Chapter II

Review of Related Literature
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The purpose of the study was to assess the contribution of selected anthropometric and motor fitness variables to soccer performance among elite adolescent boys. In order to facilitate such a study, a knowledge and evaluation of similar works done becomes essential. Hence the researcher went through text books, magazines, journals; research quarterly available in various internet services and libraries in an effort to locate some literature’s related to the present study. A discussion of the related works would help in finding the direction of the study.

2.1 Chronological changes of elite soccer players

Vaeyens et al. (2006) conducted a study to determine the relationships between physical and performance characteristics and the level of skills in young soccer players aged 12–16 years that Anthropometry, maturity status, functional and sport-specific parameters were assessed in elite, sub-elite, and non-elite young players in four age groups: U13, U14, U15 and U16. The Results showed that elite players scored better than the non-elite players on strength, flexibility, speed, aerobic endurance, anaerobic capacity and several technical skills (p<0.05). Running speed and technical skills were the most important characteristics in U13 and U14 players, while cardio respiratory endurance was more important in U15 and U16 players. The results suggest that discriminating characteristics change with competitive age levels. They concluded: Characteristics that discriminate young soccer players vary by age group. Talent identification models should thus be dynamic and provide opportunities for changing parameters in a long-term developmental context.

The anthropometric profiles for body mass and stature of soccer players in Brazil provide some clear comparisons with other values reported for a similar era. The U-17 players in Brazil were of similar stature to professional youth soccer players in the UK but appeared to have less body mass. The Brazilian based studies reported a range of mean values of 173-177cm and 60-71kg for the U-17 group. The U-20 soccer players ranged from mean values between 174-181cm and 66-75.5kg which were similar values to those players of equivalent age reported for Tunisian players and Greek players as well as similar body mass, but inferior stature to Norwegian players. The profiles of the First Division players in Brazil were similar in stature and body mass.
to players in Greece and Saudi Arabia. The ranges of mean values for these players were 173-181cm and 61-73kg. However, the players in Brazil were similar only in body mass with players of similar positions from Spain, Germany, Italy, Denmark, Norway, England and were generally smaller in stature with equivalent players from these European countries (Cristiono et al., 2008).

In a study, Figueiredo et al. (2009) compared the growth, maturity status, functional capacity, sport-specific skill, and goal orientation of 159 boy soccer players, aged 11–12 (n=487) and 13–14 years (n=472) years, which at follow-up 2 years later discontinued participation (dropout) continued at the same standard (club) or moved to a higher level (elite). Age group-specific multivariate analysis of variance was used for comparisons. Among 11- to 12-year-old players at baseline, a gradient of elite club dropout was suggested for size and function, although differences were not consistently significant. Elite players performed significantly better in only two of the four skills, dribbling and ball control. A gradient of elite club dropout was more clearly defined among 13- to 14-year-old players at baseline. Elite players were older chronologically and skeletally, larger in body size and performed better in functional capacities and three skill tests than club players and dropouts. Baseline task and ego orientation did not differ among dropouts and club and elite players at follow-up in either age group. They suggested an important role for growth and maturity status, functional capacities, and sport specific skills as factors in attrition, persistence, and moving up in youth soccer.

Vanderford et al. (2004) studied to quantify the physiological and sport-specific skill characteristics of Olympic Developmental Program (ODP) soccer athletes by age group and game experience. 59 boy athletes (age = 14.6 +/- 2.0 years; wt = 60.5 +/- 1.4 kg; ht = 172.4 +/- 1.2 cm) completed a battery of tests to determine aerobic power (V. O2max), heart rate (HRmax), ventilation (VEmax), respiratory exchange ratio (RER), anaerobic threshold (AT), blood pressure (BPrest/max), anaerobic power/capacity [peak power (PP), mean power (MP), total work output (TWO), fatigue index (FI)], leg power [vertical squat jump (VJS), countermovement jump (VJC)], body composition [percent body fat (%BF), lean body mass (LBM)], joint range of motion (trunk, back, hip, knee, and ankle), and agility/sport-specific skills (T-test, line drill test, juggling test, Johnson wall volley, and modified-Zelenka circuit). Factor analyses with subsequent multivariate analyses of variance (MANOVAs) indicated significant main effects across age (p = 0.0001) but not by game experience (p = 0.82). Older athletes exhibited greater height, weight, LBM, VEmax, Timemax, PP, TWO, and VSJ values than
younger athletes. Although not significant, there were differences with increasing age in the 
agility tests (T-test, wall volley, and juggling test). They concluded, improvements in anaerobic 
power, agility, and sport-specific skill should be addressed at this developmental level of 

competition.

