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American Football Testing with a Mobile Application



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ABSTRACT

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American football is a physically demanding sport, which has grown internationally over the past couple of decades. With the increase of interest in physical abilities around the sport, testing and measuring these abilities has become more popular for player comparison. This thesis provides theoretical knowledge on the main physical abilities of the sport and performance testing. The objective of the study was to acquire knowledge on the most relevant physical abilities and the suitable measurement methods for these on youth American football players in Finland. This thesis was commissioned by the American Football Association of Finland (SAJL). SAJL's aim for this work was to examine whether a mobile application would ease the process of collecting test results.

The author's aim for this thesis was to gather theoretical knowledge on and practical experience in physical performance testing with regards to American football. The study also examines the possibilities of modern technology, which can be used to aid in the testing event. A mobile application is presented in this work and the report on its suitability is included in the practical part of the thesis. The application was tested in field conditions and the report assessed its timeliness, reliability, convenience, and software and hardware dependency.

The main findings of the theoretical part suggest that the main abilities emphasized in American football are speed, strength, and power and testing protocols for these abilities tend to vary based on the test subject and the conductor of the tests. The analysis of the application's practicality insinuates that it may not be the best available solution for SAJL.

FOREWORD

“Theory is when you know everything, but nothing works. Practice is when everything works, but nobody knows why.” – Unknown

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1 INTRODUCTION

Over that past couple of decades, American football has increased its popularity across the globe. The National Football League (NFL), which is commonly seen as the highest level of competition, has increased its international appeal by hosting games outside the United States and as multiple players with international backgrounds are playing in the league. The sport is also played in multiple countries and there are international competitions for men, women, and youth.

Like many other sports, American football has evolved both physically and strategically and it has many demands for its players. As the level of competition increases, players are tested and evaluated on multiple aspects, these include cognitive, psychological, and physical characteristics. (NFL Combine, 2018.) Cognitive assessments are conducted to evaluate players' ability to learn new skills and strategies and psychological ones seek to understand players motivation. Physical assessments are used to determine whether a player is fit and able to meet the requirements and standards a level of competition or a playing position may hold.

Physical preparation, strength and conditioning training, is an important part of a successful American football program. Although there has been some debate on which strength and conditioning methods fit the needs of the sport and the needs of a player, physical performance testing can be used to collect data on the effectiveness of these methods. Testing can also be used for diagnosis, which helps in planning and implementing a training plan to fit the needs of an individual player.

The purpose of this thesis is to describe some of the main physical abilities required in American football and how these abilities can be tested. The author's aim for this study is to gather theoretical knowledge on and practical experience in physical performance testing with regards to American football. The theoretical part includes basic information on the abilities and test protocols, which can be used for development of the sport in Finland, author's native country. The study also examines the possibilities of modern technology, which can be used to aid in the testing event. A mobile application is presented in this work and the report on its suitability is included in the practical part of the thesis.

This thesis was commissioned by the American Football Association of Finland (SAJL). The commissioning party's objectives were to find information on testing methods to simplify the process of collecting performance data on Finnish youth players. The tests themselves were to be suitable for youth players and comparable with the tests used in high schools and colleges in the United States. Lastly, the tests were desired to be simple enough that a player could have the possibility to conduct them independently. The practical task for the author was to report whether modern technology, such as a mobile application, would be a solution to receiving test results more effectively.

2 AMERICAN FOOTBALL

American football is a contact, team sport played by 11 players per team on the field at once. The playing field is 100 yards (91.4 meters) in length, with additional 10 yards on each end, called end-zones, and 53 yards (48.5 meters) in width. (NFL, 2018.) Time of play, depending on the level competition, consists of four 12 or 15-minute quarters. The game is played in a series of “plays”. A play is the time when the ball is in play, it begins when the ball is moved from its position on the field and it ends when the referee whistles the play over. In a game of American football, a player will perform multiple, repetitive maximum-effort movements. (Hoffman, 2015).

In 2006, an observational study (Rhea, et al) examined the lengths of plays and the recovery times in American football on three different levels; high school, college, and professional. On average, a high school play lasted 5.6 seconds, and plays in high school took slightly longer (approximately 0.4-0.5 seconds) than the plays in collegiate and professional American football. The time for recovery was reported to be the shortest in high school and longest in the professional games. The work to recovery ratio, on average, was on all the levels between 1:5.5 and 1:6.2. (Rhea, Hunter & Hunter, 2006). Given the short period of time an American football player is engaged in exercise during a play, players are generally expected to perform at maximum level of intensity on each play. (Hoffman, 2015).

American football teams often have players specifically assigned to play on offense, defense, or special teams. The main offensive objective is to move the ball by either running or passing it towards the defensive end of the field, at minimum of 10 yards per four attempts (downs), and ultimately scoring a “touchdown” by advancing with the ball to the end-zone. The defensive team, naturally, plays the counterpart for the offense and tries to prevent the offensive team from advancing. Within these given groups, a player is further categorized into a position. (NFL, 2017). Each position holds different skill and performance needs, which are dictated by the positional tasks during the game. (Yamashita, et al., 2016).

The offensive team consists of five linemen, a center (C), two guards (G), and two tackles (T), linemen are generally anthropometrically larger and physically stronger individuals as their primary task in the game is to prevent, or block, the defensive players from tackling the player with the ball. (Hoffman, 2015). The remaining six positions of the allowed 11 on the field are: a quarterback (QB), one or two running back(s) (RB), one or two tight end(s) (TE), and two to four wide receivers (WR). (NFL, 2017.) The composition of the team on the field, i.e. number of wide receivers, varies and depends on the team's tactical scheme. In general, quarterback's duties include passing the ball to other players (wide receivers, tight ends, or running backs) or running with ball. Running backs' duties are running with the ball as well as blocking. Tight ends and wide receivers typically catch the passes from the quarterback or block defenders out of the ball carrier's way. Tight ends are lined up next to the offensive linemen, they tend to have similar traits to linemen, and are more engaged in the blocking, where wide receivers positioned away from the line and are more engaged in catching and running with the ball. (Hoffman, 2015).

