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Sprint Kinematic Performance Changes Upon Returning From A Declining Period In Track And Field Sprinters

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SPRINT KINEMATIC PERFORMANCE CHANGES UPON RETURNING FROM A DECLINING PERIOD IN TRACK AND FIELD SPRINTERS

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SPRINT KINEMATIC PERFORMANCE CHANGES UPON RETURNING FROM A DECLINING PERIOD IN TRACK AND FIELD SPRINTERS

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ABSTRACT

Sprinting is a key component of many competitive sports. Coaches regularly seek ways to improve their athletes' sprint performance in order to improve their sports game performance. Sprinting is a complex movement pattern that has many different subcomponents to be properly trained in order to become faster. A sprint event has three major phases (acceleration, maximum velocity/constant speed, and deceleration). Coaches are constantly looking to improve their athlete's performance. This is done by a strategic training regimen that extends throughout the entire year. During the off-season, the coaches' main focus is to maintain conditioning and performance adaptions. Previous studies have concluded that detraining has a negative impact on many aspects of an athlete's performance profile. In 2020 many sports were disrupted completely in the cause because of Corona Virus. Research on unplanned detraining/reduced training has not been explored. In the proposed study, we aim to evaluate the progression of division 1 track athlete's sprint performance from a deconditioned state to in-season shape. Coaches regularly seek ways to improve athlete sprint performance, including sprint kinematics, in efforts to translate to superior sport performance. This is generally done through a periodized training program application. This past year the COVID-19 virus significantly altered/halted many aspects of sports performance training. This specifically impacted the off-season training of Division 1 track and field athletes. **PURPOSE:** To examine the magnitude of change in sprint performance kinematics of Division 1 sprinters after participating in a training program upon returning from a COVID-19 pandemic enforced deconditioning period. **METHODS:** Thirteen Division 1 sprinters participated in two separate testing sessions 5 months apart (October 2020, February 2021). Initial testing was conducted with athletes returning in a deconditioned state resulting from COVID-19 quarantine. The second testing session was completed after a typical training in-season program. Athletes performed two trials of a 30-meter sprint-through. The sprint-through test was conducted over a 60-meter distance with the first 30 meters used for acceleration and the subsequent 30 meters being the timed zone. Athletes were instructed to attain maximal velocity upon entering the 30-meter timed zone. Speed was obtained by timing gates placed at the start and end of the 30-meter timed zone. Within the 30-meter timed zone, 6 meters of the OptoJump Next measuring system, placed in the middle of the 30-meter zone, captured sprint kinematics (stance phase, contact time, step length, stride length, and flight time, speed,). A series of paired sample t-tests were used to find differences in sprint kinematics between time points. The significance level was set at 0.05. A questionnaire was given to the athletes in order to assess the training they were performing during the lockdown. **RESULTS:** Significant differences were found in left stance phase of 19% from pre (0.119 ± 0.0159) to post (0.1 ± 0.03) ($t(12) = 2.918$; $p = 0.012$; Cohen's D = 0.76; Moderate). Other variables that showed no significance were speed ($t(12) = 0.37$; $p = 0.710$;), step length ($t(12) = 1.33$; $p = 0.207$), stride length ($t(12)= 1.33$; $p = 0.207$), and flight time ($t(10)= 0.875$; $p = 0.401$). **CONCLUSION:** After a 5-month training program following a period of detraining, improvements were seen in the stance phase and contact time in Division 1 track and field sprinters. **PRACTICAL APPLICATIONS:** Monitoring sprint performance kinematics after deconditioning can help aide strength and conditioning coaches to plan training programs to improve sprint kinematic performance.

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CHAPTER 1 INTRODUCTION

Introduction to sprint performance

Sprinting is an essential aspect too many sports such as baseball, softball, football, and soccer. In term, if an athlete is able to increase their overall sprint performance it will aid them in becoming more successful within their given sport especially if their respective position relies heavily on short bursts of maximal effort running. Sprinting is a complex concept for which it contains three major phases: the first being acceleration, the second being maximum velocity/constant speed, and lastly deceleration. Depending on the activity being performed these various phases can vary in many ways such as length of time. Within any given sport or physical activity, there are kinetic and kinematic factors that directly influence the overall performance of the athlete. Sprint performance is defined as an individual ability to smoothly coordinate the rapid cyclical movements of the arms and legs when running at maximal velocity. The ability to improve maximal sprint performance is usually the optimum training goal for most coaches and trainers in most sports. Consistent increases in instant acceleration have been associated with an overall increase in sprint performance (Petrakos, 2015). Sprint and strength coaches primarily focus on two primary methods to increase sprint performance. The first method usually focuses on increasing an individual's force and power/physical output (Cissik, 2004). The second method would focus on the overall sprint technique using drills such as heel kicks, high knees, etc. (Cissik, 2004). This method is typically related to more experienced sprinters such as athletes where the smallest improvements could make the biggest impact (Cissik 2004).

Resistance training

Resistance training also known as strength or weight training has been established as an effective method for developing muscular fitness (Hass, 2001). The primary goals of resistance training are to improve overall muscular strength and endurance (Fleck and Kramer, 1988). In untrained individual's resistance training is when most of the increases in muscular strength due to the newly developed neural adaptions (Bird, 2005). Resistance training has also been related to other health benefits such as increasing overall bone mass, reducing blood pressure, increasing muscle sectional area, and reducing body fat. Resistance training has also been shown to help with sports performance such as sprinting since the implementation of resistance training results in overall strength and power production (Young, 2006). Resistance training increase muscle strength, power enables the athlete to exert greater force with each foot contact, thus helps with the running acceleration of the sprint (Blazevich, 2000; Kraemer 2000; Ratamess 2007). Lower body strength has strong correlations between short sprint performances when the athletes training programs incorporated free weight back squats (Comfort, 2012; Comfort, 2014; Kirkpatrick, 2012; Mcbride, 2009; Meir, 2001). This is why resistance training has been a fundamental role in many physical activity programs across many different major health organizations as well as training programs for various sports (ACSM Position stand, 1988; Fletcher, 1995; Kraemer, 1999; Pollock, 2000; USDHHS Physical activity and health, 1996).

Unplanned Deconditioned/ Detraining

COVID-19 was a new rapidly spreading infectious disease (World Health Organization, 2020). On March 11th, 2020, the World Health Organization (WHO) officially declared the COVID-19 a global pandemic. The virus is spread through close unprotected contact with an infector and fomites (World Health Organization, 2020). Social distancing, quarantine, and lockdown of cities were used in order to stop the spread of the virus (World Health Organization, 2020). Sports activities were one of the major activities that were affected with most major competitions completely stopped (Fuentes-Garcia, 2020). Due to this athletes would have a period of unplanned detraining ranging 3 to 6 months depending on the region. Recent research has explored how training and physical activity has altered due to the pandemic (Choi & Bum, 2020; Wong et al., 2020; Woods et al., 2020). The main consequences of lockdown/quarantine are lack of adequate communication between athletes/coaches, no structural organization/execution of a training program, and inadequate training conditions (Chen et al., 2020; Bosquet 2020). Physiological effects of quarantine include increased body fat percentage, loss of mental sharpness, insomnia, and decrease in muscle mass (Halabchi, 2020). These consequences can have short and long-term negative effects on the athlete's performance and fitness (Bosquet, 2020). Sousa (2019), revealed that training performance adaptions can be compromised after a detraining period of 2-4 weeks (Neufer, 1987). When the detraining period exceeds more than 2-4 weeks physiological performance adaptions decline drastically. This includes further decline in maximal oxygen capacity, changes in maximal oxygen delivery, and decrease in submaximal athletic performance (Neufer, 1987). Previous research showed that 8 weeks of deconditioning results in reduced aerobic fitness, anaerobic power as well as sprint ability (Ross A and Kuppig, 1995). Similar results were shown in a study by Koundourakis (2014), that found after six-week detraining program professional soccer players had reduced completion times in their 20m sprints throughs. Another major issue with training at-home training is the intensity and volume are sufficient enough to maintain physical fitness (Koundourakis, 2014). Once regular training resumed it was suggested by Reilly and Williams (2003), Brady (1995), and Bangsbo (2008) that in order to successfully return to peak physical condition after a detraining period an individual will have to put forth a concerted effort. Godfrey (2005), suggested that high level athletes must perform exercise training a period of time twice as long as the detraining period in order to return to peak fitness levels (Godfrey, 2005).

Motivation

The impact of COVID-19 has affected individuals who were physical active before lockdown this in turn reduced the possibilities of continued of carrying out sports practice (Ammar et al,. 2020; Tison et al,. 2020; Woods et al., 2020). Since training during COVID-19 lockdown was entirely based on an athlete's motivation to continue to train and improve performance. According to (Jukic et. al., 2020; Petlichkoff, 1996), there has not been any publications regarding the effects of the pandemic crisis on athletes mental and physical health but, significant research has been done on athlete's motivation to continue train for their desired sport during an unplanned detraining period.

There is still an existing gap in the literature as to how much detraining affects division 1 track athletes' sprint performance and its corresponding kinematic variables. Very little information has been investigated regarding an unplanned detraining period and its effects on athlete's performance. Therefore, the current study aimed to fill these gaps and investigate how much improvement in sprint performance can be obtained from a detraining and retraining period in Division 1track and field athletes.

CHAPTER 2: LITERATURE REVIEW

Kinematics of Sprinting

The gait cycle is the universal unit of measurement when analyzing any form of human locomotion. The gait cycle begins when one foot comes in contact with the ground and ends when the same foot contacts the floor for a second time. According to Fletcher (2009), stride length is divided into three distinct phases: the support phase, acceleration phase, and flight phase. The support phase begins at the point of initial contact with the ground when the center of the gravity (COG) of the athlete behind him, to when the COG is over the initial ground contact point. The stance phase begins when the athlete's COG is pushed forward right until the point the foot lifts off the ground. The swing phase is the distance covered while the athlete is in the air. A complete stride is accomplished when two strides are completed together. According to Fletcher (2009), stride frequency is defined as a coalescence of contact time (amount of time the foot is in contact with the ground per stride) and flight time (the distance covered while the athlete is in the air during a stride). This **r**elationship is very sensitive in the sense that their needs to be a specific ratio of both contact time with the ground and time spent in the air in order to obtain maximum speed. Any variability within this equation would drastically affect the overall sprint performance since most tests are based on a fixed distance covered. Sprinting speed is defined by the frequency of the strides and the length of each stride (Mann and Herman, 1985; Ae, 1992; Delecluse, 1998; Bruggermann, 1999; Ferro, 2001). These two factors are dependent on each other, which is why an increase in either of these factors will affect overall speed negatively or positively (Hunter, Marshall, & McNair, 2004). According to the same authors, it was shown that stride frequency was related to faster velocities of the athletes, and stride length was not. It was also reiterated in a study by Hay, (2002); Luhtanen, and Komi (1977), where they suggested as running speed increases from almost stagnant to maximum velocity stride frequency increases, whereas stride length remains the same or decreases slightly. Controversy to which kinematic variable is more important has always been a topic of discussion. Among researchers after runners pass speeds of 7.0 m/s as both kinematic factors increase linearly. In order to increase overall maximum velocity within a given distance, an athlete would need to focus on increasing their stride frequency rather than their length of stride. It was reported by Nunmela (2007), that as the overall velocities of runners exceeded 7 m/s stride length tended to increase and eventually leveled off, whereas stride frequency continued to increase in a linear fashion. Although the debate was ultimately settled in a study conducted by Ito (2006), where they analyzed 100-meter sprinters and found that stride-length altered throughout the entire sprint. During the acceleration phase, stride length was typically longer as opposed to the maximum velocity phase. The authors did point out that even though stride length was varied during the various phases it had a significantly more impact on sprint performance than stride frequency. To reiterate proper execution of technique in all phases of the sprint cycle is crucial in order to perform maximally. Along with proper execution of the lower limb movements, it is also important to have proper coordination and synchronization of the upper limbs that will be explained in a later section.

Phases of sprinting

Maximum velocity and acceleration are essential components in many different sports in games such as rugby, soccer, and field hockey (Bangsbo, 1991; Deutsch 1998; Meir 2001). Maximum velocity is defined as the fastest velocity attainable within varying sprint performance. Three distinct phases of sprint running are the acceleration phase, the maximal phase, and the deceleration phase. In the acceleration phase is where an athlete develops about 80-90% of his maximal speed. As the individual transitions into the maximum velocity phase, this is where a runner’s center of gravity (COG) is behind the initial ground contact point. The COG of the athlete also sees a decrease in the runner’s vertical displacement while the horizontal displacement increases as the velocity of the runners goes up (Cavagna, Komarek, and Mazzoleni, 1971; Luhtanen and Komi, 1978). According to Coh (2010), the maximal speed is located between 60 and 80 meters in men and 50 to 70 meters in women. During the deceleration phase velocity decreases dramatically due to central and peripheral fatigue this is done by longer stride length time as well as an increased contact time with the ground.