Canhadas et al. (2006) investigated to determine anthropometric and physical fitness 
characteristics of Brazilian boy children and adolescents at the beginning of soccer training. 
Results showed, the boys’ height increased significantly with age as expected, whereas a 
significant difference in body weight was only observed between 13-year-old boys and the other 
age groups (p ≤ 0.001). The BMI of 13-year-old boys was significantly higher than that of 11-
year-old boys (p = 0.003). No significant difference in skin fold thickness was observed between 
age groups, except for subscapular skin fold thickness which was significantly lower in 11-year-
old boys compared to 10- and 13-year-old boys (p = 0.047). ANOVA also revealed an increase 
in bone diameter with age, but statistically significant differences (p ≤ 0.001) were only observed 
for 12-year-old boys (bistyloid and humeral biepicondylar diameters) and 13-year-old boys 
(bistyloid and femoral biepicondylar diameters). Girth measurements increased with age, but 
statistically significant differences were only observed for 12-year-old boys (forearm and relaxed 
arm girths) and 13-year-old boys (flexed arm, leg and thigh girths). Adiposity, evaluated based 
on the sum of TR and SS skin folds, sum of 11 skin folds (11SF) and %fat, did not differ 
significantly between the age groups studied. Lean body mass was significantly higher in 13-
year-old boys when compared to the other participants (p ≤ 0.001). Arm muscularity increased 
with age: 10 years = 11 years = 12 years < 13 years (p ≤ 0.001). Thirteen-year-old boys were 
also significantly stronger than 10- and 11-year-old boys in the elbow flexion exercise. No 
difference in back or hamstring flexibility was observed between groups. Lower limb power was 
greater in 12- and 13-year-old boys compared to 10- and 11-year-old boys (p ≤ 0.001). The 
results of the agility test indicated a significant increase in agility with age (p ≤ 0.001). Finally, 
V. O2max increased significantly with age (p < 0.001): 10 years < 11 years < 12 years < 13 
years. No significant differences in the different strength/lean body mass ratios were observed 
between age groups.

Williams et al. (2000) reported that the requirements for soccer play are multifactorial 
and distinguishing characteristics of elite players can be investigated using multivariate analysis. 
The aim of their study was to apply a comprehensive test battery to young players with a view to
distinguishing between elite and sub-elite groups on the basis of performance on test items. Thirty-one (16 elite, 15 sub-elite) young players matched for chronological age (15-16 years) and body size were studied. Test items included anthropometric (n = 15), physiological (n = 8), psychological (n = 3) and soccer-specific skills (n = 2) tests. Variables were split into separate groups according to somatotype, body composition, body size, speed, endurance, performance measures, technical skill, anticipation, anxiety and task and ego orientation for purposes of univariate and multivariate analysis of variance and stepwise discriminate function analysis. The most discriminating of the measures were agility, sprint time, ego orientation and anticipation skill. The elite players were also significantly leaner, possessed more aerobic power (9.0 ± 1.7 vs. 55.5 ± 3.8 ml x kg (-1) x min (-1)) and were more tolerant of fatigue (P < 0.05). They were also better at dribbling the ball, but not shooting. They concluded that the test battery used may be useful in establishing baseline reference data for young players being selected onto specialized development programmes.

The study of Di Luigi et Al. (2006) showed that a group of 110 young Italian boy soccer players ranging from 10 to 16 years of age, divided into seven different classes according to their birth-year, presented a high inter-individual variability of pubertal stage within the same class of chronological age. Although there was no difference between adolescent age groups in body fat (BF), BF was weakly, but significantly, in inverse association with age, which was explained by the stronger effect of age on fat free mass (FFM) than on fat mass (FM).

There were also indications of the importance of body composition for soccer performance in younger age. Child and adolescent players, aged 9-14.9 years had a significantly lower BF than reference population. Starter’s players, aged 10-14 years, were leaner than substitutes. Variation of body composition according to playing position was reported in players with 14-21 years of age, and in players with 16-18 years of age, in which defenders were characterized with lower BF. Moreover, 14-17-year-old successful players were taller, heavier and leaner than their non-selected counterparts. Since there was no consensus regarding the development of body composition, especially of BF, these results should be viewed with some caution until they get confirmed in other samples (Nikolaidis and Karydis, 2011).

