



Game Formats for Youth Hockey – Research by Finnish and Swedish Ice Hockey Association 2019 – 2020

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Abstract

In this study 25 different game formats were tested with five different age groups in Finland and Sweden. The age groups were U8, U10, U11, U12 and U14 boys and girls. There were two events in Finland and three events in Sweden. The aim was to see how changing the game format affected the actions of the players from $\frac{1}{8}$ of the ice to full ice games.

To collect the data, the games were recorded, and players were tagged. Tracking chips were placed inside the jerseys in both countries and a tracking puck was also used in Finland. All the games were reviewed afterwards to check that the data was correct. The events varied from one practice session to two days events (with good breaks between the ice sessions). Some of the games were the same in both countries but the data collection methods and the analyses differed.

The Game formats varied from 2-2 to 5-5 games, always playing with even strength situations. One puck was used during the games and no special situations were played (powerplay or penalty kill). One shift was about 60 seconds long. Shots and shooting attempts (SAT), passing and passing attempts (PAT), skating distance and skating velocities were recorded.

The number of players and the size of the rink influences activity and involvement in games. Reducing the number of players increases the overall technical involvement, like shooting, passing, and puck battles. 5v5 on full ice appears to be the most inefficient way if you want to optimize technical repetition in game formats. Full ice gives the players more total distance and greater chance of reaching higher speeds. Even if there are beneficial aspects of covering greater distances in full ice games, it was observed that many of the players were not involved in the plays. The players skate more but that skating tends to be more passive, without any puck touches.

According to these findings there will be some rule changes in Finland and in Sweden for the season 2020-2021. In Finland U11 and U12 leagues are played in small area and in full ice and in Sweden 6 districts will play only in small area for U11 and U12 leagues.

Introduction of the study

The purpose of the project is to study different types of game formats and to find the possible differences between the games (area of the ice and number of players). The other aspect is to study age appropriate settings to improve and optimize the learning environment for youth hockey: improving participation, joy, player development, and in the long run retain more of the youth players in the sport.

Should we use full ice or cross-ice game? How often, with which players, and when? At what point should players play full ice games? It is a hot topic within youth hockey among coaches, parents and public? Previous studies in ice hockey has shown that small area games give the player more repetition and involvement than the 5-5 full ice game.

Based on findings in other studies, in other sports, changing the number of players without changing the playing area influences the involvement and the number of skill repetitions of players. There have also been previous studies of small games in the sport of ice hockey as well: for example, a study by USA hockey together with NHL and by Charles University at Prague. These two studies concluded that small area games are more beneficial for U10 players than 5-5 full ice game.

The Finnish and Swedish Ice Hockey Associations decided to study these topics together due to similar ongoing projects. The associations decided to cooperate in planning and executing this Small-Area game project together. The Swedish Ice Hockey Association (SIHA) launched their Game Formats plan and The Finnish Ice Hockey Association (FIHA) launched their Better Play projects.

The International Ice Hockey Federation (IIHF) has supported different projects from Growing the Game Fund. This fund was founded by the IIHF together with their marketing partner Infront Sports & Media. The first projects began receiving support from this fund beginning in 2017. FIHA and SIHA made an application to this fund in 2018 and it was accepted. Therefore, while the ownership on the operations of this study belongs together FIHA and SIHA, the IIHF can be seen as a partner and will use the results for development by disseminating the information globally. As such, hopefully this study will help grow the game and assist other National Associations in developing their own domestic programs.

Games format project: Swedish Ice Hockey Association

In the last couple of years many other sports in Sweden have made great changes in how games are being played and organized. A size-reduced field or court, changes in the number of players on the field, and adapted rules were made to change the game to be more suited to the youth. Football is one example of a very conservative and big sport which has taken a big step into the future with a national game format where the games are conducted the same way in every club in Sweden.

In 2018 the Swedish Ice Hockey Association launched a game format project. A project group was assigned and has led the work in analyzing the current situation in Sweden and has set the goals in working with future game formats. This study will be one part of the work in analyzing and restructuring the formats in which games that are being played at the youth level in Sweden.

Better Play project: Finnish Ice Hockey Association

The Finnish Ice Hockey Association (FIHA) launched the Better Play project together with Rauman Lukko RY in order to find different ways for U9-U12 players to participate in ice hockey in 2018 – 2019. The time frame of the project is 2018 – 2021. The main idea is to offer optional participation days during the week. The traditional way of organizing practice days is that the club sets up the practice days and times for the families. With this project the club organizes a practice opportunity everyday Monday to Friday and the families decide themselves which days they wish to participate. The club has set up a recommendation of participation for the players that varies depending on the age group (the idea is not to participate every day).

The other aspect of the project is to use small area games (SAG) 50% of the ice times. Lukko has been using different games from $\frac{1}{8}$ to $\frac{1}{2}$ of the ice in their practices. With this study we are trying to determine if there are any possible differences in different small area game formats. If there are, are we able to determine which game would be more beneficial e.g. for shooting to improve the project in Rauma. The goal is to share all the data to the clubs and enhance the player retention in all the clubs in Finland.

1. Methods

The study includes five subtests (2 in Finland and 3 in Sweden) with 25 (12 in Sweden and 19 in Finland, 6 were the same) games in different game formats. The game formats include a variation of rink sizes as well as different numbers of players in five (5) different age groups (U8, U10, U11, U12, U14). The methods that were used in Finland and Sweden are different. This was done purposely to see how the results may differ from each other.

1.1 Ethics statement

Data collection took place anonymously and all measurements were noninvasive. All parents and/or legal guardians were informed about the procedure and gave their written informed consent to participate. Data cannot be tracked to any participants.

1.2 Participants in the project

Participants were selected by FIHA and SIHA (club level) together with local clubs (player level). The clubs were related to these projects and the selection of the clubs was done according to those criteria. FIHA and SIHA took care of the cost of the participants in the events.

1.2.1 – Participants in Sweden

The subjects of this study were players from 17 different clubs and the test days were arranged together with the clubs Djurgårdens IF, Haninge Anchors and Modo Hockey. The ages of the players were U8 (born 2011), U10 (born 2009), U12 (born 2007) and U14 (born 2005). The players signed up to participate in the study. In Haninge, only girls participated. In total 101 boys and 50 girls participated during the three subtests: the numbers include 127 skaters and 24 goalkeepers.

Not all the players who participated were tested. Six players in each age group at each subtest, 72 players in total, were randomly chosen to be included in a group of focus. These players played every shift in every game format. This to isolate the actions of the players and to follow how their activity levels change in the different game formats. The players that were not included in the focus group took turns in playing with the focus players in the different game formats. In the results you may see the difference between “All the Players” and “the Focus group”.

1.2.2 Participants in Finland

All the players were representing Rauman Lukko Ry and were born 2008 (U12), 2009 (U11) and 2010 (U10). The studies were done during the season 2019 – 2020 and therefore are different than the age categories in Sweden. 53 players were tested in Vierumäki in May 2019 and 28 players participated in the test in Rauma. In Vierumäki event there were about 120 players and 53 out of them were tracked (players were not told who were tracked and who were not). Players in Rauma testing event participated also in the test event in Vierumäki.

All the groups that were tested were divided according the skill level to keep the game level close. A timetable was created to ensure enough resting time and games were played with a 1:2 work-to-rest ratio in both events.

1.3 Design

The study design was agreed together with FIHA and SIHA before any test event was ran. The design proved to be different to see if there is any difference between the results. The Associations went through all the plans and had feedback sessions after the test events in spring 2019.

Pictures 1-8 illustrates the game areas. There are letters NS and EW used meaning the direction of the game:

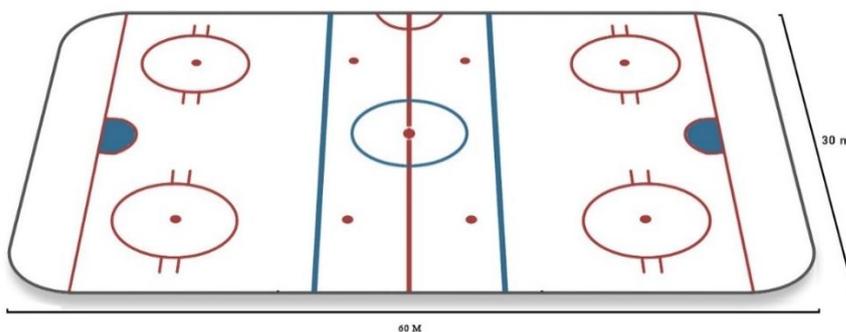
- NS = North South = game is played the direction of goal line to the other (maximum distance 60 meters)
- NS long = game is played from end to end (60 meters)
- NS short = game is played from goal line to red line (30 meters)
- EW = East West = game is played from board to board (maximum distance 30 meters)

1.3.1 Study Design in Sweden

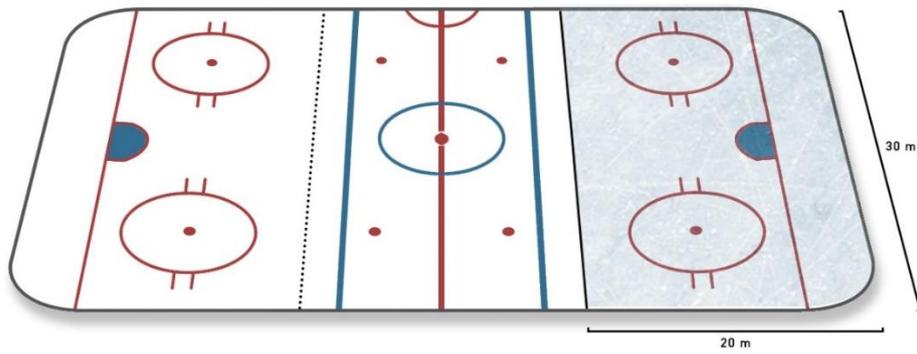
The project group decided the design of the measurements and four different types of rink areas were determined. The four types of rink areas (Pictures 1, 2, 3 and 4) was determined to resemble the full ice sheet that is rectangular. This shape was chosen in order to maintain a constant length to width ratio throughout their years in ice hockey.

The measurements consisted of overall three subtests and each subtest were carried out for two days. Three cameras were set up to film the different game formats, one main camera overlooking the game and two cameras behind each goal filming the goalkeeper.

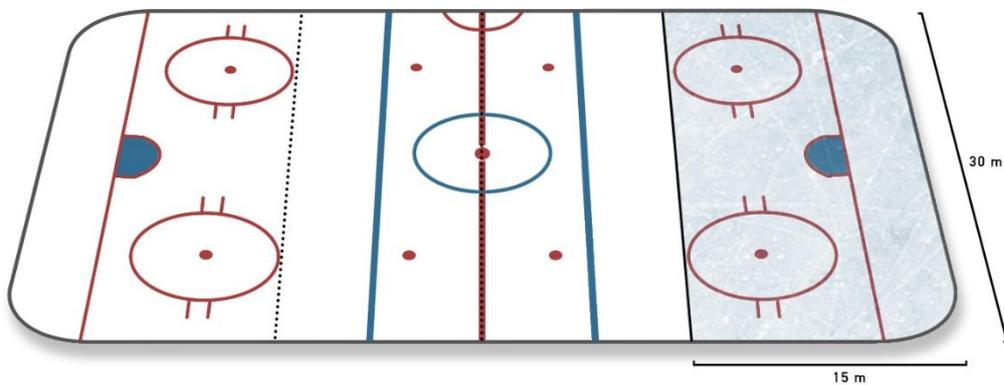
Every age group played games 5 versus 5 players, 4-4 and 3-3 on each type of rink area (Pictures 1, 2, 3 and 4). The set up for the first day was full ice and one third of the ice. The second day, one fourth of the ice and one sixth of the ice was set up. On every subtest five shifts were repeated, in the study a total of fifteen shifts per game format. The total game time per age group during the two days was 240 minutes. The same players participated on each subtest.



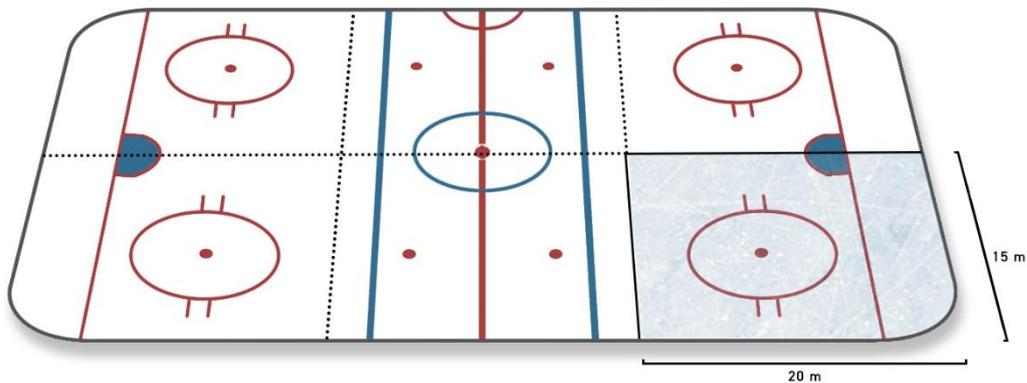
Picture 1. Full Ice - 30m wide x 60m long -1,800 sqm field size



Picture 2. 1/3 of the ice sheet (1/3 EW) - 30m wide x 20m long -600 sqm field size



Picture 3. 1/4 of the ice sheet (1/4 EW) - 15m wide x 30m long -450 sqm field size



Picture 4. 1/6 of the ice sheet (1/6 NS) - 15m wide x 20m long -300 sqm field size

All the shifts started with a face-off in the middle of the rink area. The players wore game jerseys with numbers and a colored cap of cloth that was put over the helmet in order to identify the players when analyzing the games. The shifts lasted 60 seconds with 90 seconds of rest. After five completed shifts, there was a change in numbers of players on the ice.

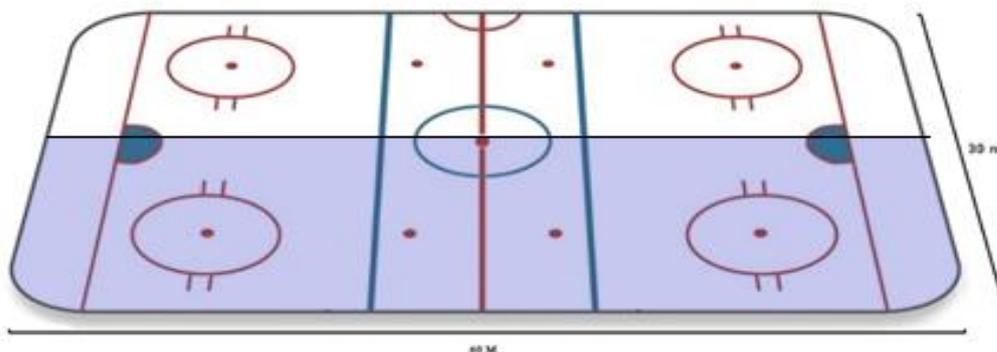
Rules of the game:

- Every shift started and ended with the timekeeper blowing the whistle
- No penalties were called, major offences were noted by coaches on the side and they spoke to the player
- Every time a goal was made, a new puck was placed to the team conceding the goal. This to maximize the game time
- Covered shots by the goalkeeper were set in play by the goalkeeper
- If the puck was out of play, a new puck was set in play by the game leader
- On icing and offside, the opposing team had to leave the puck to the other team
- Black pucks were used for U10, U12 and U14. Blue light-weight pucks were used for the age group U8.