Similarly, the defense has different positions; defensive linemen, linebackers, and defensive backs. The defensive line players, defensive ends (DE) and defensive tackles (DT), aim to push forward and battle against the offensive line in pursuit of stopping the ball carrier. Linebackers (LB) defend against the pass by dropping back, as well as the run by pushing forward and tackling the offensive player. The defensive backs (DB) mainly defend against the pass from the quarterback to the wide receivers and help defending against the run. (NFL, 2017). Generally, there are three or four linemen, three or four linebackers, and four to five defensive backs in the 11-player defensive unit, the variations are often done with regards to the team's tactical scheme or the offensive line-up. (Hoffman, 2015).

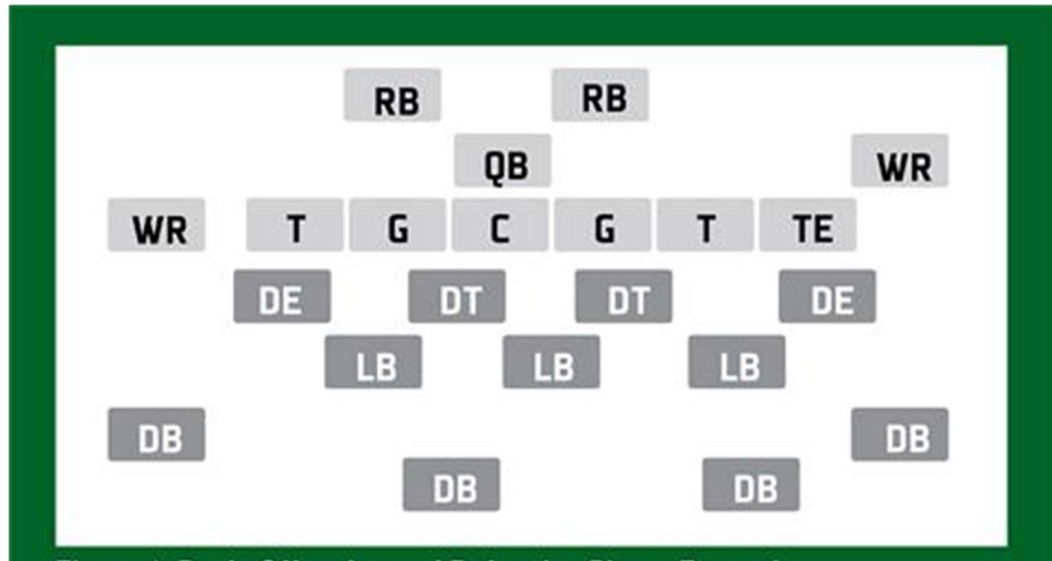


Figure 1. Basic American football formations and player positions. (Hoffman, 2015).

American football is most popular in the United States. The sport has strong ties to the American educational system and is one of the wealthiest sports in the country. (Hoffman, Falk & Manning, 2005). The popularity of the sport has been spreading across the globe within the past decades. In Finland, the sport began to emerge in the 1970's and the sport's national governing body, SAJL, was founded in 1979. SAJL, as a member of Finnish Olympic Committee and International Federation of American Football, is dedicated to offer competitive and recreational variations of the sport to the nation as well as promoting the sport within the country. (SAJL In English, 2018).

2.1 Youth American football in Finland

Youth American football in Finland is organized for players between the ages of nine (and under) to 19. Like other sports in Finland, youth American football teams are organized by clubs. There are over 30 active clubs in Finland and more than 20 of them are currently competing in the youth leagues. (SAJL nuoret, 2018). SAJL governs youth football leagues and national team programs in Finland. SAJL offers opportunities to compete in the sport outside of these age groups, but the

junior national team programs are designed as follows: for under 19 (U19), under 17 (U17), and under 15 (U15) years of age. In these age groups, similar rules apply in the game with minimum variations to the ones used in adult competition. U19, U17, and U15 teams may choose whether to compete nationally in the national youth leagues; played on a full-sized field with 11 versus 11 -rules, or to compete in youth divisions; played on a smaller field with 7 versus 7 -rules. (SAJL maajoukkueet, 2018).

2.2 SAJL Player Path

Many sports in Finland have athlete paths designed for competitive, ambitious individuals who pursue a career as a professional athlete. An athlete path serves as a general guideline for athletes and coaches describing how training should be implemented in different stages of an athlete's career. These paths are developed in cooperation with the national associations of a given sport to match the sport-specific requirements and the generic themes in physical training with regards to the athlete's age and development. (KIHU, 2018).

With regards to the athlete path, SAJL has developed its own player path (Figure 2.) for American football players with similar functions. The purpose of the player path is to aid in player development, future planning and seeking playing opportunities. For youth players, the path gives an insight on the physical and skill requirements to reach a given level of competition. The path is designed to mimic some of the competitive models used in the sport globally, to ease the transition from Finland to abroad. Different stage of the player path reflects to international, mainly American, standards of the sport. (SAJL, Pelaajapolku, 2018).

