

# **Defining physical differences between U16 national team and non- national team basketball players**

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<p>The purpose of the research is to determine does physical test separate U16 national team players from non-national team players. When the research started, there was assumed that U16 national team players have better results in physical tests than non-national team players. The material of this thesis is constructed from broader research. This broader research is funded by Ministry of Education and it includes test results of football, basketball, and ice hockey. The research included sport specific technical tests, anthropometrical tests, physical tests, and questionnaires related to players training background, self- evaluation and coach assessment. Only the results of physical tests in basketball are analyzed in this thesis.</p> <p>The thesis includes a journey from physical analysis of basketball players, human growth and development to specialization models. The thesis presents what factors has an affect on human performance and how the development towards the life of an athlete happens.</p> <p>The teams were tested in their own operating environment, during August and October 2010. U16 national team players were tested with their own club teams. Investigated subjects (N= 115) constituted of 1995 born male basketball players. The U16 national team players (N1) consisted of 23 players and non-national team players (N2) consisted of 92 players. All the players belonged to B-junior level. There were 12 teams and U16 national team that were tested and Finnish Basketball Association choose the teams for this research.</p> <p>The hypothesis of this research is following: The U16 national team players have better results in physical abilities tests than non-U16 national team players. Mean results of the U-16 national team are better, but there is not statistically significant difference between the groups in all tested areas. Statistically there is significant difference in 20m speed test (<math>P \leq 0.01</math>), and counter movement jump (<math>P \leq 0.01</math>).</p>	
<p><b>Keywords</b> Basketball, physical performance, physical development and growth, developmental stages</p>	

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# 1 Introduction

Human growth and development to become an athlete is a long journey. Physical features are partly inherited genes but also developed through versatile training, using the developmental stages and specialization models as guidelines through childhood. To become a good basketball player, one must have a high level of fitness to maintain the high levels of intensity of a basketball game. Basketball is very versatile ball game and it includes continuous chain of events. Physical performance in basketball is measured as the product or outcome of standardized motor tasks requiring speed, agility, mobility, explosive strength and, aerobic endurance. Physical performance can be evaluated through variety of different tests and the performance improves on average from childhood through adolescence.

This research is a part of Kilpa ja huippu- urheilun tutkimuskeskus, KIHU, research and it is supervised by Niilo Kontinen. The KIHU's research collects data from basketball, football and ice hockey and the research is funded by Ministry of Education. The research purpose is to determine the factors, what influence to the development of elite players in team ballgames. The test situation included anthropometric measurements such as height and weight, sport specific technical skills, physical tests, and questionnaires related to players' training background, self- evaluation, and coach assessment. All the subjects from basketball, football and ice hockey, received an agreement form where they had to ask guardian's approval to participate to the test situation. Hannele Forsman is the main researcher of this research, and through this, she is doing her doctoral thesis from this data.

This thesis includes data from 15-years-old basketball players' physical tests. The tests included counter movement jump, 20m running test, agility track, mobility tests and beep- endurance test. The purpose was to measure all the basic elements of basketball; speed, strength, mobility and endurance. In this research, the answer is looked for this question; Does physical tests separate the U16 male basketball national team players from non- U16 national team players?

## **2 Basketball as a game**

### **2.1 Game analysis**

Basketball game is played by two teams of five players on a court. The objective of the game is to score by putting the ball into opponent's basket and to prevent the other team from putting the ball into team's own basket. The ball can be moved only by passing it with the hands or by dribbling it on the floor once or several times without touching it with both hands simultaneously. Fundamental skills in basketball include shooting, passing and receiving, dribbling and ball handling. (Wissel 2004, 9-10.) According to study made by Luhtanen and Petersen, basketball is continuous chain of events where defense, transition and offense vary. The short transition period between the offense and defense play is very important. The game situation roles for an individual player are 1. Ball carrier, 2. Non-ball carrier, 3. Defending ball carrier and 4. Defending non- ball carrier. A good player can read the game fast, react in unexpected changes in game situation roles and move quickly to a new place what the new game situation role requires. (Kiiskinen 2005, 3.)

#### **2.1.1 Individual analysis**

The main objective of a basketball game is to score by putting the ball into opponent's basket and to prevent the other team from putting the ball into one's own baskets (Wissel, 2004, 9). In team sports, there can be other objectives as well, what changes depending on the game situation. For example a player's objectives in offense game are: scoring, winning space towards scoring, posses the ball within the team and readiness to play defense play. In defense play, the objectives for a player are: prevent opponent from scoring, steal the ball from opponent, to prevent the opponent from creating space in offense zone and readiness to play offense play. (Westerlund 1997, 533-534.)

Playing the game is continuous reading of the game, thinking and decision making based on previous perceptions. The requirement of a team sport player is to under-

stand team's game situation roles and the principles of co-operation. The game situation roles are ball carrier, non-ball carrier, defending ball carrier and defending non-ball carrier. (Westerlund 1997, 533- 534.) The players also have to maintain proper distance and balance in the game court (Dahlström & Miettinen 1999, 270). Game sense is also important feature. It means a player's ability to make good decisions to the team. Through a good game sense, a player can exploit one's own features, physical, emotional and skill characteristics. Game sense can be divided in three sub- factors: Understanding of the game, reading the game and decision making. But only a good game sense is not enough. A player should be able to execute one's decisions in practice and it requires technical skills. (Westerlund 1997, 533- 534.)

A player's body size mostly determines the position played in a team. This approach is universally accepted strategy in basketball to place the tallest and strongest players in key positions under the baskets and the smaller players are placed in perimeter positions. This strategy allows the smaller players to move the ball quickly around the court as the larger players position themselves close to the basket. The five player positions on a basketball team are mostly based on body size, fitness and skills. Here are the classifications: 1. Point guard, 2. Shooting guard, 3. Forward, 4. Power forward and 5. Center. The point guard is mostly responsible for carrying the ball down the court and coordinating the offense game against opponent. Shooting guard is usually the best distance shooter in a team. Forward is multi-disciplinary position, often called the "utility player" because this player should be capable to perform skills of almost any other player on the court. Power forward is usually relatively larger player responsible for aggressive play close to basket and gaining rebounds after a missed shot. Center is often the largest player and is responsible for shooting under the basket and coordinating the defense play. (Drinkwater, McKenna & Pyne 2008, 566- 567.)



### **2.1.2 Team analysis**

A basketball team forms from 12 individual at a time. In international level every individual posses their own unique talent. An unique talent may be exceptional speed, long distance throw, offensive rebound playing or leading the game. When building a team, the coaches try to find special talents from a wide range of possible. In a dream team, the five player roster includes talents from every aspect of basketball, and there's no "weakest link" in a team. (Lohikoski 2009, 412.) The basic idea in team tactics is to get the strengths out of the team and prevent possible utilization of the weaknesses of the team. Correspondingly the idea is to exploit the weaknesses of the opponent and eliminate the strengths. It is essential in team tactics that how well the players co-operate towards common goals in different game situations. The symbol of an effective team is variety of different skill possessing players who are placed in right roles and form a mutually supportive ensemble. (Westerlund 1997, 532.)

### **2.2 Physical characteristics of basketball players**

Under the rules of International basketball federation, FIBA, a basketball game consists two halves, each half consisting of two 10- minute quarters. Between the periods, there is two minute break and 15 minute break between the halves in addition to any stoppages of play for any incidents such as rule infractions or time-outs.(FIBA, 2010.) This means that <50 % of the total time to play basketball is actually spent in live play as a result of these timing rules. The frequent stoppages during the game allow the players to recover between bouts of activity, thus allowing the repeated high-intensity bouts of play. Therefore, while rest intervals are frequent during a basketball game, the activity level of live play is typically either on a high or very high level regardless of the gender or age group playing. The intensity of basketball is likely derived from the very frequent changing patterns over the duration of a game. Generating momentum and overcome the sense of fatigue are something what players have to repeat with frequent starts and stops. It is clear, that basketball players require high level of fitness to maintain the high levels of intensity, especially in a tournament play involving several games over several days. However, it does not mean that all players play at the same level of

intensity. According to study by Rodriques Alonso, it is reported that maximum heart rate, HRmax, and blood lactate concentrations were 185 beats per minute and 5,7 mmol/L among the female point guards where as the numbers for female forwards were 175 bpm and 4,2 mmol/L and for centers 167 bpm and 3,9 mmol/L. There were also differences between international and national games. During international games the HRmx was 186 bpm but during national game, the HRmax was 175 bpm. This study informs that players reached 95 % from HRmax during an international game while the players reached only 90 % from the HRmax during a national game. (Drink-water, McKenna and Pyne 2008, 568.) However, a study made by McArdle showed that mean heart rates for basketball player were 81- 95 % of HRmax during an actual game, similarly in study by McInnes of male basketball players, it was observed that players had their heart rate > 85 % from HRmax in 75 % of their playing time. McInnes also elevated blood lactate levels throughout a game and for male players the mean maximum was  $8.5 \pm 3.1$  mmol/L. In most studies, the VO<sub>2</sub>max values for basketball players have been in the range 50- 60 mmol/kg/min. (Ziv & Lidor 2009, 558- 561.)

There is a lot of energy used in the muscle work in basketball, what is produced mainly through ATP-PCr and glycolysis metabolic system but also partly through aerobic, oxidative system as well (Forsman, Dementjeff, Lampinen, Lohikoski & Nieminen 2006, 43). The phosphagen system offers ATP primarily for short-term, high-intensity activities such as resistance training and sprints. ATP energy system relies on the hydrolysis of ATP and breakdown of another high-energy phosphate called creatine phosphate. Glycolysis is the breakdown of carbohydrates. It is either glucose delivered in the blood or glycogen stored in the muscle, and it's to resynthesize ATP. The oxidative system is the primary source of ATP at rest and also during low-intensity activities. It uses primarily carbohydrates and fats as fuel. (Baechle & Earle 2008, 24-29.)

### **2.2.1 Anthropometry**

The human body's three basic components are muscles, fat and bones. During a body composition measurements, one tries to assess the mass and proportionality of these components in human body. The body composition measurements should not be

compared together with men and females because the sex has an essential factor in the measurements. Also the results of children and young people, especially under the age of puberty, should not be compared to results from adults. (Keskinen 1997, 294.)

