Lacrosse

Sport Demands Analysis

(SWE: Krav- och Kapacitetsanalys)

Measuring and Testing within Lacrosse – Closing the 'gap' to the leading countries

Laurens Hoffer T2

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Handledare: Mårten Frederikson

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Chapter 1: Capacity Analysis

1. Introduction:

The focus in the course 'Träningslära 4' is on the 'krav- och kapacitetsanalys'. During the education at the 'Gymnastik och Idrottshögskolan of Stockholm' the focus is on sports. Day in, day out students are being prepared for a living- and working in a sports environment. Courses are dominated by sports, health and helping other people to participate in a world filled with sports.

The 'krav- och kapacitetsanalys' is about the capacities and requirements in several kinds of sports. During this study the sport that is being analyzed is Lacrosse. In the first part of this study the capacities analysis will be explained. The 'Dutch Lacrosse Association (NLB) uses different tests to analyze progress by their players, but does not record/save results. The NLB is at this moment an 'association' that needs to grow. Compared to the Lacrosse Federations of the USA and Canada, the Netherlands are still two steps behind.

2. Background

Lacrosse is, worldwide, a growing sport. Not only in Canada and USA (the two leading countries) is an 'explosive' growth noticeable but also in Australia, Japan and Europe are more men interested in playing Lacrosse.

Lacrosse is often called 'the fastest game on two feet', but where does it come from? The North American Indians started playing Lacrosse as a preparation for wars. There were hundreds of Indians playing/battling each other for days on a field that could be 1 to 15 miles big. They used wooden sticks to throw a ball made of wood or deerskin stuffed with deer hair. In the spring of 1881 Lacrosse became a 'real' sport when Columbia played against Prince town (both USA) in the first Lacrosse game ever held. In the early 1900's Lacrosse was played on the Olympic Games. After the 1960's the popularity of Lacrosse increased in America. Colleges and Universities started their own teams. In the 1990's Lacrosse made his 'big entrance' in Europe, from that time on Lacrosse started to grow world wide (Jackson & Nyland, 1990).

A trainings program or test program in Lacrosse must be carefully balanced and chosen. Lacrosse is, as we now know; 'the fastest sport on two legs' and also a combination of several 'skills' out of other sports. You can find the quickness and agility of Ice hockey. The roughness of American Football or Rugby and the game understanding that is needed by soccer. Combined with the technique that a Lacrosse player uses by controlling his crosse[1], Lacrosse is one of the most complex, intense and fastest games on earth.

[1] Crosse; the word that is used to indicate the stick that is used for playing Lacrosse

There are very little studies being performed about Lacrosse and several tests that can be used in this sport. There is hardly any scientific research about testing and measuring progress. There is one thing that can be assumed as 'truth'. A Lacrosse player must gain size (body mass), strength, power, speed, agility and endurance. Because of the (almost) constantly movements during a game, these skills should be well trained, and therefore monitored (for example by using tests).

As is written above, it is known that Lacrosse is a combination of several different sports. In a previous research it showed that a Lacrosse player needs to have an average aerobic capacity similar to basketball and football players. Less endurance is needed while playing Lacrosse then for example a long distance runner or swimmers (Shaver, 1999[2]). But, there is a difference within the game of Lacrosse. A midfield player needs a significantly greater endurance than attack- or defensive players. The 'profile' of a midfield Lacrosse player shows greater likeliness with traditional distance athletes (Shaver, 1999). This is quite logical because a midfield player is allowed to move up and down the entire Lacrosse field. The defensive and offensive players only can use a part of the field and therefore need to cover less areas/meters on the field.

A Lacrosse player needs, compared to most sports, a **higher bodyweight**. This is due to the (sometimes) aggressive physical contact that is allowed in the game of Lacrosse. Besides this, a Lacrosse player (midfield- and attack players the most) needs to make quick movements and has to be agile; therefore a **low body fat percentage** is needed. If these 'facts' are translated to different sports with some similarities a Lacrosse players needs to have a lower fat percentage than for example football- basketball- or ice hockey players (Shaver, 1999).

Next to a higher bodyweight and a low fat percentage **endurance** is an important matter within the game of Lacrosse. A Lacrosse player has great benefits with hypertrophy strength training to build up a high muscle mass. But not only a strong body is needed, **endurance** is also an important skill a Lacrosse player has to have. A midfield Lacrosse player needs to have a greater endurance then the offensive- and defensive players. This because of the entire field a midfield player has to cover. Defensive and offensive players have an increased need for power and strength (Shaver, 1999).

All positions within the game of Lacrosse will need a good aerobic and anaerobic endurance. Besides that it is important to train, and test, the speed and agility of Lacrosse players. The same counts for testing and training the maximum strength, explosive power and (power) endurance.

[2] Shaver (1999), a physical trainer specialized in setting up Lacrosse practices

2.1 Objective

In this research, the tests that are being performed by the Dutch National Team and 7 (top) teams in the Netherlands are examined. **'This research investigates the tests and methods that are being used in the Netherlands'.**

These outcomes will be compared to the results/tests being used in the US and Canada, the two leading Lacrosse countries, and the possibilities for these tests and methods to improve the level of the Lacrosse in the Netherlands.

