

**TITLE**

The effect of weight and ballistic training on speed, agility, vertical jump height and skill performance in soccer players.

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**The effect of weight and ballistic training on speed, agility, vertical jump height and skill performance in soccer players.**

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## ABSTRACT

The aim of the study was to investigate the effects of two strength training methods, weight training (WT) and ballistic training (BT) on speed, agility, vertical jump height and passing skill. Furthermore, examining the possibility of having a dual beneficial effect on physical and technical abilities. Twenty amateur male outfield players all forming part of the same team were recruited and randomly split into two equal groups, WT and BT (age:  $23 \pm 5.95$  years, height:  $177.00 \pm 7.00$  cm, weight:  $75.19 \pm 8.40$  kg, BMI:  $23.93 \pm 1.78$  kg/m<sup>2</sup>). Participants were included in the study if they had been training regularly for at least three years and had no musculoskeletal or orthopaedic injuries that kept them out of training for a minimum of one month in during the season 2016/17. Each group performed two strength sessions per week for a total of eight weeks within their respective groups. WT group performed a strengthening program in the gym, whilst the BT group performed ballistic exercises on the soccer field. All players trained equally during the rest of the week. A negative effect was observed in passing ability of the WT group (LSPT pre: 58.44s, post: 77.06s,  $p = 0.023$ ). The BT group showed positive improvements in technical ability (LSPT pre: 64.66s, post: 58.84s,  $p = 0.164$ ). All other tested parameters showed improvements, however these were not statistically significant ( $p = \geq 0.05$ ). The results of this study support similar findings that heavy weight strength training will improve sprint, agility and vertical jump performance. In contrast though, passing skill ability deteriorated when performing solely weight training in the gym. Therefore, in order to obtain a dual beneficial effect through specificity of training, ballistic exercises involving passing drills should be advocated to develop physical and technical capabilities concurrently.

**Key words:** Strength training; ballistic training; speed, agility, vertical jump, LSPT

## CHAPTER 1

### INTRODUCTION

Soccer is described as an intermittent sport, which is characterised by bouts of high intensity actions. These high intensity actions are usually the most critical and game changing moments that can determine the outcome of a game (3). Match analysis shows that sprinting occurs every 90 seconds (3,8,36), equivalent to 3% of the total game time and 1 – 11% (3,36,40) of the total distance covered in a ninety-minute match. Following further in depth analysis of the sprints performed during a match, authors noted that 96% are shorter than 30m and 49% being 10m or shorter (41), highlighting the importance of acceleration and power generated in the initial steps. The importance of other explosive movements such as heading and tackling, kicking and change of direction have also been well documented (2,3,41) thus emphasising the importance of strength and power in the lower limbs (38) and the need for soccer players to be more athletic. Therefore speed, agility and vertical jump height are all very important physical attributes that need to be addressed when designing training programs, together with other technical skills such as passing.

Resistance training mechanisms to increase maximal strength and subsequent performance is well researched (8,21,38,). Improvements in 1 repetition maximum (1RM) following heavy strength training regimes have also resulted in subsequent increases in vertical jump height, and improvements in 10m and 20m sprint times (38). Likewise, improvements in lower limb strength following a gym based strength training program has been strongly correlated (27,44) to improvements in sprint times over distances shorter than 30m (41). This has been attributed to athletes being able to impart higher ground reaction forces and impulse following strength training programs (11). Similarly, weight training increased back squat strength up to 17.7% (10) and decreased sprint times and increased jump heights (7,10). Moreover, a combined training protocol

of weight training and plyometric drills, resulted in improvements in half squat strength and subsequent decreased sprint times (38). Thus, weight training programs aimed at increasing lower limb strength, resulting in better physical qualities is a widely-used method of training (7,18,40,41).

Another method commonly used for improving dynamic muscular performance in soccer is the use of plyometric and ballistic type drills. This form of strength training enhances the force generated by the muscle through the use of the stretch shortening cycle (SSC) (4,5). During the eccentric loading phase, energy is stored in the muscles elastic component, which is then used to enhance the subsequent concentric contraction, provided this is performed rapidly (46). During a ballistic contraction, the aim is to perform a movement with maximal velocity and thus the mass moved is accelerated throughout the movement pattern (30). Ballistic exercises generally involve either a jumping action or a throwing action, hence removing any braking phases involved in more common resistance training methods (23). Athletes training using ballistic movements move through a wider range of motion when compared to non-ballistic type movements. This also allows the athletes to produce greater velocity and generate higher power outputs when performing ballistic and plyometric movements such as jumps, bounds or throws (30). Numerous studies have outlined the benefits of these training methods such as, improved running economy through enhanced muscular efficiency (5) and increases in maximal strength (14,16,22). Improvements in vertical jump height (6,21,27,35,43) and sprint and agility times (13,35,38,41,42) have also been observed and well documented.

The overall aim for winning any soccer match is to score more goals than the opponent. This requires high levels of skill such as passing, heading and shooting, and therefore coaches assign ample time to train these technical abilities (3). However, match analysis indicates that many goals are scored towards the end of the game (37), and this may be due to both physical and mental tiredness that can result in unforced errors, gifting the opponents a goal scoring opportunity. This

has led to debate as to what should be the major focus of training and how to collectively improve both physical and technical capabilities concurrently. Since soccer requires a high degree of technical ability, strength and conditioning coaches trying to find methods of improving both physical and technical capabilities concurrently through sport specific training. Preparatory phases in the pre-season are generally characterised by high volume and low intensity conditioning sessions since there are no competitive games during this period. However, during the competitive phase, time is limited due to games, recovery sessions and days off from training, therefore the need to choose exercises that can have a dual beneficial effect on technical and conditioning capacities becomes paramount. One of the most frequently used methods to improve both physical and technico-tactical capabilities is the use of small-sided games (SSG). Although SSG simultaneously stimulate many factors associated with improvements in performance (2), SSG do not target individual specific strength or technical deficits. Therefore, there is still a need for individualised strength exercises and technical drills that can target specific player limitations. This notion was supported by Christou et al. (9) who suggested further research into the use of different resistance training methods incorporated with soccer training. Finding a training protocol that can have a concurrent dual benefit on both physical and technical abilities of soccer players would be extremely useful in reducing time spent away from the training grounds. The aim of the study was therefore to examine the effects of a weight training program performed in the gym and a ballistic program performed on the training field on vertical jump, sprint and agility times and the subsequent effect on the players passing ability. The hypothesis being that both groups would improve sprint and agility times and vertical jump height, however the ballistic training group would also improve their passing skill to a larger extent than the weight training group.

## CHAPTER 2

### METHODS

#### *Experimental Approach to the Problem*

A team, consisting of twenty soccer players participating in the second division of the Malta Football Association (MFA) league were recruited and divided randomly and equally into two training groups. The subjects included 8 defensive players, 8 midfield players and 4 offensive players. Goalkeepers were excluded from the study, together with any players under the age of 18. Inclusion criteria for eligibility into the study included (i) no history of musculoskeletal or orthopaedic injuries that limited training for over 1 month, (ii) must have been training regularly for at least three years and (iii) must have been registered with the team from the beginning of the competitive season 2016/17. One group followed a weight training program consisting of exercises performed in a gym, whilst the other group followed a ballistic training program which was performed on the training field. Each group had bi-weekly strength-training sessions on the same day, however technical and tactical training was the same for both groups, thus the only difference was the type of strength training program. All subjects were tested on speed, agility and vertical jump tests, together with the Loughborough Skills Passing Test (LSPT) pre-and post-intervention.

#### *Subjects*

Twenty amateur male players forming part of the same senior soccer team were recruited to participate in the study. The weight training (WT) group ( $n = 10$ ) performed exercises in the gym whilst the ballistic training (BT) group ( $n = 10$ ) performed exercises on the soccer pitch. Both groups participated in the same soccer technical and tactical training sessions with the coach during

the rest of the weekly training schedule. The weekly training schedule included six training sessions (each lasting between 60 – 120 minutes) totaling 500 minutes of training per week, and a competitive game at the weekend. All players met the inclusion criteria established before the commencement of the study. Participant’s anthropometric and descriptive data is presented in Table 1.

**Table 1.** Anthropometric data of the participants ( $n = 20$ )

<b>Variable</b>	<b>Mean <math>\pm</math> SD</b>
Age (years)	23 $\pm$ 5.95
Height (cm)	177.00 $\pm$ 7.00
Weight (kg) <i>Before</i>	75.19 $\pm$ 8.40
Weight (kg) <i>After</i>	74.86 $\pm$ 7.55
BMI (kg/m <sup>2</sup> )	23.93 $\pm$ 1.78

Each participant was briefed regarding the aim and nature of the study and had to submit both consent and screening forms before being enrolled. Participants were also informed that they could withdraw from the study at any point without having to give any reason and without any penalty. Similarly, players who missed more than two consecutive training sessions due to injury or sickness were removed from the study. Two participants, one from each group, withdrew from the study due to injuries sustained during competitive games. Ethics approval was granted by St. Mary’s University Ethics Committee, in accordance with the Declaration of Helsinki (47).

## **Procedures**

Both groups performed their respective strength training regimes over an 8-week period between January 2017 – March 2017. Strength training sessions were held a minimum of 48 hours after and 48 hours prior to any competitive game. Pre-tests were carried out on two separate days one week prior to starting the intervention, whilst post-tests were carried out one week following termination of the training regimes. Although the majority of the players had previously completed similar testing batteries, prior to starting the tests all players were verbally instructed how to perform the

tests, given a practical demonstration and walk through by the main researcher to familiarise themselves with the procedures. Since the LSPT was a rather innovative test that none of the athletes had previously done, all players were allowed a mock test, which included six randomly chosen passes within the testing grid. Players were given verbal instructions how to perform the test and also given a practical demonstration by a coach and were also allowed one minute to familiarise themselves with the testing grid dimensions and layout. Speed, agility and vertical jump tests were all done on the same day whilst, the LSPT and 1 repetition maximum tests were performed on a separate day. All tests were carried out on a FIFA 2-star artificial turf soccer pitch, with the exception of the vertical jump test, which was carried out in a multipurpose hall on parquet flooring. For the tests carried out on the artificial turf pitch, players were asked to wear their football kit and soccer boots, whilst vertical jump tests and 1RM tests, participants wore gym trainers and their soccer kit. During the training regimes, participants in the WT group were instructed to wear adequate gym trainers, whilst the BT group wore soccer boots and training kit apparel.

