exercises and training loads for both traditional and drop set (DS) training performed by the players during the study

| Exercises | Training loads | |
|---|---|---|
| | Traditional training | Drop Sets Training |
| Deep barbell squat<br>45° Leg press<br>Seated knee extension<br>Stiff-legged deadlift<br>Seated knee flexion | 3 sets of 12 repetitions at 70% of 1RM<br>(2 min of rest between sets) | 3 sets of 6 repetitions at 75% of 1RM<br>3 sets of 10 repetitions at 55% of 1RM<br>(20 seconds of intra-set rest and 2 min of rest between sets) |

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### Dynamic one-repetition maximum (1RM)

The dynamic 1RM strength test began approximately 3 min after the warm-up. Each assessment was conducted at a cadence of 60 beats per minute (using a digital metronome), resulting in 2 s for both the eccentric and concentric phases, ensuring constant muscle tension throughout the exercise (Thiele et al., 2015). To obtain the 1RM value in a half squat, a previously used protocol was employed (Brown, 2007).

In a maximum of five attempts, with three minutes of rest between them, each player determined an approximate 85% load (3 repetitions) of their 1RM in the first attempt. In subsequent attempts, gradually small loads (2.27 – 9.09 kg) were applied until the player could not complete a repetition using proper technique through the full range of motion or could no longer maintain the cadence (60 beats per minute) of the metronome (Mackey et al., 2020). All players were provided with an elastic band to give kinesthetic feedback on achieving a knee angle of 90° (Conchola et al., 2015). The equipment used was a commercial adjustable Power Rack (RockSolid Fitness, Rutland, VT, USA) with a standard Olympic barbell (20.45 kg) located in a weightlifting room adjacent to the playing court. The recorded 1RM value was the weight lifted in the maximal repetition (kg).

### Jump capacity

The players performed three repetitions of the CMJ, with 60 seconds of rest between each jump (Warr et al., 2020). A force platform (QuattroJump, Kistler 100 Instrument AG, Winterthur, Switzerland) located in the same weightlifting room where the 1RM test was conducted was used for measurement. The jump height (cm) was recorded, and the best result was utilized for statistical analysis.

### Acceleration capacity

The players placed their front foot 0.5 m before the first timing gate. They were instructed to run as fast as possible through the timing gates (Witty Timing System, Microgate, Bolzano, Italy), located at the start and 10 meters away. The players performed three repetitions with 3 min of recovery between each repetition. The time taken to cover the established distance (s) was monitored, and the best result was used for statistical analysis. This test was conducted on the teams' training court.

### *Statistical analysis*

The data are presented as means and standard deviations ($M \pm SD$). The intraclass correlation coefficient (*ICC*) was used to measure the agreement between measurements in each physical performance test (Atkinson & Nevill, 1998). The *ICC* value was interpreted according to the following ranges: poor (< 0.5), moderate (0.5 - 0.75), good (0.75 - 0.9), and excellent (> 0.9) (Koo & Li, 2016). The coefficient of variation (*CV*) was calculated to assess the relative variability of the measurements. The Shapiro-Wilk test was applied to determine the normality of the data, and the Levene test was used to assess homogeneity of variance.

Subsequently, a two-way repeated measures analysis of variance (ANOVA) was conducted to analyze the effects of the traditional strength training program and the DS training program at different measurement points (T0-T1-T2). The Wilks' Lambda was calculated, and when the F value was significant, the Bonferroni test was performed to determine differences between measurement points and the effects of the training programs. The partial eta squared value ($\eta p^2$) was calculated. Statistical analyses were carried out using SPSS for Windows, version 25.0 (SPSS Inc., Chicago, USA). The level of statistical significance was set at $p < .05$.

## Results

Table 2 displays the descriptive data for 1RM, CMJ and 10 m performance at each of the three measurement time points (T0, T1, and T2), along with the *ICC* and *CV* for each physical performance test. The agreement between measurements in each physical performance test was moderate and the *CV* ranged from 2.7% (10 m) to 10.6% (1RM).