3. Method

During this study data has been collect in several different ways. Due to the fact that Holland and Sweden are 'developing countries' in Lacrosse most data about tests has been received from the Canadian Lacrosse Federation (Stewart D. Begg, Canadian Lacrosse Federation, 2010[3]). The American Lacrosse Federation (ALF) as well as the Canadian Lacrosse Federation (CLF) are 'leading countries' when it comes to development in Lacrosse. The objective, and an explanation about the five 'del kapacitet', was sent to both Lacrosse Federations. Only the Canadian Lacrosse Federation replied. Several tests have been sent and the most 'valuable' tests are written down and explained in chapter 3 (Used tests in Lacrosse).

Several questions were asked to the Coach of the Dutch National Team (Travis Taylor) about testing in Lacrosse. Besides this, 7 (top) teams in Holland were asked about testing in Lacrosse within their own teams. The teams in Holland that were asked about testing within Lacrosse were: Amsterdam Lions, Rotterdam Jaguars, Groning Gladiators, Maastricht Lama's, Domstad Devils, Tilburg Titans and the Keizerstad Kannibalz.

3.1 The several Federations

During this study three Lacrosse Federations has been asked about tests they use to measure progress among the players. What became clear in the 'method part' is that the Canadian Lacrosse Federation is the most developed federation of the three federations that have been asked about their testing. The Dutch Lacrosse Federation is expiring a professionalization at the moment. Unfortunately the USA Lacrosse Federation did not reply. The sport of Lacrosse is growing at the moment in Europe but compared to Canada there is still a long way to go.

[3] Information is requested by e-mail from the Canadian Lacrosse Federation

3.1.1 The Dutch Lacrosse Federation

The Dutch Lacrosse Federation was founded in 2006. At this moment there are 13 clubs (some of the clubs got 2 teams) in the Netherlands that play in two leagues. Several clubs are preparing to join the league; this shows that Lacrosse is still growing in the Netherlands. During the last World Cup the Dutch National Team became 8th. In 2012 the European Championships will be held in Amsterdam (NLB, 2010).

The Dutch National Team does measure some capacities from the physiological profile, but the outcomes are not written down for future progress (Travis Taylor, Coach Dutch National Team, 2010). These tests are performed whenever the DNLT is together, preparing for an international tournament or event. Most of the times this is only a couple of days, during the Lacrosse season. Only physical outcomes are measured, no 'Physical Profile' is being made (Travis Taylor, Coach Dutch National Lacrosse Team, 2010).

3.1.2 The Canadian Lacrosse Federation

The Canadian Lacrosse Federation was founded in 1867 and is the oldest Lacrosse federation in the world. There are 11 districts in Canada, all districts consist a high amount of teams (youth and senior). During the last World Cup Canada became 2nd. Some tests are described in chapter 4 were received from the Canadian Lacrosse Federation (CLA, 2010). Several teams in Canada use these tests. Not only the national team uses these tests, but several College and University teams use them too (Stewart D. Begg, Canadian Lacrosse Federation, 2010)

4. Results: Used test in Lacrosse

There are several tests that can be used to improve the power/speed, endurance, agility and technique/coordination. The Dutch National team uses some tests but they do not record the outcomes, progress is therefore not being measured in tests that are performed further down the season (Travis Taylor, Coach Dutch National Lacrosse Team). If this is compared to the Canadian Lacrosse Federation/Team a big difference can be seen. They have several tests for the '5 capacities'. Stewart D. Begg (Canadian Lacrosse Federation, 2010) explains as well that most of the teams write down the outcomes to measure progress by Lacrosse players.

4.1 Aerobe tests

Aerobic fitness is an important skill in Lacrosse and many other sports. A high aerobic endurance is the base for high intensity sports such as Lacrosse. The aerobic endurance is important for all Lacrosse players. The defensive- and offensive players stay in the field for the whole game, while midfield players substitute al lot. The midfield players need to run up

and down the field on the top of their ability, a midfield player usually stays in the field for a shorter period (2 to 5 minutes).
The 300 meters shuttle run test is used in Lacrosse to monitor fatigue and overtraining and is an assist in periodization and long-term players' development (Shaver, 1999).
The Dutch National Team uses the 'regular' beep-test to measure Lacrosse players. Cones are places 20 meters a part. The starting pace is quite slow (8,0 km/h), after one minute the pace is increased with 0,5 km/h and so on. No results for the Dutch Lacrosse players were written down (Travis Taylor, Coach Dutch National Team, 2010).

4.2 Anaerobe tests

Anaerobe endurance is most important for the midfield players. The offensive- and defensive players stay on the field for the entire game while midfield players normally have shifts from an average of 1.50 min. to 2.00 min. (Romas & Isles, 1986).
During a Lacrosse game with the Dutch National Lacrosse Team (DNLT), 'a shift (for the midfield players)' usually last 90 seconds of playing time before a player is substituted. The test that is used in the DNLT to measure/test this 'capacity' is the '440 yard sprint' (similar to the 300 meters shuttle run test used by the Canadian Team, Stewart D. Begg, Canadian Lacrosse Federation, 2010). This test should be completed in less than 90 seconds with a 180 seconds recovery period. The players from the DNLT should be able to complete this test 10 times, go back to running 4, but only with half the recovery time. The measurement in this test is; how many times can a player perform this routine or the time of the 4th time this test is being performed (Travis Taylor, Coach Dutch National Lacrosse Team, 2010).