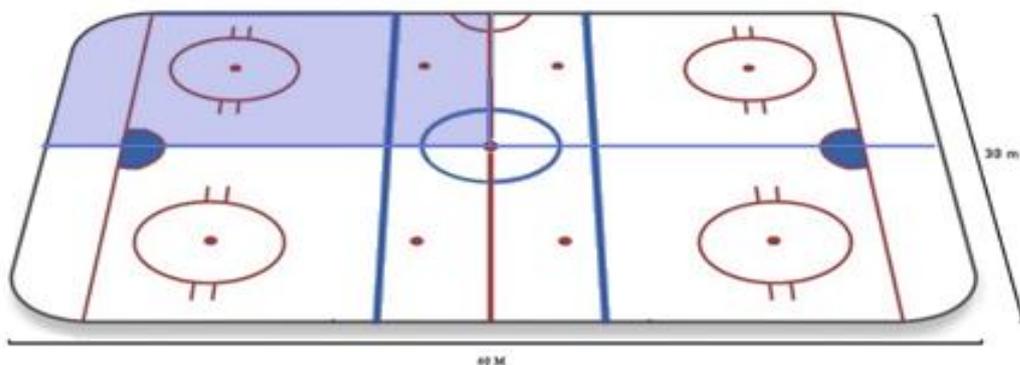
1.3.2 Study Design in Finland

In two different test events eight different playing areas were used (Pictures 1-8). The number of players varied from 2-2 to 5-5 and even strength situations were always played (2-2, 3-3 etc.). Pictures 1 to 4 were used in the test event 1 (Vierumäki) together with Pictures 5,6 and 7. In this event small nets and blue pucks were also tested in $\frac{1}{4}$ NS game (Picture 6, 2-2 and 3-3 situations). 20 different situations (playing area, number of players, the size of the net and the color of the puck) were tested in this event in two days. The games were played in two different rinks but only the games in one rink were tracked. The players were not told which of the rinks were tracked. More than one game was played in one rink that was tracked at the same time but only one game was tracked because of the limitations of using a tracking puck simultaneously. The system was not ready yet to use two different tracking pucks at the same time, because it has been built for tracking 5-5 full ice games. All the variations of the test event 1 can be seen in Appendix 1.

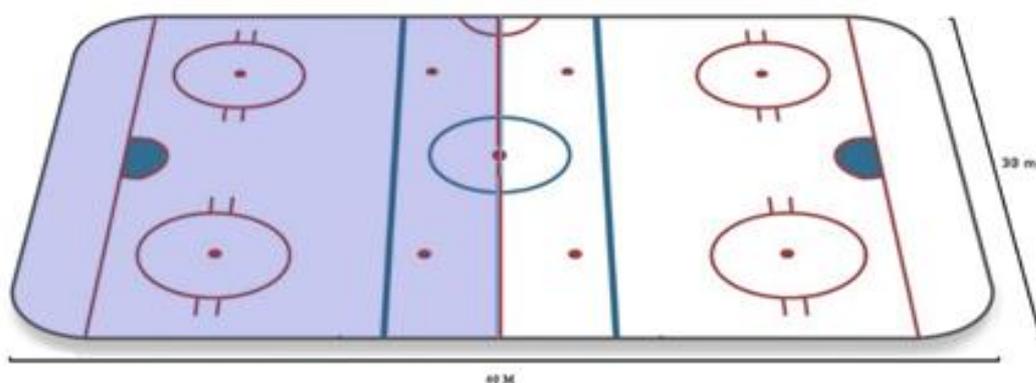
In the test event in Rauma figures 5,6 and 8 were used, having four different situations with two age groups (2009 and 2010). A total of seven games were tested in 90 minutes. One game was played all the time, so the players were aware that they were being tracked. These players were the same ones who participated in the test event 1 in Vierumäki May 2019. All the variations of the test event two can be seen in Appendix 2.



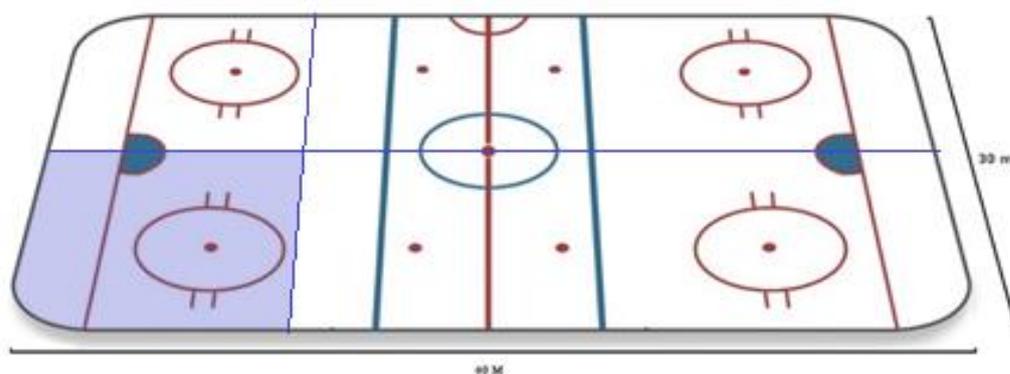
Picture 5. 1/2 of the ice sheet (1/2 NS Long) - 15m wide x 60m long -900 sqm field size



Picture 6. 1/4 of the ice sheet (1/4 NS) - 15m wide x 30m long -450 sqm field size



Picture 7. 1/2 of the ice sheet (1/2 NS Short) - 30m wide x 30m long -900 sqm field size



Picture 8. 1/8 of the ice sheet (1/8 NS) - 15m wide x 15m long -225 sqm field size

Shifts were approximately 60 seconds long (some differences due the technical difficulties). Shifts started from the face-off and puck was placed on the ice immediately after the goal was scored to ensure maximal use of the shift time. No penalties were called (there were not any reasons to call

them because of the atmosphere of fair play). All the players were tracked during the games (see more in chapter 1.5).

1.4 Data collection

Data was collected in different locations in Finland and in Sweden. It was agreed that the data would be reviewed after the test events were completed and the results prepared. The Associations wanted to compare the data from different angles.

1.4.1 Data Collection in Sweden

Three cameras were used during this study. In this report, material from one of the cameras was analyzed. The films were sent to the company Instat Sport, specialists in analyzing ice hockey and other sports. When the films were analyzed, and the many technical variables were counted, reports of the variables were available for the project group on Instat Sport platform. The following technical variables were used in this study:

- Shot
- Pass
- Technical involvement; includes merging of shot, pass, accurate pass and puck battle

Skating data was collected during two of the subtests with the clubs Haninge and Modo, and a local positioning system (LPS) (Catapult ClearSky, Catapult Sports) was used on the focus group. The LPS devices were located between the players' shoulders on their back in order to estimate the players' movements on the ice. The data were collected and processed by Catapult Sports. Raw data files were sent to the project group for analyzing. The following skating variables were used in this study:

- Total distance
- Skating speed and intensity
- Maximum velocity

The project group gathered and watched every game format on the recorded films. This was to get the subjective perception of the different game formats, the involvement of the players, and how the overall flow of the games looked like.

1.4.2 Data Collection in Finland

Data was collected by the International Ice Hockey Centre of Excellence (IIHCE) using Wisehockey system and other cameras. A Bluetooth LE chip was placed inside the jerseys and a tracking puck was used during the games (black and blue pucks). Games were taped manually by using two different cameras. Commercial video analysis software was used to code the game live during the second event.

The Wisehockey data collection system provided the following metrics:

- Passes
- Shots
- Pass received
- Total distance skated
- Maximum and mean velocity

The system was not built to track U10 – U12 players and therefore had difficulty identifying shots. Because of the age of the participants and from the observation from the games, shots and passes were defined as shooting attempts (SAT) and passing attempts (PAT). We counted SAT and not only shots as defined in traditional game statistics. This included e.g. missed and blocked shots together with shots that are counted in games (goalie statistics). In this study the action of the skaters was studied and therefore SAT gave a better view of the game actions of a player in terms of activity levels.

All the data is safe and can be used later too. New data can be added to the existing data to increase the total ice time of the games.

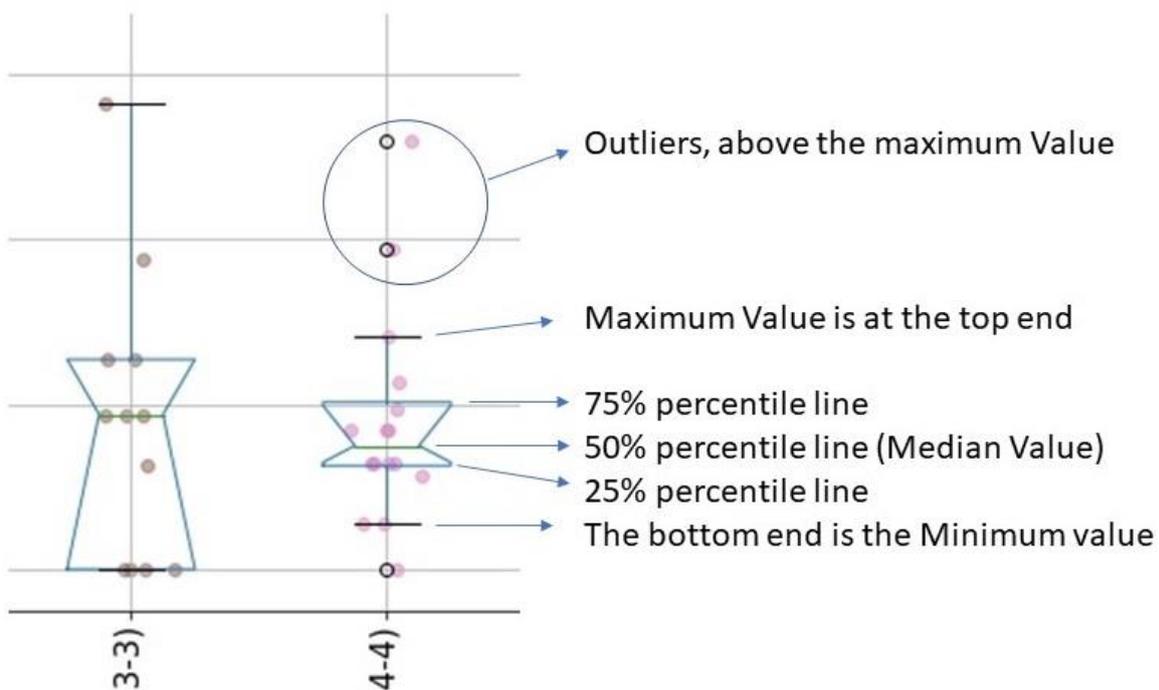
All the data was collected by watching the game video, and the statistics SAT, PAT, PR, saves, missed shots, and blocked shots were all collected by hand. All the data was collected, cleaned, and analyzed by the IIHCE located in Vierumäki, Finland.

2. Results

All the results are calculated as averages per group, if not, it is stated otherwise. The boxplot figures show the individual differences of the players in certain game. With boxplot figures one gets a visual understanding of the individual differences in values, the median or mean, the variability of individual results, and the outliers. Some results are seen by the age group and some of them are combined.

No separation between girls and boys was presented in this result. This mainly because the players in the tested age groups participates in mixed teams in their daily club environment.

These results are considered from the view of the puck and in boxplot figures you may see the individual differences of the players. Total counted actions for all the participating players and the focus group in the 36 (12 games in Sweden + 24 games in Finland) different game formats from five different age groups. Picture 9 illustrates the description of a box plot.



Picture 9: Definition of a box plot (screenshot from Figure 11 PAT/M)

Table 1 shows the results from the puck point of view of different games and the Table 2 illustrates the actions of a single player in 60 seconds. As you may see the total time may differ in games and therefore in order to compare the results as total actions / time played, in this case the game actions are shown divided by 60 seconds of playing time. Passing and shooting attempts are seen a minute in the Table 1 (e.g. PAT/M) whereas in the Table 2 the results are divided among the total number of players on the ice. The results are combined with all three age groups. PR means pass reception.

GAME	AREA	PAT	PR	SAT	TIME (S)	PAT/M	SAT/M	PR/PAT
2-2	1/8 NS	67	48	145	1320	3,0	6,6	0,72
2-2	1/6 NS	14	8	15	298	2,8	3	0,57
2-2	1/4 NS	149	64	111	1401	6,4	4,8	0,43
2-2	1/2 NS L	86	62	73	1440	3,6	3,0	0,72
3-3	1/8 NS	68	44	159	1440	2,8	6,6	0,65
3-3	1/6 NS	18	12	25	278	3,9	5,4	0,67
3-3	1/4 NS	135	80	117	1584	5,1	4,4	0,59
3-3	1/4 EW	64	41	52	756	5,1	4,1	0,64
3-3	1/3 EW	23	13	23	322	4,3	4,3	0,57
3-3	1/2 NS L	149	78	73	1436	6,2	3,1	0,52
4-4	1/4 NS	117	61	133	1393	5,0	5,7	0,52
4-4	1/4 EW	35	15	57	551	3,8	6,2	0,43
4-4	1/3 EW	44	26	29	456	5,8	3,8	0,6
4-4	1/2 NS L	132	84	94	1560	5,1	3,6	0,64
4-4	1/2 NS S	206	117	182	2692	4,6	4,1	0,67
5-5	1/4 NS	28	23	33	720	2,3	2,8	0,82
5-5	1/2 NS	128	73	67	1390	5,5	2,9	0,56
5-5	1/2 NS S	51	25	58	1109	2,8	3,1	0,49
5-5	FULL	85	57	56	1609	2,9	2,1	0,67

Table 1: Overall results from puck point of view of different games. Age groups together (Results from Finland)

GAME	AREA	PAT/M	PAT/M/P	SAT/M	SAT/M/P	PR/PAT
5-5	FULL	2,9	0,3	2,1	0,2	0,67
5-5	1/4 NS	2,3	0,2	2,8	0,3	0,82
5-5	1/2 NS	5,5	0,6	2,9	0,3	0,56
5-5	1/2 NS S	2,8	0,3	3,1	0,3	0,49
4-4	1/2 NS L	5,1	0,6	3,6	0,5	0,64
4-4	1/3 EW	5,8	0,7	3,8	0,5	0,6
4-4	1/2 NS S	4,6	0,6	4,1	0,5	0,67
3-3	1/2 NS L	6,2	1,0	3,1	0,5	0,52
3-3	1/4 EW	5,1	0,9	4,1	0,7	0,64
4-4	1/4 NS	5,0	0,6	5,7	0,7	0,52
3-3	1/3 EW	4,3	0,7	4,3	0,7	0,57
3-3	1/4 NS	5,1	0,9	4,4	0,7	0,59
2-2	1/6 NS	2,8	0,7	3	0,8	0,57
2-2	1/2 NS L	3,6	0,9	3,0	0,8	0,72
4-4	1/4 EW	3,8	0,5	6,2	0,8	0,43
3-3	1/6 NS	3,9	0,7	5,4	0,9	0,67
3-3	1/8 NS	2,8	0,5	6,6	1,1	0,65
2-2	1/4 NS	6,4	1,6	4,8	1,2	0,43
2-2	1/8 NS	3,0	0,8	6,6	1,7	0,72

Table 2: Overall results from as an average number of an individual. Age groups together (Results from Finland)

2.1 Shots and Shooting Attempts (SAT)

The results differ slightly between Finland and Sweden due to the different definitions of ‘shots’: Sweden as shots and Finland as shot attempts (SAT). The results are shown from the puck’s point of view as an average, and when using boxplots, we can see all the individual values and their differences in the games.

2.1.1 Shooting results from Sweden

During the game format full ice 5-5, the overall lowest number of shots were counted in every age group. When dividing all the counted shots per player participating on the ice, the lowest number of shots was also counted in 5-5, in each specific rink size, (Figure 1)

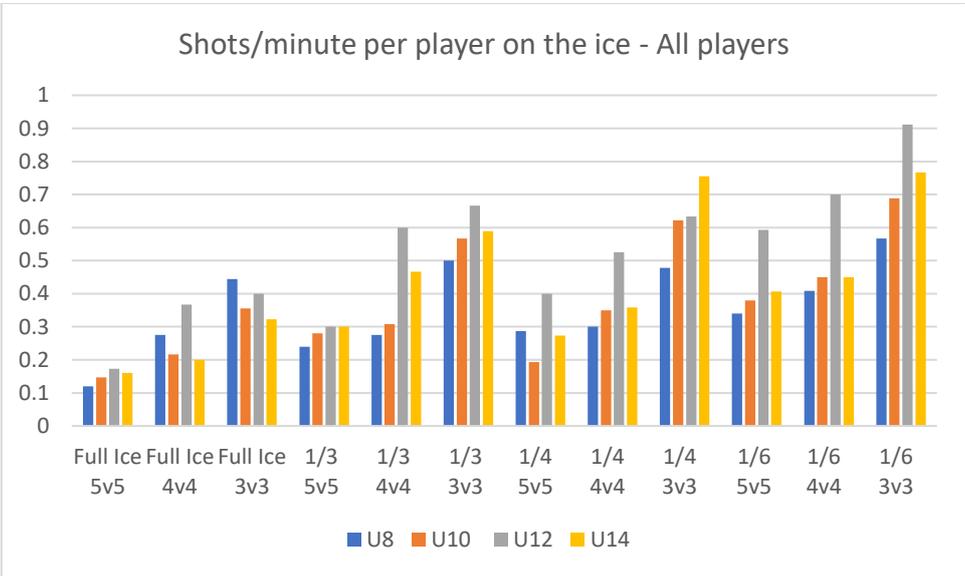


Figure 1: Shots for all players (Results from Sweden)

The focus group with the players participating in every game format had an overall greater opportunity to take a shot/player in the game format 3v3 in than in game formats with 4v4 or 5v5. (Figure 2). The game format 1/6 3v3 had the most counted shots per player on the ice in all age groups.

