

Developing World-Class Soccer Players: An Example of the Academy Physical Development Program From an English Premier League Team

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ABSTRACT

THE ROLE OF THE YOUTH ACADEMY IN ELITE SOCCER IS TO CREATE WORLD-CLASS PLAYERS. THIS INVOLVES TARGETED DEVELOPMENT OF A MYRIAD OF FACTORS, INCLUDING TECHNICAL, TACTICAL, PSYCHOLOGICAL, AND PHYSICAL QUALITIES. THE ROLE OF SPORTS SCIENCE AND MEDICINE IS TO OPTIMIZE THE PHYSICAL DEVELOPMENT OF YOUNG PROMISING PLAYERS. IN LINE WITH THE MULTIFACETED NATURE OF PLAYER DEVELOPMENT, THE SPORTS SCIENCE AND MEDICINE DEPARTMENT MUST INTEGRATE EFFECTIVELY INTO THE OVERALL YOUTH ACADEMY. THE PURPOSE OF THE PRESENT ARTICLE IS TO OUTLINE THE OBJECTIVES, METHODS, AND OPERATIONS OF A SPORTS SCIENCE AND MEDICINE DEPARTMENT OF

ONE OF THE BIGGEST SOCCER TEAMS IN THE WORLD.

INTRODUCTION

As with many sports, the identification of talent in soccer is followed by the selection onto a systematic program (the academy) for developing playing abilities and nurturing the individual toward realizing potential that has already been predicted (26). Therefore, the role of the youth academy represents an integral component in the long-term development of soccer players (19). Success in young soccer players and ultimately, later success (e.g., achieving an elite playing standard, obtaining a professional contract) is the product of a myriad of factors including training history and match experience (14,15), technical (26), motor (8), and perceptual cognitive (29) skills and also personal, social, and cultural factors (26). Other physically related parameters such as remaining free of injury (26), anthropometric (e.g., body size, percent body fat), and fitness/strength-derived qualities

(e.g., aerobic fitness, maximal sprinting, maximal anaerobic power, jumping capacity) also contribute to this myriad of predictors and success (19). As the International Olympic Committee eloquently described it, “the goal of youth athletic development is to develop healthy, capable and resilient young athletes” (4).

Frameworks for athlete physical development should be flexible, using a combination of both best practice and experience underpinned by high-quality up-to-date research (4). Although the sports performance research literature is increasing exponentially, this only forms one part of the puzzle and insights into best practice, that is, what is being done in the practical setting by experts servicing athletes, is not as widespread. It has recently been proposed in the elite sporting environment that we must start to share our knowledge and experiences to learn from each other and

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continue to improve our servicing to athletes. (27). Such work is also essential in ensuring that the field of strength and conditioning continues to move further forward.

The purpose of the present article is therefore to share our knowledge and experiences in developing elite youth soccer players with readers and fellow practitioners. We aim to provide an insight into the operations of an elite youth academy belonging to one of the biggest soccer teams in the world and demonstrate how the Sport Science and Medicine (SSM) department uses this combination of research evidence and best practice to develop world-class soccer players.

ARSENAL FOOTBALL CLUB: BACKGROUND AND PHILOSOPHY

Before delving into the specifics and sharing our experiences and practices with the readers, we feel that it is pertinent to introduce the background and philosophy of the club. Founded in 1886 by workers from the Royal Arsenal, Woolwich, London in the United Kingdom, Arsenal FC is considered one of the leading clubs in world soccer with a rich heritage of success, innovation, and financial stability. Competing in the English Premier League since its inception in 1992, the first team has a strong history of also competing in the European Union of Football Association's Champions League, with successful qualification achieved in the past consecutive 19 years. Developing young talent has long been at the center of the club's philosophy, and the club enjoys a proud history of producing players who regularly play with the first team. Consequently, the football academy is considered central to the long-term future of the club and continues to strive to produce first team players (12).