Prior to commencing training protocols, all participants took part in the same 10-minute warm up which included jogging, mobility drills and dynamic stretching exercises. Intensity was gradually increased following the RAMP protocol. Participants in the WT group performed a progression (Table 2) of four lower limb exercises, namely back squat, supine hip thrust, step up on a 40cm box and stiff legs good morning. Participants were allowed a 3-minute rest between each set to ensure full recovery. Those in the BT group performed 3 ballistic type exercises and progressed throughout the 8-weeks as shown in Table 3. The exercises included (a) squat and vertical jump with a medicine ball thrown vertically up followed by a 4-metre pass, (b) squat and forward jump with a medicine ball thrown horizontally followed by a 4-metre pass, (c) drop jump from a 40cm box followed by a jump over a 90cm hurdle, followed by a 4-metre pass. Weather conditions were mainly sunny throughout the 8-week intervention with temperatures ranging between 15 – 17 °C.

**Table 2.** Progression of exercises for players in the weight training group.

<b>Week</b>	<b>Sets x Reps</b>
Week 1 - 2	3 x 6 RM
Week 3 - 4	4 x 5 RM
Week 5 - 6	5 x 4 RM
Week 7 - 8	6 x 3 RM

**Table 3.** Progression of exercises for players in the ballistic training group. Brackets indicates weight of the medicine ball used in the exercise.

<b>Week</b>	<b>Squat jump</b>	<b>Forward throw</b>	<b>Drop jump</b>	<b>Total foot contacts</b>
1	3 x 10 (5kg)	3 x 10 (5kg)	3 x 10	90
2	4 x 10 (5kg)	4 x 10 (5kg)	4 x 10	100
3	4 x 10 (5kg)	4 x 10 (5kg)	4 x 10	120
4	5 x 10 (5kg)	5 x 10 (5kg)	5 x 10	140
5	4 x 10 (8kg)	4 x 10 (8kg)	4 x 10	120
6	4 x 10 (8kg)	4 x 10 (8kg)	5 x 10	130
7	5 x 10 (8kg)	5 x 10 (8kg)	5 x 10	150
8	6 x 10 (8kg)	6 x 10 (8kg)	5 x 10	170

#### *Anthropometric tests*

Anthropometric variables were measured 1-week before commencement of the program. Height was measured in centimeters using a SECA 700 stadiometer (SECA model 700 1021994, Germany) to the nearest tenth. On the other hand, weight was measured in kilograms using a SECA 803 digital scale (SECA model 803 1320009, Germany) to the nearest tenth, with readings also being taken 1-week after the termination of the program. Participants were asked to wear only their training shorts when taking both height and weight measurements.

#### *1 Repetition maximum testing (1RM)*

All participants in the WT group were tested for 1RM for each of the four exercises used in the training protocol. After a general warm up, participants performed 5 submaximal warm up lifts. Subjects then proceeded to lifting a weight chosen by them which they perceived as being their 1RM. More often than not, this was not their 1RM, thus the researcher proceeded to increasing 2%

to 5% more weight accordingly (34). Participants were allowed a minimum of three minutes' rest between lifts to allow full recovery. This procedure was repeated till the subjects could only perform one repetition of the chosen lift ( $CV < 2\%$ ) (35). 1RM was typically found within 6 attempts and recorded to the nearest 1kg. The same procedure was done for all the exercises used in the WT protocol. All tests were supervised by the instructor and performed using the same equipment for all participants.

### *20m sprint*

Sprint time was measured using Racetime2 Kit Light Radio version 2.3.21 (Microgate, Bolzano, Italy) system to the nearest 0.01 seconds. Photocells were placed at a height of 50cm from the ground at the start and finish lines, 20m apart. Participants were asked to place their preferred foot 0.50m behind the starting line, and encouraged to sprint maximally through the 20m linear course. Each participant performed 3 runs, interspersed with a 3-minute passive recovery, with the best time being recorded for analysis (35).

### *Agility T-test*

A cone was placed 9.14m from the starting line, with another 2 cones placed 4.57m either side, thus forming a 'T' shape. A Racetime2 Kit Light Radio version 2.3.21 (Microgate, Bolzano, Italy) timing system was placed at the start and finishing line at a height of 0.50m from the ground. Participants were instructed to run forward to the first cone, then side step across the horizontal section from side to side, and finally backpedaling to the finish line in the quickest time possible (17). Participants performed 2 runs, with a 3-minute passive recovery in between each run with the best time, recorded to the nearest 0.01 seconds, being used for analysis. The ICC value for test retest reliability for the agility T-test was 0.95 (17).

### *Vertical jump test*

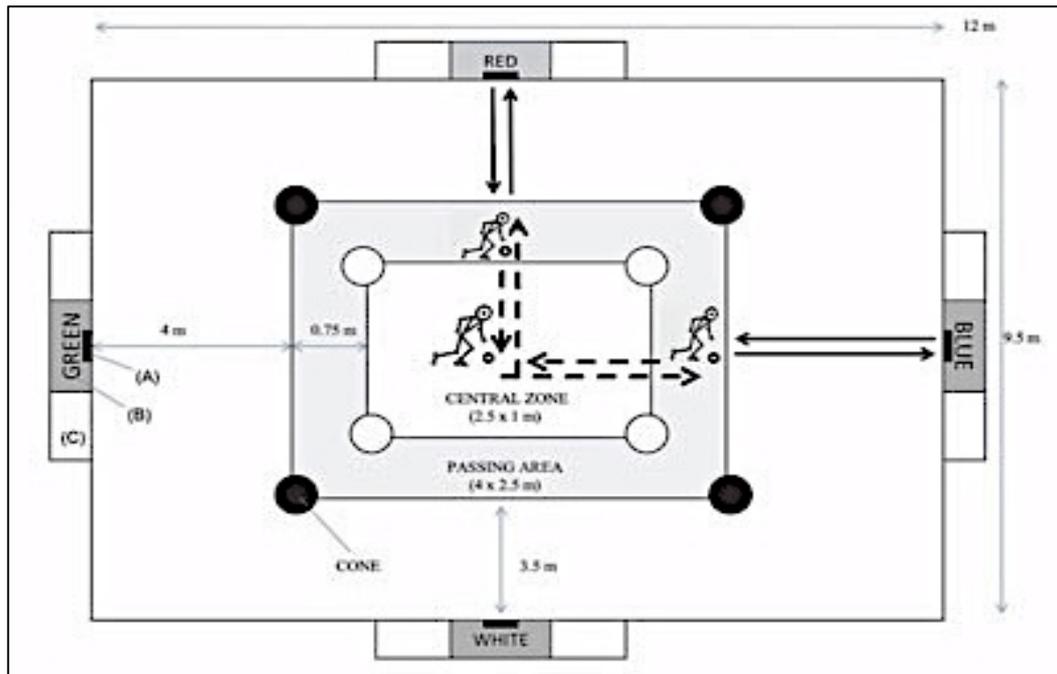
Lower limb explosive power was measured using an Opto Jump Next version 3.01.0001 (Microgate, Bolzano, Italy) system to the nearest 0.01cm. Participants were instructed to perform a counter movement jump (CMJ) by placing their hands on their waist to limit the use of the arms, squat down to 90degrees of knee flexion and then jump vertically high up as possible. Angular displacement of the knee was standardized using a goniometer during the practice jumps (38). The participants then performed 3counter movement jumps, with a maximum of 2-minutes recovery period between each jump (35,38). The Opto Jump Next software calculates flight and contact times, and thus the height jumped. The best jump was recorded for analysis (CV < 3%) (38).

### *Loughborough Soccer Passing Test (LSPT)*

Soccer skill, specifically passing was tested using the LSPT (29,31). Participants had to complete 16 randomly selected passes within a 43 second time limit. The order of the passes was predetermined to include 8 short passes and 8 long passes (31). Subjects were instructed to pass from within a designated passing area, comprising of an inner zone measuring 2.5m x 1.0m and an outer zone of 4.0m x 2.5m (Figure 1). Four different 0.6m colored strips with a 0.1m central metal strip were attached to standard 2.5m gym benches for the test. One examiner called out the colour to which the participant had to pass, whilst another noted the time taken and any errors committed by the participants during the test. Examiner roles during the pre-and post-test remained the same, thus eliminating inter-experimenter variability (31). The total time taken including penalty time and deductions is calculated as follows and recorded for analysis:

- (a) 5 seconds for missing the bench completely or passing to the wrong bench,
- (b) 3 seconds for missing the target area,
- (c) 3 seconds for handing the ball,
- (d) 2 seconds if the ball touched any cone,

- (e) 1 second for every second over the 43 second time limit,
- (f) 1 second deducted from the total time for a perfect pass when hitting the 10cm target.