**Table 2.** Descriptive data, ICC, and CV for performance in 1RM, CMJ, and 10m at each of the three measurement time points (T0, T1 and T2)

| | T0 | T1 | T2 | *ICC* | *CV (%)* |
|---|---|---|---|---|---|
| | *Mean ± SD* | *Mean ± SD* | *Mean ± SD* | | |
| 1RM (kg) | 70.440 ± 6.988 | 74.760 ± 7.247 | 78.960 ± 7.463 | .669 | 10.6 |
| CMJ (cm) | 24.582 ± 1.618 | 26.316 ± 1.706 | 26.744 ± 1.673 | .534 | 7.5 |
| 10m (s) | 1.978 ± 0.064 | 1.959± 0.045 | 1.947 ± 0.041 | .661 | 2.7 |

CMJ: Counter Movement Jump; *CV:* Coefficient of Variation; *SD:* Standard Deviation; *ICC:* Intraclass Correlation Coefficient; 1RM: 1 Repetition Maximum; 10 m: 10-Meter Linear Acceleration.

Table 3 presents the significant differences in1RM, CMJ and 10 m performance depending on the measurement time point (T0, T1, and T2) and the training program (traditional and DS). Only CMJ performance was significantly influenced by the training program ($p$ =.001; $\eta p^2$ = .376).

**Table 3.** Contrast test to determine differences in performance in 1RM, CMJ, and 10m based on the measurement time point (T0, T1 and T2) and the training program (traditional and drop sets)

| | Effects | *RMS* | *F* | *p* | ηp² |
|---|---|---|---|---|---|
| 1RM (kg) | Time | 453.690 | 200.305 | .001* | .807 |
| | Time * Training Program | 0.090 | 0.040 | .843 | .001 |
| CMJ (cm) | Time | 31.438 | 96.868 | .001* | .669 |
| | Time * Training Program | 9.370 | 28.870 | .001* | .376 |
| 10m (s) | Time | 0.006 | 10.634 | .002* | .181 |
| | Time * Training Program | 0.000 | 0.412 | .524 | .009 |

CMJ: Counter Movement Jump; *SD:* Standard Deviation; *F: F-value; RMS:* Root Mean Square; p: *p-value;* 1RM: 1 Repetition Maximum; 10 m: 10-Meter Linear Acceleration; *ηp2:* partial eta-squared. *: $p < .05$.

Specifically, the effects of the traditional strength training program on CMJ performance were higher compared to the effects promoted by the DS training program (Figure 2). Significant differences in 1RM were obtained after the entire strength training period (T0-T2, $p = .001$), after the traditional training period (T0-T1, $p = .001$) and after the DS training (T1-T2, $p = .001$). Significant differences in CMJ performance were obtained after the strength training period (T0-T2, $p = .001$) and after traditional training (T0-T1, $p = .001$), but not after DS training (T1-T2, $p = .118$). In 10 m performance, significant differences were only obtained after the strength training period (T0-T2, $p = .05$), while both traditional training and DS training showed no significant effects on performance (T0-T1, $p = .088$; T1-T2, $p = .069$).

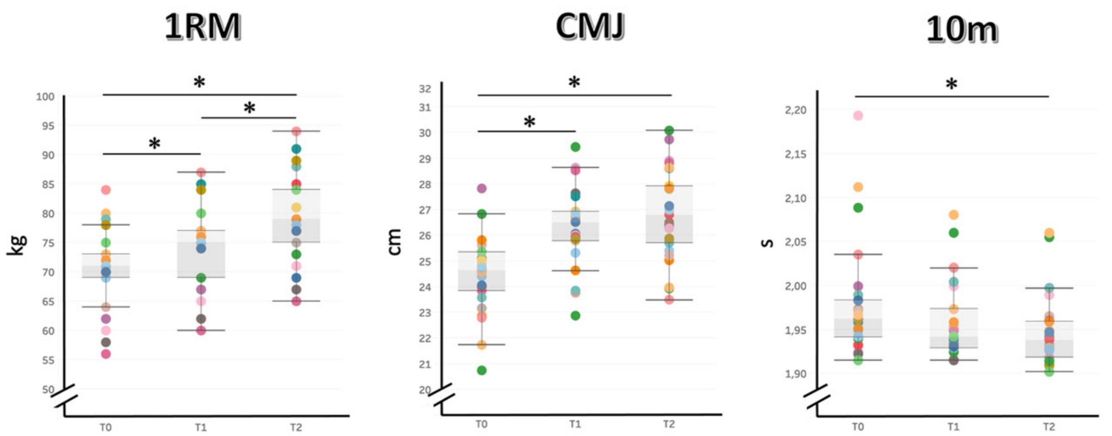


**Figure 2.** Comparison of performance in 1RM (one-repetition maximum), CMJ (counter-movement jump) and 10m (10-meter linear acceleration) between different measurement time points (T0, T1 and T2)

* Significant differences ($p < .05$). Box plots are displayed with medians, first and third quartiles, and outliers.

