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# Effect of Two Descending Loads in Distance by Two Styles on Some Functional Variables and Performance in 400 Meter Sprint

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**Abstract**

**Study Purpose.** The study aims to study the effect of using two descending loads within one set and the descending load in the distance from one set to another to reach scientific results and facts that help athletic coaches guide the training process towards the best.

**Material and method.** The experimental design was used to suit the nature of the research. The research sample consisted of 8 sprinters aged between 18 and 19 (according to the classification of the International Federation and the Iraqi Athletics Federation). This represents 72.72% of the research population.

**Result.** Among the results obtained, interval training with a descending load resulted in significant improvements in blood lactate, anaerobic power, fatigue index, aerobic power, and 400-meter sprint performance within one set and from one set to another. It should also be noted that the diversity of repetitions could be a reason for the progress and superiority of the descending loads in the distance within one set over the descending loads in the distance from one set to another. This diversity can lead to stimulating positive psychological aspects for the athlete.

**Conclusion.** The researchers concluded that the two decreasing loads over distance significantly impacted all variables studied, with all effects favoring the descending load over distance within one set. In addition, the researchers recommended relying on data obtained from blood lactate, anaerobic power, fatigue index, and aerobic power as indicators to evaluate the sprinter's training status to evaluate the training curricula for the 400-meter running competition. They also urged coaches to consider the training principles for the 400-meter sprint competition.

**Keywords**: Short-distance, Sprinters, Descending load, Training

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## Introduction

The 400-meter sprint is one of the short-distance sprint competitions in which success depends largely on the ability of the sprinter to maintain the rate of speed acquired in the initial phase of the race. Especially since the world record of 43.03 seconds recorded by the sprinter Wayde van Niekerk is equivalent to four 100-meter races with a time of 10.75 seconds each. This competition is also considered one of the most difficult athletics competitions, due to the fatigue and stress that the sprinter is exposed to, especially in the final stage of the race, resulting from the accumulation of anaerobic energy waste. In addition to the inability of aerobic energy to oxidize or dispose of these wastes. Therefore, this competition requires a high degree of anaerobic power, which helps the sprinter to withstand the pressures of the internal load, including the accumulation of lactic acid in the working muscles. Especially since the competition time falls within the limits of the work of the second anaerobic system. In the first moments of a 400-meter race, the runner mainly exploits anaerobic mechanisms, but with extended time in exerting effort, the use of oxygen increases accordingly as (Zouhal,et al., 2010) point out.

It has become known that the interval training method is carried out through several training methods, namely progressive training in distance, progressive training in speed, hierarchical training, and fartlek training. These trainings have been researched in many studies. Training with a descending load in distance is one such training that is very common in training for sprinting competitions in athletics. Especially competitions that clearly have an endurance nature, including the 400-meter sprint. It is also training that has proven its efficiency through studies on the aforementioned exercises in improving various physical qualities and abilities. In addition to improving the level of achievement in many sports competitions, these studies(Khoshnaw & Dhannoun, 2018) these studies used this type of training, specifically the descending load in the distance within one set to compare with other types of training such as progressive training in the distance and hierarchical training, and did not search at the other side of the descending training in the distance, which is the descending load in the distance from one set to another. Therefore, the current research gains its importance through experimenting with two descending loads in the distance, namely the descending load in the distance within one set and the descending load in the distance from one set to another, to reach scientific results and facts that help athletics coaches to guide the training process towards the best.

This work aims to detect the significance of statistical differences in blood lactate, anaerobic, and aerobic powers, and performance in the 400-meter sprint between the pre-and post-tests after using the descending load in the distance within one set and the distance from one set to another. Also, this work aims to identify the significance of the statistical differences in blood lactate, anaerobic and aerobic powers, and performance in the 400-meter sprint between the descending load in the distance within one set and the descending load in the distance from one set to another in the post-test.

The intensity of the training load is the most important component among the other components of the training load (volume, rest). Especially in short-distance sprint training, such as the 400-meter sprint, the intensity of the training load determines the pressure on one system over another. Moreover, the main goal of a short-distance sprinter on race day is to cover the race distance at the maximum speed and maximum intensity possible to achieve the best achievement. Training with a descending load in the distance, whether (within one set) or (from one set to another), is characterized by running each descending distance (at a higher intensity) than the intensity used in the previous distance. In other words, the process of pressure on energy production systems will be intense at the expense of shortening the sprint's distance, hence the research problem is summarized by the following question: Which of the two descending loads in the distance is better for putting pressure on the energy production systems, especially the lactic acid system, and improving the anaerobic and aerobic powers, in addition to improving performance in the 400-meter sprint descending load in the distance within one set or descending load in the distance from one set to another?

Therefore, the hypotheses of the current work are as follows: the presence of significant differences in blood lactate, anaerobic, and aerobic powers, and performance in the 400-meter sprint between the pre and post-tests after using the descending load in the distance within one set. Also, the presence of significant differences in blood lactate, anaerobic, and aerobic powers, and performance in the 400-meter sprint between the pre and post-tests after using the descending load in distance from one set to another. There were no significant differences in blood lactate, anaerobic, and aerobic powers and performance in the 400-meter sprint between the descending load in the distance within one set and the descending load in the distance from one set to another in the post-test.