Height is a very important and crucial factor in basketball but the players are not only tall, they are also large. During a basketball game, there comes lot of situations where a player must possess weight and power. It is essential, that a player's body weight and body composition are in optimal ratio towards muscular strength and effectiveness to produce power. An optimal weight is hard to define since the game roles and styles are so different. (Kiiskinen 2005, 13-14.)

### **2.2.2 Endurance**

The physical load of a basketball game comes through that the players have to produce great power levels to accelerations, turnovers, 1vs1 situations, maintaining the defense stance and repeating these often with short recovery time (Forsman et al. 2006, 43). According to study made by Verma, these things requires reaction speed, velocity and speed endurance and this means, that basketball player's anaerobic endurance efficiency of a performance has to be on a high level (Kiiskinen 2005, 21). There is a lot of energy used in the muscle work, what is produced mainly through ATP-PCr and glycolysis metabolic system but also partly through aerobic, oxidative system as well (Forsman et al. 2006, 43). Endurance is the necessary prerequisite for hard work over an extended period of time. Endurance in this case includes not getting tired too quickly during strenuous training, a game, a tournament, or for example travelling to a competition. One's body should be able to recover quickly after a relatively major exertion and this is called regeneration. (Barth & Boesing 2010, 41.) In sports training, one needs good basic endurance skills, a strong heart and a well-functioning respiratory system. Ball games, such as basketball, are usually good pace/tempo endurance training when the active recovery period between the intervals is short, under 60 seconds long, and when the intensity is not maximal. (Riski 2009, 279- 299.)

Basketball is an athletic game but it is not necessarily considered an endurance sport. Basketball player needs though good endurance so he can meet the demands of a game with concentration and in the best condition without getting continuously weaker from exhaustion. A player must be able to quickly switch from offense to defense, handle every one-on-one duel on hundred percent and even to for a fast break during the final minute. (Barth & Boesing 2010, 41.)

### **2.2.3 Speed**

Speed is the main goal of physical training in modern basketball. Speed is the most visible physical part of the game. A player, who is very quick, can solve many situations during the game with one single explosive performance. The most important conditions for speed in basketball are offered by skills and power. (Forsman et al. 2006, 37.) Speed is the ability what a player need to execute a movement with the greatest possible acceleration and velocity. A basketball game lives on fast sprints, sudden turns and crossovers. If there's an opportunity, a player wants to immediately react with lightning speed. A player who is too slow and reacts late mostly loses his duels and that kind of player is not reliable to pass the ball on to and cannot be dangerous at the basket. (Barth & Boesing 2010, 43.)

Basketball requires all four species of speed; reaction speed, explosive speed, velocity and skill (Helin, Oikarinen & Rehunen 1982, 337). Speed is known to be strongly inherited as part of neuromuscular system and achieving biological structural changes is the easiest during early in the childhood. Because the basic work developing the coordination is done in childhood, it is clear that training in childhood plays a crucial role in speed development. (Mero 2004, 294.)

### **2.2.4 Agility**

Agility can be described as changing movement velocity and performing locomotion models modes other than linear sprinting (Baechle & Earle 2008, 458). Both agility and balance require strength, power and endurance. When athlete develops speed and

power, they will become more agile. Agility also requires game knowledge. (Gaskill & Sharkey 2006, 117.) Basic motor skills, like running, jumping, throwing and catching requires coordinative abilities like agility, balance and rhythm. Through these abilities, all the components and features of movement will be organized as smooth moving. In basketball game, there are a lot of situations where a player must change his moving direction effectively, balanced and explosively so, that the movement rate maintains or accelerates. (Kiiskinen 2005, 14.)

### **2.2.5 Strength**

Strength is almost the most important basic feature behind the performance in all sports. For this argument, there are two clear explanations. Through strength training, one can affect on the basic body functions concerning movement and moving, including producing energy. From basic features, endurance can be increased in certain level with quality training and load, but strength can only be developed with meaningful training. A basketball player should reach a high basic strength level because it has several beneficial influences to moving in the court through from speed, explosive- and situation power. It is also important to maintain the already reached basic strength level and keep it in a right shape to get the speed out of it. (Forsman et al. 2006, 39.) One also need strength to hold one's body or body parts in a particular position, move quickly or to slow down movement. A strong core is important in basketball for winning defensive and offensive duels. (Barth & Boesing 2010, 42.)

### **2.2.6 Mobility**

The definition of mobility is that it is an ability to perform as wide movements as possible on your own or with a help of external power. Mobility can be split into three categories; active mobility, passive mobility and sport specific mobility. Active mobility means the greatest range of movement what is able to perform in a joint with the power of the muscles next to it. Passive mobility means the greatest range of movement reached with a help of external power in a joint. Sport specific mobility means the certain requirements what the sport has set to individual joints, muscles and support tis-

sues. (Forsman et al. 2006, 10.) Mobility enables right game positions and stances, power producing and movement angles. Also the meaning of mobility is emphasized in muscle care and recovery. (Lohikoski 2009, 410.) A Basketball player must continuously work on his mobility because it is also essential to the proper execution of jumps and shots in difficult situations. Superior mobility can prevent painful injuries and promotes better regeneration after stretching. (Barth & Boesing 2010, 47.)

## **2.3 Finnish basketball Association guidelines to physiological training**

### **2.3.1 Strength training**

The load of the bones is smaller within the children than adults. This means that the most common injuries within children caused by sports are focused on bones. Through right kind and amount of strength training, the bones next to muscles can also be strengthened. Strength training should be done through short training sessions for several days (for example 15 minutes per day) rather than long training session few days a week. Using own body weight and different jumping exercises should be included to the training. (Forsman et al. 2006, 36.)

For children, under school age, the support and movement system strengthens normally through moving, climbing and playing. For children, ages between seven to 12, speed and speed strength training can be included to practices by applying. The guidelines for this are; training should be dynamic, movements are done by using own body weight, training can include jumps and spurts and strength training techniques can be taught by using sticks. During puberty, neuromuscular system starts to mature and there can be added speed strength training by using extra weights, what are 25- 50 percentages from own body weight. After puberty, when the growth of length stops, strength training can be modified through adult training methods, derived from the sport analysis. (Forsman et al. 2006, 36.)

Strength training for basketball players aims to develop movement speed and power. Examples from strength training for basketball players are resistance training in the

gym and circuit training with different kind of methods. Both include basic movements what has affects on whole human body and lot of different kind of jumps. Training is also happening with the help of fitness balls and own body weight. (Forsman et al. 41-43.)

### **2.3.2 Speed training**

Running as overall physical activity develops within the children between the ages five to seven it enables training running speed through different plays and games. Between the ages seven to 12, movement frequencies develop the strongest and during the puberty, step and stride lengths develops the strongest. Speed and speed strength training should be done a lot among the young athletes. (Forsman et al. 2006, 36.)

Speed should be trained regularly and through sport specific style. Good examples from speed training for basketball players are coordination drills; knee lift running, heels to buttocks running and different jumps, and sprints with submaximal, supra-maximal, and maximal speed. (Forsman et al. 2006, 30- 39.)

### **2.3.3 Endurance training**

For children under school age, the endurance abilities develop the best through moving and playing. Young people endurance training have to be versatile, fun, and it should include different sports and forms of moving. Reaching a good, basic endurance level is very important for young people. Versatile endurance develops the best through different kind of ball games. (Forsman et al. 2006, 36.)

There are four different parts of endurance what basketball players train; basic endurance, pace/ tempo training, maximal endurance and speed endurance. For basic endurance the training forms are usually long distance running or interval practices, but they also include sport specific training. In pace/ tempo training the intensity level is between the aerobic and anaerobic threshold and the heart rate (HR) is between 70 80 percentage from maximum heart rate (HRmax). Intervals and playing with the speed

are common training forms for pace/ tempo training but sport specific practices are the most important training forms. In maximal endurance training the forms are usually interval practices, uphill training or sport specific training and the intensity of the training is always over the anaerobic threshold. The HR is close to HRmax, usually 85-95 percentage from the HRmax. The speed endurance training is focused on the muscles what basketball players use while playing. Training forms include intervals, short dashes with lactic acids, and short dashes without lactic acids. The intensity of the speed endurance training depends on the training form and desired training effect. (Forsman et al. 2006, 33.)

#### **2.4 Demands of international basketball**

A player, who wishes to reach international level, has to increase the training hours at steady rate from 14 hours to 30 hours in the age of 15. To make this possible, a 15-year-old player has to already manage these things:



- A good overall sport abilities, especially a good sense of rhythm, ability to react fast and sense of balance.
- Cope very fast through tasks what require ability to combine, coordination and agility.
- Master basketball's basic skills almost flawless.
- Understand the basic elements and time in goal games.
- Have enough mobility, especially in the area of hips, ankles and thoracic spine.
- Good body control, especially in the core area and in one leg's balance
- Posses a sufficient endurance base, so that training and recovering from basket-ball practices is possible. (For boys the VO<sub>2</sub>max has to be at least 54 ml/kg.)

(Lohikoski 2009, 406- 407.)

### **3 Human growth and development**

Overall it is accepted that children are not miniatures of adults, but there is no clear answer how the physical activity and performance differentiates from adult to children. Children have considerably more effective ability to recover from short anaerobic working periods. Children also can repeat over 10 maximal, couple seconds lasting sprints with short recovery time. For adults, the system requires longer recovery periods and an elite level athlete can only repeat maximal working periods under 10 times. Is the children's better anaerobic alactic metabolism behind this phenomenon or is it so that the children cannot increase the working load enough nor does the system itself protect children to hold hand brake on while working very intensively? (Hakkarainen 2009, 73.)