THE FOOTBALL ACADEMY

The principal mission of the football academy is to enhance each player's progression, both as a player and as a person, by providing a world-

leading youth development program. There are 2 elite London-based training centers; one offering approximately 150 players from U9 to U16 a part-time academic program, expert-guided personal development, and soccer training. The other training center services around 50 U18 to U23 players not only with the same personal development support and soccer training but also with full-time academic teaching. The football academy promotes the development and growth of future English Premier League players in an environment that is challenging, developmental, and inspirational. By default and rule of the English Premier League Association, all clubs are required to divide players into 3 different phases: foundation phase: 9 to 12 years; youth development phase: 12 to 16 years; and professional development phase: 16 to 21 years. In accordance with the multidimensional nature of developing talented soccer players, the football academy structure is also multifaceted and can be defined by 5 key departmental pillars (Figure 1). Figure 2 illustrates the interaction between these 5 integral pillars. The

present article is concerned with the key pillar, that is, SSM.

The SSM department works collectively toward the goal of the club to produce first team players. The main objective and what the SSM department strives for is to develop player's physical abilities and increase resilience using a combination of both best practice (our combined experiences) and evidence-based (research literature) approaches. In this way, we can maximize player availability and consequently exposure for coaching sessions and soccer skills development. A long-term structured approach to the development of athleticism in youth is warranted (13), and as such, a structured approach should not be viewed as a stringent blueprint, but rather, the programs within the model are tailored to the needs of the individual and within the confines of the unique demands of the training environment (4). With appropriate preparatory strength and fitness conditioning, the risk of sports-related injuries can also be decreased, and the likelihood of achieving and sustaining an



Figure 1. The football academy departmental structure.

