The effects of a soccer season on anthropometric characteristics, physical fitness, and soccer skills in North African elite female youth soccer players

Mohamed A. Hammami. [a*], Ben Ayed K. [a*], Ajmol Ali [b*], Hamza Marzougui [a], Jason Moran [c], Cain C. T. Clark [d], R. Mekni [a], Hassane Zouhal [d]

[a] *Sport Sciences, Health and Movement (2SHM) Laboratory, High Institute of Sport and Physical Education of Kef, University of Jendouba, Tunisia.*

[b] *School of Sport, Exercise and Nutrition, Massey University, New Zeland.*

[c] *School of Sport, Rehabilitation, and Exercise Sciences, University of Essex, 62326 Colchester, United Kingdom.*

[d] *Centre for Intelligent Healthcare, Coventry University, Coventry, CV1 5FB, United-Kingdom.*

[e] *Univ Rennes, M2S (Laboratoire Mouvement, Sport, Santé) - EA 1274, F-35000 Rennes, France.*

***: These authors contributed equally to this study.**

Corresponding author:

Prof. H. ZOUHAL, hassane.zouhal@univ-rennes2.fr

Running title: Fitness parameters in women soccer players.

Abstract

Backround and objectives: In comparison to their European counterparts, there are scarce data regarding skill performance in young elite female North African soccer players. The objectives of this study were to evaluate the effects of a season-long training regime on anthropometric and physical performance characteristics, agility, and soccer skills in Tunisian youth elite female players.

Materials and Methods: Forty-eight females (24 soccer players SG; 24 non-playing controls, CG) were evaluated at the start of a preparatory period (T1) in September, and 10 months later in June (T2), the end period of the competitive season. Anthropometrics (body mass, body composition), soccer-specific cardiorespiratory endurance (Yo-Yo Intermittent Recovery Test Level 1; YYIRT1), muscle power (countermovement jump [CMJ]; squat-jump [SJ]; 5-Jump-Test [5JT]), agility (T-test with and without ball), soccer skill (Loughborough Soccer Passing Test, LSPT) and sprint speed (30 m sprint with 5 and 10 m splits) were measured.

Results: The SG experienced significant performance improvements in all tests across the period of the competitive season, demonstrating greater ~~improvements~~ increases in height ($p<0.0001$, ES= 1.69), weight ($p<0.0001$, ES= 0.92), and BF ($p<0.0001$, ES= 1.63), in addition to better CMJ ($p<0.0001$, ES= 1.63), SJ ($p<0.0001$, ES= 1.33), and 5JT performances than the CG ($p<0.004$, ES= 0.39). Similarly, the SG performed better in the sprint, agility, and LSPT tests, and covered longer distances in YYIRTL1 ($p<0.0001$), compared to the CG.

Conclusion: Soccer season training contributed to significant variations in anthropometric characteristics, physical fitness, and soccer skills in Tunisian elite female youth soccer players, compared to control group, that are beyond those which could be expected through biological maturation alone.

Key words: performance indicators, development, annual training, adolescent elites

Introduction

Women's soccer is inexorably rising in popularity with the number of female players worldwide being estimated to be around 30 million (Sedan et al., 2009; Manson., 2014). Thate number of female soccer players has increased in recent years by approximately 50%, considering the last most recent report of FIFA (Milanovi´c., 2017). In view of this increase, several researchers have sought to understand the characteristics of these players, their physiological and physical requirements, and their training processes (Sedan et al.,2009; Ramos et al., 2017; Hammami et al., 2019). Recently, Gonçalves et al., (2021) analyzed the relationships between fitness status and match running performance and explored the main determinants of repeated-sprint ability in women soccer players, considering aerobic capacity, sprinting performance, change-of-direction, vertical height jump, and hip adductor/abductor isometric strength (Gonçalves et al., 2021). Moreover, a recent investigation has examined the anthropometric profiles and evaluated physical fitness variables of a women's national football team based on their playing positions (Villaseca-Vicuña et al.,2021). However, despite this growing trend, compared to other continents, the number of licensed players is still small in Africa, especially in North Africa, where the women's game is less developed. Traditionally, male African players have been both prominent and successful in the major soccer leagues of Europe. However, females from the same continent are less well-represented in their equivalent leagues, whilst the number of females who play the sport is comparatively smaller (FIFA, 2012; UEFA, 2017).

Soccer is a multi-faceted sport in which the most talented players possess excellent technical and tactical acumen, high physical fitness, and specific athropometric charactetristics (Castagna et al., 2010). Accordingly, coaches at the elite level are persistently searching for the most successful methods to identify and develop talented young soccer players (Francisco et al., 2011). In the field of scientific research in soccer, a number of studies have elucidated the physical characteristics of female players in Europe and the United States (Andersson et al., 2010; Krustrup et al., 2010; Krustrup et al., 2005; Miller et al., 2007; Sedano et al., 2009; Vescovi and McGuigan, 2008). However, mainly because of the low number of African female players, studies in this population are scarce, thus necessitating further investigation of the salient issues in the women’s game. Since females differ from males in many physical parameters related to soccer (Krustrup et al., 2005), an objective evaluation of young female players’ potential, in addition to a description of anthropometric, technical, and tactical abilities, would be of interest to coaches and scientists ~~interested~~ engaged in the development of~~ing~~ female talent at the foundational level of soccer in Africa (Andersson et al., 2010, Krustrup et al., 2010). Many scientific papers have indicated that the physiological loads reported during matches are similar ~~across genders~~between the sexes, suggesting that the aerobic system is heavily taxed throughout and particularly during intense periods of a game (Krustrup et al., 2010). However, female players appear to possess a lower physical capacity than male players across a range of aerobic and anaerobic fitness tests (Bradley et al., 2012; Mujika et al., 2009). Thus, it is not surprising that studies have reported that high-intensity running in elite female matches is up to 30% lower than their male counterparts of a similar competitive standard (Krustrup et al., 2005; Mohr et al., 2008).

Two reviews focusing on the physical and physiological demands of women’s soccer have been published (Martinez-Lagunas and Hartmann, 2014, Naomi et al., 2014) but, up to now, studies have only examined the effect of seasonal training on anthropometric characteristics and physical and technical qualities in adults (Silva et al., 2011; Mara et al., 2015; Miloski et al., 2016; Jaspers et al., 2017) and young male players (Williams et al., 2011; Hammami et al., 2013; Di Giminiani and Visca, 2017; Nobari et al., 2021). To our knowledge, no data on North African female soccer players has yet been published~~,~~ even though the game is historically well established on the continent. Moreover, there is no data pertaining to skill performance in U17 female African players. These observations demonstrate the need to put more emphasis on female youth players with a view to developing the scientific approach to women's soccer in African populations. The purposes of this study were, therefore, to investigate skill performances and to evaluate the effect of a season-long training regime on anthropometric and physical performance characteristics, agility, and soccer skills, compared to age-matched controls, in young female North African elite soccer players.