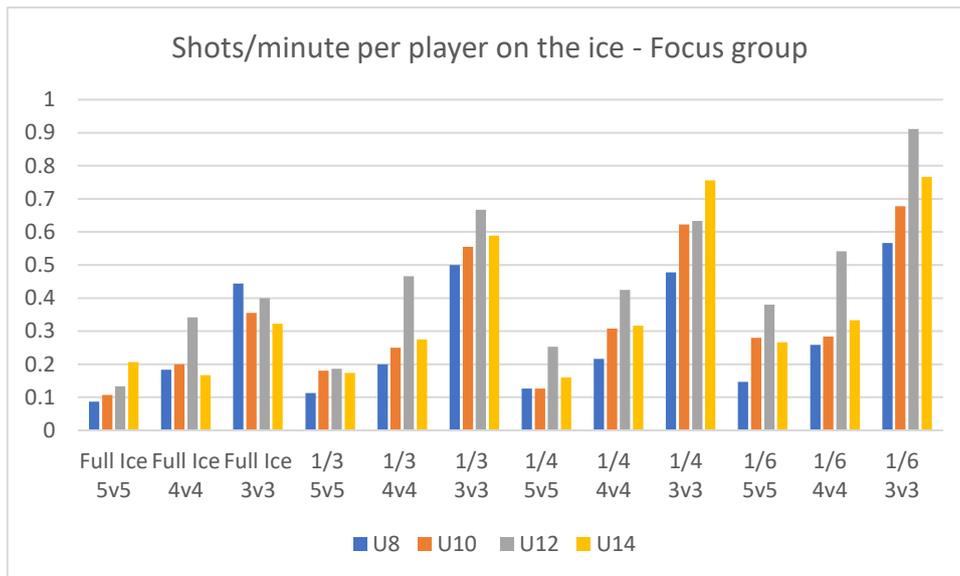


Figure 2: Shots for focus group (Results from Sweden)

Looking at the players in the focus group, there was a span regarding counted actions, between players being involved and not being involved. This can be due to many reasons, for example, physical and psychological maturity, at what age the player started to play ice hockey, luck, opportunity in the game etc. However, the study shows that the player that did succeed and dominated with more counted actions, did so in all the different game formats. The weaker player tends to have less probability to succeed with actions in each game format 5-5.

This is exemplified in the boxplot chart with the U12 focus group. (Figure 3), where the more dominating players are represented in the chart as an outlier with very high number of shots/min. The average player and the weaker player had a greater opportunity to take more shots/min in 3-3 in each rink size.

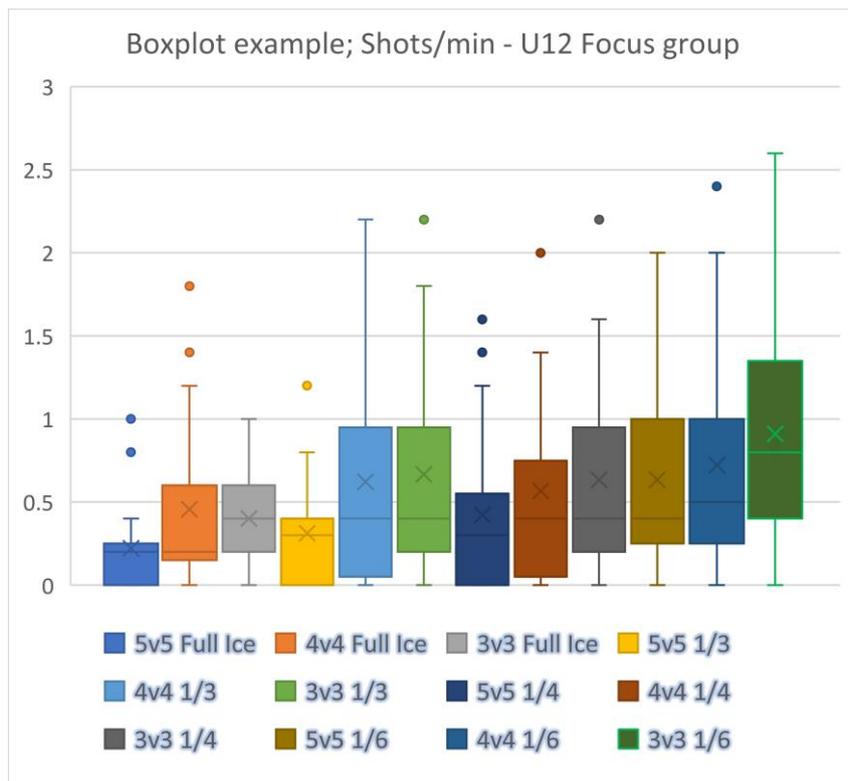


Figure 3: U12 focus group shots on different games (Results from Sweden)

2.1.2 Shooting results from Finland

In the following tables and figures Shooting Attempts (SAT) are used instead of Shots. Shooting attempts (SAT) was used to get all the shots (blocked, missed etc.) from a skater point of view, as the game actions wanted to be counted and not simply successful game actions, as is done with the traditional goalie stat "shots". Therefore, SAT is shown in the results. In Figures 3 and 4 results are combined for all three age groups. The time differs a bit between the age group and therefore the data is combined.

You may see from Figure 3 how many shooting attempts there are in different games in a minute (not dividing equally). In Figure 4 you may see what the average number for a single player would be if everybody would have equal number of attempts. From these results you may say that in 2-2 1/3 NS game provides almost 8 times (7,9) more shooting attempts than 5-5 full ice game (Figure 3). If there are only 2,1 shots in a minute for 10 skaters in 5-5 game, most of the players won't get any shooting attempts in a minute where as in 1/3 games every player has a chance to get at least 1 shooting attempt (1,1 and 1,7 in average) in a minute. In 27 of the 39 games, there was at least one and many times several players who had 0 shot attempts, however the average value does not show that information. It is important to note that the average value does not represent the individual experience.

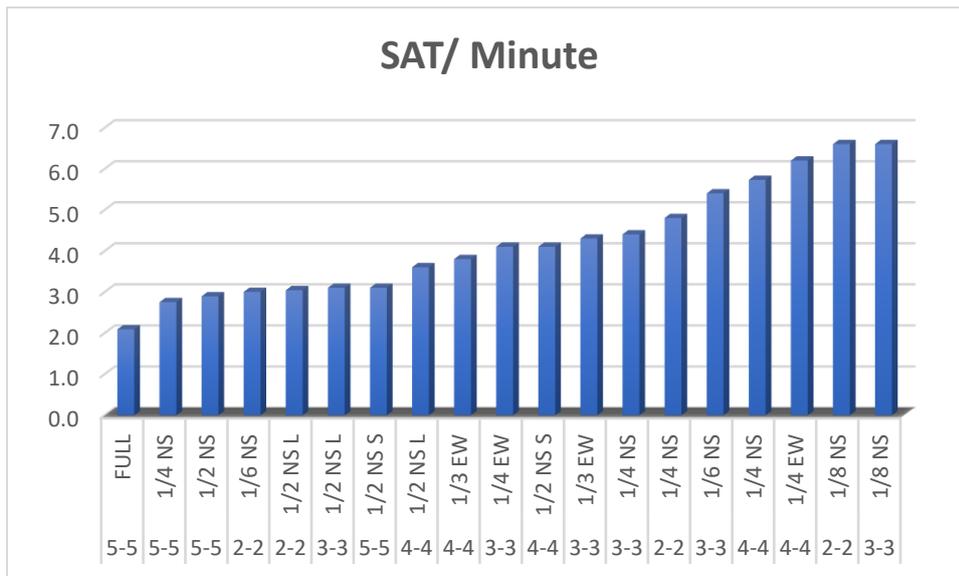


Figure 3: Games in order according the SAT/Min (Results from Finland)

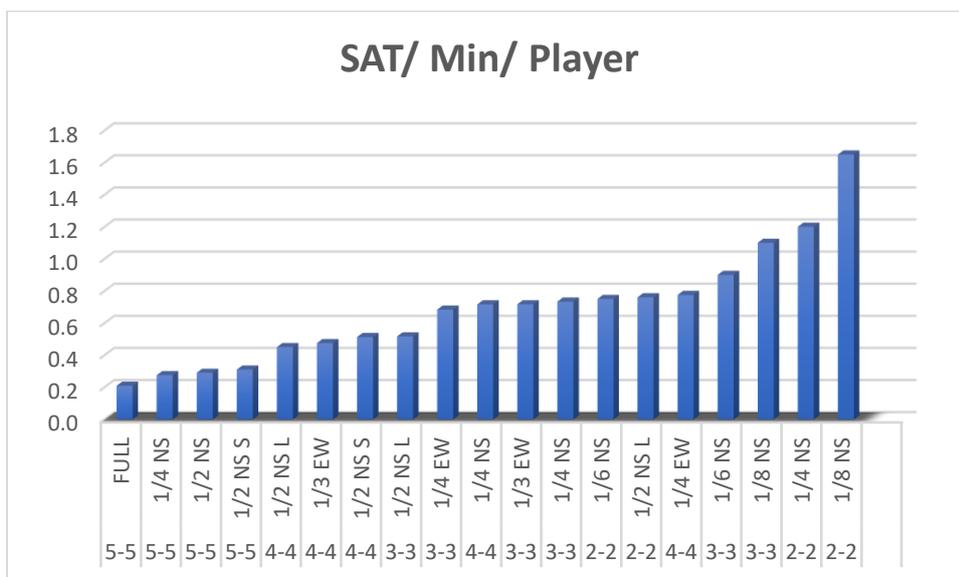


Figure 4: Games in order according the SAT/M/Player (Results from Finland)

There are all the games seen according SAT/ min by the age groups in Figure 5. The order goes from left to right where on the right side “the top” results are seen. In the Figure 5 you may see the difference between the individuals according the SAT/M. The list of all 39 games is seen in Appendix 3.

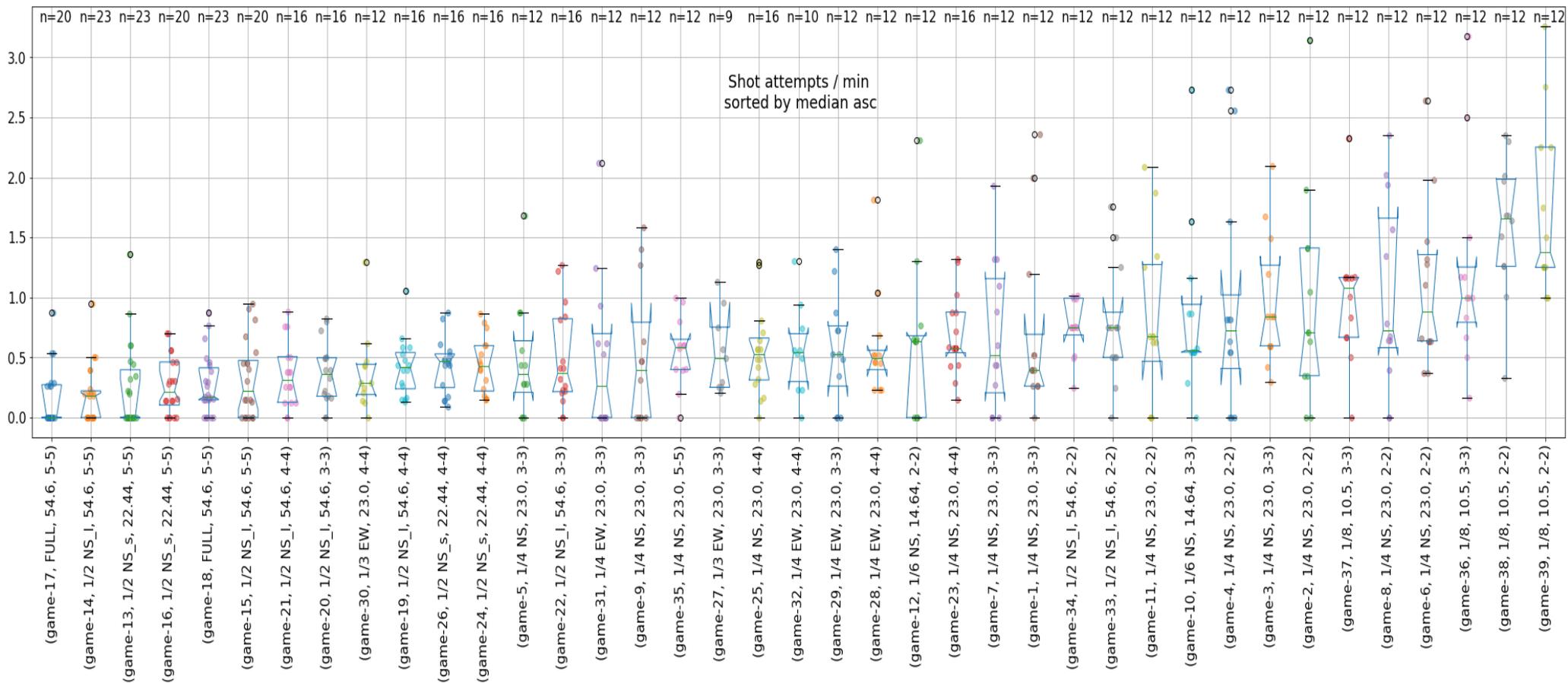


Figure 5: SAT/ M Boxplots from all the games sorted by median value (Results from Finland)

2.2 Passes and passing Attempts

Passes and passing attempts were calculated during the events. Pass reception was also counted as a data point in Finland. Passing attempts were chosen due to the same reasons than SAT in Finland (see the chapter 2.1).

2.2.1 Passing Results from Sweden

The number of counted passes shows the same tendencies as with counted shots, with overall increased passes with decreased rink size. Game formats with player number 5-5 had overall lower counted number of passes per player participating in the games. Counted passes increased in relation to each age group, even if U8 had high number of counted passes in relation to the other age groups in some of the game formats. (Figure 6 and 7)

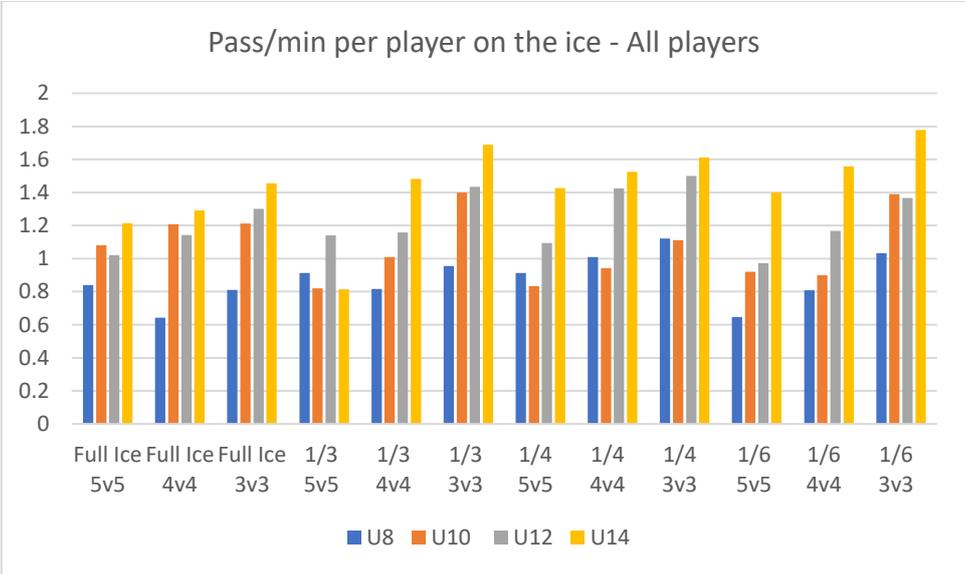


Figure 6: Passes per minutes for all players (results from Sweden)