The fields of this work are the human field: Short-distance sprinters (youth category) in the city of Mosul for the sports season (2022-2023). Temporal field: Starting from (10/6/2023) to (31/8/2023). Spatial field: Dirt athletics track in the forest area located in the city of Mosul.

## Materials and methods

### *Study participant*

The research population was determined by purposive method from the short-distance sprinter's youth category aged between 18 and 19 years (according to the classification of the International Federation and the Iraqi Athletics Federation) in the city of Mosul for the sports season (2022-2023). The research sample consisted of 8 sprinters, representing a percentage of (72.72%) of the research population of 11 sprinters. Three sprinters were excluded from the research population due to their inability to complete the one-mile (1609-meter) sprint test. This sample was randomly divided into two experimental groups, with (4) sprinters in each group. Table (1) shows the total number of the research population, its sample, and the excluded sprinters, as well as their percentages.

**Table 1.** Research population, sample, and percentages

| Items | Total No. | % |
|---|---|---|
| The research population | 11 | 100% |
| Research samples | 8 | 72.72% |
| Excluded sprinters | 3 | 27.28% |

### *Study organizational*

The researchers used the experimental method to suit the nature of the research. They used analysis, questionnaires, interviews, tests, and measurements as tools for this investigation.

*Tests and measurements:*

**RAST- test to measure anaerobic power:** The test objective is to measure anaerobic power and recognize the fatigue index. This **test** used electronic scales, stopwatches, and flat ground.

Performance method: After measuring the weight of the research sample, a straight sprint track of 35 meters in length was prepared. After the warm-up, the test begins, consisting of (6) sprints at full speed from one end to the other with a 10-second rest period between each repetition.

Recording: The time of covering a distance is recorded every (35) meters in seconds, to the nearest (0.01) of a second. The anaerobic capacity is then calculated in (Watts) through the following equation:

Anaerobic power = weight x distance$^2$ / time$^3$

After the anaerobic power for the six sprint launches is calculated, the maximum power is determined, which is the highest value recorded for a time in a sprint of 35 meters. As well as the minimum power is the lowest recorded value for time in a sprint of 35 meters. The anaerobic power rate is the sum of the values divided by 6, and the fatigue index in (W/second) through the following equation:

Fatigue Index = (Maximum Power – Minimum Power) / Sum of the six sprint launch times (Nasuka, et al., 2019)

**One-mile (1609 meter) sprint test to measure aerobic power:**
Test objective: measure aerobic power.
Instruments used: A stopwatch and an athletics track.
Performance method: The testers take a stand-by position behind the start line, and when the start signal is given, the testers start running to cover the test distance in the shortest possible time.
Recording: The time taken by the tester is calculated from the start signal to crossing the finish line to the nearest (0.01) of a second (Moqabala, 2016).

**Performance test in a 400-meter sprint:**
Test objective: to measure performance in the 400-meter sprint.
Instruments used: Stopwatch, athletics track, whistle.

Performance method: The test was conducted according to the International Association of Athletics Federations (IAAF) rules and regulations. The testers stand behind the starting line, and on the signal (on the line), the testers come forward to sit behind the start using the seated start position (low start) then the second signal is given (preparation position) and on the whistle, the testers start running for 400-meter (one cycle).

Recording: The time taken by the tester is recorded from the moment he starts until he reaches the finish line to the nearest (0.01) of a second (Al-Zubaidi, 2019b).

**Blood lactate measurement:**

Blood lactate was measured after the 400-meter sprint performance test in 7 minutes using a German-made Lactate Scout 4 device. It is one of the latest, most accurate, portable, and reliable devices (İbrahim, et al., 2020). Blood lactate was measured by taking a drop of capillary blood from the tester, placing it on the special strip, and within less than (10) seconds, the result was obtained in units of (mmol/L).

**Devices, instruments, and materials used in the research:**

A tape measure to measure height to the nearest (0.01) cm, measure a distance of (35) meters in the RAST test, and measure a distance of (9) meters after the fourth cycle of the 1-mile sprint test, electronic scale to measure mass to the nearest (0.1) kilogram, 4- electronic stopwatches to measure time to the closest (0.01) of a second, a whistle to give the start signal for the RAST test, the 1-mile meter sprint test, and the 400-meter sprint performance test, lactate scout 4 blood lactate measuring device, and cotton and sterile materials.

**Moderation of the normal distribution of the research sample:**

A normal distribution test was conducted for the research sample in the variables (height, weight, chronological age, and training age). The dependent research variables (blood lactate, anaerobic power, fatigue index, aerobic power, and 400-meter sprint performance). Table (2) shows the arithmetic average (AMA), standard deviations (SD), values of the Shapiro-Wilk test, and probability level for the variables adopted in the moderation of the normal distribution for the research sample.