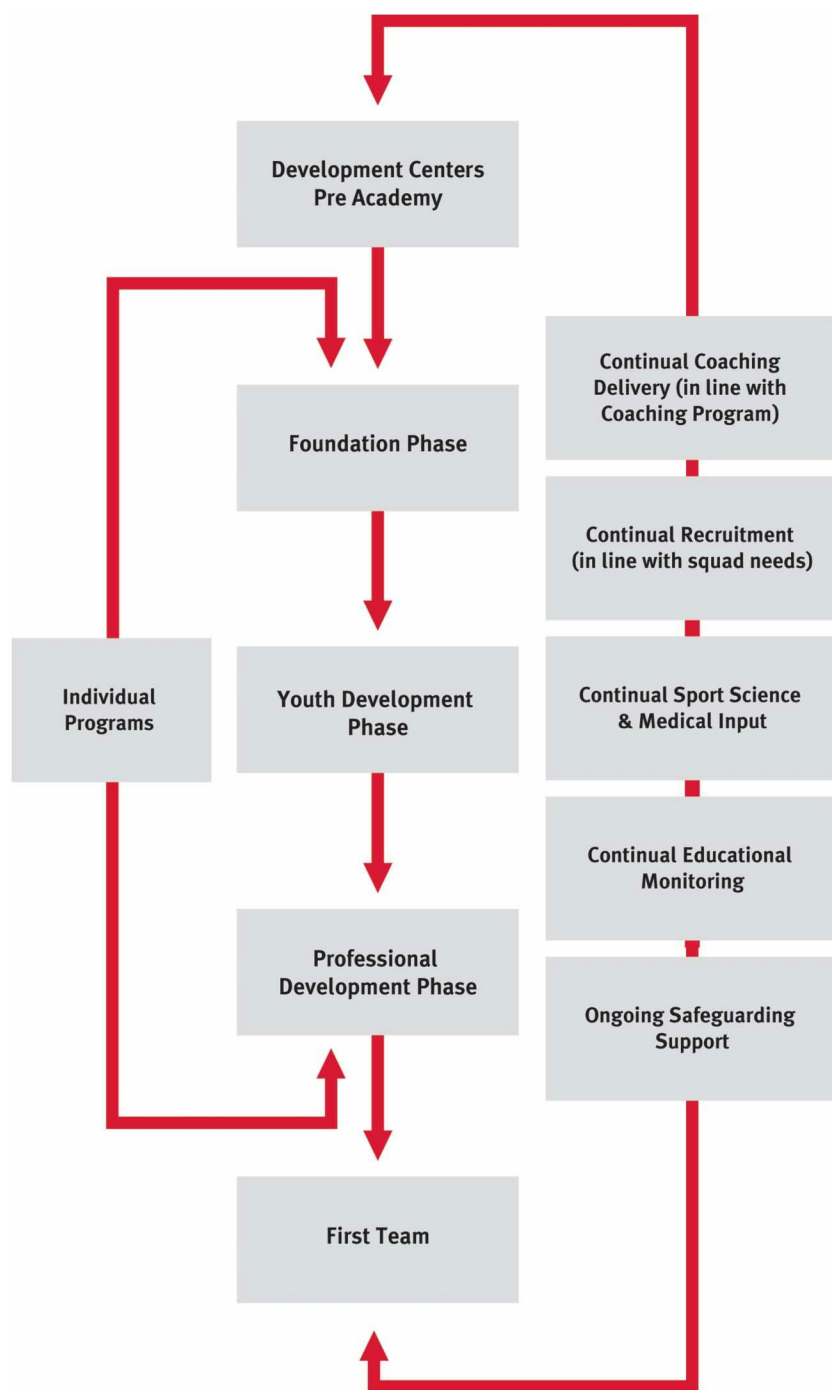


Figure 2. The interaction of the 5 departmental components of the football academy.

enjoyable high level of enhanced performance increased (4). These principles underpin the SSM framework for athlete physical development in the pursuit to develop world-class soccer players. A summary of the various roles and services

within the SSM department is also provided in Figure 3.

THE PHYSICAL DEVELOPMENT FRAMEWORK

In 2013, the previously existing athletic development framework was updated,

evolved, and retitled, the “physical development framework.” The final framework and how it integrates into the overall academy program was agreed in a series of round table discussions between experts within the football academy (academy manager, soccer coaches, strength and conditioning coaches, nutritionist, psychology, and medical staff) and again (and always) in accordance with the club’s philosophy. Although the most up-to-date version, the framework is not a fixed entity and is constantly being reviewed and evolved as new evidence and experiences emerge. An overview of the physical development framework is shown in Figure 4 and described in more detail below. In addition to providing a structure around which to build the SSM program, the system also has a huge benefit as a communication tool. A key to the success of any program is the degree of “buy-in,” in particular, from players and coaches, and to maximize this, we continually stress the “why” of what we do. This structure is used to explain our approach and method to players, parents, coaches, and other key stakeholders, all of whom play a key role in the overall success of the program.

The physical development framework can be described as the “arrow approach.” This signifies moving the player to the next level as quickly and efficiently as possible, but only when key competencies are achieved at each phase. It consists of 4 core pillars of development that players must achieve for excellence.

FUNCTIONAL COMPETENCE

The first core component of the framework is referred to as “functional competence.” This applies to all age groups and is the starting point for all program designs. Specifically, this stage highlights the importance placed on establishing the fundamental basics of athletic development. Functional competence refers to an assessment of muscle flexibility, strength imbalances, and general movement pattern proficiency in a range of performance tests to

