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Original article

Sprint training using sleds and parachutes

Entrenamiento de sprint mediante el uso de trineo y paracaídas

Treinamento de *Sprint* usando trenó e pára-quedas

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ABSTRACT

The individualized training of specific races with resisted means is an important tool for the improvement of speed. Due to the demand of this capacity for the good performance of baseball players, the objective of this study is to design a *sprint* training using sled and parachute. A quasi-experiment is planned, with two groups: control and experimental and in two moments: pre-test and post-test. The experimental stage is developed during the pre-season, conformed by a sample of ten subjects with 20.84 years of age and 79 82kg. of average weight. Theoretical methods used were analytical synthetic, inductive-deductive, historical-logical and systemic-structural-functional. The empirical methods were content analysis, observation and measurement. For the measurement of linear speed, the variables analyzed are the 60-yard *test* and the maximum strength *tests* of the sled and *squat*. The results achieved indicated significant improvements in the experimental group in the three *tests* performed, with % increases equal to 3.48, 7.25 and 7.46 respectively. In addition, it is obtained that there is a high correlation between the maximum strength of the sled and the *squat* with respect to the weight of the athletes' effort performance, with Pearson coefficients equal to 63.6 % and 62.9 % respectively and for a 95 % of confidence. It is demonstrated that resisted training provides key information in the maximum velocity phase for the improvement of *sprint* performance in baseball.

Keywords: Resisted training; Specific *sprint*; Sled; Parachute; Speed.

RESUMEN

El entrenamiento individualizado de carreras específicas con medios resistidos es una importante herramienta para la mejora de la velocidad. En virtud a la demanda de esta capacidad para el buen desempeño de los jugadores de béisbol, se reconoce como objetivo del presente estudio diseñar un entrenamiento de *sprin*t mediante el uso de trineo y paracaídas. Se planifica un cuasiexperimento, con dos grupos: control y experimental y en dos momentos: pre y postest. La etapa experimental se desarrolla durante la pretemporada, conformada por una muestra de diez sujetos con 20.84 años de edad y 79.82 kg. de peso promedio. Se emplearon como métodos teóricos el analítico-sintético, inductivo-deductivo, histórico-lógico, sistémico-estructural-funcional y como empíricos el análisis de contenido, la observación, la medición. Para la medición de la velocidad lineal, las variables analizadas son el *test* de 60 yardas y los *test* de fuerza máxima del trineo y de *squat*. Los resultados alcanzados indicaron mejoras significativas en el grupo experimental en los tres *test* realizados, con % de incrementos iguales a 3.48, 7.25 y 7.46 % respectivamente. Además, se obtiene que existe una elevada correlación entre la fuerza máxima del trineo y la de *squat* con respecto al peso de rendimiento al esfuerzo de los atletas, con coeficientes de Pearson iguales a 63.6 % y 62.9 % respectivamente y para un 95 % de confianza. Se demuestra que el entrenamiento resistido nos proporciona información clave en la fase de velocidad máxima para la mejora del rendimiento de *sprint* en el béisbol.

Palabras clave: Entrenamiento resistido; *Sprint* específico; Trineo; Paracaídas; Velocidad.

RESUMO

O treinamento individualizado de corridas específicas com mídia resistida é uma ferramenta importante para melhorar a velocidade. Em virtude da demanda desta capacidade para o bom desempenho dos jogadores de beisebol, é reconhecido como um objetivo do presente estudo projetar um treinamento de *sprint* usando trenó e pára-quedas. Está prevista uma quase-experimentação, com dois grupos: controle e experimental e em dois momentos: pré-teste e pós-teste. A fase experimental ocorreu durante a pré-época, com uma amostra de dez sujeitos de 20,84 anos de idade e pesando uma média de 79,82 kg. Os métodos teóricos utilizados foram analítico-sintético, indutivo-dedutivo, histórico-lógico, sistêmico-estrutural-funcional, e os métodos empíricos foram análise de conteúdo, observação e medição. Para a medição da velocidade linear, as variáveis analisadas foram o teste das 60 jardas e os testes de resistência máxima do trenó e do agachamento. Os resultados alcançados indicaram melhorias significativas no grupo experimental nos três testes realizados, com aumentos de % iguais a 3,48, 7,25 e 7,46 %, respectivamente. Além disso, obtém-se que existe uma alta correlação entre a força máxima do trenó e o agachamento com relação ao peso do desempenho de esforço dos atletas, com coeficientes de Pearson iguais a 63,6 % e 62,9 % respectivamente e para um 95 % de confiança. Demonstra-se que o treinamento resistido nos fornece informações chave na fase de velocidade máxima para a melhoria do desempenho do sprint no beisebol.