**Table 2.** AMA, SD, Shapiro-Wilk test, and probability level for the variables adopted in the moderation of the normal distribution for the research sample**.**

| Variables | Measurement unit | Sample | | Shapiro-Wilk value | Probability level |
|---|---|---|---|---|---|
| | | AMA | ±SD | | |
| Height | cm | 172 | 3.586 | 0.916 | 0.396 |
| Weight | kg | 63.137 | 2.522 | 0.873 | 0.162 |
| Chronological age | year | 18.878 | 0.194 | 0.964 | 0.843 |
| Training age | year | 2.575 | 0.281 | 0.965 | 0.860 |
| Blood lactate | mmol/l | 19.292 | 0.492 | 0,951 | 0.719 |
| Anaerobic power | w | 699.393 | 74.519 | 0.854 | 0.103 |
| Fatigue index | w/s | 15.088 | 3,397 | 0,878 | 0,180 |
| Aerobic power | min | 5,25,98 | 0,8,71 | 0,914 | 0,382 |
| 400-meter sprint performance | s | 59,363 | 1,80 | 0,872 | 0,157 |

Not significant at probability level ≥ (0.05).

It is clear from Table (2) that the values of the Shapiro-Wilk test for the variables adopted in the moderation of the normal distribution for the research sample were, respectively, (0.916) (0.873) (0.964) (0.965) (0.951) (0.854) (0.878) (0.914) (0.945). At the probability level, respectively (0.396) (0.162) (0.843) (0.860) (0.719) (0.103) (0.180) (0.382) (0.157), which is greater than (0.05). This indicates that the sample is normally distributed.

**Homogeneity of the sample and equivalence between the two research groups:**
**Sample homogeneity:**

Homogeneity was performed for the research sample in variables (height, weight, chronological age, and training age) and dependent research variables (blood lactate, anaerobic power, fatigue index, aerobic power, and 400-meter sprint performance). Table (3) shows the AMA, SD, and Levene tests for the variables adopted for homogeneity.

**Table 3.** AMA, SD, and Levene test for variables dependent on homogeneity

| Variables | Measurement unit | Sample AMA | ±SD | Levene test calculated (p) values | probability level |
|---|---|---|---|---|---|
| Height | cm | 172 | 3,586 | 0,325 | 0,589 |
| Weight | kg | 63,137 | 2,522 | 0,246 | 0,637 |
| Chronological age | year | 18,878 | 0,194 | 0,241 | 0,171 |
| Training age | year | 2,575 | 0,281 | 0,600 | 0,468 |
| Blood lactate | mmol/l | 19,292 | 0,492 | 0,496 | 0,508 |
| Anaerobic power | w | 699,393 | 74,519 | 1,821 | 0,226 |
| Fatigue index | w/s | 15,088 | 3,397 | 0,662 | 0,447 |
| Aerobic power | min | 5,25,98 | 0,8,71 | 0,017 | 0,901 |
| 400-meter sprint performance | s | 59,363 | 1,80 | 0,357 | 0,572 |

Not significant at probability level ≥ (0.05).

It is clear from Table (3) that the calculated (p) values for the variables adopted inhomogeneity were respectively (0,325) (0,246) (0,241) (0,600) (0,496) (1,821) (0,662) (0,017) (0,357). At the probability level, respectively (0.589) (0.637) (0.171) (0.468) (0.226) (0.257) (0.447) (0.901) (0.572). This indicates the homogeneity of the research sample in the variables mentioned above. If the value of the probability level is greater than (0.05), this indicates that the variances in a variable are equal, and this means homogeneity of the research sample (Nordstokke & Zumbo, 2010).

**Equivalence between the two research groups:**

Equivalence was conducted between the two research groups in the variables (blood lactate, anaerobic power, fatigue index, aerobic power, and 400-meter sprint performance). This is done by finding statistical differences using the calculated T value and the probability level. Table (4) shows the arithmetic means, standard deviations, calculated T-value, and probability level for the variables adopted for equivalence between the two research groups.

**Table 4.** AMA, SD, T-value, and probability level for the variables adopted for equivalence between the two research groups

| Variables | Measurement unit | First Experimental group | | Second Experimental group | | calculated (T) values | probability level |
|---|---|---|---|---|---|---|---|
| | | AMA | ±SD | AMA | ±SD | | |
| Blood lactate | mmol/l | 19.49 | 0.53 | 19.09 | 0.41 | 1.163 | 0.289 |
| Anaerobic power | W | 707.527 | 102.550 | 691.260 | 4.584 | 0.288 | 0.783 |
| Fatigue index | W/s | 15.499 | 2.757 | 14.677 | 4.345 | 0.319 | 0.760 |
| Aerobic power | M | 5,25,94 | 0,9,55 | 5,25,02 | 0,9,27 | -0.012 | 0,991 |
| 400-meter sprint performance | S | 59.60 | 1.65 | 59.12 | 2.15 | 0.351 | 0.738 |

Not significant at probability level ≥ (0.05)

It is clear from Table (4) that the calculated T values for the dependent variables in equivalence were, respectively, (1,163) (0,288) (0,319) (-0,012) (0,351). At the probability level, respectively (0.289) (0.783) (0.760) (0.991) (0.738). This indicates the equivalence of the two research groups in the variables mentioned above. If the value of the probability level is greater than (0.05), this indicates that there are no differences in the mentioned research variables, which confirms the equivalence of the two research groups.