SUMMARY OF SPORT SCIENCE AND MEDICINE ROLES AND SERVICES PROVIDED

PLAYER PROFILE AT A MACRO LEVEL & MICRO LEVEL Who - All departments When - Four times a year	PLAYERS GIVEN AN INDIVIDUAL ATHLETIC DEVELOPMENT PROGRAM Who - Strength & Conditioning Coaches When - Monthly
PLAYERS FUNCTIONALLY SCREENED Who - Physiotherapists & Strength & Conditioning Coaches When - Four times a year	PLAYER GIVEN A CORRECTIVE EXERCISE PROGRAM Who - Physiotherapists & Strength & Conditioning Coaches When - Monthly
PLAYERS FITNESS TESTED Who - Strength & Conditioning Coaches When - Three to four Times a year depending on age group	INJURIES MONITORED AND AUDITED Who - Physiotherapists When - daily and quarterly
PLAYERS MATURATION ASSESSED Who - Physiotherapists & Strength & Conditioning Coaches When - Four times a year depending on age group	PLAYERS PSYCHOLOGICAL SKILLS, WELLBEING & MENTAL HEALTH SCREENED & PROFILED REGULARLY Who - Personal Development & Psychology (liaising with SSSM, Welfare & Safeguarding) When - Weekly & Quarterly
WORKLOAD MONITORED FOR EVERY PLAYER Who - Physiotherapists & Strength & Conditioning Coaches When - Weekly	PLAYERS EDUCATED ON NUTRITION, LIFESTYLE, LIFE SKILLS, PERSONAL DEVELOPMENT & PERFORMANCE PSYCHOLOGY Who - Head of Youth Academy Personal Development and Psychology & Nutritionist & Head of Education When - Weekly
READINESS TO TRAIN MONITORED FOR PLAYERS Who - Physiotherapists & Strength & Conditioning Coaches When - Weekly	

Figure 3. Summary of sport science and medicine roles and services provided.

identify functional deficits related to proprioception, mobilization, and stabilization. Additionally, we aim to determine the existence of pain during any of the prescribed movement patterns, as previously described using the functional movement screen (FMS) (6). Superior movement proficiency is essential for safe and effective long-term physical development and performance in youth athletes (20,28) and potentially in reducing injury risk (16,24). But this may be limited as a tool to predict injury in elite soccer players (3,25).

Throughout a standard 11-month season, academy players are assessed 4 times throughout the year (start and end of preseason, midseason, and end of season) and corrective exercise programs are designed and implemented in collaboration with the strength and conditioning coaches and physiotherapists. Once the player's functional competence and technique has reached an appropriate and acceptable level, we

will then progress the player into more advanced training strategies (e.g., strength and power) with confidence that they can cope with the increased demands. In the framework, there are 20 exercises and movement screens that the player has to master to be deemed to have reached an acceptable level. These include some movements from the functional movement screens together with mastering key exercises like the squat. Players from our U9 to U11 age groups mainly focus on functional competence, fundamental movement skills, and multisport content. It is at U12 where the players can progress to biological age appropriate strength and power if they are at an acceptable level in terms of functional competence.

MOVEMENT SKILLS

The major focus at this stage of the framework is to assess, develop, and correct inefficiencies of how a player moves on the soccer pitch. The difference between functional competence

and fundamental movement skills are that functional competence focuses on mobility and stability movements and exercise competency, whereas fundamental movement skills focus on movements like acceleration and jumping. This is why the movements need to be at a mature level before the players go onto more advanced speed and power activities. Movement skills are separated into 2 distinct yet linked categories: (a) fundamental movement skills and (b) physical literacy. Our operating definitions of these terms are as follows: (a) fundamental movement skills refer to the basic movement skills of walking, running, jumping, throwing, catching, kicking, and balancing and (b) physical literacy refers to the athlete/player's ability to control his body, locomotion, and objects in a competent way and with the capacity to apply them with confidence. Both fundamental movement skills and physical literacy are important areas in the academy framework, especially in the younger age groups