Palavras-chave: Treinamento resistido; *Sprint* específico; Trenó; Pára-quedas; Velocidade.

INTRODUCTION

In physical conditioning programs, especially in group sports, resisted means are very widespread, which are a method or form of training based on applying a endurance/overload to a movement or sporting gesture through a sled, parachute, weighted vest, beach sand and inclines (Alcaraz *et al.*, 2009; Leyva *et al.*, 2017; Martínez-Valencia *et al.*, 2014).

This is a type of training based on performing *sprints* with an external resistance or load that hinders such running (hence the adjective resisted). Considered by Crowley *et al.* (2018) as that exercise performed against an endurance added to the natural resistance of the execution of the sporting gesture itself, which is determined, according to the criteria of Bahia *et al.,* (2021) by the ability to accelerate, to achieve maximum speed, as well as by the ability to maintain this maximum speed during fatigue. Performance in these phases is influenced, in turn, by biomechanical, physiological and psychological factors.

In the review conducted, several works have been found that have focused on the short-term effects of using sled drags on the acceleration phase, maximum speed and speed endurance, to create a solid foundation that allows the athlete a progression and assimilation of this type of training, influenced by strength, power and mobility, in addition to technique and coordination. Authors such as Gil *et al.,* (2018), Alcaraz *et al.,* (2008), researched the effects of sled drag training with 20 professional rugby players for six weeks, who were divided into two experimental groups. In one group, they performed two sets of three repetitions (rep) x 20 meters (m) of *sprinting* using the sled with 12.6 % of body weight and the other group performed the same *sprint* training without sled. They were subjected to a *pretest* at the distances of 10 and 30 m. respectively and after 6 weeks of training the same tests were repeated. The results indicated low significant values in both groups, although the best results were in favor of the group that used the sled, both in the 10 m and 30 m distances.

The research conducted by Cahill *et al.,* (2020), who after 7 weeks of *sprint* training with sled dragging, used different loads with 5 % of body weight (low load), 12.5 % of body weight (medium load) and 20 % of body weight (high load). It was obtained as a result that only in the group that mobilized high load improved *sprint* times in the distance of 20 m, 30 m and 40 m. 30 m. and 40 m. In addition, the average propulsive speed of the lower limbs was only improved in the groups that moved medium and high loads. In this regard, the authors believe that this is due to the significant increase in propulsive momentum and thrust against the ground during the acceleration phase, enabling the ability to produce peak power in the horizontal direction, i.e., in the forward direction of the movement.

Another reasoning was made by Alcaraz *et al.,* (2018), where he reveals in a study conducted with amateur players of collective sports to know the acute effects on the reaction strength with three different conditions, loads of 30 % of body mass, 10 % of body mass, through sled towing and with own body weight in a five-meter *sprint.* The study revealed that all braking ground reaction strength variables (peak, mean and impulse) were lower for the 30 % condition, relative to 10 % and at own body weight. But in turn it reflected that the propulsive impulse was significantly longer for the 30 % condition, alluding that this condition increases the production of horizontal strength and impulse, which allows for a longer time to apply strength against the ground. However, the authors consider it appropriate to work under the three conditions, since this allows in parallel the increase of the production of horizontal strength and the impulse corresponding to the initial thrust of the athlete on the acceleration of the *sprint* with the reaction strength of the braking ground that can produce the lower extremities of the athlete during the impulse phase, in contact with the ground.

In this type of sled and parachute training, strengths will be projected through the hip, reducing compressive and shear strengths in the lumbar region (Bompa y Buzzichelli, 2019). In addition to a great alternative to improve propulsion in the initial acceleration phase, from which the maximum speed is reached (Alcaraz *et al*., 2018). A large number of muscles generate moments of abduction, adduction, internal and external rotation to stabilize the femur and pelvis and maintain proper alignment and stabilization of the hip and femur by increasing the load on the athlete's torso, which would increase performance in *sprinting.* (Movahed *et al.,* 2019)*.*

The incorporation in baseball of the resisted means within the physical conditioning routines for the improvement of speed in its main leagues should be based on the specific demands of this sport, due to its effectiveness and versatility, as a training tool. Therefore, the objective of the present study is to design a *sprint* training using sled and parachute.