Methods

Participants

Forty-eight females volunteered to participate in ~~our~~ the study. Twenty-four participants were soccer players from the Tunisian national under 17 team. These ~~elite group~~ players were selected from six regional centers of football throughout ~~Tunisia~~the country. The players trained for ten months ~~per~~ of the year, for at least three years, with a rate of five training sessions and one competitive game per week. In addition, participants ~~had~~ undertook physical education courses at college (***ie***; two sessions of 50 minutes each per week). The first selection from these centers was made from 180 young female ~~soccer~~ players. The criteria used for selection ~~is~~ was based on technical tests and physical fitness parameters. Twenty-four players were allocated to the soccer group (SG, 16.5 ± 0.4 years), whilst the other 24 participants (CG, 16.3 ± 0.3 years) were assigned to the control group (non-athletic girls). They participated only in the compulsory physical education curriculum at school (***ie***; also two sessions of 50 minutes each per week). These girls~~y~~ were randomly chosen and were representative of the general population. No drop-outs were reported during the experimental period. ~~No drop-outs were reported during the experimental period.~~ Prior to the study, written informed consent for participation was obtained from each subject and their parents or guardians, and the study was approved by the Institutional Ethics Committee of High Institute of Sport and Physical Education of Kef, Tunisia (approval number: IEC- HSPE-19062020). Furthermore, the present study was conducted according to the Declaration of Helsinki and its latest amendments.

Experimental procedures

Comparisons between groups were facilitated by using traditional field fitness tests that have previously been reported to be relevant to soccer (Krustrup et al., 2005, Svensson and Drust, 2005). All participants were evaluated at two time-points during the season: ***i)*** at baseline, at the start of a preparatory period (T1) in September; and ***ii)*** ten months later in June (T2), at the end of the competitive season. The tests were performed by the elite female soccer players and the control group at the same time (between 8:00 and 12:00) and the same place (**Figure 1**). All test procedures were supervised by the same assessors and all participants were familiarized with all test procedures. Testing was conducted over a three-day period. Across the three testing days, all participants performed a standardized 15-min warm-up consisting of low-intensity running, a series of dynamic stretching exercises (high knee lifts, butt kicks, straight line skipping, etc.), and short accelerations. On the first day, participants performed a SJ, CMJsquat jump (SJ), countermovent jump (CMJ) with arm swing allowed, a 5JT, and a 30-m sprint. During the second day, participants performed the agility tests and soccer skill test [LSPT]. On the third day, participants performed a Yo-Yo IRT Level 1 (**Figure 1**).

Anthropometric characteristics

Each participant came to the laboratory for a medical examination and anthropometric measurements, which were collected by a paediatrician before and after the soccer season period. Height and body mass were measured with standard techniques to the nearest 0.1 cm and 0.1 kg, respectively. To estimate adiposity, skinfold thickness was measured at four sites on the left-side of the body (triceps brachii, biceps brachii, subscapular and suprailiac) using a skinfold calliper (Harpenden, British Indicators Ltd., Luton, UK) for the calculation of body fat percentage according to the equations presented by Durnin and Webster (1985). All measurements were taken in the morning by the same investigator (T1 and T2).

Puberty stage assessment

The pubertal stage was used as an indicator of biological maturity status. It was determined and recorded by a pediatrician experienced in the assessment of secondary sex characteristics, according to the method of Tanner (1975). Girls at pubertal development stages 1–5 were evaluated. At the beginning of the study, according to their pubescent status, the young female soccer players and the control group were ~~ascribed~~ classified as being ~~to~~ in ~~a~~ Tanner stages 4 and 5 ~~(4-5)~~.

Physical fitness characteristics

All tests were undertaken by the same investigators and~~,~~ were scheduled at the same time of day, ~~and were~~being carried out in the same order and using the same apparatus for each test period. All jumping tests were performed on a concrete surface with the players wearing running shoes. The running speed tests were performed on an artificial soccer pitch with the two groups wearing conventional soccer cleats. Each participant was instructed, and verbally encouraged, to exert maximal effort during all tests.

Vertical jumping

Each participant performed two kinds of maximal jump. For the SJ, participants started with knees bent at a 90° angle, and without a preceding counter movement, jumped vertically from a stationary position by extending the legs as forcefully as possible. For CMJ, the participants initiated the movement from a standing position allowing for a counter movement prestretch with the intention of achieving a flexed knee angle of around 90° prior to propulsion. The forces generated during these vertical jumps were estimated with an ergo jump apparatus (Opto Jump Microgate, Italy). In addition, participants performed the 5JT (Chamari et al., 2008). Each participant performed three trials in total, inter-spersed with a 1-min rest between each jump, with the best jump being used for analysis (Chamari et al., 2008).

Running speed test

The time needed to cover 5 m, 10 m, and 30 m was measured with an infrared photoelectric cell (Cell Kit Speed, Brower, USA). The participants were encouraged to run as fast as they could, performing three trials in total. There was a 3-min recovery period between each trial. The best (fastest) 30-m sprint time and the associated 10 m and 5 m split times were selected for analysis.

Agility (T-test)

The T-test is a measure of multidirectional agility and body control that evaluates an individual's ability to change directions rapidly whilst maintaining balance and speed (Pauole et al., 2000). Performance in the T-test (with and without ball) was measured with infrared photoelectric cells (Cell Kit Speed Brower, USA).

Loughborough Soccer Passing Test (LSPT)

The LSPT was developed to assess the multifaceted aspect of soccer skill execution including passing (Ali et al., 2007). Briefly, this test consisted of 16 passes, against coloured target areas, performed within a circuit of cones and grids as quickly and as accurately as possible. Three indices of performance were calculated: the time necessary to complete the 16 passes (LSPT time); accumulated penalties, which were calculated from the errors committed by each player during the test execution (LSPT penalty time), and total performance (LSPT total performance).

Scoring was based on the time taken to complete the test after adjustment for penalties and bonus time.

All participants were familiarizsed with the LSPT during a one week period (four times per week) before testing. They performed a total of two trials, with a 5-min recovery period between each trial. The best LSPT total performance time was selected for analysis.

Yo-Yo Intermittent Recovery Test Level 1

The Yo-Yo IRT Level 1 test was performed according to the procedures described by Krustrup et al. (2003). Briefly, the YoYo IRTL1 consists of repeated 20-m runs back and forth between a starting, turning, and finishing line, at a progressively increased speed, controlled by an audio metronome. Participants had a 10-s active rest period (decelerating and walking back to the starting line) between each running bout. Participants stopped of their own volition or were mandatorily withdrawn from the test if they failed to reach the finishing line in time on two occasions. The total distance covered was recorded for analysis.

Sample size

The total sample size was estimated using the following formula (Maxwell et al., 2008):

$$N = \frac{(r + 1)\ (Z_{\alpha/2} + Z_{1-\beta})^2\ \ \delta^2)}{r\ d^2}$$

- *"N" is equal to n_1 + n_2 ("n_1"* and "*n_2" are the sample sizes for the two groups of soccer player and the control group).
- *"$Z_{\alpha/2}$"*: normal deviate at a level of significance (= 2.58 for 1% level of significance);

- "$Z_{1-\beta}$": normal deviate at *1-β%* power with *β%* of type II error (= 1.64 at 95% statistical power);
- "*r*" (equal to n_1/n_2): ratio of the sample size required for the two groups (r = 1 gives the sample size distribution as 1:1 for the soccer players and the control group).
- "*δ*" and "*d*" are the pooled standard-deviation (SD) and the difference of the 30 m test means of the two groups determined at T1. These two values were obtained from a previous study having a similar hypothesis and including 24 male soccer players (mean±SD of age and weight were 14.5±0.4 years and 67.7±5.6 kg, respectively), and 26 non athletic boys (mean±SD of age and weight were 14.3±0.3 years and 53.6±6.1 kg, respectively) (Hammami et al, 2013). During the T1 period, the soccer players’ had a ~~T~~30 ms sprint time of 4.5±0.2 s and the non athletic boys had a ~~T~~30 m sprint time of 5.2±0.1 s (Hammami et al, 2013).