**Figure 1.** LSPT setup, (A) aluminium piece, 30 x 10cm, (B) coloured target area, 60 x 30cm, (C) wooden gym bench.

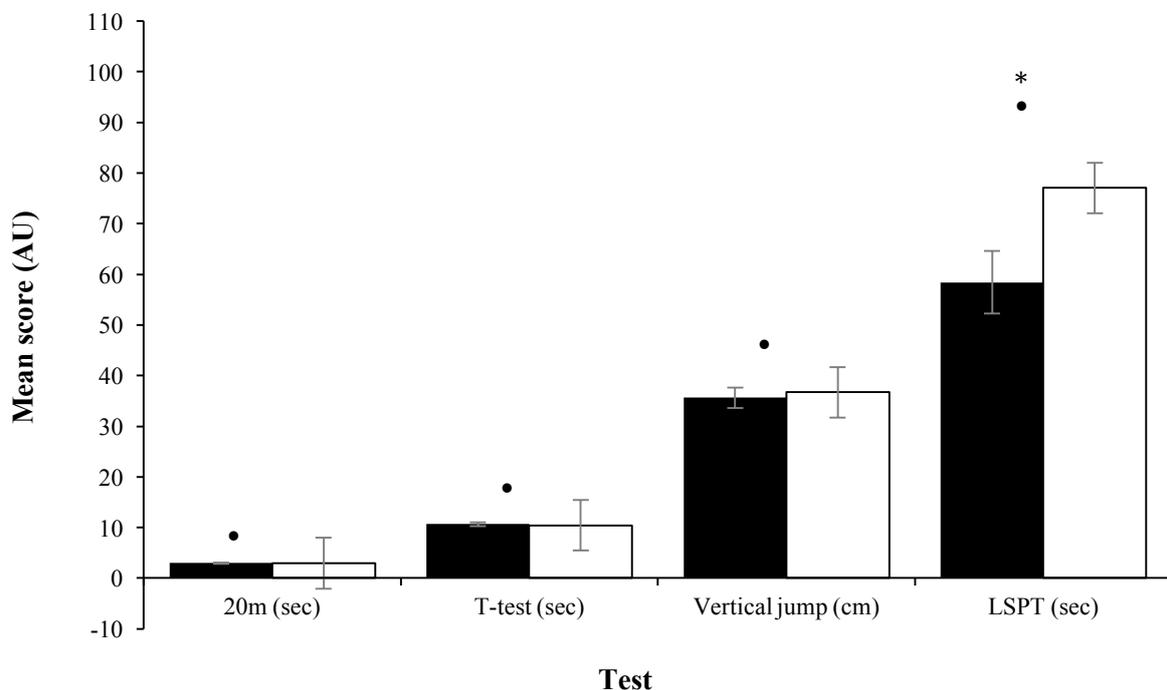
### Statistical Analysis

All results and data obtained from the intervention program were analysed using Statistical Package for the Social Sciences (SPSS for Windows, SPSS Inc., Chicago, IL). G-Power statistical software version 3.1.9.2 (University of Dusseldorf, Dusseldorf, Germany) (14) was used to establish that a minimum sample size of  $n = 18$  was required for a statistical power of  $\geq 0.90$  at an alpha level of  $p \leq 0.05$ . All data is expressed as mean  $\pm$  standard deviation (SD). Distribution of each variable was examined with the Kolmogorov-Smirnov test for normality. Data was first analysed using a 2-way analysis of variance (ANOVA). This was used to examine the differences between time (pre-/post-intervention values) over the two groups (A and B). *Post hoc* Bonferroni correction and an independent sample *t*-test were also used. The level of significance was set at  $p \leq 0.05$ .

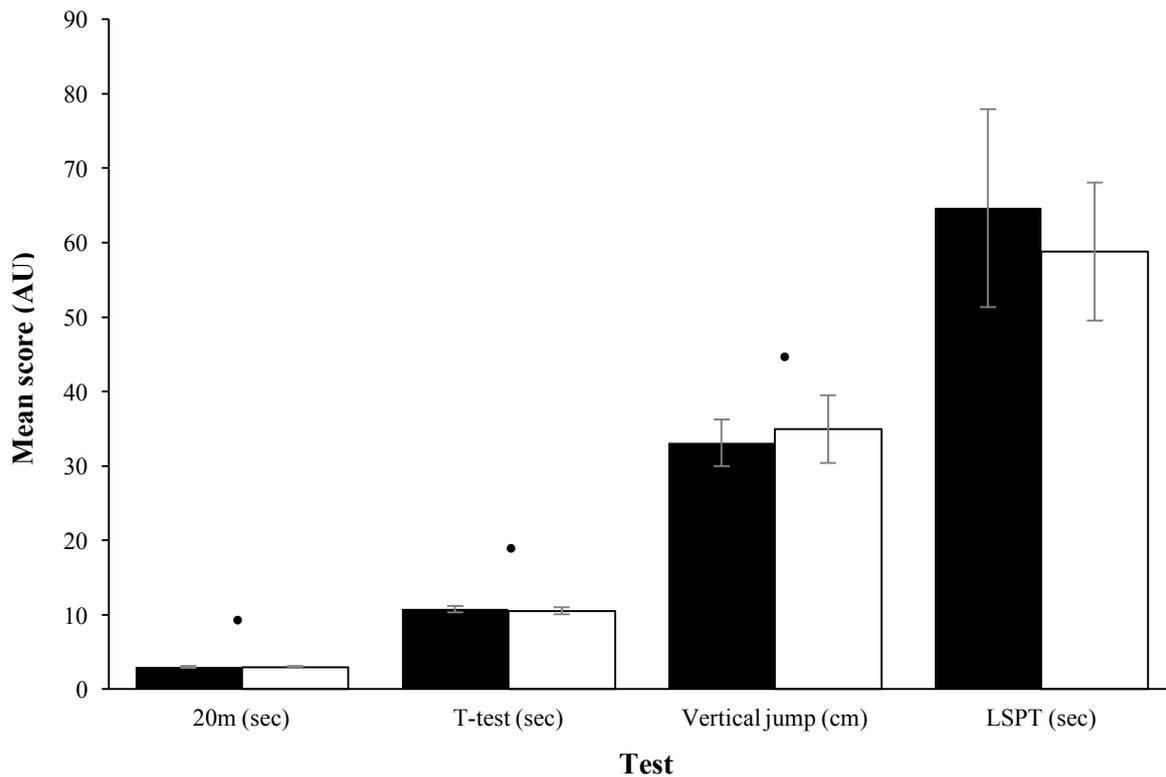
## CHAPTER 3

### RESULTS

After 8-weeks of strength training, both groups showed improvements in all but one of the physical and technical abilities tested. The only significant interaction between time (pre- / post-) and group was in the LSPT ( $F_{1,32} = 5.13$ ;  $p = 0.030$ ). All other physical tests had a  $p$ -value  $\geq 0.05$ . The LSPT values were further evaluated using an independent sample  $t$ -test. The results indicated that those players in the WT group had a 31.86% increase between pre- and post-test values,  $p = 0.023$  (Figure 2a). Contrary, players in the BT group had a 9.00% decrease in the total time taken to perform the LSPT,  $p = 0.164$  (Figure 2b). Further analysis of the group effect ( $F_{1,32} = 1.25$ ;  $p = 0.272$ ) and the time effect ( $F_{1,32} = 1.34$ ;  $p = 0.255$ ) indicated no significance of the main effects.



**Figure 2a.** Pre-and post-test mean scores for the weight training group. Asterisk (\*) indicates significant time x group interaction ( $p = \leq 0.05$ ). Closed circles (•) indicate significant change between pre-and post-test values ( $p = \leq 0.05$ ).



**Figure 2b.** Pre-and post-test mean scores for the ballistic training group. Closed circles (•) indicate significant change between pre and post-test values ( $p \leq 0.05$ ).

Although there was no significant time x group interaction for 20m sprint, ( $F_{1,32} = 0.006$ ;  $p = 0.938$ ) players in the WT group showed improvements in their 20m sprint times of 1.67%,  $p = 0.003$  (Figure 2a) whilst the BT group improved marginally by 1.00%,  $p = 0.021$  (Figure 2b). Analysis of the main effects for the 20m sprint test resulted in no significance with group effect ( $F_{1,32} = 0.376$ ;  $p = 0.544$  and time effect ( $F_{1,32} = 1.464$ ;  $p = 0.235$ ). Similarly, time x group interaction analysis returned no significance ( $F_{1,32} = 0.059$ ;  $p = 0.810$ ) in the agility tests performed. However, post-test times improved for both groups, with players in the WT group showing a 2.16%,  $p = 0.010$  (Figure 2a) improvement, whilst the BT group improved by 2.32%,  $p = 0.002$  (Figure 2b). Group effect for the agility test had no significance ( $F_{1,32} = 0.182$ ;  $p = 0.673$ ), however time effect was significant ( $F_{1,32} = 4.50$ ;  $p = 0.042$ ). Both groups also had improvements in vertical jump height of 3.00%,  $p = 0.004$  and 5.59%,  $p = 0.013$  for the WT group (Figure 2a) and

the BT group (Figure 2b) respectively. Time x group interaction ( $F_{1,32} = 0.318, p = 0.577$ ), group ( $F_{1,32} = 2.47; p = 0.126$ ) and time effect ( $F_{1,32} = 2.57; p = 0.118$ ) had no significance.

**Table 4.** Results for ANOVA analysis showing main effects and group effects. Asterisk (\*) indicates significant interaction ( $p \leq 0.05$ ).

	<b>Group</b>	<b>Time</b>	<b>Group x Time</b>
<b>20m Sprint</b>	0.544	0.235	0.938
<b>Agility</b>	0.673	0.042*	0.810
<b>Vertical jump</b>	0.126	0.118	0.577
<b>LSPT</b>	0.272	0.255	0.030*

## CHAPTER 4

### DISCUSSION

The aim of the study was to analyse the effects of two strength-training regimes, weight training and ballistic training on player's physical and technical attributes. Speed, agility, vertical jump height and passing skill were measured before and after an eight-week strengthening program, which included bi-weekly sessions. The primary results of the study indicate that 20m-sprint and agility time, together with vertical jump height improved for both groups. However, the major finding in the study was that the WT group had a significantly negative effect on the passing ability of players, whilst the BT group showed technical improvements in skill post-intervention.

The LSPT, which was developed by Ali et al. (1), assesses both speed and accuracy of players passing skill. The relative ease by which it can be implemented and the very low cost equipment needed, have made this a valuable tool for talent identification in many soccer related institutions (29). There has also been very good reliability in talent identification in participants at University age (1), and in competitive under-19 soccer players (29), and between elite and non-elite players (1), thus supporting the validity of the test. Additionally, the LSPT tests game specific skill, as players need to react to verbal cues, process commands quickly and then execute accurately control and passing (29). Players in the WT group reported a negative effect on passing skill, with the mean time taken, supplementary penalty time and general performance time to complete the LSPT increasing drastically. This could be attributed to the lack of specificity of training and minimal transfer of training effect. On the other hand, Perez-Gomez et al. (36) noted positive and significant improvements in kicking performance following six-weeks of combined weightlifting and plyometric training. However, the changes observed by Perez-Gomez et al. (36) were attributed to improved muscular strength of the hip, knee and ankle, which generate necessary forces to swing

the leg and hit the ball. Although the exercises implemented during the 8-week intervention targeted specific muscles of the hip and knee, the lack of passing skill involved in the exercise could have been a determining factor in the drastic increase in time taken to complete the LSPT. This infers that the lack of transference from the gym exercises to the passing skill could lead to detrimental negative effects.