Malina et al. (2004) examined to estimate the contribution of experience, body size and maturity status to variation in the functional capacities of adolescent football (soccer) players. Multiple linear regression analysis was used to estimate the relative contributions of age, stage of
sexual maturity, height, weight and years of formal training in football to the three indicators of functional capacity. Stage of puberty, body size and years of training accounted for 21% to 50% of the variance in the three tasks. Sexual maturity status was the primary contributor to the variance in the intermittent shuttle run, whereas weight and height were the primary contributors to the explained variance in the 30-m dash and vertical jump, respectively. In conclusion they said that biological maturity status significantly influences the functional capacity of adolescent football players 13–15 years of age. Training is a significant contributor to aerobic resistance, whereas weight and height are significant contributors to the sprint and vertical jump, respectively. The largest percentage of variation in strength and the other performance tasks accounted for by chronological age, skeletal age and body size generally occurred at 14 and 15 years in boys. At these ages, of course, chronological age, skeletal age, height and weight are highly interrelated, so that it is difficult to partition specific effects of biological maturity per se on strength and performance.

Huijgen et al. (2010) studied to assess the development and determine the underlying mechanisms of sprinting and dribbling needed to compete at the highest level in youth soccer. Talented soccer players aged 12–19 years (n=4267) were measured on a yearly basis in a longitudinal study over 7 years, resulting in 519 measurements. Two field tests, the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test, were assessed. Anthropometric characteristics, years of soccer experience, and duration of practice were recorded. The longitudinal data were analyzed with multi-level modeling. Comparing the two tests at baseline, low correlations were observed (sprinting: r=0.49; dribbling: r=0.22), indicating that each test measures distinct qualities (acceleration vs. agility). Low-to-moderate correlations were found between dribbling and sprinting within each test (Shuttle Sprint and Dribble Test: r=0.54; Slalom Sprint and Dribble Test: r=0.38). Both dribbling and sprinting improved with age, especially from ages 12 to 14, but the tempo of development was different. From ages 14 to 16, sprinting improved rapidly in contrast to dribbling; this was especially evident on the Slalom Sprint and Dribble Test. In contrast, after age 16 dribbling improved considerably but sprinting hardly improved. They concluded that besides age, the factors that contribute to dribbling performance are lean body mass, hours of practice, and playing position.
2.2 Performance characteristics of elite soccer players

Malina et al. (2005) studied to estimate the relative contributions of age, stage of sexual maturity, height, body mass and years of formal training in soccer to the six skill tests. Age, experience, body size and stage of puberty contributed significantly but in different combinations to the variance in four of the six skill tests: dribbling with a pass (21%; age, stage of maturity), ball control by head (14%; stage of maturity, height, body height * body mass interaction), ball control by body (13%; stage of maturity, years of training) and shooting accuracy (8%; stage of maturity, height; borderline significance, $P = 0.06$). There were no significant predictors for the tests of dribbling speed and passing accuracy. They concluded that the age, experience, body size and stage of puberty contributed relatively little to variation in performance in four of the six soccer-specific skill tests in adolescent footballers aged 13 – 15 years. Techniques, or sport-specific technical skills, are a central component in the development of young athletes in many sports, including soccer. A variety of tests has been developed to evaluate ball control by body (trapping), head (heading) and feet (dribbling), passing (short and long), shooting accuracy, throwing and kicking for distance, agility and volleying, among others.

Seabra et al. (2001) investigated the variation in performances on the six soccer skills tests associated with age differs among the tests in Portuguese youth players aged 10 – 16 years. The players were grouped into three playing categories, infants (11.7+0.4 years), iniciados (13.5+0.5 years) and juveniles (16.1+0.5 years). Comparisons of the three groups showed, on average, improved performances with age in the two ball control tests (with the body and with the head), but no major differences between age groups in the other four tests. They said that the focus is often on the validity of the tests, changes in performance with age among youth players, comparisons of skills in youth and professional players classified by level of competition or expertise, and occasionally relationships between skill tests and outcomes of match-play.

Rosch et al. (2000) in a comprehensive study on the soccer-specific skills, compared a combined sample of youth players from Germany, France and the Czech Republic in two age groups, 14 – 16 years (14.4 – 16.8) and 16 – 18 years (15.6 – 18.9), and at two levels (high, low) within each age group. In the younger sample (14 – 16 years), players classified as high level were, on average, older by about 6 months, taller and heavier. They also performed significantly better than those classified as low level on five juggling (ball control) tests and tests of dribbling
speed and long and short passing. The high level players also performed significantly better in functional tests related to speed (sprints), power (jumps) and aerobic capacity (distance run). They said that unfortunately, the chronological age difference between the samples was not controlled in making the statistical comparisons, and the contributions of age and body size to performances were not considered. On the other hand, differences in mean performances of high and low level players were slightly smaller, though generally significant, on the soccer-specific skill and functional capacity tests.

