Difference in estimated VO2max between the 30-15 intermittent fitness-test and 20-meter shuttle test in amateur floorball-players.

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Difference in estimated VO$_{2\text{max}}$ between the 30-15 intermittent fitness-test and 20-meter shuttle test in amateur floorball-players.

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Abstract

**Background:** Floorball is a sport where not a lot of research have been done, it is a young sport and up until now it has only been played in Europe. The sport is in present days growing rapidly in popularity and is expanding worldwide. Because of the lack of research coaches have little knowledge regarding VO$_{2\text{max}}$ testing within the sport.

**Aim:** The aim of the study was to compare results of both a 30-15 intermittent fitness test (IFT) and a 20-meter shuttle test (beep test) and see if there is a difference between estimated VO$_{2\text{max}}$ for athletes playing floorball. The hypothesis was that because the 30-15IFT mimics the movement pattern of floorball more than the beep test does, athletes playing this sport should score a higher result in the 30-15IFT.

**Methods:** The study was done on fifteen sub-elite floorball players (8 male and 7 female) aged 20.6 years ± SD 3.5. The test persons performed two aerobic fitness tests, Beep test and 30-15IFT. The beep test consists of a number of 20 meter shuttle runs with increased speeds every minute and the 30-15IFT consists of 30 seconds of running followed by 15 seconds of rest with increased running speed every 45 seconds. A paired sample t-test was used to compare the estimated VO$_{2\text{max}}$ results of both tests.

**Results:** Results show that 66% test persons scored a higher result in the 30-15IFT compared to the beep test. However, there was no statistical difference between the two tests. The players scored a mean value of 48.3 ml/kg/min ± 3.8 during the 30-15IFT and 45.4 ml/kg/min during the beep test ± 5.9, p=0.06

**Conclusion:** The 30-15IFT is equally as good as the beep test at estimating VO$_{2\text{max}}$ in floorball players. A factor that might have affected the results was that the formula for calculating VO$_{2\text{max}}$ in the beep test does not take age and weight into consideration while the formula for the 30-15IFT does. In the future, work should be done at “constructing” a new formula for the beep test.
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Introduction

Floorball is a relatively young sport in which not a lot of research have been done, many floorball coaches want to evaluate the aerobic fitness of their players but many times they choose a test not because it’s the best, but because it’s common and well-used in other sports. Because of the lack of research within the sport coaches have little knowledge about what they should look for in an aerobic fitness test for floorball players. They don’t consider the movement pattern of the sport, they simply choose a test that they know evaluates aerobic fitness. But aerobic fitness comes in different ways, there is a big difference between an elite floorball player and a long distance runner for example. The floorball player has to make repeated short sprints at maximal or near maximal velocity with a rest period in between these sprints while a long distance runner tries to maintain a velocity for a long period of time. These two types of training methods require different types of aerobic fitness and should not be tested with the same type of test. This study will compare the estimated VO$_{2\text{max}}$ results of a beep test and a 30-15 intermittent fitness test (IFT) on floorball players and see if players get a different result between the tests, these two tests both evaluates maximal oxygen uptake but are carried out differently. The beep test consist of non-stop 20-meter shuttle running and the 30-15IFT consists of 30 seconds of running followed by a 15 second rest period in between these runs. Will we see a difference in estimated VO$_{2\text{max}}$ between the two tests? This study will give floorball coaches more information about VO$_{2\text{max}}$ in floorball players.

Background

Floorball

Floorball is a relatively young team sport but is rapidly growing in popularity. It is a high paced sport that forces players to perform repeated short sprints at maximal or near maximal intensity with varied recovery time in between sprints. This type of training is called “prolonged, high-intensity, intermittent running” (PHIIR) (Sirotic & Coutts, 2007). Floorball is similar to ice hockey in many ways, it is played in three 20-minute periods and each team has six players (including the goaltender) on the court at the same time. Just like in hockey teams need to change players many times during a game because of the high pace. This is called “shift changes”, shifts usually last between 40-60 seconds and the rest period between shifts depends on how many players the team is using. Usually players rest for the same amount of time as they play, a high VO$_{2\text{max}}$ is an important factor here because it slows down
the buildup of fatigue while on the court and it helps them recover faster during the rest period between shifts (Gharbi et al., 2015). The biggest difference from ice-hockey is that floorball is played inside on a 40x20 meter rubber court, instead of a 60x30 ice rink (Tervo & Nordström, 2014). Floorball is a sport that also is similar to basketball, both sports are high paced “back and forth” sports. These two sports even have similar movement patterns. Such as rapid turns, stops and accelerations. Both sports also include many of one on one battles along the whole court (Leppänen, Pasanen, Kujala, & Parkkari, 2015). This type of movement pattern requires good agility and rapid decision making in order to successfully adjust to your teammates but also your opponents, and as described before it requires good endurance and a high VO$_{2\text{max}}$ to be able to last a full game of 60 minutes.