The total sample size was 48 (24 soccer players and 24 control group). The assumption of 20% of nonattendance during the second testing experimental condition ~~gives~~ gave a revised sample of 60 [= 48/(1-0.20)].

Statistical analyses

Data are presented as mean ± SD. The normality and the homogeneity of variance for all data were checked with the Shapiro-Wilk and Levene's tests, respectively. For statistical analyses, an analysis of covariance (ANCOVA), with group as a between-subject comparator (SG and CG), and baseline data as a covariate, was computed due to significant baseline differentials across all baseline values between the two groups. Bonferroni post hoc tests were used if significant main effects or interactions were identified. This method has been proposed as the most sufficient statistical approach for the analysis of continuous outcomes (Vickers and Altman 2001). Effect sizes (ES) were determined from ANCOVA output by converting partial eta-squared to Cohen’s "d" (Cohen, 1988). Within-group ES were computed using the following equation: ES = (mean post – mean pre)/SD (Cohen, 1988). In accordance with Hopkins et al. (2009), ES were considered trivial (<0.2), small (0.2-0.6), moderate (0.6-1.2), large (1.2-2.0) and very large (2.0-4.0) (Hopkins et al., 2009). The level of significance was set at p<0.05, *a priori*. Additionally, intraclass correlation coefficients (ICC) and coefficients of variation (CV) were computed to assess relative and absolute test-retest reliability (Table 1). All analyses were performed using Statistical Package for Social Sciences (SPSS) version 24.0 (SPSS Inc., Chicago, Illinois, USA).

Results

All players from the SG completed the study. There was a 95% adherence rate across all groups and none reported any training or test-related injury. The ICCs for the assessed physical test variables ranged from 0.879 to 0.995, indicating good to excellent agreement between trials, while CVs ranged from 1.24 to 9.73 %, indicting good intratest reliability (Table 1).

During the soccer season, height and weight results showed that there was a main effect of time for the SG in height and weight, respectively (p<0.011; ES = 0.54, small; p<0.006; ES = 0.75, moderate) (Table 2). Significant performance improvements were found over the soccer season in physical fitness, as follows: a large ES was observed in S10 sprint test, T-test with and without ball, and YYIRTL1. Large significant differences magnitude ~~was~~ were identified for height (p<0.0001; ES = 1.69, large), while %BF was lower in the SG compared to CG which demonstrated a very large ES (p<0.0001; ES = 3.112) (Table 2). In addition, the SG had a higher CMJ (p<0.0001, ES= 1.63, large), SJ (p<0.0001, ES= 1.33, large) and 5JT (p<0.004, ES= 0.39, small) (Table 3) whilst the effect sizes for linear sprint were small. For agility and the LSPT, performance was significantly lower in SG compared to CG (ES= 1.12, moderate) (Table 4). Moreover, compared to the CG, the SG covered greater distances during YYIRTL1 (p < 0.0001; ES=1.93, large) (Table 4).

Discussion

The main findings of the present study showed that anthropometric parameters, physical fitness, and soccer skills changed during a one-season training program in young female soccer players. Accordingly, this research provides novel reference data for Tunisian elite level female soccer players, aged 16.5 ± 0.4 years. To the authors' knowledge, this is the first study to examine skill performance and evaluate the effect of a season-long training regime on anthropometric and physical performance characteristics, agility, and soccer skills (LSPT) in young North African elite female soccer players, compared to age-matched controls. The two groups were evaluated before and after a 10-month competitive season. Several studies have examined the relationship between measures of training load, anthropomety, body composition, and/or physical fitness in elite adult soccer players over the course of a soccer season (Silva et al., 2011; Mara et al., 2015; Miloski et al., 2016; Jaspers et al., 2017). Findings from these studies indicate significant variations in body composition and physical fitness according to the demands of the respective training period. Regarding anthropometic characterisitcs, our study demonstrated significant seasonal increases between T1 and T2 for the SG in body height and weight, alongside a reduction in body fat (Table 2). Similarly, many studies have demonstrated that anthropometry and body composition changes occur during a soccer training season in both male and female young soccer players (Mukherjee and Chia, 2010; Hammami et al., 2013; Oyón et al., 2016; Lesinski et al., 2017; Gamble., 2006).). Indeed, Hammami et al. (2013) found significant increases in body height in young elite male young soccer players (15 ± 0.5 years). Similalry, Oyón et al. (2016) demonstrated significant increases in body height, body mass, and relative body fat during a training season for female young soccer players. The expected finding could aid to in our understanding of the factors contributing to the performance change of physical characteristics, as well as aid in further refining the accuracy of early selection, training, and testing procedures in female soccer. Concordantly, Lesinski et al. (2017) reported a significant main effect of time for almost all anthropometric and body composition measures, except for body mass index, in young female elite soccer players (15.3 ± 0.5 years). In the present study, compared to the CG, the SG showed significant differences in height, weight, and in percentage of body fat (% BF) (Table 2), with the SG being significantly taller and heavier. Correspondently, some studies (Cacciari et al., 1990; Juricskay & Mezey, 1994; Nikoladis & Karidis, 2011) have shown that sport participation has beneficial effects on growth and, accordingly, reported that young soccer players were taller and ~~skeletally~~ more skeletally mature, compared to their chronologically age-matched counterparts. (Hammami et al., 2013 ; Nebigh et al., 2009 ; Gil et al., 2007 Malina et al., 2000 ; Carling et al., 2009).

~~-~~In the current study, significant increases in fitness were observed in the SG during the 10-month study period. The~~se~~ female players had significantly greater jump height (in CMJ, SJ and 5JT) (Table 3), better performance in Yo-YoIR1~~,~~ and ~~were~~ had faster ~~in~~ 10 m and 30 m sprint times between T1 and T2 (Table 4). Similarly, the female soccer players had ~~better~~ improved performance in agility (T-test with and without ball) and in ~~total~~ performance of LSPT (Table 4). ~~Therefore~~Given these results, it appears that the superior performances revealed by the significant differences in fitness parameters may be facilitated by higher training volumes and regular soccer competition in the female soccer players.