## Discussion

The aim of this study was to analyze the effects of including DS training on dynamic maximal strength of the lower limb, acceleration capacity and jump performance in amateur female basketball players. The results show that both traditional training and DS training had a significant effect on the performance in 1RM in the half squat. However, the effects of both training programs on 1RM performance were similar. No differences were observed in CMJ and 10 m performance after DS training compared to traditional strength training. In fact, traditional strength training had significantly superior effects on CMJ performance compared to those obtained with DS training. These results confirm the initial hypothesis. Although CMJ performance was significantly influenced by the training program ($p = .001$; $\eta p^2 = .376$), the inclusion of DS training did not statistically increase the magnitude of neuromuscular effects produced by traditional strength training in CMJ and 10 m. However, it demonstrated that it could maintain the effects achieved with the DS program.

In the present study, 1RM increased significantly after completing both training programs, although the magnitude of the changes was similar, as no Time*Training Program interaction was found ($p = .843$; $\eta p^2 = .001$). These results support previous findings indicating that DS training does not have superior effects compared to traditional training in strength improvements. In this regard, Fink et al. (2018) demonstrated that a six-week DS training program promoted greater hypertrophy compared to a conventional strength training program, although the magnitude of strength gain was higher after conventional training than after the DS training program (traditional: 25.2 ± 17.5%,

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*ES* = 1.34; *DS*: 16.1 ± 12.1%, *ES* = 0.88). This implies that, although hypertrophy is one of the factors explaining the increase in muscle strength (Folland & Williams, 2007), greater hypertrophy does not guarantee superior strength gains (Fink et al., 2018; González-Badillo et al., 2022). Moreover, there is not enough evidence regarding greater hypertrophy when performing strength training close to muscular failure compared to strength training performed without reaching muscular failure (Refalo et al., 2023). Therefore, based on the results of the present study and in accordance with previous research, it seems not advisable to apply DS training to improve the 1RM of amateur female basketball players, as similar results can be obtained with traditional strength training and lower volume (i.e., fewer sets and repetitions than with DS).

Basketball is characterized by the execution of various vertical movements, such as jump shots, dunks, rebounds and blocks (Gottlieb et al., 2014; Meckel & Gottlieb, 2009; Meckel et al., 2009). Therefore, basketball players need to apply force as quickly as possible to produce effective vertical movements that facilitate optimal performance (Delextrat & Cohen, 2008). The results of the present study show that CMJ performance significantly improved after traditional strength training, which had significantly greater effects compared to those obtained with DS training. Additionally, it was the only test significantly influenced by the training program ($p$ = .001; $\eta p^2$ = .376). It has been suggested that the potential transfer of strength training exercises to high-intensity sports actions is not only determined by the relative load used (% 1RM) but also by the degree of fatigue experienced during the sets, which is associated with the velocity loss during each set (Rodríguez-Rosell et al., 2020). In this regard, it has been shown that squat training with loads of 70-85% 1RM is less effective in inducing improvements in CMJ performance when a velocity loss of 40 – 45% is reached compared to 10 - 20% (Pareja-Blanco et al., 2017; Rodríguez-Rosell et al., 2020). Considering that reaching a velocity loss in each set of 40 – 45% in the squat exercise implies proximity to muscular failure (Rodríguez-Rosell et al., 2020), and that DS training involves performing additional repetitions until a new muscular failure (Angleri et al., 2020; Krzysztofik et al., 2019), it seems that the accumulated fatigue during DS training results in undesirable adaptations or negative interference in high-intensity actions such as jumps.

Basketball is also characterized by the execution of accelerations and changes of direction (Gottlieb et al., 2014). In fact, these accelerations and changes of direction performed by basketball players are based on horizontal movements (Meckel & Gottlieb, 2009; Meckel et al., 2009), so and adequate performance in this sport is partially determined by the ability to perform accelerations in the horizontal plane (Delextrat & Cohen, 2008). The results obtained in the present study indicate that strength training improves acceleration capacity in 10 m, a finding that has been demonstrated previously (Young et al., 2001). However, no differences were observed in 10 m performance after DS training compared to traditional strength training. Like in CMJ performance, the results obtained in the 10 m acceleration capacity may be influenced by the relative load used (% 1RM), but also by the fatigue experienced during the sets of both training programs (i.e., velocity loss), which is associated with the number of repetitions. In this sense, Rodríguez-Rosell et al. (2020) showed that a strength training performed until a 10% velocity loss during each set corresponds to completing less than half of the repetitions performed during a strength training reaching a 30% velocity loss during each set, with a greater increase in 20 m sprint performance (-1.5% vs. 0.4%). Considering that DS training increases the time under tension and training density (Coleman et al., 2022; Schoenfeld & Grgic, 2018), it seems not advisable to apply DS training when aiming for amateur basketball players to improve horizontal acceleration capacity, as similar results can be obtained with traditional strength training and lower volume (i.e., fewer sets and repetitions than with DS).