MATERIALS AND METHODS

Participants

The sample used was chosen intentionally and consisted of a total of 20 male baseball players, under 23 category of Matanzas (20.84 ± 0.72 years, 79.82 ± 5.21 kg), they were organized into two groups, a control group (GC) and an experimental group (GX). The experimental group (GEX) performed individualized *sprint* specific training work with sled, with weights between 20-35 kg and parachute. It ended with exercises based on the repetition of free sprints, considering its insertion throughout the entire preparation process, incorporated within the normal balance of loads together with non-specific methods of strength exercises with weights for squat lower limbs, combined with complementary quadriceps and plyometric exercises, without constituting a complement, nor additional workload, in addition to their usual training, five times a week and a competition match. Control group (CG), performed their usual training, five times a week, plus the competition match on the weekend. All players were subjected to identical tests under equal conditions and had to train a minimum of three times a week (approximately 9 to 12 h/week) during the three months of the preseason, which consisted of 12 weeks (wk). Before the start of the study, all subjects voluntarily signed the informed consent form and read the participant information document beforehand.

Instruments

Two measurements per participant were recorded through the field *test* (60 yards) widely used and widespread in the evaluation of baseball players for reliability and validity and two measurements were progressively taken in the maximum sled strength (FMT) and *squat* (FMS) *tests.*

- *Displacement speed test (60yards)*: it was performed following the next protocol. The time was counted in seconds (s) and thousandths of a second (ms), using a Casio electronic stopwatch, with an accuracy of 0.1 c/s, with an error of ± 0.001 second (s).
- *Squat 1 repetition maximum (1RM) test:* it was performed following the next protocol, it was measured through the maximum weight or resistance lifted in kilograms (kg), with which only one repetition can be performed.
- *FMT 1RM test*: to define the maximum strength of the sled dragging, it was quantified through the maximum weight or dragged endurance in kilograms (kg), with which only one repetition can be performed. With the harness fixed on the shoulders, the subjects were placed behind a line, having to drag the sled, increasing the weight on the device progressively every two meters (2m.), until it fails to move forward and the highest weight reached by the subject is recorded.

Research methods

The use of theoretical and empirical methods should be emphasized. Among the first one, the analytical-synthetic method was used to support the research topic on the basis of bibliographic analysis, allowing the authors to recognize the multiple relationships and components of the problem approached separately and then integrate them into a whole as it is presented in reality, which was the way through which the interpretation of the information gathered after consulting various authors was carried out; the inductive deductive method, which provided the determination of the problem and the differentiation of the tasks to be developed during the research process and allowed the design of the training. In addition to providing the establishment of the relationships between the facts that were analyzed and the explanations and conclusions reached in the present research, the historical-logical was used to verify the existence of antecedents that use this type of activities which, at the same time, allowed inquiring about the process of physical preparation (speed) and the systemic-structural-functional, taking into account that the task as a basic level in the concretion of the objective, should be structured as a system that privileges the work aimed at the improvement of the process addressed in the application of the methods of science. The second comprised the content analysis, which was needed to analyze and evaluate the use of means (exercises) for the development of the muscular strength of the lower limbs as a support for the increase of speed displacement 60 yards in the Integral Program for the Preparation of the Athlete. The observation allowed to verify the initial state or starting point of the players in relation to this distance, equivalent to two bases in baseball, through parameters and indicators considered in the guide made for this purpose and the measurement in three moments pre- and post-test, controlling and recording the times performed.

Statistical analysis

For the statistical treatment of the data, STATGRAPHICS PLUS Version 5.1 software was used. Hypothesis tests were applied to determine the existence or not of significant differences in the results obtained between the experimental group (GEX) and the control group (GC), for the two moments (pre- and post-test). A regression analysis was also performed to obtain the degree of correlation between FMT and PR performance weight (kg) and between FMS and PR performance weight (kg), for the GEX, based on Pearson's coefficient and the probability value. Both tests are performed with a significance level equal to 0.05. The effectiveness of the 60-yard dash of baseball players, under 23 category, from Matanzas, is calculated from the percent (%) increase (Incrt) taking as a base the following (Equation 1) y (Equation 2).

$$\%Incrt = \frac{\bar{x}_1 - \bar{x}_2}{0{,}5 * (\bar{x}_1 + \bar{x}_2)} * 100 \quad (1)$$

Where:

$\bar{x}_1 y \bar{x}_2$: (2) are the means of each sample

Training

Most of the actions, both offensive and defensive, that are performed in baseball, incorporate as fundamental components five tools or physical capacities within the preparation process of this sport. Due to the characteristics of this sport, which competitive period is longer than three months, specific adaptations should be sought to the nature of the training regime performed and the same should be specific in terms of movement pattern, speed of contraction, type of contraction and contraction strength.