THE ARSENAL ACADEMY APPROACH TO PHYSICALLY DEVELOPING YOUNG PLAYERS

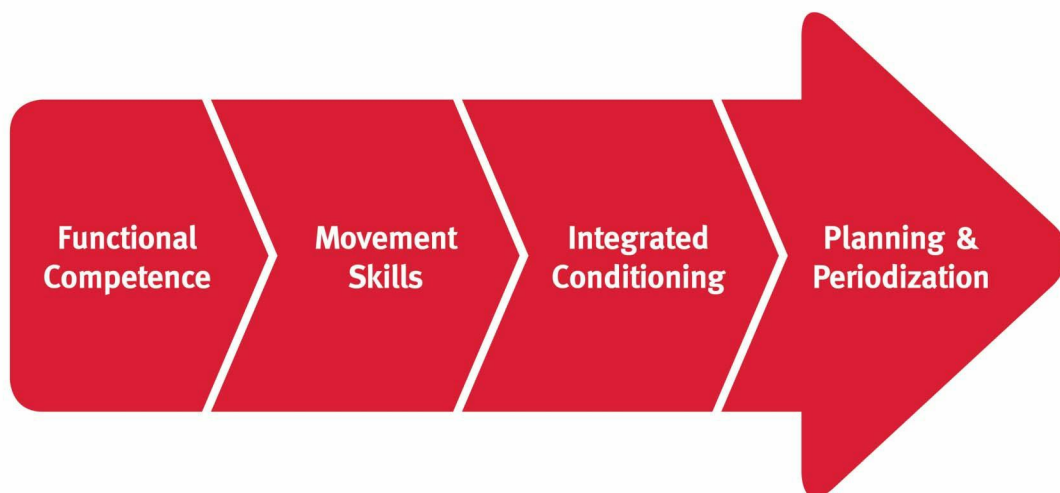


Figure 4. The sports science and medicine physical development framework.

because it has been shown that good progress can be achieved at the early stages of development (14). Successful development of fundamental movement skills is essential to ensure that correct movement patterns are mastered in a protected and fun environment to ensure safe and effective performance of more complex sports movements at a later stage (20). Once a player masters an appropriate level of movement skill, he can then progress to more advanced speed and power exercises. As with functional competence, even after the player is moved to the next stage of the framework, the movement skills are continuously monitored to ensure that no regression of performance occurs.

INTEGRATED CONDITIONING

The third part of the framework focuses on integrated conditioning. Integrated conditioning simply means incorporating physical development strategies into a soccer-specific context. As the club demands development of highly technical players, it was agreed with the soccer coaches and technical directors that specific conditioning drills be completed within the context of soccer training and match-play as much as possible while ensuring the physical goals are met. This means that the player's endurance/fitness conditioning should be completed using activities closely related to the game, and, where

appropriate, the content is completed by the soccer coach or in conjunction with the soccer coach and closely monitored for specificity and overload. Indeed, specific soccer drills, such as purpose-built small-sided games, can provide superior results in match-related variables of young soccer players (5). Anecdotally, within soccer and in our own experience, motivation and coach compliance is higher also when put into the soccer context. This stage generally increases in focus as the players reach the professional academy (U18 and over) and is not emphasized at lower age groups to avoid early specialization. Physical personal improvement plans (PIPs), targeting individual player's physical

weaknesses, are implemented in combination with the technical director and soccer coaches at the end of regular soccer training sessions. The additional training and match loads associated with these PPIPs are monitored closely and prescribed based on individual player needs. These sessions are typically more traditional in nature, for example, “interval, intermittent-type running activities.” Players with similar PPIPs and with similar physiological profiles can also be grouped together in the same sessions because it has been recommended that such an approach can permit coaches to balance oppositions and reduce the variability of the physiological outcomes (1).