Despite the findings obtained for basketball training, this research also has certain limitations. Firstly, the 1RM value can change during the training process (González-Badillo et al., 2022), so the actual daily relative training load (% 1RM) of the participants in this study may have differed from the programmed or intended effort. Additionally, the current trend is to determine the 1RM based on the maximal intended velocity of the first repetition performed (González-Badillo et al., 2022), but in this study, dynamic maximum strength could not be evaluated in this way. Therefore, it would be interesting to replicate this study using velocity-based methods to monitor strength training and determine the 1RM value. Secondly, although the load in minutes during training sessions and the task design were similar in both teams, individual response to effort was not monitored, as could have been done through a rating of perceived exertion. Finally, the results may be influenced by the sample characteristics and may not be applicable to other athletes with different characteristics. Therefore, it would be advisable to replicate this study in male basketball players of similar competitive level (amateur) and in male and female players of higher level (professional, elite). A further associated research that could be interesting would be to implement DS training for a few weeks initially and then apply traditional training during another period. Lastly, it is essential to consider that the design of this study was quasi-experimental, so it is recommended to replicate the study using a larger sample size and including a control group.

## Conclusions

The results show that both traditional strength training and DS training had a significant effect on 1RM performance. However, the effects of both training programs on 1RM performance were similar. Although performance in the CMJ test was significantly influenced by the training program, no differences were observed in the 10 m performance after DS training compared to traditional strength training. In fact, traditional strength training had significantly superior effects on CMJ performance compared to those obtained with DS training. These results suggest that, despite the supposed lower efficacy of DS training compared to traditional strength training in improving jumping and acceleration performance in amateur female basketball players, both training methods can be complementary within a 14-week competitive period plan, maintaining the achieved effects.

## References

Alsasua, R., Arana, J., Lapresa Ajamil, D., & Anguera, M. T. (2022). Analysis of efficiency in under-16 basketball: A log-linear analysis in a systematic observation study (Análisis de la eficacia en baloncesto U16: aplicación del log-linear en metodología observacional). *Cultura, Ciencia y Deporte, 17*(51). https://doi.org/10.12800/ccd.v17i51.1736

Angleri, V., Ugrinowitsch, C., & Libardi, C. A. (2017). Crescent pyramid and drop-set systems do not promote greater strength gains, muscle hypertrophy, and changes on muscle architecture compared with traditional resistance training in well-trained men. *European Journal of Applied Physiology*, *117*(2), 359–369. https://doi.org/10.1007/s00421-016-3529-1

Angleri, V., Ugrinowitsch, C., & Libardi, C.A. (2020). Are resistance training systems necessary to avoid a stagnation and maximize the gains muscle strength and hypertrophy? *Science & Sports, 35*(2), 65.e1-65.e16. https://doi.org/10.1016/j.scispo.2018.12.013.

Atkinson, G., & Nevill, A. M. (1998). Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Medicine, 26*(4), 217–238. https://doi.org/10.2165/00007256-199826040-00002

Ben Abdelkrim, N., El Fazaa, S., & El Ati, J. (2007). Time-motion analysis and physiological data of elite under-19-year-old basketball players during competition. *British Journal of Sports Medicine*, *41*(2), 69–75. https://doi.org/10.1136/bjsm.2006.032318

Brown, L. E. (2007). *Strength training*. Human Kinetics.

