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ΣΧΟΛΗ ΕΠΙΣΤΗΜΩΝ ΦΥΣΙΚΗΣ ΑΓΩΓΗΣ
ΑΘΛΗΤΙΣΜΟΥ & ΔΙΑΙΤΟΛΟΓΙΑΣ

ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΦΥΣΙΚΗΣ ΑΓΩΓΗΣ & ΑΘΛΗΤΙΣΜΟΥ

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Μεταπτυχιακή Εργασία

Ανάλυση Προπόνησης Υπερταχύτητας

Overspeed Training Analysis

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ΠΕΡΙΕΧΟΜΕΝΑ

ΑΝΑΛΥΣΗ ΠΡΟΠΟΝΗΣΗΣ ΥΠΕΡΤΑΧΥΤΗΤΑΣ

Περίληψη

Είναι γνωστό ότι η ταχύτητα αποτελεί την πιο σημαντική φυσική ικανότητα του ανθρώπου στα αθλήματα-αγωνίσματα. Υπάρχουν διάφορες προπονητικές μέθοδοι για την βελτίωση της ταχύτητας του σπριντ, όμως, υπάρχει μία άγνωστη μέθοδο, η προπόνηση της Υπερταχύτητας. Η προπόνηση της Υπερταχύτητας αποτελεί μία νέα μέθοδο υποβοηθούμενης προπόνησης, η οποία δίνει τη δυνατότητα στους αθλητές να τρέχουν πιο γρήγορα από τη μέγιστη ταχύτητά τους. Στη προκυμμένη περίπτωση, η υπερταχύτητα προέρχεται από ένα ελαστικό σχοινί, το οποίο στερεώνεται στους σπρίντερ και έχει τάση έλξης 19 κιλών στην εκκίνηση, ως αποτέλεσμα να τους αναγκάζει να τρέχουν με υπερμέγιστη ταχύτητα. Σκοπός της παρούσας μελέτης ήταν η ανάλυση των κινηματικών και κινητικών χαρακτηριστικών της προπόνησης υπερταχύτητας, στην απόδοση-επίδοση του οριζόντιου σπριντ και η αξιολόγηση του σχηματισμού-εγκυρότητας του ελαστικού σχοινιού. Δέκα Έλληνες άντρες υψηλού επιπέδου αθλητές των σπριντ του στίβου έλαβαν μέρος στην έρευνα και πραγματοποίησαν δύο σπριντ των 20 μέτρων ο καθένας με μέγιστη προσπάθεια: το πρώτο ήταν ελεύθερο σπριντ (Πρωτόκολλο Ελέγχου) και το δεύτερο ήταν ένα σπριντ υπερταχύτητας από το ελαστικό σχοινί (Πρωτόκολλο Υπερταχύτητας). Η στατιστική ανάλυση έδειξε ότι, στο Πρωτόκολλο Ελέγχου, υπήρχε σημαντική συσχέτιση μεταξύ του χρόνου και του χρόνου ομόκεντρης επαφής, όσο μικρότερος ήταν ο χρόνος ομόκεντρης επαφής, τόσο μικρότερος ήταν ο χρόνος, ο οποίος ήταν ο μόνος παράγοντας που επηρέασε τον χρόνο στα 20 μέτρα σπριντ. Επιπλέον, στο Πρωτόκολλο Υπερταχύτητας, υπήρχαν σημαντικές συσχετίσεις μεταξύ του χρόνου και των συνολικών βημάτων και του μήκους διασκελισμού, όσο λιγότερα ήταν τα συνολικά βήματα και όσο μεγαλύτερο ήταν το μήκος του βήματος, τόσο μικρότερος ήταν ο χρόνος. Συγκρίνοντας τα δύο πρωτόκολλα, η στατιστική ανάλυση έδειξε ότι ο μέσος όρος του χρόνου, τα συνολικά βήματα, ο χρόνος έκκεντρης επαφής, ο χρόνος ομόκεντρος επαφής, ο χρόνος επαφής και το μήκος διασκελισμού του Πρωτοκόλλου Υπερταχύτητας μειώθηκαν σημαντικά, λόγω της υποβοηθούμενης δύναμη του ελαστικού σχοινιού. Συμπερασματικά, από αυτά τα αποτελέσματα, διαπιστώθηκε ότι η Προπόνηση Υπερταχύτητας αποτελεί μία αποτελεσματική μέθοδο προπόνησης για την αύξηση της ταχύτητας του σπριντ. Επιπρόσθετα, ένα άλλο σημαντικό εύρημα είναι ότι, αυτού του είδους το ελαστικό σχοινί, αποτελεί ένα λειτουργικό προπονητικό μέσο και απαραίτητο εργαλείο για όσους θέλουν να βελτιώσουν τον χρόνο του σπριντ. Τέλος, απαιτείται περισσότερη έρευνα για περισσότερα μέτρα σπριντ και για τις οξείες επιπτώσεις στις μακροπρόθεσμες νευρομυϊκές προσαρμογές της Προπόνησης Υπερταχύτητας στην απόδοση-επίδοση των αθλητών στο σπριντ.

Λέξεις Κλειδιά: Προπόνηση Υπερταχύτητας, Ελαστικό Σχοινί, Απόδοση-Επίδοση του Σπριντ

OVERSPEED TRAINING ANALYSIS

Abstract

It is well known that speed is the most important physical ability of human in the sports-events. There are different kinds of training methods for improving sprint speed, but, there is an unknown kind, of sprint training, the Overspeed Training. The Overspeed Training is a new method of assisted training, which enables the athletes to run faster than their maximal speed. In this project, the overspeed comes from an elastic cord, which fastens on the sprinters and has a pulling tension of 19 kilograms (kg) in the start, as a result of forcing them to run at a supramaximal speed. The aim of this study was to analyze the kinematic and the kinetic characteristics of overspeed training, in the horizontal sprint performance and to evaluate the formation-validity of the elastic cord. Ten Greek male elite sprinting participants took part in the research and performed two sprints of 20 metres (m) each with maximal effort: the first one was a free sprint (Control Protocol) and the second one was an overspeed sprint by the elastic cord (Overspeed Protocol). The statistical analysis showed that, in the Control Protocol, there was a significant correlation between the time and the concentric contact time, the shorter the concentric contact time was, the shorter the time was, which was the only factor that affected the time of the 20 metres sprint. Moreover, in the Overspeed Protocol, there were significant correlations among the time and the total steps and the stride length, the fewer the total steps and the longer the stride length were, the shorter the time was. Comparing the two protocols, the statistical analysis showed that the means of the time, the total steps, the eccentric contact time, the concentric contact time, the contact time and the stride length of the Overspeed Protocol were decreased, significantly, because of the assisted force of the elastic cord. To conclude, from these results, it is found that the Overspeed Training constitutes an effective method of training to increase the sprint speed. Furthermore, another important finding is that this kind of elastic cord is a working form and a necessary tool for those who want to improve their sprinting time. Finally, more research is needed on extended metres and on the acute effects for long term neuromuscular adaptions of the Overspeed Training in the athletes’ sprint performance.

Keywords: Overspeed Training, Elastic Cord, Sprint Performance

1. INTRODUCTION

General Knowledge

Speed is, perhaps, the most important physical ability in sports. Speed is divided into two directions, the vertical and the horizontal speed. There are a lot of researches about the speed and its improvement. Speed improvement is a challenging task, because it depends more on genetics variants (Deoxyribonucleic Acid, known as abbreviated DNA) and less on physical training. There are different kinds of training methods for improving sprint speed, but, there is an unknown kind, of sprint training, the Overspeed Training. The Overspeed Training is a new method of assisted training, which enables the athletes to run faster than their maximal speed. There are different kinds for performing Overspeed Training, but, lately, there has been an effort by a few researchers to investigate and find new approaches for this kind of training. There are plenty of these methods such as Downhill Running, Elastic Cord, Motorized Towing System, Body Weight Supporting Kite and Lower Body Positive Pressure Treadmill with reliable results, tested in elite athletes of different sports-events.