PLANNING AND PERIODIZATION

The final part of the framework concerns “planning and periodization” of the players’ program. This stage highlights the importance of monitoring and periodization of the player’s content to make sure that he is positively adapting and not entering a state of over or under training, “that is, to ensure optimal loads for continued and optimal development.” Every session is monitored for workload, and the players’ readiness to train is calculated to check how they are coping with the prescribed workloads. For example, this involves a combination of objective and subjective measures. We use various Global Positioning System-derived metrics, such as total distance per minute and high-speed running parameters (accounting for measurement errors in these), to assess the external load that has been imposed on players from U13 to the oldest age group regularly and sporadically for the younger age groups. We simultaneously measure heart rate and session rating of perceived exertion (s-RPE) to determine the internal load experienced from the external stimulus. Duration of sessions and s-RPE are taken for all age groups. All teams above U16 implement a 3-week high workload and 1-week down-load pattern. The normal week contains 1 football conditioning day, where the acute training variables are manipulated to overload

the players to create positive adaptation. The other training days are predominately technical or tactical development days and a tapering day pre and/or post game.

APPLICATION OF THE PHYSICAL DEVELOPMENT FRAMEWORK TO INDIVIDUAL PLAYERS

MATURATION

It is important to highlight that although each stage of the framework can typically be associated with a chronological age (e.g., U9 versus U12 versus U17), high consideration is given to the individual maturation level of players also. The physical competence of the young player varies according to maturation status (21), and as such, it needs to be assessed and the program adapted accordingly. This is an integral and ever evolving component of the SSM department. Biological maturity is assessed noninvasively by incorporating measures of body mass (in kilograms), standing height (in centimeters), and parental height (in centimeters) into a regression equation titled the Khamis-Roche method (17). Biological parents of the players reported their heights, and as adults tend to overestimate height (10), the self-reported height of each parent was adjusted for overestimation using an equation constructed from more than 1,000 measured and estimated heights of adults (10).

Estimated biological maturity status is expressed as a z-score, using percentage of predicted adult height attained at the time of measurement. Boys are classified as prepubertal growth spurt when they are assessed to be between 89% or less of predicted adult height, during pubertal growth spurt when they are between 89 and 95% of predicted adult height, and past pubertal growth spurt when they are past 95% of adult height. As a practical example, if we consider a young soccer player at the prepubertal level, this player will not have the same physiological capability to adapt fully to strength training as the more mature player at the post pubertal or adolescent stage (21).

However, they will have the capacity to develop movement competency and to gain the ability to express force through this movement, predominantly through neural mechanisms (20). The key, at the early stage, is to learn the movement skill of the exercise as opposed to seeking to develop maximum strength. Also, players who are more mature biologically can be progressed more aggressively in their athletic development program. To the same extent, players who are close to 92% of adult height are predicted to be at their peak height velocity (7). Once these have been assessed, the strength and conditioning coaches and physiotherapist can closely monitor and guide the player, helping them through the possible adolescent awkwardness phase. Once the player has shown signs of this phase, the workload on the pitch can be reduced, and corrective and coordination work can be increased.

PERSONAL DEVELOPMENT AND PSYCHOLOGY

As part of developing world-class players and people, we aim to nurture individuals into becoming the best person they can be. As highlighted by Eubank (11), the nature of high-performance sport can be laden with intense, uncertain, and challenging realities all built around a constant preoccupation with achievement, outcome, and success. This cultural reality can lead to a player being over-absorbed, and the overnarrowing of their identity can come at the detriment of developing other areas of what could be considered “normal life” (9) and can lead to what has been termed as “foreclosed identities” (22). This is where the athlete overidentifies with their performance role, leading to the loss of psychological and sociological development and well-being of themselves (2,23).

Within the academy, an immersed player development program is implemented covering a broad range of opportunities. These include personal development, (e.g., learning styles and personality preferences), performance

psychology (e.g., performing under pressure and breathing techniques), life skills (e.g., finance and cooking skills), and player care (well-being and welfare, life after football). The key question is how does this fit alongside the overall physical development framework? The player development program aims to offer seamless continual support and learning opportunities throughout the elite player pathway from U9 to U23 and into the first team. It supports the various transitions, sporting and nonsporting, that a player may experience. This support has been intentionally broadened, to encompass the needs of the players and coaches (as evidenced through continual feedback and research within the club over the past 20 years). We hope that this ensures that sporting transitions are not seen as a singular event but more of holistic, career-life span perspective (30).