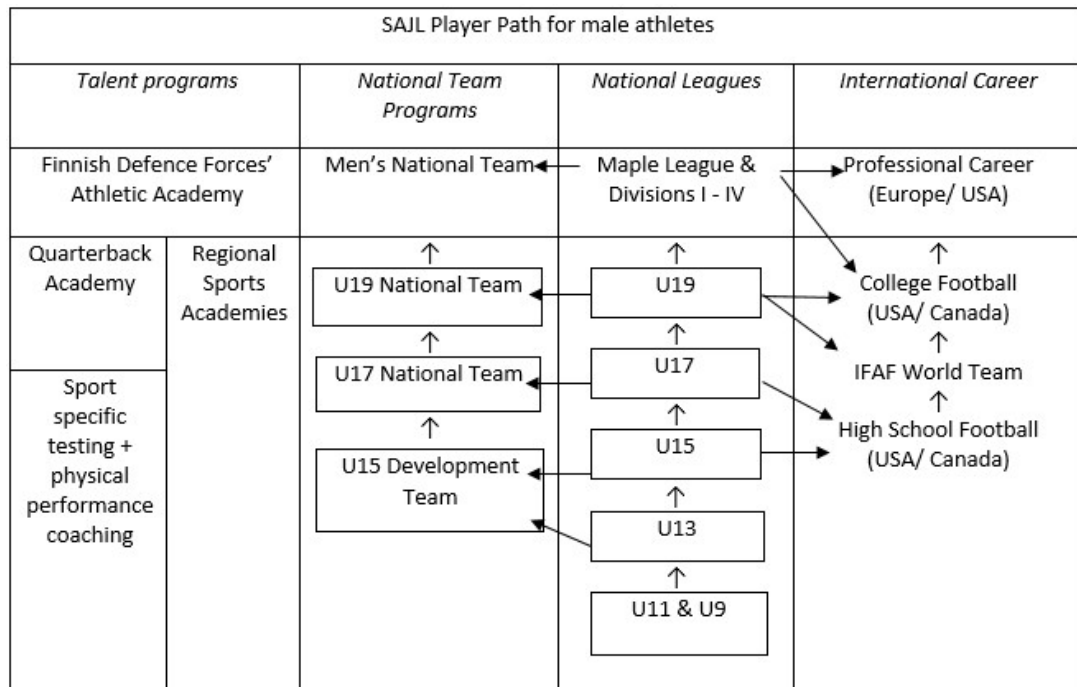


Figure 2. Modified and translated player path. (SAJL Pelaajapolku, 2018).

2.3 College to professionals

National Collegiate Athletics Association (NCAA) is the largest organization governing collegiate sports in the United States with over a thousand member-institutions. For American football, NCAA has structured three main levels of competition: Division I, Division II and Division III. (NCAA, 2018a). Generally, Division I is considered the highest level of college football, as most of the athletes selected to play in NFL played on the Division I level prior to their professional careers. In 2017, 253 athletes were selected, or “drafted”, by NFL teams, 247 of them were from Division I schools and only 6 drafted players were from Division II schools. (NCAA, 2018b).

As described in the SAJL player path, the highest level of competition in American football is organized in North America and there are different ways for a Finnish player to pursue an international career. (SAJL Pelaajapolku, 2018). Since 1984, 61 Finnish citizens have enrolled into North American institutions and participated

in collegiate, inter-scholastic American football as student-athletes. (SAJL college football, 2018).

According to NCAA, more than one million students competed in high school American football during 2016-2017 season. Within the NCAA schools, the number of participants in the sport was just over 73,000. The estimation showed that approximately seven percent of high school football players continue to play American football in the NCAA. The NCAA has also estimated the probability of pursuing a professional career in American football after playing in college, which is less than two percent. (NCAA, 2018b).

As it shows, a professional career in American football is very unlikely for a college player, even if the player competed in NCAA Division I. (NCAA, 2018b). However, there has been one player drafted directly from Europe who did not compete in collegiate American football in the United States. In this particular case, the player's athleticism was mostly praised by the drafting team's coach. (Kelly, 2016).

3 MAIN PHYSICAL ABILITIES IN AMERICAN FOOTBALL

A game of American football consists of short, high-intensity forms of exercise; thus, the sport can be characterized as acyclic. (Fullagar, McCunn, & Murray, 2017). Given that a single play lasts approximately five seconds, (Rhea, Hunter & Hunter, 2006.) anaerobic energy systems are predominantly used in the sport. Anaerobic energy systems, especially the phosphagen system, provides energy for short-term (0-6 seconds), high-intensity activities. (Baechle & Earle 2008, 23-32).

It has been shown that strength, power and speed are the main physical abilities used to differentiate and rank players within a team, or subsequently, differentiate players between different levels of competition. These physical abilities also influence the recruitment process as well as the development of training programs for American football. Due to the duration of the game event, varying from 2-4 hours depending on the level of competition, it is suggested that there are needs for aerobic sources of energy production for a football player, yet this has been studied less with American football players. (Hoffman, 2015).

“Speed and power are essential qualities for American football players of all ages and ability levels.” (Lockie, Jeffriess, Schultz & Callaghan, 2012).

3.1 Speed in American football

Speed is defined as movement distance per unit time and it can be quantified by timing an athlete’s run over a fixed distance. (Baechle & Earle 2008, 252). In most sports, speed is an important quality and it can be divided into different subcategories, such as: reaction speed, explosive speed, and linear speed. (Keskinen, Häkkinen & Kallinen 2007, 164-165). In a game of American football players generally exhibit these forms of speed by reacting to the ball or to other players, by accelerating and decelerating in explosive changes of direction, and by sprinting various distances. (Wellman et al., 2016).

A recent study (Wellman et al., 2016) has shown there are differences between the distances and intensities of sprints between playing positions. The study suggests that wide receivers, defensive backs and linebackers are subject to longer and more intense forms of sprints compared to other players on the team. Additionally, running backs and tight ends were more engaged in longer and higher velocity sprints compared to offensive linemen, although less than wide receivers. (Wellman et al., 2016). This indicates that there are different needs for linear speed depending on the playing position, and it has been also shown that running speed tested over a 40-yard (36.6-metre) distance is in some cases related to player selection (Yamashita et al., 2016).

40-yard sprint times (seconds) mean values			
Playing position group	NFL Combine invitees	Japanese selected	Japanese non-selected
WR, DB, RB	4.54	4.84	4.95
LB, TE	4.77	4.97	5.34
OL, DL	5.13	5.37	5.53

Figure 3. 40-yard sprint time means from NFL Combine and Japanese players. (Yamashita et al., 2016).