**VO$_{2\text{max}}$ testing methods**

There are two methods for measuring VO$_{2\text{max}}$, the direct method or the indirect method. The direct method is when you measure breathing and oxygen uptake with a special oxygen mask in a laboratory treadmill test. With the direct method you can see precise values of an athletes relative VO$_{2\text{max}}$ (ml/kg/min) (Cooper, 1968). The indirect method is when you conduct a field test outside of a laboratory, the indirect methods does not give exact values of relative VO$_{2\text{max}}$ but rather an estimation (Cooper, 1968). Therefore all indirect methods must be validated against a laboratory test before they can be used for research purposes. The beep test (also known as the 20 meter shuttle test) was created by Luc Leger in 1982 and are used worldwide and within many sports (Bitworks-engenering, 2011). The 30-15IFT was created by Martin Buchheit, a French scientist who currently operates at ASPIRE, Academy for Sports Excellence in Qatar (Buchheit, 2010). These two tests are common indirect test methods to estimate VO$_{2\text{max}}$, both tests use a formula in order to get the estimated VO$_{2\text{max}}$ values. The beep test have more ways than one to estimate VO$_{2\text{max}}$ though, Ahmaidi, Collomp, Caillaud, & Préfaut (1992) presents a formula for estimating VO$_{2\text{max}}$ in their study and Ramsbottom, Brewer, & Williams (1988) uses premade tables of VO$_{2\text{max}}$ in their study to compare their results to. Both the beep test and the 30-15IFT has been deemed as valid tests for estimating VO$_{2\text{max}}$, which means that the results of those tests are similar to the laboratory treadmill test (Buchheit, Lefebvre, Laursen & Ahmaidi, 2011). The 30-15IFT are not as well-known as the beep test, but the popularity is growing and is commonly used within sports like handball, basketball and (American) football. Both tests predict the same thing but they are carried out differently, the beep test have non-stop shuttle running between two lines separated by 20
Meters while the 30-15IFT consists of 30 seconds of 40-meter shuttle running followed by 15 seconds of rest. Studies have been made to examine the validity of both tests. Paradisis, Zacharogiannis, Mandila, Smirtiotou, Argeitaki and Cooke (2014) did their study on 48 college students (25 male, 23 female) aged 21.20 ± 1.91 years and found a large correlation between number of shuttles in a 20-meter beep test and treadmill VO\textsubscript{2max} (r=0.87, p<0.05). In another study about estimating the validity of the beep test Martinez & Coyle (2006) used 10 division 1 female soccer players. They compared results between a 20-meter beep test and a VO\textsubscript{2max} laboratory treadmill test. They found a correlation coefficient of r=0.78 (P <0.01) in VO\textsubscript{2} between the two tests which concludes that the beep test provides a reasonably valid prediction of VO\textsubscript{2max}. In his review study about the 30-15IFT Buchheit (2010) compared values of maximal VO\textsubscript{2max} reached during a 30-15IFT with values from a reference laboratory test and found a large correlation (r=0.68), in the review Buchheit also compared the results of a 30-15IFT with two valid multi stage field tests and found a large correlation between the tests (r=0.79 and r=0.80). In another study about the validity of the 30-15IFT on ice hockey players Buchheit et.al. (2011) used 17 young elite players. They found that correlations between maximal velocities and Heart rate (HR) were large (r=0.72), and also that maximal speed was largely correlated to estimated VO\textsubscript{2peak} (r=0.71). These results provide support of the validity of the 30-15IFT.