#### **3.1 Physical growth, biological maturation and overall view of physiological development and physical performance**

The exercise response and physical performance development within children and young people is based on body's different size, ability to perform, and regulatory efficiency of organic systems. Examples from this are the volume of the heart, the amount of muscle mass, length of limbs and hormonal activity. These variables are greatly effective by three partly interdependent but still independent developmental biology phenomenon; 1) Physical growth, 2) Biological maturation and 3) Physiological evolution. Physical growth means the growth of structure and proportions of the body. Biological maturation means the maturation of human body towards adulthood. Two factors are connected to this, timetable and speed. Timetable in this case means when the genital parts start to mature, when the growth spurt's peak is reached, and when the growth in length is over. Speed, in this case, means how fast the growth of length is and how fast the final individual sexual maturation to maturity lasts. The physiological development means the development of physical features such as strength, speed, endurance, mobility and skills. (Hakkarainen 2009, 73-75.) Figure 1 describes the amount of and size of muscle cells during different ages. Figure 2, in the next page describes the growth of organ system as percentages.

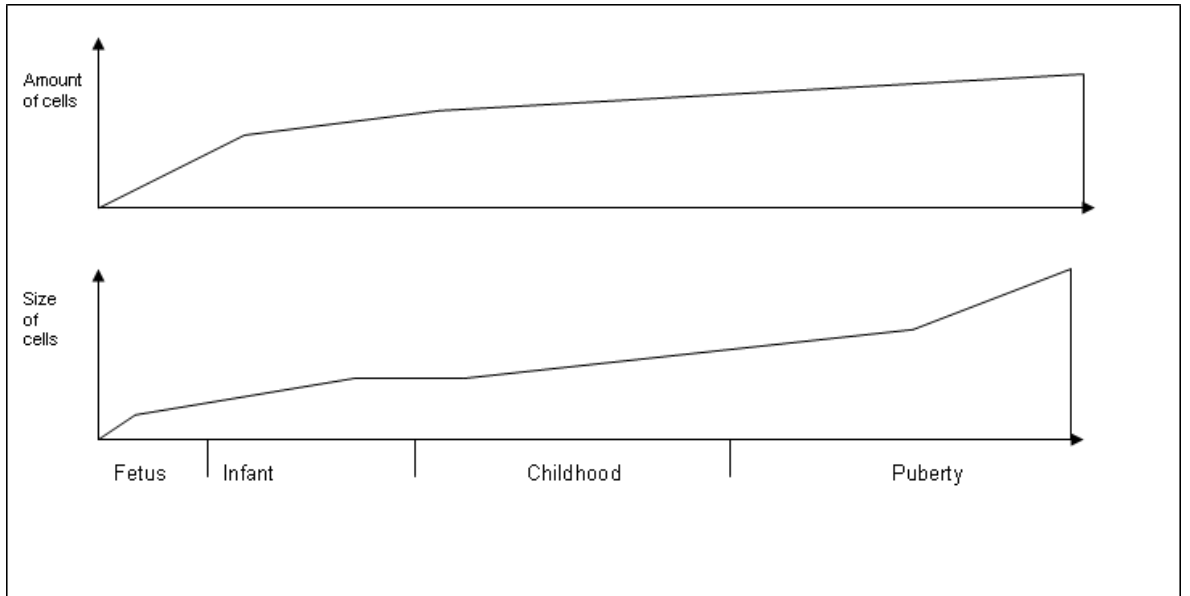


Figure 1 is modified from Hakkarainen (2009, 74). It presents the increase of amount of muscle cells and the size of muscle cells during different ages. Both mechanisms cause the increase of muscle mass.

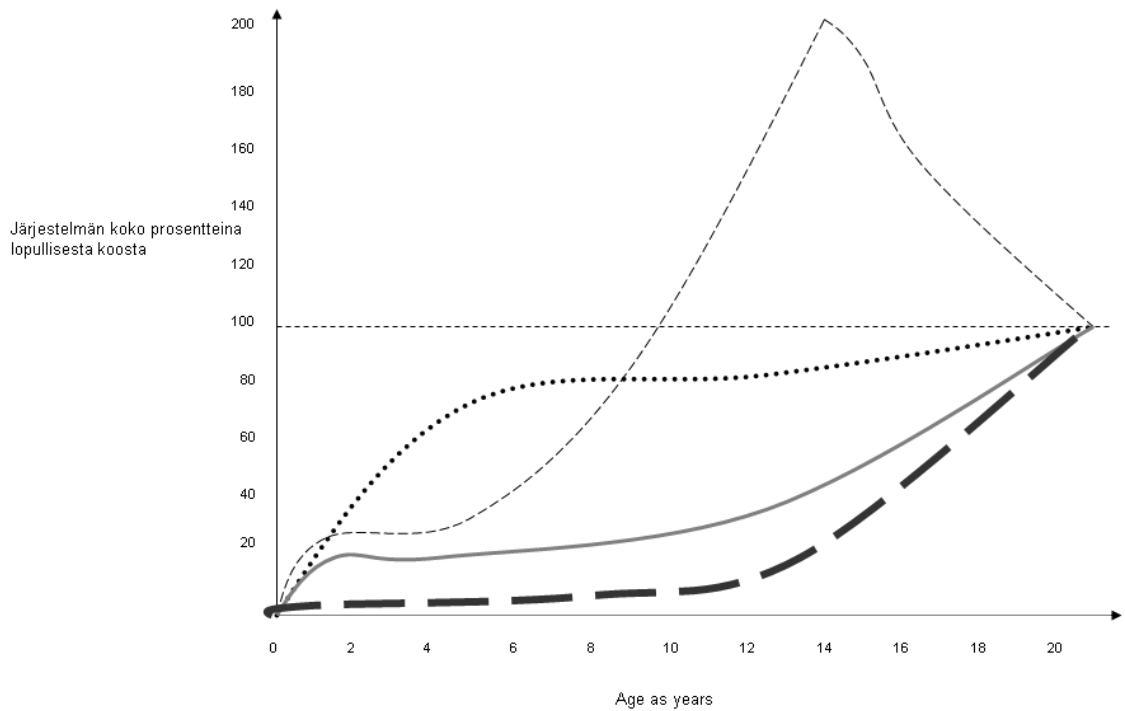


Figure 2 is modified from Hakkarainen (2009, 76). It presents the main growth of the organ system as percentages from the final development stage. The black circular dashed line presents nervous system, the grey line overall growth, big dashed line genital maturation and light dashed line presents the defensive system, meaning immunity.

It is important to know how the maturation of different parts of human body develops when you consider basketball training. Especially observing the fast maturation of nervous system developmental stage and growth in length enables good conditions for basketball training. (Lohikoski 2009, 406.)

Physical performance is usually measured as the product or outcome of standardized motor tasks requiring speed, agility, flexibility, balance, explosive strength, local muscular endurance, and static muscular strength. Physical performance can be evaluated through variety of different tests; sprints, shuttle runs, jumps, distance throws, sit-ups, and flamingo stand (balance). The performance improves on average from childhood through adolescence. Most fitness test batteries include an indirect or a direct estimate of aerobic power. For girls, the absolute aerobic power (VO<sub>2</sub>max) reaches a plateau at

13- 14 years of age but it increases from childhood to adolescence with boys.  
(Hebestreit & Bar-Or 2008, 3-4.)

### 3.2 Biological age

Differences in growth and development between individuals and sexes are very large. Between initial phase and final stage of growth spurt, the differences are several years. Children and young people, who are competing with others, born in the same calendar year, results should not be compared for this reason. Particularly between boys, the puberty affects on physical performance very heavily and in so called “physical sports”, performance is happening spontaneously. Based on physical tests and anthropometric results, the estimates of talent indication can be very inaccurate. (Hakkarainen 2009, 86.) Table 1 describes the stages of life concerning boys and girls growth where 95 per- centages of children reaches the growth period.

Table 1. Modified from Hakkarainen (2009, 87) From the table 1 can be the growth periods for boys and girls.

<b>Growth period</b>	<b>Boys</b>	<b>Girls</b>
Start of growth spurt	10,0 - 12,1 y	8,2 - 10,3 y
Peak of growth	13,3 - 14,4 y	11,3 - 12,2 y
Decrease of growth	13,5 - 17,5 y	13 - 15,5 y
Peak of muscle mass growth	Starting 14 - 17 y	Starting 13 - 15 y

Defining biological age in competitive sports with children and young people is very important but practically very difficult. Using only one method to assess the biological age can lead to miscalculation. Using two different methods is the most effective way to define the biological age but it usually requires knowledge and expertise of a doctor or health nurse. Here are a few ways how to assess the biological age; bones, peak height velocity and maturity assessment based on sex characteristics. (Hakkarainen 2009, 86-89.)

### 3.3 Neuromuscular system's growth and development

Nervous system, muscles, tendons, connective tissues and, bones form the central power producing and movement mechanism (Mero 1997, 50). Neuromuscular system consists of nervous system and muscles. Muscles can be described as commands-fulfilling tissue, which is greatly dependent on the type and quality of neural commands. The development of muscles is largely dependent on maturation of the nervous system. The development of nervous system during fetal period is mostly guided by genes inherited from parents. In early childhood, the development is also guided by environmental stimuli. Since the nervous system develops strongly during the childhood, versatile motoric stimuli (skill, balance, agility, speed, body control) should be emphasized until the puberty. Of course previous mentioned abilities should be developed and maintained after puberty. (Hakkarainen 2009, 91.)

The amount of muscle cells does not increase after birth but the mass of the cell increases through the increase of functioning structures. This is how the cross-sectional area of a muscle cells increases and hypertrophy occurs in muscle cells. (Hakkarainen 2009, 91; Mero 2004, 22.) During the natural growth of a child, the increase of muscle area varies depending on the load and it can increase 5- 10 times in the final stage of growth spurt. The cross-sectional area of the muscle reaches its final size at the age of 10 with girls and at the age of 14 with boys. Hormones connected to growth spurt, especially growth hormone and testosterone, has a major impact on the growth of muscle's cross-sectional area. (Hakkarainen 2009, 91-92.) Figure 3 describes the changes in muscle mass according to age and sex.