Players in the BT group showed improvements in the overall time taken to complete the LSPT. The mean time taken for players in the BT group ( $58.84 \pm 9.27s$ ) compares to results from non-elite players ( $52.50 \pm 7.4s$ ) from a study conducted by Ali et al. (1). Players already possess relatively good technical motor skills (36), and therefore adding a skill drill following a strength exercise can result in a dual beneficial effect. Gains in skill level following the eight-week intervention hence could be linked to the exercise design used in the intervention, which involved a ballistic exercise, followed by a pass to a fixed target. As improvements are attributed to the level of specificity of training, this further supports the notion that enhancements of both the physical and technical characteristics could be due to the fact that players practiced passing following the execution of the strength exercise. Additionally, since the WT group did not have any technical drills included in the exercise design, whilst the BT group had passing included following the exercise, with all other training sessions being equal for both groups, further strengthens the conclusion that the major improvement were associated to skills practice.

Besides players being skillful, sprinting at the right time and faster than your opponent can be crucial in a soccer game (3). This highlights the need of appropriate training strategies that can elicit the best adaptations; with various studies concluding that strength training will lead to improved sprint times (13,38,41). Following an in-season weight training program, spread over six-weeks, Styles et al. (41) concluded that sprint times over 5m, 10m and 20m decreased by 5%, 3% and 1% respectively. This is comparable with the findings of this study, were players in the WT group, who

had back squat as part of the training regime decreased sprint times by 1.67%. The slightly higher improvements can be credited to the duration of the study being longer than that of Styles et al. (41). Kotzamanidis et al. (20) also found significant improvements in 30m sprint times following a heavy strength training program, but also highlighted the lack of skill transfer. Kotzamanidis et al. (20) argued that since sprinting involves high levels of interlimb coordination, there is little or no learned effect from the gym based strength training. The observed improvements in this study can be attributed to an enhanced rate of force development (RFD), which is a more determining factor than maximal force production in sprinting distances greater than 10m (41). De Hoyo et al. (13) also highlighted the importance of RFD in sprint distances <30m, whilst Chelly et al. (7) recommending using heavy loads in the region of 70 – 90% of 1RM to achieve substantial improvements. This is in accordance to the load used during the eight-week program of this study, with players gradually progressing from lifting loads of 6 repetition maximum (RM) to heavier loads of 3RM. Comfort et al. (10) also showed similar improvements in 20m-sprint performance following an eight-week period of strength training, however his study was held in the pre-season.

Plyometric and ballistic type training methods are commonly used for improving sprint times and potentially soccer playing performance (7). Structural and neuromuscular adaptations such as increases in muscle fibre diameter, specifically type I (11%), type IIa (10%) and hybrid type IIa/x (15%) have been observed together with an increased neural drive following plyometric and ballistic training (5). Subjects within the BT group showed percentage improvements (1.00%) in sprint times similar to the findings from Thomas et al. (42), who documented improvements of 0.68% following a six-week plyometric training program incorporating countermovement jumps (CMJ) and drop jumps (DJ). The minor improvement observed in this study when compared to Thomas et al. (42) could be due to the longer duration of the study and to the added weight when performing a CMJ. Since the ability to generate muscular power in the lower limbs, specifically the ankle, knee and hip extensors is highly correlated to short-distance sprint times (12), the weighted

ballistic actions included within this study could possibly result in higher production of explosive ground reaction forces (42) resulting in better sprint times. This could be because the squat and vertical jump and the squat and horizontal jump are both exercises that consist of triple extension patterns of the lower limbs, which were overloaded with a medicine ball. Equally, Ronnestad et al. (38) established that a seven-week combined plyometric and strength-training program resulted in overall improvements in acceleration, peak running velocity and 40m-sprint time, whilst Marian et al. (24) noted improvements in CMJ and squat jumps (SJ) following eight weeks of SJ training. This however is contradicted by findings from Perez-Gomes et al. (36) who found no change in sprint performance over 20m following a six-week intervention.

Soccer players also need to respond to various stimuli during a game that affect their running direction and speed (3) thus ability to quickly change direction is fundamental in soccer. In contrast to linear sprinting, agility involves acceleration and deceleration, sudden stops and changes of direction (43), consequently players require powerful lower limbs to generate high RFD. Players in the WT group showed improved in the agility T-test that can be attributed to the neuromuscular adaptations following strength training. Increased intermuscular coordination (44) and increased firing frequencies allow players to swiftly and forcefully decelerate and then generate enough power to accelerate in a different direction (42). The use of heavy loads in exercises involving triple extension patterns, such as the back squat used in this study, have been shown to improve these explosive actions (19). Contrary to this, De Hoyo et al. (13) found no significant enhancement in agility performance between back squat, plyometric and resisted training groups during an eight-week study, thus concluding that there may be other factors that should be considered when aiming to improve agility performance. Mujika et al. (34) also noted no improvements in change of direction ability following short-term sprint and power training. In this regard, agility is considered a multifactorial task that involves proper technique, amongst others (13). Therefore, the marginal

improvements observed in the WT group could be due to the neuromuscular adaptations, which however may also be limited due to the lack of proper technique when changing directions (34).

Vaczi et al. (43) observed significant improvements of 2.5% in agility following a six-week plyometric training program. This result is similar to the percentage improvement (2.32%) seen in BT group. Various other authors have studied the effects of plyometric and ballistic type exercises on agility. Thomas et al. (42) documented a 9.0% enhancement in agility times in semi-professional adolescent soccer players, whilst Manouras et al. (27) reported 2.5-3.7% reduction in agility test time. Although many authors are in agreement that plyometric and ballistic exercise will improve agility, one must note the varying percentage increases between studies. This may be due to numerous factors such as, length of study, level of athletes, age and type of test examined. Thomas et al. (42) used a 505-agility test, which takes an average time of 2.7 seconds to complete, whilst Manouras et al. (27) used the Illinois test that takes approximately 13-17 seconds to complete. The longer agility tests thus are dependent not only on the ATP-PCr system, but also on the glycolytic system for energy (44), and therefore this could explain why there is less percentage improvement observed when compared to shorter agility tests. The vertical and horizontal components in the exercises prescribed in this study are also analogous to those used in Manouras et al. (27) eight-week study. The similarity between both training regimes (vertical vs. horizontal exercises) and results, could imply that both regimes could improve agility performance in conjunction with other methods (27).

Another positive development observed in this study is vertical jump height, which was examined using a CMJ. The relationships between the squat exercise and CMJ have been closely related (13). Kawamori et al. (19) inferred that the triple extension pattern observed in the lower limb during a squat is comparable to movement patterns in a CMJ, thus including the back squat in a strength training program could impact CMJ height. Players in the WT group had a 3.0% increase in vertical

jump height, which is half the change observed by De Hoyo et al. (13). This could be attributed to differences in loads lifted and participant age. Likewise, Wong et al. (46) implied that following a twelve-week gym based strengthening program, including squats amongst other exercises, increased vertical jump height by some 7.0%. The difference in the length of the study, and the choice of exercises used in the study could account for the better results. The key point to note however is the speed at which the exercises are performed. In this study, a slow descent, emphasising eccentric loading, followed by a forceful and fast concentric triple extension of the ankles, knees and hips during back squat training was advocated (46). The overloading of the vertical component positively affects jump height (13,46). This was also highlighted by Wong et al. (45) who suggested that speed of movement during strength training affects jump performance more than the load lifted.

One of the most frequently studied performance outcomes following plyometric and ballistic training is vertical jump (5). Studies ranging from four to twelve weeks' duration, cohorts of amateur or professional athletes and low to high intensity plyometric and ballistic drills have documented improvements in the region of approximately 8.7% (25). Players in the BT group compared evenly with results in studies from Thomas et al. (42) and Marques et al. (26) who recorded increases of 6.0% and 7.7% respectively. Manouras et al. (27) also observed improvements in vertical jump height of approximately 3.2-5.8% following eight-weeks of vertical and horizontal jump training. This also relates closely to this study, both in exercise design and to results obtained. Players in the BT group performed both vertical and horizontal based exercises and improved by 5.59% following the eight-week intervention. The improvements observed are attributed to the neural adaptations in the early stages of strength training, the increased synchronization of body segments, the superior coordination levels and greater muscular strength and power (26,36). Changes in muscle stiffness, specifically the musculotendinous complex, efficient transmission of force and cross-sectional area have also been linked to greater vertical

jump heights (25). Furthermore, the increase in tendon stiffness allows for an improved force transmission due to a reduction in energy dissipation (25). Moreover, the CMJ involves the use of the SSC and is therefore very closely associated with the exercises prescribed in this study. The high degree of training specificity between the CMJ and the exercises used in the study in relation to the application of force, has also been previously well documented (27).

It would be interesting to see the results obtained had the WT group also performed a passing drill. The exercise design would have to be re-examined as heavy strength training would limit the player's successful and effective ball practice following this concurrent training. Another limitation is that it is unclear if elite players with already a high level of technical ability would have comparable results to amateur players. Similarly, young athletes in their developmental stage could also be investigated to see if there could be greater improvements at a young age. The study was implemented during the competitive phase of the season where training intensity is usually high and a lower volume. It would be interesting to observe results of both physical and technical attributes if a similar study was performed in the preparation phase of the season.

## CHAPTER 5

### PRACTICAL APPLICATIONS

Results from previous studies have demonstrated significantly positive improvements in speed, agility and vertical jump height following short-term strength training programs involving gym based resistance training, plyometric and ballistic exercises. The extent of improvements observed was dependent on load, frequency of sessions, athlete level and phase of the season the intervention was performed. Although improvements in physical attributes were recorded in this study, further research is warranted, possibly using a larger sample size and with athletes of different skill levels. On the other hand, S&C coaches looking to improve passing skill in conjunction with player's physical qualities, could use similar exercises used in this study, that highlight the importance of specificity of training and subsequent transfer of skill. Likewise, coaches looking to gain maximal benefit from strength training programs should also take into account the possible negative effects of concurrent training methods.

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## Appendix A - Participant information sheet and consent form



St Mary's  
University  
Twickenham  
London

### Background to the study

Twenty players forming part of the same soccer team will be recruited to form part of the study. The study aims to evaluate the effects of a gym based strength training program or an on field ballistic strength program on speed, agility and soccer skill performance. All participants will be tested for speed, agility, vertical jump height and a soccer skill passing test prior to the study. Following an 8-week intervention period, participants will be re-tested and data collected will be analysed.

### Statement of consent

I have read the above information and received answers to any questions I have asked. I therefore consent to take part in the study. In addition to agreeing to participate in the study, I also consent to having my physical data recorded for analysis.