Wong et al. (2009) examined the relationship between anthropometric and physiological performances among youth soccer players and the positional differences for these variables. Seventy U14 boy soccer players (goalkeeper: 10, defender: 20, midfielder: 25, and forward: 15) participated in this study. Body mass was significantly ($p < 0.05$) correlated with ball shooting speed ($r = 0.58$) and 30 m sprint time ($r = -0.54$). Body height was significantly ($p < 0.05$) correlated with vertical jump height ($r = 0.36$), 10 m ($r = -0.32$) and 30 m ($r = -0.64$) sprint times, Yo-Yo intermittent endurance run (YYIER) distance ($r = 0.26$), and running time during maximal oxygen uptake ($\text{VO}_2\text{max}$) ($r = 0.35$). Body mass index (BMI) was significantly ($p < 0.05$) correlated with ball shooting speed ($r = 0.31$), 30 m sprint time ($r = -0.24$), Hoff test dribble distance ($r = -0.29$), YYIER distance ($r = -0.25$), sub maximal running cost ($r = -0.38$), $\text{VO}_2\text{max}$ ($r = -0.42$), and the corresponding running time ($r = -0.24$). Significant positional differences were observed in anthropometry (body mass [$p < 0.01$], height [$p < 0.01$], and BMI [$p < 0.01$]) but not in physiological performances. They Saied: their study provides a scientific rationale behind the coaches’ practice of selecting young soccer players according to their anthropometry for short-term benefits such as heavier players for higher ball shooting speed and 30-m sprint ability as an example.

Strudwick et al. (2002) investigated to describe anthropometric and performance characteristics of elite players in two football codes and explore the differences between them showed that the variability in stature was significantly greater in the soccer players compared to the Gaelic (ethnic) footballers ($p<0.01$). Performances in the 10m and 30m-sprints, and in vertical jump were superior in the soccer group compared to the Gaelic footballers ($p<0.01$). The authors concluded that intra-group variability on the anthropometric and performance measures of the soccer players is likely to be due to the specificity of positional roles. The combined
groups could be described as lean and muscular with a reasonably high level of capacity in all areas of physical performance. Anaerobic characteristics of the professional soccer players were superior to those of Gaelic football players. They concluded that anthropometric and performance assessment of elite footballers using mean values masks the heterogeneity evident within the football codes.

Vazini taher and Haddadi (2011) to determine the applicability of a multivariate test battery in youth soccer players, made a comparison between 45 elite and 51 sub-elite youth soccer players concerning physiological, psychological, anthropometrical and technical factors. They reported that some researchers have also proposed similar TI models to be applied on soccer schemes. Their subjects completed the ACSI-28 questionnaire as a psychological test, and also performed the FA soccer star tests in order for their technical characteristics to be determined. The seven measures in anthropometrical cluster analysis were included: height, body mass, body fat percentage and four girths (waist, shoulder, mid-thigh, calf). Besides, five tests performed by players to determine their physiological characteristics: Vertical jump, sit-ups, 280 meter shuttle run, 10 and 40 meter sprints. The results of their study demonstrated significant differences between elite and sub-elite players in the four measured clusters. A significant difference was also found in age as a covariate. The most distinguishing factors, accentuating the importance of speed in TI models, were 40-m sprint and shuttle run (among physiological factors), peaking under pressure (among psychological factors) and speed (among technical factors). There were significant differences between U14 and U15 groups in physiological and technical factors. Besides, the elite U16 players showed better points than their sub-elite peers in psychological and technical measurements. Their results indicated that a multivariate approach, considering age differences, can successfully distinguish elite soccer players from sub-elite players at young ages.

2.3 Positional characteristics of elite soccer players

The assessment and determination of the anthropometric characteristics (height, body mass and composition) is essential to a successful achievement of a soccer team not only during a game, but also along the whole sportive season, and such information can and must be used by
the coach to change the player’s function or even the tactical formation of the whole team, with
the purpose to maximize the performance, once each positioning presents specific features
(shepherd, 1999).

Arni (2004) in results of a study reported that a significant relationship was found
between team average jump height and team success. The same trend was also found for leg
extension power (P = 0.097), body composition (% body fat, P = 0.07), and the total number of
injury days per team (P = 0.09). Goalkeepers demonstrated different fitness characteristics from
outfield players. They were taller and heavier, more flexible in hip extension and knee flexion,
and had higher leg extension power and a lower peak O2 uptake. However, only minor
differences were observed between defenders, midfield players, and attackers.