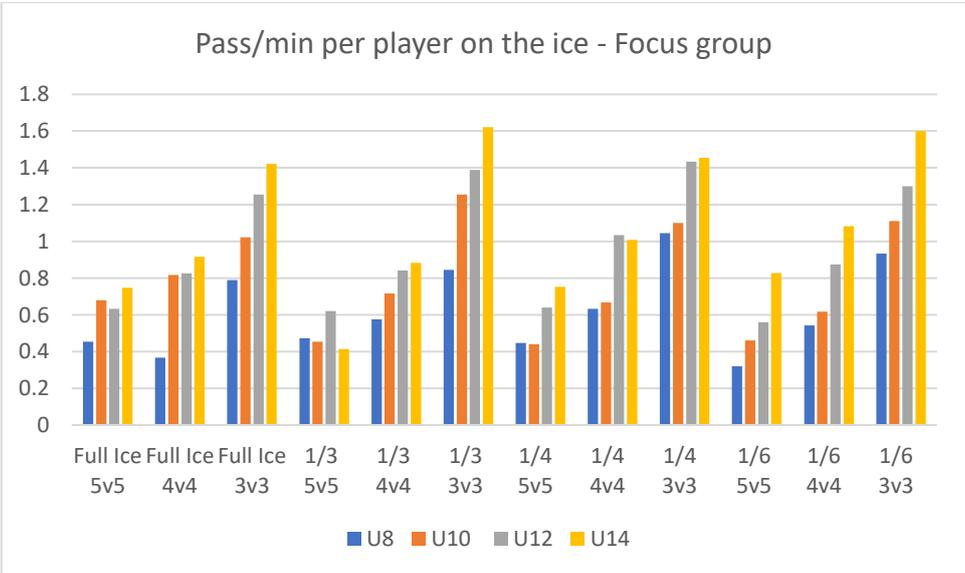


Figure 7: Passes per minutes for all players (results from Sweden)

The players in the focus group had an average greater chance to pass more in game formats 4-4 and 3-3, than in 5-5 in each rink size. This exemplified in the boxplot chart. (Figure 8)

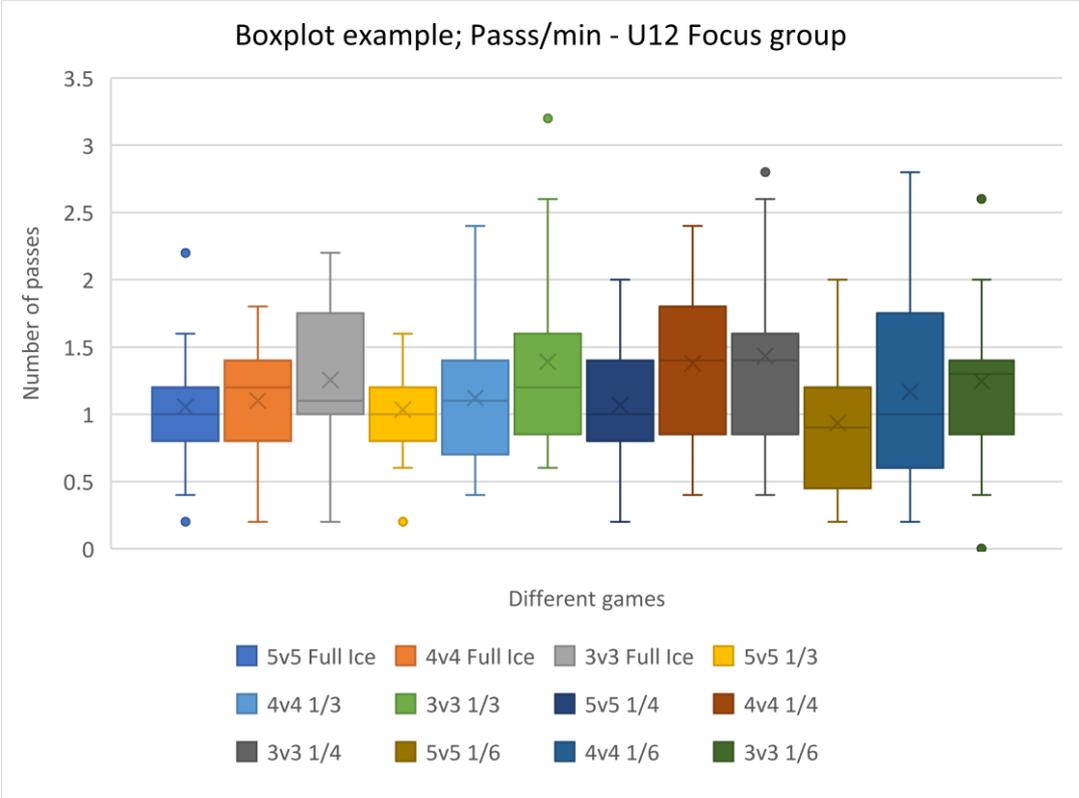


Figure 8: U12 passes from different games (results from Sweden)

2.2.2 Passing results from Finland

Passing attempts and passes received were calculated in the events in Finland. In Figures 9 and 10 are seen the results from different games (age groups combined). You may see from the results that 2-2 and 3-3 might offer more passing attempts than 4-4 and 5-5 games for a single player. The same tendency is seen in the Figure 11.

When comparing results to 5-5 full ice game, you could say that in 2-2 ¼ NS game there are 5,3 time more passing attempts (PAT) and in 3-3 ½ EW game 2,3 time more PAT for single player (Figure 10). From full length games (60-meter distance) 3-3 ½ NS Long provides 3,3 times more PATs and 4-4 ½ NS Long game 2 times more PATs than 5-5 full ice game. Only one game provides more than one passing attempt for single player: average 1,6 PAT at 2-2 ¼ NS game. As was seen in SAT, PAT also shows that in 23 of the 39 games, at least one but often several players had 0 passing attempts during the game. However, the average value does not show this information. It is important to note that the average value does not represent the individual experience.

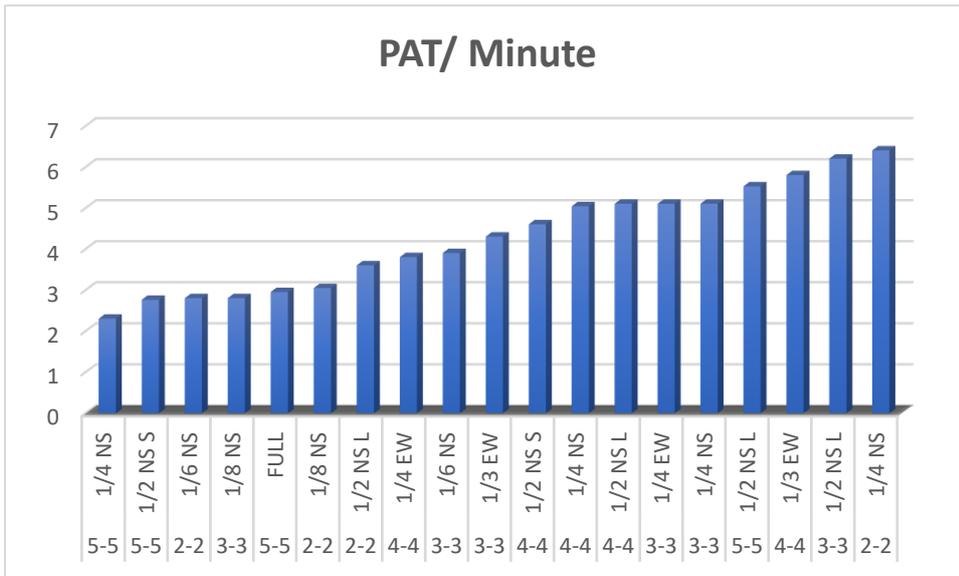


Figure 9: Passing attempts per minute in different games

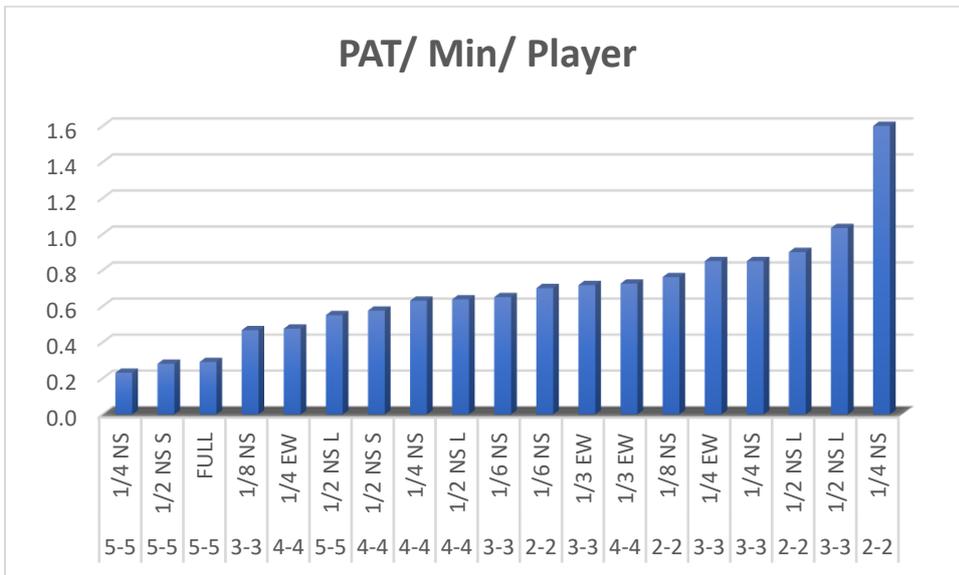


Figure 10: Passing attempts per minute per player in different games

Figures 9 and 10 are average numbers from the games. These values give an idea how games are differing from each other from the puck point of view and as an average number for the players. From Figure 11 you may see how the individuals differs from each other in different games.

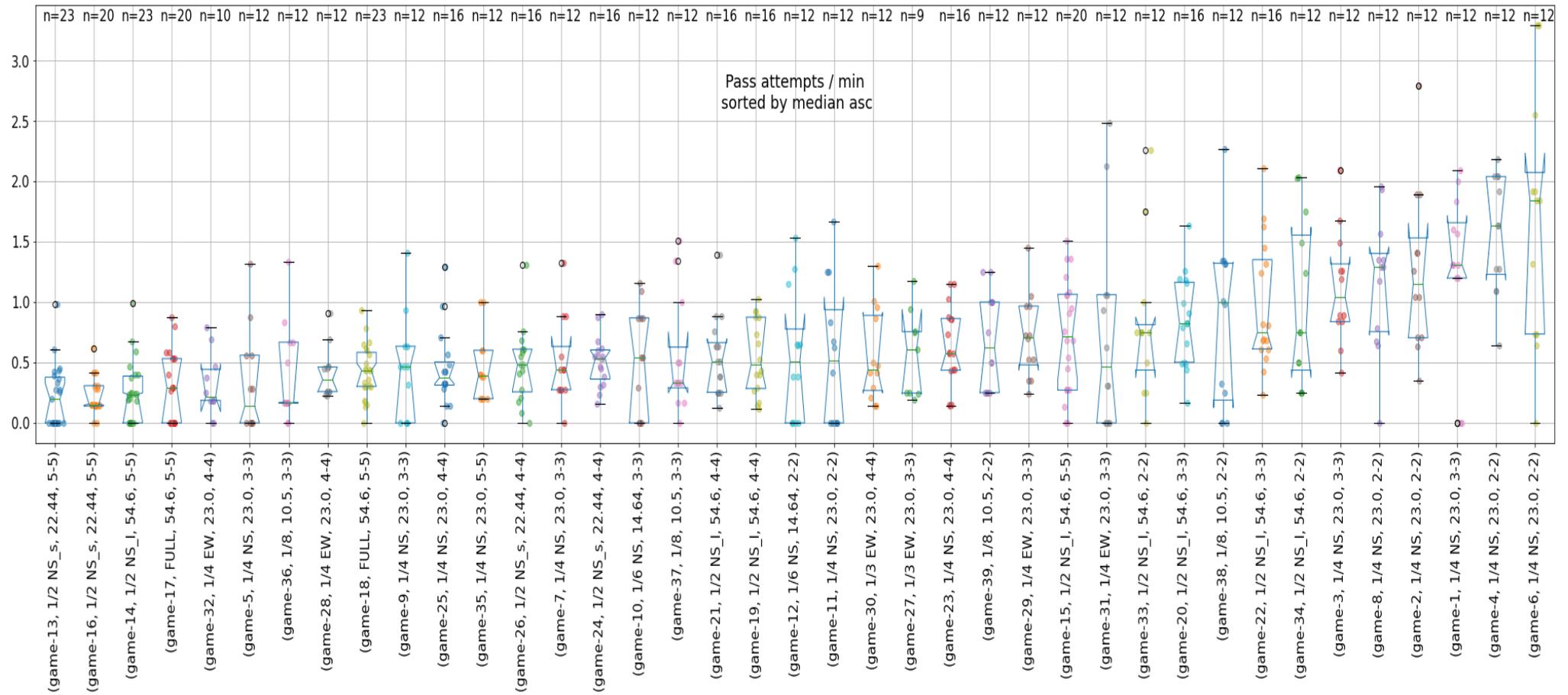


Figure 11: Passing Attempts for all the games divided by the age groups (Results from Finland).

Pass completion percent was calculated in the study by dividing Pass receptions by Pass attempts (PAT). The differences between the games are seen in Figure 12. When watching the results from individual point of view, it looks like that 2-2 and 3-3 might offer more passes received than 4-4 and 5-5 games (Figure 13).

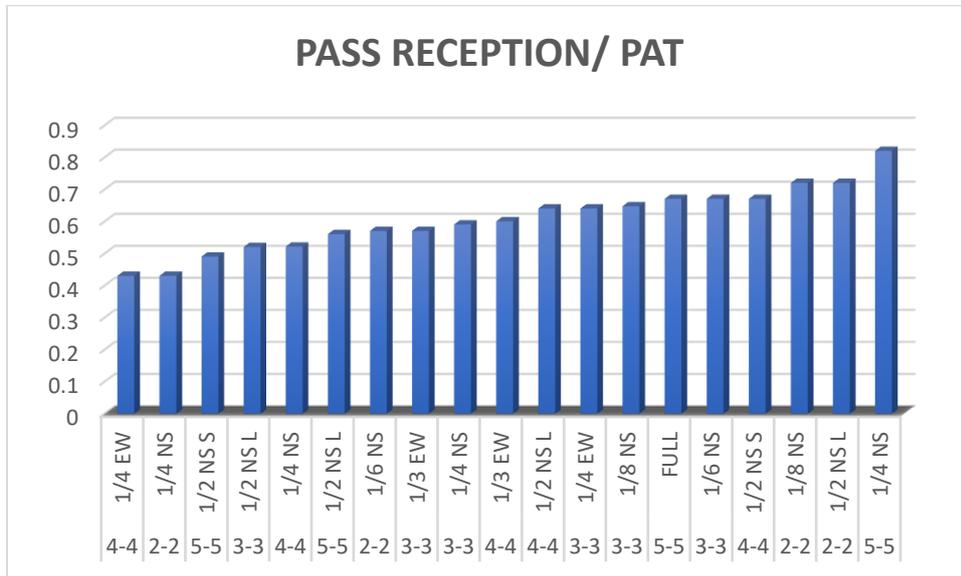


Figure 12: Average number of pass received/ PAT (Results from Finland)

When observing the SAT/M and PAT/M results, those seems to be similar: average number of a player varies from 0,2 – 1,6 attempts in 60 seconds, but not in the same games. One could think that there are more passing than shooting in a game. This observation might occur the age of the players. They are in the development stage where it still hard to observe the other players in the game. For individual experience it might be better to observe the boxplot figures.

2.3 Size of the net and the color of the puck

In test event one at Vierumäki blue puck and small nets were used in ¼ NS games. Results are seen in the Figures 13 and 14. Normal net size (N) and small nets (S) were used together with black and blue pucks. The game format was ¼ NS game 2-2 and 3-3 with 2009 (U11) and 2010 (U10) age groups.