Literature Review

First of all, there is a research from Ebben, (2008), that its purpose was to estimate a range of downhill slopes in an effort to define the ideal slope for overspeed training. Moreover, in this study, took place 13 college athletes of soccer, track, football and they had to run 40 yards (36.6 metres) sprints in downhill slopes of 2.1°, 3.3°, 4.7°, 5.8° and 6.9°, in random order. The statistical analysis showed that the 5.8° downhill slope was optimal compared with the other slopes the flatland. Furthermore, the sprint in this optimal slope decreases the 40 yards sprint time by an average of 0.35 seconds (6.5±4.0 % increase in maximal speed) compared with the flatland. So, the 5.8° slope was 0.10 seconds faster than the 4.7° slope, resulting a 1.9% increase in the maximal speed of the athletes. From the results, Ebben, (2018) concluded that sprinting in a 5.8° downhill slope has positive effects and can increase the maximal speed of the athletes.

Secondly, the study of Bartolini and his partners, (2011), materialized to determine if an optimal assistance of the elastic cord would be an effective method for overspeed training. In the research, took place 18 women soccer players and they performed 3 training sessions, which consisted of 5 minutes warm up and 5 experimental conditions of 0-10-20-30-40 % body weight assistance (BWA). Furthermore, the athletes wore a special belt, with 2 elastic cords on it and completed 2 maximal efforts of sprinting in each condition. In addition, the subjects rested for 5 minutes between each maximal effort and condition. Bartolini and his teammates (2011), examined the split times of 0-5, 5-10, 10-15, 15-20 and 0-20 yards of each condition. The statistical analysis showed that, there were a significant main effect of the split time of 0-20 yards. The more the body weight assistance increased the less the sprint times decreased up to 30% [BWA (0%: 3.20 ± 0.12 seconds, 10%: 3.07 ± 0.09 seconds, 20%: 2.96 ± 0.07 seconds, 30%: 2.81 ± 0.08 seconds, 40%: 2.77 ± 0.10 seconds)], but there was no significant effect between 30-40 % of BWA. Moreover, there was another significant main effect when they analyzed the results. They understand that as BWA increased, sprint times decreased up to 30% for distances up to 15 yards. Bartolini and his partners, (2011), concluded that the 30% of body weight assistance with the elastic cords were an optimal BWA and, also, constituted an effective method to improve the sprint time, up to 15 yards, of the collegiate women soccer players.

In addition, the research of Nealer and his partners, (2017), wanted to show the acute effects of different rest intervals after assisted sprinting by an elastic cord. In this project, took part 24 female soccer players and were divided into 2 groups (a: recreational, b: collegiate). The 2 groups attended 5 sessions, in which the first one was carried out some anthropometric measurements and familiarization in sprints with body weight assistance (BWA). In the others, there was a dynamic warm up and, then, all the participants executed a 20 metres (split in 4 parts of 5 metres each) sprint of a 30% BWA. After that, they rested for 30 seconds or 1, 2, 3 minutes, randomly, followed by a sprint with no BWA. The results showed that there was no significant difference in sprint time for the 0-20 metres sprint in either group. But, there were significant differences in sprint time for the 0-5 metres sprint, only for the athletes that were rested 1 and 2 minutes after the BWA sprint. Finally, this revealed that trained athletes should rest 1 or 2 minutes after 30% BWA supramaximal sprinting to increase their sprint speed.

The research of Tillaar, (2021), was about the kinematics of normal and assisted 60 metres sprints with a portable motorized pulling system and different loads in well trained sprinters. Kinematics were calculated using Inertial Measuring Units (IMU) attached to a 3 axis gyroscope and a laser gun in 24 experienced male and female sprinters. Moreover, they performed a normal 60 metres sprint and sprints with a 3, 4 and 5 kilograms pulling force. The results showed that using increasing assisted loads ended up in faster 60 metres times as an outcome of higher step speed, basically, caused by longer step lengths in both genders and by shorter contact times in women. Men had, also, longer step lengths, longer contact times, and shorter flight times than women. The assisted loads had a more important result in women than in men because of their bigger decrease in sprint times. These differences came out, because of the increasing maximal step speed, for women 70-80 % of distance and for men 65-70 %. That was due to shorter contact times and more increased step lengths in women than in men. To conclude, by using assisted loads, athletes are capable to succeed higher step speeds and keeping it for longer, which can be a way to breakdown the speed barrier.

Moreover, the research of Clark, Cahill, Korfist and Whitacre, (2021), aims to examine the acute kinematic effects of assisted sprinting. This study used 14 male sprinters of developmental age. They were asked to perform maximal 60 metres sprint efforts. Half of those sprints were unassisted and the other ones were with a motorized towing device of a 7 kilograms load. The results showed that the maximum speed had increased due to the longer stride length and not to the stride rate. Although, stride length increased due to insignificant changes in distance traveled by the center of mass during ground contact, combined with exceptionally large changes in distance traveled by the center of mass during flight. Assisted sprinting, significantly, reduced contact time, and increased flight time, too. The motor assisted sprinting produced supramaximal velocities with short contact times which can act as a neuromuscular stimulus for the athletes, who want to improve sprint performance.

After all, the researchers concluded that is needed more studies with different loads and kinds of athletes to understand if this method can, indeed, be used to increase maximum velocity.

The research of Cecilia-Gallego, Odriozola, Beltrán-Garrido and Álvarez-Herms, (2022), targeted to find the optimal load in the training period of young athletes and evaluate the severe effects of three overspeed loads [2, 4 and 5.25 kilograms (kg)]. The present study used eight young athletes who run a total of 4 sprints. One sprint was unassisted and the other 3 were assisted by a motorized towing system. The researchers wanted to find the differences between those 3 and the similarities as well. The results showed significant increases in step velocity, step length with 2, 4, and 5.25 kilograms in maximum running speed. In addition, significant results were found in flight time and horizontal distance from the first contact to the vertical projection of the center of mass with 4 and 5.25 kilograms. Significant time decreases were, also, found in 5 metres flying sprint and contact time with 4 and 5.25 kilograms, but there were no significant changes in step rate. Finally, the outcomes showed that we can use the results to imitate and use new devices to explore the effects of overspeed.

Additionally, there is a research from Kratky and Müller, (2013), about overspeed training. The purpose of this study was to investigate the effects of body weight support during full effort sprints on ground contact time. Further, in this study took place 19 Austrian male elite sprinters. They had to run flying 20 metres sprints under 3 conditions: (a) free sprint, (b) body weight supported sprint – normal speed (BWS-NS) and (c) body weight supported sprint – overspeed (BWS-OS). For the body weight supported sprint was used a kite with a lifting effect, for overspeed was used a towing system and to record the high speed phase of each sprint was used an acquisition system. On the one hand, the statistical analysis showed, from the 20m sprint, that BWS-NS had remained unchanged in running velocity, step length and step frequency, after compared with fastest sprint. However, there were some changes in ground contact time (-5.80%) and in air time (+5.79%). On the other hand, in BWS-OS, statistical analysis showed that had more changes, regarding with ground contact time (-7.66%), running velocity (+2.72%), air time (+4.92%), step length (+1.98%) and step frequency (+1.05%). Overall, Kratky and Müller, (2013), recommend that sprinting with the body weight supporting kite is an additional tool in overspeed training to achieve higher running velocities and to reduce ground contact times.