Explosive speed can be defined as acyclic movement which is, as mentioned above, important to American football players. Explosive speed consists of explosive power (discussed in 3.3), technique and skill are required to perform a given movement. Reaction speed can be challenging to measure without advanced equipment. (Keskinen, Häkkinen & Kallinen 2007, 164-165.)

3.2 Strength in American football

Widely accepted definition for strength is the ability exert force. Measurements for strength have traditionally been focused on the amount of weight one can lift. Yet in sports that require accelerations at high speed, isometric low-speed resistance

strength scores hold limited value. (Baechle & Earle 2008, 73-74). However, muscular strength is essential to developing power abilities, as maximized overall strength levels have shown to be the foundation for maximal power production, in other words, generating high amounts of force in a short period of time. (Haff & Nimphius, 2012).

For American football players, offensive and defensive linemen in particular, the ability to produce force and power at lower speed (strength) is an important component of performance. In this performance, consisting of pushing against one another, where the initial high-speed movement is slowed down by the opponent, the player with more strength has the advantage. (Baechle & Earle 2008, 75). To develop and test upper- and lower-body strength, resistance training exercises like bench press and back squat have been used. As illustrated below, (Table 1.) American football players tend to improve their strength levels with age and level of competition. When compared with baseball and basketball players of the same level of competition, NCAA Division I, (Table 2.) American football players were superior in strength results. The values presented are the mean values (kg) of one repetition maximum (1RM) scores from bench press, squat, and power clean. Data from NCAA Division III athletes' power clean scores was unavailable. (Baechle & Earle 2008, 250; 276-277).

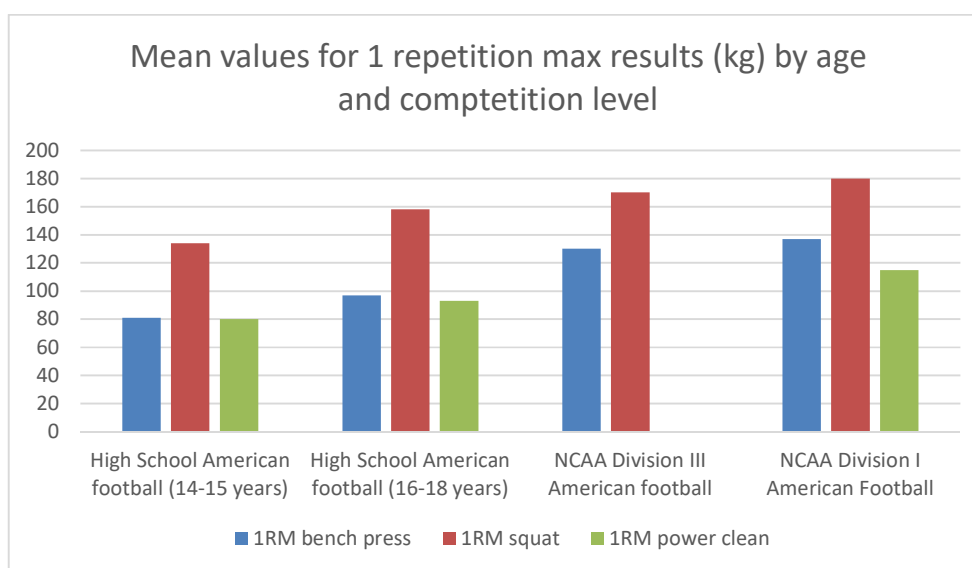


Table 1. Strength level means of American football players by age and level of competition. (Baechle & Earle 2008, 276).

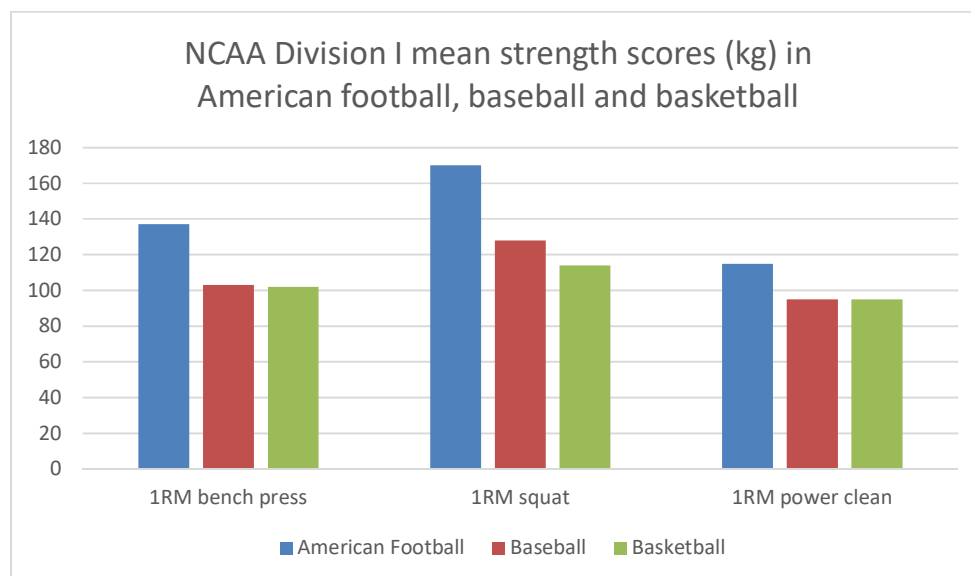


Table 2. Comparison of strength level means in different NCAA I sports. (Baechle & Earle 2008, 276-277).

3.3 Power in American football

The limited value of isometric and low-speed strength scores has increased the significance of power in sports. (Baechle & Earle 2008, 74). Power, from physics perspective, is the product of the amount of force produced and the velocity of the performance.

$$\text{Power} = \text{Force} \times \text{Velocity}$$

(Haff & Nimphius, 2012).