The limitation of this type of training with specific adaptations is that, when used continuously in training cycles longer than 6 weeks, it can produce negative results such as the well-known speed barrier, which is a nervous system pattern that develops as a result of the use of similar training with similar training loads over the long term.

There are different types of exercises that help to avoid the speed barrier, where the principle of complementarity in sports activity plays an important role, by combining methods or means of training that provide each other with the elements that the other lacks to give rise to a superior quality. Hence, in *sprint* training, methods and means of general, specific and competitive training are combined throughout the season. The incorporation of resisted methods and means (sleds and parachutes), has different effects on the athlete's speed endurance, as well as on the *sprint* mechanics.

During the application of this training, which specify that the optimal load to be used in the different resisted methods will determine the effect produced by the specificity of the same, the Strength-Velocity relationship of muscle shortening and its similarity to the *sprint* technique. For this type of resisted training to be effective, it must not produce a loss in maximum velocity of more than 10 %.

Sequence of *sprint* speed exercises with resisted means

When performing this type of work for sprinting, a large number of muscles generate moments of abduction, adduction, internal and external rotation to stabilize the femur and pelvis and maintain correct hip and femur alignment. In order to seek the maximum possible specificity during execution, the athlete's movement patterns should be as similar as possible to those performed in the competitive context. Due to the unilateral nature of sled drag training, these muscles are activated considerably.

For the application of the exercise sequence with sled dragging, the strength-velocity profile must be taken into consideration, which is nothing more than the evaluation of the manifestation of the strength through the peak strength achieved and the time necessary to reach it in a dynamic action and the strength-time profile is the evaluation of the manifestation of the strength through the peak strength achieved and the time necessary to reach it in a static or dynamic action. This strength-velocity power profile is based on strength velocity and velocity-power relationships that characterize the maximum mechanical capacities of the neuromuscular system of the lower extremities and is formed by a series of key variables for the optimization of performance:

Vertical profiles: this is the maximum concentric strength production (per unit of body mass) that the athlete's lower extremities can theoretically produce during a ballistic thrust and will provide information on the physical capabilities that must be developed to improve the athlete's ballistic thrust performance and on the maximum levels of strength and velocity of the athlete's neuromuscular system.

Horizontal profiles: this is the maximum concentric strength production (per unit of body mass) in the horizontal direction, which corresponds to the athlete's initial thrust on *sprint* acceleration. The higher the value, the higher the *sprint-specific* horizontal strength production, which will provide information about the specific *sprint* acceleration movement and which underlying physical or technical characteristics primarily limit each individual's *sprint* performance.

Special stride length speed exercise (alternating jump with sled drag): As depicted in the (Figure 1) sequence A, the aim of this exercise is to increase stride length and with transfer to the unresisted sprint. Try at all times to keep the body upright to decrease the contact time with the ground.

Fig. 1 - Exercise sequence A) - alternating jump with sled drag, B) - skipping with sled drag, C) - resisted *sprint* with sled

Special exercise of stride frequency speed (skipping with sled dragging): As shown in (Figure 1), sequence B, the aim of this exercise is to increase the frequency of strides or steps per minute and with transfer to the unresisted sprint. Try at all times to keep the body upright to decrease the time of contact with the ground.

Special speed exercise (resisted sprint with sled): As depicted in the (Figure 1) sequence C, this exercise is intended to increase speed, combined with increased frequency and maximal extension of the lower limbs.

A group of requirements to be taken into consideration that, affect *sprint* performance are proposed:

- Stride frequency: time on the ground and in the air, muscle activation/relaxation ratio.
- Stride Amplitude: muscle and tendon length, flexibility, joint range.
- Power: fiber type/cross-sectional area, muscle strength, muscle activation velocity, muscle recruitment, stiffness/elasticity.
- Anthropometry.
- Biomechanics: Direction of strength application in the stance phase.

Fatigue:

- • Metabolic: decrease of ATP and PC, increase of acidosis.
- • Neural: decrease in motor neuron firing frequency, pain tolerance.
- • High forward horizontal strength production.
- • Combination of movements: hip and knee flexion-extension.
- • Generation (acceleration) of large magnitudes of (horizontal) reaction strength against the soil.
- • Maximal velocity phase: *rateofstrength development* (RFD), asymmetric strength production and relative maximal strength.
- • Intermuscular coordination, intramuscular recruitment patterns and neuromuscular control of the torso.
- • Technical ability to apply horizontal strength (angle of application of *ground reactionforcé* (GRF).
- • Perform the maximal load *test* for experienced athletes or use between 10 %-30 % of body weight for novice athletes.
- • Choose training distances (30-60 yards), close or equal to competition distances.
- • Percentage of the load to be used for the different expressions of strength
- • Load control is essential to ensure that the technique is as correct as possible.