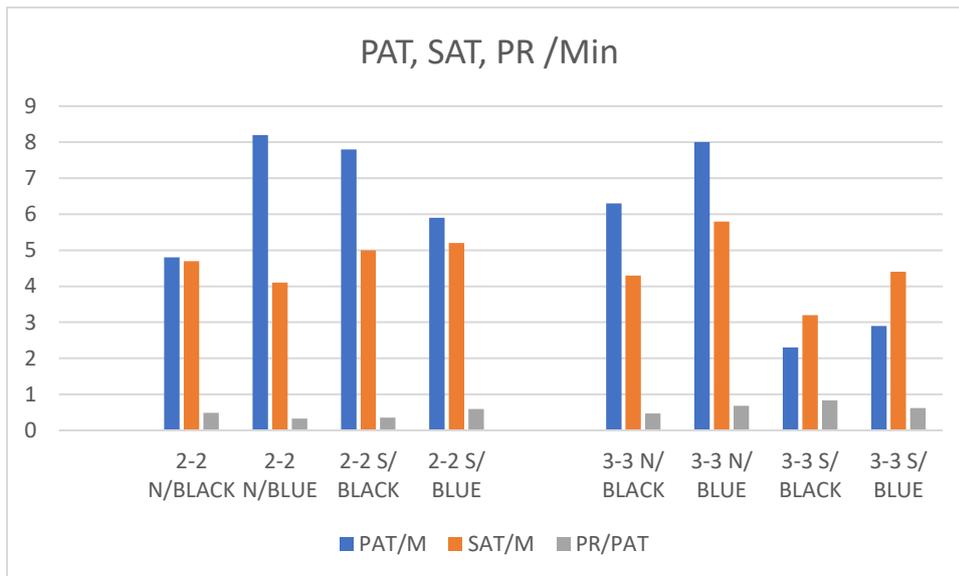


Figure 13: ¼ NS games with average numbers a minute

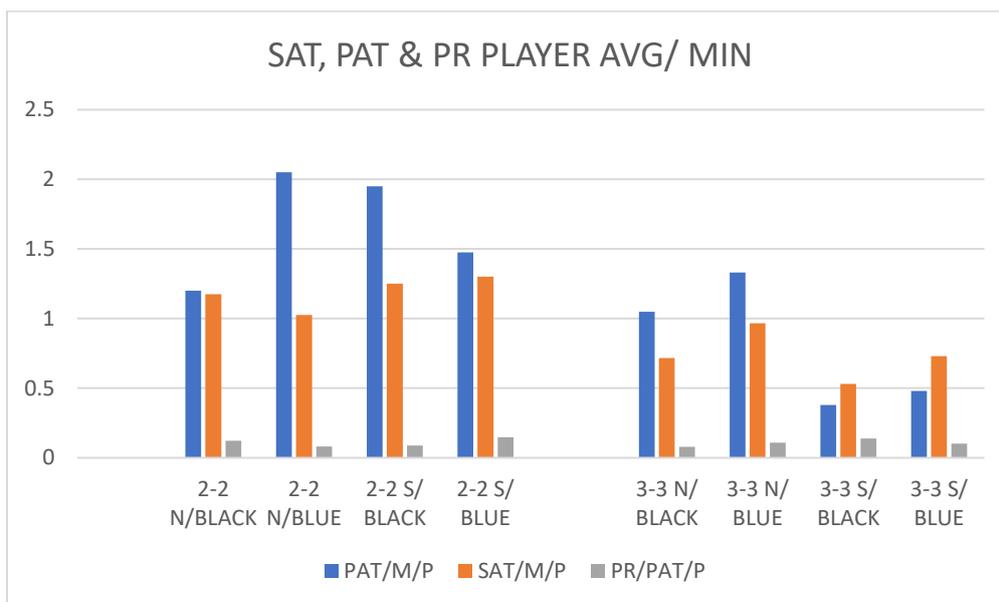
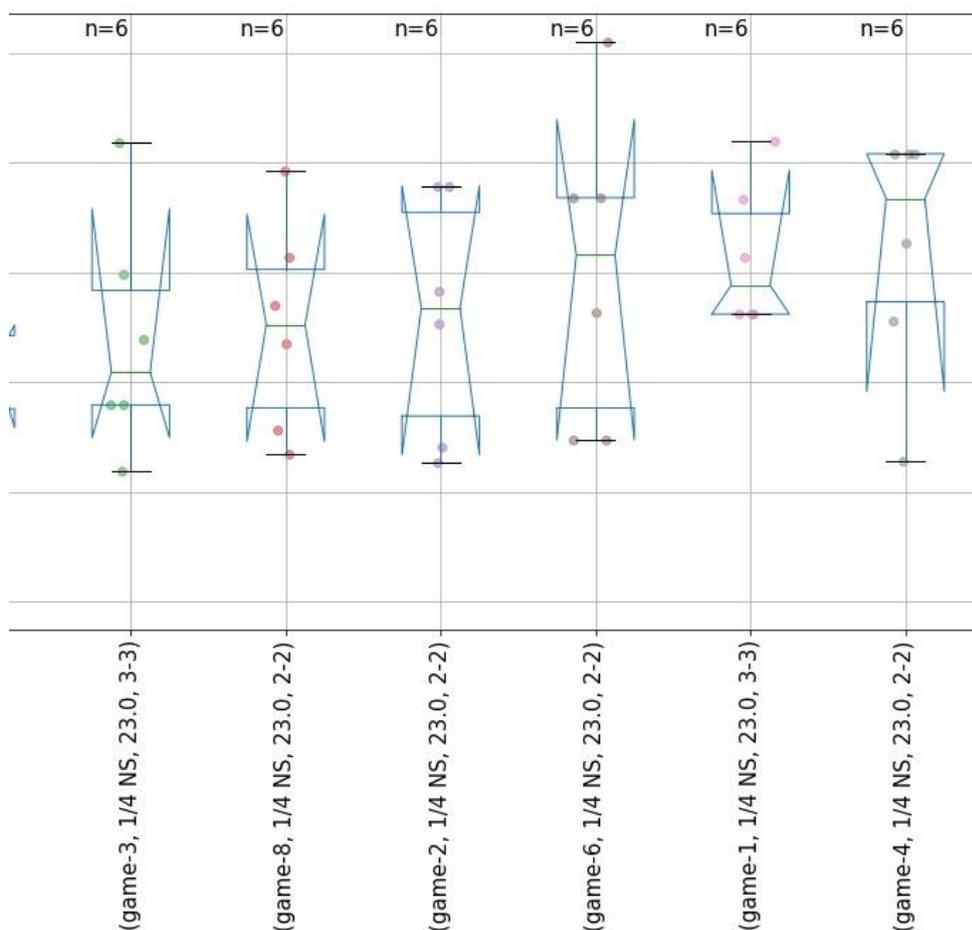


Figure 14: ¼ NS games average number per player a minute

The total time of testing was not high and therefore it is impossible to make any conclusions about how different pucks or nets affect the game. (Table 3). When looking at Figures 13 and 14, and the Table 3, you could say that there could some difference when using a different puck. For example, in SAT blue puck games are a bit above the average number of all 3-3 ¼ NS games. However, when watching a single boxplot (Picture 10), you cannot see any difference when using a different puck with this data. The games that used a blue puck are games 3,4,7 and 8 (Picture 10 and Figures 5, 11 and 25). This is one difference when using average numbers comparing to see the how the individuals differs in the game (boxplots). This is one topic need to be studied in the future.

GAME	AREA	PAT	PR	SAT	PAT/M	SAT/M	PR/PAT	TIME (S)	NET	PUCK
2-2	1/4 NS	43	21	42	4,8	4,7	0,49	533	NORMAL	BLACK
		42	14	21	8,2	4,1	0,33	306	NORMAL	BLUE
		37	13	24	7,8	5	0,35	286	SMALL	BLACK
		27	16	24	5,9	5,2	0,59	276	SMALL	BLUE
3-3	1/4 NS	64	30	44	6,3	4,3	0,47	611	NORMAL	BLACK
		44	30	32	8	5,8	0,68	331	NORMAL	BLUE
		12	10	17	2,3	3,2	0,83	315	SMALL	BLACK
		16	10	24	2,9	4,4	0,62	327	SMALL	BLUE

Table 3: Results of using blue puck and small nets (Results from Finland)



Picture 10: PAT/M 1/4 NS games. Games 3,4 and 8 with Blue Puck and Games 1,2 and 6 with Black Puck

2.4 Game actions

Technical involvement includes five technical variables; goal, shot, pass, accurate pass, and puck battle, divided by the number of the players participating in every type of game format (Figure 15 and Figure 16). The number of players in the different game format influenced the counted actions,

where 5-5 had the smallest counted technical involvement in each rink size. The number of technical involvements increased with the increased age.

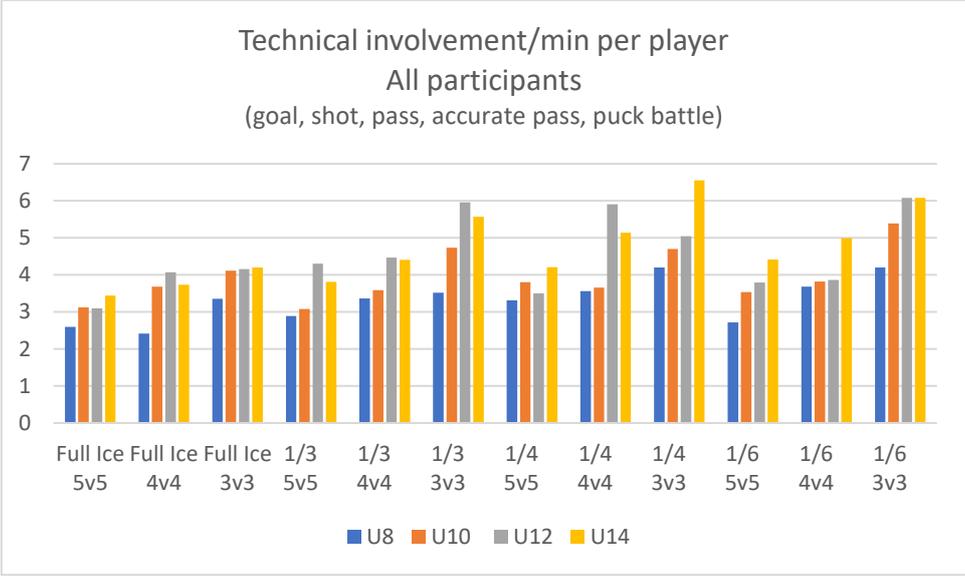


Figure 15: Technical involvement all players (results from Sweden)

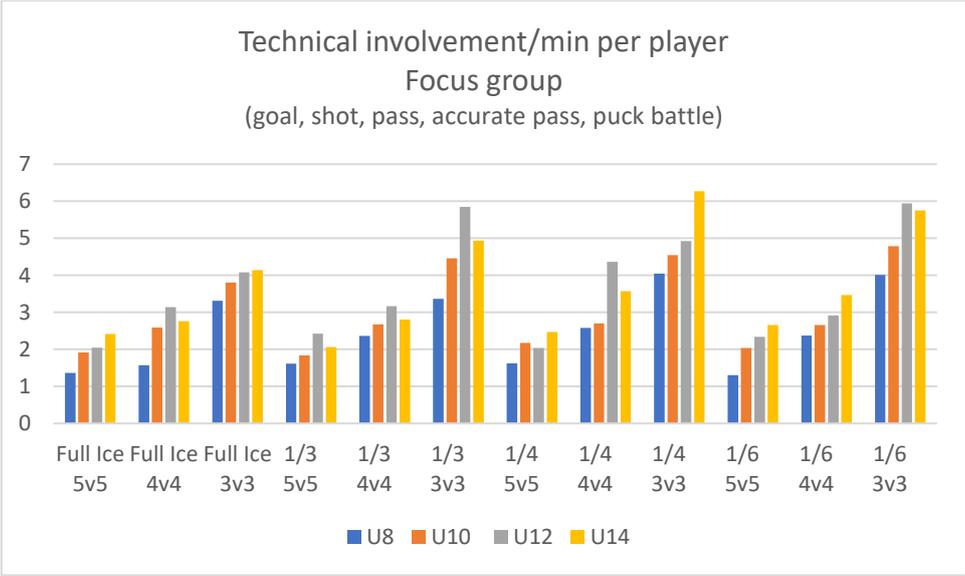


Figure 16: Technical involvement focus group (results from Sweden)

2.5 Skating Results

Skating was one variable that was tested in this study. Skating distance and velocity was calculated in both countries and the distance traveled with different velocities tested in Sweden. In chapter 2.5.1 are the results from Sweden and in chapter 2.5.2 are the results from Finland.

2.5.1 Skating and activity pattern in Sweden

Only the data from the focus group from Modo hockey Club will be shown in this result, due to technical problems with the Catapult System at the measurement in Haninge, meaning a low number of participants was counted in the system and not included in the result.

The highest total distance was covered in the game format full ice 3-3, in every age group. (Figure 17) Maximum velocity measured by one player was reached playing full ice in every age group. (Figure 18)

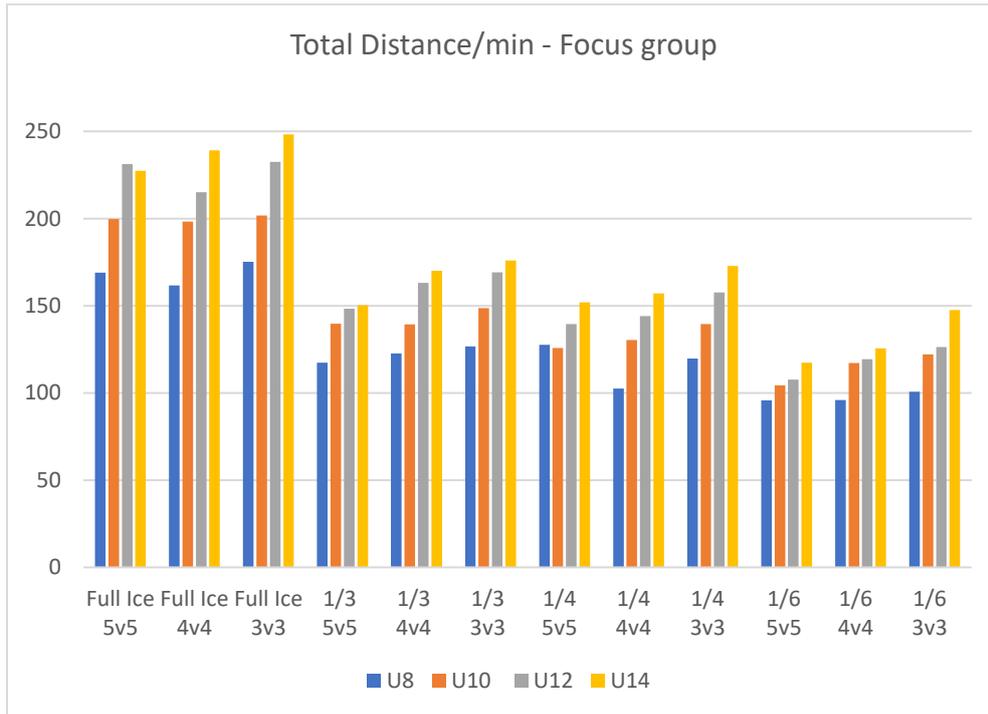


Figure 17: Total Distance Skated in Meters (Results from Sweden)

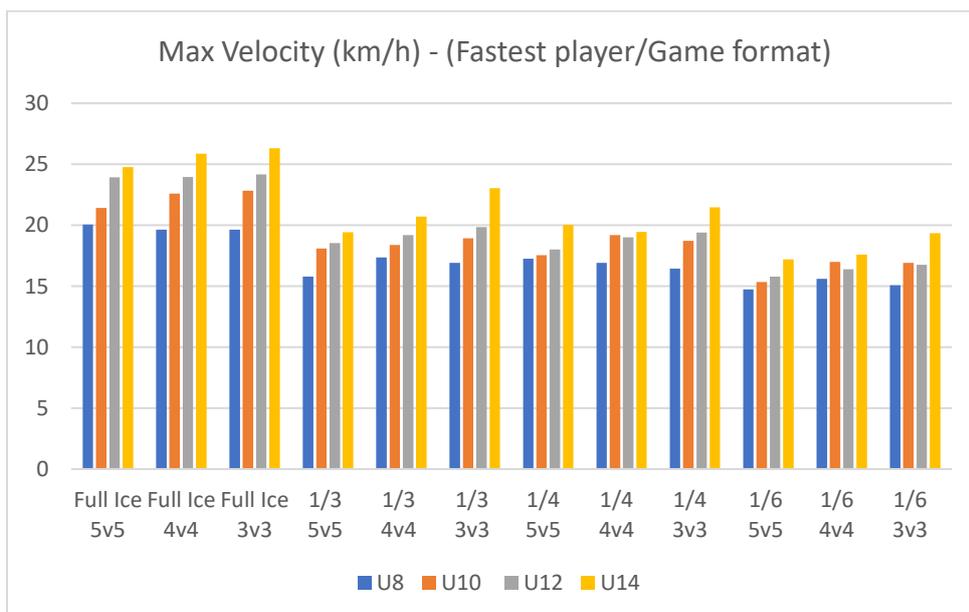


Figure 18: Max velocity (Results from Sweden)

On the smaller rink sizes, low intensity skating was measured (Figure 19). The number of players had effect on the skating, all the game formats with 5-5 had more low intensity work, whereas game formats with 3-3 had more high intensity skating. The result also shows that the oldest U14 players are capable of skating with more high intensity and the youngest age group U8 has harder to reach high intensity skating (Figure 21). In this study, the main meters per minute were covered with “slow skating” (Figure 20), this in all the age groups.