Matkovic et al. (2003) studied the analysis of morphological characteristics and body
composition of elite Croatian soccer players with respect to their team position. The
measurements were performed on 57 soccer players, members of the First Croatian National
League. The anthropometrical measurement encompassed 13 variables (body fat %, lean body
mass %, body height, body mass, length of the leg, length of the arm, bi-acromial and bi-cristal
diameters, knee and elbow diameters, upper arm girth, forearm girth, thigh girth and calf girth).
Descriptive statistics, t-test and MANOVA were used in data processing. The results showed the
goalkeepers were the tallest and the heaviest (182.9 _4.3 cm; 80.1_5.1 kg), and had significantly
higher amounts of body fat (20.2% goalkeepers vs. 13–15% others; p<0.05), whereas the
forwards and the midfield players were on the average about 3 cm shorter. The goalkeepers had
longer legs and arms (p<0.05), and the largest bi-acromial diameter (43.2_1.9 cm). The forwards
were the shortest on the average (179.2_6.3 cm). The lowest values of fat tissue were found in
defenders (13.9%) and midfield players (14.4%). They concluded, the differences in
morphological characteristics according to the team position were noticed only in goalkeepers,
especially regarding their height, weight and the percentage of fat tissue.

Prado et al. (2006) conducted to evaluate the anthropometric profile, total energy value of
the diet and macronutrient intake of professional soccer players, as well as verifying the
differences among tactical positions: goalkeepers, center backs, median fields, running backs and
 strikers in the studied variables. The sample was composed by 118 professional players (23 years
± 5 years) of the elite of the São Paulo state. All the evaluations were accomplished during the
competitive period. Body composition was determined through skin folds measurement and the dietary data obtained through usual food intake. In the results, the goalkeepers and center backs were shown taller, heavier and with larger amount of lean mass than the other athletes, even so without significant differences among body fat percentage. The dietary habits of these athletes indicate a lower carbohydrate ingestion, hyper protein and tendency to hyperlipidic diet. Thus, they concluded that there are nutritional inadequacies and anthropometric differences among the players and their tactical positions.

Joksimovic et al. (2009) defined the average values for all the 368 participants in the 2008 European Football Championship by analyzing basic anthrop morphological parameters, as well as certain body indices. Their research results point to the fact that the average height of all the participants in the 2008 European Football Championship was 182.97 cm and the average body mass was 77.88 kg. The tallest average was noted in goalkeepers, followed by defense and forwards players, while the lowest values for height 179.02 cm and body mass 73.89 kg were noted in midfield players. They concluded that body height and body mass in elite football players have increased in the course of time, and it is also noticeable that apart from forwards, each particular position requires a particular body type.

Mendez-Villanueva et al. (2011) conducted a study entitled “Does on-field sprinting performance in young soccer players depend on how fast they can run or how fast they do run?” The aim of their study was to examine the impact of maximal sprinting speed (MSS) on the peak speed attained during soccer matches. Time-motion analysis of running activity was collected from 14 highly trained young boy outfield footballers (8 wide midfielders [WM] and 6 central defenders [CD], 173.2 ± 0.06 m, 60.8 ± 8.1 kg, and 16.7 ± 0.7 years) during 14 different friendly international club level matches. The 2 fastest players (a WM and a CD) were compared with the slower players who played in the same position. Each player's MSS was determined using the fastest 10-m split time during an electronically timed 40-m sprint. Game speed was recorded via portable global positioning systems. Faster players reached higher absolute peak running speeds in games than did their slower counterparts regardless of the playing position, with large to very large effect sizes and qualitative indications of "almost certain" and "very likely" positive effects associated with being fast. None of the players reached their MSS during the matches; however, the fastest CD attained a lower percentage of his MSS compared to both, his slower CD counterparts and the fastest WM. They resulted that given the higher peak speeds reached in
games by the fastest players, and the fact that all players (irrespective of their MSS) used a high percentage of their MSS, these preliminary results provide direct support to the hypothesis that MSS can impact on what a player can do in actual playing conditions. They said our results also indicate that playing position has an important role in influencing the expression of MSS.

2.4 Physical demands of elite soccer players

During the last two decades, there has been significant accumulation of scientific data regarding soccer physiology and medicine. Previous investigations have evaluated ideal physiological and anthropometric profile of successful soccer players mostly from Western Europe and America. The physique of soccer players may be one of the key factors that contribute to the lack of success of Yugoslav soccer teams in international competition. Aspects such as experience, body composition, endurance, balance between anaerobic and aerobic power, among other factors, are of primary importance in evaluation of elite Soccer players. The purpose of several recent studies was to describe structural and functional characteristics of elite soccer players, and make comparisons with non-elite counterparts to find a relationship between results from the physiological tests and competition level. Understanding the profile of successful players could give coaches, trainers, and exercise scientists’ better working knowledge of this particular group of athletes. To our knowledge, study by Ostojic (2002) provided the most comprehensive comparison between professional and amateur soccer teams in East European soccer players up to date. Ostojic (2002) indicated that a strong relationship exists between aerobic fitness, anaerobic power and performance results in elite soccer players (Sergej and Ostojic, 2003).