Forces

There are two forces that are applied when an athlete is sprinting in order to complete the movement. One being horizontal forces which are used to push the runner forward and the vertical forces are used to allow the runners to achieve the necessary heights. The combination of an athlete's underlying force and velocity mechanical outputs creates an individualized force-velocity profile (Samozino 2012, 2014; Morin and Samozino 2016). The three main variables that make up the force-velocity profiles are the theoretical maximal force, the theoretical maximum velocity, and maximal power. All of these parameters are characterized by the neuromuscular system, the morphological/technical factors, and muscle mechanical properties components that are used to complete the act of running (Cormie, 2011). Another important component related to sprint performance is the ground reaction force (GRF) which is the ability to produce and apply high amounts of power in the horizontal direction into the ground (Jasklolska, 1999b; Morin, 2011a, 2012; Rabita, 2015). Recent research conducted by Morin (2010) concluded that when comparing horizontal and vertical GRF vectors during the acceleration phase was most influenced by the individual’s overall technique.

Proper Sprint technique

Executing proper running technique is tremendously important in order to achieve maximal performance Without the proper coordination of the body the individual will not be able to execute all necessary movement of the sprint cycle. At the beginning of a stance phase in order to gain speed, it must overcome inertia by pushing both downward, and backward into the ground generated primarily by the hip extensor muscles (Bezodis, Kerwin and Solo, 2008). As the individual moves into the latter portion of the stance phase, the dependence of creating the necessary force output to gain acceleration goes to the plantarflexion muscles. Throughout this the body has a slight lean with almost no trunk flexion in order for the individual's center of gravity and mass is as forward as possible to allow for sustained acceleration. Restrictive hip flexion is also simultaneously happening to reduce the initial stride length and increase initial stride frequency (Baughman, 1984). As the individual enters the swing phase (acceleration) and the initial acceleration slows the posture of the body becomes more of an upright position, in which the new priority becomes a downward push onto the ground in order to fully utilize the body's initial momentum. The strength of the hip flexors are used to drive the knee upwards but, at the same time, the individual must keep the heel of the swinging foot close to the gluteal muscle in order to decrease opposing inertia. At the same time, the arms work in opposition to the legs working in a rhythmic continuous pattern throughout the entire sprint cycle. During the arm swing, the shoulders should be as relaxed as possible in order for them to remain square in the direction of the run. The arm swing should be strong in order to help provide force for the legs. The hands should remain relaxed throughout the entire swing however on the upper portion of the swing the hand should end as soon as it is equal level to the chin but still inside of the shoulder (Baughman, 1984). The elbows should stay close to the body and not swing out away from the body. Throughout all phases of the sprint the head needs to stay aligned with the trunk in order to cause unnecessary trunk flexion, and stiffness of the neck and shoulders muscles that will decrease sprint performance (Young, 2006). Sprinting is complicated bodily coordination of the muscles that requires precise firing of motor neurons. Repeated practice and drills need to be routinely performed to successfully go through the sprint cycle.

Resistance/plyometric training for sprint performance

The ability to generate high forces against large resistances and be able to produce high power is important for various sports such as football, rugby, etc. Resistance exercise and plyometric exercise programs have become an important component to the physical preparation of sports performance. This concept is important for athletes as well as their coaches/trainers in order to find the most efficient training regimen to achieve the greatest gains in performance. Numerous studies have shown a significant correlation between sprinting performance and various measures of strength/power output (Meckel, 1995; Young, 1995; Bret, 1999; Kukoji, 1999; Hennessy, 2001). Strength and, power have also shown commonalities in muscular function when compared to sprint running. Sprint performance has been shown to relate more to power than strength although findings by Wilson, (1993); Harris, (2000); Lyttle, (1996); Mcbride, (2002), showed training with jump squats/plyometric exercises showed improvements in sprint performance. The results of a study by Rimmer (2000), reported that 8 weeks of plyometric training including unilateral exercises showed significant improvements in 10-meter sprint time. Similar results were also shown in a 9-week sprint and plyometric program which also included unilateral exercises which showed significant improvements in sprint performance when compared to just a sprint training program (Delecluse, 1995).

Strength and power production in sports are greatly influenced by neuromuscular factors in accordance with muscle sectional area (the extent to how much of the muscle mass is activated) (Sale, 1987; Hakkinen, 1989; Behm, 1995). Neuromuscular function is of vast importance to sprinting since it such a complex movement that requires many different muscles to be activated at certain points in time in order to achieve maximum performance (Ross, 2001). Muscle cross-sectional area is most commonly related to overall voluntary strength. This is why hypertrophy training is the most common regiment used in order to increase power/force output in sports movements. Hypertrophy training commonly leads to increases to muscle mass/body mass however there is a fine line to how these physiological adaptions affect performance. According to Carroll (2001), hypertrophy training could produce either positive or negative to sports performance. Negative transfer could occur if there is an increased co-activation of antagonist muscles because it creates forces that would counter the natural movement direction. Positive transfer occurs if resistance training aids the optimum muscle activation patterns of the particular sport skill (Carroll, 2001). This is achieved if the training program incorporates movements that increase neural activation movement of the muscles that contribute to the required skill or by inhibiting the muscles that degrade performance.

Detraining/ Training Cessation

Detraining or training reversibility states that regular physical training results in improved physiological changes related to athletic performance. In contrast, if regular physical training is stopped or reduced then overall athletic performance is decreased (Hawley, 1998). Athletes regularly experience strategic interruptions in order to allow proper injury recovery, and at the end of the season to have a mentally/physical break from competition. Depending on the duration of irregular physical training determines the extent as to which the qualitative and quantitative adoptions are affected (Fleck 1994; Neufer 1998; Sysler 1970; Fringer 1974; Shaver 1975; Hodkin 1982 Coyle 1985; Lacour 1984; Martin III 1986). Exercise performance has been shown to be negatively affected by 3 to 6 weeks of detraining in athletic populations (Coyle 1984; Martin 1985). It has also been suggested that the higher level of training an individual is at the greater risk for decline in physiological adaptations (Izquierdo, 2007). A decline in aerobic capacity has been associated with reductions in blood volume, stroke volume, cardiac output, and ventilator functions (Mujika, 2000a). Maximal oxygen uptake has been shown to decline in highly trained individuals between the ranges of 4-14% depending on the duration of interrupted training (Coyle; 1985; Martin III 1986; Moore 1987; Houston 1986; Ghosh 1987; Houmard 1992). Similarly detraining in aspects such as muscular strength is a direct result of muscle fiber size decreasing due to mitochondrial ATP production and enzymatic activities (Mujika, 2000b). Capillary density of all 3 muscle fiber types, muscle glycogen levels have been shown to reduce in 4 weeks of physical training reduction (Klausen 1981; Mikines 1989).

Motivation

Researchers have examined the role of motivation with persistence of physical activity (Buckworth et al., 2002; Calfas et al., 1994; Cardinal 1998). According to the self-determination theory an individual is motivated to participate in an activity based on the three theories intrinsic motivation, extrinsic motivation, and amotivation (Deci, 2000). Intrinsic motivation is defined as a person engaging in an activity and challenges purely by self-determination Extrinsic motivation is defined as a non-self-determined form of motivation in which they seek rewards attained or to avoid punishment. Amotivation is when an individual has no intention of engaging in a physical activity (Deci et al., 2000). Due to the COVID-19 pandemic athletes were unable to do their sport specific training due to social distance restrictions and were forced to train on their own

(Bok et al., 2020). This has forced athletes to train without any training programming or proper equipment (Mon-Lopez et al., 2020). Not all three types of motivation are as effective and in particular intrinsic motivation allows for more of a lasting engagement especially with athletes since in theory the athletes that succeed more tend to train based on their own self will (Ryan and Deci, 2000).

Detraining/ Training Cessation and its effects on Athletic Performance

Due to research is has been established that sprint velocity and maximum strength of an individual are closely related. Within short distances, an individual's strength being a greater influence because of the substantial amount of force needed to propel themselves forward. Long-term training cessations of more than 4 weeks have been investigated and, performance is more likely to be maintained or reduced rather than improved (Hortobágyi 1993). It was also stated by Hortobágyi (1993), that after 2 weeks of detraining no significant decreases were seen in surface muscle electromyography and associate muscles. According to Weiss (2003), who investigated the effects of short-term training cessation on exercise performance in 54 young male participants by training the seated heel raise movements 3 days per week for 8 weeks. The participants showed significant improvements in isokinetic plantar flexor and 1 rep max (RM) seated heel raise following the program. The subjects were then divided into 4 groups which ceased training for either 2,3,4, or 5 days. The 4 days of training cessation showed significant improvements compared to 2 or 5 days of training cessation. Similar results were shown in a study by Anderson & Cattanach (1993), which found nonsignificant improvements in 1 RM bench press and squat strength in 41 track and field athletes after 7 days of training cessation. Another finding by Ptritchard (2016), reported that it is typical of high-level powerlifters to take between 4 through 6 days off prior to a competition in order to maintain, or perhaps improve performance. In contrast, a study by Loturco (2015), did find significant increases in the rate of force development in 5 and 15-meter sprint velocity in elite women pole-vaulters after a detraining period of 28 days. Further research is needed to determine if detraining periods are beneficial or detrimental to performance in high-level athletes.

Hypothesis

There is still an existing gap in the literature as to how much does detraining affects division 1 track athletes' sprint performance and its corresponding kinematic variables. Therefore, the current study aimed to fill these gaps and investigate how much improvement in sprint performance can be obtained from a detraining and retraining period in Division 1track and field athletes. It was hypothesized that there will be an improvement in overall sprint performance and kinematic parameters from the 1st testing session (Pre) to the 2nd testing session (Post).

CHAPTER 3 METHODS

The proposed study used 13 male and female Division 1 Track and field athletes. The athletes ran through outdoor track assessment. Subjects' sprint performance was evaluated by a 30-meter sprint through (fly by) speed assessment. Pre and post assessments were conducted on October 23rd, 2020 (Pre), and February 12th, 2021 (Post) allowing two to five minutes of rest between trials. Pre and post testing were done to examine how they were able to perform shortly after the lockdown was lifted (pre) and after 5 months of re-training (post). A total of two trials were used for data analysis. During both testing sessions, a kinematic movement analysis was conducted by using the OptoJump Next movement analysis system in order to assess stride length, stride frequency, flight time, and ground contact time during the maximal speed phase of the sprints A Motion Start Timing System (TC-System, Brower Timing Systems, Draper, UT, USA) with two-timing gates were used to capture maximal sprint speed time. A questionnaire was given out to the athletes on February 23rd 2021 in order to understand what type of training the athletes were completing during the lockdown period and determine if a detraining period indeed effected performance. The questions were designed to help us determine some basic components of their at-home training regimen.

Subjects

A total of 13 subjects 7 male and 6 females between the ages of 18-28 years old, 2) free from any underlying diagnosed health conditions (spine deformities, impaired gait, restricted range of motion, heart conditions, musculoskeletal deformations, etc.), 3) free from any serious injuries were used for testing. Exclusion criteria for subjects included: 1) Chronic medical conditions or recently diagnosed medical conditions (spine deformities, impaired gait, restricted range of motion, heart conditions, musculoskeletal deformations, etc.); 2) Any major injury within the past 2 years that would affect sprinting (injured ankle, leg, foot, back, etc.). The same subjects were used for both testing dates in order to compare results accordingly. The study was approved by the University of Texas at El Paso Institutional Review Board before subject recruitment and data collection. All subjects will be informed of the risks and benefits of the study. Due to the COVID-19 outbreak, extra precautions and safety protocols were implemented in order to ensure the safety of the test facilitators and subjects. All individuals involved were tested for COVID-19 and had received negative results prior to arriving on the day of data collection. All test facilitators wore facemasks at all times and maintain the recommended 6 feet distance between others. Subjects were not required to wear masks during testing as it would restrict necessary breathing. The track events that each subject participated in as well as their class level was also added to Table 1. In order to keep the privacy of the athletes, they were each assigned a TR subjects code beginning with TR101. In order to define the gender of the subjects TR100's was given to males and TR200's was given to females. An overview of the athletes is presented in Table 1.