~~-~~Chamari et al. (2008) showed that CMJ, SJ and 5JT are reliable tests for evaluating a player's ability to achieve high muscular power in the lower limbs, which is of great importance in soccer performance. ~~Regarding~~ In relation to muscular power, our findings were concordant with Sander et al. (2013), who reported that, in soccer, strength, power, and speed are very important because of the large number of ~~power~~ rapid muscle actions performed during the course of a ~~game~~match. The authors examined the influence of periodised strength training for power performance for more than two~~2~~ years, ~~and found~~finding that for strength training, there was significantly better performance from the soccer training group (p <0.001), whilst in ~~the~~ a sprint test, significantly ~~better~~ larger improvements, of up to 6%, were reported (p <0.05 to p <0.001). (Sander et al., 2013). Further, our results correspond with the data of Todd et al. (2002), who demonstrated significant differences in vertical jump ~~performance~~ height in English female players and ~~confirmed~~ suggested that ~~vertical jump height~~performance in this test is ~~considered~~ a discriminating variable in the identififcation of talented female soccer players. Also, Manson et al. (2014) concluded that coaches should emphasize the development of speed, maximal aerobic velocity~~,~~ and leg strength in developing female soccer players; concomitant to Mujika et al. (2009), who posit that coaches ~~and fitness trainers~~ should consider specific explosive strength training when ~~dealing~~ working with prospective female soccer players.

In soccer games, 96 % of sprint bouts are shorter than 30m in distance, with 49% of those being shorter than 10m. Haugen et al. (2014) indicated that straight-line sprinting is the most frequent action before goals, both for the act of scoring, and ~~the~~ in assisting ~~of a~~another player to do so. In this study, female soccer players were faster in 10 m and 30 m sprinting speed after 10 months of soccer training, and these results are similar to those presented by Mara et al. (2015)~~,~~ who ~~discerned~~ reported ~~the~~ variation in training demands, physical performance ~~,~~ and player well-being across a women's soccer season. The aforementioned authors showed that ~~performance~~ speed in 5 m, 15m, and 25m sprints increased significantly after one season of training. These results can ~~be also~~ be ~~explained~~ contextualsied ~~according to~~by evidence put forward by Wong et al. (2009), by reference to ~~the~~ anthropometric characteristics. ~~In fact, they~~These authors demonstrated that ~~body height~~stature was significantly correlated with 10 m and 30m ~~speed~~ sprint ~~time~~ speed and that body mass was significantly correlated with ~~30m sprint time~~the latter of those two tests. Jovanovic et al. (2011) showed that agility was an important component of soccer play and mentioned that a training program~~me~~ of agility, with and without a ball, was found to be an effective way of improving some aspects of power performance.

In the present study, agility was assessed as time taken ~~during~~ to complete a T-test with and without the soccer ball with the~~.~~ ~~Similarly, the~~ SG displaying~~yed~~ statistically significant ~~differences~~ increases ~~in agility~~ between T1 and T2. ~~Thus~~Accordingly, our study shows~~ed~~ that one season of soccer training could exert positive effects on agility with and without a ball ~~for~~ in female ~~soccer~~ players ~~and this can be explained by the fact that the training programme recommended for elite female soccer players was focused on coordination exercises with and without the ball~~with these enhancements in performanc potentially due to coordination exercises carried out throughout the year. Indeed, such practices were deemed important by Weineck et al~~.~~ (2000)~~, as they~~who included relevant technical elements within ~~the~~ conditioning training ~~and this type of training program improves~~to improve agility ~~performance in agility, which is considered to be one of the key components of contemporary soccer~~which is considered a key demand in contemporary soccer play (Jeffreys, 2004; Meckel et al., 2009). Our results ~~regarding~~ relating to agility performance were in agreement with the study of Zoran et al. (2011)~~,~~ who demonstrated that 12 weeks of a conditioning program~~me~~ involving speed, agility, and quickness training was an effective way of improving agility, with and without the ball, ~~for~~ in young soccer players and can be included in physical conditioning program ~~programmes~~.

In our study, the young ~~soccer~~ female players ~~have~~ demonstrated statistically significant difference in LSPT ~~total~~ performance times between T1 and T2 ($p<0.0001$). The observed results of this test ~~LSPT total performance times at T1 and T2 for our elite SG are similar to~~reflect those reported in ~~the~~ a study in elite female players ~~of~~ by Ali et al. (2008) ~~in elite female players,~~ ~~and~~ but were lower in magnitude than those reported in ~~the~~ young players elsewhere in the literature (Ben Ounis et al., 2012)~~ in young soccer players~~. ~~Indeed, t~~This can be explained by the documented differences ~~between~~ in ~~the~~ performance ~~of~~ between boys and girls, ~~and such a detailed analysis could be useful for~~with sex-specific training seemingly key for optimal preparation (Bradley et al., 2014).

~~In the present study, o~~Our results showed a significant increase ~~of~~ in the ~~the~~ total distance covered during the Yo-Yo test (level-1)~~, after 10 months of soccer trainin~~ g~~. This~~ with this finding ~~can be~~potentially explainableed by the training intensity to which these athletes were exposed throughout the training period~~-~~. Our results at T2 are ~~almost the same as~~equivalent to those presented by Mujika et al. (2009) for junior female soccer players (826 m ±160) and Zoran et al. (2011) who showed that Serbian elite female soccer players ~~A national team,~~ (aged 23.95 ± 4.52) covered between 880m and 930 m. ~~and~~ Similarly, Nosomu and Kuzuhara (2015) ~~who~~ reported that Japanese ~~women's soccer~~ first division ~~league~~ female players ~~witch have mean age~~ (aged 19.4±0.9 years) performed achieved a mean distance of ~~(~~889±321 mm~~)~~. The distances covered by the SG in our study were lower than ~~the distance~~those in the Yo-YoIR1 for professional female first division players from the Danish League (mean 1379 m, range 600–1960 m) during the competitive season (Castagna et al., 2010), and also lower than those of Mujika et al. (2009) for senior female first division players (1224 m±255). ~~The research of~~Research by Castagna et al. (2006) and Krustrup et al. (2003)~~, noted~~ indicates that differences in Yo-YoIR1 performance have been reported depending on training status, period of the season, and explosive strength of the lower limbs in soccer players.

Strengths and limitations

The present study, to the authors' knowledge, represents the first work to have examined skill performance and evaluated the effect of a season-long training regime on anthropometric and physical performance characteristics, agility, and soccer skills (LSPT) in young North African elite female soccer players, compared to aged-matched controls. ~~Indeed, t~~We believe this ~~is~~ to be a vitally important element of developing female players given the distinct lack of published data pertaining to ~~female players from the continent of~~this population in Africa.

~~However, d~~Despite ~~the~~ its novel ~~addition~~ contribution to the literature, it should be recognized that this study does have some limitations. The utilized sample size ~~is~~ was small, and thus, a larger sample ~~, including other sports teams such as handball, basketball or rugby, could have increased the generalizability~~would increase the statistical power of the results. ~~In addition, female elite young athletes represent a highly limited population, thus precluding the recruitment of a markedly higher sample. We hypothesize that a~~The pooling of data between North African countries could have allowed us to understand, more precisely, the exact the characteristics of players from that region, and to compare them to stronger African soccer nations such as Nigeria, Cameroon, South Africa, Ghana, and Ivory Coast.