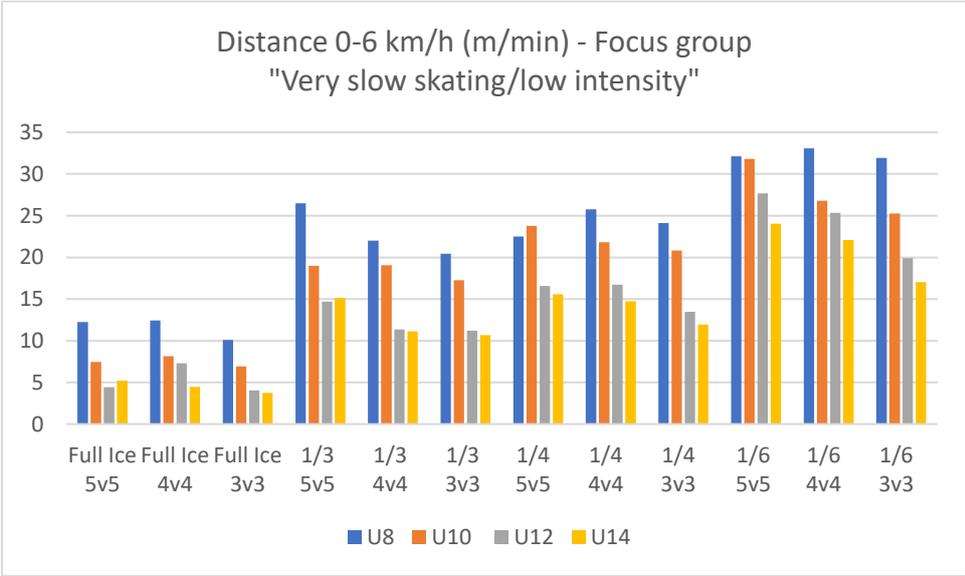


Figure 19: Distance travelled with low intensity

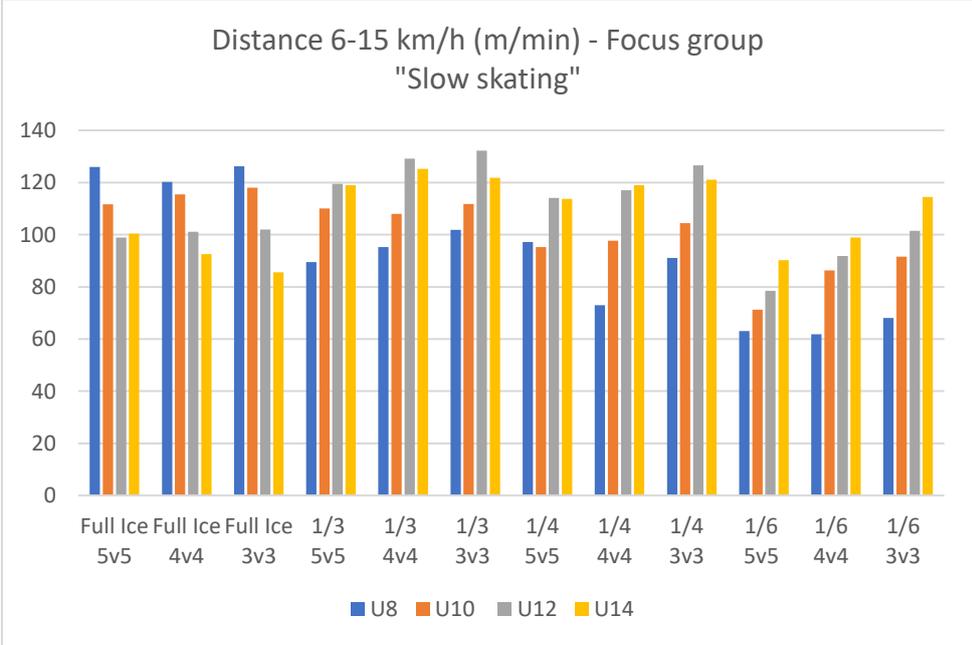


Figure 20: Distance travelled slow skating (Results from Sweden)

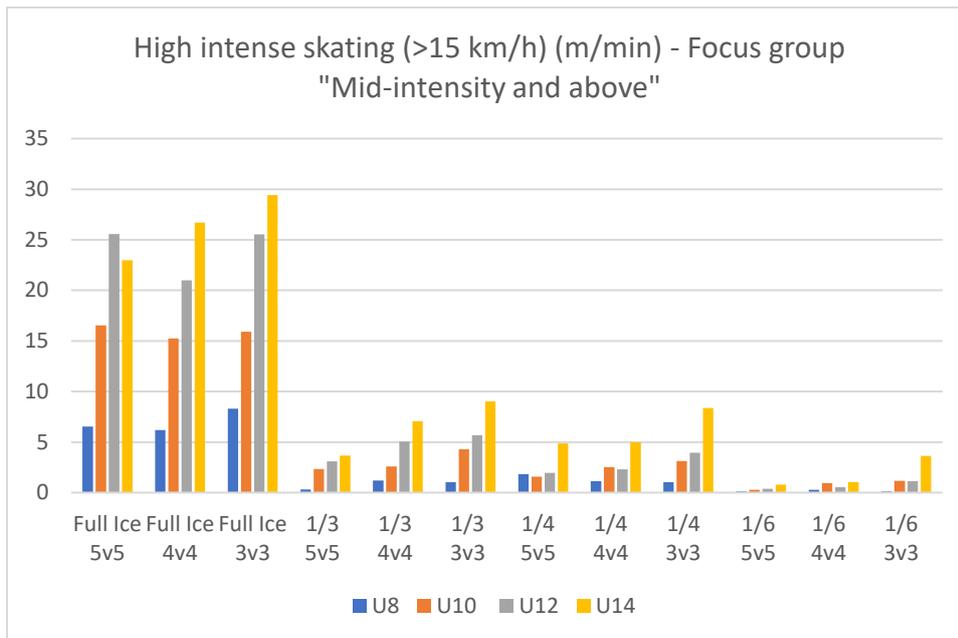


Figure 21: Distance travelled mid intensity (Results from Sweden)

2.5.2 Skating results from Finland

Skating results and data came automatically from the Wisehockey system. Only the games that were played NS direction were able to get the data out because the system has been built to analyze 5-5 Full Ice games, not Cross Ice games. Maximum and Mean Velocities came from all the games that were played NS direction and those are seen in Table 4. Estimated distance skated in 60 seconds have been counted from the Mean Velocity value. It is shown as an average number of all the age groups together.

From the Table 4 you may see which age group had the highest mean from different games. Interesting is to see that U12 (2008) were able to get the highest result from the 5-5 Full Ice game. There could be several reasons for this, such as some of the games were recorded in 6 months' time between the testing conditions, the area per player was too small for larger or faster players (playing area was "too small", the skill level of the age groups is different etc. At the same time, the youngest age group (2010) was able to get higher results in 3-3 ¼ NS game, in 4-4 ½ NS Short and in 5-5 ½ NS Short games comparing to U11 and U12 age groups. 2-2 ½ NS (U12), 3-3 ½ NS (U12) and 5-5 ¼ NS (U10) was only done with single age group. In the Table 4 you may see the difference between the age group result from the estimate average value.

GAME	AREA	MEAN (KM/H)	M/P/60S
		VELOCITY	ESTIMATED
2-2	1/8 NS	6,73	112
2-2	1/6 NS	7,16	119
2-2	1/4 NS	7,65	128
2-2	1/2 NS Long	12,20	203
3-3	1/8 NS	6,48	108
3-3	1/6 NS	6,78	113
3-3	1/4 NS	7,46	124
3-3	1/2 NS Long	9,49	158
4-4	1/4 NS	6,96	116
4-4	1/2 NS Short	8,11	135
4-4	1/2 NS Long	9,21	154
5-5	1/4 NS	6,90	115
5-5	1/2 NS Short	6,90	117
5-5	1/2 NS Long	7,81	130
5-5	FULL ICE	9,50	158

Table 4: Mean velocities (km/h) and estimated distance (meters) skated in 60 seconds

When seeing the results from the estimated distance skated (Table 4 and Figure 22. Meters per player in 60 seconds), you may see that the full length (60 meters long, 1/2 NS Long and FULL) games estimates the most meters in 60 seconds. 2-2 1/2 NS Long seems to be most beneficial when thinking about the distance in 60 seconds (almost 30% than other full-length games and 50% more distance comparing to the highest SAG, 4-4 1/2 NS game). People often say that Full Ice game (30x60 meters) provides the most distance per player, but according to these results 1/2 NS games provides more. 1/2 NS Long games might not be the best way to organize league games (e.g. safety) but could use in practice. There are about 12% more skating in full ice game comparing to 4-4 1/2 NS Short game and about 23% more comparing to 3-3 1/4 NS game. On 5-5 games there are more standing on the ice comparing to 2-2 and 3-3 games. Standing on the ice or less skating on the ice has an influence on Mean Velocity value of different games (more variability in speed). However, some players do skate more than the others during 60 seconds in 5-5 games. The difference of the age groups of different games are seen in Figure 23.

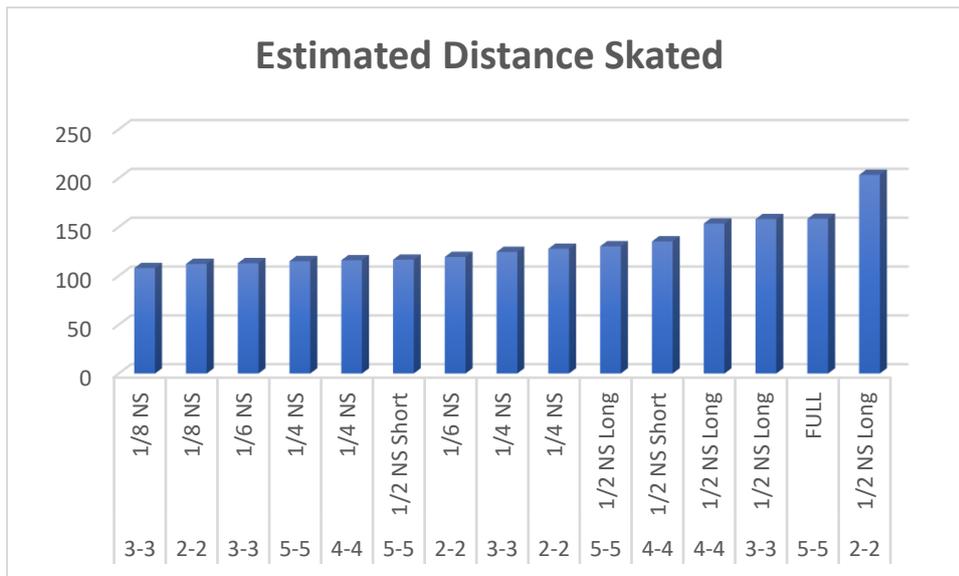


Figure 22: Skating distance by a single player in 60 seconds in meters (Results from Finland)

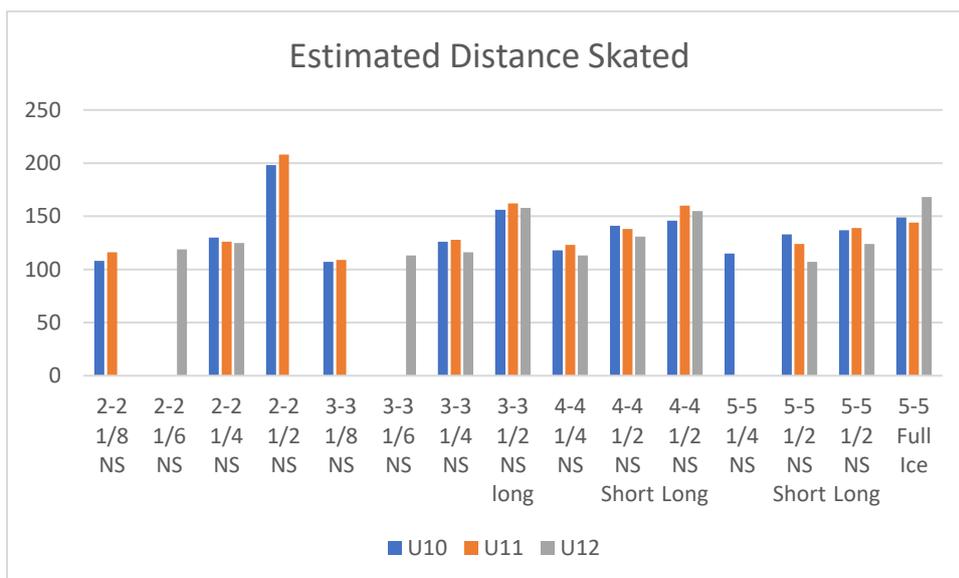


Figure 23: The difference of the age groups of Estimated Distance Skated (meters) in 60 seconds

Figure 24 shows the mean velocities from the Rauma test event. With this boxplot the individual differences of the players are seen better comparing the average numbers. Games 34, 35, 37 and 39 show the results of U10 players and in the rest of the games (33, 36 and 38) are boxplots of U11 players. The U11 games, 36 and 38, have bigger max values comparing to U10 players, but in mean values but there are not large differences in mean values between the games. With that Figure is easy to illustrate how different the players act in a game. The U12 age group was not tested in Rauma.

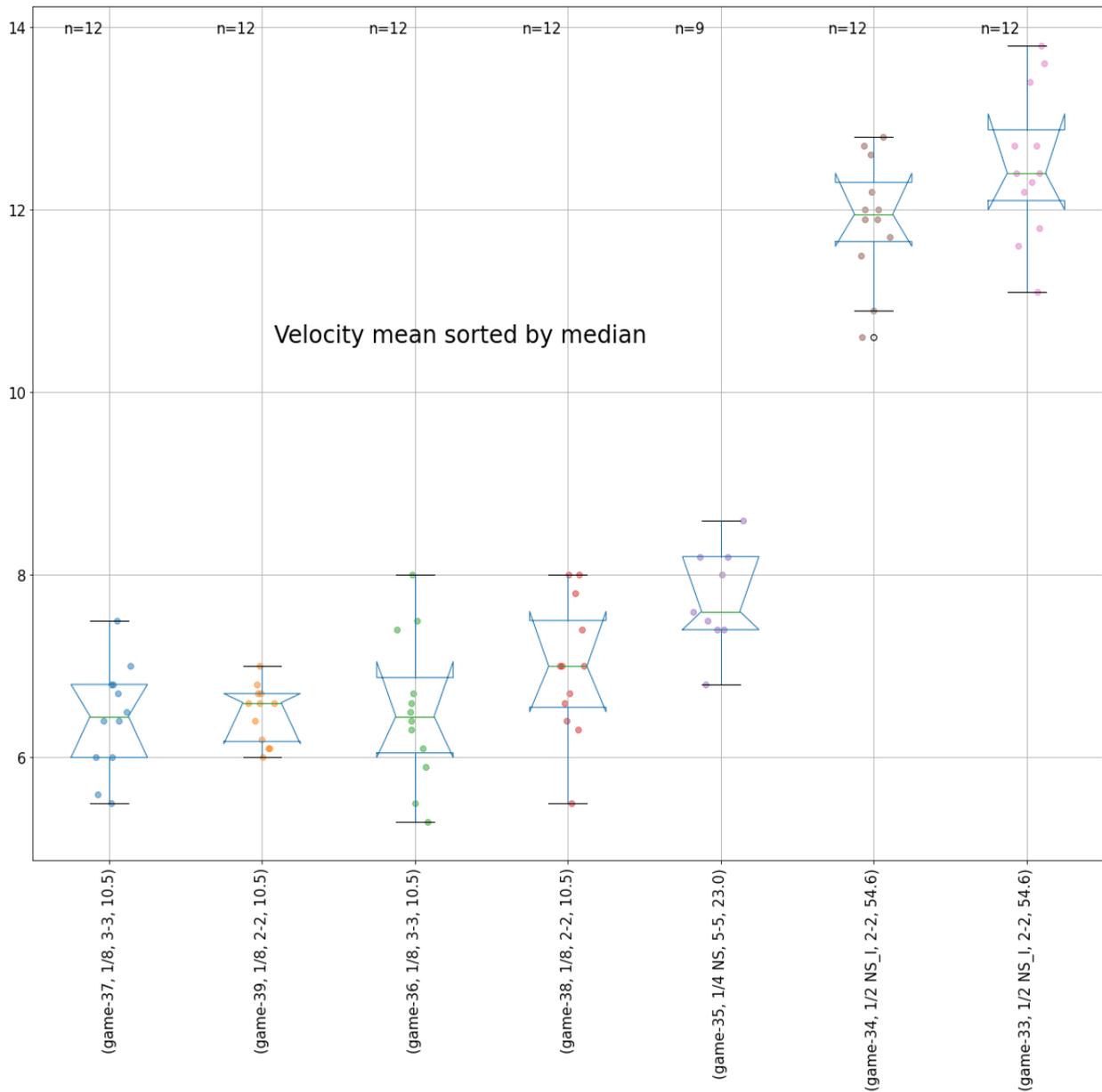


Figure 24: Mean velocity from Rauma test event with different age groups (results from Finland)

In Figure 25 the results seem to show that higher velocities might occur when the nets are further away from each other. Same tendency is seen in figure 25. The highest Peak value in maximum skating was 29,9 km/h in game 22 (3-3 ½ NS long, U12), the second highest in Game 13, 27,7 km/h (5-5 ½ NS Short, U12) and the third highest peak value came from the game 33, 26,9 km/h (2-2 ½ NS Long, U11). When comparing the peak values in smaller space than ½ games, the highest peak value is in Game 9, 23,2 km/h (3-3 ¼ NS, U12). The peak value from U10 games (26,1 km/h) came from the game 34 (2-2 ½ NS Long).