**Experimental design:**

The researchers used an experimental design called (two-equivalent groups design) with random selection and distribution with pre-and post-tests (Al-Naimi, 2021).

**Field procedures steps:**

**Design of the two descending loads:**

The researchers designed the two descending distance loads. Then they presented them to a group of specialists in the fields of sports training, athletics, and the physiology of sports training to indicate their opinion on their suitability for the two research groups.

**Determine the maximum intensity of training distances:**

A test was conducted on the research sample on the training distances (300-meter, 200-meter, and 100-meter) on June 10-14, 2023. This is to determine the maximum intensity to work with the percentages adopted in the two descending loads of the two research groups.

**Exploratory experiments**:

The researchers conducted two pilot experiments on sprinters from the research sample with the help of an assistant work team, as follows:

The first exploratory experiment: It was conducted on (24-26/6/2023) to identify the validity of the RAST test and the one-mile sprint test and their suitability for the research sample. In addition to identifying the validity of the instruments used.

The second pilot experiment: It was conducted on (3/7/2023) in which a complete training session was implemented, to determine the number of repetitions, the number of sets, and the length of the rest period between repetitions and sets. In addition to identifying all the difficulties and obstacles that researchers may face during the implementation of the research experiment, and trying to overcome them.

**Pre-tests and measurements:**

The pre-tests and measurements were conducted during the period (8-13 July 2023).

**Implementation of the two descending loads**:

The two descending loads were carried out on the two research groups in the period (15/7/2023) until (24/8/2023) and the following points were taken into account:

The two descending loads were implemented in the special preparation period. Each descending load consisted of two intermediate cycles, and each intermediate cycle contained (3) weekly cycles. That is, the two descending loads were carried out in (6) weeks, using an undulating load movement (2:1) in each intermediate cycle. Each weekly cycle contained (3) daily training sessions, that is, (18) training sessions were implemented. The daily training units for the two research groups were carried out on (Saturday, Monday, and Thursday). Start all training modules with a preparatory section that includes general and special warm-ups. The main section of the training session consisted of the two descending loads in distance and the concluding section consisted of cool down and relaxation. The main section of the training sessions implemented on (Sunday, Tuesday, and Wednesday) included special strength endurance exercises, maximum sprint speed, as well as the cardiorespiratory endurance system.

Training distances (300 meters, 200 meters, 100 meters) were used in the two descending loads.The two descending loads were performed in (3) sets, with (3) repetitions in each set. The volume was standardized in the two descending loads of the two research groups, which amounted to (1800) meters in each training session. The intensity used in the training distances for the two research groups was standardized as shown in Table (5).

**Table 5.** Undulation of the load movement in each intermediate cycle according to the intensity

| Intensity | First intermediate cycle | | | Second intermediate cycle | | |
|---|---|---|---|---|---|---|
| | Week 1 | Week 2 | Week3 | Week 4 | Week 5 | Week 6 |
| 90% | | | | | • | |
| 85% | | • | | • | | • |
| 80% | • | | • | | | |

The rest periods between repetitions in the training distance sprint for the two research groups were as follows:

a. In the 300-meter sprint, at 80% intensity, the rest period was (4.30) minutes.
b. In the 200-meter sprint, at 80% intensity, the rest period was (3.30) minutes.
c. In the 100-meter sprint, at 80% intensity, the rest period was (3) minutes.
d. The rest periods between the sets in the two descending loads lasted (7) minutes.
e. Using the Flying Start in the training distance sprint used in the two descending loads.
f. Using the interval training method to train the two descending loads of the two research groups.

**Post-tests and measurements:**

After completing the implementation of the two descending loads, the post-tests and measurements were conducted during the period (26-31/8/2023) and in the same sequence in which the pre-tests and measurements were conducted.

**Statistical methods:**

The statistical program (SPSS) was used to extract the research results, and the following statistical methods were adopted: (Arithmetic mean, standard deviation, Shapiro-Wilk test, Levene test, t-test for related samples, t-test for independent samples, and effect size - Cohen's (D) (Nasiri, 2020).