- • Number of sets (2), repetitions (3-4), pause between sets (3-5 minutes) and between repetitions (1 minute).
- • The weight of the load to be used oscillates with intensities lower than 10 %., in relation to the percentage of the individual maximal strength of the athlete. In addition, recommends a volume of 150-160 m. of the distance to be covered per training units.
- • Perform one repetition of conversion exercises with free *sprinting* provided that each set is finished with a maximum run of 4 seconds.

Resisted *sprint* with parachute

The use of parachutes as a means of training is very common for the development of speed and speed strength. These can vary in size, offering greater or lesser endurance and will not increase the vertical reaction strengths acting on the athlete's body. Depending on the size of these, we will train the manifestation of one capacity or another or the combination of them; therefore, depending on the size of these, we will train the following:

- Small parachutes: speed development.
- Medium parachutes: development of speed-resistance.
- Large parachutes: development of strength-velocity and acceleration strength.

The endurance of the parachute is called "aerodynamic drag" and will increase with speed, which will be influenced, depending on the size of the instrument, but *sprints* should always be performed at maximum speed, which will normally be between 6 and 10 m/s depending on the size of the parachute. The use of parachutes favors a longer stride length, without causing major changes in the kinematics of the stride. Without causing major modifications in the sagittal plane kinematics, so it does not affect the mechanics of running.

One of the advantages of this means is that you can quickly disengage and reach maximum speed, which will be ideal for working on speed and, above all, stride frequency. The distances of the training with parachutes vary depending on the size of the same between 30 and 150m., where the latter distance will be used with small parachutes.

The use of these parachutes should be gradual and progressive, using the larger ones over a period of several weeks. In doing so, it will be essential to periodically decrease the session load and apply the method of contrasts with parachute release to improve the training effect.

Special speed exercise (resisted sprint with parachute): For maximum speed improvement, the *sprint* should be 95-100 % and for maximum speed endurance development it is between 90-100 % of maximum speed (Figure 2).

Fig. 2. -Sprint resisted with parachute

Keys to resisted means training

- The training load should be similar to that used in standard training for the development of maximal speed.
- The resisted means have different characteristics, therefore, different adaptations.
- The direction of the endurance applied to the athlete is different, depending on the resisted medium (different effects on the athlete's speed and *sprint* mechanics*).*
- Development of the Acceleration Phase: sledging with high loads and hill *sprinting.*
- Improved Maximum Speed Phase = sled dragging with low loads, weighted vest and parachute.
- Increase in VTC-Pmax and/or decrease in FVimb.
- Training program designed to improve acceleration performance = HZT-Pmax (HZTF0 and HZT-V0).

RESULTS AND DISCUSSION

Shows the results obtained in the evaluations in the pre and posttest, reveal that the control group (GC) reduces its values in the 60 yards in 0.14 m/s, for a slight percent increase (% Incrt) of 1.30 %, when contrasting the results obtained against the evaluation scale for the 60 yards proposed by (Reynaldo, 2017, cited García-Ponce de León *et al.*, 2019), these are placed evaluated of bad (M) (Table 1).

For its part, in the GEX group improved in the 60 yards by 0.40m/s, for a 3.48 % Incrt, going from the scale of regular (R) or a value of 30 points, to the scale of average (P) or a value of 50 points, which places them very close to the desired values for an optimum, according to the parameters established by Major League Baseball (MLB) for talent selection (MLB, 2014, cited by García-Ponce de León and Carreño-Vega, 2021).

Table 1. - GC and GEX 60-yard test pretest and posttest results

60 yards (s) GC GEX				
No	Pre-test	Post-test	Pre-test	Post-test
1	7,26	7,53	7,23	6,85
2	7,73	7,64	7,18	6,79
3	8,56	7,70	7,29	6,89
4	8,13	7,99	7,51	7,02
5	7,65	7,40	7,07	6,86
6	7,58	7,50	6,97	6,54
7	7,56	7,48	7,43	7,32
8	7,53	7,42	7,12	6,60
9	7,65	7,55	7,13	6,85
10	7,40	7,36	7,18	6,75
Average	**7,71**	**7,56**	**7,21**	**6,85**
% Incrt	**1,30**			**3,48**

The GC group does not present significant differences between the pre-test and the posttest, since a probability value (p-value 0.279) greater than the significance level (0.05) is obtained, while the GEX group shows significant improvements in their performance in the 60 yards since the probability value (p-value 0.0005) is less than the significance level (0.05), which demonstrates the effectiveness of the exercises proposed during the pre-season for a 95 % confidence level (Figure 3).