This is a club-wide commitment achieved through positive partnerships with coaching, sport science, medicine, education, and welfare. The aim is to enable those involved to fulfill their potential as a player and person, someone who continually strives to be able to combine and manage successfully the demands of elite soccer alongside other holistic personal contentment and future aspirations (18).

STRUCTURE AND STAFFING OF THE SSM DEPARTMENT

Although the structure and the methods of application are fundamental to the development of an effective youth development program, ultimately, success will depend upon the quality of delivery and here the role of the coach is critical. As stated recently by Bergeron et al. (4) in the IOC consensus statement on youth athletic development, “coaches of youth athletes play a pivotal role in determining whether sport systems provide opportunities for peak athlete performance and shape personal development accordingly” and “coaches require a unique mix of professional, interpersonal, and intrapersonal knowledge to effectively cultivate athletes’ competence, confidence,

connection and character” (4). Development programs delivered by qualified professionals using long-term and systematically progressed approaches to developing athleticism will enable more effective control over training variables, a reduction in the risk of overtraining, and an enhanced overall adaptation in physiology and performance (13). It is therefore evident that the selection of key, qualified, competent, and adaptable staff to operate within the athletic development of players is crucial, and the development of a highly skilled and qualified team of professionals has been pivotal to the successful application of the program.

In the world of high-performance sport, there is always discussion on what qualifications and experience a head of department should hold. The lead author of this article and head of SSM was selected first and foremost due to his high level of experience working with the youth athlete. From a “qualifications” perspective, the head of SSM holds a Master’s in strength and conditioning and is both United Kingdom Strength and Conditioning (UKSCA) and British Association of Sports and Exercise Sciences (BASES) accredited. There are a high number of full-time strength and conditioning coaches delivering the program, and these are expected to hold a minimum of a sport science or related degree, be UKSCA accredited, and are also encouraged to attain BASES accreditation. Similarly, there is also a high number of full-time physiotherapists employed in the Academy, and they all must be on the Health and Care Professions Council registry and a member of the Chartered Society of Physiotherapy. The nutritionist, doctors, Head of Personal Development, and psychologist also have comparable qualifications for their respective fields, and most importantly, have a vast level of experience working with youth athletes.

The quality and level of knowledge, competencies, and experience of the staff within the SSM department is

testimony to the importance that the club places on the development of young players. Critically, progression in the system has not only been vertical but also horizontal, and this plays a key role. Typically, coaches progress through coaching structures by starting at the younger age groups and working their way progressively through to senior teams. Unfortunately, this means that the younger age groups, who often have the most to gain from high-quality coaching, are normally coached by younger less experienced coaches. To combat this, we aim to ensure that we have experienced coaches working at all levels, with the placement depending upon the coach’s skill sets and how we feel they can best impact upon the overall mission. In this way, progression can be achieved horizontally, “that is, becoming a senior coach with the junior teams and not only vertically.” To provide a specific example, one of our most experienced strength and conditioning coaches fills one of our most senior positions working with the under 9 to under 16. This is just one example crediting the clubs’ philosophy of embedding highly experienced coaches with the youngest players.

OVERVIEW OF THE SPECIFIC ROLE OF A STRENGTH AND CONDITIONING COACH IN OUR CLUB

Effective coach functioning depends upon clarity of roles, and therefore, it is important that we clearly define the strength and conditioning role within the SSM. Currently, there are a number of job titles connected to the sport science and strength and conditioning industry. Examples would be sport scientist, strength and conditioning coach, physical performance coach, soccer scientist, fitness coach, fitness and conditioning coach, soccer conditioning coach, movement specialist, and pathway scientist. A conscious decision was made to standardize the title to strength and conditioning coach, while encompassing a variety

