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OFF SEASON TRAINING PROGRAM WITH NOVICE
SYNCHRONIZED SKATERS

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Synchronized skating is the youngest figure skating discipline by having its first world championships held in 2000. In Finland synchronized skating has spread across the country and has great number of amateur teams. Competition program consists of basic required elements such as circle, block, intersection, wheel, move element and creative element. Choreography, music and theme has a big role in the sport. Skater needs to be able to keep up high level and demanding technical elements while performing difficult, even dance type of choreography and all in perfect unison with 15 other skaters.

In this thesis the aim was to create a test battery that met the demands and requirements in advanced novice level synchronized skating. This thesis was made in co-operation with Turun Riennon Taitoluistelu skating club and their advanced novice team Filiae Aboenses. There was a need to test skaters' qualities to lower the risk of possible injuries that may occur due to the high amount of practice hours. Test moves were decided to be as sport specific as possible. Based on the test results feedback was given to both coaches and skaters.

The findings on the test showed poor pelvic area control, hip – knee – and ankle alignment problems and lack of flexibility in posterior kinetic chain.

Based on the results gotten from the test, off-season training program was created. The goal was to increase pelvic area control and add flexibility to posterior kinetic chain to meet sport requirements. The program was carried out during skaters' individual summer training season. Training program needed to be planned carefully so that it could be done in home setting and without equipment.

There is very little or no earlier knowledge or studies to show how to test synchronized skaters' qualities. There for this study, test battery and training program should help other professionals when working in this field.

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1 INTRODUCTION

This thesis was conducted together with Turun riennon taitoluistelu (TRT) skating club. They contacted the authors regarding their novice synchronized skating team Filiae Aboenses. Filiae Aboenses is an advanced novice team from Turku Finland, the team consist of skaters between the ages of 11 and 15. In season 2018-2019 the team has 23 skaters. The team was established in 2017, so this is its second year in advanced novice category. The team practices 7,5 hours on ice and approximately 6 hours off-ice during the basic season which is from August to April. On-ice practice includes sports specific training such as technique exercises and competition program practicing. Off-ice training consists of physical training, ballet, sports specific training as well as recovery and flexibility training. This team is aiming to move up to the junior category within the next couple of years, where practice hours increase even more.

It was decided together with TRT that the authors would be testing the team, giving feedback to the coaches and skaters and create an off-season training program based on the results of the tests.

This thesis covers the basic knowledge on synchronized skating and the demands of the sports, as well as the physical changes and development which take place in children and adolescence. The focus is on the ages between 11-15 since that is the age category the tested team falls to. The tested team's line-up is all females which is why the physical changes which may affect one's performance are only discussed regarding females. In the thesis, there is found the theory behind the test battery and each of its movements.

2 AIM AND OBJECTIVES OF THE THESIS.

This thesis aims to determine possible muscle weaknesses, dysfunctions in movement and insufficient mobility in a national level novice synchronized skating team. Objective of this thesis is to create a test battery while keeping the demands of the sport in mind. An off-season training program is created according to the results got from the test battery using an injury risk reducing point of view.

3 SYNCHRONIZED SKATING

Synchronized skating is a team sport, where all the skaters need to skate in unison (Jääskeläinen 1995, 10). Costumes and music are the ground for a competition program (Website of Finnish skating association 2019). There are lot of different levels where one can skate, novice team consists of skaters aged 10-15 years. (Website of Finnish skating association 2019) Synchronized skating is the youngest figure skating discipline, by having it first official world championships held 2000 in Minneapolis USA (Website of international skating union 2018). The sport consists of several basic elements combined with different kind of transitions. The basic elements of synchronized skating program are block, circle, wheel, line, intersection, move element and creative element. Novice team perform only free program that is 3 minutes long (Special Regulations & Technical rules 2019). “Synchronized skaters require the team skills and unison of pair skaters and ice dancers and the athleticism and artistry of single skaters to perform difficult step sequences at high speed, all while linked to the skaters next to them” (Abbot & Hecht 2013).

In Finland, there is almost 80 skating clubs and 8000 competing skaters. In skating schools, there are approximately 10 000 children. There are almost 130 different synchronized skating teams in different levels. Finland has won in total over 20 world championship medals, and eight of them are gold (Website of Finnish skating association 2019).

Top level synchronized skating demands good physical condition. Programs in advanced level are technically and artistically demanding. Learning the proper technique and knowing how to control the movements need different physic and skill qualities from the skaters. (Jääskeläinen 1995, 65)

3.1 Endurance features

In sports where performance takes two minutes or more and includes many short duration, high intensity periods, the meaning of endurance training increases. (Mero,

Nummela, Kajala 2016, 272.) Good sport specific endurance enables technically high performance (Mero et al. 2016, 335.)