\_\_\_\_\_  
Participant signature

\_\_\_\_\_  
Name in block letters

\_\_\_\_\_  
Date

## Appendix B – Application for ethical approval



St Mary's  
University  
Twickenham  
London

### St Mary's University

Ethics Sub-Committee

Application for Ethical Approval (Research)

This form must be completed by any undergraduate or postgraduate student, or member of staff at St Mary's University, who is undertaking research involving contact with, or observation of, human participants.

Undergraduate and postgraduate students should have the form signed by their supervisor, and forwarded to the School Ethics Sub-Committee representative. Staff applications should be forwarded directly to the School Ethics Sub-Committee representative. All supporting documents should be merged into one PDF (in order of the checklist) and clearly entitled with your **Full Name, School, Supervisor**.

Please note that for all undergraduate research projects the supervisor is considered to be the Principal Investigator for the study.

If the proposal has been submitted for approval to an external, properly constituted ethics committee (e.g. NHS Ethics), then please submit a copy of the application and approval letter to the Secretary of the Ethics Sub-Committee. Please note that you will also be required to complete the St Mary's Application for Ethical Approval.

Before completing this form:

- Please refer to the **University's Ethical Guidelines**. As the researcher/ supervisor, you are responsible for exercising appropriate professional judgment in this review.
- Please refer to the Ethical Application System (Three Tiers) information sheet.
- Please refer to the Frequently Asked Questions and Commonly Made Mistakes sheet.
- If you are conducting research with children or young people, please ensure that you read the **Guidelines for Conducting Research with Children or Young People**, and answer the below questions with reference to the guidelines.

**Please note:**

**In line with University Academic Regulations the signed completed Ethics Form must be included as an appendix to the final research project.**

If you have any queries when completing this document, please consult your supervisor (for students) or School Ethics Sub-Committee representative (for staff).



**St Mary's Ethics Application Checklist**

The checklist below will help you to ensure that all the supporting documents are submitted with your ethics application form. The supporting documents are necessary for the Ethics Sub-Committee to be able to review and approve your application.

Please note, if the appropriate documents are not submitted with the application form then the application will be returned directly to the applicant and may need to be re-submitted at a later date.

Document	Enclosed? (delete as appropriate)		Version No
	YES	Not applicable	
1. Application Form	<b>YES</b>		
2. Risk Assessment Form	YES		
3. Participant Invitation Letter	<b>YES</b>		
4. Participant Information Sheet	<b>YES</b>		
5. Participant Consent Form	<b>YES</b>		
6. Parental Consent Form		N/A	
7. Participant Recruitment Material - e.g. copies of Posters, newspaper adverts, website, emails		N/A	
8. Letter from host organisation (granting permission to conduct the study on the premises)	<b>YES</b>		
9. Research instrument, e.g. validated questionnaire, survey, interview schedule		N/A	
10. DBS (to be sent separately)		N/A	
11. Other Research Ethics Committee application (e.g. NHS REC form)		N/A	

12. Certificates of training (required if storing human tissue)		N/A	
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I can confirm that all relevant documents are included in order of the list and in one PDF document (any DBS check to be sent separately) named in the following format: **Full Name, School, Supervisor.**

Signature of Applicant: Cedric Sciberras

Signature of Supervisor: 



Ethics Application Form

1) Name of proposer(s)	Cedric Sciberras
2) St Mary's email address	132045@live.smuc.ac.uk
3) Name of supervisor	Dr Stephen Patterson

4) Title of project  The effect of weight and ballistic training on speed, agility, vertical jump height and skill performance in soccer players
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5) School or service	St Mary's University
6) Programme (whether undergraduate, postgraduate taught or postgraduate research)	M.Sc. Strength and Conditioning
7) Type of activity/research (staff/undergraduate student/postgraduate student)	Postgraduate Student

8) Confidentiality	
Will all information remain confidential in line with the Data Protection Act 1998?	YES

9) Consent	
Will written informed consent be obtained from all participants/participants' representatives?	YES

10) Pre-approved protocol	
Has the protocol been approved by the Ethics Sub-Committee under a generic application?	Not applicable Date of approval:

11) Approval from another Ethics Committee	
a) Will the research require approval by an ethics committee external to St Mary's University?	NO
b) Are you working with persons under 18 years of age or vulnerable adults?	NO

12) Identifiable risks	
a) Is there significant potential for physical or psychological discomfort, harm, stress or burden to participants?	NO
b) Are participants over 65 years of age?	NO
c) Do participants have limited ability to give voluntary consent? This could include cognitively impaired persons, prisoners, persons with a chronic physical or mental condition, or those who live in or are connected to an	NO

institutional environment.	
d) Are any invasive techniques involved? And/or the collection of body fluids or tissue?	NO
e) Is an extensive degree of exercise or physical exertion involved?	NO
f) Is there manipulation of cognitive or affective human responses which could cause stress or anxiety?	NO
g) Are drugs or other substances (including liquid and food additives) to be administered?	NO
h) Will deception of participants be used in a way which might cause distress, or might reasonably affect their willingness to participate in the research? For example, misleading participants on the purpose of the research, by giving them false information.	NO
i) Will highly personal, intimate or other private and confidential information be sought? For example, sexual preferences.	NO
j) Will payment be made to participants? This can include costs for expenses or time.	NO
k) Could the relationship between the researcher/	NO

supervisor and the participant be such that a participant might feel pressurised to take part?	
1) Are you working under the remit of the Human Tissue Act 2004?	NO

13) Proposed start and completion date
<p>Please indicate:</p> <ul style="list-style-type: none"> <li>• When the study is due to commence.</li> <li>• Timetable for data collection.</li> <li>• The expected date of completion.</li> </ul> <p>Please ensure that your start date is at least 3 weeks after the submission deadline for the Ethics Sub-Committee meeting.</p>
Recruitment will begin at the beginning of January 2017 following approval from the ethics committee. There will be a total of four days for data collection, two days for the pre-test and two days for the post test. The study is expected to be completed by end of March 2017.

14) Sponsors/Collaborators
<p>Please give names and details of sponsors or collaborators on the project. This does not include your supervisor(s) or St Mary's University.</p> <ul style="list-style-type: none"> <li>• Sponsor: An individual or organisation who provides financial resources or some other support for a project.</li> <li>• Collaborator: An individual or organisation who works on the project as a recognised contributor by providing advice, data or another form of support.</li> </ul>
N/A

#### 15. Other Research Ethics Committee Approval

- Please indicate whether additional approval is required or has already been obtained (e.g. the NHS Research Ethics Committee).
- Please also note which code of practice / professional body you have consulted for your project.
- Whether approval has previously been given for any element of this research by the University Ethics Sub-Committee.

N/A

#### 16. Purpose of the study

In lay language, please provide a brief introduction to the background and rationale for your study. *[100 word limit]*

- Be clear about the concepts / factors / performances you will measure / assess/ observe and (if applicable), the context within which this will be done.
- Please state if there are likely to be any direct benefits, e.g. to participants, other groups or organisations.

During a 10 month season, strength and conditioning coaches meticulously plan various training parameters together with their respective tactical coaches. However, conflict often occurs due to the fact that tactical coaches prefer using training time for technical and tactical purposes, whilst S&C coaches are usually more inclined to using non sport specific exercises such as gym based strength exercises. Therefore, the aim of the study is to compare the effects of an 8 week gym based strengthening program or a ballistic program on speed, agility and soccer skill (passing). Other coaches could benefit from the results as they can use similar training concepts.

#### 17) Study Design/Methodology

In lay language, please provide details of:

- a) The design of the study (qualitative/quantitative questionnaires etc.)
- b) The proposed methods of data collection (what you will do, how you will do this and the

nature of tests).

- c) You should also include details regarding the requirement of the participant i.e. the extent of their commitment and the length of time they will be required to attend testing.
- d) Please include details of where the testing will take place.
- e) Please state whether the materials/procedures you are using are original, or the intellectual property of a third party. If the materials/procedures are original, please describe any pre-testing you have done or will do to ensure that they are effective.

### Study design

Twenty players forming part of a senior men's soccer team participating in the Malta Football Association league will be recruited. All participants will be asked to fill in a screening form prior to the study. This will include information such as date of birth, nationality, playing position, experience and injury history. Anthropometric data of the participants will also be recorded, and will include age, height, weight and BMI. 1 week prior to starting the intervention program, pretest data will be recorded. This will include a 20m linear speed test and a T-agility test which will both be timed using infrared timing gates and vertical jump height using an opto jump system. Skill level of the athletes will be assessed on a separate day using the Loughborough soccer passing test.

### Anthropometric Data

Anthropometric data will be taken 72 hours after the last competitive match prior to training and on the same day for all players involved in the study. Readings taken on week 0 and week 7 will be recorded in an excel document for further analysis. The same digital weighing scale is used for all the test subjects and recorded to the nearest 0.1kg, whilst height is measured using a stadiometer and recorded to the nearest 0.1meter. Body mass index is then calculated by dividing the weight (kg) by the height (cm) squared. Players will be asked to wear only their underwear when recording height and weight.

### 20m Sprint

Sprint time is calculated to the nearest 0.01 seconds using an infrared timing gates system. The subjects are instructed to take a starting position at one end of the gates, placing their preferred foot 0.5m behind the starting line. On verbal signaling, the subjects are asked to sprint from the start line across a linear 20m runway with maximal effort. Subjects are instructed to run through the timing gates and not decelerate at any point during the test. Each subject will perform 3 runs, interspersed by 3 minutes' passive recovery, and the best time recorded for analysis.

### T-Agility test

Four cones are placed in a T-shape. The vertical and horizontal sections will measure 9.14m each. The players are instructed to run forwards the vertical section to a cone placed in the middle of the horizontal section, then they are to side shuffle to the left, then all the way to the other end of the horizontal section and back again to the middle cone, where they will backpedal to the starting position. Players are instructed to touch each cone at the base and not to cross over their feet when side shuffling. Each player will perform the test twice with a 3-minute passive recovery in between. The best time will be recorded for analysis.

### Vertical jump

Lower limb explosive power will be measured using a vertical jump height test. Subjects will be asked to perform a counter movement jump by squatting to 90 degrees of knee flexion and jumping vertically up as high as possible, whilst keeping their hands on their waist. To standardize knee angular displacement in the squat phase, subjects will be allowed 2 practice jumps before the test followed by 3-recorded trial and the best jump recorded for further analysis. Each subject will be given 2 minutes' rest between each jump and flight times registered and converted to jump height. Players are encouraged to give a maximal effort during the test, whilst their jump height will be recorded using an Optojump optical measurement system to the nearest 0.01 centimeters.