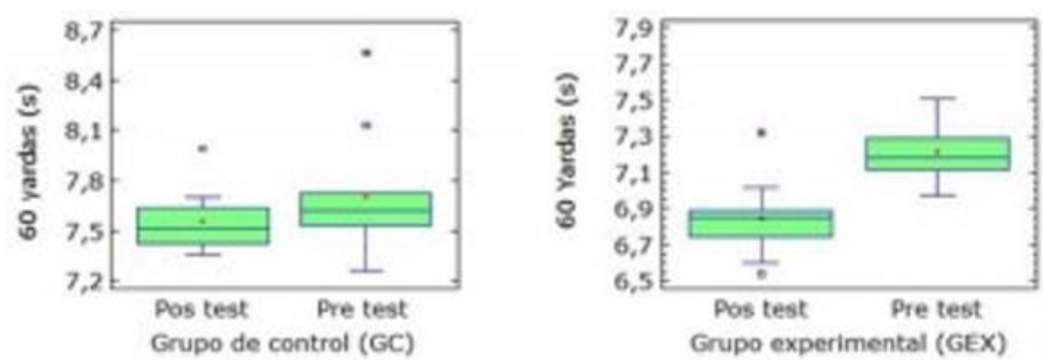

Fig. 3 - Pretest and posttest results of the GC and GEX at 60 yds

When comparing the behavior of the 60-yard test between the pretest GC and GEX and the posttest GC and GEX significant differences are denoted in both cases, since probability values equal to 0.0013 and0. 0000 respectively are obtained, lower than the level of significance (0.05) for 95% confidence. Caused in the first case because the GC subjects did not have the influence of the previous season's training and in the second case the contribution of the resisted work associated to the training with sleds and parachutes is demonstrated (Figure 4).

In the specific case of the behavior of the muscular strength of the lower limbs applied to the GEX, through the maximum strength tests of the FMT sled and the maximum strength of the FMS squat (Tables 2 and 3), a notable Incrt (7.25) was obtained between the pretest and the posttest and the body weight ratio was improved with respect to the FMT from 1.2 to 1.4. In the case of FMS, a 7.46 % Incrt is also denoted between pretest and posttest and the body weight ratio with respect to FMS was improved from 1.3 to 1.5, although in this variable this result is still lower than the parameters proposed by Verkhoshansky (2019), where the optimal ratio should be between 1.8 and 2. This is mainly due to the little experience of the investigated subjects with squat exercises.

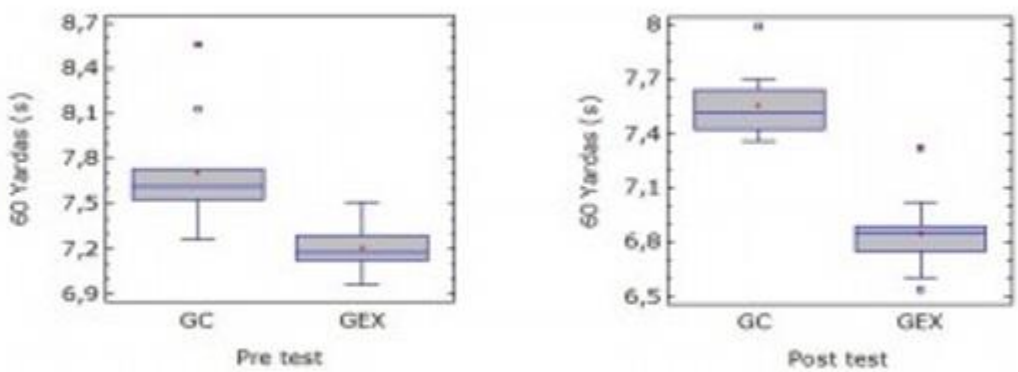

Fig. 4. - Behavior of the 60-yard test between pretest GC and GEX and posttest GC and GEX

Table 2. - FMT test results of the GEX pre-test and post-test

Maximum Sled Strength FMT vs PC					
No	**PC (kg)**	**Pretest**	**Post test**	**Pretest**	**Post test**
1	94,5	111	125	1,2	1,3
2	78,8	101	112	1,3	1,4
3	80,5	96	115	1,2	1,4
4	74,6	96	108	1,3	1,4
5	80	105	117	1,3	1,5
6	70	90	97	1,3	1,4
7	75	93	99	1,2	1,3
8	77	85	94	1,1	1,2
9	80	93	101	1,2	1,3
10	63	85	99	1,3	1,6
Average	**77,34**	**95,5**	**106,7**	**1,2**	**1,4**
% Incrt			**7,25**		