Amount of  
muscle mass  
(kg)

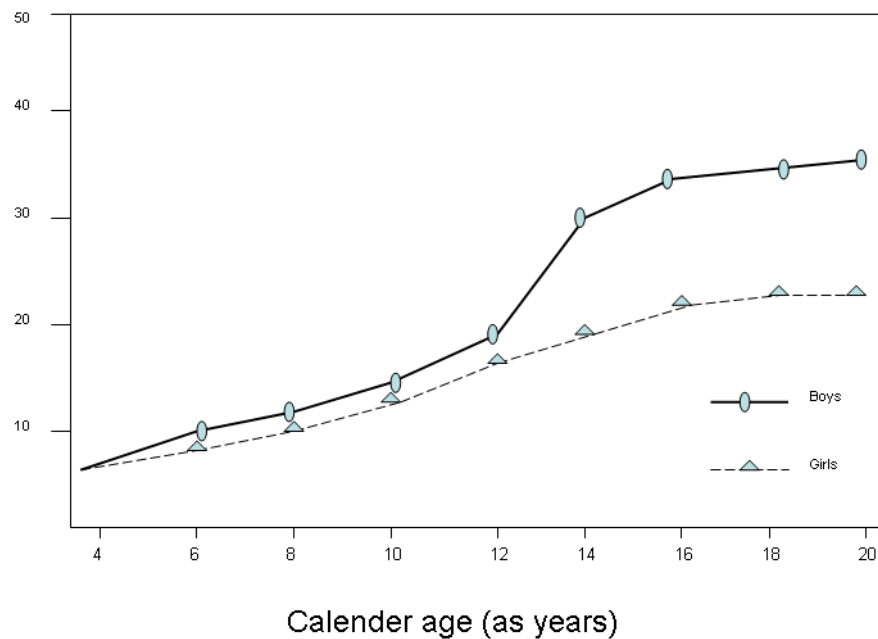


Figure 3 is modified from Hakkarainen (2009, 93). It presents the changes in muscle mass according to age and sex. The line with circles presents boys and the line with triangles presents girls.

### 3.4 The development of bones, articular cartilages, joints and ligaments

At birth, a child already possess all priorities ossification nuclei, from which the final bones will form. The timetable for this is very individual though. A child's maturity is usually assessed by the age of bones because it is a clear way to find out the biological age. Usually the assessment is done by taken x-ray photos from wrists because usually the ossification happens first in body's peripheral parts. (Hakkarainen 2009, 94; Mero, 2004, 24.)

Articular cartilages requires movement to strengthen itself and there has been detected in many studies that regular physical activity is an advantage for the load resistance of articular cartilages. In turn, biomechanically abuse of range of movements can cause cartilage injuries in the very early stage of childhood. Regular physical activity also ac-

celerates the strengthening of support structures such as joints and ligaments as well. The mobility of joints and support tissues is at its best between the ages of 11-14. (Hakkarainen 2009, 94.)

### **3.5 The growth and development of respiratory and circulatory system**

At birth, the basic structure of the lungs is ready but the size of the structure, ability to function and gas exchange will change the entire growth period. The size of the structure will change along the growth of upper body all the way at the end of growth of length. At the first year of life, the weight of lungs will increase three-fold and the volume of the lungs will increase six-fold. The amount of alveoli will increase, during the first 8-years, from 20 millions to 300 millions. (Hakkarainen 2009, 96-96; Mero 2004, 25.) The factors concerning respiration and functioning of the lungs, are limiting factor only for very few children thinking about sport performance. Arterial blood oxygen depletion, caused by a maximal load, can occur to some children during a strong performance. For this reason, very intense maximal VO<sub>2</sub> training for little children is not fully risk-free, and it should be administered with moderate way. (Hakkarainen 2009, 97.)

The cardiac stroke volume and the size of the heart muscle increases after birth as a requirement of normal growth and load. The changes in the capacity of the heart, follows the overall internal organ growth and it's in relation to changes in fat-free weight of the human body. The left ventricle of the heart pumps the blood into artery and through that the blood flows into muscles and other tissues and because of this, the heart's growth is dependent on the load what human body offers for it. (Hakkarainen, 2009, 97-98.)

### **3.6 The development of energy metabolism**

Researching anaerobic and aerobic metabolism with children is difficult because it is difficult to motivate the children to perform test and maximal experiments with maximal effort. Also taking muscle biopsy from children may not be very ethical. For this



reason, knowledge concerning metabolism within children is based on minimum research information. It seems that the oxidative metabolism is more effective with children than adults but children possess relatively weaker glycolysis energy-metabolism than adults. This means that within children, the muscles include more needed enzymes to burn fat so children use more aerobic metabolism and alternatively adults use more anaerobic metabolism. The aerobic performance ( $VO_2\text{max}$ ) develops with both sexes along the normal growth. With boys, the normal development seems to continue all the way at age of 16 while with girls it reaches the maximum at the age of 13. The maximal oxygen intake is largely affected by the changes in body proportions, the total weight of the body and muscle mass. (Hakkarainen 2009, 99-101.)

## **4 Developmental stages**

The developmental stages should be considered when planning the long-term goals in training. During the developmental stages, there are specific time periods where the development of some specific ability occurs partly through natural growth. This is when the development is the easiest and most effective. But these time periods only provide direction for training and consideration for child's individuality. The development stage and training background have to be always taken into consideration when planning the training. The developmental stages do not mean, that during a specific time period, one cannot practice other abilities as well. There is a book called *Laatua käytännön valmennykseen*, written by Lampinen and Forsman (2008, 415), and they have introduced the developmental stages. The first stage is for the years between 6-12, the second stage is for the years between 12-15 and the last stage is for year 15-20.

### **4.1 6-12 years old**

During this stage, it is very important to develop overall elements of skill so that later in life the learning process is easier. It is important to perform versatile exercises because motoric learning, balance, ability to be agile and coordination ability develops the best during this stage. Also the development of mobility is the most effective during this phase. During this stage, one should start a preliminary practicing for speed, speed strength and aerobic endurance and try to avoid anaerobic endurance and strength training. (Lampinen & Forsman 2008, 415.)

### **4.2 12-15 years old**

During this phase, the overall elements of skill should be in order so that the focus can be more on sport specific skill development. Maintaining the overall skills, coordination, agility and mobility continues even though the developmental stages for them are over. In this phase, the elasticity, speed, and speed strength development are at its best and it is very important to practice them. An effective training for them is now possible because the preliminary practicing in earlier phase. Also the developmental stage

for aerobic endurance starts in here and continues until the age of 20 years, but aerobic endurance should not be practiced at the expense of speed and elasticity. Anaerobic endurance training and strength training can be started now even though the developmental stages for them starts later on. (Lampinen & Forsman 2008, 415.)

### **4.3 16-20 years old**

This phase is about mastering the skill learning into top level. The base for overall skills and the basics for sport specific skills should be in order. It enables to modify the skills into the top level. From physical features, the developmental stages are now for elasticity, endurance, and strength. Training should include anaerobic endurance training and strength training in the level what the one's own sport requires. Considering the sport's physical requirements is very important and practicing should be based on them. (Lampinen & Forsman 2008, 415.)

## **5 Specialization models**

### **5.1 Late specialization model**

#### **5.1.1 Fundamentals**

The first stage in late specialization model is directed to 6-9 years old males and 6-8 years females. The main objective for this phase is to learn all fundamental movement skills and build overall motor skills. Before the sport-specific skills are introduced, the fundamental movement skills should be practiced and mastered. Using positive and fun approach, the development of these skills will contribute significantly to future athletic achievements. Participation for many different sports is encouraged and this kind of emphasis on motor development will help to produce players and athletes who have better trainability for long-term, sport specific development. (Balyi 2001, 25-28.)

#### **5.1.2 Learning to train**

The second stage is directed to 9- 12 years old males and 8-11 years old females. The objective remains closely the same as in fundamentals, learning all fundamental movement skills and also build overall sport skills. Specialized sport skills are developed from age seven to age eleven. If the fundamental and specialized skill development phase is passed, it is likely to be detrimental to the child's future engagement in physical activity and sport. Early specialization in late specialization sports can also be detrimental to the future stages of skill development. During this phase, all fundamental movement skills should be further developed and general overall sport skills should be learned. If fundamental motor skills are not developed between the ages of eight to 11 and nine to 12 for females and males, a significant window of opportunity has been lost, compromising the ability of the young player or athlete to reach his or hers full potential. Strength should be developed by medicine ball, Swiss ball or with own body weight exercises. Endurance should be developed through games and relays. Basic mobility exercises should be introduced during this phase and speed can be developed

with specific exercises such as agility, quickness and change of direction. (Balyi 2001, 25-28.)

### **5.1.3 Training to train**

The third stage is directed for 12- 16 year-old males and 11- 15 year-old females. The objective of this stage is to build the aerobic base, build strength towards the end of this stage and further development of sport- specific skills. This stage is for adaptation to aerobic and strength training because the optimal aerobic trainability begins in the moment of Peak High Velocity or during the maturation of major growth spurt. It should be remembered that aerobic and strength trainability is dependent on maturation levels. Due the sudden growth of bones, tendons, ligaments and, muscles, a special emphasis is also required for mobility training. During this phase, the athletes and players train daily in competitive situations, in the form of practice matches or competitive games and drills. The training to train phase is addressed to two sensitive periods of physical development. This phase together with learning to train phase are the most important phases in athletic preparation. (Balyi 2001, 25-28.)

### **5.1.4 Training to compete**

The fourth stage is directed to 16- 18 year-old males and 15- 17 year-old females. The objective is to optimize fitness preparation and performance. The development of this phase is introduced after goals and objectives of the training to train stage have been achieved. In this stage, fifty percent of available time is spent to the development of technical and tactical skills and fitness improvements and the other fifty percent is spent to competition and competition- specific training. The athletes, who are now able to perform both basic and sport specific skills, learn to perform these skills under competitive conditions. The special emphasis is now put on optimum preparation by modeling training and competition. Different programs planned for athletes, including fitness, recovery, psychological preparation and technical development, are now tailor made for each individual and are based on individual strengths and weaknesses. (Balyi 2001, 25-28.)

### **5.1.5 Training to win**

The fifth stage is directed to 18 years or older males and 17 years and older females. The objective is to maximize the fitness preparation and sport performance and this is the final stage of athletic preparation. Athletes are trained to peak for major competitions and all aspects of athlete's life are fully focused on maximization of performance. High intensity and relatively high volume are the characterized of training, but this period must include frequent breaks to help to prevent injuries and mental burnouts. (Balyi 2001, 25-28.)