El-Naggar (1990) compared various anthropometric measurements of top sportsmen playing soccer, basketball, volleyball, handball, swimming, and track and field, and analyzed chronological and sports age effects. Variables were 29: 16 circumferences and 10 lengths of body parts, in addition to chronological and sports ages and the sport played. Results showed that chronological age is more related to lengths, while sports age is more related to circumferences. Handball players were superior to soccer, volleyball, track and field, and swimming players in circumferences. Basketball players were superior to soccer, volleyball, track and field, and swimming players in some circumferences and some lengths.
Hatzimanouil et al. (2005) performed a study that its aim was to review the literature about somatotype and anthropometric characteristics of known elite athletes in team sports (waterpolo, handball, volleyball, football, basketball) and also to clarify the relation between these characteristics and athletic performance. The research findings showed that the athletes’ somatotype and anthropometric characteristics are related to the type of each sport. In addition there is a relation between high athletic performance and physical characteristics like high height, low percentage of body fat and high muscle mass.

Chin (1992) evaluated the physiological profiles of elite soccer players in Hong Kong. It was conducted in conjunction with the selection of the Hong Kong team before the 1990 Beijing Asian Games. In all, 24 professional soccer players were selected from a pool of 180 players as subjects for the study. The following means(SD) were observed: height 173.4(4.6) cm; weight 67.7(5.0) kg; body fat 7.3(3.0)%; forced vital capacity (FVC) 5.1(0.6) l; maximum oxygen uptake (VO2max) 59.1(4.9) ml kg⁻¹ min⁻¹; anaerobic threshold (AT 80.0(7.2)% of VO2max; alactic power index 13.5(2.4) W kg⁻¹; lactic work index 298(27) J kg⁻¹; peak Isokinetic dominant knee extensor and flexor strengths 2.72(0.36) Nm kg⁻¹ and 1.65(0.20) Nm kg⁻¹. He concluded that on average the physique of Hong Kong soccer players appeared to be smaller and lighter than those found in Europe, which may be one of the key factors that contribute to the lack of success of Hong Kong soccer teams in international competition.

Gabbett and Georgieff (2007) investigated the physiological and anthropometric characteristics of junior volleyball players competing at the elite, semi-elite, and novice levels and established performance standards for these athletes. Significant differences (p < 0.05) were detected among junior national, state, and novice volleyball players for height, standing reach height, skin fold thickness, lower-body muscular power, agility, and estimated maximal aerobic power, with the physiological and anthropometric characteristics of players typically improving with increases in playing level. Boy players were taller, heavier, leaner, and had greater standing reach height, speed, agility, muscular power, and estimated maximal aerobic power than feboy players. These findings provide normative data and performance standards for junior volleyball players competing at the elite, semi-elite, and novice levels. They concluded that given the improvements in lower-body muscular power, agility, and estimated maximal aerobic power with increased playing level, and given the importance of these qualities to competitive
performances, conditioning coaches should train these qualities to improve the playing performances of junior volleyball players.

Reeves et al. (1999) conducted to compare the anthropometric measurements and body composition of football teams in the UK and Malaysia. A total of 32 footballers from two teams were studied. The teams were the St Mary’s University team (UK) and the Selangor Reserved League team. The height and body weight of the subjects were measured using SECA digital balance with height attachment. Skin fold thickness measurements were taken using Harpenden skin fold calipers at four sites (biceps, triceps, subscapular and suprailiac) and the VO2 max of the subjects was estimated by participation in a multi-stage 20m shuttle-run test. The results showed the UK team were significantly heavier (p<0.05), taller (p<0.05) and had a higher body fat content (p<0.05) than their Malaysian counterpart. There was no significant difference in VO2 max between the two teams, with the Malaysians recording a slightly higher VO2 max. With regard to playing position, the defenders were found to be the most physically robust and yet had the highest VO2 max, whilst the midfielders had the lightest body weights. They concluded that more data on the body composition and nutritional status of Malaysian footballers would allow adjustments to be made to dietary intakes and training levels in order to obtain maximum performance throughout the football season.