Synchronized skating program is mainly interval type of performance, due to its different kind of elements, change of skating direction and change of speed during the program (Mero et al. 2016, 335). Novice free skating program is three minutes long and includes seven required elements (Special regulations & technical rules 2019, 67.) During the first minute of the program skaters' heart rate rises approximately to maximum or near to it and stays there for the rest of the program (Mero et al. 2016, 335). When the program reaches its last minutes the significance of anaerobic processes and maximal oxygen uptake increases. Good anaerobic power (explosive movements) and anaerobic capacity (tolerance for tiredness and economical movements) are the ground demands in competition program (Mero et al. 2016, 335.)

Good endurance capacity appears as good ability to resist tiredness, get oxygen and use it in the energy production that muscle work requires. Good endurance capacity helps the body to get the needed amount of oxygen and energy to the tissues and manage well on the task. (Hakkarainen, Jaakkola, Kalaja, Lämsä, Nikander, Riski 2009, 285.) When a skater has good endurance, they are able to compete and recover from long competition season and can avoid injuries (Mero et al. 2016, 336.) also the skater is able to perform good quality in practice situation (Jääskeläinen 1995, 66.) The significance of aerobic endurance highlights on the regular training season so that the skater can practice and recover from the practice (Jääskeläinen 1995, 66. & Mero 2016 et al. 2016, 336).

3.2 Power and strength features.

Power can be defined as athlete's ability to produce the biggest submaximal force as fast as one can. In most sports that include fast changes of direction or a lot of kicking or boxing movements, power is needed. (A. Mero et al. 2016, 265.) In synchronized skating athletes need plyometric training and pure power. Combining movements such as steps and turns can be done in fast phase and can include a lot of changes in

skating direction, skater needs skills and power. In power qualities synchronized skating highlights velocity skills and explosive velocity. (Mero et al. 2016, 336).

Muscle endurance and strength endurance is needed to maintain postures such as spirals and spins. Skater need all types of muscle work; eccentric, concentric and isometric. For example, in sit spin skater need eccentric muscle work while squatting down to the position. To be able to add rotation skater needs to use concentric muscle work when pulling free leg close to the supportive leg. To be able to maintain the position in the spin skater needs isometric muscle work. (Mero et al. 2016, 337.)

3.3 Flexibility

Mobility or flexibility is defined as the ability to of a joint to move through a full range of movement (Ingraham 2003, 58). Many of the movements are not possible to perform without needed mobility (Mero et al. 2016, 313.) Athlete must have as well functional range of motion. Definition to functional range of motion is the motion required to perform the specific skill (Ingraham 2003, 58). In some sports, the needed flexibility is almost hypermobility. In judgement sports, good flexibility has connection to esthetic impression and by that makes a difference in the points. (Hakkarainen et al. 2009, 264.) In skill-based sports such as synchronized skating, there are even some movements that are impossible to learn without flexibility. (Jääskeläinen 1995, 68.)

With good flexibility can be achieved the economical movements, better preparation for sport performance and get optimal muscle and tendon range of motion. Flexibility has a positive effect on injury prevention, and for example with good flexibility the recovery from sprains is faster (Hakkarainen et al. 2009, 264.)

3.4 Balance and coordination

Definition of coordination is the ability to combine the movements of muscles, joints, and limbs so that the needed movement is achieved. (Sandström, Ahonen 2011, 48.)

Coordination is the capability to absorb different movements and combine them into bigger movement patterns by using the knowledge already gathered. In synchronized skating, skater needs to control the skate, contact to the ice and the surroundings. To be able to do that skater must have good movement control, fast learning skills, and ability to use skills even in unexpected situations (Jääskeläinen 1995, 69.) Synchronized skaters need to be skilled enough to not only control own movements but to adapt to the whole team's movements. (Jääskeläinen 1995, 69.)

Ability to maintain postural balance and balance is relevant skill in everyday life as well as in sports performances. (Sandström et al. 2011, 48.) In synchronized skating skaters are balancing on the thin blade all the time and because of that it's one of the most important skills (Jääskeläinen 1995,70.) Free skating moves such as spread eagle must be held for at least three seconds in the correct position and correct edge of the skate's blade. (Communication No. 2182 Synchronized skating 2018, 27-28.) Balance isn't any specific posture rather multiple postures that can be carried out within certain space limits (Sandström et al. 2011,50). Space limits are affected by base of support, joints range of motion, muscle force and feedback from senses (Sandström et al. 2011, 51.)

4 SYNCHRONIZED SKATING & INJURIES

“During the past decade, organized youth sports has become more professionalized, as reflected by an increased training volume and early specialization” (Theisen, Malisoux, Seil, Urhausen 2014,248). Sports participation entails an increased risk of injury for elite and recreational athletes. Recent studies show that it may be possible to reduce incidence of knee and ankle injuries in adults and adolescents by using various training programs. (Barh & Krosshaug 2005, 324.) Injury incidence in youth sport is typically within a range of 1-10 injuries in 1000 hours. Risk of injury is higher in team sports than in individual sports and in competition compared to training. (Theisen et al. 2014, 249.)