of responsibilities. This is aligned with our belief that a youth academy strength and conditioning coach is a generalist and needs to be competent in several areas. The strength and conditioning coach will have to work in various environments and develop the players across several facets. The typical roles of a strength and conditioning coach operating in the SSM include, but are not limited to: workload monitoring (microtechnology, subjective wellness), planning and periodization of training content on and off field, coaching movement and exercise techniques, assessing maturation, assessing training age, and undertaking physical tests. Adaptability to an everchanging environment is a key skill, and modifying training based on that and other information is a typical role. Additionally, effective integration within the medical and coaching staff is imperative.

At the U18 and U23 age groups, we have a ratio of 1:9 (i.e., 1 strength and conditioning coach for every 9 players). The players are distributed to the strength and conditioning coach not based on age but based on the needs of the player and the personality type of the player and coach to get the best match for development. The player coach ratios are slightly higher at the younger age groups, and they each take responsibility of an age group, but there may be more than 1 strength and conditioning coach at a development session.

ACADEMY GRADUATES: FROM ACADEMY TO FIRST TEAM

In support of the effectiveness of the program, we feel that it is important to give readers an insight into some of the talented players who have been developed through the club's football academy. Below is the current number of graduates in the current squad (with the oldest graduate making his first team debut in 2008). This section is based on 3 different criteria: (1) academy graduates currently regular playing members of

the first team squad, (2) academy graduates who played for the first team in a competitive game and are currently on loan at an elite-level team, and (3) academy graduates who played for the first team in at least 1 competitive game and are still part of the club's academy.

CRITERIA 1

There are currently 6 players (22% of the team) who have come through the academy system and are regular starters in the first team squad of 27 players.

CRITERIA 2

We have 7 players who have been brought through the academy system and competed in the first team and who are currently on loan at other elite-level teams. The loan system is used in the English soccer leagues, whereby teams such as in the present article will loan out younger players to other teams playing at a slightly lower standard with the aim of providing them with experience in senior soccer. The goal is to provide further development, with the aim to bring them back to the club more capable to compete regularly within the club's own first team.

CRITERIA 3

We have 7 players in our academy who have been called up from the academy to compete in at least 1 competitive match for the first team.

PRACTICAL APPLICATIONS

When creating an effective SSM department, a combination of both evidence base and best current practice should be considered the gold standard. Physical development frameworks should be tailored according to the needs of the sport and the club/sporting industry. Programs should be individualized according to the specific needs of the players/athletes and must be malleable to adapt to the everchanging sporting environment. We also recommend that professionals working within the science and medicine department of the elite youth

academy should not only hold the appropriate university standard qualifications but also possess accreditation from a national governing body (e.g., UKSCA accreditation or the National Strength and Conditioning Association, Certified Strength and Conditioning Specialist for strength coaches, and the Federation of State Boards of Physical Therapy). Finally, maximizing the impact of sport science/medicine into the elite youth academy requires effective communication between and among the key stakeholders; therefore, practitioners should concentrate on building good relationships with staff, coaches, and players to maximize uptake of recommendations.

CONCLUSION

The present article has provided an insight into the objectives, methods, and operations of an elite sport science and medicine department of one of the biggest soccer teams in the world, renowned for producing high-profile players.

In summary, the role of sports science and medicine within the overall academy is to complement and enhance the multifactorial nature of developing a high-level soccer player. The goal of the SSM department in the current article is to (a) develop the physical qualities of players and (b) to make them "resilient" to cope with the demands of training and competition required to become a top-level player able to compete in arguably the highest competition in world soccer. We hope that by us sharing our experiences and knowledge, that this insight will assist practitioners in developing their own systems.

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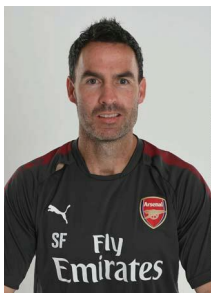
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