4.3 Strength/Power/Speed tests

Speed in Lacrosse is one of the most important skills to possess for a Lacrosse player. Generally known is that Lacrosse is 'the fastest game on two legs', speed is most important for offensive- and midfield players while defensive players have more benefits with (muscle) power and strength.
Speed is simply tested by a 40-yard sprint. Most of the DNLT players should be able to perform this test under 5 seconds. The best players in the world should be able to perform this test in 4.4 seconds (Travis Taylor, Coach Dutch National Lacrosse Team, 2010).
Strength/Power is tested in different ways by the DNLT. Most of the time there is no weight room available so the tests are measured by doing 'push ups' and 'squat thrusts'. Players have to perform as many as possible push ups and squat thrusts in one minute (maximal output) with 1.30 min. recovery time (Travis Taylor, Coach Dutch National Lacrosse Team, 2010).

4.4 Agility tests

Agility and quickness are key factors in Lacrosse. Agility measures the ability of a Lacrosse player to move in to different directions within the horizontal plane. Besides this the Illinois Agility Test (IAT) trains a Lacrosse player to quickly change direction, visual processing, timing, reaction time, perception and anticipation. The IAT is a measure of speed, agility and the ability to change directions without losing balance. This routine can be performed by using the crosse by doing this 'technique' can be measured/tested as well (Stewart D. Begg, Canadian Lacrosse Federation, 2010).

The DNLT team uses, just like the Canadian Lacrosse Federation, the Illinois Agility test to measure agility by their players. There is only one big difference the Canadian team uses this test to measure progress in the players physical skills (Stewart D. Begg, Canadian Lacrosse Federation, 2010) the Dutch team only use it to make progress in agility, they do not save results (Travis Taylor, Coach Dutch National Lacrosse Team, 2010).

It is important that all players know how to perform the routine of the test. The player should lie down on his stomach with his arms above his head. On the 'go' command, the stopwatch start recording the time and the player needs to get up as quick as possible using his arms to do a 'push up'. Make sure the player makes the 'right path' through the cones without knocking them down. The trainer/tester needs to record the time (Travis Taylor, Coach Dutch National Lacrosse Team, 2010).

4.5 Technique/coordination

As is said in §4.4 (agility) the Illinois Agility Test, quickness and the ability to change direction without losing coordination is very important in Lacrosse (Shaver, 1999).

Testing technique is not that difficult. It is a very large section in Lacrosse. For example shooting is an easy section that can be easily tested. Simply having a player on the run and shooting at designated areas and record how many times the Lacrosse player hits the target (Travis Taylor, Coach Dutch National Lacrosse Team, 2010).

5. Discussion

The first thing that needs to be said is that testing is not that common in the Netherland. From the 7 (top) teams in the Netherlands 4 do not perform any kind of testing. They use several training methods to visualize progress but no data is being recorded or saved. The same can be said about the National team. They use some kind of tests/testing but they do not save or write down any data out of it.

Besides this there are only two levels of Lacrosse in the Netherlands. There is a 'first league' and a 'second league'. There are no youth teams playing Lacrosse in Holland. A player can start playing Lacrosse from the age of 16. Also, there are no College or University teams in

the Netherlands. The sport is growing at the moment, from 6 clubs in 2006 to 13 clubs (18 teams) in 2009 and still clubs subscribe to the Dutch Lacrosse Federation.
When a closer look is being taken to 'testing' in the Dutch National Team a conclusion can be written down. There is 'some kind of testing', but not on a professional basis. A few tests are being performed but no data is saved or recorded. There are no physical profiles from players. Therefore progress cannot be measured. Whenever the team is together tests are being performed again, but not being compared to previous tests.

Aerobe:

For testing the 'aerobe capacity' of the Dutch team a regular beep-test is used. After the test is being performed no data is saved about performance of the players (Travis Taylor, Coach Dutch National Team, 2010). To measure progress by athletes it is important to save data from several tests. If the coaches would write down the results progress among the players can be measured. By working like this individual schedules for different players can be made. The Lacrosse player self should have access to the outcome of the tests as well so he is able to see where opportunities occur for improving his physiological profile.

Anaerobe:

The focus by the Dutch team lies more on the 'anaerobe capacity' then on the 'aerobe capacity'. The defensive- and offensive players stay in the field for the entire quarter. The midfield players work in shifts (this is very common in Lacrosse). A 'shift' usually last 90 sec. to 120 sec. The midfield player needs to fulfill 'his task' on a maximal capacity.
The 'anaerobe testing' is therefore being performed more often than the 'aerobe testing'. The Dutch team uses the '440 yard sprint' to test the 'anaerobe capacity' of their players (Travis Taylor, Coach Dutch National Lacrosse Team, 2010). The Canadian team uses a similar test; 'the 300 meters shuttle run test' (Stewart D. Begg, Canadian Lacrosse Federation, 2010). There is one big difference. Again the Dutch team does not write down any data in to a physiological profile.
In the second part of this research becomes clear that Lacrosse is an aerobe sport with anaerobe aspects in it[4].