Maximal oxygen uptake
Maximal oxygen uptake (VO\textsubscript{2max}) is an important factor in PHIIR type team sports, a high VO\textsubscript{2max} helps athletes recover faster between sprints and also increases their resistance to fatigue during PHIIR training (Gharbi, Dardouri, Haj-Sassi, Chamari & Souissi, 2015). To understand VO\textsubscript{2max} you need to understand the whole chain of event that happens within the body from the moment to take a breath until the oxygen reaches the muscles. In their book, McArdle, Katch & Katch (2015) describe VO\textsubscript{2max} from a physiological point of view. The authors states that attaining a high VO\textsubscript{2max} is important for athletes when it comes to sustaining the energy metabolism in exercise and that it is a measurement of a person’s capacity for aerobic ATP resynthesis. According to McArdle, Katch & Katch (2015) VO\textsubscript{2max} depends on the functional capacity and the co-ordination of diverse physiological systems. These physiological systems are pulmonary ventilation, hemoglobin concentration, cardiac output, peripheral blood flow and cellular metabolic capacity. Pulmonary ventilation involve everything about the breathing mechanism, from when you take a breath until the oxygen
reaches the bloodstream via the alveoli in the lungs. To increase VO2max with pulmonary ventilation athletes need to increase their minute volume (liters of oxygen per minute) somehow. Athletes can’t train in order to increase the number of alveoli, they need to increase either their breathing frequency or their tidal volume (Liters of oxygen per breath). The only way an athlete can increase his tidal volume is to strengthen the respiratory muscles, this will not increase the athlete’s lung volume. But stronger respiratory muscles are able to force more oxygen down the lungs each breath (McArdle et al. 2015). **Hemoglobin concentration** is key for improving VO2max because hemoglobin is the greatest oxygen transporter in the body, 98% of all the oxygen is transported by hemoglobin. Each hemoglobin molecule can bind four oxygen molecules, in males each dl of blood contains about 15 g of hemoglobin. The value is between 5-10% less in women. Red blood cells produce a compound called 2,3-diphosphoglycerate (2,3-DPG), this compound binds loosely to a hemoglobin molecule and reduces the affinity for oxygen. By doing so the hemoglobin molecules ability to release oxygen to other tissues increases, for athletes this means that more oxygen will be released to the muscles. 2,3-DPG production is increased by physical activity and it’s also shown that people that live on a high altitude have higher levels of red blood cell 2,3-DPG (McArdle et al. 2015). Some people argue that it’s not solely the hemoglobin concentration that improves your VO2max, in a study on 34 elite (17male, 17 female) field hockey players made by Hinrichs, Franke, Voss, Bloch & Schänzer (2010) they found a correlation between the total hemoglobin mass and VO2max in both male (r=0.57) and female (r=0.56).

**Cardiac output** is the amount of blood pumped by the heart in one minute. Two factors influence cardiac output, heart rate (HR) and stroke volume (SV). HR is the frequency of the hearts strokes and SV is how many ml of blood the heart pumps each stroke, maximal cardiac output is the maximal HR times the maximal SV (McArdle et al. 2015). HR is a factor that an athlete can’t provoke in order to attain a higher cardiac output, but SV can be improved by endurance training. In a study done by (Wilmore et al., 2001) they tested the effect of a 20-week endurance training program on 630 healthy adults. When the participants where tested at 60% of their VO2max, test leaders found a significant decreases in HR and significant increases in SV and cardiac output for all subgroups in the study. **Peripheral blood flow** is the blood flow that circulates away from the chest and abdomen area and out to our limbs (arms and legs), this blood flow supplies our muscles with oxygen. During rest the hearts cardiac output is about 5 l per minute, only 20% (1 l) of this output is for the muscles, the remaining 4 l is divided between the body’s organs. During physical activity the hearts cardiac output increases to about 25 l per minute and the majority of the output increase is
diverted to the peripheral system, to the muscles. About 85% (21 l) is diverted to the muscles during strenuous activity and the remaining 15% (4 l) is divided between the body’s organs (McArdle et al. 2015). **Cellular metabolic capacity** describes one of the main functions of the muscle cell, the ability to produce adenosine triphosphate (ATP). ATP is the “energy currency” of living organisms and muscles use it as fuel in every task they perform. (Bishop, Granata, & Eynon, 2014). The production of ATP takes place inside the mitochondria in two advanced biochemical processes named “citric acid cycle” and the “electron transport chain” (McArdle et al. 2015). Physical activity stimulates mitochondrial biogenesis, which means the formation of new mitochondria or the remodeling of the mitochondrial network to generate more mitochondrial components. Physical activity also increases the mitochondrial functions and content, which means that athletes can improve their ATP production with physical activity (Bishop, Granata, & Eynon, 2014).