Conclusion

In summary, following a longitudinal follow-up ~~during~~ after one season of soccer ~~season~~, the applied training stimuli~~us~~ may explain ~~the~~ increases in anthropometric, physical performance characteristics, agility, and soccer skill of North African youth elite female soccer players, compared to a control group of the same age. There were minimal changes in the non-athlete group and, therefore, any observed changes in the soccer players ~~was~~ could ~~likely~~ be attributable to their exposure to training. For future investigations, a larger sample, including other age categories, and team sports would be of major importance. Indeed, there has been very few published data on skill performance in young elite female African soccer players compared to the extant literature on European players. Thus, we strongly advocat that North African researchers and coaches work more collegiately on women's soccer, with the aim of generating more data on anthropometric, physical, technical, and tactical characteristics.

Practical Applications:

The anthropometric characteristics and physical fitness level of female players have been shown to be important attributes ~~for~~ in soccer performance. Therefore, this study provides novel baseline data of youth North African female soccer players, which is necessary for coaches to inform training prescription design. Coaches can structure their programs of physical development in soccer according to the decribed parameters in this study and could expect outcomes of a similar magnitude in female players. Accordingly, this could facilitate enhancements in the standard of girls and~~in~~ women's soccer on the continent of Africa and in the wider game in general~~and contribute to increasing the success of football game~~.

Further studies are needed to compare the results of the North African players by countries (Nigeria, Cameroon, South Africa, Ghana, and Ivory Coast) where the game is well established on the continent. Furthermore, we query as to why, until the year 2022, ~~there~~ no North African teams have progressed to the group stages of the age groups' (FIFA Under 17, U20 and Senior) Women's World Cup tournaments?

ACKNOWLEDGMENTS

We wish to express our warmest gratitude to all those who contributed to this study. We would especially like to thank the players, coaching staff and the Tunisian Football Federation for facilitating the development of this research.

References

Ali, A., Williams, C., Hulse, M., Strudwick, A., Reddin, J., Howarth, L., McGregor, J. (2007). Reliability and validity of two tests of soccer skill. Journal of Sports Sciences, 25(13), 1461–1470. doi: 10.1080/02640410601150470

Ali, A., Foskett, A., and Gant, N. (2008). Validation of a soccer skill test for use with females. International Journal of Sports Medicine. 29 (11), 917–921.

Andersson, H.A.; Randers, M.B.; Heiner-Møller, A.; Krustrup, P.; and Mohr, M. (2010). Elite female soccer players perform more high-intensity running when playing in international games compared with domestic league games. J Strength Cond Res. 24, 912-9. doi: 10.1519/JSC.0b013e3181d09f21

Ben Ounis, O., Benabderrahman, A., Chamari, K., Ajmol, A., Benbrahim, M., Hammouda, A., Hammami, M.A., Zouhal, H.; (2012) Association of Short-Passing Ability with Athletic Performances in Youth Soccer Players. Asian Journal of Sports Medicine. 4 (1): 41-8. doi: 10.5812/asjsm.34529

Bradley, P. S., Bendiksen, M., Dellal, A., Mohr, M., Wilkie, A., Datson, N., et al (2012). The application of the Yo-Yo Intermittent Endurance Level 2 Test to elite female soccer populations. Scandinavian Journal of Medicine & Science in Sports (Epub ahead of print).

Bradley, P.S.1., Bendiksen, M., Dellal, A., Mohr, M., Wilkie, A., Datson, N., et al. (2014). The application of the Yo-Yo intermittent endurance level 2 test to elite female soccer populations. Scand J Med Sci Sports. 24 (1): 43–54. doi: 10.1111/j.1600-0838.2012.01483.x.

Cacciari, E., Mazzanti, L., Tassinari, D., Bergamaschi, R., Magnani, C., Zappulla, F., . Nanni, G., Cobianchi, C., Ghini, T., Pini, R., et al. (1990). Effects of sport (football) on growth: Auxological, anthropometric and hormonal aspects. European Journal of Applied Physiology, 61, 149–158. doi: 10.1007/bf00236710

Can, F., Yilmaz, I., and Erden, Z. (2004). Morphological characteristics and performance variables of women soccer players. J Strength Cond Res.18: 480-5.doi: 10.1519/12032.1

Castagna, C., Impellizzeri, F. M., Chamari, K., Carlomagno, D., and Rampinini, E. (2006). Aerobic fitness and Yo-Yo continuous and intermittent tests performances in soccer players: A correlation study. Journal of Strength and Conditioning Research,20, 320–325. doi: 10.1519/R-18065.1

Castagna, Manzi, Impellizzeri, Weston, and Barbero, A. (2010). Relationship Between Endurance Field Tests and Match Performance in Young Soccer Players. J. Strength Cond.Res. 24-12. 3227-3233. doi:10.1519/JSC.0b013e3181e72709

Chamari, K., Chaouachi, A., Hambli, M., Kaouech, F., Wisløff, U., and Castagna, C. (2008). The five-jump test for distance as a field test to assess lower limb explosive power in soccer players. Journal of Strength and Conditioning Research. 22, 944–950. doi: 10.1519/JSC.0b013e31816a57c6.

Cohen, D. (1988). Statistical power analysis for behavioral sciences. New York, NY: Routledge Academic.

Datson, N., Hulton, A., Andersson, H., Lewis, T., Weston, M., Drust, B., and Gregson, W. (2014). Applied Physiology of Female Soccer: An Update. Sports Med. doi: 10.1007/s40279-014-0199-1

Davis, J.A., and Brewer, J. (1993). Applied physiology of female soccer players. Sports Med. 16(3), 180–9. doi: 10.2165/00007256-199316030-00003

Di Giminiani R, Visca C (2017) Explosive strength and enduranceadaptations in young elite soccer players during two soccer seasons. PLoS ONE 12(2): e0171734.doi:10.1371/journal. pone.0171734

Durnin, J.V., and Webster, C. I. (1985). A new method of assessing fatness and desirable weight for use in the Armed Service Army department, Technical Report. Ministry of Defense.

Emmonds, S; Till K; Redgrave, J; Murray, M; Turner, L; Robinson, C; Jones, B. (2018). Influence of age on the anthropometric and performance characteristics of high-level youth female soccer players. International Journal of Sports Science and Coaching. DOI:10. 11771749954118757473.Corpus.ID:4112047

FIFA. Women's football; 2012. Available at: http://www.fifa.com/mm/ document/footballdevelopment/women/01/59/58/21/wf_backgroundpaper_200112.pdf; [accessed 03.02.2014].

Francisco, J.; Martin, L.; and Gallego, A. C. (2011). Deficits of accounting in the valuation of rights to exploit the performance of professional players in football clubs. A case study. Journal of Management Control. 22, 335–357.