Strength/Power/Speed

The testing of this 'capacity' depends on several circumstances. It is not always possible, when power/strength is tested, to attend a weight room. If there is the possibility to make use of a weight room some tests are being performed. Most of the time there is no weight room

[4] Romas & Isles (1986) in '*A game analysis of the physiological requirements of attack and midfield state league Lacrosse players.*

available so regular strength testing is being performed ‘outside’ doing (push ups, sit ups and squat thrusts). Data is not being compared or recorded; therefore progress cannot be measured or written down in to a physiological profile. Coaches and players miss hereby the opportunity to compare previous data with recent data.

Agility

If the testing of ‘agility’, in the Dutch Lacrosse team, is being compared to tests being performed in the Canadian Lacrosse team, a similarity can be seen. They DNLT use the same tests as the Canadian team. Again, the difference occurs by saving the results of the tests. The Canadian Lacrosse team writes down data and compares these results to measure improvement among their players. The Dutch team only performs this test.
To measure progress it is a must to write down collected data about performance in different tests.

Technique/coordination

Technique testing in Lacrosse is not that difficult, simply let a player shoot/aim to a certain area and count the times the player hits this ‘designated spot’ (Travis Taylor, Coach Dutch National Lacrosse Team, 2010). Lacrosse is a ‘complex sport’ where a proper technique will indicate whenever a player is an ‘elite sportsmen’ or just an average Lacrosse player.

If a conclusion is drawn out of these results, the most important thing is that the Dutch team should start writing down data about player testing. In their search for getting closer to the ‘worlds best’ Lacrosse countries, USA and Canada, player testing and the establishing of a physiological profile are key factors. With writing down several results in the different ‘capacities’ a Physiological profile should be made for each player. By comparing test results from previous tests to results from tests that are performed after this first test the progress of a player can be viewed and measured. The coach and the player should have access to this profile. Together, or the player himself, can set goals to improve his skills within the game of Lacrosse.
Next to this, the starting age of playing Lacrosse in the Netherlands should go down. Players can start playing Lacrosse when they are 16. It they would start at a younger age they would get ‘used to’ handling the crosse (technique) and the movements (agility) that are necessary in Lacrosse.

Chapter 2: Requirements analysis

1. Introduction

In this part of the study, previous performed and evidence based research is analyzed to get an insight about testing and physiological profiles within Lacrosse. Several 'evidence based articles/studies' are used to get a better understanding about the different capacities that are needed to be an 'elite Lacrosse player'. Results that are used were searched on online databases. Several articles needed to be requested at 'GIH's Bibliotek' because of the 'age' of the articles. In general there were little articles about Lacrosse and player testing within the sport of Lacrosse, which contributed to this study. Most of the articles that are used are quite dated (1980, 1982 and 1986).

2. Background

It is well known that physiological testing in sports is a common way of testing and measuring individual performance and physical 'skills' of athletes. Although the testing is very common in most sports, there are very little test results about Lacrosse. The sport of Lacrosse is growing world wide, but there are still limited trainings programs written for the sport (Burger et al, 2006).

Through both laboratory and field-testing, physiological profiles are often provided to coaches and athletes so they can develop individualized and sport specific goals. With good testing and feedback, this information (physiological profile) helps players to improve their physical skills as well as decreasing the risk of getting injured (Steinhagen et al, 1998). Physiological testing is used in a lot of sports to assess the physical status of players. Unfortunately there is little research being held among Lacrosse players. The study '*Physiological Profile of College Club-Sport Lacrosse Athletes'* displays a profile about college Lacrosse players (Steinhagen et al, 1998). The results in this study indicated that Lacrosse players were above average on several 'skills'. Compared to other college athletes Lacrosse players had a higher maximal power, maximal aerobic power and maximal total work out. Next to some other physical benefits a Lacrosse player has, the anaerobic power also showed an 'above average' level (Steinhagen et al, 1998). At the top of any sport it is important for both the coaches and the players to understand the specific physiological requirements of each position in the field (Romas & Isles, 1986). The players that were tested in the studies of Jackson & Nyland (1990) and Steinhagen (1998) showed that Lacrosse players possess an above average flexibility, VO2max and strength.

3. Objective

In line with the 'objective from part 1' the 'objective from part 2' reflects to the physical tests that are used in Lacrosse. With physical testing the Dutch National team should start closing 'the gap' it still has with the world leading Lacrosse countries Canada and USA. **'Which tests are generally used within Lacrosse to measure physical skills of Lacrosse players and thereby improve the level of Lacrosse in the Netherlands?'**
By knowing which tests are useful within the sport of Lacrosse, and recording the results, the level of Dutch Lacrosse could improve within the upcoming years.

4. Method

The results that were found, and used, in this research were very little. Only a few studies that have been performed are Lacrosse related. Evidence based studies were found on 'Sport discus'. Several options were requested on this online database. Search words were; '**Lacrosse and physical'** which provided 364 hits. A more specified search was being performed by using **'Lacrosse and physical and profile'** which only resulted in 5 hits. **'Lacrosse and physical and testing'** resulted in 21 hits, as **'Lacrosse and player and profile'** resulted in 105 hits. Most of the articles that were found were older than 1990 and therefore not available in the GIH library. 5 articles were 'ordered' by the 'GIH bibliotek'. Besides the online search for information several e-mails has been sent to different Lacrosse federations. The American and Canadian Lacrosse federation were asked about testing and player profiles. The Dutch and Swedish Lacrosse Federations were asked about if they were using any tests at the moment. The Canadian Lacrosse Federation provided several tests that the national team uses to measure and test the physical aspects of the players. The coach from the Dutch National team answered several questions about testing in the DNLT. The Swedish and American Lacrosse Federations did, unfortunately, not send any information about testing in Lacrosse.