#### Loughborough passing test

Skill will be testing using the Loughborough Passing Test. The aim is to complete 16 passes against different coloured target areas situated on standard gymnasium benches from within the designated passing zone. The designated passing zone is 4.0m x 2.5m and has an inner zone of 2.5m x 1.0m and is 4.0m away from the green and blue panels, and 3.5m from the white and red panels. As the ball is being played, the investigator calls the next pass (next colour) whilst the second investigator records the time to complete the 16 passes and awards penalty points for missed targets or wrong colour. Penalty points include, 5 seconds for missing the bench or hitting the wrong colour bench, 3 seconds for missing the target area, 2 seconds for passing the ball outside the designated area, 2 seconds for the ball touching any cone and 1 second for every second over the allocated 43 second time limit to complete the test. When a player hits the designated 10cm strip in the middle of the bench, 1 second is deducted from the time, this is termed a perfect pass. The total time including penalties and deductions is recorded for each player.

#### Intervention

Following the pre-tests, the participants will be divided into 2 groups (n=10), matched for their vertical jump height. Group 1 will follow a gym based strength training regime which will include the following exercises:

- (a) Back squat
- (b) Good mornings
- (c) Step ups
- (d) Hip thrusts

The participants will have 2 strength training sessions per week and will progress as follows:

- (i) Week 1 & 2 – 3 x 6RM
- (ii) Week 3 & 4 – 4 x 5RM
- (iii) Week 5 & 6 – 5 x 4RM
- (iv) Week 7 & 8 – 6 x 3RM

Group 2 will follow an on field ballistic strengthening regime. The participants will follow 3 separate exercises as follows:

- (a) Medicine ball squat jump throw (vertical direction), followed by a 4m pass against a bench
- (b) Forward fall with medicine ball throw (horizontal direction) followed by a 4m pass against a bench
- (c) Drop jump from 40cm box over a 90cm hurdle, followed by a 4m pass against a bench. The participants will have 2 strength sessions per week and will progress as follows:
  - (i) Week 1 – (a) 10 x 3 (5kg med ball), (b) 10 x 3 (5kg med ball), (c) 10 x 3 = 90 foot contacts
  - (ii) Week 2 – (a) 10 x 4(5kg), (b) 10 x 4(5kg), (c) 10 x 2 = 100 foot contacts
  - (iii) Week 3 – (a) 10 x 4(5kg), (b) 10 x 4(5kg), (c) 10 x 4 = 120 foot contacts
  - (iv) Week 4 – (a) 10 x 5(5kg), (b) 10 x 5(5kg), (c) 10 x 4 = 140 foot contacts
  - (v) Week 5 – (a) 10 x 4(8kg), (b) 10 x 4(8kg), (c) 10 x 4 = 120 foot contacts

- (vi) Week 6 – (a) 10 x 4(8kg), (b) 10 x 4(8kg), (c) 10 x 5 = 130 foot contacts
- (vii) Week 7 – (a) 10 x 5(8kg), (b) 10 x 5(8kg), (c) 10 x 5 = 150 foot contacts
- (viii) Week 8 – (a) 10 x 6(8kg), (b) 10 x 6(8kg), (c) 10 x 5 = 170 foot contacts

## 18) Participants

Please mention:

- a) The number of participants you are recruiting and why. For example, because of their specific age or sex.
- b) How they will be recruited and chosen.
- c) The inclusion/exclusion criteria.
- d) For internet studies please clarify how you will verify the age of the participants.
- e) If the research is taking place in a school or organisation then please include their written agreement for the research to be undertaken.

### Sample size

The total number of participants in the study will be 20. This is due to the fact that the full squad compliment of a senior men's team usually includes 20 outfield players and 2 goal keepers. Therefore, all the outfield players will be included in the study, assuming they are registered with the club to form part of the squad for the 2016-2017 season.

### Criteria

All players included in the study must be healthy adults, aged 18 – 40 and train regularly with the club. Players who have joined the club less than a month before the intervention or have had serious injury that sidelined them for at least 1 month will be excluded from the study. All participants will be asked to fill in a screening form prior to the study.

(d) N/A

(e) N/A

## 19) Consent

If you have any exclusion criteria, please ensure that your Consent Form and Participant Information Sheet clearly makes participants aware that their data may or may not be used.

- a) Are there any incentives/pressures which may make it difficult for participants to refuse to take part? If so, explain and clarify why this needs to be done
- b) Will any of the participants be from any of the following groups?
  - Children under 18

- Participants with learning disabilities
- Participants suffering from dementia
- Other vulnerable groups.

c) If any of the above apply, does the researcher/investigator hold a current DBS certificate? A copy of the DBS must be supplied **separately from** the application.

d) How will consent be obtained? This includes consent from all necessary persons i.e. participants and parents.

(a) No

(b) No

(c) N/A

(d) Participants will be given a screening form before the study, and will provide written consent for participation and data collection.

#### 20) Risks and benefits of research/ activity

a) Are there any potential risks or adverse effects (e.g. injury, pain, discomfort, distress, changes to lifestyle) associated with this study? If so please provide details, including information on how these will be minimised.

b) Please explain where the risks / effects may arise from (and why), so that it is clear why the risks / effects will be difficult to completely eliminate or minimise.

c) Does the study involve any invasive procedures? If so, please confirm that the researchers or collaborators have appropriate training and are competent to deliver these procedures. Please note that invasive procedures also include the use of deceptive procedures in order to obtain information.

d) Will individual/group interviews/questionnaires include anything that may be sensitive

or upsetting? If so, please clarify why this information is necessary (and if applicable, any prior use of the questionnaire/interview).

e) Please describe how you would deal with any adverse reactions participants might experience. Discuss any adverse reaction that might occur and the actions that will be taken in response by you, your supervisor or some third party (explain why a third party is being used for this purpose).

f) Are there any benefits to the participant or for the organisation taking part in the research (e.g. gain knowledge of their fitness)?

(a) No

(b) N/A

(c) No

(d) No

(e) In the case of adverse reactions such as injury to any of the participants, these will be excluded from the study and will not participate in any further intervention.

(f) Following the study, the club and coach will have a detailed knowledge of their player's strength, speed, agility and skill level prior to and post intervention.

## 21) Confidentiality, privacy and data protection

a) What steps will be taken to ensure participants' confidentiality?

- Please describe how data, particularly personal information, will be stored (all electronic data must be stored on St Mary's University servers).
- Consider how you will identify participants who request their data be withdrawn, such that you can still maintain the confidentiality of theirs and others' data.

b) Describe how you will manage data using a data management plan.

- You should show how you plan to store the data securely and select the data that will be

made publically available once the project has ended.

- You should also show how you will take account of the relevant legislation including that relating data protection, freedom of information and intellectual property.
- c) Who will have access to the data? Please identify all persons who will have access to the data (normally yourself and your supervisor).
- d) Will the data results include information which may identify people or places?
- Explain what information will be identifiable.
  - Whether the persons or places (e.g. organisations) are aware of this.
  - Consent forms should state what information will be identifiable and any likely outputs which will use the information e.g. dissertations, theses and any future publications/presentations.

(a) All participants will be given a numeric code, known only to the researcher. This will enable total data confidentiality. Data collected will be stored electronically on St. Mary's University servers, and any data collected on paper will be locked away in a cabinet in the researcher's office. If at any point data is to be withdrawn, the researcher will use the participants code to identify the appropriate data and withdraw it. All data will be disposed of securely after 5 years.

(b) As stated previously, participants will be allocated a numeric code and any data made public will show only the numeric code and no other identification. All data will be kept safely and password protected on a computer which is only accessed by the researcher.

(c) Cedric Sciberras and Dr. Stephen Patterson

(d) No

## 22) Feedback to participants

Please give details of how feedback will be given to participants:

- As a minimum, it would normally be expected for feedback to be offered to participants in an acceptable to format, e.g. a summary of findings appropriately written.
- Please state whether you intend to provide feedback to any other individual(s) or organisation(s) and what form this would take.

After data collection and necessary data analysis, all the participants will be given a short presentation of the study, including findings and conclusions. Any further personal data that is requested by any individuals taking part in the study will be only be given to the respective individual and will include only pre-and post-testing data.

The proposer recognises their responsibility in carrying out the project in accordance with the University's Ethical Guidelines and will ensure that any person(s) assisting in the research/ teaching are also bound by these. The Ethics Sub-Committee must be notified of, and approve, any deviation from the information provided on this form.

Signature of Proposer(s)	Date:
Cedric Sciberras	22 <sup>nd</sup> December 2016
Signature of Supervisor (for student research projects)	Date:
	06. 01. 2016



Approval Sheet

Name of applicant: Cedric Sciberras

Name of supervisor: Dr. Stephen Patterson

Programme of study: M.Sc. Strength and Conditioning

Title of project: The effect of weight and ballistic training on speed, agility, vertical jump height and skill performance in soccer players

Supervisors, please complete section 1 or 2. If approved at level 1, please forward a copy of this Approval Sheet to the School Ethics Representative for their records.

SECTION 1

Approved at Level 1

Signature of supervisor (for student applications).....

Date.....

SECTION 2

Refer to School Ethics Representative for consideration at Level 2 or Level 3

Signature of supervisor.....

Date.....

SECTION 3

To be completed by School Ethics Representative

Approved at Level 2

Signature of School Ethics Representative: 

Date: 11/01/2017

SECTION 4

To be completed by School Ethics Representative. Level 3 consideration required by the Ethics Sub-Committee (including all staff research involving human participants)

Signature of School Ethics Representative.....

Date.....

Level 3 approval – confirmation will be via correspondence from the Ethics Sub-Committee

The following Risk Assessment template may be used by any individual intending to undertake a research or practice activity. This should be completed in combination with a relevant activity approval or Ethics Application form where relevant. Referring to appropriate sources of information, including the HSE website and University Health and Safety Policy Guidelines, the relevant activity coordinator must complete the fields below to adequately address the stages of managing hazards in any working environment.