This study will examine the difference in estimated VO\(_{2}\)max between the two field tests, 30-15IFT and the beep test. Two tests that both evaluate aerobic fitness but are carried out differently, the beep test shows characteristics of a long distance endurance sport and the 30-15IFT show characteristics of the intermittent nature of sports like floorball or basketball.

**Aim**

The aim of the study was to compare results of both a 30-15IFT and a 20-meter shuttle test (beep test) and see if there was a difference between estimated VO\(_{2}\)max for athletes playing floorball

**Hypothesis**

Because the 30-15IFT mimics the movement pattern of floorball more than the beep test does, athletes playing floorball should score a higher result in that test.
Method

Subjects
Fifteen sub-elite floorball players participated in the study, 8 male and 7 female. They were all recruited from a local floorball club in Laholm. Anthropometric data about the subjects was collected in order to work out the VO$_{2\text{max}}$ formulas for each test. The anthropometric data shows that subjects had a mean age of 20.6 years ± 3.5 years, their height were 178.2 cm ± 6.2 cm and their weight were 75.8 kg ± 11.9 kg. The tests were conducted late in the player’s season and the inclusion criteria were that all players had been active within the sport of floorball at least two times a week for a minimum of 1 hour per session during the whole season. Exclusion criteria’s for the study was that players could not participate if they were sick or injured in a way that impeded their ability to run. Subjects were divided into two groups and each group had two separate testing days divided by one week, this was done to simplify the data collection for the lone test leader.

Data collection and testing procedures
Before each test the subjects preformed a 5-minute monitored warmup similar to regular floorball warmup. Subjects ran 10 laps on the court (ca 800 meters) in a low pace and performed different exercises while they were running. These exercises consisted of backwards running, vertical jumps, elevated knee running, side-jumps, “zigzag” running and on the last lap subjects performed two 20-meter sprints. The warmup was performed in the same way every time in order to make sure the results wasn’t affected by differences in warmup.

The 30-15IFT required a 40-meter long test area, marker cones, a laptop and audio speakers for the interval announcements. The laptop and speakers were used to play the 30-15IFT interval audio file received by Martin Buchheit. (M. Buchheit, email, 3 February 2016). The cones were placed 3 meters from the “end lines” which were the 0 and 40 meter lines. And also 3 meters from both sides of the middle line, these cones form a 6-meter “safe zone” (see figure 1).The subjects started behind line A, they ran for 30 seconds and then walked/rested for 15 seconds. They started running when they heard the first beep from the interval announcement, the subjects tried to keep a pace that would put them in the 20-meter “safe zone” (line B) by the time they heard the second beep and in the 40-meter “safe zone” (line C) when they heard the third beep. They continued to run in this pace until they heard a double
beep from the interval announcement, which indicated that this running stage was over. When they heard the double beep the subjects stopped running and started to slowly walk forward to the closest line and waited for the next stage of running, this walking/resting period lasted for 15 seconds. The starting velocity was 8.0 km/h and it increased by 0.5 after each 45 second period. The subjects continued to run for as long as they could but when they failed to reach the “safe zone” before two beeps in a row the test was over for them. After the data was collected the test leader used the following equation by Bucheit (2010) to estimate the relative VO$_{2 \text{max}}$ (ml/kg/min) for each subject:

$$28.3 - (2.15 \times G) - (0.741 \times A) - (0.0357 \times W) + (0.0586 \times A \times VIFT) + (1.03 \times VIFT)$$  \hspace{1cm} (1)

Where $G$ stands for gender (female = 2 ; male = 1), $A$ for age, and $W$ for weight and $VIFT$ for the maximum velocity the subject reached during the 30-15IFT.

The beep test required a 20-meter long test area, marker cones, a laptop and audio speakers for interval announcements. The laptop was used to access the “team beep test” software, which is free to download on the “topend sports” webpage (Topend sports, 2011). The software announced the beep test intervals automatically and the laptop was connected to
speakers in order to amplify the sound from the software. The test leader placed the cones at the “end lines” which are the 0 and 20-meter lines. (Line A and B, see figure 2) The beep test consisted of different stages, each stage lasted about one minute and within each stage there were a number of 20-meter runs. Subjects started to run when they heard the first “beep” announcement from the test software. They had to make it all the way to the next line before they heard a second beep, once they heard the beep they turned and ran back to the first line again. The subjects continued to run in the same pace until they heard a “double beep” which indicated that the first stage was over. After the double beep they had to speed up because after each stage the velocity was increased by 0.5 km/h, the first stage started at 8 km/h. The subjects tried to run as far as possible but when they failed to reach the line before the beep two times in a row the test was over for them. The test leader then used the following equation from Ahmaidi et al (1992) to calculate relative VO$_2$max (ml/kg/min) for each subject:

$$\text{VO}_2\text{max} = 31.025 + 3.238 \times \text{Speed} - 3.248 \times \text{Age} + 0.1536 \times \text{Speed} \times \text{Age}.$$  \hfill (2)