**Results**

Results presentation and analysis of the pre-and post-tests for the first experimental group used (descending load in distance within one set), as shown in Table (6):

**Table 6.** AMA and SD in blood lactate, anaerobic power, fatigue index, aerobic power, 400-meter sprint performance, calculated T-value, and probability level between the pre-and post-tests for the first experimental group used (descending load in the distance within one set)

| Variables | Measurement unit | Pre-test | | Post-test | | calculated T-value | probability level |
|---|---|---|---|---|---|---|---|
| | | AMA | ±SD | AMA | ±SD | | |
| Blood lactate | mmol/l | 19.49 | 0.53 | 20.69 | 0.92 | -4. 557 | 0.020* |
| Anaerobic power | w | 707.527 | 102,550 | 771.628 | 98.789 | -4.317 | 0.023* |
| Fatigue index | w/s | 15.499 | 2.757 | 14.711 | 2.657 | 4.358 | 0.022* |
| Aerobic power | min | 5,25,94 | 0,9,55 | 5,19,87 | 0,9,73 | 8.581 | 0.003* |
| 400-meter sprint performance | s | 59.60 | 1.65 | 57.76 | 1.95 | 11.778 | 0.001* |

*Significant at probability level ≤ 0.05

Results presentation and analysis of the pre-and post-tests for the second experimental group used (descending load in the distance from one set to another), as shown in Table (7).

**Table 7.** AMA and SD in blood lactate, anaerobic power, fatigue index, aerobic power, 400-meter sprint performance, calculated T-value, and probability level between the pre-and post-tests for the second experimental group used (descending load in the distance from one set to another).

| Variables | Measurement unit | Pre-test | | Post-test | | calculated T-value | probability level |
|---|---|---|---|---|---|---|---|
| | | AMA | ±SD | AMA | ±SD | | |
| Blood lactate | mmol/l | 19.49 | 0.53 | 20.69 | 0.92 | -4. 557 | 0.020* |
| Anaerobic power | w | 707.527 | 102.550 | 771.628 | 98.789 | -4.317 | 0.023* |
| Fatigue index | w/s | 15.499 | 2.757 | 14.711 | 2.657 | 4.358 | 0.022* |
| Aerobic power | min | 5,25,94 | 0,9,55 | 5,19,87 | 0,9,73 | 8.581 | 0.003* |
| 400-meter sprint performance | s | 59.60 | 1.65 | 57.76 | 1.95 | 11.778 | 0.001* |

*Significant at probability level ≤ 0.05.

Results presentation and analysis of the post-test for the two research groups used (the descending load in the distance within one set) and (the descending load in the distance from one set to another) as shown in Table (8).

**Table 9.** AMA and SD in blood lactate, anaerobic power, fatigue index, aerobic power, 400-meter sprint performance, the calculated (T) value, and probability level between (the descending load in the distance within one set) and (the descending load in the distance from one set to another) in posttest.

| Variables | Measurement unit | descending load in the distance within one group | | descending load in the distance from one group to another | | calculated T-value | probability level |
|---|---|---|---|---|---|---|---|
| | | AMA | ±SD | AMA | ±SD | | |
| Blood lactate | mmol/l | 20.69 | 0.92 | 20,26 | 0.68 | 0.721 | 0.498 |
| Anaerobic power | w | 771.628 | 98.789 | 741.466 | 64.351 | 0.512 | 0.627 |
| Fatigue index | w/s | 14.711 | 2.657 | 14.077 | 3.992 | 0.589 | 0.577 |
| Aerobic power | min | 5,19,87 | 0,9,73 | 5,22,45 | 0,9,67 | -0.375 | 0.720 |
| 400-meter sprint performance | s | 57.76 | 1.95 | 57.74 | 2.31 | 0.015 | 0.989 |

Not significant at probability level > 0.05

Results presentation and analysis of the effect size, Cohen's type (D), for the two research groups used (descending load in distance within one set) and (descending load in distance from one set to another), as shown in Table (9).

**Table 9.** Effect size, Cohen's type (D) on blood lactate, anaerobic power, fatigue index, aerobic power, and 400-meter sprint performance

| First experimental group<br>Descending load in the distance within one group | | | Second experimental group<br>Descending load in distance from one group to another | | |
|---|---|---|---|---|---|
| Variables | Cohen (D) | | Variables | Cohen (D) | |
| Blood lactate | 2.27 | Very large | Blood lactate | 2.10 | Very large |
| Anaerobic power | 2.15 | Very large | Anaerobic power | 2.13 | Very large |
| Fatigue index | 2.17 | Very large | Fatigue index | 1.65 | Very large |
| Aerobic power | 4.29 | Very large | Aerobic power | 4.26 | Very large |
| 400-meter sprint performance | 5.89 | Very large | 400-meter sprint performance | 5.01 | Very large |

## Discussion

In light of the results obtained from Tables (5, and 6), showed significant differences in blood lactate, anaerobic power, fatigue index, aerobic power, and 400-meter sprint performance between the pre-and post-tests. It was in favour of the posttest for the two research groups used (descending load in distance within a set) and (descending load in distance from one set to another). This means that the first and second hypotheses assumed by the researchers are fulfilled.