Table 1. Subject Data Sheet

Subject ID	Events	Class
TR101	Sprints	Graduate
TR107	Throws	Senior
TR111	Sprints	Sophomore
TR115	Sprints	Junior
TR123	Throws	Sophomore
TR124	Sprints	Sophomore
TR129	Sprints/Hurdles	Senior
TR202	Sprints/Hurdles	Junior
TR206	Sprints	Junior
TR209	Sprints/Hurdles	Junior

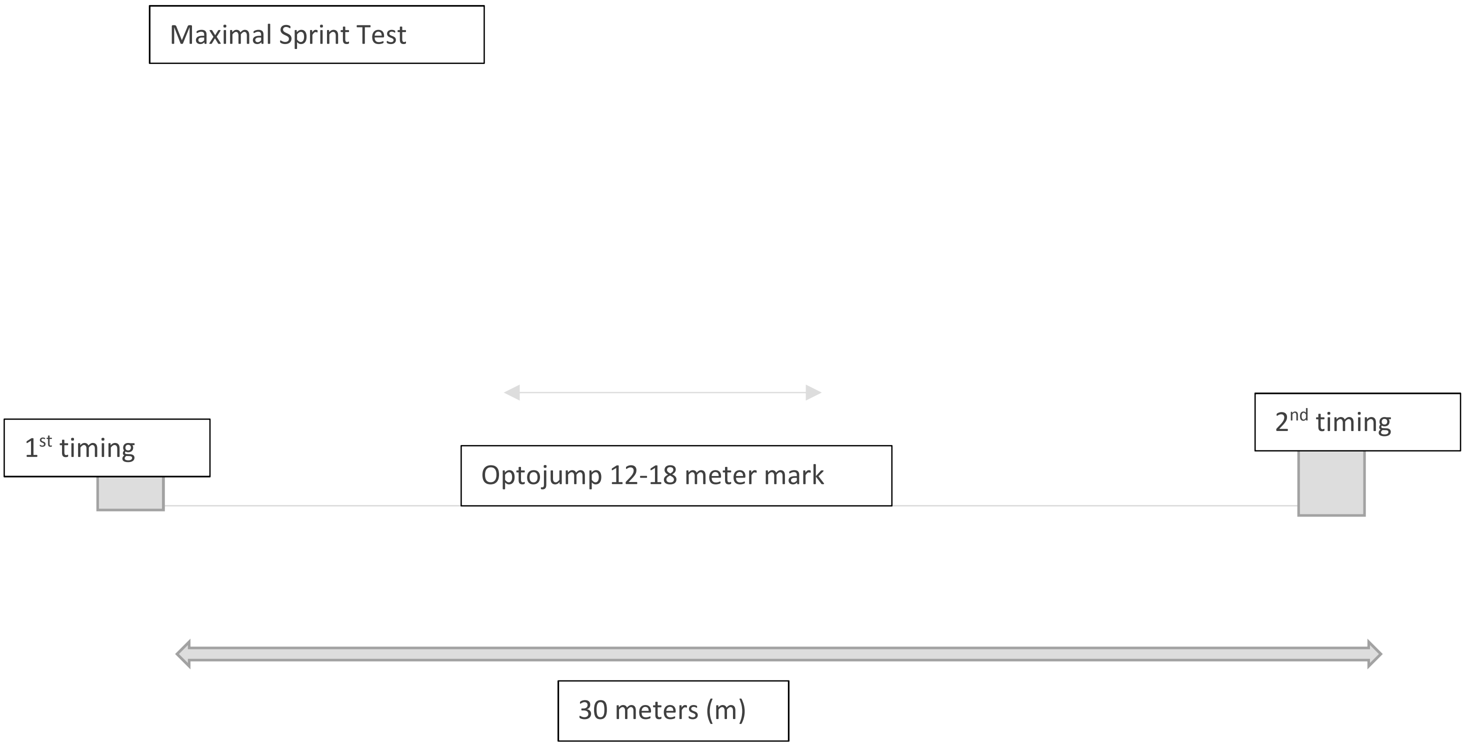
TR210	Sprints	Senior
TR214	Sprints	Freshman
TR218	Sprints	Junior

*TR100's subject IDs were given males
*TR200' subject IDs were given to females

Testing Protocols

The maximal sprint assessment test (Figure 1) was conducted over a 50-meter distance with the first 20-m used to attain maximal sprint speed and the last 30 meters for assessment. Within the last 30-m, the 12–18-m mark was used for sprint analysis via the Optojump panels and corresponding software. A Motion Start Timing System (TC-System, Brower Timing Systems, Draper, UT, USA) with two-timing gates were used to capture maximal sprint speed. The first timing gate was adjusted to begin 12-m before the Optojump panels began in order to measure maximal speed kinematics were captured. Sprint kinematics were measured for both legs. The subjects had been instructed to run the remaining 12-m of the 50-m sprint with maximal effort. The second timing gate will be placed at the 50-m end mark (Figure 1). Twelve 1-m panels of the OptoJump Next optical measuring system were used to capture foot kinematics (6 transmitting and 6 receiving panels). The 12 1-m panels of the OptoJump Next system on each side of the track lane were joined together creating a total of 6-m combined. For the maximal sprint assessment, subjects had been instructed to reach maximum velocity prior to entering the Optojump panels. A visual overview of the experiment and the sprint assessments are displayed in Figure 1.

Figure 1. Illustration of Maximal Sprint testing set up



Maximal Sprint-through (fly by) Speed Assessment

The UTEP track and field stadium was used for both testing sessions (400m outdoor track with a 100-m). Tests were carried out on a non-rainy day with wind speed of less than 3 miles per hour. Prior to testing subjects were asked to wear athletic clothes with running shoes. The total runway of 50-m is selected to ensure subjects would reach their maximal speed prior to entering the first timing gate. All subjects had begun 20 meters before the first Optojump panel and were asked to use the 20-m to build up acceleration. As the subjects had approached the panels they were informed to be at maximum acceleration and to run through the entire 50-m. Subjects performed a general warmup of running two 400-m laps, followed by static and dynamic stretching for 12 minutes. Five minutes were given to subjects for additional stretches if they desired. Each subject was lined up by the start line and only approached the start line when their names were called. Five minutes were given to each subject prior to each trial to allow sufficient enough time to recover.

Subjects had lined up at the start line 20-m before the start of the Optojump panels. The subjects were then instructed to start at their own will. Throughout the test, subjects were verbally encouraged to attain top speed before the start of the Optojump panel at the 30-m mark and were asked to sprint all the way through the 50-m mark. The times were collected from the first timing gate and the second timing gate. Times were recorded via the handheld display of the timing system.

Pre and Post Assessments/ Training Programs

Sprint assessments were recorded on October 23rd, 2020 (Pre), and February 12th, 2021 (Post). Both testing sessions had begun at 8:00 am and ended around 3:00 pm. Testing days were determined and altered depending on the weather forecast. Some exclusion factors included high winds speeds, and inclement weather such as rain, sleet, or excessive dust. Practice/Training for the track team was completely stopped on March 12th, 2020 approximately 2 days before spring break and did not resume until September 4th, 2020. There was also an additional shutdown from November 2nd through November 16th for the 2020 season

Pre-assessments had been conducted to establish a baseline for the athlete's sprint performance shortly after a deconditioning period caused by COVID-19. Post-tests were conducted 5 months after the athletes had resumed their regular training programs.

Multiple efforts were made to gain more information in regard to their training program but, feedback was not received. Athletes did train 6 days a week (Monday-Saturday).

Track Athlete Questionnaire

A follow-up interview was conducted on April 23rd, 2021, to attempt to understand the training the athletes had gone through during the COVID-19 lockdown. The purpose was to attempt to understand of whether the lockdown period did indeed cause a detraining effect based on their at-home training regimen. During this 5-month time period most of the athletes training was based on previous knowledge. Proper training programs could not have been assigned by the coaches as it would have broken NCAA rules at the time. The questionnaire was developed for this study but was not previously validated. A visual overview of the questionnaire is represented in Figure 2.

Figure 2. Track Athlete Questionnaire

Subject Name________________________
Subject ID___________________________
Date_______________________________
Administrator Name__________________________

Note there is a front and back to this questionnaire
Please indicate answer by circling the corresponding option

1. Please select the best answer indicating the number of times per week that you trained on your own during the COVID-19 lockdown period:

    - 1 session per week
    - 2 sessions per week
    - 3 sessions per week
    - 4 sessions per week
    - 5 sessions per week
    - 6 sessions per week
    - 7 sessions per week

2. Please select the best answer indicating the average duration of one weekly training sessions during the COVID-19 lockdown period:

    - 30 minutes
    - 60 minutes (1 hour)
    - 90 minutes (1.5 hours)
    - 120 minutes (2 hours)
    - 150 minutes (2.5 hours)
    - 180 minutes (3 hours)

3. Please indicate the average <u>time</u> (in minutes) spent on each component of fitness during <u>one</u> weekly training sessions during the COVID-19 lockdown period:

    - Strength Training _________________
    - Cardiorespiratory Training ________________
    - Mobility/Flexibility Training ________________

4. Please indicate the average number of <u>sets</u> completed during <u>one</u> exercise of Strength/Resistance Training during the COVID-19 lockdown period:

    - 1
    - 2
    - 3
    - 4
    - 5+

5. Please indicate the average number of <u>repetitions</u> completed in <u>one</u> set of an exercise during Strength/Resistance Training during the COVID-19 lockdown period:

    - 1-3
    - 3-5
    - 5-10
    - 10-15
    - 15+

6. Please indicate if you used bodyweight or traditional weights for your Strength/Resistance Training during the COVID-19 lockdown period:

    - Bodyweight
    - Traditional Weights

7. Please indicate the average rest time taken between in sets of an exercise during Strength/Resistance Training during the COVID-19 lockdown period:

    - 30 seconds
    - 60 seconds (1 minute)
    - 120 seconds (2 minutes)
    - Above 120 seconds (2 minutes+)

8. If you used traditional weights for your Strength/Resistance Training during the COVID-19 lockdown period, what was the average load:

    - Below 50% of one repetition maximum
    - Between 50-75% of one repetition maximum
    - Above 75% of one repetition maximum

9. Please indicate the primary focus of your Resistance training sessions during the COVID-19 lockdown period:

    - Muscular Power/Speed
    - Muscular Strength
    - Muscular Endurance

10. What were the primary types of exercises you performed during your training sessions during the COVID-19 lockdown period **(select all that apply)**?

    - Squats
    - Lunges
    - Deadlifts
    - Olympic Lifts (clean, snatch)
    - Bench Press
    - Push-Ups
    - Pull-Ups
    - Lat Pull Downs
    - Rows
    - Others

    ____

11. Did you regularly (at least twice a week) participate in your event while exercise training during the COVID-19 lockdown period? For example, sprinters = sprinting; throwers = throwing; long-distance runners = long-distance runs.

    - Yes
    - No

12. How many competitions did you participate in during the **2020** season:

    - 1 – 3 competitions
    - 2 - 4 competitions
    - 4 – 6 competitions
    - 6 – 8 competitions
    - 8 – 10 competitions

13. How many competitions did you participate in during the **2021** season?

    - 1 – 3 competitions
    - 2 - 4 competitions
    - 4 – 6 competitions
    - 6 – 8 competitions
    - 8 – 10 competitions

Data Management and Analysis

All collected data were entered into a password-restricted Microsoft Excel Sheet (2016) and the data were checked for accuracy. Data from the Optojump had been converted into a Microsoft Excel sheet for statistical analyses. All statistical analysis was done on Microsoft Excel. The fastest completion time was selected for analysis for both the pre-and post-test. Data appeared to be normally distributed. Data are represented as standard deviation and mean. Paired T-tests were run in order to compare both sets of data (Pre-Test, Post Test). Paired T-tests allowed users to compare the kinematic variables (contact time, contact time of left foot, contact time of right foot, stride, speed, flight time, step length of left foot, step length of right foot) from Pre to Post. Significance was set $p < 0.05$. For measures of interest, effect size (Cohen's d) was calculated. A commonly used interpretation to refer to the significance level of this test is as follows < 0.1 trivial *d,* small $d = 0.1$, medium $d = 0.3$, and large $d = 0.8$ (Cohen D, 1988).

CHAPTER 4 RESULTS

Table 2. Overview of Mean and Standard Deviation of all Kinematic Variables

There was no statistical significance in weight from pre to post testing (t (12) = 2.055; p = 0.062; Cohen's d =0.048; *Medium*). There was no statistical significance in height from pre to post testing (t (12) = 1.003; p = 0.335; Cohen's d = 0.023l; *Small*).

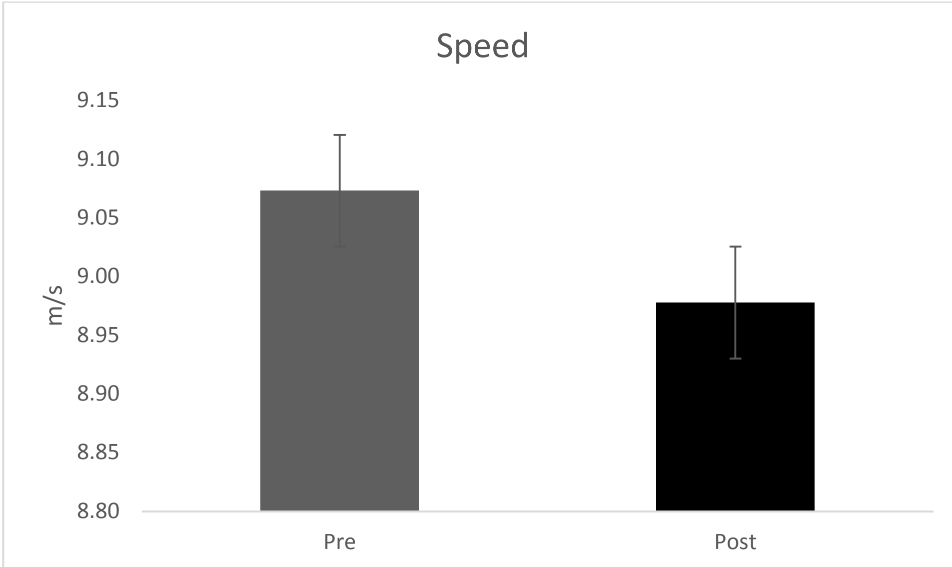
Variables	Mean (Pre)	SD	Mean (Post)	SD
Heigh (cm)	172.95	10.959	172.69	10.794
Weight (kg)	76.170	23.759	77.360	24.958
Step Right (s)	198.77	13.893	194.46	15.878
Step Left (s)	201.77	17.829	198.38	19.564
Step Overall (s)	200.261	15.104	196.423	17.376
Stance Right (s)	0.119	0.0152	0.115	0.020
Stance Left (s) *	0.119	0.0159	0.100	0.030
Stride (cm)	400.542	30.209	3932	34.80
Speed (s)	9.07	0.808	8.981	1.157
Contact Time Right Foot (s)	0.110	0.026	0.115	0.018
Contact Time Left Foot (s)	0.110	0.026	0.115	0.019
Contact Time Overall (s)	0.112	0.025	0.116	0.019
Flight Time (s)	0.110	0.007	0.113	0.019
Flight Time Right (s)	0.112	0.011	0.107	0.012
Flight Time Left (s)	0.107	0.008	0.118	0.028

*represents the variable is statistically significant differences from pre to post

Sprint Speed

Overall sprint speed (m/s) did not show any significant changes (m/s) (t (12) = 0.37; p = 0.710; Cohen's d = 0.090; *Trivial*) from Pre to Post testing.