Gamble, P. (2006). Periodization of training for team sports athletes. Strength Cond. J. 28, 56–66. doi: 10.1519/00126548-200610000-00009

Gonçalves, L.; Clemente, F.M.; Barrera, J.I.; Sarmento, H.; González-Fernández, F.T.; Rico-González, M.; Carral, J.M.C. Exploring the Determinants of Repeated-Sprint Ability in Adult

Women Soccer Players. Int. J. Environ. Res. Public Health 2021, 18, 4595. https://doi.org/10.3390/ ijerph18094595

Gonçalves, L.; Clemente, F.M.; Barrera, J.I.; Sarmento, H.; González-Fernández, F.T.; Palucci Vieira, L.H.; Figueiredo, A.J.; Clark, C.C.T.; Carral, J.M.C. Relationships between Fitness Status and Match Running Performance in Adult Women Soccer Players: A Cohort Study. Medicina 2021, 57, 617. https://doi.org/10.3390/ medicina57060617

Hammami, M.A., Abderraouf, B.A., Ammar, N., Emmeran, L., Omar, B.O., Zohayer, T., and Zouhal, H. (2013). Effects of a soccer season on anthropometric characteristics and physical fitness in elite young soccer players. Journal of Sports Sciences. 31(6): 589-96. doi: 10.1080/02640414.2012.746721

Hammami M.A, Ben Klifa , K. Ben Ayed , R. Mekni , A. Saeidi , J. Jand, H. Zouhal . (2019). Physical performances and anthropometric characteristics of young elite North-African female soccer players compared with international standards. Sci Sports. https://doi.org/10.1016/j.scispo.2019.06.005

Haugen, T., Tønnessen, E., Hisdal, J., and Seiler, S. (2014). The role and development of sprinting speed in soccer. Int J Sports Physiol Perform. 9 (3), 432-41 doi: 10.1123/ijspp.2013-0121

Hopkins, W. G., Marshall, S. W., Batterham, A. M., and Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. Med. Sci. Sports Exerc. 41, 3–13. doi: 10.1249/MSS.0b013e31818cb278

Impellizzeri, F.M., Rampinini, E., Maffiuletti, N.A., Castagna, C., Bizzini, M., and Wisloff, U. (2008). Effects of aerobic training on the exercise-induced decline in short-passing ability in junior soccer players. Applied Physiology, Nutrition, and Metabolism, 33(6), 1192–1198. doi: 10.1139/H08-111.

Ingebrigtsen, J., Dillern, T., and Shalfawi, S.A. (2011). Aerobic capacity and anthropometric characteristics of elite-recruit female soccer players. J Strength Cond Res. 25(12):3352-7. doi: 10.1519/JSC.0b013e318215f763

Jaspers, A., Brink, M. S., Probst, S. G., Frencken, W. G., and Helsen, W. F. (2017). Relationships between training load indicators and training outcomes in professional soccer. Sports Med. 47, 533–544. doi: 10.1007/s40279-016-0591-0

Jeffreys, I. (2004). The use of small-sided games in the metabolic training of high school soccer players. National Strength and Conditioning Journal. 26 (5), 77-78

Jovanovic, M., Sporis, G., Omrcen, D. and Fiorentini, F. (2011). Effects of speed, agility, quickness training method on power performance in elite soccer players. The Journal of Strength and Cond Res. 25 (5), 1285-92. doi: 10.1519/JSC.0b013e3181d67c65

Juricskay, Z., and Mezey, M. (1994). Effect of regular training on the anthropometric parameters and urine steroids in childhood. European Journal of Applied Physiology and Occupational Physiology, 68, 367–72. doi: 10.1007/bf00571459

Kirkendall, D.T., Leonard, K, and Garrett, J.W.E. (2005). On the relationship of fitness to running volume and intensity in female soccer players. In: Reilly T, Cabri J,Arau´jo D, editors. Science and football V: the proceedings of the Fifth World Congress on Science and Football. Abigdon, OX: Routledge. 395-8

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., Pedersen, P.K., and Bangsbo, J. (2003). The Yo-Yo intermittent recovery test:Physiological response, reliability, and validity. Medicine & Science in Sports & Exercise, 35, 697–705. doi: 10.1249/01.MSS.0000058441.94520.32

Krustrup, P., Mohr, M., Ellingsgaard, H., and Bangsbo, J. (2005). Physical demands during an elite female soccer game: importance of training status. Med Sci Sports Exerc. 37, 1242-8. :10. doi1249/01.mss.0000170062.73981.94

Krustrup, P., Zebis, M., Jensen, J.M., and Mohr, M. (2010). Game-induced fatigue patterns in elite female soccer. J Strength Cond Res. 24(2), 437–41. doi: 10.1519/JSC.0b013e3181c09b79

Lesinski M, Prieske O, Helm N and Granacher U (2017) Effects of Soccer Training on Anthropometry, Body Composition, and Physical Fitness during a Soccer Season in Female Elite Young Athletes: A Prospective Cohort Study. Front. Physiol. 8:1093. doi: 10.3389/fphys.2017.01093

Manson, S.A., Brughelli, M., and Harris, N.K. (2014). Physiological characteristics of international female soccer players. J Strength Cond Res. 28: 308-18. doi: 10.1519/JSC.0b013e31829b56b1.

Mara, J. K., Thompson, K. G., Pumpa, K. L., and Ball, N. B. (2015). Periodization and physical performance in elite female soccer players. Int. J. Sports Physiol. Perform. 10, 664–669. doi: 10.1123/ijspp.2014-0345.

Martinez-Lagunas, V., and Hartmann, U. (2014). Validity of the Yo-Yo intermittent recovery test level 1 for direct measurement or indirect estimation of maximal oxygen uptake among female soccer players. Int J Sports Physiol Perform. 9, 825-31. doi: 10.1123/ijspp.2013-0313

Meckel, Y., Machnai, O. and Eliakim, A. (2009). Relationship among repeated sprint tests, aerobic fitness, and anaerobic fitness in elite adolescent soccer players. The Journal of Strength and Cond Res. 23(1), 163-169. doi: 10.1519/JSC.0b013e31818b9651.

Milanovi´c, Z.; Sporiš, G.; James, N.; Trajkovi´c, N.; Ignjatovi´c, A.; Sarmento, H.; Trecroci, A.; Mendes, B. Physiological demands, morphological characteristics, physical abilities and injuries of female soccer players. J. Hum. Kinet. 2017, 60, 7 .

Miller, T.A., Thierry-Aguilera, R., Congleton, J.J., Amendola, A.A., Clark, M.J., Crouse, S.F., Martin, S.M., and Jenkins, O.C. (2007). Seasonal changes in VO2max among division 1a collegiate women soccer players. J Strength Cond Res. 21, 48-51. doi:10.1519/00124278-200702000-00009

Miloski, B., de Freitas, V. H., Nakamura, F. Y., de A Nogueira, F. C., and Bara-Filho, M. G. (2016). Seasonal training load distribution of professional futsal players: effects on physical fitness, muscle damage and hormonal status. J. Strength Cond. Res. 30, 1525–1533. doi: 10.1519/JSC.0000000000001270

Mohr, M., Krustrup, P., Andersson, H., Kirkendal, D., & Bangsbo, J. (2008). Match activities of elite women soccer players at different performance levels. Journal of Strength & Conditioning Research, 22, 341–349.