### **5.1.6 Retirement**

The last stage is for retired athletes and the objective is to retain athletes to coaches, administration, official etc. It concerns athletes who are permanently retired. Some ex-athletes will continue to sport related careers, for example officiating, coaching, small business enterprises and master's competition media. (Balyi 2001, 25-28.)

## **5.2 Early specialization model**

Early specialization sports require a four-phase model and it includes these stages: 1. Training to train, 2. Training to compete, 3. Training to win, 4. Retirement. Each early specialization sport should develop their own four-stage sport-specific model because a generic model would lead to serious oversimplifications. (Balyi 2001, 25-28.)

## 6 Physical testing

When athletes participate on physical tests, there is certain information what has to be given to the athletes before the tests. The athlete must be aware of why the tests are done, for what purpose, how they are done and, who is doing the tests and responsible for them. Underage athletes need guardian's approval to participate to the tests. Purpose of all kind of testing, is that the athlete knows where he or she is going and that the tests are chosen to be as valid as possible. (Valmennuskeskus 2010, 7.)

Before the test situation, certain information should be given for the athletes so that the outcome of the test results could be realistic as possible. Here are the main things on this matter:

- Training during the previous two days before the tests should be constant
- Breakfast before the tests should be constant
- Heavily eating, using nicotine products or drinking caffeine should be avoided 2- 3 hours before the tests
- The use of certain medication (asthma- and cardio medicine) may affect to the test results
- No participation to the tests if a person is sick (acute infection or fever within a week)

(Valmennuskeskus 2010, 7.)

Before the test situation, the staff responsible of the tests has to go through few things before hand. Checking the measuring equipment and the test room or facilities is very important. If there is not enough testing staff or room for testing, the tests cannot be done. Also the testing staff has to be on time, so that the test preparations will go correctly. (Valmennuskeskus 2010, 9.) Safety is also an important matter. The risks for injuries or incidents should be minimized beforehand. The test situation should be stopped, if one suffers from these symptoms; chest pain or anxiety, dizziness, sense of confusion, sudden changes in heart rate or anti- arrhythmic symptoms or, if the test person wants to quit. (Valmennuskeskus 2010, 9-10.)

According to study made by McInnes, the mean value of jumps during a basketball game per player is 46. This means that the jumping is particularly important for the game, so testing jump for basketball players is necessary. Also there are approximately 1000 changes in movement pattern and over 30 percent of them are occurring in a lateral fashion. This means, that an agility test is also required for basketball players. The basketball court is 28 meters long, so the sprint test should not be any longer than that. Sprints during a basketball game are an average 1.7 seconds in duration, so sprint distances between 10 to 20 meters that focus on acceleration rather than speed are more appropriate for basketball fitness testing. Most basketball testing protocols includes a test of aerobic fitness because of the high volumes of activity time in a basketball game. (Drinkwater, McKenna & Pyne 2008, 569.)



## 7 Aim of the study, study problems, and hypothesis

In this research, 1995 born male basketball players' physical test results were examined. The purpose of this study is to determine do the U16 male basketball national team players have better results in physical tests than non- national team players. In the re- search, the answer is searched for the question:

Does physical tests separate the U16 male basketball national team players from non- U16 national team players?

Based on the question, the hypothesis is:

The U16 national team players have better results in physical abilities tests than non- U16 national team players.

## **8 Research Methods**

### **8.1 Target group of the research**

The number of subjects in this research is 115. The group was constructed from 1995 born male basketball players, who were part of U16 national team or players who played in B-junior level in Finland. There was 12 teams selected for this study and they were selected by Finnish Basketball Association. The number of investigated subjects in the thesis is 115 (N= 115.) The total amount of subjects consisted 23 (N1) U16 national team players and 92 (N2) non-national team players.

### **8.2 Study design**

The data collection was made through visits to the hometowns of the teams, into their own operating environments. The data collection was made during August and October 2010. The tests included two sport specific tests, five physical tests and questionnaires related to players' training background, self-evaluation and coach assessment. Height and weight of the players were also measured during the test situation. In this thesis, the physical tests were only analyzed. The order of the tests was depending on the teams' schedules. The test day was arranged so that it would fit both the researcher's and the team schedule and before the test day, an agreement forms were sent to the clubs because the players had to ask a guardians' permission to participate to the tests.

### **8.3 Measurements**

The test what were chosen to this research, measures the basic elements of basketball; speed, endurance, strength, agility and mobility.

### **8.3.1 Countermovement jump**

The counter movement jump test was done by using a New Test contact mat. The countermovement jump test formula was following. The researcher set the New Test contact mat ready for the athlete and gave a permission to step on the mat with both legs on it. Then the athlete jumped as high as possible and the New Test contact mat measured the time spent in air and transformed it to centimeters. After the jump, the athlete stepped off from the mat and the next athlete was waiting for the permission to step on the mat. The starting position was standing still, hands on hips. The total performance was done by following: A quick visit to a natural squat position, knees slightly flexed, and then maximal jump up. Hands had to stay on the hips, and the landing had to come on toes, knees straight. Two attempts and the best one was marked down. There was approximately two to three minute recovery period between the jumps.

### **8.3.2 20m running test**

20 meter track was measured by using two researchers and the lines were marked down first with a tape, and then the researchers put cones on the tape markings. The markings were placed at start, 10 m stop and at 20 m stop and the track was 2 m wide. The measurements were done by using New Test's light cells. The light cells were put at same places as the cones, only a bit further away from the running track. There were wires coming from the light cells to a Hewlett Packard computer and the running test results were shown in a computer. The athletes were put on an alphabetical order and one by one they ran the test. When the first round was over, the athletes had two minute break and then the second round started. The start was 70 cm behind the starting line, toes on the line, optional leg in front and optional start.

### **8.3.3 Agility track**

The agility track was measured by two researchers and the lines were marked down first with a tape, and then the researchers put cones on the tape markings. The athletes were put on an alphabetical order and one by one they ran the test. The start happened

with front foot heel on the line and with optional start. Then the runner goes around the cones as “eight”, starting from left corner, and after two cones, the athlete touches the head cone with a hand and then rotates the two remaining cones. The cones in a square cannot be touched but the head cone must be touched. Time stops when athlete crossed the starting / finishing line. There was a New Test light cell on the starting/ finishing line, and a wire going from light cell to a computer what showed the time. Figure 4 describes that agility track. The track was planned by Finnish Football Association for football players but it was used for basketball players in this research.

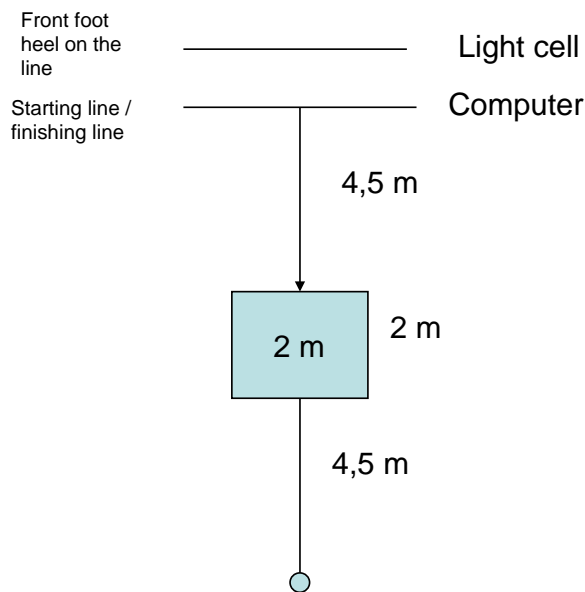


Figure 4 presents the agility track.

### 8.3.4 Mobility test

A researcher first showed the whole test. The idea was to take a stick, with thumbs wide grip and lift the stick up with straight hands, shoulders as back as possible. Then there was another stick put between the neck and shoulders to stabilize the movement of upper body and measuring the mobility of shoulders. Then the point was to do a deep squat as possible with the two sticks. The scoring scale for the mobility test was one to three. For shoulders, the scoring was following; one point if the stick could not be placed between the neck and shoulders at all, two points if the stick could be placed between the neck and shoulder with a little push, three points if the stick could easily

fall in to it's place between the neck and shoulder. For back the scoring was following; one point if the back started to lean forward heavily in a squat position, two points if the back only lightly leaned forward in a squat position, three points if the back was straight in a squat position. For ankles the scoring was following; one point if the heels came up in a squat position, two point if the subject reached 90 degrees angle in the knees in a squat position, three points if subject could perform a deep squat with heels on the ground. From these three stages, a total mobility was calculated and the minimum scoring was three and maximum was nine.

### **8.3.5 Beep- endurance test**

A track, 20 meter long was made for every athlete, track next to track. The tracks were marked down first with tape, then with cones. The idea was to run back and forth the 20 meter track as the sound gives to signal to go. The sound came from Sony Cd-player and the cd was provided by Finnish Basketball Association. The purpose was to keep up with the pace of the signals so that the start from a line happened when one heard the signal and turning back from the other end of the track happened when another signal was heard. The athletes ran as long as they could keep up the pace. If an athlete was once late from the pace, he got a warning. If he was late again, he's test ended there. When the signal was heard, one or the other leg had to be on the line. The pace of the signals accelerated when the test advanced. The athletes were put in an alphabetical order and only the repeats, how many times the athlete ran back and forth on the track, were written down as result of the test. This beep endurance test is used by Finnish Basketball Association and it was provided by them. The point of the test is to measure how many times a subject can run the 20 meter track. The Finnish Basketball Association did not provide a conversion table to transform the results from laps to actual maximal oxygen uptake ( $VO_{2max}$ ) as ml/kg/min.

## **8.4 Statistical methods**

The statistical analysis was performed using Excel 2010 for Mac spreadsheet program. To analyze the results significant value  $p \leq 0.05$  is used. The statistical significance is

described using following symbols ‘\*’ =  $P < 0.05$ , ‘\*\*’ =  $P \leq 0.01$ , ‘\*\*\*’ =  $P \leq 0.001$ . The results are described as mean values and standard deviations (sd). U16 national team players are marked as group N1 and non-national team players as group N2.