### Section 1 – Activity and Coordinator details:

<b>Activity coordinator name:</b>	<i>Cedric Sciberras</i>	<b>Tutor / supervisor:</b>	<b>Dr Stephen Patterson</b>	
<b>Phone number:</b>	<i>+356 7903 2281</i>	<b>Email address:</b>	<b>132045@live.smuc.ac.uk</b>	
<b>Activity title:</b>	<b>The effect of weight and ballistic training on speed, agility, vertical jump height and skill performance in soccer players</b>			
<b>Activity location(s) full details:</b>	<b>San Gwann FC Training Ground, Triq Il-Kampanella, San Gwann</b>			
<b>Outline of activity (please specify the type of activity being undertaken):</b>	<b>No</b>	<b>Yes</b>	<b>If yes, please provide details:</b>	
<b>1. Use of Human Subjects:</b> demographic type, requirements, age/young persons?		√	<b>Adult male soccer players</b>	
<b>2. Use of an intervention (either solely or in combination) including dosage or application:</b> E.g. ingestion of food, liquids or supplement, diet, massage, occlusion, environmental exposure, physical activity or other. <b>Outline of specific dosage or application where relevant</b> E.g. mg per kilo of body weight		√	2 sessions per week for a total of 8 weeks of either gym based exercises or on field ballistic exercises. Gym based exercises will be done twice a week: 8reps x 3sets @ 80% 1RM, whilst ballistic exercises will be progressed with foot contacts	
<b>3. Use of data and/or sample collection (solely or in combination):</b> E.g. questionnaire/survey, human tissue sampling (blood / urine / saliva / sweat or other), respiratory analysis, body composition, performance tests or other.		√	Tests done: Anthropometrics (age, weight, height, BMI), Agility T-test, 20m sprint, countermovement jump (CMJ), Loughborough passing skill test	
<b>4. Use of chemicals/gas cylinders:</b> Type(s), hazardous or not, MSDS available?	√			
<b>5. Equipment to be used:</b>				
Anthropometrics: stadiometer, digital weighing scales 20m sprint and Agility T-test: Electric timing gates, synthetic football pitch CMJ: Optojump Hurdles of varying height Weight training: Olympic bar bell and rubber weight plates				

**SECTION 2: Risk Controls** - For each hazard identified in Section 1, complete Section 2. Please refer to the Risk Assessment Guidance notes on simmsCAI folder for Risk Matrix. Please note that **L** refers to **Likelihood**; **S** refers to **Severity** and **RS** refers to **Risk Score (L times S equals RS)**

<b>Outcome due to Hazard</b> description (Substance / equipment / procedure)		<b>Initial Risk Level</b> High (13-25) Med (5-12) Low (0-4)	Necessary controls to eliminate or adequately reduce the <b>Initial Risk Level</b> of an associated hazard to a suitable <b>Remaining risk level</b> .	<b>Remaining Risk Level</b> High (13-25) Med (5-12) Low (0-4)
1	Access and usage of designated facility, site or location, including private or public.	High	Written approval to access and make use of the designated facility, site or location must be sought from the relevant owner, keeper or manager, where appropriate. Terms & conditions, qualifications, notification, booking requests, reporting, statements of intent or other formal agreement must be confirmed in advance of access and use. A separate assessment of local hazards should be undertaken to ensure safe working practice. Gauge which person(s) will be responsible for dealing with any potential emergency incident, including use of First Aiders, Security or other individual.	Low
2	Fire management and evacuation	High	Ensure appropriate responsibilities of relevant individuals or parties are established ensuring fire prevention, evacuation and individual roles are established prior to activity commencing. Please refer to University policy.	Low
3	Environmental exposure (internal and external) including temperature, humidity, lighting ventilation or relative weather conditions	High	Ensure suitable local working conditions including regulating temperature, lighting, and humidity where possible. Prepare relevant individuals to manage uncontrollable/unavoidable conditions including instruction on use of personal protective equipment, clothing, shelter, rehydration, rest periods/breaks or other relevant means to maintain suitable comfort and function. Brief individuals on managing experience of deliberate exposure to stressful conditions, including adequate avoidance of visual/physical exposure to sources of high level lighting and associated heat. Ensure low lighting allows participant to still work safely including avoiding injury or subsequent strain/pathology.	Low

4	Risks relating to layout, storage, space, obstructions including fall of objects, spillages, slips, trips & falls	High	Ensure all equipment layouts maintain a safe working environment. Ensure measures are in place to manage trip hazards including suitable form(s) of cable covers, excess cabling, objects or equipment do not affect walkway routes. Highlight visually and by instruction unavoidable trip hazards. Manage liquids to avoid spillages. Establish equipment available to manage spillages and who is responsible to address an incident. Ensure the avoidance of any falling object, or safe management processes for any item likely to or intended fall.	Low
5	Manual handling, repetitive movements and working at heights	High	Ensure users have received adequate training, adhering to the HSE and University manual handling guideline found on the staff H&S portal page. Identify and avoid or adequately reduce repetitive movements that may cause harm. Any individual working with ladders must receive appropriate training and qualification.	Low
6	Use of Equipment including electrical	High	Ensure users have received adequate competency training as specified on Section E) of the <b><u>Student Research Approval Form</u></b> to use the equipment. Check electrical items are Pat tested annually, no faults are present. No fluids near the equipment. Check wires for damage during setup and prior to use. Switch off equipment when not in use or in the event of an incident.	Low
7	Mechanical (machinery) and use of portable tools / equipment	High	Staff and students may only use equipment that is permitted and training has been provided for.	Low

**SECTION 2: Risk Controls (continued)** - For each hazard identified in Section 1, complete Section 2. Please refer to the Risk Assessment Guidance notes on simmsCAPital folder for Risk Matrix.

***Please note that L refers to Likelihood; S refers to Severity and RS refers to Risk Score (L times S equals RS)***

Hazard No.	<u>Outcome due to Hazard</u> description (Substance / equipment / procedure)	Initial Risk Level High (13-25) Med (5-12) Low (0-4)	Controls needed to eliminate or adequately reduce risks	Remaining Risk Level High (13-25) Med (5-12) Low (0-4)
8	Exposure to sharps – use of razors, lancets or other sharp object	High	Ensure users wear separate PPE per human subject. Ensure different (disposable only) razor, lancet or other invasive equipment used per human subject. Do not reuse disposable item more than once. Discard in suitable biohazard sharps container.	Low
9	Human subject physical activity, manipulation, treatment or other including use of equipment where relevant.	High	Prior to commencing any activity, ensure the practical activity coordinator(s) has completed all necessary competency training as specified on Section E) of the <b>Student Research Approval Form</b> . Adhere to the University Ethics procedures ensuring all human subjects have received a relevant information sheet, completed an Informed consent form and (Physical Activity Readiness Questionnaire (PARQ)/Medical History Form under the relevant Health and Safety procedures. Ensure documents are countersigned and dated at the same time (witness process) by the relevant research coordinator. Ensure documents are retained during the testing period, and then returned to the University for data protected archiving when testing has been completed This may vary where members of the public are approached on an ‘at the time’ basis under typical survey work. All ingestion interventions must address maximum safe dosage fit for the relevant human participant (s).	Low
10	Exposure and reaction to use of food, drinks or supplements	High		Low

11	Biological hazards	High	Ensure Practical Activity Coordinators (PACs) students have received Human Tissue sampling training and the relevant competency forms signed off by the trainer, considering all aspects of the School's use of Human Tissue (HT) Guideline (available in MyModule student information folder) for the management of biological hazards.	Low
12	Working at heights	High	Students and Human subjects not to work at heights. Only suitably qualified staff may assist.	Low
13	Lone working, including out of hours	High	Students not to undertake <u>unsupervised</u> out of hour's activity within University facilities. Field testing locations should be assessed for safe exposure and co-worker or check in systems should be adopted where deemed appropriate. Ensure University Security is notified of any supervised work taking place outside of normal weekday hours (Monday-Friday 9am-5pm)	Low
14	Use of chemicals	High	Ensure suppliers are appropriately registered and provide adequate Material Safety Data Sheet (MSDS). Refer and adhere to all instructed practice as detailed by the relevant MSDS for all chemicals used. <b>See HSE CHIP and REACH regulations.</b>	Low
15	Other (Please specify and attach a copy of the relevant methodology with associated safety notes):	High	To ensure safety during the intervention program for the gym based exercises players will have a familiarization session to get accustomed to the proper technique of exercise. Qualified coaches and trainers will be present to spot and ensure proper technique throughout the exercise. 20m sprint is done on a dry day to make sure synthetic grass is not wet and unsafe for the players, and players will make use of adequate footwear. Ergo jump used for countermovement jump is safely handled by qualified personnel and subjects will wear appropriate footwear. All testing and intervention program are done after all players properly warmed up. See attached note.	Low

**SECTION 3: Arrangement for supervision and/or monitoring effectiveness of control**

Monitoring is achieved through pre-and post-checks, continual test supervision and/or a separately recruited individual where further supervision or monitoring required. Even where subjects demonstrate high levels of competency, regular checks will be made by supervising staff that should also be readily available assist with any questions or problems subjects might have. Any malpractice will be amended or stopped if an emerging hazard dictates such a response. TI option will be adopted where any uncertainty occurs, seeking advice from suitable staff.

**SECTION 4: Referral guidelines relevant to the intended activity (scanned PDF of hard copy, listed web link or other source):**

Please ensure that all relevant reliable sources of information can be easily referred to at any time both during the preparation phase and period of activity. Please note some of the relevant University links will include:

<b>Information source</b>	<b>Location</b>	<b>Areas of information</b>
Student Information Folder	MyModules	Student Research Approval Form Laboratory specific guidelines and consumable costs School of SHAS Use of Human Tissue Guideline (new)
University Ethics Committee	Student portal	Ethics Application process and associated forms Example Human Subject Consent Form
University Health and Safety portal	Student portal	Health and Safety Policy guidelines including Risk Management, Loan working, Manual lifting, Display Screen Equipment and COSHH
The Health and Safety Executive	Website found through any web search engine	Well-presented sources of legally approved regulation and legislation covering COSHH, CHIP, RIDDOR, DSE and many other areas of health and safety at work
Further discipline specific sources of information may be relevant to the area of activity including accreditation bodies such as <b>BASES, BASRAT, SENR, AfN, BPS, UKSCA, REPS, HTA, ITEC etc</b>		

## **SECTION 5: Emergency response procedures**

In the event of an emerging incident, engage the individual(s) who have been previously agreed as responsible for addressing an emergency incident. Assess and eliminate (where safe) hazards that might place the individual(s) needing care or carer(s) at risk. Apply up to date first aid and/or seek medical assistance where appropriate. Contact the University security team for assistance with any incident on or off campus. Contact relevant staff (tutor, Technical team or other) where relevant. Complete relevant reporting form (accident, medical emergency or near miss) available to staff on the University H&S portal page, passing to the Technical Services team for processing. Complete HSE RIDDOR form where relevant, which can be found on the HSE website.