Chaouachi, A., Brughelli, M., Chamari, K., Levin, G. T., Ben Abdelkrim, N., Laurencelle, L., & Castagna, C. (2009). Lower limb maximal dynamic strength and agility determinants in elite basketball players. *Journal of Strength and Conditioning Research*, *23*(5), 1570–1577. https://doi.org/10.1519/JSC.0b013e3181a4e7f0

Coleman, M., Harrison, K., Arias, R., Johnson, E., Grgic, J., Orazem, J., & Schoenfeld, B. (2022). Muscular adaptations in drop set vs. traditional training: A meta-analysis. *International Journal of Strength and Conditioning*, *2*(1). https://doi.org/10.47206/ijsc.v2i1.135

Conchola, E. C., Thiele, R. M., Palmer, T. B., Smith, D. B., & Thompson, B. J. (2015). Acute postexercise time course responses of hypertrophic vs. power-endurance squat exercise protocols on maximal and rapid torque of the knee extensors. *Journal of Strength and Conditioning Research*, *29*(5), 1285–1294. https://doi.org/10.1519/JSC.0000000000000692

Delextrat, A., & Cohen, D. (2008). Physiological testing of basketball players: toward a standard evaluation of anaerobic fitness. *Journal of Strength and Conditioning Research*, *22*(4), 1066–1072. https://doi.org/10.1519/JSC.0b013e3181739d9b

Drinkwater, E. J., Lawton, T. W., McKenna, M. J., Lindsell, R. P., Hunt, P. H., & Pyne, D. B. (2007). Increased number of forced repetitions does not enhance strength development with resistance training. *Journal of Strength and Conditioning Research*, *21*(3), 841–847. http://dx.doi.org/10.1519/00124278-200708000-00032

Enes, A., Alves, R. C., Schoenfeld, B. J., Oneda, G., Perin, S. C., Trindade, T. B., Prestes, J., & Souza-Junior, T. P. (2021). Rest-pause and drop-set training elicit similar strength and hypertrophy adaptations compared with traditional sets in resistance-trained males. *Applied Physiology, Nutrition, and Metabolism*, *46*(11), 1417–1424. https://doi.org/10.1139/apnm-2021-0278

Fink, J., Schoenfeld, B. J., Kikuchi, N., & Nakazato, K. (2018). Effects of drop set resistance training on acute stress indicators and long-term muscle hypertrophy and strength. *Journal of Sports Medicine and Physical Fitness, 58*(5), 597–605. https://doi.org/10.23736/s0022-4707.17.06838-4

Folland, J. P., & Williams, A. G. (2007). The adaptations to strength training: morphological and neurological contributions to increased strength. *Sports Medicine, 37*(2), 145–68. https://doi.org/10.2165/00007256-200737020-00004

González-Badillo, J. J., Sánchez-Medina, L., Ribas-Serna, J., & Rodríguez-Rosell, D. (2022). Toward a New Paradigm in Resistance Training by Means of Velocity Monitoring: A Critical and Challenging Narrative. *Sports medicine, 8*(1), 118. https://doi.org/10.1186/s40798-022-00513-z

Gottlieb, R., Eliakim, A., Shalom, A., Dello-Iacono, A., & Meckel, Y. (2014). Improving anaerobic fitness in young basketball players: Plyometric vs. specific sprint training. *Journal of Athletic Enhancement, 3*(º). https://doi.org/10.4172/2324-9080.1000148.

Goto, K., Nagasawa, M., Yanagisawa, O., Kizuka, T., Ishii, N., & Takamatsu, K. (2004). Muscular adaptations to combinations of high- and low-intensity resistance exercises. *Journal of Strength and Conditioning Research*, *18*(4), 730–737. http://dx.doi.org/10.1519/00124278-200411000-00008

Izquierdo, J. M., Pedauga, L. E., Pardo, A., & Redondo, J. C. (2021). Marginal contribution of game statistics to probability of playing playoff at elite basketball leagues. *Cultura, Ciencia y Deporte, 16*(49), 433-442. https://doi.org/10.12800/ccd.v16i49.1586

Koo, T. K., & Li, M. Y. (2016). A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. *Journal of Chiropractic Medicine*, *15*(2), 155–163. https://doi.org/10.1016/j.jcm.2016.02.012

Kraemer, W. J., & Ratamess, N. A. (2004). Fundamentals of resistance training: progression and exercise prescription. *Medicine and Science in Sports and Exercise*, *36*(4), 674–688. https://doi.org/10.1249/01.mss.0000121945.36635.61

Krzysztofik, M., Wilk, M., Wojdała, G., & Gołaś, A. (2019). Maximizing muscle hypertrophy: a systematic review of advanced resistance training techniques and methods. *International Journal of Environmental Research and Public Health*, *16*(24), 4897. https://doi.org/10.3390/ijerph16244897

Mackey, C. S., Thiele, R. M., Schnaiter-Brasche, J., Smith, D. B., & Conchola, E. C. (2020). Effects of power-endurance and controlled heavy squat protocols on vertical jump performance in females. *International Journal of Exercise Science, 13*(4), 1072. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7449342/