## 9 Results

### 9.1 Counter movement jump

Mean value of U16 national team (N1) in counter movement jump is  $37\text{cm} \pm 5,41\text{cm}$ , and mean value of non-national team (N2) in counter movement jump is  $33\text{cm} \pm 4,74\text{cm}$ . Statistically the difference is significant between the groups N1 and N2,  $p \leq 0.01$ . (Figure 5)

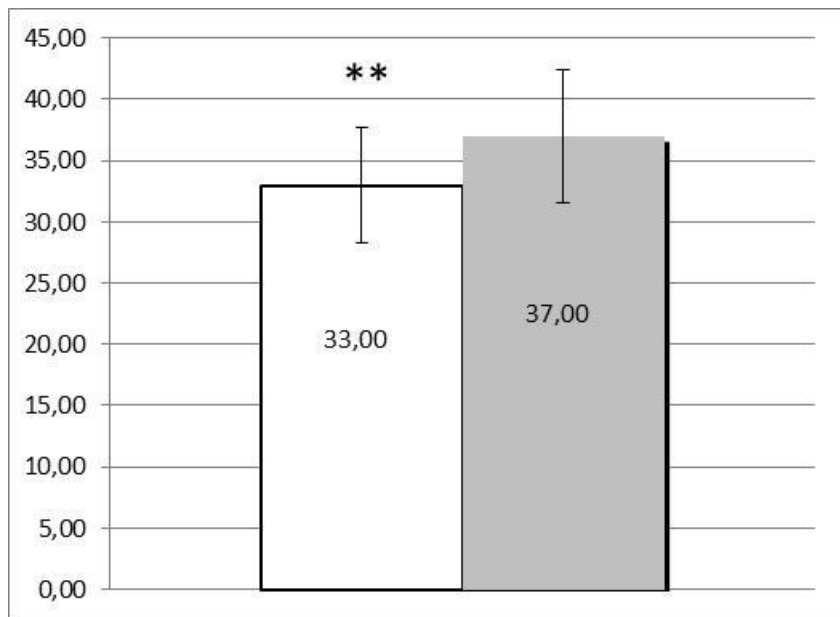


Figure 5. From the figure 5 can be seen the mean values, sd, and statistical difference  $p \leq 0.01$  (\*\*) of the groups N1 and N2 in counter movement jump. The results are marked down as centimeters on vertical axis. Light grey column describes the mean value of group N1 ( $37\text{cm} \pm 5,41\text{cm}$ ) and white column describes the mean value of group N2 ( $33\text{cm} \pm 4,74\text{cm}$ )

## 9.2 20 m running test

The mean value of U16 national team (N1) in 20 m running test is  $3,23s \pm 0,11s$  and mean value result of non- national team (N2) in 20 m running test is  $3,33s \pm 0,17s$ . Statistically the difference is significant between the groups N1 and N2,  $p \leq 0.01$ . (Figure 6)

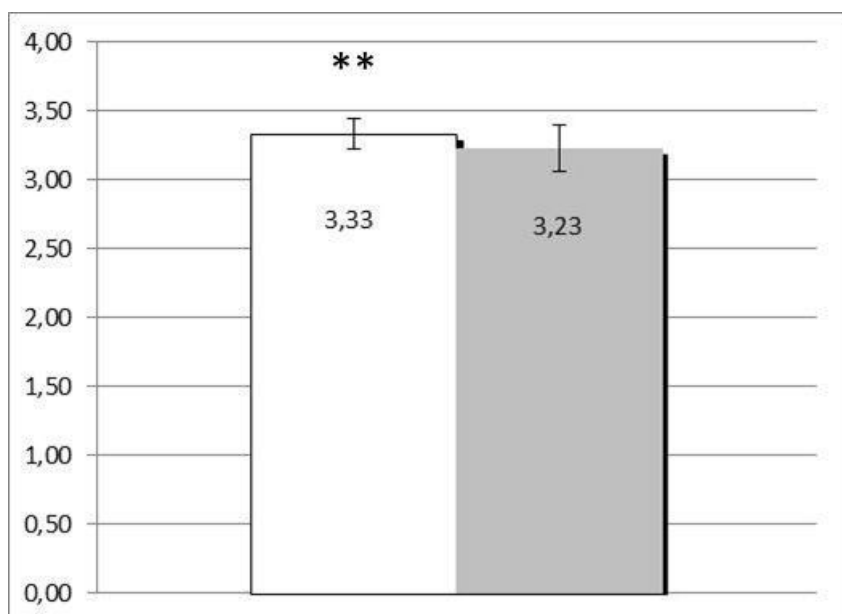


Figure 6. From the figure 6 can be seen the mean values, sd, and statistical difference  $p \leq 0.01$  (\*\*\*) of the groups N1 and N2 in 20 m running test. The results are marked down as seconds on vertical axis. Light grey column presents the mean value ( $3,23s \pm 0,11s$ ) of group N1 and the white column presents the mean value ( $3,33s \pm 0,17s$ ) of group N2.

## 9.3 Agility track

The mean value of U16 national team (N1) in agility track is  $7,06s \pm 0,35s$  and the mean value of non-national team (N2) in agility track is  $7,12s \pm 0,33s$ . Statistically there is no significant difference between the group N1 and N2 in agility track. (Figure 7)



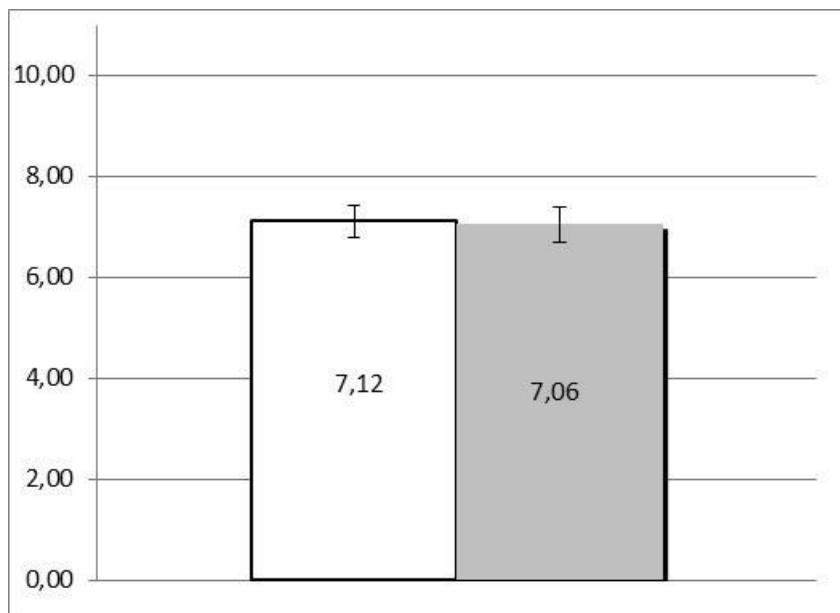


Figure 7. From figure 7 can be seen the mean values and sd of the groups N1 and N2. The results are marked down as seconds, and they can be seen on vertical axis. Light grey column presents the mean value ( $7,06s \pm 0,35s$ ) of group N1 and white column presents the mean value ( $7,12s \pm 0,33s$ ) of group N2.

## 9.4 Mobility test

### 9.4.1 Results of N1 and N2 in shoulder mobility test

The mean value of U16 national team in shoulder mobility test is  $2,17 \pm 0,72$  and the mean value of non- national team (N2) in shoulder mobility test is  $2,07 \pm 0,67$ . Statistically there is no significant difference between the group N1 and N2 in shoulder mobility test. Figure 8.

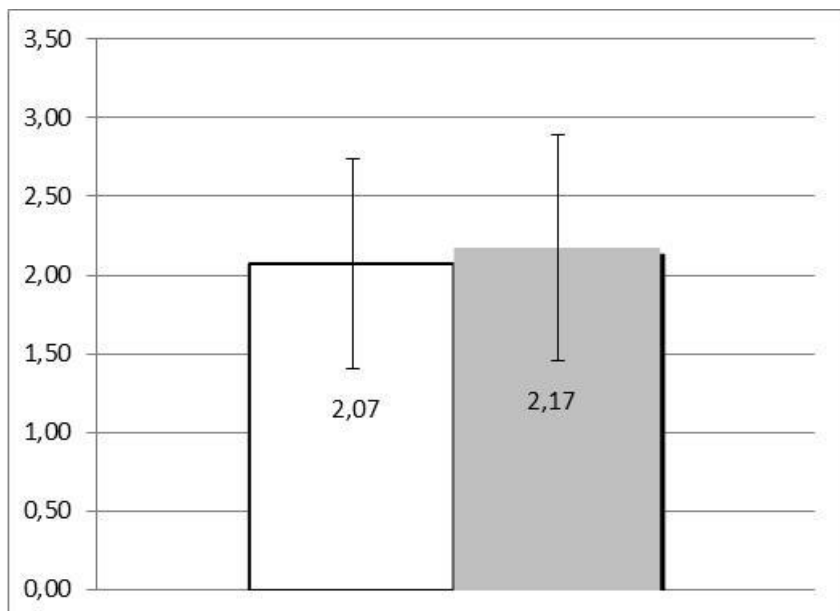


Figure 8. From figure 8 it can be seen the mean values and sd of the groups N1 and N2 in shoulder mobility test. Light grey column presents the mean value ( $2,17 \pm 0,72$ ) of group N1 and white column presents the mean value ( $2,07 \pm 0,67$ ) of group N2.

#### 9.4.2 Results of N1 and N2 in back mobility test

The mean value of U16 national team in back mobility test is  $1,65 \pm 0,78$  and the mean value of non- national team (N2) in back mobility test is  $1,60 \pm 0,74$ . Statistically there is no significant difference between the group N1 and N2 in back mobility test. Figure 9.