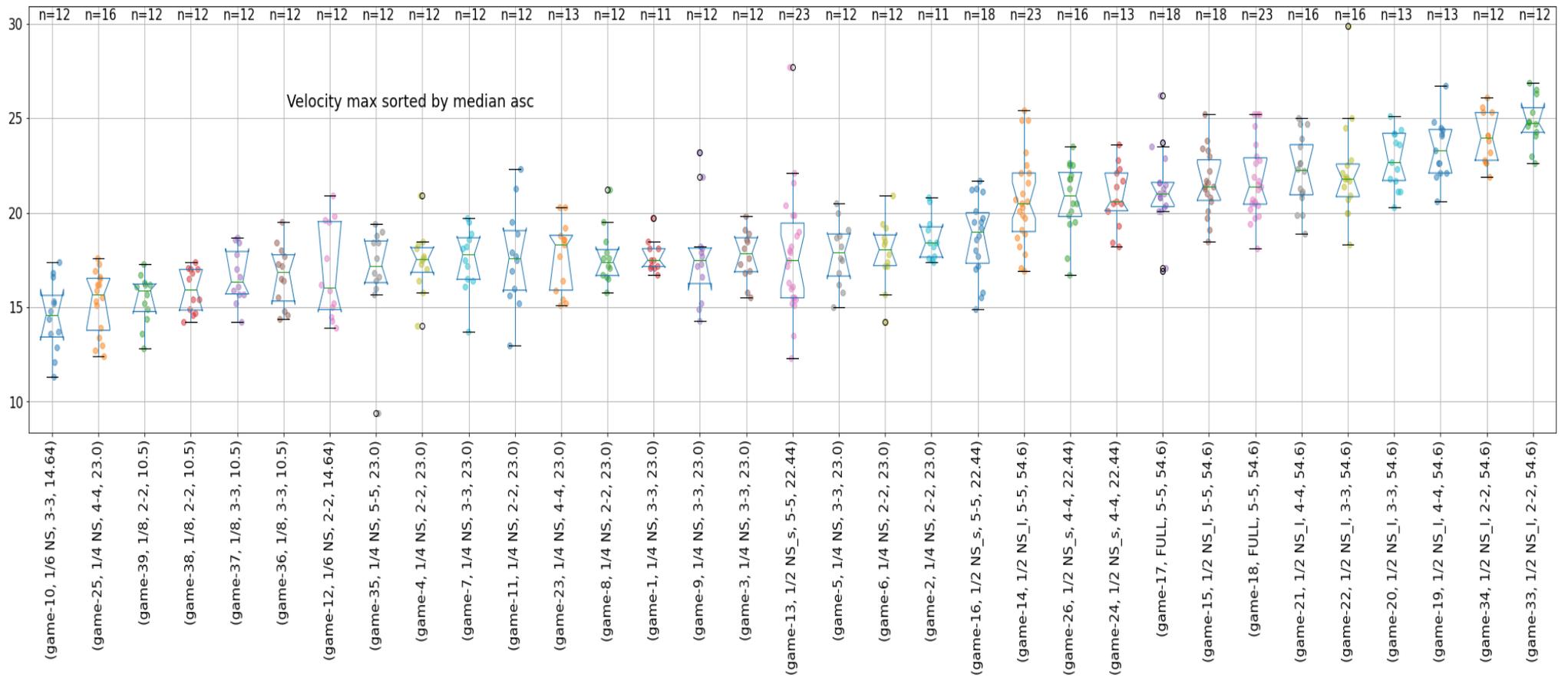


Figure 25: Max velocities from all the games (Results from Finland)

Most of the games that were either played on half ice (30 meters long) or full length (60 meters long) are on the right side of the Box plot in Figure 26. When comparing the skating maximum between game 24 (4-4 ½ NS Short) and 17 (5-5 Full Ice) with U10 and U11 players (age groups were combined) it appears that there are no significant differences in skating maximum. With these results it seems that these players were able to reach the same maximum when playing 4-4 half ice (30x30 meters) or 5-5 full ice (30x60 meters).

The highest maximum speeds were found in 2-2 ½ NS long game (15m x 60m): Game 33 U11 and Game 34 U10. However, the test event in Rauma was done 7 months later, therefore it might be better to use ones that were tested in the event one: Game 19 and Game 20. These two games were played with the same area (½ NS Long, 15mx60m) either 3-3 or 4-4 games.

2.6 Observations from Sweden

The counted actions were compared by the project group with subjective observations from the recorded film material.

5-5 was perceived as the worst game format with many of the players being inactive and skating around without being near the puck. The 4-4 was perceived as a better format with good activity and flow, however many players ended up in fixed positions and often become static and passive, often as a defenseman.

The overall perception was that the game formats with 3-3 involved the players the most, with greater flow and activity. All the players participated in all the different positions that occurred in the game and were constantly forced to act without any chance of hiding.

With the smaller rink area, the overall perception was that problem solving and decision making increased. The player had to be more attentive and constantly create new solutions to different situations. The full ice game formats tend to give fewer opportunities to solve problems, with too much time and space, far away from situation both offensively and defensively.

During full ice games the players performed more intense skating, but observation tells that much of the skating was performed in sequences without any puck and with players out of the action. Game formats with 5-5 in the 1/3-, 1/4- and 1/6-rinks, were perceived as chaotic without any flow and with players mostly battling along the boards. Passing in game formats 5-5 was also perceived as high but many times the puck was just moved around without any purpose, especially in the youngest age groups U8 and U10.

U14 was the only age group that was able to handle the full ice game format, and also was the group that was superior in adjusting to the smaller rinks and areas.

Some differences of the players ability were observed during the games. The differences between the players ability could be explained for example in physical and psychological difference (maturity) or in the number of years that they have played ice hockey. Many of the stronger players were more challenged when the rink was tighter, and they had to achieve more to be successful. On the full ice game format, they often could rely on their skating and they did not seem to be challenged to succeed with their actions.

The weaker player did often tend to come closer to the puck and closer to the action on the smaller rinks. However, on the full-ice, they were often on the periphery without much involvement in the action.

The skating was observed to have a different quality on the smaller areas, a more technical skating with more twisting, turning, stopping etc. The skating during full ice tended to be more long sequences of skating north to south.

2.7 Observations from Finland

Games were watched during the test event and afterwards from the videos. Observations were similar to the ones made in Sweden. It looks like that in 5-5 and 4-4 games there are more inactive players than in 3-3 and 2-2 games. The results shown in the boxplot figures support this observation: e.g. more players 5-5 game who have 0 shots.

In 3-3 and 2-2 games every player must be involved with the game action in order to be successful. There are no playing positions and players must read and react to the situation. In these games, due to a smaller number of players, more players get more opportunities during one shift.

In 5-5 and 4-4 games, more players had a null result (0 count shots or passes) than in 2-2 or 3-3 games, meaning that they do not have e.g. any shooting (SAT) nor passing attempt (PAT) during the shift. On half ice games these players tended to stay in the middle of the rink and wait for the puck. There are, however, those outlier players who are active than the others.

It seems that players can reach higher speeds when there is more distance between the nets on the ice (30 or 60 meters). This was observed during the games and confirmed by the data (Figure 25). With smaller distances between the nets, the players were observed to change direction (from offence to defense or from defense to offence) more often. It is difficult to say exactly how much a player skates in one shift by observing the games because every shift is different in the games. Players seem to skate the most meters in games where the nets are the same distance apart as in full-ice games.

The players were divided according to age level and to skill level. In these events there were those outliers who were able to get more shooting and passing attempts than the others even though the skill level was supposed to be similar. A single player had more shooting attempts in one game than in another game. This is seen in Figure 5.

One topic that came up by watching the games was the number of body contacts and player safety. The players had more puck battles in small area games (SAG) than in full length games. In SAG speeds were lower and therefore the impact of the body contact (not body checking) should be lower. In SAG players need to be more aware what is happening in the game than full ice games because the area is smaller, and the opponent is closer. This might be beneficial for skill development.

3. Discussion

The findings show how the number of players and the size of the rink influences activity and involvement in games. If you want to increase the chance and the probability for the individual player to be involved in the game and get as many puck touches as possible, 5-5 full-ice appears to be one of the most inefficient of the game formats. However, full ice games (60 meters length), provide the most distance skated in 60 seconds.

The skating is also influenced by the number of players and the size of the rink, where the player has a greater chance to reach higher speeds and cover greater distances on full ice than on the smaller surfaces. 2-2 and 3-3 games seem to increase intensity in all the rink areas.

In the last couple of years other team sports have implemented adjustments in the game formats at the youth level. Both the field size and the number of players have been adjusted to promote enjoyment, learning, and development. Increased involvement and the chance to succeed are some of the key factors supporting the structural changes to the game. For example, the Swedish Football Association has implemented new game formats, where the game is seen as the best learning opportunity. The aim is for the children to touch the ball as many times as possible and to make many decisions. In the end this will have a positive impact on skills and game understanding.

Internationally, Belgium football¹ has led the way, experimenting with both field size and player number. The focus has always been to what is in the best interest of the child, with this clear philosophy as a foundation of how they want to educate their players. For example, in the youngest ages they play 2-2.

Small area games have been the game format in Lions League in Finland for the last 15-20 years. Games have been played either cross-ice (20x30 meters) or half ice (30 x 30 meters). The decision to use those formats has been based on expert observation and by feedback from the hockey community. Now these games have been studied more closely and future decisions can be data driven.

In 2017, USA Hockey and the NHL conducted a study² to investigate the differences between full ice games vs. cross-ice games. Actions such as puck touches, passing, shots, receptions, puck battles and change of directions were counted. Their conclusion was in favor of using cross-ice games, with more repetitions and more involvement in cross-ice games when compared to full-ice games. Similar findings from a study done in Prague⁵, in Czech Republic: 5-5 is the most inefficient game format for 10U players. Studies in other sports like handball³ and basketball⁴ show how technical involvement and intensity could be manipulated by changing numbers of players on the field.

¹ Van der Haagen, Kris. Dribbling Football: How a child-centered approach led Belgian youth football from 11v11 to 2v2. *Icoachkids*. <https://www.icoachkids.eu/dribbling-football-how-a-children-centred-approach-led-belgian-youth-football-from-11v-1-into-2v2.html>

² USA Hockey, *Video Quantifies Cross-Ice Advantages*. 2019-05-30
https://www.usahockey.com/news_article/show/472676-video-quantifies-cross-ice-advantages

³ Madsen Mads. Et al. Activity Profile, Heart Rate, Technical Involvement, And Perceived Intensity and Fun in U13 Male and Female Team Handball Players: Effect of Game Format. (2019)

⁴ Markus J. Klusemann , David B. Pyne , Carl Foster & Eric J. Drinkwater (2012) Optimising technical skills and physical loading in small-sided basketball games, *Journal of Sports Sciences*

⁵ Activity tracker - 10U different structure of the game. Study of Faculty of PE and Sport Charles University, Prague.

The main findings of our study were that the number of players participating on the ice affects the technical involvement per player in the game. 2-2 and 3-3 games seem to activate the player more, as shown in passing, shooting, and in technical involvement. 4-4 and 5-5 games might increase the number of inactive players in the game. It is logical at the same time because there is only one puck in the game. The fewer players or less space you have in the game, the more involvement players probably have when playing with one puck.

However, for practical thinking just playing a game might not be the only way to practice skills. According to this data, is quite inefficient when playing single puck invasion games without any e.g. adapted rules or restrictions. In the results the best number for shooting (0,9) or for shooting attempts (1,2) was about 1 one shot a minute for an individual player. For practicing shooting a coach might need to find different ways to practice the skill he or she want to teach. It could be, for example, a drill where you shoot pucks against the board or against the GK during one minute (20-30 shots in a minute) or a more game-like drill where you can apply shooting technique in game like environment (hopefully more than once a minute). A coach should pay attention to the kind of learning environment when planning the practice to optimize number of repetitions for every player. When comparing these results to 5-5 full ice games (0,2 shots or SAT), small area games may create about 5-8 times more shooting attempts in one shift for a single player. However, there were several games where many players had no SAT (See figure 5).

Intensity increases with age and with fewer players on the ice, which results in a higher working load and more actions. U12 and U14 seem to handle the smaller rinks better than U8 and U10, which could be explained by more game experience and greater maturity, both physically and mentally. This could also be an argument to have the older players, in this case U12 and U14, playing more organized small area games.

The findings in the skating data, are also logical: when you have more space between the nets and more distance to cover, you might skate with higher velocity and intensity than playing in small space. However, the results also show that some players may reach in high velocity in the smaller space too.

In this study the young players, U8 and U10, are spending most of the time skating with low intensity. Even when playing in the full-ice game, where the chance of reaching higher intensity increases, they cover very few meters on the ice with high intensity skating. This could be one argument for creating game structures and games with low intensity, because they do not have the physical ability to skate in a high-intensity mode.

What the data does not show is the character of the skating. Even if the observations are subjective opinions, it tells that many players are skating empty, far away from the puck and not being involved. From observations the skating tends to be more complex and technical in formats with $\frac{1}{3}$, $\frac{1}{4}$ and $\frac{1}{6}$, than in the full ice format. The full ice gives the player long skating sequences, north to south, whereas in the smaller rinks the player gets challenged more, with more pivoting, turning, changing directions and a constant need to adjust the head to be aware of the position of teammates, opponents and the puck.

When playing 2-2 and 3-3 games, all the players must be active and participate in many different roles, both offensively and defensively. This might put the players outside their comfort zone where they are being challenged in a more complex way. In 4-4, 5-5 the players tend to self-impose a role

when playing. For example, some player ends up being defenseman and stays in that position throughout the whole shift. When educating players, the aim must be to give them as many tools as possible and let them try to play in different positions and situations of the game. In the end there might be a great chance for them to develop better understanding of the game.

With greater amount of technical actions in the smaller rink areas and with a fewer number of players, there are strong reasons to believe that the mental load among the players will be higher than in the full ice game format 5-5. More problem solving and decision making will increase the mental constraint on each player, an important part of the game for the youth player to develop.

From a more practical point of view, with 3-3 in two end zones, there are 12 skaters and 4 goalkeepers participating on the same sheet of ice. As when playing 5-5 full ice, there are only 10 players and 2 goalkeepers participating. This should be a more effective way of organizing games and optimizing involvement and skating time for the individual player and the team. When dividing the ice more than in two stations, the player participation will be even higher, and it could reduce the cost of ice too for single participant.