The researchers attribute this significant progress in the aforementioned research variables to the effectiveness of the two descending loads in the distance, whether (within one set) or (from one set to another), relying on interval training, which had a significant impact in achieving this progress. It is the type of training that is characterized by the use of incomplete rest periods between repetitions. In addition to the intensity that is adopted in the two descending loads in the distance, which ranged between (80%-90%) of the maximum intensity for each training distance agreed upon in scientific sources. It is the most important feature of interval training. Laursen & Buchheit point out, “The first, and perhaps the most influential feature in training units based on interval training is the intensity chosen for the exercise period. This intensity (used in this research) can be worked with and largely maintained for (30-60) minutes (Laursen & Buchheit, 2019). This is a time range that has been adopted in the two descending loads in the distance, specifically in the main section. Finally, the appropriate number of repetitions was adopted through the proper standardization of the two descending loads used by the two research groups.

Certainly, the use of interval training played a major role in achieving this progress for both research groups, through the biochemical and functional adaptations that this type of training brings to the individual athlete’s body. According to Al-Hiti interval training works to achieve the adaptation process sought by the player and the coach by controlling the degrees of training load (Al-Hiti, 2011). As interval training develops anaerobic power as a primary goal, by increasing the endurance of lactic acid accumulated in the working muscles. This type of training creates an oxygen deficiency, due to the incomplete rest periods that intersect the repetitions. This deficiency hinders the process of adequate consumption of oxygen by the working muscles. As a result of the need for rapid energy, sugar, and glycogen stores are targeted to meet the requirements of muscular work often performed at high intensity. Therefore, lactic acid accumulates in working muscles. This accumulation increases gradually from one repetition to another and from one set to another, causing an increase in the acidity of the muscle cell environment, which disrupts the work of enzymes. Interval training develops the athlete’s aerobic capacity as a secondary goal, by improving cardiovascular and lung functions. In this regard, both Khuraibet and Abdel Fattah state that “interval training is mainly used to increase anaerobic power. As, most exercises are performed quickly and with a lack of oxygen, which leads to the accumulation of lactic acid in the working muscles. In addition to use, it increases aerobic power, by improving the functions of the circulatory and respiratory systems (Khuraibet & Abdel, 2016).

Sanders confirms this: “Interval training leads to pushing the athlete into an anaerobic zone in which he can feel his heart coming out of his chest. This improves his anaerobic and aerobic endurance, through improved cardiovascular health (Sanders, 2015). The increase and significant progress in blood lactate that accompanied the improvement in anaerobic power and the performance of the 400-meter sprint, confirms the aforementioned. This increase indicates the adaptation of working muscles to high lactate levels. In addition to improving the physiological state of the athlete. By increasing the ability of the muscles to endure the accumulated lactate and continue to perform with high efficiency, due to several factors, the first of which is the increase in anaerobic enzymes and their activity. This is what Cissik & Dawes indicated when they stated, “Interval training increases anaerobic enzymes. This allows for increased anaerobic energy turnover and the use of lactate as a fuel source during exercise (Cissik & Dawes, 2015).

This is confirmed by Ross & Leveritt, the activity of glycolytic enzymes, especially the activity of lactate dehydrogenase an enzyme that catalyzes the transformation of pyruvate into lactate, phosphofructokinase an enzyme that catalyzes the transformation of glycolysis into pyruvate and glycogen phosphorylase an enzyme that catalyzes the mobilization of muscle glycogen stored in the glycolysis pathway, increases after short-term rapid less than 10 seconds and long-term more than 10 seconds interval training. In addition to improving the ability to perform physical work (Ross & Leveritt, 2001).

The second factor that reflects the improved ability of the muscle to endure increased lactate is the improvement in buffering capacity. (Pfitzinger & Latter) explained that during anaerobic work at the level of the second energy system, lactic acid accumulates in working muscles, which is rapidly converted to lactate and positively charged hydrogen ions (H+). High concentrations of hydrogen ions create a burning sensation during exercise that contributes to the rapid arrival of fatigue because the release of hydrogen ions will lower the pH. That leads to increased acidity that inactivates enzymes, thereby limiting energy production ((Pfitzinger & Latter, 2015). Improving the buffering capacity means increasing resistance to changes in pH by increasing the ability of skeletal muscle to buffer chemicals that buffer positive hydrogen ions (H+). Interval training improves the buffering capacity.

Reuter adds, that as a result of anaerobic training, the amount of bicarbonate ($HCO_3$) in skeletal muscles increases. The bicarbonate acts as a very effective buffer to reduce acidity in muscles that are exercising (Reuter, 2024). As for the significant progress that occurred in aerobic capacity, it is attributed to the occurrence of adaptations at the cardiovascular and lung levels as a result of interval training. Billat explained athletes must spend at least several minutes in each training session based on interval training using an intensity exceeding 90% of the maximum oxygen consumption (an intensity that was adopted in the two descending loads). This is to obtain optimal stimulation and cardiac and respiratory adaptations, as well as vascular adaptations (Billat, 2001).Cissik & Dawes add that many of the cardiovascular and respiratory benefits produced by traditional aerobic training methods are also provided by interval training. These benefits include improving the ability to consume oxygen, increasing the ability to transport oxygen to working muscles, and increasing the size and density of mitochondria, which allows for the production of more energy (Cissik & Dawes, 2015).