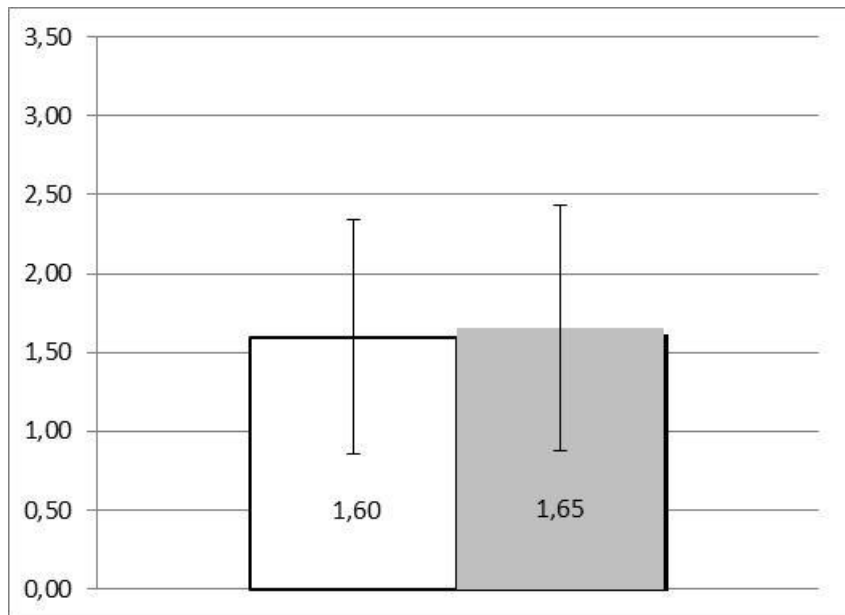


Figure 9. From figure 9 it can be seen the mean values and sd of the groups N1 and N2 in shoulder mobility test. Light grey column presents the mean value ( $1,65 \pm 0,78$ ) of group N1 and white column presents the mean value ( $1,60 \pm 0,74$ ) of group N2.

#### 9.4.3 Results of N1 and N2 in ankle mobility test

The mean value of U16 national team in ankle mobility test is  $2,00 \pm 0,90$  and the mean value of non- national team (N2) in ankle mobility test is  $1,82 \pm 0,89$ . Statistically there is no significant difference between the group N1 and N2 in ankle mobility test. Figure 10.

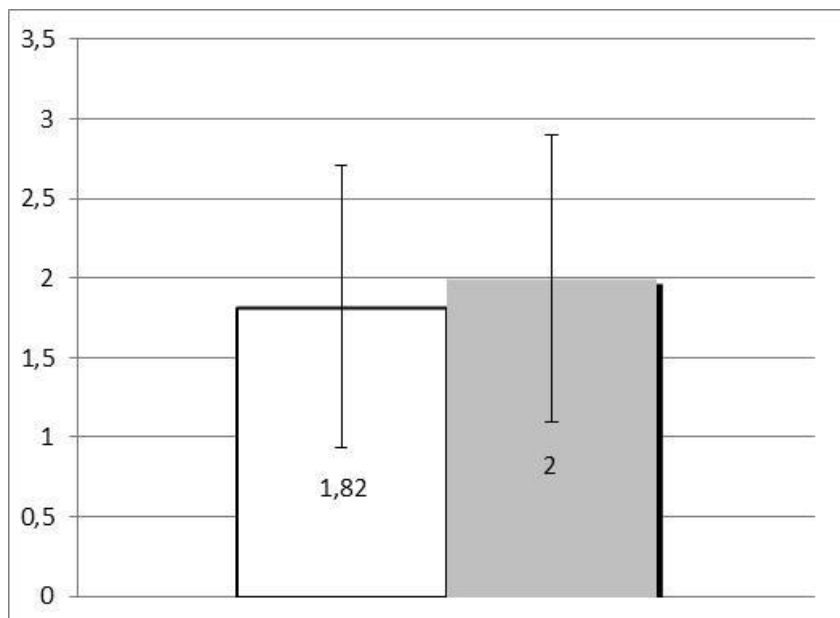


Figure 10. From figure 10 it can be seen the mean values and sd of the groups N1 and N2 in shoulder mobility test. Light grey column presents the mean value ( $2,00 \pm 0,90$ ) of group N1 and white column presents the mean value ( $1,82 \pm 0,89$ ) of group N2.

#### 9.4.4 Results of N1 and N2 in total mobility test

The mean value of U16 national team in total mobility test is  $5,83 \pm 1,80$  and the mean value of non- national team (N2) in total mobility test is  $5,05 \pm 2,34$ . Statistically there is no significant difference between the group N1 and N2 in mobility test. Figure 11

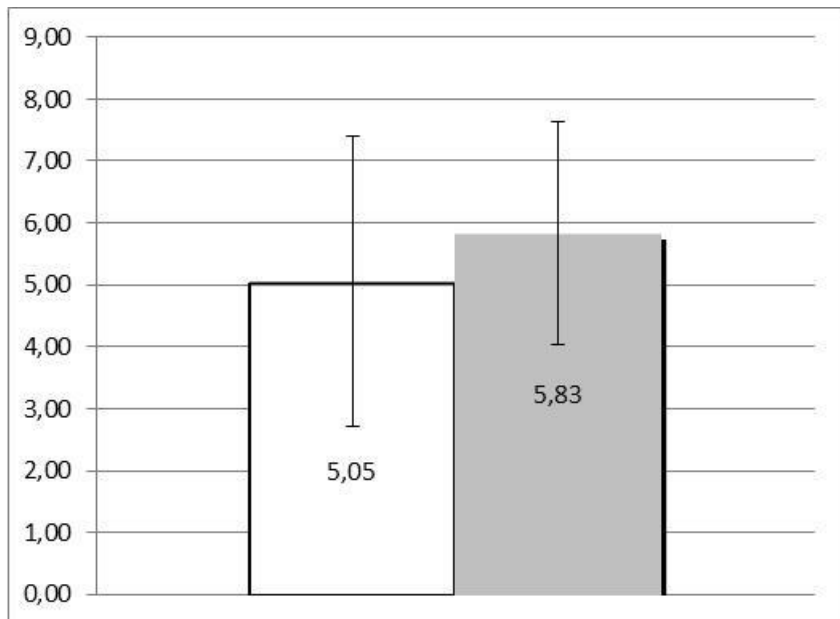


Figure 11. From figure 11 it can be seen the mean values and sd of the groups N1 and N2 in total mobility test. The total mobility result is the combined results from three different mobility tests. Light grey column presents the mean value ( $5,83 \pm 1,80$ ) of group N1 and white column presents the mean value ( $5,05 \pm 2,34$ ) of group N2.

### 9.5 Beep- endurance test

The mean value of U16 national team (N1) in beep- endurance test is 104,74 reps  $\pm 21,61$  reps and mean value of non-national team (N2) in beep- endurance test is 98,38 reps  $\pm 14,53$  reps. Statistically there is no significant difference between the group N1 and N2 in beep- endurance test. (Figure 9)

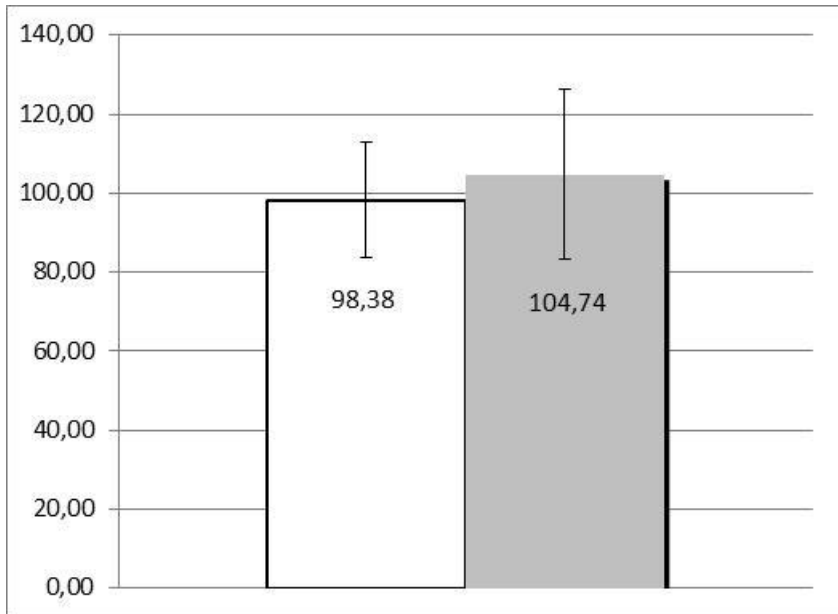


Figure 9. From figure 9 there can be seen the mean values and sd of the groups N1 and N2 in beep- endurance test. The results are marked down as reps, how many times a subject did run the 20 m track, on vertical axis. Light grey column presents the mean value (104,74 reps  $\pm$ 21,61 reps) of group N1 and the white column presents the mean value (98,38 reps  $\pm$ 14,53 reps) of group N2.

## 10 Discussion

Based on the mean values of the group N1 (U16 national team players) and N2 (non-national team players), the group N1 has better results in every physical test than group N2. Statistically the two biggest separating factors are counter movement jump and 20 meter running. According to Forsman et al. (2006, 37), speed is the most visible physical part of the game. A player, who is very quick, can solve many situations during the game with one single explosive performance. The most important conditions for speed in basketball are offered by skills and power. Speed is also the ability what a player need to execute a movement with the greatest possible acceleration and velocity. A basketball game lives on fast sprints, sudden turns and crossovers. If there's an opportunity, a player wants to immediately react with lightning speed. A player who is too slow and reacts late mostly loses his duels and that kind of player is not reliable to pass the ball on to and cannot be dangerous at the basket. (Barth & Boesing, 2010, 43.) Also, speed is known to be strongly inherited as part of neuromuscular system and achieving biological structural changes is the easiest during early in the childhood. Because the basic work developing the coordination is done in childhood, it is clear that training in childhood plays a crucial role in speed development. (Mero 2004, 294) According to Forsman et al. (2006, 39) strength can only be developed with meaningful training. A basketball player should reach a high basic strength level because it has several beneficial influences to moving in the court through from speed, explosive- and situation power. It is also important to maintain the already reached basic strength level and keep it in a right shape to get the speed out of it. If strength can only be developed through meaningful training, could childhood training also play a crucial role in strength development as well as in speed development? More research is necessary on this matter to determine; Does the childhood training separate the U16 national team players from non-national team players?