Mujika, I., Santisteban, J., Impellizzeri, F.M., and Castagna, C. (2009). Fitness determinants of success in men's and women's football. J Sports Sci. 15; 27(2): 107-14. doi: 10.1080/

02640410802428071

Nebigh, A., Rebai, H., Elloumi, M., Bahlous, A., Zouch, M.,Zaouali, M., Tabka, Z. (2009). Bone mineral density of young boy soccer players at different pubertal stages: Relationships with hormonal concentration. Joint Bone Spine. 76, 63–69. doi: 10.1016/j.jbspin.2008.03.002

Nikoladis, P., and Karidis, N. (2011). Physique and body composition in soccer players across adolescence. Asian Journal of Sports Medicine, 2, 75–82. doi: 10.5812/asjsm.34782

Nobari H, Alves AR, Clemente FM, Pérez-Gómez J, Clark CCT, Granacher U and Zouhal H (2021). Associations Between Variations in Accumulated Workload and Physiological Variables in Young Male Soccer Players Over the Course of a Season. Front. Physiol. 12:638180. doi: 10.3389/fphys.2021.638180

Nosomu Hasegawa and Kenji Kuzuhara. (2015). Physical characteristics of Collegiate Women's Football Players. Football Science.12, 51-57.

Ozbar, N. Effects of Plyometric Training on Explosive Strength, Speed and Kicking Speed in Female Soccer Players. (2015). Anthropologist,. 19(2): 333-339. doi: 10.1080/ 09720073 2015. 11891666

Pantelis, T. N. (2013). Body mass index and body fat percentage are associated with decreased physical fitness in adolescent and adult female volleyball players. J Res Med Sci. 18 (1): 22-28

Pauole K., Madole, K., Garhammer, J., Lacourse, M., and Rozenek, R. (2000). Reliability and Validity of the T-Test as a Measure of Agility, Leg Power, and Leg Speed in College-Aged Men and Women. Journal of Strength and Conditioning Research. 14 (4), 443–450. doi: 10.1519/00124278-200011000-00012

Ramos, G.; Nakamura, F.Y.; Pereira, L.A.; Wilke, C.F. Movement patterns of an U-20 National female soccer team during competitive matches: Influence of playing position and performance in the first half. Int. J. Sports Med. 2017, 38, 747–754.

Rampinini, E., Impellizzeri, F. M., Castagna, C., Azzalin, A., Ferrari Bravo, D., and Wisloff, U. (2008). Effect of match-related fatigue on short-passing ability in young soccer players. Medicine & Science in Sports & Exercise, 40(5), 934–942. doi: 10.1249/ MSS. 0b013e3181666eb8.

Reilly, T., Secher, N., Snell, P., and Williams, C. (1990). Physiology of sports: An overview. Physiology of sports. UK: Taylor & Francis. 465-485

Reilly T, Williams AM, Nevill A, Franks A. A multidisciplinary approach to talent identification in soccer. (2000). J Sports Sci. 18: 695–702. doi: 10.1080/02640410050120078

Reilly T and Gilbourne D. (2003). Science and football: a review of applied research in the football codes. J Sports Sci. 21(9), 693-705.

Sander, A., Keiner, M., Wirth, K., and Schmidtbleicher, D. (2013). Influence of a 2-year strength training programme on power performance in elite youth soccer players. Eur. J. Sport Sci. 13, 445–451. doi: 10.1080/17461391.2012. 742572

Sedano, S., Vaeyens, R., Philippaerts, R.M., Redondo, J.C., and Cuadrado, G. (2009) Anthropometric and anaerobic fitness profile of elite and non-elite female soccer players. J Sports Med Phys Fit. 49(4), 387–94.

Silva, J. R., Rebelo, A., Marques, F., Pereira, L., Seabra, A., Ascensão, A., et al. (2014). Biochemical impact of soccer: an analysis of hormonal, muscle damage, and redox markers during the season. Appl. Physiol. Nutr. Metab. 39, 432–438. doi: 10.1139/apnm-2013-0180

Sporis, G., Canaki, M., and Barisic, V. (2007). Morphological differences of elite Croatian female soccer players according to team position. Croat Sports Med J. 22, 91-6.

Stolen, T., Chamari, K., Castagna, C., and Wisløff, U. (2005) . Physiology of soccer: an update. Sports Med. 35 (6), 501–36. doi: 10.2165/00007256-200535060-00004

Svensson, M., and Drust, B. (2005). Testing soccer players. J Sports Sci;23:601-18. doi: 10.1080/02640410400021294

Tanner, J. M. (1975). Growth endocrinology of the adolescent. In, Endocrine genetic diseases of childhood and adolescence. Philadelphia, L. Gardner (Edition) PA: W. B. Saunders

Todd, M.K., Scott, D., and Chisnall, P.J. (2002). Fitness characteristics of English female soccer players: an analysis by position and playing standard. In: Spinks W, editor. Science and football IV. London: Routledge. 374-81.

Thorpe JL and Ebersole, K.T. (2008). Unilateral balance performance in female collegiate soccer athletes. J Strength Cond Res. 22(5), 1429-33. doi: 10.1519/JSC.0b013e31818202db.

UEFA. 2017. Women's football across the national associations. UEFA Rep. 1–93.

Vescovi, J.D., and McGuigan, M.R. (2008). Relationships between sprinting, agility, and jump ability in female athletes. J Sports Sci. 26, 97-107. doi: 10.1080/02640410701348644

Villaseca-Vicuña, R.; Molina-Sotomayor, E.; Zabaloy, S.; Gonzalez-Jurado, J.A. Anthropometric Profile and Physical Fitness Performance Comparison by Game Position in the Chile Women's Senior National Football Team. Appl. Sci. 2021, 11, 2004. https://doi.org/10.3390/app11052004

Weineck, J. (2000). Optimales Traning. Nürberg: Spitta-Veri; Nürberg: Journal of Sports Science & Medicine. Medical Faculty of Uludag University

Wong, P. L., Chamari, K., Dellal, A., and Wisløff, U. (2009). Relationship between anthropometric and physiological characteristics in youth soccer players. Journal of Strength and Conditioning Research. 23, 1204–10. doi: 10.1519/JSC.0b013e31819f1e52.

Zoran, M., Goran, S., and Nebojsa T. (2011). Differences in body composite and physical Match performance in female soccer players according to team position. 6th INSHS Internationa Chrismas Sport Scientific Conference, 11-14 Décembre 2011. International Network of Sport and Health Science. Szombathely, Hungary.

Zoran, M., Goran, S., Nebojša, T., Nic, J., and Krešimir, Š. (2013). Effects of a 12 Week SAQ Training Programme on Agility with and without the Ball among Young Soccer Players. 12(1), 97–103.

Table 1. Intraclass correlation coefficients (ICCs) for relative reliability and coefficients of variation for absolute reliability of the applied physical fitness tests.

Measures	ICC	95% CI	% CV
CMJ (cm)	0.983	0.970-0.990	4.62
SJ (cm)	0.991	0.985-0.995	3.98
5JT (m)	0.979	0.963-0.988	3.77
Speed 5 m (s)	0.879	0.790-0.931	4.36
Speed 10 m (s)	0.995	0.992-0.997	6.03
Speed 30 m (s)	0.994	0.989-0.996	1.24
t-test without balls (s)	0.981	0.966-0.989	2.63
t-test with balls (s)	0.974	0.955-0.985	3.65
LSPT TP (s)	0.939	0.893-0.965	3.54
YYIRTL1 (m)	0.893	0.813-0.938	9.73

ICC intraclass correlation coefficient ; CI - confidence interval ; CV - coefficient of variation (%).

Table 2: Anthropometric characteristics of female soccer group and control group determined at the beginning of the season (T1) and after 10 months (T2).