With American football players, power abilities are traditionally developed by the means of explosive weight lifting, like the power clean, and jumping exercises. (Baechle & Earle 2008, 250; 276-278). As illustrated above (Table 2.) American football players tend to be superior in maximal power (power clean) compared to basketball and baseball players. Normative values for vertical jump (Table 3.) suggest that there is a wide range of standards between playing positions and that some positions in American football possess superior vertical jumping ability compared to basketball and baseball players. American football players need power in

blocking and tackling one another viciously, jumping to catch the ball and making sudden accelerations and decelerations throughout the game. (Yamashita et al., 2016). For example, defensive backs and wide receivers need explosive power to quickly change the direction of their running and jump high in the air to defend or catch a thrown ball. (Hoffman, 2015).

Normative Data for Vertical Jump (cm)	
NCAA Division I American football (WR, DB, & RB)	80
NCAA Division I American football (LB & TE)	75
NCAA Division I American football (QB)	72
NCAA Division I basketball (men)	71
NCAA Division I American football (OL & DL)	64-71
College baseball players (men)	58

Table 3. Normative vertical jump data from college athletes by position and/or sport. (Baechele & Earle 2008, 278).

4 PHYSICAL PERFORMANCE TESTING

The purpose of a physical performance testing program is to serve the customer. When testing the performance of a competitive athlete, the program needs to be sport specific. The main characteristics of a carefully designed testing program are: validity of the tests, reliability of the results, control and supervision of the performance, repeatability of the measurements, interpretation and explanation of these results directly to the customer and respecting the human rights of the customer. (Keskinen, Häkkinen & Kallinen 2007, 14-15). There are multiple reasons for testing in sports; two main ones include the assessment of athletic talent and identification of physical abilities in need of improvement. Tests can be also used to provide reference values, evaluate the effectiveness of a training program and set realistic training goals. (Baechle & Earle 2008, 238; 246).

Validity, in its simplicity, means that the test or test item measures what it is supposed to measure. This is the most important characteristic of testing. Validity for anthropometrics, such as height and weight, is easy to establish, where tests for sport abilities are more difficult to validate. (Baechle & Earle 2008, 239). Validity of physical performance tests can be enhanced by careful test selection. The selected tests must relate to the energy requirements and movement patterns of the sport and the experience and training status of the test subject. (Baechle & Earle 2008, 241-242).

Reliability refers to the consistency or repeatability of a test. By minimizing potential variables when, which can be dependent on the test subject (one performing the test), the test administrator (one assessing or scoring the results), or the test itself, the reliability of test can be enhanced. Reliability directly affects the validity of a test; a test must be reliable to be valid. (Bachle & Earle 2008, 240-241).

Performance testing in team sports has much more emphasis on sport-specific field tests. (Keskinen, Häkkinen & Kallinen 2007, 208-210). Field tests are performed away from the laboratory and do not require extensive training or expensive equipment. (Baechle & Earle, 2008, 238). Nowadays, performance tests in

team sports are often conducted once or twice per year. (Keskinen, Häkkinen & Kallinen 2007, 208-210).

4.1 American football related tests

When American football players are collectively evaluated and measured for their physical characteristics and performances it is commonly called a scouting combine. In the United States, NFL holds an annual scouting combine for collegiate athletes to present their skills for their potential employers, professional American football teams. (NFL Combine, 2018). According to an experimental study (Yamashita et al, 2016) performance in the combine tests has a connection to a player's ability to play American football.

There are many standardized, American football-specific tests that are commonly used to measure different speed and power abilities. These include, but are not limited to, the 40-yard (36.6-metre) sprint, 20-yard agility shuttle, and vertical jump. For the assessment of upper- and lower-body power in American football players, medicine ball throws have also been used. (Lockie et al, 2012). Where adult NFL prospects are tested for their upper-body strength by performing the bench press with a 102,5kg load for a maximal number of repetitions (NFL Combine, 2018.), some testing protocols for youth athletes have replaced bench press with medicine ball tests. (Wood, 2008). According to National Strength and Conditioning Association, 1RM weight lifting tests can be conducted youth athletes as long as proper testing guidelines are followed, however, it is not advised to test for maximal effort lifts without close supervision of strength and conditioning professionals. (Baechle & Earle, 2008, 148-149).

4.1.1 40-yard sprint

Speed is commonly tested by measuring the time it takes for an athlete to run a specific distance. (Baechle & Earle 2008, 252). In American football, speed testing is conducted by running a 40-yard sprint. The 40-yard sprint measures linear

speed, acceleration and power. (Robbins, 2010). Reaction speed as a variable can be taken out of the equation by allowing the athlete to start the sprint on one's own mark. The athlete will start from a three-point stance, which means the athlete will stagger one's feet and place one hand directly behind the start line. Athlete must hold this static position for approximately two seconds, and the timing will start from the first movement. With American football players, 10- and 20-yard intervals are sometimes recorded to further examine acceleration and power. (NFL Combine, 2018). For example, 10-yard sprint result is more meaningful for a defensive lineman, who sprints for shorter lengths in the game, compared to a wide receiver, who must be able to sprint 30-100 yards quickly, has more value on the 40-yard sprint result. (Baechle & Earle 2008, 242).

4.1.2 Vertical Jump

A typical way to assess an athlete's explosive power production is to test for one's vertical jumping ability. (Keskinen, Häkkinen & Kallinen 2007, 151). Vertical jump results can be measured either from the height an athlete reaches by jumping and extending one's arm, or from the time an athlete spends in the air. There are two variations to the height measuring method. One can be tested by using chalk on the athlete's fingertips to mark the point of standing reach and the highest point while jumping on a wall. The score is the distance between these two marks. The other variation to this method requires a commercial Vertec apparatus (Figure 3.). In both variations, the athlete will begin the jump from a standing position without any preparatory steps, performs a rapid countermovement by flexing the knees and hips while moving the trunk forward and downward and swinging the arms backward. During the jump, the athlete will reach with one's dominant arm and tap the highest possible point. (Baechle & Earle 2008, 256-257). The jump time measuring method requires more advanced equipment, such as, a contact mat, a laser device, or a video system. With this method the protocol is similar for the first phase, yet it is important that the jump is performed with full extension of the lower limbs once airborne to avoid misleading results. (Keskinen, Häkkinen & Kallinen 2007, 149-153).