![Figure 2 - Test area for the beep test](image)

**Ethical and social considerations**

In Sweden we have a law about human rights within studies that have experiments on humans, the law is called “law 2003:460 about ethical testing on science regarding tests on humans” and can be applied to research that involve sensitive personal information. The law
states that the research only can be conducted if it can be done with respect for the human value and that human rights are considered within the studies ethical considerations. The law states that the wellbeing of the subjects must be more prioritized than the study results, therefore a subject can choose to quit the study any time they want. (Vetenskapsrådet, 2016).

With this law in consideration all subjects who participated in the study was informed about risks involving the participation of the tests, what was being tested and how the test would be carried out and also a short background about both tests and the aim of the study. All subjects had to sign a written letter of consent before they could participate during the tests, any subjects under the age of 18 needed to get their consent letter signed by a parent or guardian as well before they could participate in the tests. The subjects were informed that they were free to drop out of the study at any time they wanted. If anyone dropped out the test leader did not question why or try to pressure them into staying. All information about the subjects was strictly confidential and only the test leader had access to it while the study was undergoing. The method for collecting, storing and reporting the information made it impossible for anyone except the test leader to link the information to a specific person. The information gathered will not be used for anything except research purposes within this study, and cannot be used again in another study (Vetenskapsrådet, 2009). This study might be interesting for more sports than floorball. As previously described, handball and basketball are also PHIIR type sports with similar movement patterns. This study could help coaches within these sports, from youth-coaches to elite-coaches, to get a better understanding about why \( \text{VO}^{2\text{max}} \) is important within their sport and how to test it.

**Statistical analyses**

Data from each subject was collected manually and later inserted to SPSS (IBM SPSS version 20, Chicago, IL, USA). A Shapiro - Wilk’s test was done in SPSS to see if the results were normally distributed. The results from the Shapiro – Wilk’s test showed that the \( \text{VO}^{2\text{IFT}} \) results was clearly normalized (\( p=0.71 \)) and the \( \text{VO}^{2\text{Beep}} \) had a positive skewness but was still deemed normal (\( p=0.06 \)). Because the data was normally distributed the parametric statistics test “paired sample t-test” was used in SPSS to compare the results of the two tests. The significance level was set to 0.05 and all results above this would be deemed as not statistically significant.
Results

Results show that 66% (10 out of 15) test persons scored a higher result in the 30-15IFT than in the beep test (see Figure 3). The players got a mean value of 48.3 ml/kg/min ± 3.8 during the 30-15IFT and 45.4 ml/kg/min during the beep test ± 5.9 (see Table 1). There was no statistical difference between the two tests, the significance level of the results was 0.06 and was above the significance interval of this study.

![Figure 3. Compares the results of both tests for each test person.](image)

Table 1. Compares means of all test persons and shows the p-value of the results

<table>
<thead>
<tr>
<th>VO_{2\max} results</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO_{2\text{Beep}} (ml/kg/min)</td>
<td>45.4</td>
<td>± 5.9</td>
<td>0.06</td>
</tr>
<tr>
<td>VO_{2\text{IFT}} (ml/kg/min)</td>
<td>48.3</td>
<td>± 3.8</td>
<td>0.06</td>
</tr>
</tbody>
</table>
Discussion

Results
There was no statistical difference between the two tests, this indicates that the 30-15IFT is equally as good as the beep test at estimating VO_{2\text{max}} in floorball players. No statistical difference was found between the two tests but the results show that 66% of the players scored a higher result in the 30-15IFT which indicate that the results might depend on a type II error. After both tests was completed the players was asked about what they thought about the tests, the majority of the players said that the 30-15IFT was more fun and that they found it easier to motivate themselves into running a little bit further in that test. These player statements might suggests that motivation was higher during the 30-15IFT than during the beep test, which might have been a contributing factor to that 66% of the players scored a higher result in that test. This could be interesting for coaches to know when they evaluate which test they should use for measuring aerobic fitness in their players.