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Table 3. - FMT test results of the GEX pre-test and post-test

Maximum Squat Strength FMS vs PC					
No	PC (kg)	Pretest	Post test	Pretest	Post test
1	94,5	124	132	1,3	1,4
2	78,8	106	121	1,3	1,5
3	80,5	106	124	1,3	1,5
4	74,6	96	105	1,3	1,4
5	80	112	127	1,4	1,6
6	70	101	113	1,4	1,6
7	75	97	108	1,3	1,4
8	77	92	100	1,2	1,3
9	80	100	115	1,3	1,4
10	63	90	103	1,4	1,6
Average	**77,34**	**102,4**	**114,8**	**1,3**	**1,5**
% Incrt		**7,46**			

Significant differences are obtained between pretest and posttest, both in the weight dragged by the sled (probability value =0.0153) and in the weight obtained in the *squat* (probability value =0.0169, for 95 % confidence (Figura 5). Equations 2 and 3 describe the mathematical models that reflect the relationship that exists between performance weight (PR) and FTM and between performance weight (PR) and FMS in the GEX, which performance weight is obtained from the difference between PR (kg)=body weightballast weight, which indicator is evaluated as good. Both show a strong correlation, since they yield a Pearson coefficient equal to % 63.6and 62.9 %, for a 90 % level of correlation. (Hernández *et al.*, 2018) for a 90% confidence level, with probability values = 0.0 4and 0.0 5respectively (Equation 3).

$$PR = -44.79 + 19.16 * \log FMT$$

$$PR = 25.73 + 0.16 * FMS \text{(ec. 3)}$$

In both cases, the influence of the training protocol applied in the results obtained in this study is denoted by a 90 % confidence level (Figure 5).

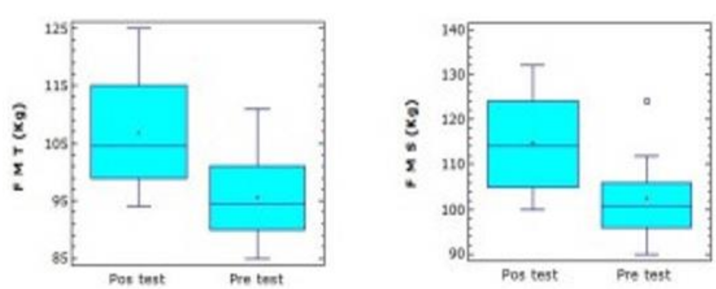

Fig. 5. - Behavior of the (FMT) and (FMS) tests applied to GEX

The main reason to perform this type of training with resisted exercises is that they will help to improve the speed-strength ratio, contributing to the improvement of our ability to generate greater strength in the *sprints*, as well as greater acceleration and be able to reach the maximum speed more quickly. In addition, it helps to generate functional energy, the more strength the athlete is able to generate against the ground the faster he can propel himself.

Studies conducted where it is proposed that individualized sprint-specific training through the resisted method with sled and parachute are appropriate for improving lower-body power and maximal straight-line running speed. However, Cross *et al.,* (2018) asserts that the application of this method provides an overload stimulus for *sprint* mechanics in the acceleration phase, recruiting the hip and knee extensors, resulting in increased horizontal power application.

Comparing the results of this research with baseball players, it was found that Spinks *et al.,* (2007, citado por Lockie *et al.*, 2012), conducted a study in team sports (soccer, rugby and Australian soccer) with resisted training, seeking to improve the acceleration phase in 15 meters and lower body power, in an eight-week intervention, showing significant differences in the results for both variables. Although their study has similarities with ours, significant differences were also found for both variables, but more notable. This protocol was performed in 12 weeks of duration, resisted training with sled and parachute was used and the maximum speed phase 30-60 yards was enhanced and unlike what was done by Spinks *et al.,* (2007, citado por Lockie *et al.*, 2012). The training was complemented with strength work of the lower limbs through *squat* exercises combined with complementary quadricep and plyometric exercises (García Ponce de León *et al.*, 2019). The purpose of these exercises is pre-or post-fatigue, positively reinforcing the effect of the main exercise (*squat*). It ended with exercises based on the repetition of free *sprints,* which according to researches by (Schrader *et al.*, 2016). The exercises were finished with exercises based on the repetition of free sprints, which according to researches by (Reynaldo y Padilla, 2007, citado por García-Ponce de León *et al.*, 2019).