Figure 3. Testing vertical jump using Vertec apparatus. (Baechle & Earle 2008, 256).

4.1.3 20-yard shuttle

The 20-yard (18.3-meter) shuttle test is used to measure agility and change-of-direction speed. (Lockie et al, 2012). 20-yard shuttle test requires a timing device, measuring tape – if not conducted on a marked American football field – and three marker cones. The test measures the time it takes for an athlete to complete the shuttle run. A player will begin one's performance from a three-point stance and sprint towards the first five-yard-line. Once the athlete reaches the line by touching it by hand, one will turn back and run 10 yards and touch the opposite line. Timing stops once the player has crossed the starting line. (Wood, 2008).

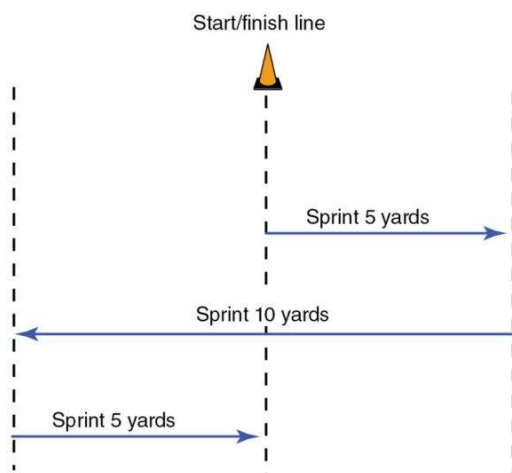


Figure 4. 20-yard shuttle test. (Humankinetics).

4.1.4 Kneeling medicine ball toss

The kneeling medicine ball toss, or chest launch, is a tests upper-body strength and power. The test requires a 3-kilogram medicine ball and measuring tape as the distance of the throw is measured and recorded. The performance begins once the athlete is in a kneeling position facing the direction of the assigned throwing area, knees behind the start line. The athlete must extend one's ankles, anterior plane of the feet on the ground, to avoid the use of toes for greater traction. From this position, the athlete will begin the throw by holding the ball above one's head with both hands, bring the ball close to one's torso while simultaneously sinking the hips towards the heels, and launch the ball forward in one explosive motion. (Wood, 2008). This test is a part of the Nike SPARQ -rating, which was designed to assess athleticism of high school athletes and is recommended for its broad application and relatively simple administration it requires. (Peterson, 2015). A recent study (Lockie et al., 2012) suggests that the results from medicine ball throw tests should be examined relatively to athletes' anthropometrics for more accurate evaluation and comparison of power production. (Lockie et al., 2012).

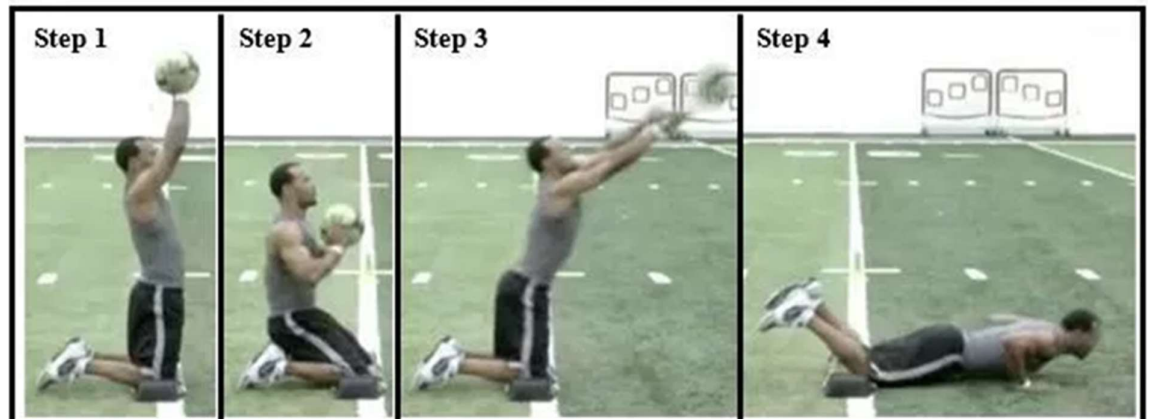


Figure 4. Phases of kneeling medicine ball toss. (Peterson, 2015).

4.2 Hudl Combine

Hudl Combine, a mobile application developed by Nike Inc. in partnership with Agile Sports Technologies Inc. was launched in July 2015. The main function of the application is to make previously mentioned combine tests easier to perform independently. With this application, an athlete may perform the combine tests individually, while having another individual to help film the performance, and receive verified test results. (Heitner, 2015). The application is only available on iOS devices. According to sensortower.com, Hudl Combine has an estimated 5,000 downloads worldwide – mainly in the United States (94%). The application has not been updated since May 2016. (Sensor Tower Inc., 2018).

The application is aimed for youth athletes, who seek to increase their exposure in the recruiting process, share their results for comparison amongst peers for comparison, and improve their abilities based on their performance. The video feature of this application allows coaches and athletes to further examine the athletes' performance and it also increases the reliability of the results. The videos and results are analyzed by the company after the athlete has performed the four tests with the application and one has submitted them for verification. The verified results and performances are then posted on both the national leaderboard and the team leaderboard, which the athlete is a member of via one's Hudl subscription. (Agile Sports Technologies Inc., 2018).

5 RESEARCH TASKS

The purpose of the thesis was to establish a protocol of physical performance tests for the commissioning party, American Football Association of Finland (SAJL) for the purposes of testing youth athletes while utilizing modern technology. The main ideas for this protocol were that it should be easily accessible and performable by youth athletes individually. Additionally, the selected tests for the protocol were to be comparable with the ones used in high school and college football in the United States. The main findings of this study were to be shared with SAJL member clubs for educational purposes.