5. Results

Lacrosse players must possess a high degree of several 'skills'. Agility, speed, strength/power, flexibility, aerobic and anaerobic 'skills' are needed in this game (Steinhagen et al, 1998). The sport involves a lot of different requirements from other sports; together they are combined into Lacrosse. As said in 'part 1' requirements from basketball, football, ice hockey, field hockey and soccer can be found in Lacrosse (Walker, 1980). During a test that was performed by Steinhagen et al (1998) 30 Lacrosse players were tested, 14 from the first team and 16 from the second team. A physiological profile was made, the most relevant aspects of it are written down below.

Physiological Profile Lacrosse player 1998

	Offensive (5)	Defensive (8)	Goalie (2)	Midfield (15)
Height (cm)	178,3 cm	183,1 cm	184,7 cm	181,8 cm
Weight (kg)	75,7 kg	94,3 kg	78,8 kg	78,4kg
Body fat (%)	12,7 %	21,6 %	11,9 %	13,7%
VO2max (ml/kg)	51,8	44,6	51,0	51,2
Max power (W)	718,2	847,1	694,5	753,5
Mean power (W)	567,2	682,3	558,0	607,2
Total work output (kJ)	17,0	20,5	16,7	18,2
Max power (W/kg)	9,5	9,1	8,8	9,7
Mean power (W/kg)	7,5	7,4	7,1	7,8
Total work output (kJ/kg)	0,23	0,22	0,21	0,23

(Fig. 1 Steinhagen et al, 1998)

If this Physiological profile from Steinhagen et al (1998) is compared to the Physiological profile of Jackson & Nyland we can see a few differences. VO2max (green) was significantly bigger for midfielders in Jackson's & Nyland's (1990) research. The other outcomes of VO2max showed some differences but were quite equal to each other. If the size/height (blue) of the players is compared, results show that players in 1998 are bigger than the players in 1990 on every position in the field. The same applies for the weight (yellow) of the players that have been tested. Body fat (pink) was lower for all players in 1998. Unfortunately power cannot be compared due to the fact that no similar tests were being performed on the Lacrosse players.

Physiological Profile Lacrosse player 1990

	Offensive (6)	Defensive (4)	Goalie (1)	Midfield (11)
Height (cm)	182,6 cm	173,7 cm	182,8 cm	179,8 cm
Weight (kg)	75,0 kg	81,2 kg	69,5 kg	75,5 kg
Body fat (%)	19,9 %	23,4 %	23,0 %	19,3 %
Sit ups (per min.)	43,8	30,5	39	40,9
Push ups (per min.)	36,3	37,5	52	39,5
VO2max (ml/min/kg)	47,7	48,3	49	57,5

(Fig. 2 Jackson & Nyland 1990)

5.1 Aerobe capacity

Within the game of Lacrosse outcomes vary about if Lacrosse is an aerobic or an anaerobic game. For goalies, offensive- and defensive players the game relies more on the aerobic capacity as for the midfield players the anaerobic capacity dominates (shifts of 90 to 120 seconds).

In the study of Steinhagen et al (1998) the aerobic capacity was measured on a treadmill. The Lacrosse players breathed through a mask while they were running on the treadmill. The test was stopped when the Lacrosse player could no longer keep pace with the treadmill; the maximal time was recorded (Steinhagen et al, 1998).

The test showed that defensive Lacrosse players had lower aerobic capacity then midfield- and offensive players. Besides that, the players from the first team had a higher VO2max. In the 'Physiological profile' (see fig. 1) is visible that the average VO2max is 49,5 ml/kg. This shows that Lacrosse players had an above average aerobic power (Steinhagen et al, 1998). If these outcomes are compared to the Physiological profile (see fig. 2) of Jackson & Nyland (1990) little differences do occur. On average midfield players seem to have the highest VO2max in both studies. Compared to other athletes Lacrosse players have an above average of VO2max.

Midfield players cover a large percentage of their total distance by jogging, running and sprinting (70%) compared to 43% of the offensive players (Romas & Isles, 1986). Offensive players rely therefore more on their aerobe capacity. Training and testing on the 3500 meter run can be helpful for Lacrosse players in average. It increases the players 'cardiovascular endurance' and it stimulates players to constantly jog instead of walking during a game (Romas & Isles, 1986).

On average midfield players are the fittest players among Lacrosse athletes if it comes to VO2max and aerobe capacity (Jackson & Nyland, 1990).

5.2 Anaerobe capacity

The anaerobic capacity dominates only for the midfield players. The period on the field ranged between 1.53 and 1.58 minutes (Romas & Isles, 1986). If this result is compared to the Dutch National Lacrosse Team there is a similarity. A 'shift' in the DNLT, for midfield players, lasts 90 to 120 seconds (Travis Taylor, Coach Dutch National Lacrosse Team).

By using the 'Wingate test' the anaerobe capacity is measured and tested by several Lacrosse teams. The Lacrosse players had to fulfill a '30 seconds all out' maximal effort on a cycle ergometer. The resistance for each player was different and was set according to the players' weight (Steinhagen, 1998).