The research presented, that group N1 had better results in agility track than group N2 but it was not statistically significant. According to Baechle & Earle (2008, 458), in basketball game, there are a lot of situations where a player must change his moving direction effectively, balanced and explosively so, that the movement rate maintains or

accelerates. Agility can be described as changing movement velocity and performing locomotion models modes other than linear sprinting. (Baechle & Earle 2008, 458) According to study made by Luhtanen and Petersen, basketball is continuous chain of events where defense, transition and offense vary. A good player can read the game fast, react in unexpected changes in game situation roles and move quickly to a new place what the new game situation role requires. (Kiiskinen 2005, 3) These analyses gives the expression, the agility is also very important physical feature, what a good basketball player must possess. Should agility be statistically separating factor between the groups N1 and N2? According to Gaskill and Sharkey (2006, 177), when athlete develops speed and power, they will become more agile. Could it be that speed and strength development has not been in a required level to be shown as ability to be agile? The test was planned by Finnish Football Association, and it is planned for football players. Because of this, the test may not be the most valid for basketball players. If the test could have been planned for measure agility in basketball ball, it could have been more valid and the test results could have been statistically significant.

According to Forsman et al. (2006, 43), the physical load of a basketball game comes through that the players have to produce great power levels to accelerations, turnovers, 1vs1 situations, maintaining the defense stance and repeating these often with short recovery time. Endurance in this case includes not getting tired too quickly during strenuous training, a game, a tournament, or for example travelling to a competition. One's body should be able to recover quickly after a relatively major exertion and this is called regeneration. Basketball is an athletic game but it is not necessarily considered an endurance sport. Basketball player needs though good endurance so he can meet the demands of a game with concentration and in the best condition without getting continuously weaker from exhaustion. (Barth & Boesing 2010, 41) In this research, endurance features were measured by beep- test. The test results included reps, how many times one player ran 20 meters long track at the pace of beep- sound. Since the Finnish Basketball Association did not provide conversion table to transform the results into VO<sub>2</sub>max results, it was impossible to analyze whether the beep- test results were in a good level or did the players reach the international level, where the VO<sub>2</sub>max is at least 54 ml/kg/min for boys according to Lohikoski (2009, 406- 407.) The same



problem recurs, was this test the most valid and best one to measure endurance in this research? If the results cannot be fully analyzed, how can one know if they are good or bad? Now the results only say that group N1 ran more reps than group N2 but the differences were not statistically significant. If the results were transformed into VO<sub>2</sub>max results, could the outcome be statistically significant then?

The physical load of a basketball game comes through that the players have to produce great power levels to accelerations, turnovers, 1vs1 situations, maintaining the defense stance and repeating these often with short recovery time. (Forsman et al. 2006, 43) According to study made by Verma, these things requires reaction speed, velocity and speed endurance and this means, that basketball player's anaerobic endurance efficiency of a performance has to be on a high level. (Kiiskinen 2005, 21) Since the game includes many turnovers and 1vs1 situations, does a player run directly forward more than couple of meters in a basketball game? Velocity and reaction speed are emphasized when analyzing basketball as game, so could the 20 meter running and agility test be replaced by something what measures the movement speed or reaction speed in basketball game? A research could be made that; Is there more sufficient way to measure speed and agility in basketball than simple running and agility tracks?

The hypothesis of this research is this; The U16 national team players have better results in physical abilities tests than non-U16 national team players. The results clearly show that this came true. It was a bit disappointment, that statistically only two tests were significantly separating factors, but the differences were in the major features of basketball, speed and strength. Conclusion is that this research provided a good knowledge, what physical factors separate basketball players from U16 national team and non-national team at the age of 15. More studies have to be made to find out how big role does the childhood training have in one's life, when developing physical abilities. For the future researches, other tests could be used or developed to determine the separating factors so that the tests would be as valid as possible for basketball.

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# Appendices

## Attachment 1. Players agreement form to the test situation.



SUOSTUMUS



Kansainväliset sopimukset ihmisillä tehtävistä tutkimuksista edellyttävät, että tutkimuksiin osallistuville selvitetään mittauksiin ja testeihin liittyvät riskit ja hyödyt, ja että tutkittavat antavat kirjallisen suostumuksensa tutkimukseen osallistumisesta. Myös henkilökohtaisten tietojen keräämiseen, rekisteröintiin ja julkaisemiseen tarvitaan henkilötietolain mukaan ko. henkilön kirjallinen suostumus.

Kilpa- ja huippu-urheilun tutkimuskeskuksessa (KIHU) tehdään jatkuvasti tutkimuksia, joissa ammattitaitoiset työntekijät mittaavat urheilijoiden ja muiden tutkittavien fysiologisia, biomekaanisia ja psykologisia muuttujia levon ja kuormituksen aikana. KIHU on vakuuttanut tutkittavat ja tutkijat mittaustapahtumiin liittyvien ulkoisten syiden aiheuttamien tapaturmien, vahinkojen ja vammojen varalta. Tutkittavalla on kuitenkin suotavaa olla oma henkilökohtainen tapaturma/sairaus- ja henkivakuutus, koska vakuutusyhtiöt eivät myönnä tutkimusprojekteja varten täysin kattavaa vakuutusturvaa esim. sairauskohtauksia ja äkillisen ponnistuksen aiheuttamia lihas- tai jännevammoja varten. Osallistuminen mittauksiin on täysin vapaaehtoista ja tutkittava voi kieltäytyä mistä tahansa kokeista ja mittauksista, ja hän saa keskeyttää kokeen milloin tahansa. Mittaushenkilökunnalla on koulutus, ohjeistus ja välineistö tapaturmien ja sairaskohtausten ensiapuun. Mittaajat selvittävät ennen kutakin mittausta tarkemmin suoritusohjeet ja testin turvalliseen suorittamiseen liittyvät seikat. Mittaushenkilökunta antaa tarvittaessa lisätietoa testeihin liittyvistä riskeistä ja niistä saatavasta hyödyistä. Tutkijat raportoivat mittauksista suoraan tutkimuksiin osallistuville henkilöille näiden kanssa sovituilla tavoilla, sekä tieteellisissä ja valmennuksellisissa julkaisuissa siten, että yksityiseen henkilöön identifioitavissa olevia tietoja ei julkaista. Tutkimuksesta saatavaa tietoa voidaan edelleen käyttää hyväksi harjoitusmenetelmien kehittämisessä ja urheilusuoritusten parantamisessa. Vastuullinen tutkija vastaa kerätyn aineiston turvallisesta säilyttämisestä.

### Väitöskirjatutkimus – pelaajan kehittymiseen vaikuttavia tekijöitä

Tämän tutkimuksen tavoitteena on selvittää pelaajan kehittymiseen vaikuttavia tekijöitä joukkuepalloilussa. Tutkimuksen tavoitteena on antaa käytännönläheistä tietoa suomalaisesta valmennuksesta ja suomalaisten junioripelaajien ominaisuuksista, harjoittelusta ja kehitymisestä. Tutkimukseen on valittu 12-14 seurajoukkuetta jalkapallosta, jääkiekosta ja koripallosta. Tutkimus on osa laajempaa KIHU:n nuorisourheilututkimusta.

Tutkimus antaa koko suomalaiselle palloiluvalmennukselle kokonaisvaltaista tietoa pelaajien ominaisuuksista, harjoittelusta ja kehitymisestä. Tulosten perusteella voimme ohjata suomalaista juniorivalmennusta oikeaan suuntaan ja kehittää pelaajiamme laadukkaammin. Tutkimuksen tuloksia julkaistaan kansallisissa ja kansainvälisissä julkaisuissa sekä käytetään hyväksi Suomen Urheiluopiston ja mukana olevien lajiliittojen valmennuksen ja valmentajakoulutuksen kehittämisessä.

### Tutkimuksen hyödyt pelaajalle ja valmentajalle

Tutkimus antaa yksittäiselle joukkueelle, pelaajalle ja valmentajalle arvokasta tietoa pelaajien kehitymisestä sekä harjoittelun laadusta ja määrästä suhteessa muihin suomalaisiin pelaajiin. Tutkimukseen osallistuva pelaaja saa vastineeksi tutkimukseen osallistumisesta käyttöönsä omat testituloksensa sekä yhteenvedon harjoittelustaan ja kehitymisestään tutkimuksen aikana suhteessa muihin samanikäisiin pelaajiin Suomessa.

### Suostumus testitilaisuuteen osallistumiseen

Tutkimukseen valittujen seurajoukkueiden pelaajat osallistuvat urheilussa yleisesti käytettyihin taito- ja fysiikkatesteihin sekä lomakyselyihin. Testit toteutetaan seurajoukkueen omassa harjoitusympäristössä elokuussa 2010. Tutkijoilla on kokemusta testien toteuttamisesta ja he ovat ammattilaisia asiassa.

Tutkimuksessa tehtävät mittaukset:

- pituus, paino, syliväli
- laji- ja yleistaitotestit
- liikkuvuus- ja lihaskuntotestit
- voimantuotto/nopeus/ketteryytestit
- maksimaalinen kestävyystesti (piip-testi)
- lomakkeet: pelaaja- ja valmentaja-arviointi, harjoitushistoria ja harjoittelun seuranta

**Olen tutustunut suoritettaviin testeihin ja mittauksiin, ja olen ymmärtänyt mittausten tarkoituksen ja niihin liittyvät riski- ja hyötynäkökohdat. Voin kuitenkin halutessani keskeyttää kokeen tai kieltäytyä mittauksista tai harjoittelusta missä tutkimuksen vaiheessa tahansa.**

Tällä lomakkeella vahvistan, että...

- Suostun yllämainitun projektin mittauksiin annettujen ohjeiden mukaisesti
- Annan luvan tulosteni käyttöön tutkimuksen raportoinnissa
- Annan luvan tulosteni säilyttämiseen KIHUn tutkimusrekistereissä
- Annan luvan tulosteni lähettämiseen henkilökohtaiselle ja liiton valmentajalle
- Annan luvan tulosteni käyttöön tuotekehitystoiminnassa
- Annan luvan mittausten yhteydessä otetun video/valokuvani käyttöön tutkimuksen kirjallisessa ja suullisessa raportoinnissa

**Yhteystiedot:**

Pelaajan nimi: \_\_\_\_\_

Äidin/ Isän nimi: \_\_\_\_\_

Äidin/ Isän puhelinnumero: \_\_\_\_\_

Paikka ja aika \_\_\_\_\_ Huoltajan allekirjoitus \_\_\_\_\_

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