SAJL's objective for this project was to find new ways to collect physical performance data on youth athletes as well as motivate coaches and players towards better strength and conditioning in the offseason. The author's aim was to further develop one's level of competence and knowledge in the field of organized sports and coaching.

According to the objectives of KUAS Degree of Sports and Leisure Management there are several competences for students. The competences are physical activity, health promoting physical activity and coaching, pedagogy and didactics and areas of physical exercise involving leadership and enterprise.

The research questions were:

What are the main physical abilities required in American Football?

How are American football players tested for these abilities?

5.1 Research methods

The theoretical part of the thesis was conducted by the means of secondary research. The author used internet and library resources that were available free of

charge. Peer-reviewed sources such as journal articles and academic publications in the fields of coaching, strength and conditioning, and physical performance testing were preferred.

Primary research was conducted qualitatively since there were no previous studies conducted on the application's suitability with Finnish players. Author conducted interviews in person, via telephone and e-mail, and made personal observations on the Hudl Combine application during an experimental field testing event.

5.2 Research ethics

Author followed research ethics to his best ability and knowledge. For the theoretical part author used source criticism and the information is cited to credit the original authors and to avoid plagiarism. It has been clearly stated which sections of this thesis is based on previous works and what represents authors own work. The practical part, field-testing, was conducted with consent and volunteer-based cooperation of all parties present and the report on the application was reviewed and accepted by the administrator of the event, the head coach.

6 HUDL COMBINE REPORT

Hudl Combine application was selected to be used in field-testing at a football camp organized by the commissioning party. Testing took place in Pajulahti Olympic Training Center football dome on April 11, 2018 between 10:30am and 12:20pm. The participants were informed about the test and its objectives prior to testing. Participation in the test was voluntary and, as discussed with the head coach, players were not pushed for maximal effort given the physical stress they had experienced earlier during the camp.

The subject of the test was the application itself and its suitability for combine testing. 15 players volunteered to be measured via the application. Author used the application on his personal device. The following assessment criteria were used for Hudl Combine: timeliness, reliability, convenience, and software and hardware dependency.

6.1.1 Timeliness

When using Hudl Combine, one is required to perform various preparations to complete the four combine tests on a field which include these three steps:

1. downloading the application, signing up and logging into one's personal Hudl and Nike+ -accounts
2. Preparing the field with measuring tape and marker cones (if tested on a field without yard markings) and a 3kg medicine ball
3. Recruit an able individual to film the tests.

As the author had completed step 1 prior to the event it did not consume any additional time during testing. The field used in this test was not an American football, therefore distances for the 40-yard sprint and 20-yard shuttle needed to be measured and marked with cones. Throwing area for the medicine ball toss needed to be assigned and prepared with measuring tape spread on the field for scoring.

Step 2 took approximately 20 minutes since the necessary equipment were at hand in the facility. Since author filmed and measured the tests, step 3 was changed to warm-up routine, which the players performed prior to testing, the warm-up lasted for 15 minutes. Test scores from all 4 tests were collected from 12 players (three players did not finish the tests because the device ran out of charge) in 1 hour and 50 minutes, the actual testing, excluding the time for warm-up, took 1 hour and 35 minutes.

6.1.2 Reliability

Since author's device was used for testing multiple individuals, the test results were not processed via the application, which would have provided a verified score for each exercise and calculated a Nike+ -rating based on the results and submitted height and weight. Author has no comparative data nor evidence on the lack of reliability in test results. In terms of product reliability, the application malfunctioned multiple times during this experiment. The application crashed on three occasions prior to the battery discharge of the used device.

6.1.3 Convenience

Besides the above-mentioned difficulties, the application was relatively easy to use for collecting the results from 40-yard sprint, 20-yard shuttle and vertical jump tests. The video from the performance has also value from a coaching perspective, especially for the running tests, where technique has a major impact on the results. The medicine ball throw test, however, was not made any more convenient by using the application, since the submission of the scores had to be done manually.

6.1.4 Software and hardware dependency

For one being able to use Hudl Combine is dependent on multiple different software and hardware companies and products. An individual must be signed up and

listed as a player on an American football team in the Hudl system and signed up for Nike+. Hudl Combine is only available on iOS -operating system, which is supported solely by Apple Inc. devices. Performing all the tests with Hudl Combine also requires access to some equipment and facilities, i.e. medicine ball, measuring tape or markers.

7 ANALYSIS OF THE STUDY

Studies on American football players and their physical abilities and characteristics have been well documented in the past, although more recently the focus has been on injuries, particularly on concussions and other forms of head trauma. Majority of the performance data available on American football players is originally from the United States, which may sometimes cause difficulties in testing due to different units of measurement – metric system (m, cm, kg) and imperial system (yards, ft., in., lbs.) – which are relatively easy to convert to one another with the aid of modern technology, yet they pose a challenge to reliability if or when results are rounded for more practical scores. The author received and gathered performance data on Finnish American football players, yet the quality and quantity of these test scores restricted him from making any statistical analysis. However, it can be collectively stated, by the author and multiple American football coaches in Finland, that the levels of physical fitness and skills are very inconsistent within leagues, age groups, clubs and teams.

Practicality of Hudl Combine application turned out to be below initial expectations. From a Finnish youth American football coach's perspective, the application had more limitations compared to its benefits, especially in the European markets. As the use of this application is highly dependent on specific products, brands, and services, it makes Hudl Combine difficult to implement for Finnish youth players. Also, a negative sign about the application was revealed once examining the product's life cycle. It seems that Hudl Combine has passed its growth and maturity stages and is currently on the decline, since the application has not been updated since 2016. (Sensor Tower Inc., 2018.)

8 THESIS PROCESS

The thesis process began in the fall of 2017, when author contacted the commissioning party for a potential topic for his thesis. The initial agreement included several topics and ideas, from which author decided to focus on the main physical abilities required in the sport of American football. With regards to these abilities, author researched methods and protocols used in physical performance testing. Lastly, it was decided with the agreement of the commissioner that Hudl Combine was to be used for practical testing.