The significant improvement in the fatigue index is attributed to the improvement in anaerobic power due to the inverse relationship between anaerobic power and the fatigue index according to the law of the fatigue index. As the greater the anaerobic power, the later the onset of fatigue, in addition to the significant improvement in aerobic power. This is pointed out: "The development of aerobic power creates adaptations that enable the muscles to continue working for a long period after the phenomenon of fatigue occurs. The development of the fatigue index is also attributed to training leading to fatigue. We also find that systematic training based on an appropriate period and appropriate intensity leads to improving the athlete's physical capabilities (Theofilidis, et al., 2018). Interval training is the type of training that is mainly categorized as anaerobic training. Anaerobic training is known to lead to fatigue earlier than aerobic training due to the rapid consumption of stored energy sources. In addition, interval training is carried out according to certain principles, namely performing exercises with a high number of repetitions carried out at high intensity and with many sets. This is what was adopted in the two descending loads under study.

In this regard, Khuraibet confirms, interval training is characterized by increasing the body's resistance. This is done by working against the factors that lead to fatigue. This is done by using energy sources during training by alternating between exertion and relaxation, fatigue and recovery, and energy storage and depletion. Reducing fatigue during training can increase the degree of load (intensity-volume) (Khuraibet, 2014). This is what actually happened in the post-tests, which is an increase in intensity (a decrease in sprint time) in both anaerobic and aerobic powers, and performance in the 400-meter sprint.

Using the aforementioned conditions and principles of interval training, led to increased accumulated lactate endurance, improved anaerobic power, fatigue index, and aerobic power, and the improvement in these variables, in turn, led to improved 400-meter sprint performance. In the early moments of the race, the sprinter utilizes mainly anaerobic mechanisms, as the amount of oxygen used by the sprinter is limited. But as the time of physical exertion extends, oxygen utilization increases accordingly (Zouhal, et al., 2010). Rogers and Coordinator quote Clyde Hart: “The 400-meter race is an event that lacks oxygen. This means that the level of oxygen absorption is lower than the level necessary to provide ATP. Much of the energy used in this race is derived from the dissolution of high-energy phosphate compounds and the splitting of glycogen into lactic acid (Rogers & Coordinator, 2000).

One of the reasons for the progress of the two research groups is to take into account the training principles for the 400-meter sprint competition. The two descending distance exercises included developing a set of important physical qualities that are consistent with achieving the requirements of the 400-meter sprint competition. At the forefront of these qualities is speed endurance, using different training distances (300 meters, 200 meters, and 100 meters), which are distances that target the specific development of this quality. This is what scientific sources indicate, as Rogers & Coordinator mentions, according to Clyde Hart, that developing the speed of endurance is a vital matter for sprinting well at a distance of 400 meters. Sprint distances can range from 100 meters to 600 meters (Rogers& Coordinator, 2000). The times for performing these distances fall within the limits of the work of the second anaerobic system, leading to the accumulation of high concentrations of lactic acid. This is the most important principle that must be taken into consideration when training 400-meter sprinters. During a 400-meter sprint, energy is generated by splitting glycogen into lactic acid (which later turns into lactate). However, this mechanism must be addressed in training, as high concentrations of lactic acid must be obtained (Snyder, 2024), similar to the internal state of a 400-meter sprinter during a race. The body must be exposed to the stress of this type to learn how to deal with it. Freeman adds that the 400-meter race is unique in that the athlete must maintain the energy necessary to continue exerting a high-level effort for more than 40 seconds. Therefore, lactate endurance becomes an essential part of an athlete’s preparation (Freeman, 2015).

In addition to the development of speed endurance, the design of the two descending loads in distance was based on the development of special strength endurance and maximum sprint speed. In addition to the endurance of the circulatory and respiratory systems (general endurance), these are influential qualities that must be emphasized in varying proportions during the various training cycles for 400-meter sprinters. In this regard, Muhammad states, that speed and strength training are among the most important aspects that must be developed to achieve the highest performance (Muhammad, et al., 2024). However, the accompanying aspects such as speed and general endurance must not be overlooked. Although they do not have a direct effect, they are linked to the general development of the annual 400-meter sprint training programs as well as long-term training programs.

It is important to note that the use of general training principles has played an important role in the progress of both research groups. At the forefront of these principles is the principle of regular training and continuity, which represents the backbone of success in achieving optimal achievement in any aspect. Especially the physical aspect by achieving physiological adaptation, which can only occur by repeatedly stimulating physiological responses and within a specific period. Maffetone stated, that most anaerobic benefits occur within three to four weeks of beginning anaerobic training (Maffetone, 2010).