Figure 3. Overview of Speed Performance



Step Length

No significant changes were seen in overall step length (cm) (t (12) = 1.33; p = 0.207; Cohen's d = 0.29; *Moderate*). No significant changes in right footstep length were seen from pretest to post test (t (12) = 1.505; p = 0.157; Cohen's d = 0.317; *Moderate*). No significant difference was seen in the step length of the left foot (t (12) = 0.892; p = 0.38; Cohen's d = 0.181; *Small*).

Figure 4. Overview of Overall Step Length

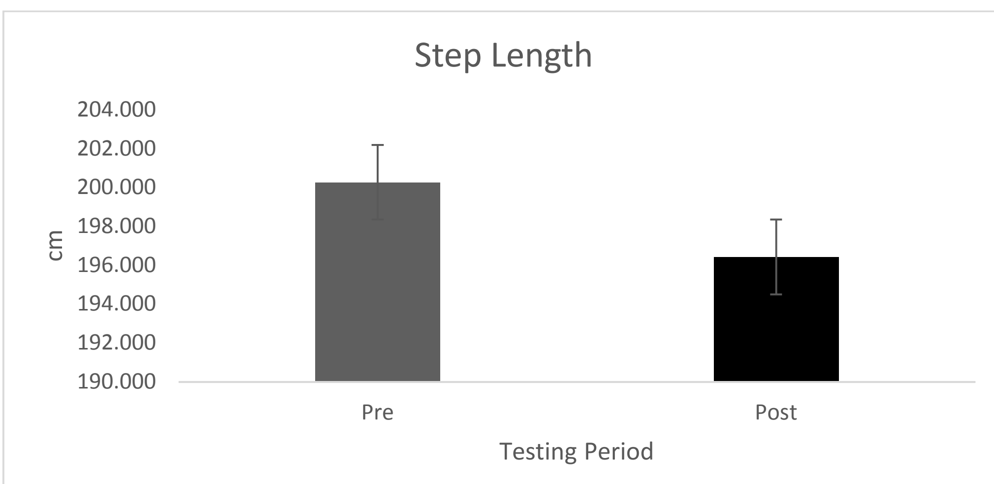


Figure 5. Overview Step Length of Right Foot

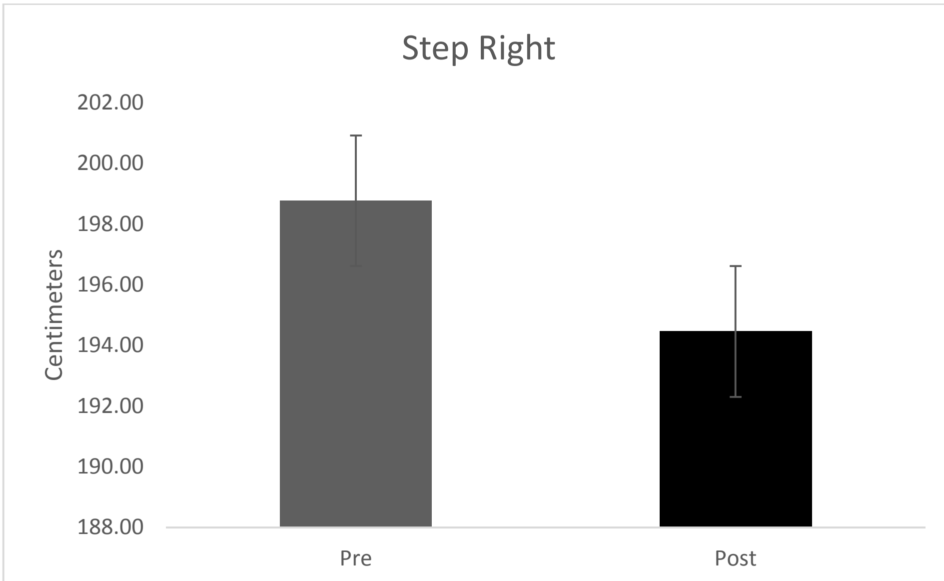
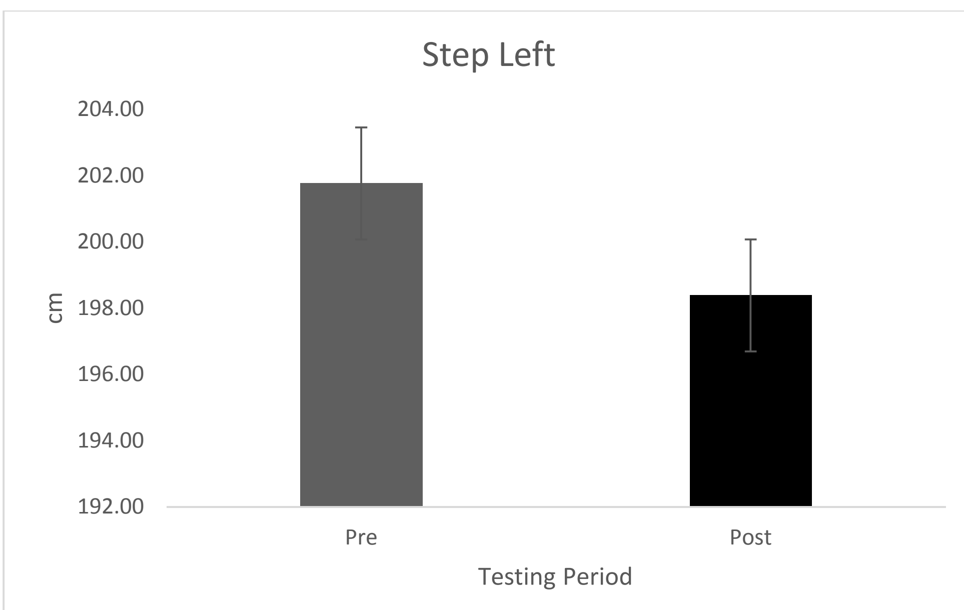


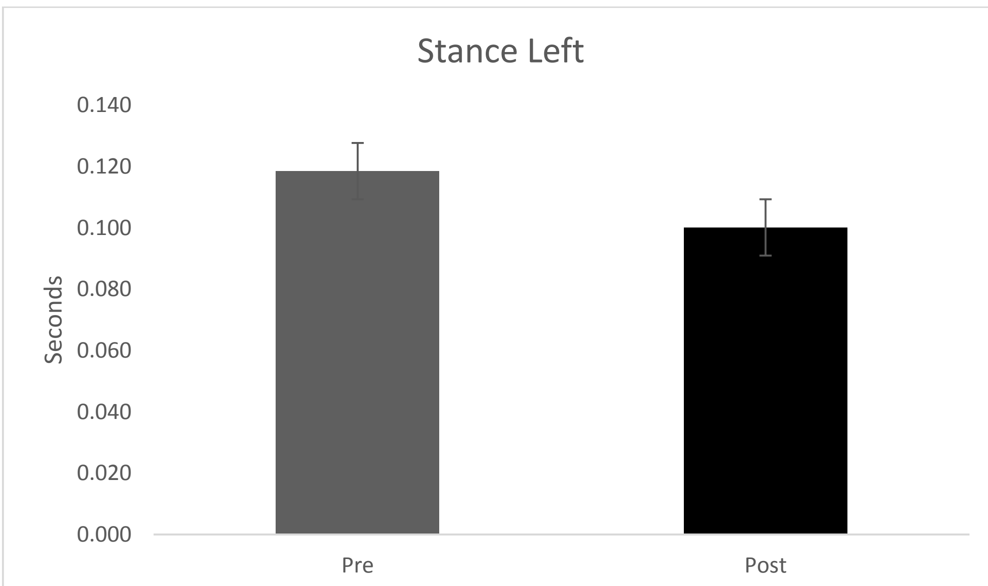
Figure 6. Overview Step Length of Left Foot



Stance Phase

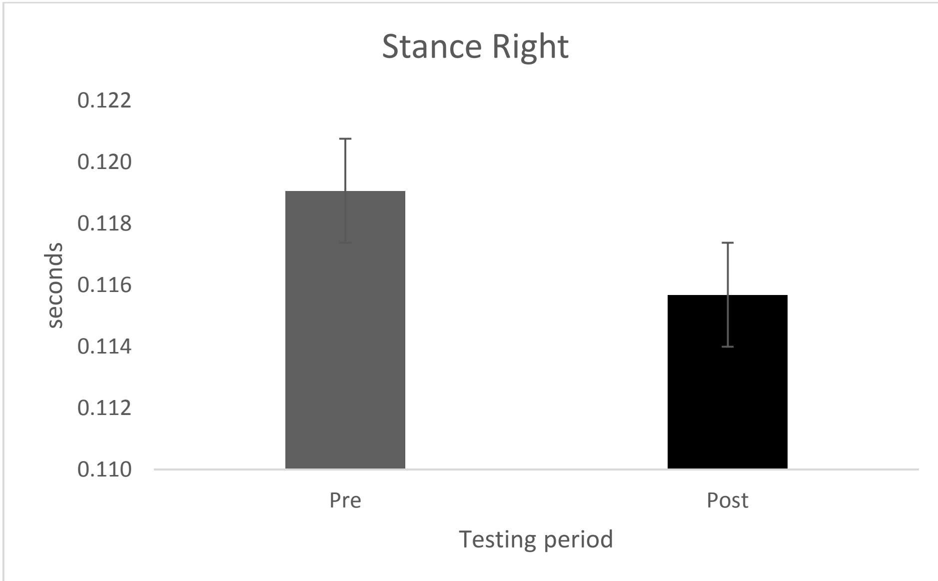
No significant changes were seen in the right stance phase (s) (t (12) = 1.774; p = 0.106; Cohen's d = 0.226; *Small*). There was a significance difference of 19% from pre (0.119± 0.0159) to post (0.1± 0.03) in the left stance phase (t (12) = 2.918; p = 0.012; Cohen's d = 0.76; *Moderate*)

Figure 7. Overview of Left Stance Phase



*Statistically significant

Figure 8. Overview of Right Stance Phase



Contact Time

Overall contact time (s) had no significant difference between pre and post testing (t (12) =0.834; p = 0.420; Cohen's d = 0.180; *Small*). There was no significant difference in the contact time of the left foot (t (12) = 0.336; p = 0.740; Cohen's d = 0.219; *Small*). There was no significant difference in contact time of the right foot from pre to post training (t (12) = 1.35; p =0.200; Cohen's d = 0.212; *Small*).