This study was very comprehensive and time consuming. The reason for studying the wide span of age groups and 25 different game formats was to increase the knowledge of different game formats. The other aspect was to create a standardization for different age groups. More data needs to be collected to make clear conclusions, especially with more of the existing skating parameters and more parameters as changes of directions, accelerations etc. However, the result shows a clear direction of how games should be organized if you want to optimize ice time, repetition, intensity and overall involvement for young ice hockey players in games.

The use of blue puck and small nets was tested but there should be more data to make any conclusions in the future. It has been observed that the blue puck might be easier for players to handle to create more shooting and passing attempts, but with limited data, it is hard to say at this point. Neither the size of the net nor type of puck, in this study, made any difference in the results and therefore should be studied further.

All the statistics were processed and produced by external parties, in Sweden Instat Sport and Catapult Sports and in Finland IIHCE (International Ice Hockey Centre of Excellence) and Bitwise. For the project it was good to have an independent view of the material and together with the data, complement this with subjective observations. Limited numbers of technical variables were included in this study, this to make the study comprehensible. More variables are available for further detailed studies.

One topic that came out by observing the games was player safety. In small area games players seems to have more puck battles and natural body contact situation than in full ice game. This observation might be beneficial for player safety in the future when skating speeds are getting higher. There is more traffic in a smaller area, so players need to observe what is happening in the game more rapidly, whereas in full ice games in these ages (U11-U12) different situation happens more slowly. This should be taken into considerations when developing programs in different Federations, Associations, or clubs.

Ice hockey is a conservative game, and many people hold the perception that ice hockey should be played 5-5 full ice, from the Pro's to the youth players. Over the last two decades the training

methods have evolved among the coaches, where training in small areas and small area games has become very important part of the practice planning. Unfortunately, the structure of organizing games has not evolved as quickly. People often are organizing events (games and/ or tournaments) with full ice format as often as rules allow it. One reason could be that the ones that make the decision of the game structure are not the same as the ones working with player development, or it could be that people do not see small area games as an official way to play games. More education and research is needed on the positive effects of the small area games. This study is giving some answers already.

Within the hockey community and other sports, there is an established conception of coaches coaching the system. Most of the coaches will train the players to be successful in the next game and will organize the practice accordingly. So, if you play full ice games, there is a strong reason to believe that the coach will practice the full ice format. If we are able to change the structure of the organized games to smaller surfaces, and player numbers other than 5-5, might we get more efficient practices and, in the end, better player development? By using small area games in the leagues, we could increase the use of SAGs in practices too.

So, what is the best game format for which age group, if you want to optimize repetition, involvement and in the end a great learning environment? There is no clear answer to this question. It depends on what you want to get out of the game. This data supports the view that if you want more shooting, passing, and puck battles, different small area games are better than full ice games. If you want to reach higher speeds and skate a bit more distance (about 30-35% more), you should use bigger surface.

To have better answers, this topic could be studied even more. From the result in this study the answers lie within smaller rinks and with player numbers other than 5-5. More studies must be made in specific age groups, but the ambition must be to try out new structures. From the data of this study together with the experience in the hockey community a best practice could be setup.

For small countries like Finland and Sweden, the player retention is the key. We cannot lose any athlete and the structure must be strong enough to keep everybody involved with the game as long as possible. Today the SIHA experiences a big drop-out among the players in the younger age groups and a structural change in organizing games could play one part in preventing this. In Finland almost 40-50% of the players who started in Lion Hockey School have quit when they turn 15. Some of these dropout players have only tried the sport, but only some.

May be the future lies somewhere between the small area games and full ice games. May be the communities with small number of the players play only in small area even though the other games are played in full ice in the league? May be those players who only want to play for fun and/ or play in recreational level play in small area instead of full ice? In small area games you need less players in the team and therefore it could be easier to set up the games. That is what people do when playing pond hockey.

When an organization, federation, or association decides to develop and experiment with different game formats, the structure, the following topics should be taken into consideration:

Player development - What type of player do we want to educate and develop? Are the settings good enough? And do we optimize the learning environment? What rules and regulations need to be applied to enhance player development?

Number of players - How many players do we have? Can we afford for players to be inactive and risk that they lose interest when not being involved in the games? Do we have enough players to form teams?

Ice time - How much ice time do we have? Do we optimize the time on ice for the players and in the end the cost for everybody involved in ice hockey?

Rink size and infrastructure – How does it look at the rinks and arenas, with size of the rink, nets, puck barriers etc. What are the practical demands when making a structural change?

Implementation – How do we implement a new structure, both politically and practically. Is it optional or mandatory? How do we evaluate the new structure?

Education – How do we educate people in our program and people who are observing our program. Do we know or do we think that we know?

A more philosophical question that needs to be answered is, “when does hockey stop being ice hockey?” Many will argue that 3-3 on a smaller rink is not real hockey, but then at the same time the top leagues in the world included Liiga (Finnish Pro League), SHL (Swedish Hockey League) and NHL play 3-3 full ice in overtime. Many of the situations in a game happen in a small space and the players need to adapt fast for changing situation like from offence to defense. By practicing and playing with fewer players in smaller spaces through the developmental years, can we emphasize and enhance the player’s abilities to manage these critical situations that occur in the full-ice game?

In Finland and Sweden and many other parts of the world, youth sport has changed both in team sports and individual sports. The hockey community also needs to start to think outside the box and try new methods to stay relevant and to attract kids, parents and other people involved in the sport. The more active people are in their countries, the stronger the different sports will be.

Further studies need to be done in this field and with the result of this study, the following areas would be interesting to add to the existing parameters.

Working load - More repetition and more actions, how does that affects the working load of the player? More movements twisting, turning, stops etc.

Mental load - With more actions on smaller areas, decision making and problem-solving increases. How does this affects the player?

Goalkeeper – Tighter rink, more shots and overall involvement for the goalkeepers, what are the effects?

Size of the nets – Should there be a change in size of the nets in different age groups and on what grounds?

Color of the puck - How the Blue puck differs from the black? Should it be same size or smaller than the regular puck?

Adapted rules – With what kind of adapted rules may you provide the most shots in a game in practice? Are we able to determine a game for each skill?

Skill Level – How these results may change or not, when playing with equal skill level or mixed skill level

4. Conclusion

In this study 25 different game formats were tested with five different age groups. When adding all the variables (space, number of players, age groups, color of the puck and net size) together there were 87 (39 in Finland + 48 in Sweden) different games that were tested. According to the results it seems that the numbers of players and the size of the rink has an effect on the player activity in the game. To enhance the number of actions, game intensity and flow, and overall involvement there should be fewer players on the ice. An increased number of players on the ice might decrease the total activity.

When increasing the rink area, the players will have more space, time, longer skating sequences, and will be less involved in the game, whereas decreased rink area will enhance the number of actions, problem solving, decision making, technical skating and the overall involvement. Smaller rink areas tend to be beneficial for both the stronger and weaker players, as the strong players get more challenged and the weaker players are closer to the puck and to the game action.

When looking at the results, you may say that most often small area games create more opportunities than full ice games. However, a coach needs to understand that every player acts differently in the game. In some games, player A will have more shooting attempts than player B and in the other game player C gets most of the shots. When using single-puck invasion games, a coach needs to understand that he or she cannot just rely on games to teach different skills. For example, in the best small area games on average, the players were able to shoot about one SAT/M. This is about 5-8 times more than in 5-5 full ice game, but a coach should understand the need to use some other drills for practicing shooting skills when seeing these results. Just using small area games in practice might not be the most effective way. At the same time playing games teaches players other things like habits or tactical elements of the game. A coach should plan what are the most important skills to teach in different years and create learning environment for those topics. You cannot teach everything at once.

The role of coach is very meaningful when running practices. There might be lots of shots in the practice, but a player D might not get any shots when the game starts. This is however a natural part of the game in pro hockey but should not be the case in development ages. The coach should see how the players act in a small area games and adjust the playing rules according those observations. This could be a next step to study small area games: which small area games with different rules would provide e.g. lots of shooting attempts for every skater?

No absolute conclusion can be drawn on which game format is best for optimizing repetition and technical involvement. We can say that 2-2 and 3-3 games most likely activate players more than 4-4 and 5-5 games. We can say that players might get more shooting and passing attempts in small area games than in full length (full ice and ½ NS Long) games. We can say that players seem to obtain higher velocities in full length games than in a smaller space.

In this study it seems evident that 5-5 and especially 5-5 on full ice format are likely to be the least beneficial if you want to optimize game time and involvement for every player. According to these findings, some rule changes will be done in Finland and Sweden for the season 2020 – 2021:

U11 and U12 age groups league games are played in 3-3 small area and 5-5 full Ice in Finland (used to be just full ice in U11 and U12) and in Sweden in 6 districts all the league games are played in small area for U11 and U12 age groups.

Appendix

Methods of statistical observations and Instat Hockey terminology

- Shot** In general, shot represents any puck, directed towards the goal intentionally. In case it is not clear whether there was a pass or a shot, the analysts consider the direction of a moving puck as a main factor. If the puck is moving towards the goal, the shot is registered.
- Pass** is a targeted movement of the puck between the players of one team. The pass can be made by a stick, hand, skate, etc., where the main criterion is a deliberate direction of the pass. Thus, if the puck is flicked from one player to another without obvious intention, the pass is not registered.
- Goal** results in the stoppage of playtime. Even if the video suggests that the puck did not cross the goal line, the goal is deemed scored when the referee confirmed it and stopped the game.
- Accurate Passes** A missed pass is recorded in the following cases:
- if the puck leaves the rink after the pass, followed by a game stoppage;
- if the puck is lost by the pass receiver;
- if the player passes the puck outside the opponent's defensive zone, when his team is positioned there. In all the other cases the program automatically records the pass accuracy.
- Puck battle** When a player without the puck gets physical contact with the puck carrier or battles for a neutral puck. Every time a player without the puck, stick checks the player with the puck.

Definitions and terminology skating Catapult Sport Systems

- Total distance** Total distance is the amount of distance covered in the session
- Distance 0-6 km/h** Standing or very slow skating
- Distance 6-15 km/h** Slow skating
- ” High-intense skating” (> 15 km/h)** Concept for all types of skating load from mid-intensity and above.
- Max Velocity** Maximum speed measured

Definitions and terminology of IIHCE and WiseHockey

PAT	Pass Attempt. A clear pass directed at a teammate.
PR	Pass Reception. A clear possession gained from a pass attempt.
SAT	Shot Attempt. A clear intent and action to shoot the puck, regardless if the puck went inside the goal posts. Sub variable SAT result includes: MISS, GOAL, SAVE, BLOCK
Activity time	Amount of wall-clock time allowed for the activity.
Game time	Actual playing time, the 'virtual' stop-time game-clock. Changes on-the-fly did not stop the virtual game-clock.
PAT/M	Pass Attempt per minute of game time.
SAT/M	Shot Attempt per minute of game time.
PR/PAT	Pass completion rate, in percent (%). Pass Reception divided by Pass Attempt.

Variables from Wisehockey Time On Ice

Shots (player level)
Skating Distance
Average Speed (Km/h)
Maximum Speed (Km/h)
Possession (team level)

Variables with Hand Notation

Time on Ice (checked against video)
Shooting Attempts (player level)
Pass Attempts (player level)
Pass Receptions (player level)
Game Time

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Appendix 1: Test event 1 in Vierumäki

MASTER PLAN VIERUMÄKI 2019									
			2008 PLAYERS			2009 AND 2010 PLAYERS			
PLAYING SURFACE	PRATICE		PRACTICE 1		TIME	PRACTICE 1			TIME
(5-5)	Full Ice	1 & 2	(3-3)	1/4 NS	15'	(3-3)	1/4 NS	Norm. Net + Black Puck	7'
(5-5)	1/2 NS	2	(2-2)	1/4 NS	15'	(2-2)	1/4 NS	Norm. Net + Black Puck	7'
(5-5)	1/2 EW	1 & 2	(5-5)	1/2 EW	15'	(3-3)	1/4 NS	Norm. Net + Blue Puck	7'
(4-4)	1/2 NS	3	(5-5)	Full Ice	15'	(2-2)	1/4 NS	Norm. Net + Blue Puck	7'
(4-4)	1/2 EW	4	PRACTICE 2			(3-3)	1/4 NS	Small Net + Black Puck	7'
(4-4)	1/3 EW	2	(4-4)	1/3 EW	15'	(2-2)	1/4 NS	Small Net + Black Puck	7'
(4-4)	1/4 EW	2	(3-3)	1/3 EW	15'	(3-3)	1/4 NS	Small Net + Blue Puck	7'
(4-4)	1/4 NS	4	(4-4)	1/4 EW	7'	(2-2)	1/4 NS	Small Net + Blue Puck	7'
(3-3)	1/2 NS	3	(3-3)	1/4 EW	7'	PRACTICE 2			
(3-3)	1/3 EW	2	(5-5)	1/2 NS	15'	(3-3)	1/4 EW		7'
(3-3)	1/4 EW	2	PRACTICE 3			(4-4)	1/4 EW		7'
(3-3)	1/4 NS	1	(4-4)	1/2 NS	15'	(5-5)	1/2 NS		15'
(2-2)	1/4 NS	1	(3-3)	1/2 NS	15'	(5-5)	1/2 EW		15'
(2-2)	1/4 EW	4	PRACTICE 4			(5-5)	Full Ice		15'
			(4-4)	1/4 NS	20'	PRACTICE 3			
			(4-4)	1/2 EW	30'	(4-4)	1/2 NS		15'
						(3-3)	1/2 NS		15'
						PRACTICE 4			
			(4-4)	1/2 EW					30'

Appendix 2: Test event 2 at Rauma

MASTER PLAN AT RAUMA	
Game Format and age group	Time
5-5 ¼ -10 syntyneet	12min /15min
2-2 ½ Täyspituus -10 syntyneet	12min /15min
2-2 ½ Täyspituus -09 syntyneet	12min /15min
3-3 ⅓ -10 syntyneet	12min /15min
3-3 ⅓ -09 syntyneet	12min /15min
2-2 ⅓ -10 syntyneet	12min /15min
2-2 ⅓ -09 syntyneet	12min /15min

Appendix 3: The list of different games

NRO:		GAME	AREA	AGE GROUP	PUCK	NET
GAME 1		3-3	1/4 NS	2009 and 2010		
GAME 2		2-2	1/4 NS	2009 and 2010		
GAME 3		3-3	1/4 NS	2009 and 2010	BLUE	
GAME 4		2-2	1/4 NS	2009 and 2010	BLUE	
GAME 5		3-3	1/4 NS	2009 and 2010		SMALL
GAME 6		2-2	1/4 NS	2009 and 2010		SMALL
GAME 7		3-3	1/4 NS	2009 and 2010	BLUE	SMALL
GAME 8		2-2	1/4 NS	2009 and 2010	BLUE	SMALL
GAME 9		3-3	1/4 NS	2008		
GAME 10		3-3	1/6 NS	2008		
GAME 11		2-2	1/4 NS	2008		
GAME 12		2-2	1/6 NS	2008		
GAME 13		5-5	1/2 NS Short	2008		
GAME 14		5-5	1/2 NS Long	2008		
GAME 15		5-5	1/2 NS Long	2009 and 2010		
GAME 16		5-5	1/2 NS Short	2009 and 2010		
GAME 17		5-5	FULL ICE	2009 and 2010		
GAME 18		5-5	FULL ICE	2008		
GAME 19		4-4	1/2 NS Long	2009 and 2010		
GAME 20		3-3	1/2 NS Long	2009 and 2010		
GAME 21		4-4	1/2 NS Long	2008		
GAME 22		3-3	1/2 NS Long	2008		
GAME 23		4-4	1/4 NS	2009 and 2010		
GAME 24		4-4	1/2 NS Short	2009 and 2010		
GAME 25		4-4	1/4 NS	2008		
GAME 26		4-4	1/2 NS Short	2008		
GAME 27		3-3	1/3 EW	2010		
GAME 28		4-4	1/4 EW	2008 and 2010		
GAME 29		3-3	1/4 EW	2008 and 2010		
GAME 30		4-4	1/3 EW	2008 and 2010		
GAME 31		3-3	1/4 EW	2008 and 2010		
GAME 32		4-4	1/4 EW	2008, 2009 and 2010		
GAME 33		2-2	1/2 NS Long	2009		
GAME 34		2-2	1/2 NS Long	2010		
GAME 35		5-5	1/4 NS	2010		
GAME 36		3-3	1/8 NS	2009		
GAME 37		3-3	1/8 NS	2010		
GAME 38		2-2	1/8 NS	2009		
GAME 39		2-2	1/8 NS	2010		
U10	2010					
U11	2009					
U12	2008					