The anaerobic capacity was the highest by the defensive players, followed by the midfield- and the offensive players. Lacrosse always has been characterized as an anaerobic sport supported by aerobic components (Steinhagen et al, 1998).

5.3 Strength/Power/Speed

In the research of Jackson & Nyland (1990) the power/strength was tested by timing sit ups and push ups. Both performed on the maximum repetitions in one minute (Jackson & Nyland, 1990). Midfield players showed to be the fittest athletes on the field. Strength testing in Lacrosse can be performed on the quadriceps and the hamstrings when testing the lower extremities. Strength testing in the upper body can be performed and measured by doing push ups and sit ups on the maximal output within 60 seconds (Jackson & Nyland, 1990).

Strength testing showed some variability among Lacrosse players. By performing push ups and sit ups, defensive players seem to be the 'weakest' players with the highest percentage of body fat (Jackson & Nyland, 1990).

The research of Romas & Isles (1986) shows that offensive players are the most active players on a 10 to 20 meter sprint. Sprints of approximately 50 meters were most performed by midfield players (Romas & Isles, 1986).

5.4 Agility

In the study; *'Club Lacrosse: A physiological and injury profile'* of Jackson and Nyland (1990) the authors refer to a 'flexibility/agility test'. Lacrosse players were tested on a scale from 1 (bad flexibility) to 5 (extreme good flexibility).

The flexibility testing showed that all players were quite equal on this test. Only the defensive players showed less flexibility in several muscles (quadriceps, hamstring and gastrocsoleus) than their teammates that play in the midfield or offensive areas. If Lacrosse is compared to other sports players show an average flexibility (Jackson & Nyland, 1990).

5.5 Technique/coordination

Testing technique is not that difficult. It is a very large section in Lacrosse. For example shooting is an easy section that can be easily tested. Simply having a player on the run and shooting at designated areas and record how many times the Lacrosse player hits the target (Travis Taylor, Coach Dutch National Lacrosse Team, 2010).

For testing and training 'game related movements' a Lacrosse player has to carry his 'crosse' during most of the training/technique tests. A coach/tester can add variety to several tests to improve 'stick skills' and thereby the technique and coordination of the players. (Romas & Isles, 1986)

6. Discussion

The search for evidence-based studies, about physiological profiles and demands in Lacrosse, showed to be a difficult command. As Burger (2006) in '*Strength and Conditioning journal'* wrote in his article about Lacrosse (*a Preseason Resistance Training Program for Men's Lacrosse*): 'there has been a lack of specific training programs for the sport'. Romas and Isles (1986) confirm this point of view by writing in their study about Lacrosse (*A game analysis of the physiological requirements of attack and midfield state league Lacrosse players*) that: 'no research has been conducted on the movements of Lacrosse players. Lacrosse coaches have tended to use results from other game analysis, which they see to be similar of their game'. A game analysis which analysis the physiological demands of Lacrosse players provides valuable information for a coach (Romas & Isles, 1986). Known is

that physiological testing is typically used to assess physical status of athletes in numerous sports, no research has been published that addresses to the physiological profile of Lacrosse players (Steinhagen et al, 1998 in *'Physiological profile of college club-sport Lacrosse athletes*'). Burger et al (2006) confirm these theories about testing in Lacrosse in the article: *'A preseason resistance training program for men's Lacrosse'*. 'Despite the popularity and growth of Lacrosse, training and testing programs are still limited' (Burger et al, 2006).

Other points of discussion in this research are the evidence-based articles that are used. Two of them are from the 1980's and two are from the 1990's. For a reliable research recent data and information is needed. Even though Lacrosse is growing there still is a 'lack' on evidence-based research about this sport.

Aerobe

Opinions within Lacrosse are divided when it comes to aerobe or anaerobe capacity. Most of the articles show that midfield players use most of the time the anaerobe capacity while they stay on the field for a relative short period (90 to 120 seconds). Offensive- and defensive players stay in the field most of the time from a Lacrosse game. During the game they jog or walk almost constantly which indicates a higher percentage of using the aerobe capacity. Generally a Lacrosse player must possess an above average VO2max (Jackson & Nyland, 1990). If the results from both the physiological profiles (Jackson & Nyland 1990 and Steinhagen 1998) are compared, it shows that the average VO2max of Lacrosse players lays around 52 ml/min/kg. Nowadays an average sportsmen needs to possess a VO2max of approximately 60 to 65 ml/min/kg. Lacrosse players seem to be one of the fittest athletes (Jackson & Nyland, 1990).

Anaerobe

If the anaerobe capacity is compared to the aerobe capacity a conclusion can be drawn out of the articles. The midfield Lacrosse player relies, on average, on the anaerobe capacity. Two studies proved[5] this as well as the coach from the DNLT (Travis Taylor, 2010). When a closer look is being taken to the game of Lacrosse a lot of 'short movements' are made by al players (checking, chasing players, sprinting). This indicates that all Lacrosse players should possess a high anaerobe capacity **besides** a high aerobe capacity.