Figure 9. Overview of Overall Contact Time

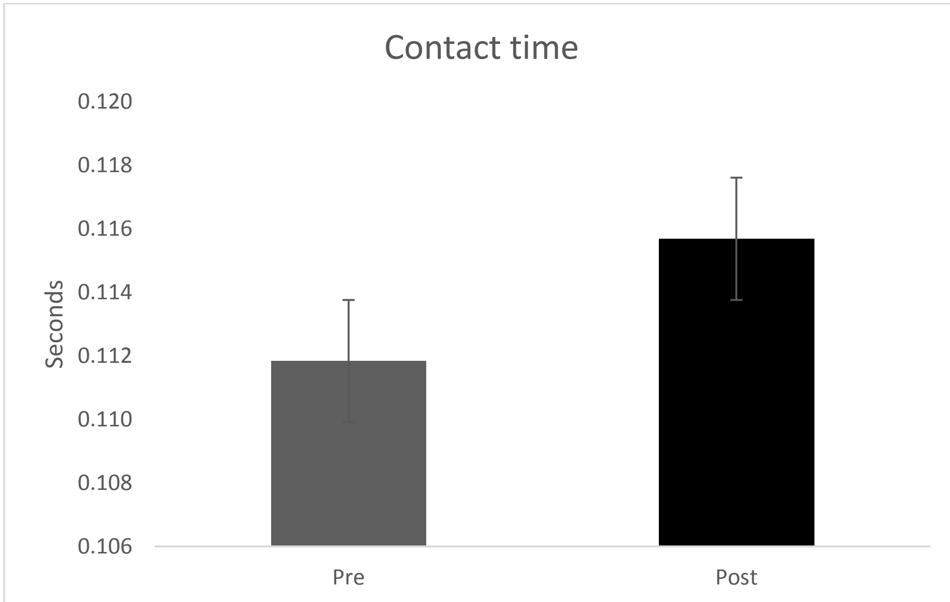


Figure 10. Overview of Contact Time of Right Foot

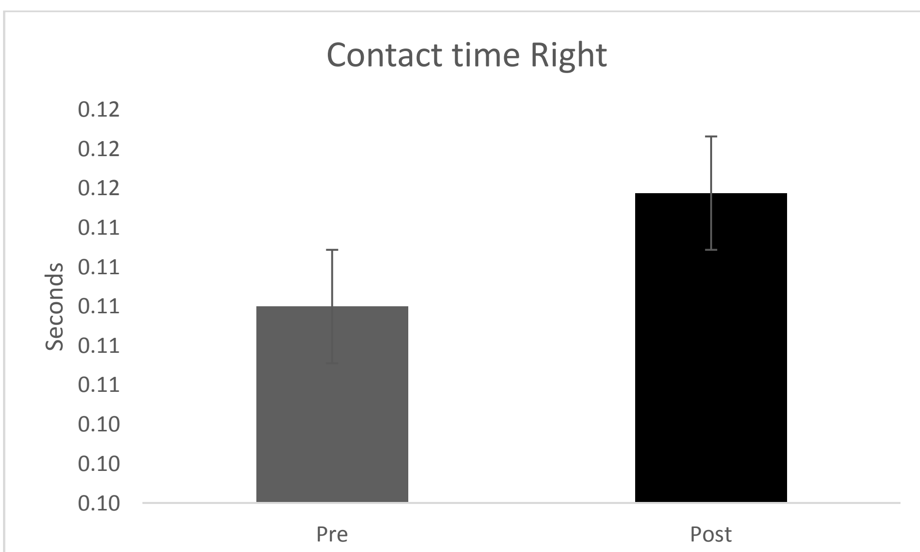
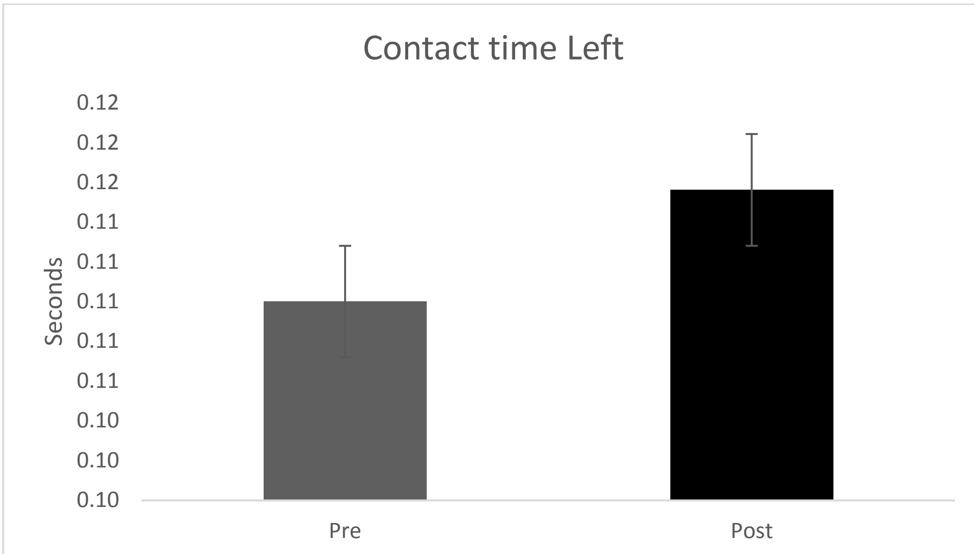


Figure 11. Overview of Contact Time of Left Foot



Flight Time

Overall flight time (s) had no significant difference between pre and post (t (11); p = 0.40; Cohen's d = 0.206; *Small*). For two of the original 13 subject's data was not able to be extracted for overall flight time, the flight time of left foot, and flight time of right foot. There was no significant difference in flight time of right foot (t (10); p = 0.60; Cohen's d = 0.332; *Small*). There was no significant difference in flight time of left foot (t (10); p = 0.144; Cohen's d = 0.503; *Medium*).

Figure 12. Overview of Overall Flight Time

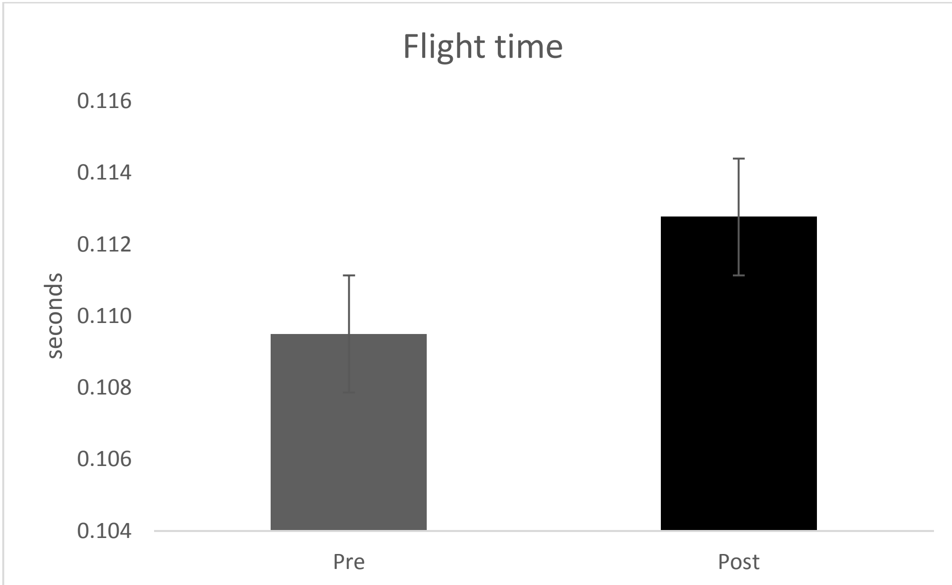


Figure 13. Overview of Flight time of Left foot

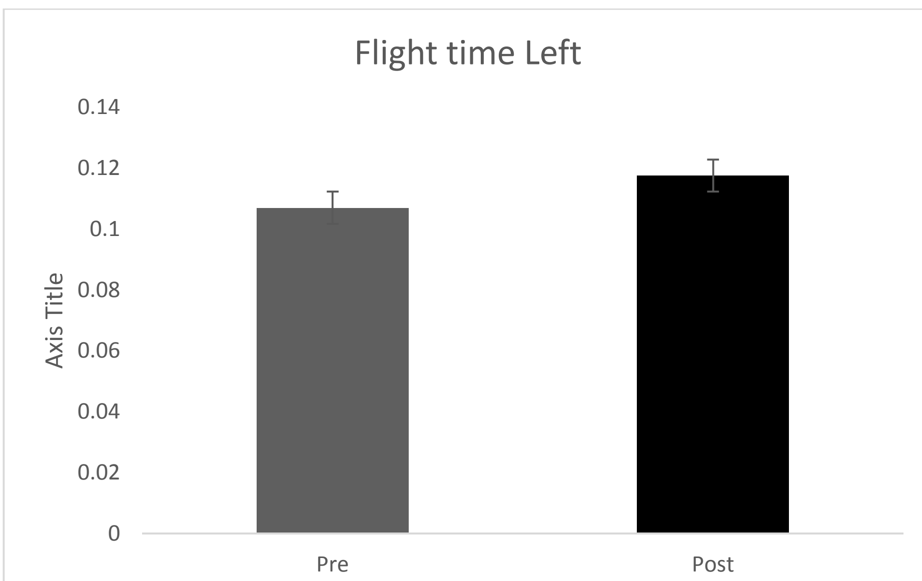
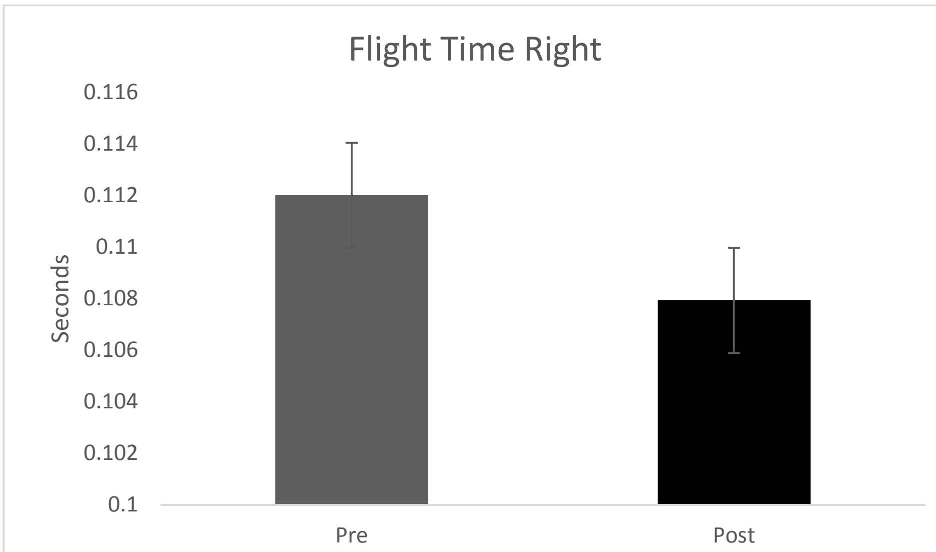


Figure 14. Overview of Flight time of Right foot



Stride

Overall stride length had no significant differences between pre and post (t (12); p = 0.20; Cohen's d = 0.236; Small).

Figure 15. Overview of Stride length

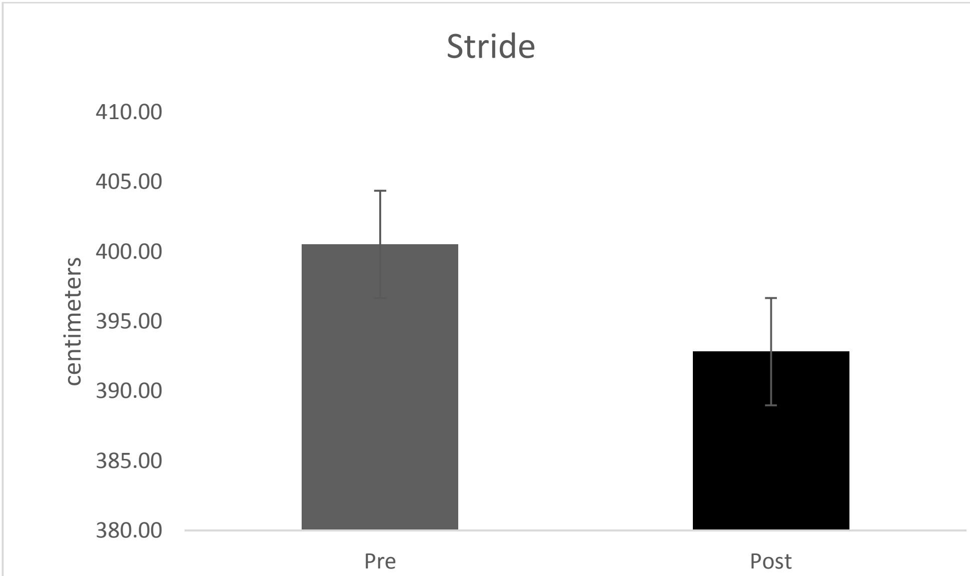


Table 3. Questionnaire Overview 1-3

Subject ID	**Ques. 1**	**Ques. 2**	**Ques. 3A**		**Ques. 3B**		**Ques. 3C**		**Ques.3D**	
TR101	3	60min	180min/	3	180min/	3	0min/	0	180min/	3
TR107	3	60min	240min/	4	120min/	3	30min/	1	80min/	4
TR111	1	30min	0min/	0	30min/	1	0min/	0	0min/	0
TR115	5	90min	180min/	3	30min/	1	360min/	4	40min/	2
TR123	4	120min	360min/	4	120min/	4	0min/	0	40min /	4
TR124	1	60	0/	0	60	1	0/	0	0 /	0
TR129	3	120	360/	3	270/	3	90/	3	60 /	3
TR202	5	120	375/	5	625/	5	50/	5	75 /	5
TR218	3	60	50 /	3	50 /	3	180 /	3	0 /	0
Mean	3.11	80	163.57	2.7	84.28	2.66	136	1.77	130	2.33
SD	1.45	33.54	158.23	1.71	60	1.41	141.52	1.98	70.71	1.93

*Question 3 = (min/number sessions per week)

* SD = Standard deviation

Questions 1-3

It's important to note that the data from the questionnaire will only include results from the athletes involved in the study however only 9 showed up to complete the questionnaire. The remaining 4 did not attend due to being out of town for competition.

Based on the collected data the mean number of days the athletes worked out per week during COVID-19 was 3.11 days (Question 1). The average number of minutes each workout session lasted was 80 minutes (Question 2). The average number of minutes spent on each component of fitness (strength, cardiorespiratory, speed/ speed endurance, mobility/flexibility) training during a full week and number of sessions are as follows (Question 3). For strength training, the average number of minutes was 163.57 over an average of 2.7 sessions. The average number of minutes spent on cardiorespiratory training during a full week was 84.4 minutes over 2.66 sessions. The average number of minutes spent on speed/ speed endurance training during a full week was 136 minutes over an average of 1.77 sessions. The average number of minutes spent on mobility/flexibility training during a full week was 130 minutes over an average of 2.33 sessions.