Furthermore, the study of Gojanovic, Cutti, Shultz and Matheson, (2012), intended to research the changes at maximal cardiometabolic response during a run in a lower body positive pressure treadmill [antigravity treadmill (AG)]. The AG can be useful for rehabilitation of injuries, reduction of body weight and high speed running as well. Fourteen trained runners (5 female, 9 male), at the age of 27±5 years, were evaluated for accomplishing a treadmill incremental test (CON) to calculate aerobic capacity and heart rate (VO2max and HRmax). They accomplished 4 similar tests, 48 hours apart with randomized order on the AG at body weight of 100%, 95%, 90%, and 85% (AG100 to AG85). Stride length and rate were calculated at peak velocities (Vpeak). The results showed that VO2max was identical in all terms. Similar outcome came up for HRmax except for AG85 in men and AG100 and AG90 in women. Vpeak in men was lower in all conditions, compare to CON. Vpeak in women was equal between CON and AG100 but, higher at AG95, AG90 and AG85. Finally, they ended up that the AG is useful for maximal exercise intensities at body weight of 85% to 95%, accomplishing faster running speeds than usual. The AG would be useful for overspeed running programs at the highest metabolic response levels.

Aim Of The Study

The purpose of this project was to analyze the kinematic and the kinetic characteristics of overspeed, which resulted through an assisted elastic cord, in horizontal sprint performance in male athletes. An additional aim was to evaluate the formation and the validity of the elastic cord. Finally, to compare these results with the other projects' results and examined, if overspeed constitutes an essential kind of training to improve the horizontal sprint performance.

2. METHODS

Subjects

The study was conducted with 10 participants track and field athletes [age: 20.40±12.20 (yrs), body mass: 70.56±5.70 (kg), body height: 1.80±0.05 (m), body fat (skinfold): 7.82 ±1.59 (%)] (Table 1). The athletes were, randomly, selected and were training daily. All these athletes were, also, experienced of sprint training in the previous years, so they were familiar with the procedures. No one of the participants had taken medication in the past and there were no reports of musculoskeletal injuries or metabolic disorders.

	Age (yrs)	**Body Mass (kg)**	**Body Height (m)**	**Body Fat (%)**	**BMI**
Mean	20.40	70.56	1.80	7.82	19.65
St.Dev.	2.20	5.70	0.05	1.59	1.38

Table 1. Track and Field athletes' anthropometric characteristics

Measurements

Body Mass: was measured by using a standard scale (Seca, 777).

Body Height: was measured using a standard tape.

Body Fat: was calculated utilizing the measurements of seven skin folds (chest, sub scapular, triceps, sub scapula, abdominal, suprailiac, quadriceps, biceps brachii) by using a skinfold (Harpenden Skinfold Caliper). We used SIRI equation (0.00043499*SUMSKIN)+(0.00000055*SUMSKIN^2)-(0.00028826*AGE) to calculate the body fat and the following equation to calculate the density [body fat%=(495/DENSITY)-450].

BMI: was measured by the equation of [BMI=BODY MASS/(BODY HEIGHT^2)]

Sit and Reach Test: The participants sat on the floor with the two legs stretched out straight ahead and they removed their shoes. The soles of the feet are placed flat against the box. Both knees were locked and pressed flat to the floor. With the palms were facing downwards and the hands on top of each other or side by side, the subject reached forward along the measuring line, as far as possible. After some time in this position, the subject reached out and held that position for, at least, one or two seconds, while the distance was recorded. Furthermore, the Sit and Reach Test was executed again with the right leg in stretch and the left was bent at the knee, while pressing flat to the floor. The same procedure was completed and for the left leg, respectively.

20 metres sprints: were completed in lane with tartan and the time was measured by an electronic device, which had photocells at the end of the 1st and 2nd 10 metres.

IMU (Inertial Measurement Unit): is an electronic device (X-io Technologies), which reports the acceleration, the orientation, the angular rates and other gravitational forces. It is composed of 3 accelerometers, 3 gyroscopes and 3 magnetometers depending on the heading requirement. Two of these devices were used, one for each leg, and were attached in the front view of the shinbone to measure the sprinting parameters.

Elastic Cord: was a cord, which had elastic effects during the sprints. The edge of the cord was held by one person and the participants' sprints were executed next to it. The other edge of the cord was stabilized in the front of the examinee with a belt and the start was performed from an upright static position. The elastic tension of the cord was 19 kilograms in the starting position (0 metres), 9.5 kg in the middle of the 20 metres sprint (10 metres) and 5 kg in the finish (20 metres).

Video Analysis: In the middle of the 20 metres and at a distance of 2 metres sideways from the elastic cord placed a mobile phone (Galaxy A13) to record every trial of the athletes. This procedure done with purpose to verify the validity of the working process of the elastic cord and the correct technique of the sprints.

Photo 1. The Elastic Cord and the Electronic Device of the athlete's sprint

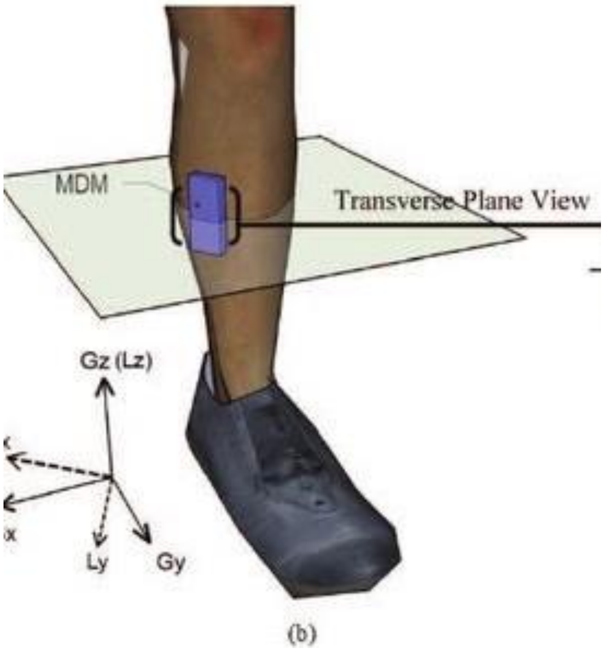


Photo 2. The placement of IMUs in the athlete's shin

Procedures

All the measurements took place at the Municipal Stadium of Trikala Greece, inside the indoor track and field's facilities. The scientific experiment consisted of 2 sessions:

i) In the first session were included some of the anthropometric measurements [(body mass, body height, body fat) and sit & reach test]. Moreover, there was included some familiarization with the elastic cord for all the participants.

ii) In the second session were included 2 different protocols (Table 2). These 2 protocols were one week apart and the athletes did not train the previous day. In each protocol were included a warm up of 30 minutes and 5 minutes rest time to be prepared for the next procedures. After each protocol were included a warm down of 5 minutes. The sequence of the 1st and the 2nd protocol performed randomly.

  iia) Protocol 1: In this protocol, the participants performed 1 maximum effort of sprint in 20 metres.

  iib) Protocol 2: In this protocol, the participants performed 1 maximum effort of sprint in 20 metres with the elastic cord.

Control	Overspeed
Protocol 1	Protocol 2
30 minutes warm up 5 minutes rest time 20m sprint free 5 minutes warm down	30 minutes warm up 5 minutes rest time 20m sprint with the elastic cord 5 minutes warm down

Table 2. The procedure of the 2 protocols.