Another study was conducted by Brady, cited by Leyva *et al.,* (2017), where he compares assisted, resisted and regular training of full speed or *sprint* running, in 12 training sessions for 4 weeks. They found that the assisted training was more effective in distances below 13.7 m and the resisted *sprint* training was more effective in distances between 13.7 and 36.6 m. This is probably because the assisted *sprint* training achieves a very fast movement of the legs, while the resisted *sprint* training makes the legs more powerful. This is because resisted means training applies an overload to the muscles involved in the drive to produce greater neural activation, and greater recruitment of fast twitch motor units (Faccioni, 1994 citado por Alcaraz, 2010). Used primarily in sports where travel speed plays a major role or for some team sports that require short *sprints* such as baseball.

Research conducted shows that, with this type of *sprint-specific* training*,* with the sled, muscle strength is improved and favors greater neural activation, recruiting fast twitch motor units (Alcaraz *et al.*, 2014). In the specific case of speed parachutes, they enhance the increase of specific strength, speed endurance, strength-endurance, improved acceleration, maximum speed and explosiveness (Tabachnik, 1992, citado por Alcaraz, 2010).

The main findings of this study suggest that 12 weeks of sled resisted training with intensities lower than 10 %, taking as a starting point what is described by Murray et al., 2005, cited by Leyva *et al.,* (2017), which suggests the application of sled loads in relation to the percentage of the individual maximum strength of the athlete, although there are other protocols proposed by Alcaraz *et al.* (2009) and (Lockie *et al.*, 2012), which have established an equation to know the loads to be applied based on the percentage of the athlete's body weight, considering the loss of speed produced by the increase of the load of the same, in the maximum speed training with this device.

In the particular case of the use of speed parachutes, which purpose is the development of acceleration, where authors such as. Tabachnik, 1992, cited by Alcaraz (2010), establishes a difference in time when using small parachutes with respect to normal *sprints* over short distances, which should be between 0.1-0.3 seconds. Together with the multiple benefits associated with this important tool, significant increases in maximum *squat* strength were obtained, which was effective, providing sufficient stimuli to produce positive adaptations in the improvement of the maximum power of the 60yard sprint. Produced mainly by the speed of execution with which the exercises were performed, considered as a determining criterion to be taken into account in the prescription, control and evaluation of the intensity of the strength training, due to the fact that both the neural demands of the exercises and the strength of the squat and the speed of the squat were very high. (González-Badillo *et al.*, 2017), this is due to the fact that both the neuromuscular demands and the effects of the training depend on the speed at which the exercises were performed (Pareja-Blanco *et al.*, 2014). The lack of control over this variable can lead the training to orientations substantially different from those intended.

On the other hand, this study also revealed that this type of resisted training is not only sufficient to guarantee the residual effect during a good part of the competition season, but it is also a stimulus to achieve statistically significant adaptations at the end of this phase. This method is one of the keys to improving *sprinting* capacity in baseball, a mechanism that is contingent on this specific protocol.

CONCLUSIONS

Resisted means are a form of training, based on applying a endurance or overload to a movement or sporting gesture through sled, parachute or other means, which demand a series of requirements that must be organized and planned correctly. An individualized specific *sprint* training with sled and parachute is applied, ending with exercises based on the repetition of free *sprints*, together with non-specific methods of combined and complementary *squat* exercises of quadriceps and plyometric with two weekly frequencies and the usual training five times a week, during the preseason that consisted of 12 microcycles. The results obtained indicated significant improvements in the 60-yard dash, with a 3.48 % Incrt, as well as in the maximum strength of the sled with a remarkable % Incrt 7.25 % and the maximum strength of *squat* %7.46 Incrt, with a high correlation coefficient of 63.6 % and 62. 9% for both tests, in correspondence with the weight of performance at effort. No significant differences were appreciated between the results achieved in the pre- and post-test of the CG, which performed a baseball training.

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Authors' contribution:

Alexis García Ponce de León: Conception of the idea, literature search and review, instrument making, instrument application, compilation of information resulting from the instruments applied, statistic análisis, preparation of tables, graphs, and images, database preparation, general advice on the topic addressed, drafting of the original (first version), review and final version of the article, article correction, authorship coordinator, translation of terms or information obtained, review of the application of the applied ibliographic standard .

José Enrique Carreño Vega: General advice on the topic addressed, review and final version of the article, article correction, translation of terms or information obtained, review of the application of the applied bibliographic standard.