The initial idea for the thesis was described as a testing battery for youth American football players, which would have ties to the tests conducted in the United States and would be relatively simple to perform independently without expensive equipment. Author began his research on the physical demands of the sports, which would determine the test methods and protocols. Main abilities on multiple studies emphasized speed, strength and power.

Once the core abilities were determined, different testing methods and protocols were examined. There were various tests that had been used with American football players in the past. Testing protocols tended to vary depending on the age and competition level of the test subjects. Generally, adult players on higher levels of competition were tested more extensively and the results were also published. On lower levels of competition and with youth players, the protocols tended to include a smaller number of tests and the results were published scarcely. This turned out to be a challenge to establish accurate comparisons.

After discussing with the commissioner about the testing protocols, it became clear to the author that instead of creating new tests was not the main objective, rather it was assessing how modern technology could be used to aid in performance testing. Author searched for different applications that could be used for testing American football players. At the time, only one application, Hudl Combine, met the requirements and this was to be tested in the field in April 2018. The final report on the application was shared with the commissioner and accepted by the coach who was present in testing.

9 DISCUSSION

Physical performance testing has its place in sports. In American football the purpose of testing can be viewed from different perspectives, individual athlete and coaching staff. From an athlete's perspective, testing serves as a tool of monitoring one's own development and it helps setting goals for future reference. It is important for individuals, especially youth players, to become more aware of their own performance and become more interested in monitoring it. However, a competent coaching staff is needed to assess and analyze these test results, to guide the athlete through the training program, and to further develop these programs to fit the athlete's needs of development.

To minimize the expenditure of scarce resources, such as training time on the field, available staff, and money, coaches may ask their players to record and report their test results independently. By doing this, the coach might obtain the wanted test results, but more importantly it gives an insight on player motivation; which players have trained and tested themselves without the coach's presence. As modern technology allows us to film, edit and share videos on our mobile devices, this should not be an impossible task even for younger players.

What makes independently conducted testing challenging, is lack of administration and supervision of the performance, which may open a discussion about the reliability of the results. For example, players might perform the tests in different surroundings or use different equipment. Video evidence would, without a doubt, help coaches to assess these variables and their effects on the performance. Another benefit of the visual recording would be the in-depth analysis which it permits. This analysis, naturally, should be conducted by a qualified expert and the results should be interpreted to the players to maximize the benefits of testing.

Performance testing and training in American football is a topic under constant controversy. For one, the varying demands for the sport with regards to player positions and types make it practically impossible to build universal, one-fits-all, protocols and guidelines for everyone. Another challenge comes with international play, as the organization and administration of the sport differs between countries.

For example, in the United States, players are often part of a school team and schools have more control over the player's training, where in Finland, the club system is separate from the school system and clubs tend to have less means to develop their players collectively in terms of strength and conditioning. American football is also considered a minor sport in Finland, in terms of popularity, which may limit the available resources for the sport. American football, and sports in general, also have inferior significance in the Finnish culture, compared to the cultural impact the sport has in the United States.

With regards to culture, coaching philosophies and practices also tend to have differences between the two nations. American football in the United States is highly competitive, which allows coaches to use testing to select the best fitting players, both physically and skillfully, for their teams. In Finland, most clubs struggle to find enough players to fill their rosters and are often willing to recruit players with inferior physical ability if they are skilled and experienced in the sport or on the contrary, recruit physically superior athletes with less experience in the sport. To summarize, testing is, perhaps, more valuable for coaches as the level of competition increases and players need to be evaluated more thoroughly to make decisions on who gets to play.

There are also different views when it comes to sport-specific coaches and strength and conditioning coaches. Understanding of both perspectives is needed to build a testing protocol that would serve both purposes. American football coaching has a tradition of studying and analyzing players for their on-field performances via filmed footage. In general, American football coaches are more interested in the actual game performances rather than the standardized test results. Strength and conditioning coaches, on the other hand, need the data from testing to develop the physical training of the players' abilities which would correlate to that in game performance. For future development of the game, both physiological and sport related knowledge is needed.

In terms of both American football and physical exercise, the current trend is the increased use of technology. Technology allows coaches of both fields of expertise to obtain and manage performance data from athletes. However, the use of new platforms and products requires the above-mentioned expertise. For example, a

new way of collecting raw data, with a mobile application for instance, may be useless if there is no one to interpret the results. Vice versa, by collecting performance data with less-advanced methods can be as useful for the players and coaches if there is a qualified individual to interpret these results. As it is with American football in Finland, testing should be done with minimum cost to all parties (players, coaches, and administrators). This limits the quantity and quality of products and equipment that can be used in testing, yet testing should be conducted to a high standard to serve its purpose.

To author's understanding, this raises a complex issue of responsibility and reward. By this he refers to: who is responsible of testing and who does it benefit? If a player conducts the tests independently, one should be rewarded with an analysis and help with setting goals for development and planning the training which is required to achieve those goals. Collectively, in a team or a club setting, the responsibility for the coaches is to administrate the entire process, which requires plenty of effort and resources, yet the reward is sometimes unclear if the results are not examined thoroughly. A way to reward the clubs would have to come from the governing organization, which would then be responsible of interpreting the data as well as prescribing standardized guidelines for testing and education for the clubs about coaching.

From an organizational perspective, this all comes down to structure and leadership. Awareness and knowledge about physical fitness and performance testing is theoretically on a solid ground, however this does not always reflect to Finnish American football in practice. To implement theories in practice, there needs to be a consensus amongst the governing organization and the clubs on the performance tests that are valued in the sport, to what degree they need to mimic the ones in the United States, who has access to the results players have submitted, and what are the acceptable methods for testing. Understandably, the ideals and realities do not always meet, yet author feels that this work has shed light on some of the theoretical issues around the sport in Finland and has examined some of the current trends in practice to help the commissioning party in its decision making.

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