Statistical Analysis

SPSS statistical software (SPSS 21, Illinois USA) used for statistical analysis. The significance level was set at 0.05 and the data was presented as MEAN±SD. First of all, the sample was examined, if followed the normal distribution with the Shapiro Wilk Test and, then, Spearman Correlation was used to examine the correspondences between the protocols (Control, Overspeed) and among the anthropometric measurements, Sit & Reach Test (RL SRT), Right leg Sit & Reach Test (R SRT), Left leg Sit & Reach Test (L SRT) and the sprinting parameters [Right Steps (RS), Left Steps (LS), Total Steps (TS), Time, total Eccentric Contact Time (EccCT), total Concentric Contact Time (ConCT), total Contact Time (CT), total Flight Time (FT), Step Frequency (SF), Stride Length (SL)] of the 20 metres sprint (20m) and each 10 metres separately (1st 10m, 2nd 10m). In addition, the comparisons of the above sprinting parameters between the Control protocol and the Overspeed protocol were examined by the Wilcoxon Signed Ranks Test.

3. RESULTS

Spearman Correlations

Control Protocol (1st 10m): the Spearman Correlation showed that there was a significant statistical medium positive correlation between the Time and the Total Steps ($r=0.696$, $p=0.025<0.05$), a significant statistical strong positive correlation between the Time and the Flight Time ($r=0.806$, $p=0.005<0.05$) and a significant statistical medium negative correlation between the Time and the Stride Length ($r=-0.696$, $p=0.025<0.05$).

Control Protocol (2nd 10m): the Spearman Correlation showed that there was a significant statistical strong positive correlation between the Time and the Total Steps ($r=0.801$, $p=0.005<0.05$), a significant statistical strong positive correlation between the Time and the Contact Time ($r=0.770$, $p=0.009<0.05$), a significant statistical medium positive correlation between the Time and the Flight Time ($r=0.648$, $p=0.043<0.05$) and a significant statistical strong negative correlation between the Time and the Stride Length ($r=-0.801$, $p=0.005<0.05$).

Control Protocol (20m): the Spearman Correlation showed that there was a significant statistical medium positive correlation between the Time and the Concentric Contact Time ($r=0.673$, $p=0.033<0.05$).

Overspeed Protocol (1st 10m): the Spearman Correlation showed that there was a significant statistical medium positive correlation between the Time and the Total Steps ($r=0.640$, $p=0.046<0.05$) and a significant statistical medium negative correlation between the Time and the Stride Length ($r=-0.640$, $p=0.046<0.05$).

Overspeed Protocol (2nd 10m): the Spearman Correlation showed that there was a significant statistical strong positive correlation between the Time and the Total Steps ($r=0.881$, $p=0.001<0.05$), a significant statistical strong positive correlation between the Time and the Concentric Contact Time ($r=0.758$, $p=0.011<0.05$), a significant statistical medium positive correlation between the Time and the Contact Time ($r=0.697$, $p=0.025<0.05$), a significant statistical strong positive correlation between the Time and the Flight Time ($r=0.867$, $p=0.001<0.05$) and a significant statistical strong negative correlation between the Time and the Stride Length ($r=-0.881$, $p=0.001<0.05$).

Overspeed Protocol (20m): the Spearman Correlation showed that there was a significant statistical strong positive correlation between the Time and the Total Steps ($r=0.845$, $p=0.002<0.05$) and a significant statistical strong negative correlation between the Time and the Stride Length ($r=-0.845$, $p=0.002<0.05$).

Wilcoxon Signed Ranks Tests

1st 10m: the Wilcoxon Signed Test showed that there were significant statistical differences in the mean increasing numbers of the Total Steps ($Z=-2.530$, $p=0.011<0.05$) between the Control Protocol (7.200±0.422) and the Overspeed Protocol (6.400±0.516), of the Eccentric Contact Time ($Z=-2.803$, $p=0.005<0.05$) between the Control Protocol (0.310±0.030 seconds) and the Overspeed Protocol (0.238±0.028 seconds), of the Concentric Contact Time ($Z=-2.293$, $p=0.022<0.05$) between the Control Protocol (0.711±0.070 seconds) and the Overspeed Protocol (0.604±0.130 seconds), of the Contact Time ($Z=-2.805$, $p=0.005<0.05$) between the Control Protocol (1.021±0.065 seconds) and the Overspeed Protocol (0.842±0.131 seconds), of the Step Frequency ($Z=-2.191$, $p=0.028<0.05$) between the Control Protocol (3.912±0.166 steps/second) and the Overspeed Protocol (3.721±0.255 steps/second) and of the Stride Length ($Z=-2.456$, $p=0.014<0.05$) between the Control Protocol (2.786±0.151 metres) and the Overspeed Protocol (3.143±0.246 metres).

2nd 10m: the Wilcoxon Signed Test showed that there were significant statistical differences in the mean increasing numbers of the Total Steps ($Z=-2.236$, $p=0.025<0.05$) between the Control Protocol (5.500±0.527) and the Overspeed Protocol (5.000±0.667), of the Time ($Z=-2.701$, $p=0.007<0.05$) between the Control Protocol (1.214±0.132 seconds) and the Overspeed Protocol (1.032±0.146 seconds), of the Eccentric Contact Time ($Z=-2.701$, $p=0.007<0.05$) between the Control Protocol (0.223±0.039 seconds) and the Overspeed Protocol (0.159±0.021 seconds), of the Contact Time ($Z=-2.497$, $p=0.013<0.05$) between the Control Protocol (0.654±0.097 seconds) and the Overspeed Protocol (0.525±0.083 seconds), of the Step Frequency ($Z=-2.701$, $p=0.007<0.05$) between the Control Protocol (4.544±0.312 steps/second) and the Overspeed Protocol (4.858±0.232 steps/second) and of the Stride Length (Z=-2.070, p=0.038<0.05) between the Control Protocol (3.667±0.352 metres) and the Overspeed Protocol (4.067±0.562 metres).

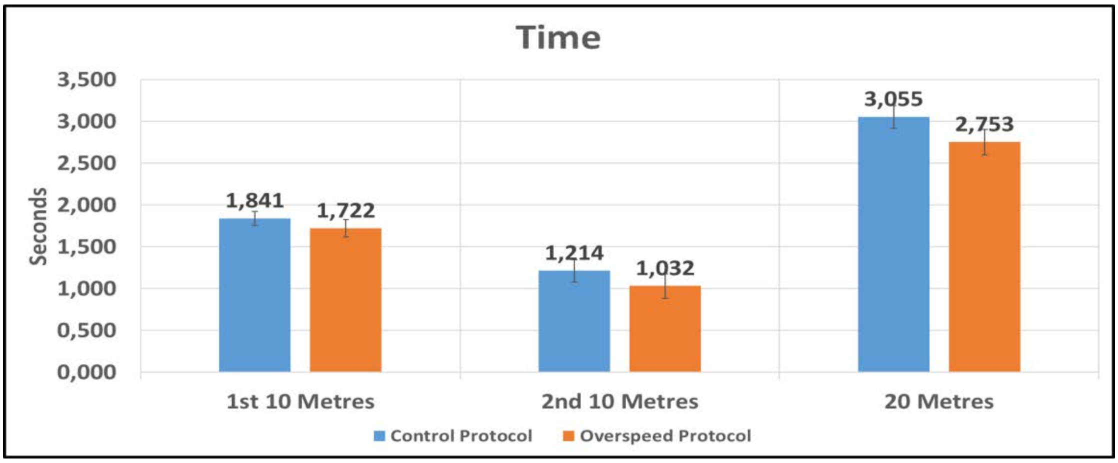
20m: the Wilcoxon Signed Test showed that there were significant statistical differences in the mean increasing numbers of the Total Steps (Z=-2.919, p=0.004<0.05) between the Control Protocol (12.700±0.675) and the Overspeed Protocol (11.400±0.966), of the Time (Z=-2.805, p=0.005<0.05) between the Control Protocol (3.055±0.136 seconds) and the Overspeed Protocol (2.753±0.153 seconds), of the Eccentric Contact Time (Z=-2.803, p=0.005<0.05) between the Control Protocol (0.533±0.046 seconds) and the Overspeed Protocol (0.397±0.036 seconds), of the Concentric Contact Time (Z=-2.803, p=0.005<0.05) between the Control Protocol (1.142±0.141 seconds) and the Overspeed Protocol (0.970±0.167 seconds), of the Contact Time (Z=-2.803, p=0.005<0.05) between the Control Protocol (1.675±0.140 seconds) and the Overspeed Protocol (1.367±0.171 seconds) and of the Stride Length (Z=-2.825, p=0.005<0.05) between the Control Protocol (3.157±0.165 metres) and the Overspeed Protocol (3.532±0.305 metres).