The beep test show characteristic movement patterns of long distance running since the players don’t get any pauses from running, the main differences from long distance running is that they change direction every 20 meters and increase their speed every minute. The 30-15IFT consist of 30 seconds of running and 15 seconds of rest between these runs with a 0.5 km/h speed increase every 45 seconds, this tests share characteristics with the intermittent nature of floorball. In floorball, a players shift usually last for 30 seconds with a rest period of 30 seconds between the shifts. The rest period is based on how many players the team is using but usually a player rest the same amount of time as he or she plays. When you compare the testing procedures of the both tests it is show that the 30-15IFT have more shared characteristics with floorball then the beep test does. Because of these shared characteristics, the players might have been able to push themselves over the lactate threshold during the 30-15IFT. Because that is what they usually do during a game, and when you push yourself over the lactate threshold you are literally performing above your VO_{2\text{max}}. If that is the case then the 30-15IFT measures the player’s endurance more than the actual VO_{2\text{max}}. To safely determine which test is better at estimating VO_{2\text{max}} in floorball players a laboratory treadmill test must be conducted in order to get exact reference values for each player. Another VO_{2\text{max}} field test is the Yo-Yo intermittent recovery test, Castagna et.al. (2008) had the aim of evaluating the validity of this test for basketball players. They had seen that the standard test for assessing VO_{2\text{max}} in basketball players was the beep test and they hypothesized (just like in this study) that because of the intermittent nature basketball, an intermittent fitness test
might be more sport specific. In their study they found a large correlation between Yo-Yo performance and VO$_{2\text{max}}$ from a laboratory treadmill test which indicates that the Yo-Yo intermittent recovery test is a valid test for assessing VO$_{2\text{max}}$ in basketball players. Based on these results and the similarities between floorball and basketball it might be interesting to investigate the validity of this test on floorball players as well.

**Method**

All four test days was carried out without any major problems, the fact that the test persons were split into two groups made it easy for the test leader to manage the test and write down the results even though he was alone. Also, by connecting the laptop to audio speakers the test leader was able to shift his full attention to the subjects, to make sure they reached the supposed lines before the announced “beep”.

The significance interval of the study was set to 0.05 and the p-value of the results was 0.06 which indicates that the results are not statistically significant for this study. But a p-value of 0.06 indicates that there was a difference between the tests, just not big enough for this study. One can argue that the lack of test persons was a contributing factor to the results not being statistically significant. Possibly with twice as many test persons the p-value would be below 0.05. Another thing that can be discussed is the significance interval, levels of 0.05 are commonly used in studies but that level is not a “golden rule” and it can be changed. In their book about research methods in sports Thomas, Nelson & Silverman (2015) states that the significance interval can be increased if it is important to the study to show that there is a difference between two training methods or two tests, but by increasing the significance interval you also increase the risk of making a type II error. With this in mind perhaps the significance interval of this study was too low, a small increase of 0.02 would have made the results statistically significant and the risk of making a type II error would only increase by 2 in 100.

A factor that may have affected the results of the study is that the formulas for calculating VO$_{2\text{max}}$ are very different between the two tests. The formula for the 30-15IFT was published by Buchheit (2010) (see Formula 1). This formula takes age, gender, weight and speed into consideration while the formula used to calculate VO$_{2\text{max}}$ for the beep test (see Formula 2) was published by Ahmaidi et.al. (1992) and it does not take weight or gender into effect and it emphasizes a lot on age. This study revealed an interesting fact, the young players got good
scores simply because the formula emphasizes on age so much and old players had to run a greater number of shuttles than the younger players to get similar results as them. Also the fact that the formula does not take weight into consideration is strange since the formula is supposed to calculate relative $V_O^{2max}$, and relative $V_O^{2max}$ means “ml of oxygen per kg bodyweight per minute”. There is however another way of calculating $V_O^{2max}$ for the beep, the method is published by Ramsbottom, Brewer, & Williams (1988). With their method you simply compare your results to the tables of “average values” in their study, this is also a common method because it’s faster than using the formula to calculate the values. However this method for calculating $V_O^{2max}$ does not take age or weight into consideration either, and the reason that I chose the Ahmaid et.al formula instead of the Ramsbottom et.al method is because the formula is more similar to the method I used for calculating $V_O^{2max}$ in the 30-15IFT.