### **Important contact details (including where activities are undertaken off campus):**

- **St Mary's University Security – 0208 240 4335 or 4060** (advise in the event of calling the emergency services)
- **St Mary's University main reception – 0208 240 4000**
- **Health and Safety Executive (HSE) Information line – 0845 345 0055 / [www.HSE.gov.uk](http://www.HSE.gov.uk)**

**Please make note of any other relevant contacts here:**

**SECTION 7: Period of cover – If a more complex assessment is required, continue below:**

PERIOD OF COVER FOR TASK/EVENT		PRINT NAME OF TASK/EVENT LEADER(S)	SIGNATURE	DATE SIGNED	HAZARDS IDENTIFIED (mark with a tick or a cross)
FROM	TO				

**SECTION 8: Student liability declaration:**

By signing this risk assessment, I confirm that I have read and understood the above information that is relevant to my activity, and will ensure adherence appropriate practice at all times, based on completing formal competency training relevant to the activity I am planning to undertake. I understand that the above statements are intended to be generalised, being applicable to all forms of activity. Not all parts may apply to a specific activity, but it is my responsibility to outline any possible/further detail of necessary hazard management procedures as safety notes within the relevant activity methodology, as statements of intent within the associated Ethics Application Form and as associated Human Subject Consent Form and Information sheet.

<b>SIGNATURE:</b>	<b>Cedric Sciberras</b>	<b>PRINT NAME:</b>	<b>Cedric Sciberras</b>	<b>DATE COMPLETED:</b>	<b>22/12/2016</b>
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## **Methodology associated with safety measures**

All participants will warm up prior to the intervention. Warm up will consist of a 10min light jog which will include active mobility exercises. Subjects in the gym based exercise group will then do a few reps of back squat with a 20kg bar bell to prepare the joints for the required movements. A spotter will be on hand at all times in case of emergency, whilst the coach will be present to verify that adequate technique and form of each exercise is being done.

As for the ballistic exercise group, following the general warm up they will immediately start off with the intervention program. Coaches will be present on site at all times to identify any wrong techniques, and encourage subjects to give their maximal effort.

### **During testing:**

#### **20m sprint**

This is done on a different day than the 1Rm testing. Participants are asked to warm up on the outdoor synthetic pitch using the RAMP protocol. If the grass is too wet and the risk of slipping is high, then the test will be done on another day. However, participants are asked to stay in their football boots to minimize the risk of slipping. Participants finish off their warm up by a couple of sprints to raise the heart beat and prepare the subjects for maximal effort. Once the test starts, they are asked to sprint maximally past the last photocell gate and decelerate gradually once past the gate.

#### **Countermovement jump**

This test is done on the same day of the 20m sprint. After warming up, participants are asked to complete a couple of jumps to ensure proper technique and try out the ergo jump apparatus. Participants are reminded to land with bent knees after the jump to avoid knee injuries. Once the test starts, participants will be tested individually whilst the rest of the subjects will be asked to keep actively moving and readily prepared for their test.

#### **Loughborough Passing Skills Test**

This test is done on a separate day. Following a general warm up, participants will be guided and familiarised with the testing procedure and given adequate time to familiarise themselves with the commands to be given during the test. Coaches will be on hand to supply the test subject with soccer balls should there be the need. Subjects are asked to use soccer boots during this test.



## Section A: The Research Project

### Title of Project

The effect of weight and ballistic training on speed, agility, vertical jump height and skill performance in soccer players

### Purpose and value of study

The project is part of my final year for my Masters degree course at St Mary's University College, Twickenham, London. The aim of the study is to provide further insight on the effects of a gym based strengthening program and a ballistic training program on speed, agility and soccer skill performance.

### Invitation

I would like to invite you to participate in this project, which will examine the effects of two strength training programs on speed, agility and soccer skill performance.

### Who is organising the research

The research is being organised by myself (a postgraduate student at St Mary's University college Twickenham), together with the help of my supervisor Dr Stephen Patterson (Senior lecturer at St Mary's University College Twickenham).

### What will happen with the results of the study

The results are used for the purpose of the study only. A copy of the study will be available at the University's library.

### Source of funding for the research

Players registered with their senior squad for the season 2016/2017 will participate in this study. San Gwann FC will provide the premises and equipment for the intervention. The Malta Football Association (MFA) on the other hand will provide the equipment for the testing (20m sprint, agility and countermovement jump).

### Contact for further information

If you wish to get further information you may do so by using the following contact details

**Researcher:** Cedric Sciberras

Email: [132045@live.smuc.ac.uk](mailto:132045@live.smuc.ac.uk)

**Supervisor:** Dr Stephen Patterson  
Email: [Stephan.patterson@stmarys.ac.uk](mailto:Stephan.patterson@stmarys.ac.uk)  
St Mary's University College,  
Waldegrave Road  
Strawberry Hill  
Twickenham  
TW1 4SX

## Section B: Your participation in the Research Project

Why have you been invited to take part?

You are asked to participate in this study as you are currently registered with San Gwann FC for the season 2016/2017.

Can you refuse to take part?

You are not obliged in any way to take part in this study. You are free to refuse participation and will not have to give a reason should you wish to refuse participation.

Can you withdraw from the Project at any time? How?

Should you wish to withdraw from the study you are free to do so at any point and you will not need to give any reason for doing so. You can do so by informing the researcher via email.

What happens if you agree to take part?

Signing the attached consent form will automatically include you in the study group. I will then contact you and inform you the date for the pre-testing and which strength training program you will follow. You will be required to participate in two weekly sessions for a total of eight weeks. Following this you will be re-tested and data collected will be analysed.

Following termination of the study I will provide a summary of results to the squad.

Are there any risks involved?

There are no adverse reactions or risks by participating in this study. You are advised to follow instructions carefully and ask any questions should you not understand any particular exercise.

Will your legal rights be compromised if something goes wrong after agreeing to take part?

No

Are there any special precautions you must take before, during or after taking part in the study?

There are no special precautions required at any point of the study. Should you feel pain or sustain any injury during the eight weeks, you are kindly asked to advise the researcher at your earliest.

What will happen to the information and data collected from you?

Your results will be used for the purpose of this project only. You can be assured that if you take part in the project you will remain anonymous.

Are there any benefits of taking part?

Participating in this study will possibly result in physical and technical improvements, although the extent of which training program is more beneficial is still to be defined. Upon completion of the study, the participants and coaches will have a better insight on which training regime will produce the most favourable results during in season training.

How much time you will need to give up to take part in the Project?

The intervention program will last a total of ten weeks. Participants will perform their daily training session with the squad as per usual, however there will be two days per week in which the intervention program will be done. The table below explains exactly what will happen in each week.

Week	Day	Activity
1	Tuesday and Thursday	Test day 1 and 2
2 to 9	Tuesday and Thursday	Intervention program
10	Tuesday and Thursday	Test day 1 and 2

How will your participation in the Project be kept confidential

Your name will not be recorded on the test results and the information will not be disclosed to other parties.

**Researcher:** Cedric Sciberras

Postgraduate student, St Mary's University College Twickenham, London

**Supervisor:** Dr Stephen Patterson

Senior lecturer – Sport Science

Sport, Health and Applied Science

St Mary's University College Twickenham, London



St Mary's University Twickenham London

Name of Participant: \_\_\_\_\_

Title of the project: The effect of weight and ballistic training on speed, agility, vertical jump height and skill performance in soccer players

Main investigator and contact details: Cedric Sciberras Email: 132045@live.smuc.ac.uk

Members of the research team:

1. I agree to take part in the above research. I have read the Participant Information Sheet which is attached to this form. I understand what my role will be in this research, and all my questions have been answered to my satisfaction.
2. I understand that I am free to withdraw from the research at any time, for any reason and without prejudice.
3. I have been informed that the confidentiality of the information I provide will be safeguarded.
4. I am free to ask any questions at any time before and during the study.
5. I have been provided with a copy of this form and the Participant Information Sheet.

Data Protection: I agree to the University processing personal data which I have supplied. I agree to the processing of such data for any purposes connected with the Research Project as outlined to me.

Name of participant (print) .....

Signed .....

Date .....

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If you wish to withdraw from the research, please complete the form below and return to the main investigator named above.

Title of Project: The effect of an 8-week in season gym based strength-training program versus an on field ballistic strength-training program on speed, agility and soccer skill performance in adult soccer players.

I WISH TO WITHDRAW FROM THIS STUDY

Name: \_\_\_\_\_

Signed: \_\_\_\_\_

Date: \_\_\_\_\_

**Appendix C – Participant screening form**



**St Mary's  
University  
Twickenham  
London**

Name: \_\_\_\_\_

Surname: \_\_\_\_\_

Date of birth: \_\_\_\_\_

Age: \_\_\_\_\_

Nationality: \_\_\_\_\_

Preferred foot:  Left

Right

Position:  Central Defender

External Defender

Central Midfielder

External Midfielder

Central Attacker

External Attacker

Years playing soccer:  1 – 5  6 – 10  11 – 15  16+

Ever sustained serious injury that required surgery?  Yes  No

If yes, specify what operation and year: \_\_\_\_\_

Have you had any injury in the past 2 months that kept you out of action for more than 2 consecutive games?  Yes  No

If yes, specify what injury and which side: \_\_\_\_\_

How do you rate your knowledge and skills in the weight room?

Poor

Average

Good

## Appendix D – Confirmation letter for participation in the study



20<sup>th</sup> December 2016

Reference: Participation in an intervention study entitled, 'The effect of weight and ballistic training on speed, agility, vertical jump height and skill performance in soccer players'.

To whom it may concern,

This is to confirm that San Gwann FC is granting permission to Mr Cedric Sciberras to use its facilities and registered players to participate in the above-mentioned study. The coach and players have been briefed about the study and any questions asked have been explained by Mr Sciberras.

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Mr Stefano Grima

Head Coach