Protocols		1st 10 metres				2nd 10 metres				20 metres			
		Time (sec)	**EccCT** (sec)	**ConCT** (sec)	**CT** (sec)	**Time** (sec)	**EccCT** (sec)	**ConCT** (sec)	**CT** (sec)	**Time** (sec)	**EccCT** (sec)	**ConCT** (sec)	**CT** (sec)
Control	Mean	1.841	0.310	0.711	1.021	1.214	0.223	0.431	0.654	3.055	0.533	1.142	1.675
	St. Dev.	0.085	0.030	0.070	0.065	0.132	0.039	0.087	0.097	0.136	0.046	0.141	0.140
Overspeed	Mean	1.722	0.238	0.604	0.842	1.032	0.159	0.366	0.525	2.753	0.397	0.970	1.367
	St. Dev.	0.102	0.030	0.130	0.131	0.146	0.021	0.072	0.083	0.153	0.036	0.167	0.171
Differences %		-6.5	-23.3	-15.1	-17.6	-15	-28.7	-15.1	-19.8	-9.9	-25.6	-15.1	-18.4
Asymp. Sig. (2-tailed)		0.114	**0.005**	**0.022**	**0.005**	**0.007**	**0.007**	0.083	**0.013**	**0.005**	**0.005**	**0.005**	**0.005**

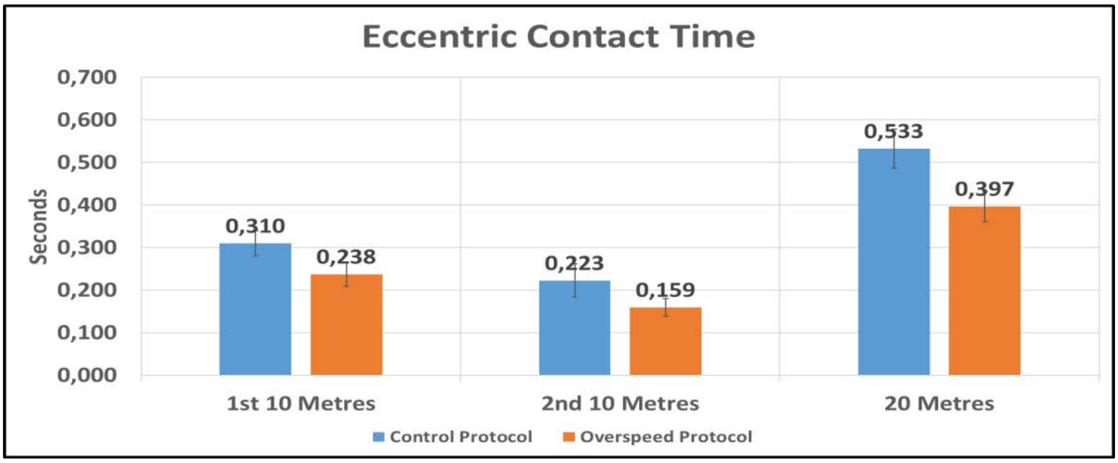
Table 3. The differences of the Time, the total Eccentric Contact Time, the total Concentric Contact Time and the total Contact Time in the 20 metres sprint and the 10 metres splits between the 2 protocols.

Protocols		1st 10 metres				2nd 10 metres				20 metres			
		TS	**FT** (sec)	**SF** (steps/sec)	**SL** (metres)	**TS**	**FT** (sec)	**SF** (steps/sec)	**SL** (metres)	**TS**	**FT** (sec)	**SF** (steps/sec)	**SL** (metres)
Control	Mean	7.200	0.820	3.912	2.786	5.500	0.560	4.544	3.667	12.700	1.381	4.159	3.157
	St. Dev.	0.422	0.095	0.166	0.151	0.527	0.090	0.312	0.352	0.675	0.135	0.188	0.165
Overspeed	Mean	6.400	0.880	3.721	3.143	5.000	0.507	4.858	4.067	11.400	1.387	4.138	3.532
	St. Dev.	0.516	0.143	0.255	0.246	0.667	0.093	0.232	0.562	0.966	0.174	0.211	0.305
Differences %		-11.2	+6.9	-4.9	+11.4	-9.1	-9.5	+6.5	+9.9	-10.3	+0.5	-0.6	+10.7
Asymp. Sig. (2-tailed)		**0.011**	0.721	**0.028**	**0.014**	**0.025**	0.114	**0.007**	**0.038**	**0.004**	0.799	0.959	**0.005**

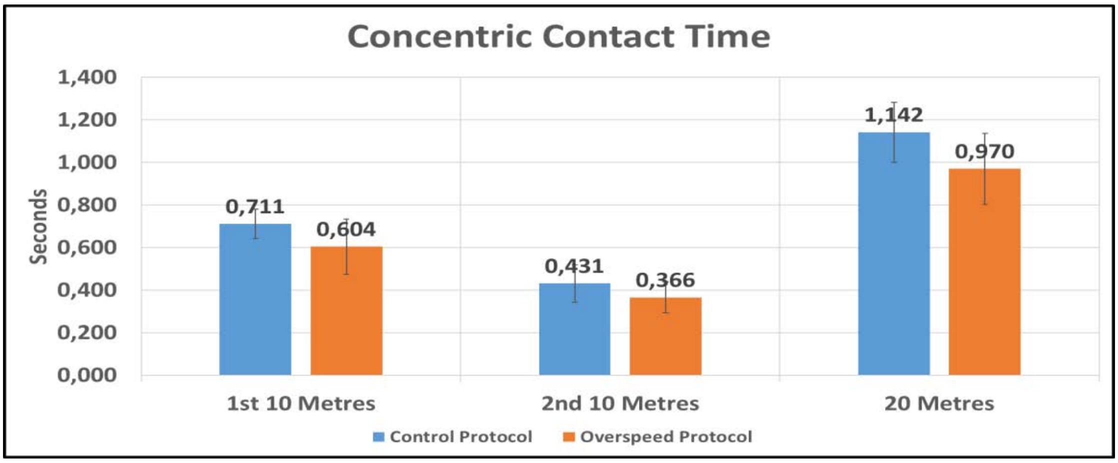
Table 4. The differences of the Total Steps, the total Flight Time, the Step Frequency and the Stride Length in the 20 metres sprint and the 10 metres splits between the 2 protocols.