[5] Jackson & Nyland (1990) and Steinhagen (1998)

Strength/Power/Speed

Speed is a key factor for all Lacrosse players, it is more important than strength. A quick player who is on full speed can easily pass a big and strong Lacrosse player. Therefore quickness testing and training should get a higher grade of intention. As Dr. J. Fleck (guest lecture at GIH) said; '*strength/power and big muscles do not mean you are the best player in your sport'.* Little information was collected from the researched studies. No data about speed was available. Strength or power testing is used in Lacrosse but is not recorded by the DNLT (Travis Taylor, 2010).

Agility

Agility is very useful in Lacrosse, avoiding checks from opponent players and switching into other directions without losing control of the ball (Steinhagen, 1998) are needed to be a elite Lacrosse player. Agility testing in the Netherlands need to become more precise then the testing is at this moment. Testing of agility at the DNLT is being performed by shooting to designated area's (Travis Taylor, 2010).

Technique/coordination

This 'capacity' may be one of the most important capacities a Lacrosse player must possess. Without a proper technique all other capacities are 'fading away'. The stick handling must be close to perfect by catching and throwing a ball. A good Lacrosse player needs to be 'two handed'. Tests should be performed on both hands. The Illinois Agility Test can be performed with a 'crosse' as well. The DNLT should measure time in this test and recorded the data.

To improve the level of Lacrosse in the Netherlands, the Dutch National Team has to start performing tests within the several 'different capacities'. By saving data and comparing results in future tests the 'gap' between leading countries USA and Canada can be decreased.

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Appendix 1: Literature search

Objective and question of issue

'Which tests are generally used within Lacrosse to measure physical skills of Lacrosse players and thereby improve the level of Lacrosse in the Netherlands?'

Which 'search words' did you use?

'Lacrosse and physical' (364 hits)
'Lacrosse and physical and profile' (5 hits)
'Lacrosse and physical and testing' (21 hits)
'Lacrosse and player and profile' (105 hits)

Where have you been searching?

PubMed
SportDiscus
GoogleScholar
GIHBibliotek

Studies that showed relevance

Body *composition, endurance capacity and strength of college lacrosse players.* Sports Med Phys Fitness 1999
A game *analysis of the physiological requirements of attack and midfield state league Lacrosse players.* Sports Coach, Australia
Club Lacrosse*: A physiological and injury profile.* Departments of Rehabilitation Medicine and Sports Medicine
A preseason *Resistance training program for men's Lacrosse*. Strength and Conditioning Journal
Lacrosse. *A history of the game*. The Johns Hopkins University Press

Comments

There were very little evidence-based articles found in the online database that were of any relevance. This study therefore relies on several ' out aged' studies.

Appendix 2: *Illinois Agility test (technique/agility)*

The Illinois Agility test (IAT) is a test that improves the agility and speed/quickness in the lower part of the body (feet and legs). Agility and quickness are key factors in Lacrosse. Agility measures the ability of a Lacrosse player to move in to different directions within the horizontal plane. Besides this the IAT trains a Lacrosse player to quickly change direction, visual processing, timing, reaction time, perception and anticipation. The IAT is a measure of speed, agility and the ability to change directions without losing the balance. This routine can be performed with using the crosse so 'technique' can be measured/tested as well. With increasing the agility a Lacrosse player provide him more opportunities over untrained Lacrosse players. This test should be performed at the end or at the beginning of a regular Lacrosse practice. When this test is being performed in combination with other tests, the trainer/tester has to make sure there is enough 'recovery/resting' time between the tests.

How to start the Illinois Agility test

Supplies for the test	Stopwatch, cones, measuring tape (for the lines), a non slippery surface
Important considerations	The players should be well warmed-up Make sure that the player make the right path through the 'test'
Critical points	The player must run around all cones in the right order for a good test outcome The trainer/tester must make sure that all the cones are on the right place

Setup

- Setup a square of 5x10 meters
- Mark a 'start line' 1m from the first cone. Mark a 'finish line' 1m from the last cone
- Start and finish are 5m away from each other
- Place 4 cones down the middle of the field, with 3,3m between each cone

Test implementation

Make sure that all the players know how to perform the routine of the test. The player should lie down on his stomach with his arms above his head. On the 'go' command, the stopwatch start recording the time and the player needs to get up as quick as possible using his arms to do a 'push up'. Make sure the player makes the 'right path' through the cones without knocking them down. The trainer/tester needs to record the time. Timing lights can be used for more precise data.

Appendix 3: *Sprint, 40 meters (anaerobe)*

Acceleration and speed are very important in the game of Lacrosse. When a player is faster than his opponent he may outrun him and at the same time provide himself more time to consider a next move. It is important for a Lacrosse player to make sure his 'stick skills' (technique) do not suffer when he is improving his speed during the game. The 40 meters sprint test examines two measurements of speed. One is the ability to accelerate from a 'static position' in to full speed. Two is the ability to reach and maintain a linear speed. The choice for a 40 meters sprint is typical for Lacrosse while this is the optimal distance within the different zones of the Lacrosse field.

This test should be performed in the 'pre season' and at the end of each training program. When the 40 meters sprint test is being performed in combination with other tests make sure the player has enough recovering/resting time.