Table 4. Question Overview 4-7

Subject ID Code	Question 4	Question 5	Question 6	Question 7
TR 101	3 sets	5-10 reps	Body weight	120 seconds
TR 107	4 sets	5-10 reps	Traditional weight	60 seconds
TR 111	1 set	1-3 reps	N/A	N/A

TR 115	4 sets	5-10 reps	Body weight/ and Traditional weight	Above 120 seconds
TR 123	5 sets	1-3 reps	Traditional weight	60 seconds
TR 124	1 set	1-3 reps	No training	No training
TR 129	3 sets	3-5 reps	Body weight/ and Traditional weight	60 seconds
TR202	3 sets	5-10 reps	Body weight	60 seconds
Mean	3.22			
SD	1.48			

*SD = standard deviation

Questions 4-7

The average number of sets completed during one exercise of strength training during COVID lockdown was 3.22 sets (Question 4). Two of the 34 athletes claimed they did not participate in any strength and resistance training. Three out of nine athletes 44.44% indicated that completed about 5-10 repetitions during one exercise of strength training (Question 5). Out of the nine athletes 33.33%indicated that they completed about one to three repetitions during one exercise of strength training. (Question 5). Only one athlete indicated that they completed about three to five repetitions during one exercise of strength training which is equivalent to 11.11% (Question 5). Question 6 asked the athletes whether they used traditional weight or bodyweight training for their strength and resistance training during COVID lockdown. Two athletes out of the nine indicated they did Bodyweight training which is equivalent to 22.22%.

Two athletes selected both bodyweight and traditional weight training which is equivalent to 22.22 % of the nine athletes (Question 6). Two athletes' chose traditional weight training which is equivalent to 22.22% of the athletes. Two athletes' chose Non applicable/ No training which is equivalent to 22.22% of the 34 athletes. Question 7 asked the athletes how much rest time they took between sets. Only one athlete athletes chose to take 120 seconds between sets which is equivalent to 11.11% of the nine athletes. Only one rested above 120 seconds between sets which is 11.11% out of the nine students. Two took about 60 seconds which is 22.22% of the athletes. No athletes took about 30 seconds of rest between sets out of nine athletes.

Table 5. Question Overview 8-10

TR code	Question 8	Question 9	Question 10
TR 101	Below 50%	Muscular Strength	Squats/ Lunges/ Pull-ups or Lat Pulldowns
TR 107	50-75%	Muscular Strength	Squats/ Lunges/ Deadlifts/ Olympic Lifts, Bench press, Push-ups/ Pull-ups, Lat Pulldowns/ Rows
TR 111	N/A	N/A	N/A
TR 115	50-75%	Muscular Power	Squats/ Lunges/ Deadlifts/ Bench Press, Push-ups/ Pull-ups, Lat Pulldowns/ Rows
TR 123	50-75%	Muscular Strength	Squats/ Lunges/ Bench Press/ Deadlifts/ Olympic Lifts/ Rows
TR 124	N/A	N/A	N/A
TR 129	50-75%	Muscular Power/ Muscular Strength/ Muscular Endurance	Squats/ Lunges/ Deadlifts/ Olympic Lifts, Bench press, Push-ups/ Pull-ups, Lat Pulldowns/ Rows
TR202	50-75%	Muscular Power	Squats/ Lunges/ Bench Press, Push-ups/ Pull-ups or Lat Pulldowns
TR 218	50-75%	Muscular Power	Squats/ Lunges/ Bench Press/ Pull-ups or Lat Pulldowns

Questions 8-10

For question eight we asked the athletes that if they used traditional weight training at what percentage of their one rep max did, they train at during COVID lockdown. One of the athletes reported training at below 50% which is approximately 11.11% of the nine athletes. Six out of the nine athletes reported they trained at 50-75% which is approximately 66.66% of the 34 athletes. No athletes trained at 75% out of the nine. 2 athletes chose nonapplicable (N/A) because they did not use traditional weight training which is 22.22% of the nine athletes. Question 9 asked the athletes what the primary focus of their resistance training was they had three options 1) Muscular Power, Explosiveness, Speed development (MP) 2) Muscular Strength (MS) 3) Muscular Endurance (ME). Three athletes focused primarily on MS which is approximately 33.33% of the nine athletes. Three athletes focused on MS which is approximately 33.33% of the nine athletes. No athletes focused on ME. One athlete focused on both MP, MS and, ME which is approximately 11.11% of the athletes. Question 10 displays the types of exercises they focused on during strength and training sessions.

Table 6. Question Overview 11-13

TR Code	Question 11	Question 12	Question 13
TR 101	Yes	5-8 competitions	2-4 competitions
TR 107	No	5-8 competitions	5-8 competitions
TR 111	No	2-4 competitions	2-4 competitions
TR 115	Yes	1-3 competitions	2-4 competitions
TR 123	No	N/A	5-8 competitions
TR 124	Yes	5-8 competitions	2-4 competitions
TR 129	No	5-8 competitions	2-4 competitions

TR202	Yes	5-8 competitions	2-4 competitions
TR 218	Yes	2-4 competitions	2-4 competitions

Questions 11-13

Question 11 asked if their training was directly related to their event. five of the athletes responded yes which is approximately 55.55% of the nine athletes. four athletes responded no which is approximately 44.44% of the nine athletes. Question 12 asked how many competitions they competed in the 2020 season. five athletes competed in five to eight competitions which are approximately 55.55% of the nine athletes. Two athletes competed in two to four competitions which are approximately 22.22% of the athletes. One athlete competed in one to three competitions which are approximately 11.11% of the athletes. No athletes competed in more than eight competitions of the nine athletes who completed the questionnaire. One athlete did not compete in any competitions in 2020 which is approximately 11.11% of the athletes. Question 13 asked the athlete how many competitions they competed in 2021. Seven athletes competed in two to four competitions which is approximately 77.77% of the athletes. Two athletes competed in five to eight competitions which is approximately 22.22% of the athletes. None of the nine athletes competed in one to three competitions in 2021.

CHAPTER 5 DISCUSSION

The current study aimed to fill these gaps and investigate how much improvement in sprint performance can be obtained from a detraining and retraining period in Division 1 track and field athletes. It was hypothesized that there will be an improvement in overall sprint performance and kinematic parameters in both legs from the 1st testing session (Pre) to the 2nd testing session (Post) 5 months after regular training was resumed. The findings of the present study indicated that after a 5-month hiatus of regular training the sprint performance of 13 Division 1 track and field athletes only showed a significant difference in the left stance phase from pre (-19% 0.119± 0.0159) to post (0.1± 0.03) testing. There were no significant changes in the other kinematic variables measured (overall speed, stride, left foot flight time, right foot flight time, overall flight time, left foot contact time, right foot contact time, overall contact time and, right stance phase). During any sprint the aim is to cover a specific horizontal distance as fast as possible or in the shortest amount of time. With high level athletes they have learned to allow their stance phase to be predetermined prior to the full extension of the leg joints which allows greater recovery during the swing phase (Mann, 1985). This derives for more power to move through the gait cycle faster. There is not much research as to why stance phase performance is different between the right limb and left limb. It was brought up by Ziyagaki (2010), that a potential explanation for this could be that if athletes are foot dominant either right or left it can have altering dissimilar performance kinematics. This could explain why their left stance time decreased between strides from pre and post testing but, not the right stance. Large strength imbalances or foot dominance can alter speed or physical performance unilaterally (Ziyagali et al., 2010; Mcgrath et al., 2016; Brown et al., 2017). In essence the predicted hypothesis was correct but, not to the extent that performance and, all kinematic parameters would be improved. Even with this sprint performance did not alter in a significant manner. This aligns with most literature for instance in a study by Neifer (1987) and Homarid (1989), in which sprint athletes were tested for their overall sprint performance followed by participating in a 4-week reduced training period. Afterwards their overall sprint performance was tested again and showed no major significant difference from pre to post testing.

A questionnaire was utilized in order to try to understand the training regimen the athletes were doing on a weekly basis during COVID-19 lockdown compared to a typical in season training regimen. As mentioned before there was not much insight from the coaches on specifics from the training program. We do know the athletes practiced 6 days a week typically 2 workout sessions a day. Based on the questionnaire we were able to determine the mean number of days the athletes worked out per week during COVID-19 was 3.11 days (Question 1). The average number of minutes each workout session lasted was 80 minutes (Question 2). The average number of minutes spent on each training component of fitness strength training (ST): 163.57 over an average of 2.7 sessions, cardiorespiratory (CD): 84.4 minutes over 2.66 sessions: speed/ speed endurance: 136 minutes over an average of 1.77 sessions, mobility/flexibility (MF): 130 minutes over an average of 2.33 sessions (Question 3). The average number of sets completed during one exercise of strength training during COVID lockdown was 3.22 sets (Question 4). Based on the questionnaire it can be said though there was no organized or systematic training, so training was based primarily on the will of the athletes. Intrinsic motivation is defined as performing an activity for pleasure and derived from participation (Vallerand, 1997). In line with various studies show that intrinsic motivation leads to more positive results than extrinsic motivation. Given that these university athletes are normally competing during this lockdown, they continued training at home using an unstructured training program. Literature has also shown that in order to maintain physiological and performance adaptions training intensity must be preserved (Van Handel 1988; Neufer 1989; Houmard 1991; Shepley 1992; Houmard & John 1994; Mujika 1998). Training volume can be altered/reduced within athletes and still maintain physical conditioning/ performance. The at-home self-training allowed them to not decrease performance on most parameters, and even increase according to our results in the left stance phase. Hence, the COVID-19 training cessation did not appear to affect these athletes to a great extent. According to Costill (1985) and, Cavanaugh & Musch (1989), training volume reductions can range from 60-90% of normal training regimens and still maintin physiological adaptions. Training frequency reduction should be moderate in order to maintain athletic conditioning and, should not exceed 20-30% compared to normal regiment (Neufer 1987; Houmard 1989; Neufer 1989; Houmard 1991; Houmard & Jones 1994; Mujika 1998; Mujika 2002). Study findings indicate significant difference in left stance phase which is entire time the left is in contact with the ground and the limb is bearing weight. As mentioned before no significant changes were seen in the main kinematic variables typically associated with sprint performance (total foot contact time, stride, step length).

Limitations of this study included not recording or monitoring individual training programs both during COVID-19 lockdown (March – September 2020), No specific monitoring of athlete’s nutritional program was during COVID-19 lockdown and after regular training resumed. The small sample size of athletes who were available to be tested for both Pre and Post testing could lead to skewed or unreliable conclusions. Testing reliability due to only having one testing session for both pre and post testing. Insight on the track athletes training program once regular training was resumed did not allow us to get a full spectrum of how training regimen changed from the initial pretesting to post testing. The study findings are specific to track and field athletes and therefore cannot be generalized to all collegiate athletes. Future research should desire to explore the full complexity and a detailed view of how a detrained athlete returns to proper physical conditioning.

It was hypothesized that there would be an improvement in overall sprint performance and kinematic parameters from the 1st testing session (Pre) to the 2nd testing session (Post) after 5 months of resumed regular training. The findings of the present study indicated that after a 5-month hiatus of regular training the sprint performance of 13 Division 1 track and field athletes only showed a significant difference in the left stance phase (-19% 0.119$\pm$ 0.0159) to post (0.1$\pm$ 0.03). In conclusion a prolonged detraining period caused by the outbreak of COVID-19 did not significantly impact sprint performance however, based on these findings it showed that high level athletes tend to hold onto physiological performance adaptions even during an unplanned detraining period such as the one caused by COVID-19 in 2020.

Practical Applications

Detraining is going to be a part of the normal training cycle for any athlete in order to prevent injury and allows a mental break from competition. The overall goal of coaches and trainers during this detraining (off-season) period is to maintain as many physiological/performance adaptions that had been gained. The results of this study might give some insight as to how detraining affects high-performance track and field athletes. This study could also offer some relief on the part of the coaching/trainers if an unplanned detraining period were to happen again since there was not much effect on sprint performance after a long unplanned detraining period. Based on the results of this study coaches might be encouraged to alter their philosophy on detraining periods and may incorporate them more into a training cycle since the penalty seems to be minimal when dealing with high performance track and field athletes.

REFERENCES

ACSM Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults. *Med. Sci. Sports Exerc.* 30:975– 991.

Ae M, Ito A, Suzuki M. (1992). The men's 100 meters. Scientific Research Project at the III World Championship in Athletics, Tokyo 1991. *New Studies in Athletics*; 7:47–52.

Ammar, A., Brach, M., Trabelsi, K., Chtourou, H., Boukhris, O., Masmoudi, L., et al. (2020). On behalf of the ECLB-COVID19 consortium. Effects of COVID-19 home confinement on eating behavior and physical activity: results of the ECLB-COVID19 international online survey. *Nutrients* 12:1583.

Anderson T and Cattanach D. Effects of three different rest periods on expression of developed strength. Journal of Strength & Conditioning Research 7: 185, 1993.

Arata A. (1999). Kinematic and kinetic evaluations of high speed backward running. *[Dissertation]: University of Oregon*. 2000; 81.

Bangsbo J., Nørregaard L., Thosøe F. (1991). Activity profile of competition soccer. *Canadian Journal of Sport Sciences* 16, 110-116.

Baughman, M, Takaha, M, and Tellez, T. (1984). Sprint training. *NSCA J* 6: 34–36.

Behm DG. (1995). Neuromuscular implications and applications of resistance training. *J Strength Cond Res*. 9(4):264-274.

Bezodis, I. N., Kerwin, D. G., & Salo, A. I. (2008). Lower-limb mechanics during the support phase of maximum-velocity sprint running. *Medicine and science in sports and exercise*, *40*(4), 707-715.