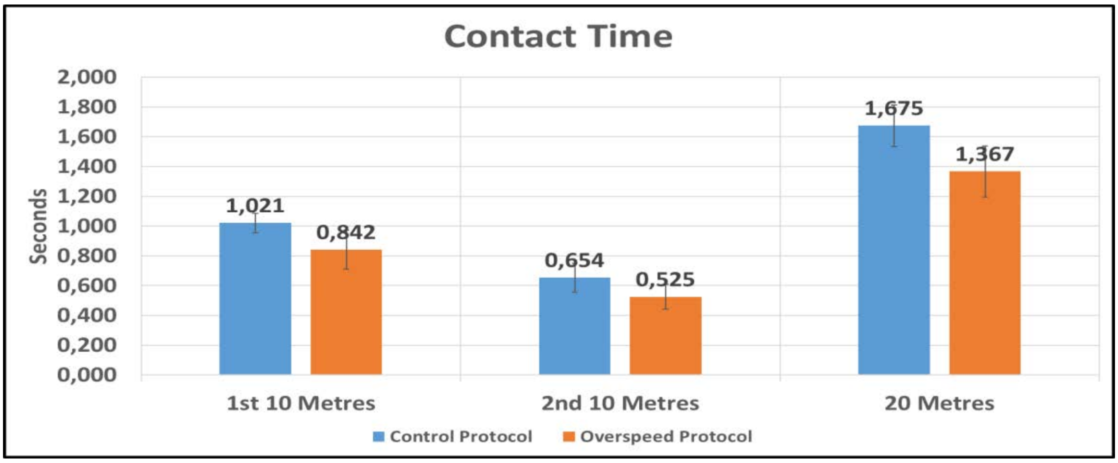
Graph 1. The differences of the Time, in the 20 metres sprint and the 10 metres splits between the 2 protocols.



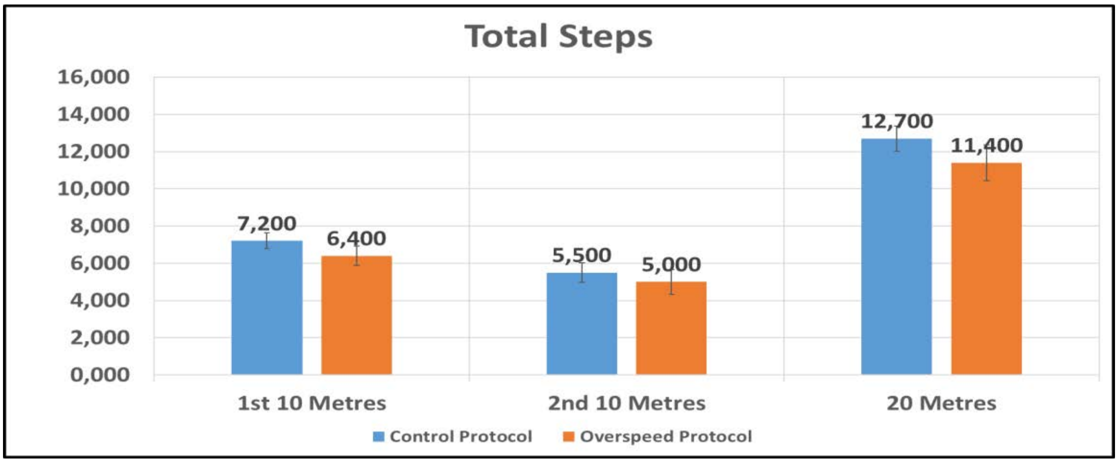
Graph 2. The differences of the total Eccentric Contact Time, in the 20 metres sprint and the 10 metres splits between the 2 protocols.



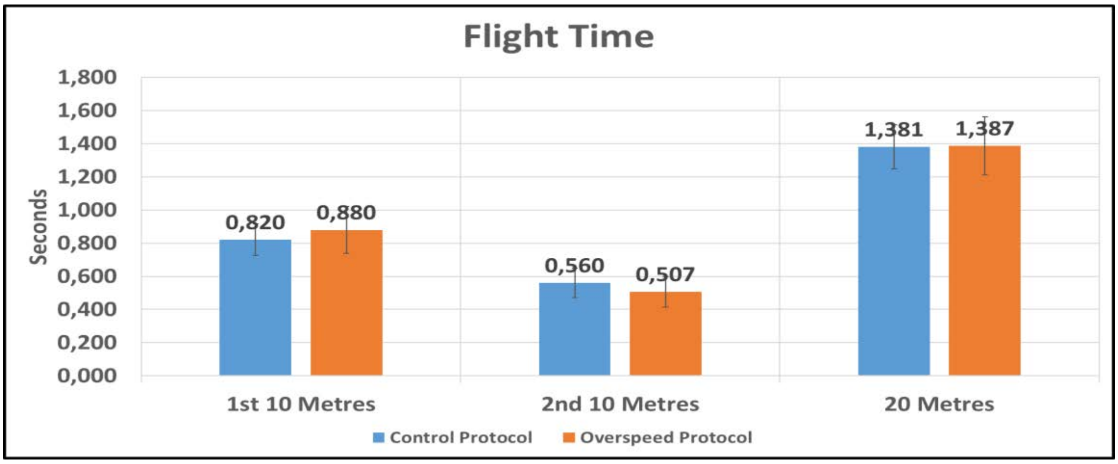
Graph 3. The differences of the total Concentric Contact Time, in the 20 metres sprint and the 10 metres splits between the 2 protocols.



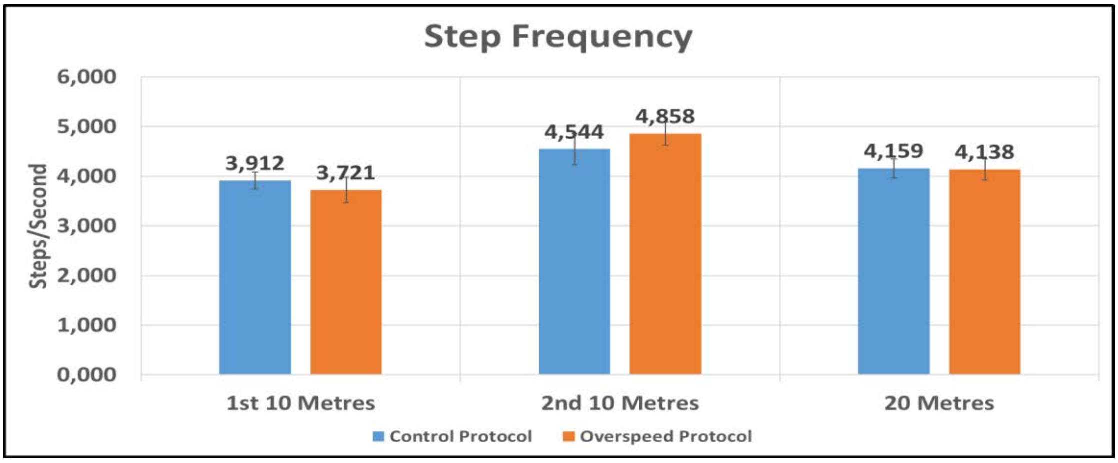
Graph 4. The differences of the total Contact Time, in the 20 metres sprint and the 10 metres splits between the 2 protocols.