Mancha-Triguero, D., García-Rubio, J., Antúnez, A., & Ibáñez, S. J. (2020). Physical and physiological profiles of aerobic and anaerobic capacities in young basketball players. *International Journal of Environmental Research and Public Health*, *17*(4), 1409. https://doi.org/10.3390/ijerph17041409

Meckel, Y., Gottlieb, R., & Eliakim, A. (2009). Repeated sprint tests in young basketball players at different game stages. *European Journal of Applied Physiology, 107*, 273-279. https://doi.org/10.1007/s00421-009-1120-8

Meckel, Y., Machnai, O., & Eliakim, A. (2009). Relationship among repeated sprint tests, aerobic fitness, and anaerobic fitness in elite adolescent soccer players. *Journal of Strength & Conditioning Research, 23*(1), 163-169. https://doi.org/10.1519/JSC.0b013e31818b9651

Montgomery, P. G., Pyne, D. B., & Minahan, C. L. (2010). The physical and physiological demands of basketball training and competition. *International Journal of Sports Physiology and Performance*, *5*(1), 75–86. https://doi.org/10.1123/ijspp.5.1.75

Pareja-Blanco, F., Rodríguez-Rosell, D., Sánchez-Medina, L., Sanchis-Moysi, J., Dorado, C., Mora-Custodio, R., Yáñez-García, J. M., Moralea-Alamo, D., Pérez-Suárez, I., Calbet, J. A. L., & González-Badillo, J. J. (2017). Effects of velocity loss during resistance training on athletic performance, strength gains and muscle adaptations. *Scandinavian Journal of Medicine & Science in Sports, 27*(7), 724-735. http://dx.doi.org/10.1111/sms.12678

Raeder, C., Wiewelhove, T., Westphal-Martinez, M. P., Fernandez-Fernandez, J., de Paula Simola, R. A., Kellmann, M., Meyer, T., Pfeiffer, M., & Ferrauti, A. (2016). Neuromuscular fatigue and physiological responses after five dynamic squat exercise protocols. *Journal of Strength & Conditioning Research, 30*(4), 953-965. https://doi.org/10.1519/JSC.0000000000001181

Refalo, M. C., Helms, E. R., Trexler, E. T., Hamilton, D. L., & Fyfe, J. J. (2023). Influence of Resistance Training Proximity-to-Failure on Skeletal Muscle Hypertrophy: A Systematic Review with Meta-analysis. *Sports Medicine, 53*(3), 649–665. https://doi.org/10.1007/s40279-022-01784-y

Rodríguez-Rosell, D., Yáñez-García, J. M., Mora-Custodio, R., Pareja-Blanco, F., Ravelo-García, A. G., Ribas-Serna, J., & González-Badillo, J. J. (2020). Velocity-based resistance training: impact of velocity loss in the set on neuromuscular performance and hormonal response. *Applied Physiology, Nutrition, and Metabolism, 45*(8), 817-828. https://doi.org/10.1139/apnm-2019-0829

Schoenfeld, B. J., Contreras, B., Krieger, J., Grgic, J., Delcastillo, K., Belliard, R., & Alto, A. (2019). Resistance training volume enhances muscle hypertrophy but not strength in trained men. *Medicine and Science in Sports and Exercise*, *51*(1), 94–103. https://doi.org/10.1249/MSS.0000000000001764

Schoenfeld, B. J., & Grgic, J. (2018). Can drop set training enhance muscle growth? *Strength and Conditioning Journal*, *40*(6), 95-98. http://dx.doi.org/10.1519/SSC.0000000000000366

Thiele, R. M., Conchola, E. C., Palmer, T. B., DeFreitas, J. M., & Thompson, B. J. (2015). The effects of a high-intensity free-weight back-squat exercise protocol on postural stability in resistance-trained males. *Journal of Sports Sciences*, *33*(2), 211–218. https://doi.org/10.1080/02640414.2014.934709

Warr, D. M., Pablos, C., Sanchez-Alarcos, J. V., Torres, V., Izquierdo, J. M., & Redondo, J. C. (2020). Reliability of measurements during countermovement jump assessments: Analysis of performance across subphases. *Cogent Social Sciences, 6*(1), 1843835. https://doi.org/10.1080/23311886.2020.1843835

Young, W., Benton, D., & John Pryor, M. (2001). Resistance training for short sprints and maximum-speed sprints. *Strength & Conditioning Journal, 23*(2), 7. https://doi.org/10.1519/00126548-200104000-00001