Blazevich, J. Optimizing hip musculature for greater sprint running speed. Strength Cond J 22(2): 22–27, 2000

Bosch F and Klomp R. (2005). Running: Biomechanics and Exercise Physiology in Practice. London, United Kingdom*: Elsevier Churchill Livingstone*, pp. 147–150.

Bosquet, L.; Mujika, I. Detraining. In *Endurance training: Science and Practice*; Iñigo Mujika, S.L.U., Ed.; Iñigo Mujika: Vitoria-Gasteiz, Spain, 2012; pp. 99–106.

Bret C, Rahmani A, Dufour AB, Messonnier L, Lacour JR. (2002) Leg strength and stiffness. ability factors in 100 m sprint running. *J Sports Med Phys Fitness*.. 42:274-281.

Brown, S. R., Feldman, E. R., Cross, M. R., et al. (2017). The potential for a targeted strength training programme to decrease asymmetry and increase performance: a proof-of-concept in sprinting. Int J Sports Physiol Perform

Brüggemann GP, Koszewski D, Müller H. (1997). Biomechanical Research Project Athens 1997, Final report. *Meyer & Meyer Sport; Oxford:* pp. 12–41

Buckworth J. and Wallace L. S. (2002). Application of the transtheoretical model to physically active adults. Journal of Sports Medicine and Physical Fitness; 42(3), 360-7.

Bunn JW. (1972). Scientific Principles of Coaching. Englewood Cliffs, NJ: *Prentice Hall*. 95.

Calfas K. J., Sallis J. F., Lovato C. Y. and Campbell J. (1994). Physical activity and its determinants before and after college graduation. Medicine, Exercise. Nutrition, and Health; 323–334.

Cardinal, B.J. (1998) 'Interaction between Stage of Exercise and History of Relapse' , Journal of Human Movement Studies 34: 175-185 .

Carroll TJ, Riek S, Carson RG. (2001). Neural adaptations to resistance training. Implications for movement control. *Sports Med*. 31(12): 829-840.

Cavagna GA, Legramandi MA, La Torre A. (2012). An analysis of the rebound of the body in backward human running. *J Exp Biol.*75-84.

Cavanaugh, D.J. & Musch, K.I. (1989) Arm and leg power of elite swimmers increase after taper as measured by biokinetic variable resistance machines. *Journal of Swimming Research* **5**, 7–10

Choi, C., & Bum, C. H. (2020). Changes in the Type of Sports Activity Due to COVID-19: Hypochondriasis and the Intention of Continuous Participation in Sports. *International journal of environmental research and public health*, *17*(13), 4871

Cissik JM. (2004). Means and methods of speed training, part I. *Strength Cond J.*; 26(4): 24–9.

Coh, M., Babic, V., & Maćkała, K. (2010). Biomechanical, Neuro-muscular and Methodical Aspects of Running Speed Development. *Journal of Human Kinetics*, *26*(1), 73–81.

Costill, D.L., Fink, W.J., Hargreaves, M., King, D.S., Thomas, R. & Fielding, R. (1985) Metabolic character- istics of skeletal muscle during detraining from com- petitive simming. *Medicine and Science in Sports and Exercise* **17**, 339–343

Coyle EF, Martin III WH, Sinacore DR, et al. Time course of loss of adaptations after stopping prolonged intense endurance training. *J Appl Physiol 1984*; 57 (6): 1857-64

Deci, E., and Ryan, R. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. Psychological Inquiry; 11(4), 227–268.

Delecluse, C. (1997). Influence of strength training on sprint running performance. *Sports Medicine,* 24, 148 156.

Deutsch M. U., Maw G. D., Jenkins D. J., Reaburn P. R. J. (1998) Heart rate, blood lactate and kinematic data of elite colts (under-19) rugby union players during competition. *Journal of Sports Sciences* 16, 561-570

DeVita P, Stribling J. (1991). Lower extremity joint kinetics and energetics during backward running. *Med Sci Sports Exerc.* 602-10

Egbuonu M, Cavanagh P, and Miller T. (1990). 100 degradation of running economy through changes in running mechanics. *Med Sci Sports Exerc* 22: S17.

Embling S. (1984) The sprint start. *Mod Athl Coach* 22: 30–31.

Ferro A, Rivera A, Pagola I. (2001). Biomechanical analysis of the 7thIAAF World Championships in Athletics – Seville 1999. *New Studies in Athletics*.;(1,2): 25–60.

Fleck SJ, Kraemer WJ. (1988). Resistance training: basic principles part 1. *Phys Sportsmed*; 16: 160-71.

Fleck SJ. Detraining: its effects on endurance and strength. *Strength Cond 1994*; 16 (1): 22-8

Fletcher, G.F., G. Balady, V.F. Froelicher, L.H. Hartley, W.L. Has-kell, AND M.L. Pollock. Exercise Standards. (1995). A statement for health- care professionals from the American Heart Association Writing Group. *Circulation* 91:580–615. .

Fletcher, I. (2009). Biomechanical aspects of sprint running. *UK Strength and Conditioning Association,* 16(16), 20-23.

Flynn TW, Soutas-Little RW. (1993). Mechanical power and muscle action during forward and backward running. J Orthop Sports Phys Ther.108-12.

Flynn TW, Soutas-Little RW. (1995) Patellofemoral joint compressive forces in forward and backward running. *J Orthop Sports Phys Ther*.277-82.

Fringer MN, Stull GA. Changes in cardiorespiratory parameters during periods of training and detraining in young adult females. Med Sci Sports 1974; 6 (1): 20-5

Ghosh AK, Paliwal R, Sam MJ, et al. Effect of 4 weeks detraining on aerobic and anaerobic capacity of basketball players and their restoration. *Indian J Med Res 1987*; 86: 522-7

Häkkinen K. (1989). Neuromuscular and hormonal adaptations during strength and power training. *J Sports Med Phys Fitness*. 29:9-26.

Halabchi, F.; Ahmadinejad, Z.; Selk-Ghaffari, M. COVID-19 Epidemic: Exercise or Not to Exercise; That is the Question! *Asian J. Sports Med.* 2020, *11*.

Hass CJ, Feigenbaum MS, Franklin BA. (2001). Prescription of resistance training for healthy populations. *Sports Med.* 31: 953-64.

Hawley J, Burke L. Peak performance: training and nutritional strategies for sport. *St Leonards: Allen & Unwin,* 1998.

Hay, J. (2002). Cycle rate, length, and speed of progression in human locomotion. *J. Appl. Biomech*. 18:257-270.

HennessyL, KiltyJ. Relations hip of the stretch-shortening cycle to sprint performance in trained female athletes. *J Strength Cond Res*. 2001;15(3):326-331

Herrero, JA, Izquierdo, M, Maffiuletti, NA, and Garc´ıa Lo´pez, J. Electromyostimulation and plyometric training effects on jumping and sprint time. *Int J Sports Med* 27: 533–539, 2006.

Hinrichs RN, Cavanagh PR, and Williams KR. (1972). Upper extremity function in running. I: Center of mass and propulsion considerations. *Int J Sport Biomech 3*: 222–241.

Hodikin AV. Maintaining the training effect during work stop page. *Teoriya i Praktika Fiziocheskoi Kultury 1982*; 3: 45-8.

Hoogkamer W, Meyns P, Duysens J. (2014). Steps forward in understanding backward gait: from basic circuits to rehabilitation. *Exerc Sports Sci Rev*. Jan;42(1):23-9.

Hopper B. (1964). The mechanics of arm action in running. *Track Tech* 17: 520–522.

Hortobágyi T, Houmard JA, Stevenson JR, et al. The effects of detraining on power athletes. Medicine and Science in Sports and Exercise. 1993 Aug;25(8):929-935.

Houmard JA, Hortobágyi T, Johns RA, et al. Effect of short- term training cessation on performance measures in distance runners. *Int J Sports Med 1992*; 13 (8): 572-6

Houmard, J.A. (1991) Impact of reduced training on performance in endurance athletes. *Sports Medicine 12*, 380–393.

Houmard, J.A., Kirwan, J.P., Flynn, M.G. & Mitchell, J.B. (1989) Effects of reduced training on submaximal and maximal running responses. *International Journal of Sports Medicine* 10, 30–33.

Houmard, J.A., Scott, B.K., Justice, C.L. & Chenier, T.C. (1994) The effects of taper on performance in distance runners. *Medicine and Science in Sports and Exercise* 26, ; 624–631.

Houston ME, Bentzen H, Larsen H. Interrelationships between skeletal muscle adaptations and performance as studied by detraining and retraining. *Acta Physiol Scand 1979*; 105: 163-70.

Hunter, J. P., Marshall, R. N., & McNair, P. J. (2004). Interaction of step length and step rate during sprint running. *Medicine & Science in Sports & Exercise*, 36(2), 261-271.

Ito, A., Ishikawa, M., Isolehto, J., & Komi, P. V. (2006). Changes in the step width, step length, and step frequency of the world's top sprinters during the 100 meters. *New Studies in Athletics*, *21*(3), 35.

Izquierdo M, Ibañez J, González-Badillo JJ, Ratamess NA, Kraemer WJ, et al. (2007) Detraining and tapering effects on hormonal responses and strength performance. *J Strength Cond Res 21: 768–75*

Jaskolska A, Goossens P, Veenstra B, Jaskolski A, Skinner JS (1999). Treadmill measurement of the force-velocity relationship and power output in subjects with different maximal running velocities. *Sports Med Train Rehab*, 1999b: 8: 347–358.

Jukic I, Calleja-González J., Cos F., Cuzzolin F., Olmo J., Terrados N., Njaradi N., Sassi R., Requena B., Milanovic L., Krakan I., Chatzichristos K., and Alcaraz E. P. (2020). Strategies and Solutions for Team Sports Athletes in Isolation due to COVID-19. Sports; 8, 56.

Kirkpatrick J, Comfort P. Strength, power, and speed qualities in English junior elite Rugby league players. J Strength Cond Res 27: 2414–2419, 2012.

Klausen K, Andersen LB, Pelle I. Adaptive changes in work capacity, skeletal muscle capillarization and enzyme levels during training and detraining. *Acta Physiol Scand* 1981; 113: 9-16

Kraemer, W.J., K. Adams, E. Caferelli, G.A. Dudley, C. Dooly, M.S. Feigebaum, S.J. Fleck, B. Franklin, A.C. Fry, J.R. Hoffman, R.U. Newton, J. Potteiger, M.H. Stone, N.A. Ratamess, T. Tripplet- Mcbride, AND American College of Sports Medicine American College of Sports Medicine position stand. (2002). Progression models in resistance training for healthy adults. *Med. Sci. Sports Exerc.* 34:364–380.

Kraemer, WJ, Ratamess, NA, Volek, JS, Mazzetti, SA, and Go´mez, AL. The effects of the Meridian shoe on vertical jump and sprint performances following short-term combined plyometric/sprint and resistance training. J Strength Cond Res 14: 228–238, 2000.

Kugler F and Janshen L. (2010). Body position determines propulsive forces in accelerated running.

Lacour JR, Denis C. Detraining effects on aerobic capacity. *Med Sport Sci 1984*; 17: 230-7

Lindstedt SL, LaStayo PC, Reich TE. (2001). When active muscles lengthen: properties and consequences of eccentric actions. *News Physiol Sci.*16:256-61

Lockie RG, Murphy AJ, and Spinks CD (2003). Effects of resisted sled towing on sprint kinematics in field-sport athletes. *J Strength Cond Res* 17: 760–767.

Luhtanen, P., and P. V. Komi. (1977). Mechanical factors influencing running speed. In Biomechanics VI-B, P. V. Komi (Ed*.). Baltimore: University Park Press*. pp. 23-29.

Luhtanen, P., and P. V. Komi.(1977). Mechanical factors influencing running speed. In Biomechanics VI-B, P. V. Komi (Ed.). *Baltimore: University Park Press*, pp. 23-29.

Mann R and Herman J. (1985). Kinematic analysis of Olympic sprint performance: Men's 200 meters. *J Sport Biomech* 1: 151–162,

Mann R. (1981). A kinetic analysis of sprinting. *Med Sci Sports Exerc* 13: 325–328.

Martin III WH, Coyle EF, Bloomfield SA, et al. Effects of physical deconditioning after intense endurance training on left ventricular dimensions and stroke volume. *J Am Coll Cardiol 1986;* 7 (5): 982-9.

McBride JM, Blow D, Kirby TJ, Haines TL, Dayne AM, Triplett NT. Relationship between maximal squat strength and five, ten, and forty yard sprint times. J Strength Cond Res 23: 1633–1636, 2009.

McGrath, T. M., Waddington, G., & Scarvell, J. M., et al. (2016). The effect of limb dominance on lower limb functional performance—a systematic review. J Sports Sci. 34(4), 289–302.

McNaughton JM and Kelly VG. (2010) The effect of weighted sleeves on sprint performance. *J Aust Strength Cond* 18: 14–19.

Meir R, Newton R, Curtis E, Fardell M, Butler B. Physical fitness qualities of professional rugby league football players: Determination of positional differences. J Strength Cond Res 15: 450–458, 2001

Meir R., Colla P., Milligan C. (2001) Impact of the 10-metre rule change on professional rugby league: implications for training. *Strength and Conditioning Journal* 23, 42-46

Mohr M, Krustrup P, Bangsbo J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. *J Sports Sci*.;21:519-28.