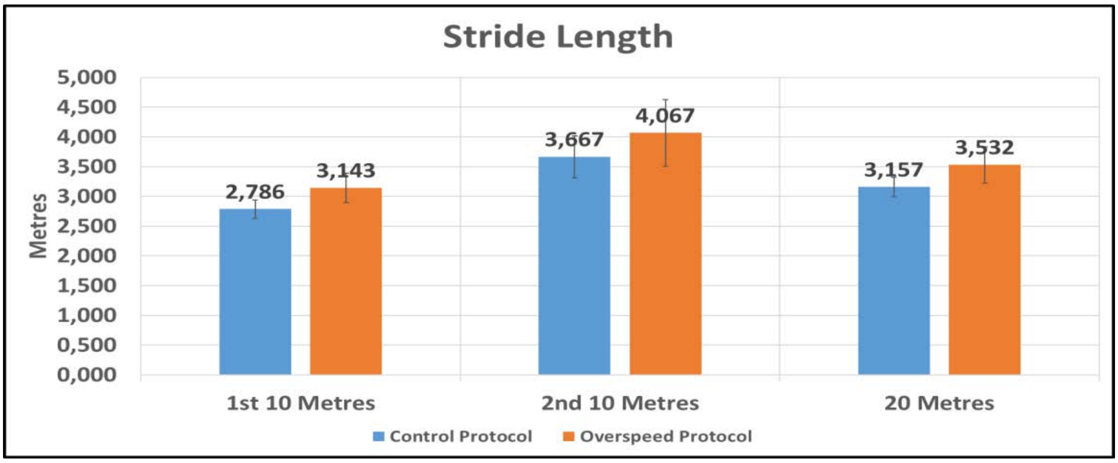
Graph 5. The differences of the Total Steps, in the 20 metres sprint and the 10 metres splits between the 2 protocols.



Graph 6. The differences of the total Flight Time, in the 20 metres sprint and the 10 metres splits between the 2 protocols.



Graph 7. The differences of the Step Frequency, in the 20 metres sprint and the 10 metres splits between the 2 protocols.



Graph 8. The differences of the Stride Length, in the 20 metres sprint and the 10 metres splits between the 2 protocols.

4. DISCUSSION

Correlations in the Two Protocols

The purpose of this investigation was to analyze the kinematic and the kinetic characteristics of the sprinting parameters in overspeed, which came from an assisted elastic cord, in horizontal sprint performance in male athletes. Additionally, other aims were to evaluate the formation and the validity of the elastic cord and examined, if overspeed constitutes an essential kind of training to improve the horizontal sprint performance. Specifically, in the one hand, the study aimed to determine the effects in the 20 metres sprint and each 10 metres separately of the Control Protocols' sprinting parameters in male Track and Field athletes. The statistical analysis showed that, in the first 10 metres of the Control Protocol, there were significant correlations among the Time and the Total Steps, the Flight Time and the Stride Length. These correlations revealed that the fewer the Total Steps, the shorter the Flight Time and the longer the Stride Length were, the shorter the Time was. In the second 10 metres, the statistical analysis showed that there were significant correlations among the Time and the Total Steps, the Contact Time, the Flight Time and the Stride Length. The only difference between the first and the second 10 metres was the Contact Time, the fewer the Contact Time was, the shorter the Time was. In the whole 20 metres, the statistical analysis showed that there was a significant correlation between the Time and the Concentric Contact Time, the shorter the Concentric Contact Time was, the shorter the Time was, which was the only factor that affected the Time of the 20 metres sprint. In the project of Lockie, Murphy, Schultz, Jeffriess and Callaghan (2013), was found that, in 25 male athletes', the faster acceleration involved longer Step Length with shorter Contact Time. Moreover, in a case study of an elite athletes' group (Bezodis, Kerwin, Cooper, & Salo, 2018), in which were studied the athletes' sprints for kinematic analysis during 5 months of training, the conclusion was that the importance of Step Frequency over Step Length to the changes in performance was clearly evident for the sprinters, who experimented. Additionally, in another case study of two elite athletes (Hicks, Drummond, Williams, & Tillaar, 2022), in which were investigated 12 and 11 kinematic assessments of sprints, respectively, for a periodized training year, concluded that there was a greater reliance on Step Length than Step Frequency to achieve faster sprint performances.

In the other hand, the study aimed to uncover the effects in the 20 metres sprint and each 10 metres, separately, of the Overspeed Protocols' sprinting parameters in male Track and Field athletes. The statistical analysis showed that, in the first 10 metres of the Overspeed Protocol, there were significant correlations among the Time and the Total Steps and the Stride Length. These correlations displayed that the fewer the Total Steps and the longer the Stride Length were, the shorter the Time was. In the second 10 metres, the statistical analysis showed that there were significant correlations among the Time and the Total Steps, the Concentric Contact Time, the Contact Time, the Flight Time and the Stride Length. These correlations revealed that the fewer the Total Steps, the shorter the Concentric Contact Time, the Shorter the Contact Time, the shorter the Flight Time and the longer the Stride Length were, the shorter the Time was. In the whole 20 metres, the statistical analysis showed that there were significant correlations among the Time and the Total Steps and the Stride Length, the fewer the Total Steps and the longer the Stride Length were, the shorter the Time was. In the study of Chang, Qian, Zong and Shen (2024), which has a jueying equipment for assisted force of 7-9-11 kg during 30 metres sprints, there were no significant differences among the loads. But, the statistical analysis showed that the maximum speed ability came from the decrease of the Total Steps, the Contact Time and the increase of the Step Length, compared to the unload sprints. These results agree with ours, so athletes should train with overspeed methods to improve their kinematic parameters and, subsequently, their sprinting time.

Comparisons Between the Two Protocols

This study investigated, also, the differences in the mean increasing numbers of the sprinting parameters in the 20 metres sprint and each 10 metres separately between the Control and the Overspeed Protocol. The statistical analysis showed that, in the first 10 metres of the Overspeed Protocol, the means of the Total Steps (-11.2%), the Eccentric Contact Time (-23.3%), the Concentric Contact Time (-15.1%), the

Contact Time (-17.6%) and the Step Frequency (-4.9%) decreased, significantly, while the Stride Length (+11.4%) increased, significantly, compare to the Control Protocol. These results explained by the pulling effects of the elastic cord. When the cord had its most elastic power and the participants started from an upright static position with zero starting velocity, after the beginning of the process, the elastic cord was forcing them with supramaximal horizontal velocity. So, the athletes' Total Steps decreased and all the contact times with the ground were shorter. The Stride Length was longer as a result of decreasing the Step Frequency, significantly. Oppositely, the Flight Time raised (+6.9%), but had not significant change, because of the decrease of the Step Frequency. It is important to note that the Time reduced (-6.5%) in the Overspeed Protocol, but had no significant difference between the two protocols, because the 10 metres were very short for the athletes to develop their maximal velocity, despite the assisted supramaximal elastic force of the cord. According to these findings, in the first 10 metres, the elastic cord affected only the kinematic characteristics and transformed the participants' overspeed sprint mechanics, with decreasing Time, but not at a significant level.

In the next 10 metres, where the participants had a supramaximal starting velocity, the statistical analysis showed that the means of the Total Steps (-9.1%), the Eccentric Contact Time (-28.7%) and the Contact Time (-19.8%) decreased significantly, compared to the Control Protocol, because of the elastic cord's assisted force. Furthermore, the Concentric Contact Time (-15.1%) and the Flight Time (-9.5%), also, reduced, but had no significant difference. Moreover, the Time (-15%) reduced, significantly, compared with the Control Protocol, because the assisted elastic force of the cord was pulling the participants, constantly, with speed higher than their producing maximal velocity. Oppositely, the Step Frequency (+6.5%) and the Stride Length (+9.9%) increased, significantly, because decreased the Flight Time and the Total Steps, respectively. According to these outcomes, in the second 10 metres, the elastic cord, not only, adjusted the kinematic characteristics, which transformed the participants' overspeed sprint mechanics, but reduced and the Time, significantly, so there were neuromuscular adaptions, because the participants were sprinting with higher speed from what they could produce.