Variables	**CG (n=26)**			**SG (n=26)**			**p-value (ES)**
	T1	**T2**	**ES**	**T1**	**T2**	**ES**	
Height (cm)	156.5 ±8.2	157.6± 2.9	0.18	161.4±7.6[b]	165.5±7.7[ac]	0.54	<0.0001* (1.698)
Weight (kg)	59.7± 7.7	62.9±7. 2	0.43	60.4±8.4	66.4±7.7[d]	0.75	<0.0001* (0.922)
BF (%)	26.5± 4.0[ef]	29.2±3. 1[g]	0.76	24.4±2.2	20.3±1.6[h]	2.13	<0.0001* (3.112)

Data are presented as mean ± standard deviations. ES: Effect Size; BF: Body Fat; SG: Female Soccer Group; CG: Control Group. [a]p = 0.011 different from T1; [b]p = 0.004 different from CG at T1; [c]p < 0.0001 different from CG at T2; [d]p = 0.006 different from T1; [e]p = 0.001different from T2; [f]p = 0.01 different from SG at T1; [g]p < 0.0001: different from SG at T2; [h]p < 0.0001different from T1; *: significant differences between means for SG and CG.

Table 3: Jumping measurements for female soccer group and control group determined at the beginning of the season (T1) and after 10 months (T2).

Variables	**CG (n=26)**			**SG (n=26)**			**p-value (ES)**
	T1	**T2**	**ES**	**T1**	**T2**	**ES**	
CMJ	16.6± 0.8	17.2± 0.8	0.75	23.8± 4.4[b]	26.9± 4.1[ac]	0.73	<0.0001* (1.634)
SJ	12.4 ±0.4	13.2 ±0.4	0.20	20.5± 3.9[b]	22.7 ±3.6[cd]	0.59	<0.0001* (1.334)
5JT	6.6 ± 0.5	7.7 ± 0.5[a]	0.22	9.3± 0.5[b]	10.9 ±0.5[ac]	0.32	0.004* (0.398)

Data are presented as mean ± standard deviations. ES: Effect Size; SG: Female Soccer Group; CG: Control Group; CMJ: Countermovement Jump; SJ: Squat Jump; 5JT: Five Jump Test. [a]$p < 0.0001$ different from T1; [b]$p < 0.0001$ different from CG at T1; [c]$p < 0.0001$ different from CG at T2; [d]$p = 0.001$ different from T1; *: significant differences between means for SG and CG.

Table 4: Sprinting, agility, skills and aerobic measurements for female soccer group and control group determined at the beginning of the season (T1) and after 10 months (T2).

Variables	CG (n=26)			SG (n=26)			p-value (ES)
	T1	T2	ES	T1	T2	ES	
S5 (s)	1.50 ±0.11	1.50 ± 0.06	0	1.43± 0.51	1.40 ± 0.15[a]	0.08	0.005* (0.387)
S10 (s)	2.90 ± 0.16	2.82 ± 0.15[b]	0.65	2.12± 0.11[d]	2.00 ± 0.13[ce]	0.99	0.029* (0.238)
S30 (s)	6.32 ± 0.31	6.20 ± 0.27	0.41	5.20± 0.31[d]	5.11± 0.28[e]	0.31	0.006* (0.380)
T-test (s)	15.78± 0.69	15.54± 0.68	0.35	13.16± 0.76[d]	12.04± 0.80[ef]	0.82	<0.0001* (1.160)
T-test with Ball (s)	21.78± 0.76	21.50± 0.88	0.34	17.05± 1.12[d]	14.94± 1.09[ef]	0.91	<0.0001* (1.135)
LSPT (s)	91.58± 2.27	90.12± 2.03	0.68	78.59± 7.64[d]	74.35± 5.04[ce]	0.66	<0.0001* (1.126)
YYIRTL1 (m)	580.4±70.9	645.5±61.2[c]	0.72	780.4±124.9[d]	990.8±69.3[ef]	0.99	<0.0001* (1.913)

Data are presented as mean ± standard deviations. ES: Effect Size; SG: Female Soccer Group; CG: Control Group; S5: 5m straight sprint; S10: 10m straight S5: 5m straight sprint; S30: 30m straight sprint; LSPT: Loughborough Soccer Passing Test; YYIRTL1: Yo-Yo Intermittent Recovery Test Level 1. [a]p = 0.003 different from CG at T2; [b]p = 0.04 different from T1; [c]p = 0.003 different from T1; [d]p < 0.0001 different from CG at T1; [e]p < 0.0001 different from CG at T2; [f]p < 0.0001 different from T1; *: significant differences between means for SG and CG.

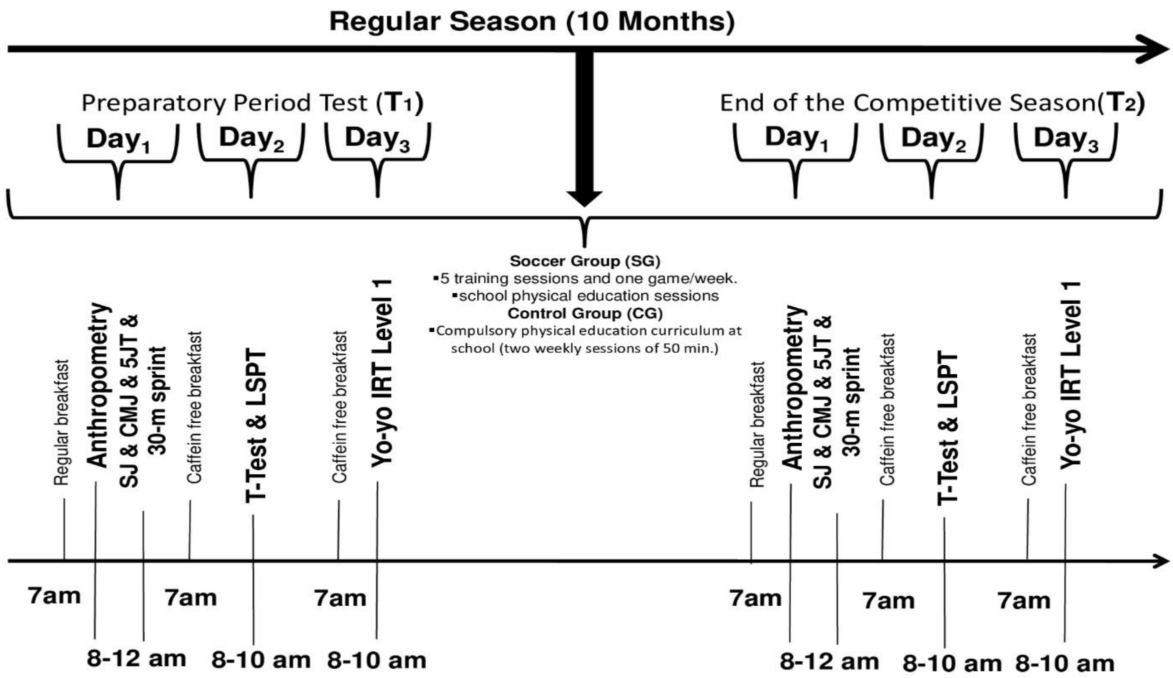

Figure 1: Study flowchart