Mon-López, D., de la Rubia Riaza, A., Galán, M. H., and Roman, I. R. (2020). The impact of COVID-19 and the effect of psychological factors on training conditions of handball players. *Int. J. Environ. Res. Public Health*. 17:6471.

Moore RL, Thacker EM, Kelley GA, et al. Effect of training/de- training on submaximal exercise responses in humans. *J Appl Physiol 1987*; 63 (5): 1719-24

Morin JB, Bourdin M, Edouard P, Peyrot N, Samozino P, Lacour JR (2012). Mechanical determinants of 100-m sprint running performance. *Eur J Appl Physiol* 2012: 112: 3921–3930.

Morin JB, Edouard P, Samozino P (2011). Technical ability of force application as a determinant factor of sprint performance. *Med Sci Sports Exerc* 2011a: 43: 1680–1688.

Morin, J. B., and Samozino, P. (2016). Interpreting power-force-velocity profiles for individualized and specific training. *Int. J. Sports Physiol. Perform.* 11, 267–272.

Morin, J. B., Bourdin, M., Edouard, P., Peyrot, N., Samozino, P., & Lacour, J. R. (2012). Mechanical determinants of 100-m sprint running performance. *European journal of applied physiology*, *112*(11), 3921-3930.

Morin, J. B., Edouard, P., & Samozino, P. (2011). Technical ability of force application as a determinant factor of sprint performance. *Medicine and science in sports and exercise*, *43*(9), 1680-1688.

Mujika I, Padilla S (2000a) Detraining: loss of training-induced physiological and performance adaptations. Part I: short term insufficient training stimulus. *Sports Med 30: 79–87*.

Mujika I, Padilla S (2000b) Detraining: loss of training-induced physiological and performance adaptations. Part II: Long term insufficient training stimulus. *Sports Med 30: 145–54.*

Mujika, I. (1998) The influence of training character- istics and tapering on the adaptation in highly trained individuals: a review. *International Journal of Sports Medicine* **19**, 439–446.

Neufer PD. The effect of detraining and reduced training on the physiological adaptations to aerobic exercise training. *Sports Med* 1989; 8 (5): 302-21

Neufer, P.D., Costill, D.L., Fielding, R.A., Flynn, M.G. & Kirwan, J.P . (1987) Effect of reduced training on muscular strength and endurance in competitive swimmers. *Medicine and Science in Sports and Exercise* 19, 486 – 490.

Neufer, P.D.; Costill, D.L.; Fielding, R.A.; Flynn, M.G.; Kirwan, J.P. Effect of reduced training on muscular strength and endurance in competitive swimmers. *Med. Sci. Sports Exerc.* **1987**, *19*, 486–490.

Nummela, A., Keränen, T., & Mikkelsson, L. O. (2007). Factors related to top running speed and economy. *International journal of sports medicine*, *28*(08), 655-661.

Petlichkoff, L. M. (1996). The drop-out dilemma in youth sports. In O. Bar-Or (Ed.), The child and adolescent athlete. Encyclopedia of sports medicine; 6, 418-430

Petrakos, G., Morin, J.-B., & Egan, B. (2015). Resisted Sled Sprint Training to Improve Sprint Performance: A Systematic Review. *Sports Medicine*, *46*(3), 381–400.

Pollock, M.L., B.A. Franklin, G.J. Balady, B.L. Chaitman, J.L. Fleg, B. Fletcher, M. Limacher I.L. Pina, R.A. Stein, M. Willaims, AND T. Bazzare AHA Science Advisory. (2000). Resistance exercise in individuals with and without cardiovascular disease: Benefits, rationale, safety, and prescription: An advisory from the Committee on Exercise, Rehabilitation, and Prevention, Council on Clinical Cardiology, American Heart Association; Position paper endorsed by the *American College of Sports Medicine*. *Circulation* 101:828–833.

Posture. Jul;42(2):172-7.

Pritchard HJ, Tod DA, Barnes MJ, Keogh JW, and McGuigan MR. Tapering practices of New Zealand's elite raw powerlifters. Journal of Strength & Conditioning Research 30: 1796-1804, 2016.

Ratamess, NA, Kraemer, WJ, Volek, JS, French, DN, Rubin, MR, Gomez, AL, Newton, RU, and Maresh, CM. The effects of ten weeks of resistance and combined plyometric/sprint training with the Meridian Elyte athletic shoe on muscular performance in women. J Strength Cond Res 21: 882–887, 2007.

Ratamess, NA, Kraemer, WJ, Volek, JS, French, DN, Rubin, MR, Gomez, AL, Newton, RU, and Maresh, CM. The effects of ten weeks of resistance and combined plyometric/sprint training with the Meridian Elyte athletic shoe on muscular performance in women. J Strength Cond Res 21: 882–887, 2007.

Ratamess, NA, Kraemer, WJ, Volek, JS, French, DN, Rubin, MR, Gomez, AL, Newton, RU, and Maresh, CM. The effects of ten weeks of resistance and combined plyometric/sprint training with the Meridian Elyte athletic shoe on muscular performance in women. J Strength Cond Res 21: 882–887, 2007.

Rimmer, E., & Sleivert, G. (2000). Effects of a Plyometrics Intervention Program on Sprint Performance. *The Journal of Strength and Conditioning Research*, *14*(3), 295.

Ropret, R., Kukolj, M., Ugarkovic, D., Matavulj, D., & Jaric, S. (1998). Effects of arm and leg loading on sprint performance. *European Journal of Applied Physiology*, *77*(6), 547–550.

Ross A, Leveritt, Riek S. (2001) Neural influences on sprint running—training adaptations and acute responses. *Sports Med*. 31,6:409-425.

Rupp, S and Kuppig, R. Muscle flexibility and injury rates in soccer: Prospective study over one season. *Geriatr J Sports Med 46: 127–131*, 1995.

Ryan RM, Deci EL. Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemp Educ Psychol*. 2000: 25: 54-67.

Sale DG. (1987). Influence of exercise and training on motor unit activation. In: Pandolf KB, ed. *Exerc Sport Sci Rev*.15:95-151.

Samozino, P., Rejc, E., Di Prampero, P. E., Belli, A., and Morin, J.-B. (2012). Optimal force-velocity profile in ballistic movements–altius: citius or fortius? *Med. Sci. Sports Exerc.* 44, 313–322

Sayers M. (2000). Running techniques for field sport players. Sports Coach 23: 26–27.

Schnier B. (1982). Sprints and hurdles/film analysis. *Track Field Quar Rev* 82: 36–38. *Sci Sports Exerc*. 1995;27(8):1203-1209

Shaver LG. Cross-transfer effects of conditioning and deconditioning on muscular strength. Ergonomics 1975; 18 (1): 9-16

Shepley, B., MacDougall, J.D., Cipriano, N., Sutton, J.R., Tarnopolsky, M.A. & Coates, G. (1992) Physiological effects of tapering in highly trained athletes. *Journal of Applied Physiology* **72**, 706–711.

Slawinski J, Bonnefoy A, Ontanon G, Leveque J-M, Miller C, Riquet A, Cheze L, and Dumas R. (2010). Segment-interaction in sprint start: Analysis of 3D angular velocity and kinetic energy in elite sprinters. *J Biomech 43*: 1494–1502.

Sterzing T, Frommhold C, Rosenbaum D. (2016). In-shoe plantar pressure distribution and lower extremity muscle activity patterns of backward compared to forward running on a treadmill. *Gait Posture*.135-41. .

Sysler BL, Stull GA. Muscular endurance retention as a function of length of detraining. *Res Q 1970; 41 (1)*: 105-9

takeoff, a less efficient rebound. *Proc Biol Sci.*339-46. *University of Oregon*.
takeoff, a less efficient rebound. *Proc Biol Sci.*339-46. *University of Oregon*.
Terzis, G, Stratakos, G, Manta, P, and Georgiadis, G. Throwing performance after resistance training and detraining. J Strength Cond Res 22: 1198–204, 2008.

Tison, G. H., Avram, R., Kuhar, P., Abreau, S., Marcus, G. M., Pletcher, M. J., et al. (2020). Worldwide effect of COVID-19 on physical activity: a descriptive study. *Ann. Intern. Med.* 173, 767–770

USDHHS. Physical Activity and Health: A Report of the Surgeon Gen- eral. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996

Uthoff, A., Oliver, J., Cronin, J., Harrison, C., & Winwood, P. (2018). A New Direction to Athletic Performance: Understanding the Acute and Longitudinal Responses to Backward Running. *Sports Medicine*, *48*(5), 1083–1096.

Vallerand, R. J. (1997). Toward a hierarchical model of intrinsic and extrinsic motivation. In M. P. Zanna (Ed.), Advances in experimental social psychology (pp. 271e360). New York: Academic Press.

Van Handel, P.J., Katz, A., Troup, J.P., Daniels, J.T. & Bradley, P.W. (1988) Oxygen consumption and blood lactic acid response to training and taper. In: *Swimming Science V* (Ungerechts, B.E., Wilke, K. & Reischle, K.eds). Human Kinetics, Champaign, IL: 269–275.

Weiss LW, Coney HD, and Clark FC. Optimal post-training abstinence for maximal strength expression. Research in Sports Medicine 11: 145-155, 2003.

Weyand PG, Sandell RF, Prime DN, Bundle MW. (2010). The biological limits to running 48 speed are imposed from the ground up. *J Appl Physiology*. 950-61.

Weyand, P. G., Sternlight, D. B., Bellizzi, M. J., & Wright, S. (2000). Faster top running speeds are achieved with greater ground forces not more rapid leg movements. *Journal of Applied Physiology*, *89*(5),

Woods, J., Hutchinson, N., Powers, S., Roberts, W., Gomez-Cabrera, M. C., Zsolt Radak, Z., et al. (2020). The COVID-19 pandemic and physical activity. *Sports Med. Health Sci.* 2, 55–64.

World Health Organization [WHO]. Basic Protective Measures Against the New Coronavirus. 2020.

Young W, McLean B, Ardagna J.(2006). Relationship between strength qualities ands printing. *International Journal of Sports Physiology and Performance,* 2006; 1:74-83.

Ziyagil, M. A., Gursoy, R., Dane, S., & Yuksel, R. (2010). Left-handed wrestlers are more successful. Perceptual and Motor Skills, 111, 65-70

Zois, J., Bishop, D., & Aughey, R. (2015). High-Intensity Warm-Ups: Effects During Subsequent Intermittent Exercise. *International Journal of Sports Physiology and Performance*, *10*(4), 498–503.

APPENDIX

Institutional Review Board

Office of the Vice President for Research and Sponsored Projects The University of Texas at El Paso IRB FWA No: 00001224 El Paso, Texas 79968-0587

P: 915-747-7693 E: irb.orsp@utep.edu

Date:

To:

From:

Study Title:

IRB Reference #:

Submission Type: Action:

Review Type:

Approval Date: Expiration Date:

November 21, 2019

Joshua Del Rio

University of Texas at El Paso IRB

[1488058-1] Arm Swing Mechanic and Its Role on Sprint Performance

College of Health Sciences - Kinesiology

New Project APPROVED

Expedited Review

November 21, 2019 November 20, 2021

The University of Texas at El Paso IRB has approved your submission. This approval is based on the appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This study has received Expedited Review based on the applicable federal regulation.

Based on the risks, this project requires Continuing Review by this office on an annual basis. Please use the appropriate renewal forms for this procedure. The renewal request application must be submitted, reviewed and approved, before the expiration date.

This approval does not replace any departmental or other approvals that may be required. Other institutional clearances and approvals may be required. Accordingly, the project should not begin until all required approvals have been obtained.

Please note that you must conduct your study exactly as it was approved by the IRB. Any revision to previously approved materials must be approved by this office prior to initiation, except when necessary, to eliminate apparent immediate hazards to the subject.

All serious and unexpected adverse events must be reported to this office. Please use the appropriate adverse event forms for this procedure. All FDA and sponsor reporting requirements should also be followed.

Please report all Non-Compliance issues or Complaints regarding this study to this office.

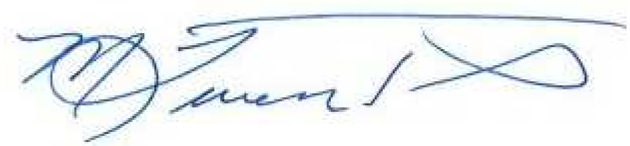
Remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Upon completion of the research study, a Closure Report must be submitted the IRB office. You should retain a copy of this letter and any associated approved study documents for your records.

All research records must be retained for a minimum of three years after termination of the project. The IRB may review or audit your project at random or for cause. In accordance with federal regulation (45CFR46.113), the board may suspend or terminate your project if your project has not been conducted as approved or if other difficulties are detected.

If you have any questions, please contact the IRB Office at irb.orsp@utep.edu or Christina Ramirez at (915) 747-7693 or by email at cramirez22@utep.edu. Please include your study title and reference number in all correspondence with this office.

Sincerely,



Dr. Lorraine Torres, Ed.D, MT(ASCP) IRB Chair

CURRICULUM VITA

Joshua Del Rio was in El Paso, Texas on June 7, 1995. They attented elementary schools in El Paso, Texas and graduated from Montwood High School with honors in May 2013. The following August they began attending the University of Texas at El Paso and May 2017 received the degree of Bachelor of Science in Kinesiology. In August of 2017 they began the masters program of the Bachelors of Science in Kinesiology at the University of Texas at El Paso. They received their masters degree in May 2021.