How to start the 40 meters sprint test

Supplies for the test	Timing lights, measuring tape, cones, stopwatch, a non slippery surface
Important considerations	The players who will perform the test must be well warmed-up When performing this test indoor make sure there is enough space after the finish line to provide a 'slow down area'
Critical points	The player should sprint through a final set of timing lights Start 'low' with quick steps, then 'stride out' Use arms to maintain linear momentum

Setup

- Mark a timing line for the first timing light (0m), a second timing light after 5m and a third timing light at 40m. Use the tape or cones to indicate the 'points of measurement'
- Mark a starting line 30cm back from the first timing light
- The timing light should be set on about 30 to 50cm from the floor
- Make sure the after the last timing light is enough space to 'slow down the momentum'

Test implementation

The player can start whenever he feels he is ready for the test and stand with one foot close to the starting line. The player sprints as fast as possible to the finish line, he has to make sure he does not slow down before passing the final timing light. The time should be measured by the nearest 0,01sec. The player can do the test again after a minimal recovering/resting period of 90 seconds. If a player wants to he can get the results after each performed test.

Appendix 4: *Core test (strength/power)*

The 'core test' is being used to measure the strength and stability of a Lacrosse player. These skills are important during a Lacrosse game. Strength and stability provide a Lacrosse player a 'steady basis' while opponents 'body check' in to the player. An increased strength and stability makes it easier for a Lacrosse player to maintain the right technique during the game, and it's physical aspects of it. Agility and speed can also be affected if the core strength and stability is weak. This test also provides a view in the development/growth of the 'abdominal' and the lower back muscles.

This test can be performed at the beginning or at the end of each practice. Make sure the player has enough recovering/resting time before this test is being performed.

How to start the Core test

Supplies for the test	A flat surface, a stopwatch
Important considerations	The player should be well warmed-up Young players should not do this test Make sure the different position is being performed well to measure the right outcome
Critical points	The player should fully stretch (hold legs and/or arms straight out) The trunk should be in a proper 'push up position'

Setup

The trainer/tester should be in a position where he can see if the 'different stages' of the test are performed correctly. 'Time' properly the 'different stages' of the test

Test implementation

- The player should start in a 'proper push up position' and hold this for 60 seconds
- Lift right arm out horizontally and hold this position for 15 seconds (1 point)
- Go back into 'push up position' and repeat this routine with the left arm, stretch out for 15 seconds (1 point)
- Go back into 'push up position' and stretch out right leg for 15 seconds (1point)
- Go back into 'push up position' and stretch out left leg for 15 seconds (1 point)
- Go back into 'push up position' and stretch out left arm and right leg for 15 seconds (2 points)
- Go back into 'push up position' and stretch out right arm and left leg for 15 seconds (2 points)
- Go back into 'push up position' and hold this position for 30 seconds (2 points)
- Record the points that the player has gained by performing the 'different stages' correctly (maximum of 10 points)

Appendix 5: *The 300 meters shuttle run test (aerobe)*

Aerobic fitness is an important skill in Lacrosse and many other sports. A high aerobic endurance is a base for high intensity sports as Lacrosse. The aerobic endurance is important for all Lacrosse players. The defensive and offensive players stay in the field for the whole game, while midfield players substitute al lot. The midfield players need to run up and down the field on the top of their ability, a midfield player usually stays in the field for a shorter period (2 to 5 minutes).

The 300 meters shuttle run test is used in Lacrosse to monitor fatigue and overtraining and is an assist in periodization and long-term players development.

How to start the 300 meters shuttle run test

Supplies for the test	A stopwatch, cones, masking tape, long measuring tape
Important considerations	Performing this test indoor use a non slippery floor for decreasing 'slipping' This test, tests the maximal VO2max so 100% effort is required from the player Make sure the player have not eaten a large meal for 2 hours prior to the test
Critical points	Pivot at turning points, do not make wide corners The player should try to run on a steady pace The player must 'touch' the cones at the turning point Recovery time is at least 3 minutes of active rest (walking)

Setup

- Setup a 'start line' by the first cone
- Setup a 'turning point' at 25 meters from the 'starting line'

Test implementation

The player starts at the 'starting line' by the first cone. When he crosses the line the stopwatch starts counting. The player runs towards the '25m cones' and touches this 'marking point' then pivots back to the 'starting line' and touch the cone there. The player repeats this routine for 12 times.

Appendix 6: *3.5 Hexagonal Agility test (coordination/agility)*

As is explained in the Illinios Agility test, quickness and the ability to change direction without losing coordination is very important in Lacrosse. The Hexagonal Agility Test (HAT) measures the ability of a Lacrosse player to quickly change direction while maintaining a good balance. This test could be performed while using a 'crosse' to measure/test technique as well.

The test could be performed at the beginning or ending of each practice. When measuring more tests at one moment this test should be performed at the beginning of all tests.

How to start the Hexagonal Agility Test

Supplies for the test	A stopwatch, a 60cm sided hexagon marked on the floor, tape
Important considerations	The player should be well warmed-up The player must make sure that he does the right movements, each wrong move decreases the reliability of the test
Critical points	If the player jumps over or on top of the line the test has to be restarted

Setup

Mark a hexagonal on the floor. The player should stand in the middle of the hexagonal.

Test implementation

The player stands in the middle of the hexagonal facing line A. Throughout the whole test the player should face this line. On the command 'GO' the players jumps over line B. with both feet, then back to the middle of the hexagonal. After this the same routine with line C., and so on. The test is completed when the player has jumped twice over each line. Time can be recorded to measure progress. This test can be performed with giving commands about which line the player should 'jump over'.