Bandyopadhyay (2007) conducted a study on anthropometry and body composition in soccer and volleyball players in west Bengal, India. They were selected 50 sedentary boys and 128 sportspersons (volleyball=82, soccer=46) of 20–24 years, to evaluate and compare their anthropometry and body composition. The results showed skin folds, girth measurements, body fat percentage (%fat), and endomorphy were significantly higher among sedentary individuals, but lean body mass (LBM) and mesomorphy were significantly (p=0.001) higher among the sportspersons. Soccer and volleyball players were found to be ectomorphic mesomorph, whereas sedentary subjects were endomorphic mesomorph. The soccer and volleyball players had higher %fat with lower body height and body mass than their overseas counterparts. %fat exhibited a significant correlation with body mass index (BMI) and thus prediction equations for %fat from BMI were computed in each group. He said that the data will serve as a reference standard for the anthropometry and body composition of Indian soccer and volleyball players and the prediction norms for %fat will help to provide a first-hand impression of body composition in the studied population.
Little and Williams (2005) comprised 106 professional soccer players who were assessed for 10-m sprint (acceleration), flying 20-m sprint (maximum speed), and zigzag agility performance. The relationships between the performances on the acceleration, maximum speed, and agility tests were determined by Pearson correlations (r), whereas coefficients of determination (r²) were used for interpreting the meaningfulness of the relationships. Although performances in the three tests were all significantly correlated (p=0.0005), coefficients of determination (r²) between the tests were just 39, 12, and 21% for acceleration and maximum speed, acceleration and agility, and maximum speed and agility, respectively. Based on the low coefficients of determination, it was concluded that acceleration, maximum speed, and agility are specific qualities and relatively unrelated to one another. They continued the findings suggested that specific testing and training procedures for each speed component should be utilized when working with elite players.

Huijgen et al. (2010) conducted a study to assess the development and determine the underlying mechanisms of sprinting and dribbling needed to compete at the highest level in youth soccer. Talented soccer players aged 12–19 years (n=4267) were measured on a yearly basis in a longitudinal study over 7 years, resulting in 519 measurements. Two field tests, the Shuttle Sprint and Dribble Test and the Slalom Sprint and Dribble Test, were assessed. Anthropometric characteristics, years of soccer experience, and duration of practice were recorded. The longitudinal data were analyzed with multi-level modeling. Comparing the two tests at baseline, low correlations were observed (sprinting: r=40.49; dribbling: r=40.22), indicating that each test measures distinct qualities (acceleration vs. agility). Low-to-moderate correlations were found between dribbling and sprinting within each test (Shuttle Sprint and Dribble Test: r=40.54; Slalom Sprint and Dribble Test: r=40.38). Both dribbling and sprinting improved with age, especially from ages 12 to 14, but the tempo of development was different. From ages 14 to 16, sprinting improved rapidly in contrast to dribbling; this was especially evident on the Slalom Sprint and Dribble Test. In contrast, after age 16 dribbling improved considerably but sprinting hardly improved. Besides age, the factors that contribute to dribbling performance are lean body mass, hours of practice, and playing position. They reported that previous research has assessed the role of each playing position. One study reported that attackers and full-backs sprinted more than midfielders and defenders in professional soccer. Research on elite young Brazilian soccer players found that the fewest sprints were made by full-
backs and the most sprints by attackers; also, attackers and offensive midfielders sprinted more with the ball than players from other positions. Other research on young non-elite soccer players found that forwards were the fastest players in the 30-m straight and agility sprint, followed by midfielders. These results indicate that attackers are the best sprinters, although limited information is available regarding which position shows the best dribbling performance.

Soccer is one of the most widely played and complex sports in the world, where players need technical, tactical, and physical skills to succeed. However, studies to improve soccer performance have often focused on technique and tactics at the expense of physical resources such as endurance, strength, and speed. The average work intensity, measured as percent of maximal heart rate (\( f_{\text{cmax}} \)), during a 90-min soccer match is close to the lactate threshold (LT), or 80–90% of \( f_{\text{cmax}} \). However, expressing intensity as an average over 90 min could result in a substantial loss of specific information. Indeed, soccer matches have periods and situations of high intensity activity where accumulation of lactate takes place. Therefore, the players need periods of low-intensity activity to remove lactate from the working muscles. A significant correlation between maximal oxygen uptake (\( V' O_{2\text{max}} \)) and distance covered during a match was found. Moreover, the finding that the rank among the best four teams in the Hungarian top soccer division was the same as the rank among their average \( V' O_{2\text{max}} \) strengthens the correlation between \( V' O_{2\text{max}} \) and performance. A professional soccer player should ideally be able to maintain a high level of intensity throughout the whole game. Some studies, however, have shown a reduction in distance covered, a lower fractional work intensity, reduced \( f_c \), reduced blood sugar levels, and reduced lactate levels in the second half of games compared with the first half. In determining aerobic endurance, \( V' O_{2\text{max}} \) is considered the most important element (Helgerud et al., 2001).