It can be said that the gradual progression of the training load is an important principle that undoubtedly led to the progress of the two research groups. Training at one pace cannot reap its benefits and may lead to a decline in the level in general unless increased pressure occurs on the body's functional systems in a non-linear manner. This means that there are weeks in which the load is high, and other recovery weeks in which the load is low to achieve functional adaptation, and not to overtrain or be exposed to injury. In the current research, a load movement formation (1:2) was used in each intermediate cycle, which is an appropriate formation for the training period of the research sample (the special preparation period). In this regard, Reuter states one of the primary goals of a well-designed training program is to help the athlete achieve positive physiological adaptations through appropriate training and recovery so that the athlete can optimally reach peak competition. As well as reducing the chance of injury and illness while promoting systematic recovery throughout the training plan (Reuter, 2024).

Pfitzinger & Latter add to continue improving performance, the athlete needs to continue increasing training motivation, as continuing the same difficult exercise from time to time reduces performance. On the contrary, if an appropriate plan is developed and the athlete's exercises are adjusted according to the difficult/easy principle, a good level of performance can be achieved (Pfitzinger & Latter, 2015). Bompa & Buzzichelli confirm that "training gradually leads to adaptations in the environment and functions of the athlete's body, thus increasing his motor potential and ultimately leading to improved performance(Bompa & Buzzichelli, 2015).

Among the training principles that were adopted in the design of the two descending loads, which led to the progress of the research sample in all variables, is the principle of return and repetition. Each descending load contained an appropriate number of repetitions, which were (9) repetitions, which were performed in (3) sets, with (3) repetitions in each set. The importance of this principle lies in the fact that it works to increase the workload on the functional organs and energy production systems operating within the training unit by repeating the stimulus, thus targeting the maximum potential of the athlete. As a result, the athlete is pushed to a better level. Regarding the importance of this principle, Al-Zubaidi states repeating a specific exercise leads to the adaptation of the muscles and functional body systems reaching a better state of physical performance and then improving the athletic level for the better (Al-Zubaidi, 2019a)

In light of the results obtained from Table (7), it becomes clear to us that the differences in blood lactate, anaerobic, and aerobic powers, the fatigue index, and performance in the 400-meter sprint between the two research groups in the post-test were non-significant. This fulfills the third hypothesis assumed by the researchers. This result confirms the convergence of the level of development between the two research groups in its adopted variables, and this means that both descending loads have led to the achievement of functional and physical progress for the two research groups, as we mentioned previously. But when we look at Table (8), we see that the size of the effect that occurred on blood lactate, the anaerobic and aerobic powers, the fatigue index, and the 400-meter sprint performance for the first group that used (the descending load in the distance within one set) was greater than the effect size that occurred for the second group that used (descending load in the distance from one set to another). This is an indication that shortening the sprint distance from one repetition to the next is better than shortening the sprint distance from one group to another. This means that gradually increasing the speed of repetitions is better than gradually increasing the speed of training groups because repetitions are interspersed with an incomplete rest period according to the principles of interval training, while training groups are interspersed with a complete rest period. The process of sprinting at a higher intensity after a short period of rest will place a greater burden on the body's functional systems and greater pressure on the energy production systems than the process of running at a higher intensity after a complete period of rest, despite the fixed duration of the stimulus. Another reason that can give (descending load in the distance within one set) superiority over (descending load in the distance from one set to another) is starting the second and third training sets with a more specific distance, which is (300 meters), despite the fatigue and stress that the athlete is exposed to after performing the first training set. Thus, the athlete is pushed into a more private area. Unlike (the descending load in the distance from one set to another), the second training set begins at a distance of (200 meters) and the third set begins at a distance of (100 meters). These are fewer private distances compared to (300 meters).

It should also be noted that the diversity of repetitions could be a reason for the progress and superiority of (the descending load in the distance within one set) over (the descending load in the distance from one set to another). This diversity can lead to stimulating positive psychological aspects for the athlete, despite the doubling of the training requirements (increasing speed at the expense of shortening the distance), which prompts the athlete to exert more effort through feeling the ease of completing the training set. Unlike the routine method, which is repeating the same stimulus in each training set.

## Conclusions

The use of descending distance loads in interval training for the two experimental groups led to significant improvements in all measured variables, including blood lactate levels, anaerobic power, fatigue index, aerobic power, and 400-meter sprint performance. However, the statistical analysis did not reveal a significant advantage of one descending distance load over the other for these variables. While both descending loads had a highly significant impact on the outcomes, the effects were more pronounced for the descending load within a single set. The researchers recommend using two descending loads in distance training based on interval training for 400-meter sprinters. This approach, particularly the descending load within a single group, has proven to be more effective and efficient for achieving functional adaptations related to accumulated lactate endurance. It also enhances anaerobic power, fatigue index, and aerobic power, ultimately improving performance metrics. The evaluation of the sprinter's training status should rely on data from blood lactate levels, anaerobic power, fatigue index, and aerobic power to assess training programs for the 400-meter event. Also urging coaches to consider the training principles for the 400-meter sprint competition. Furthermore, it is important to conduct similar studies focusing on other physical characteristics and various sprint competitions.

## Conflict of interest

The authors state that they have no competing financial interests or personal relationships that could have influenced the work.

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