Another factor that might have affected the results is that the floor where the tests was conducted was fairly slippery. It is possible that players suffered fatigue buildup faster during the beep test than the 30-15IFT because the number of turns are twice as many in the beep test and turning on slippery floors causes even more fatigue to build up. It is possible that players might have been able to run a greater distance during the beep test if the floor had better grip, this might be true for the 30-15IFT as well but the floor probably affected the results of the beep test more than it affected the results of the 30-15IFT because of the large amount of changes in direction during the beep test. For future studies I suggest that a new formula to calculate $V_O^{2max}$ in the beep test is “constructed”, a formula that takes, age, gender and weight into effect. Because the biggest problem in this study was making a fair comparison of the results against each other because one formula was very well formulated but the other one was not. The beep test formula affected the results of the young (under 18 years old) positively and the old (above 24 years old) negatively. In the future it might be interesting to perform a similar study as this one, but only using players aged 20-22.
Conclusion

The results indicate that the majority of the players (66%) scored a higher result in the 30-15IFT compared to the beep test. However, there was no statistical difference between the two tests. The results show that the 30-15IFT is equally as good as the beep test at estimating VO$_{2\text{max}}$ in floorball players. Future research should focus on “constructing” a new VO$_{2\text{max}}$ formula for the beep test which takes age, gender and weight into effect. A study with either more test persons than I had, or a study with players only aged 20-22 should also be done in the future.
References


Appendices

Appendix 1 – Information letter for the test subjects

Information till deltagare

Hej!


Beep-test är ett vanligt syreupptagnings test som används inom många sporter i hela världen. Det går ut på att man springer fram och tillbaka på ett 20 meter långt testområde, deltagarna måste hinna fram till 20-meterslinjen innan de hör en signal. Testet består av olika nivåer, varje nivå består av ett antal 20-meters löpningar och efter varje nivå så ökar hastigheten med 0.5 km/h

30-15 testet är inte speciellt vanligt i Sverige men används flitigt i bland annat USA. Testet går ut på att man springer fram och tillbaka över ett 40-meter långt testområde i 30 sekunder för att sedan vila i 15 sekunder. Efter varje 45-sekundersperiod ökar hastigheten med 0.5 km/h.

Syftet med studien är att jämföra resultaten av dessa två tester gjorda på innebandyspelare och se ifall det är någon skillnad mellan dem.

Förfrågan om deltagande

Du tillfrågas för att du är innebandyspelare och spelar i IBK Puma. För att delta i studien krävs att du under säsongen i snitt varit aktiv inom innebandyn ( träning/match) minst två gånger i veckan under en timme per gång. Det krävs även att du är skadefri och fri sjukdom under testtillfällena. Är du under 18 år så krävs godkännande av målsman/vårdnadshavare

Tillvägagångssätt

cirka 20-30 minuter att genomföra och kommer att utföras i samma lokal som du normalt tränar innebandy i. Ditt deltagande i studien medför inga ytterligare risker utöver de risker som kan förekomma under dina vanliga träningspass.

**Frivilligt deltagande**

Du som testperson har rätt att avbryta testet när som helst utan att ange orsak. Om så önskas kommer då redan insamlad data att förstöras.

**Sekretess**


**Ansvariga**

Ansvariga för studien är:

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Samtycke till deltagande i forskningsstudie

Nedan ger du ditt samtycke att delta i den studien som jämför resultaten av två syreupptagningstester på innebandyspelare. Läs igenom informationen noga och ge ditt medgivande genom att signera ditt namn nederst på sidan.

Jag medgiver att jag:

- Har tagit del av informationen kring studien förstår vad den innebär.

- Har fått ställa de frågor jag önskar och vet vem som är ansvarig huvudman om jag har fler frågor.

- Deltar frivilligt i studien och förstår varför jag har blivit tillfrågad.

- Vet att jag när som helst kan avbryta mitt deltagande i studien utan att ange orsak.

Jag intygar att jag har läst det informerade samtycket och tagit del av informationen kring studien. Jag förstår vad deltagande i studien innebär och ställer upp frivilligt.

Ort och datum______________________________________________________

Underskrift__________________________________________________________

Namnförtydligande_____________________________________________________

Ort och datum______________________________________________________

Underskrift vårdnadshavare____________________________________________

Namnförtydligande_____________________________________________________