Arnason et al. (2004) investigated the relationship between physical fitness and team success in soccer, and to test for differences in physical fitness between different player positions. Participants were 306 boy soccer players from 17 teams in the two highest divisions in Iceland. Just before the start of the 1999 soccer season, the following variables were tested: height and weight, body composition, flexibility, leg extension power, jump height, and peak O2 uptake. Team average physical fitness was compared with team success (final league standing) using a linear regression model. Physical fitness was also compared between players in different playing positions. In the results, a significant relationship was found between team average jump
height and team success ($P < 0.009$). The same trend was also found for leg extension power ($P < 0.097$), body composition (% body fat, $P < 0.07$). Goalkeepers demonstrated different fitness characteristics from outfield players. They were taller and heavier, more flexible in hip extension and knee flexion, and had higher leg extension power and a lower peak O2 uptake. However, only minor differences were observed between defenders, midfield players, and attackers. They Saied: soccer is a sport characterized by short sprints, rapid acceleration or deceleration, turning, jumping, kicking, and tackling. It is generally assumed that through the years, the game has developed to become faster, with more intensity and aggressive play than seen previously. Elite soccer is a complex sport, and performance depends on a number of factors, such as physical fitness, psychological factors, player technique, and team tactics. During a 90-min soccer match an elite player covers on the average between 10 and 11 km per game. Although the distance covered by different players in the same position varies, studies have shown that midfielders travel farther than defenders or attackers, probably because of their linking role in the team. Among the defensive players, the fullbacks usually cover more distance than center backs, since they are usually more involved during the attacking phase. Although most of the movement for all players is at low or sub maximal intensity, it has been estimated that the mean work rate is about 70–75% of maximum oxygen uptake and close to the anaerobic threshold. Midfield players cover a greater percentage of their distance at lower intensity, whereas attackers cover a greater proportion at a sprint. This indicates that there may be a difference in the requirements between different playing positions, but whether this is reflected by differences in fitness is not clear. Studies on the physical performance of elite soccer players indicate that the average maximal O2 uptake ranges between 56.8 and 67.6 mL·kg\(^{-1}\)·min\(^{-1}\), whereas mean body fat (%) is between 8.6 and 11.2%. Muscular power has mainly been reported as jump height, using different tests. Some studies have found a vertical jump of 55.6–63.4 cm, whereas other studies reported a countermovement jump height of 41.4–41.6 cm and a standing jump height of 38.5–39.0 cm. Flexibility, muscle strength and hamstring to quadriceps strength ratios among soccer players have also been reported in several studies, but methodological differences (test type, speed, joint angle, etc.) make direct comparisons difficult. Although one might expect team success to be strongly correlated to physical fitness, there is limited evidence for such a relationship. One study found a correlation between the amount of training and the training to match ratio on one side and team success on the other. Wisloff et al. compared the fitness of one
team at the top and another at the bottom of the Norwegian elite division and found that the best team had significantly higher test values for maximal O2 uptake and 1-RM squat.

Elferink-Gemser et al. (2004) studied the relationship between multidimensional performance characteristics and level of performance in talented youth field hockey players. Elite youth players (n = 38, mean age 13.2 years, SD = 1.3) were compared with sub-elite youth players (n = 88, mean age 14.2 years, SD = 1.3) on anthropometric, physiological, technical, tactical and psychological characteristics. Multivariate analyses with performance level and gender as factors, and age as the covariate, showed that the elite youth players scored better than the sub-elite youth players on technical (dribble performance in a peak and repeated shuttle run), tactical (general tactics; tactics for possession and non-possession of the ball) and psychological variables (motivation) (p < 0.05). The results showed, the most discriminating variables were tactics for possession of the ball, motivation and performance in a slalom dribble. Age discriminated between the two groups, indicating that the elite youth players were younger than the sub-elite players. They concluded, in the guidance of young talented players to the top as well as in the detection of talented players, more attention has to be paid to tactical qualities, motivation and specific technical skills.

Gall et al. (2010) in their study, by univariate analysis revealed a significant difference in maturity status in amateurs and professionals versus internationals (p < 0.05), in body mass in professionals versus amateurs, in height and maximal anaerobic power in both professionals and internationals versus amateurs. There was also a significant difference in counter-movement jump and 40-m sprint time in internationals versus amateurs, as well as a significant main effect for age and playing position (p < 0.001). Significant differences were reported for maturity status, body mass, height, peak concentric torque, maximal anaerobic power, and sprint and jump performance with results dependant on age category and playing position. They said that the best performances in the velocity, agility and power tests were observed in the group of forwards. These results suggest that anthropometric and fitness assessments of elite youth soccer players can play a part in determining their chances of proceeding to higher achievement levels. Injury risk, training history and match experience, psychological, technical, motor, and perceptual cognitive, skills have been investigated as predictors of expertise and successful performance in youth soccer. They stated that additionally, anthropometric and physiological characteristics, maturity status and the influence of the period during the selection year in which players are
born, have been shown to be predictors of success in young soccer players. As research is generally cross sectional in nature, there is a need for a longitudinal approach to help talent prediction and development. Nevertheless, it is clear that the requirements for play are multifactorial and the distinguishing characteristics of elite players need to be investigated using multivariate analysis.