In the entire 20 metres, the statistical analysis showed that the means of the Time (-9.9%), the Total Steps (-10.3%), the Eccentric Contact Time (-25.6%), the Concentric Contact Time (-15.1%), the Contact Time (-18.4%) decreased, significantly, and the Stride Length (+10.7%) increased, significantly, because of the assisted force of the elastic cord, compared to the Control Protocol. Similarly, the Step Frequency (-0.6%) decreased, but not significantly, and, oppositely, the mean of the Flight Time (+0.5%) increased, but not significantly.

Comparisons Among This Study With Others

In the research of Bartolini and his partners (2011), eighteen women sprinted up to 18.2 metres with an assisted pulling force of an elastic cord. The results were that the time of the first 13.7 metres decreased to a significant level, but after that point increased, because the elastic cord had lost its tension, which left the subjects to run at maximal speed, but with no assistance to be supramaximal. These outcomes differ from our study and the reason is that our participants did not catch their maximal speed in the first 10 metres and, also, our elastic cord had a higher assisted pulling tension from the 13.7 metres and then.

Moreover, in another research (Tillaar, 2021), 24 athletes, both male and female, run a 60 metres normal sprint and assisted sprints of 3, 4 and 5 kg each one by a motorized pulling system with a distance of 60 metres overspeed. From the statistical analysis proved that the sprint times decreased, significantly, in each assisted pulling load, for both genders, comparatively to the normal sprint. The number of steps, also, decreased, significantly, with the increasing assisted loads for both women and men. From the kinematic parameters, the flight time increased and the step frequency decreased, but not in significant amounts. In the opposite way, the step length increased, significantly, in all conditions and the contact time decreased, also, significantly, only with the 5 kg assisted load. These outcomes match, exactly, with our project's, regardless of the different running distance (20 metres in ours against 60 metres in Tillaar's, 2021) and the assisted force (9.5-19 kg in ours against 5 kg in Tillaar's, 2021).

In a similar study of Cecília-Gallego and his partners (2022), eight young athletes performed 1 control sprint and 3 more with different loads of 2, 4 and 5.25 kg each. The sprints had a duration of 50 metres, where the first 20 metres were unassisted and the other 30 were assisted by a towing device. The statistical analysis showed that the time of the last 5 metres decreased, significantly, the contact time of the total overspeed sprint, also decreased in a significant way in the loading conditions of 4 and 5.25 kg. Oppositely, the flight time increased, significantly, in the 4-5.25 kg and the stride length in all protocols, but the step frequency had not significant changes. Compared to our study, the time, the contact time and the stride length had all the same changes, but the overspeed's step frequency was, significantly, higher in our project in the last 10 metres. The flight time, also, differs as it decreased in our study, because our elastic cord did not allow the athletes to be in the air for a long time. This happened, possibly, because our elastic tension was bigger in the start (19 kg) than the others (4-5.25 kg) with a result that the sprinters had higher speed as they were approaching the finish line.

In another similar research (Clark et al., 2021), 14 developmental male sprinters performed maximal trials of 60 metres sprints, both unassisted and assisted with a motorized towing device using a load of 7 kg. The statistical analysis showed that, in the split 30-40 metres, the contact time decreased significantly, oppositely, the flight time and the stride length increased, significantly, between the conditions, but there were no significant differences for the stride frequency. These sprinting parameters were, almost all of them, similar to our project, which mean that our elastic cord has the same overspeed effects with the motorized towing device 1080 Sprint. These parameters remained, also, the same in larger metres (40 metres) comparatively to our study (20 metres), because their towing device had the same assisted tension in the entire duration of the sprint, but, in our project, the pulling tension was decreasing as the sprint was carrying on.

In addition, the study of Ebben (2008), used 13 college athletes to run 36.6 metres sprints in flatland and in downhill slopes of different angles. He found that the sprint time reduced, significantly, in the optimal downhill slope of, approximately, 5.8° in compared to the flatland. This fact matches to our project as our sprint time decreased in the 20 metres of overspeed with the assisted force. Like this way, the downhill slope and the elastic cord offers similar neuromuscular adaptions in those who want to reduce their sprint time in the acceleration phase.

Furthermore, Kratky and Müller (2013), used 19 male athletes and they had to run flying 20 metres sprints under 3 conditions of a free sprint, a body weight supported sprint – normal speed and a body weight supported sprint – overspeed. In the comparison between the free sprint and the body weight supported sprint – normal speed, the statistical analysis revealed that, there were a significant decrease in the ground contact time and an increase in in the flight time, but the step frequency and the step length remained, almost, unchanged. In the comparison of the free sprint and the body weight supported sprint – overspeed, the statistical analysis showed that there were, similarly, a significant decrease of the ground contact time, whereas the flight time, the step frequency and the step length were increased, significantly. Moreover, the comparison of both body weight supported situations revealed that, significantly, in the overspeed condition, the ground contact time was smaller, the step frequency was faster, the step length was bigger than the normal speed condition. Compared to our study, in the first case, the flight time and the stride length differ, because the producing force of the kite was vertical, as a result the flight time to grow and the stride length not to raise. In the second case, similarly, the flight time and the step frequency differ with our overspeed protocol, maybe, because the mechanism of the kite was more vertical than our elastic cord. Furthermore, they differ, because their towing system had the same elastic pulling tension during the whole distance than ours, as the assisted force was getting smaller with the passage of time or, even more the combination of the two theories. To sum up, the contact time, both of the kite and the elastic cord decreased significantly, but the other sprinting parameters were unclear for the improvement of the sprint speed. For these reasons, further projects must carried out to clarify if the body weight supporting kite is an effective method for overspeed training.

In the end, the Gojanovic and his partners' project (2012), utilized 14 participants (9 men, 5 women), which completed a control protocol and another 4 protocols (AG: 100-95-90-85 %) of running in the lower body positive pressure treadmill AG. The statistical analysis showed that, the step frequency in men increased as body weight was reduced, with a significant difference for all AG conditions compared with the control, but, in women, did not change. Stride length was higher in men for AG95, AG90, and AG85 and higher in women for AG95 and AG85, compared with the control protocol. Similarly, in our study the stride length was higher from the elastic pulling effects, oppositely, the step frequency did not has significant changes in men. From these findings determine that so the lower body positive pressure treadmill AG as the elastic cord can change major sprinting parameters, but need additional research between the genders.

5. CONCLUSION

To conclude, the results of the current investigation demonstrated that there were significant correlations among the Time and the sprinting parameters, both in the two protocols and in the first 10 metres, in the second 10 metres and the entire 20 metres. Moreover, it is important to notice that there were, also, significant differences in the means of the Time (-9.9%), the Total Steps (-10.3%), the Eccentric Contact Time (-25.6%), the Concentric Contact Time (-15.1%), the Contact Time (-18.4%) and the Stride Length (+10.7%) of the Overspeed Protocol, because of the assisted force of the elastic cord, compared to the Control Protocol. These findings drive in the result that the Overspeed Training constitutes an effective method of training to increase the sprint speed. Another result is that this kind of elastic cord is a necessary tool for those who want to improve the sprinting time. But, more research is needed for these or extended metres on the acute and long term effects on the neuromuscular adaptions.

6. LIMITATIONS OF THE STUDY

Finally, more participants should be involved in the present study. The athletes must have better familiarization to maximize their sprinting efforts with the elastic cord, so they do not cut down their speed, because of their braking reflexes.

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