4.1 Most common injuries in synchronized skating

Overuse injuries and acute injuries are the most common injuries in synchronized skating. In both types of injuries, the biggest percentage of the injuries take place in the lower extremity. In female synchronized skaters the two most common ones for overuse injuries are jumper’s knee and shin splint, where in acute injuries contusions and lacerations are the most common ones. 82% of the acute injuries happen on ice, 73,1% of on-ice injuries happen during team element practice and the rest while practicing individually. (Dubravcic-Simunjak, Kuipers, Moran, Simunjak, Pecina 2006; 27: 493-499) Poor hip abductor strength, increased the possibility to a non- contact injury. Good mobility in hamstrings was positive factor in preventing injuries, but all in all great amount of flexibility increased the risk for injuries. (Parisod 2010, 16)

4.2 Intrinsic and extrinsic risk factors

Intrinsic risk factors are dependent on the person and do not change due to circumstances such as age, gender, personality, muscle strength, previous injuries, fitness, ability to concentrate and many more qualities. Some of the risk factors are fixed but many of the risk factors can be affected and improved e.g. flexibility and motor control. (Website of UKK-institute 2019) The risk for stress injuries is partly hereditary for example regarding the structures and how much load the tissues can take (Seppänen 2010, 127).

Extrinsic risk factors are dependent on the sport and the circumstances. Some of the risks may be fixed but many of them can be affected for example safety gear. The following are examples of extrinsic risk factors: total amount of physical activity, rules of a sport, competitions, safety gear, foot-wear, rest, other people's actions. (Website of UKK-institute 2019)

5 PHYSICAL DEVELOPMENT IN ADOLESCENCE

Between the ages of 10-12 is the second physical sensitivity period which is optimal for learning sport specific skills (Miettinen 1999, 16). Young females who train certain sports, such as figure skating, start their period on average later and thus go through

puberty later compared to their peers who train different sports (Miettinen 1999, 11). When the young athletes start going through puberty, they also start a growth spurt which accelerates the growth of their limbs and therefore might make them temporarily clumsy while they get used to the changes in ranges of motion (Miettinen 1999, 17). Maximal flexibility and mobility should be reached approximately between the ages 11-14 (Seppänen, Aalto & Tapio 2010, 39; Website of Terve urheilija 2019). During the growth spurt the muscles do not necessarily keep up with the growth of the bones which is why it should be paid attention to stretching (Seppänen et. al 2010, 41). After the growth spurt good general mobility and flexibility should be maintained and training can be shifted towards improving sports specific mobility (Miettinen 1999, 17; Seppänen et. al 2010, 39). At the age of 16 the height growth starts to slow down or stops in females (Seppänen et. al 2010, 40). When the puberty progresses and gets to its end, the growth plates fuse and the spine stops growing (Miettinen 1999, 21). The hip and shoulder joint start decreasing at the age of 7-13 (Seppänen et. al 2010, 104).

6 SPORT-SPECIFIC MUSCLE BALANCE TEST

The aim for testing and evaluating athletes is to; screen their individual needs for training, optimize training, development in sport, maximizing results and staying healthy. Typical tests for basic physical features aim to screen the level of sport-specific physical features as well as motor skills, motor control and muscle balance. Different sports

require various sets of different features and there is multiple test for testing and evaluating these features. The tests used should always be chosen based to meet the demands and requirements of the sport. (Website of Terve urheilija, 2019.) Muscle balance is the dynamics and interaction between muscle strength and mobility. In sports which have a clear dominant side, it is important to train both sides equally because disturbances in muscle balance cause functional changes in the body's function and structure. Poor muscle balance noticeably increases the risk of injury. (Seppänen et. al 2010, 100-101)

6.1 Posture

In assessment observation is the inspection phase. The aim in observation is to gain information on visible defects, functional deficits and any possible abnormalities of alignment. (Magee 2008, 14) The control of standing posture and maintaining a neutral position of the thoraco-lumbar spine are prerequisites for a back's health. There should be found some rotational movement from the lumbar spine which is needed in certain sports for example synchronized skating and extreme positions of the lumbar spine like an over exaggerated lordosis or a very straight lumbar spine decrease the rotational movement. If the position in the lower back is not neutral, the load is not distributed optimally on the spine. Metabolism of the intervertebral discs is dependent on these small rotations which is why correct posture and restoring the normal movement is important. (Sandström & Ahonen, 2011. 176)

6.2 Single leg mini squat

Single leg mini squat test is used as a functional and dynamic real-time screening tool. (Junge, Balsnes, Runge, Juul-Kirstensen, Weddekopp 2012, 2.) Testing single leg mini squat to evaluate of postural orientation of the knee, ankle, hip and trunk strength has shown good results. (Junge et al. 2012, 2.) Single leg mini squat as a movement can be seen in everyday life functions such as walking and running. In sports such as hockey or gymnastics single leg mini squat is used a lot (Bailey, Selfe, Richards 2010,18). Single leg squat test is used mainly in evaluating individuals with lower

extremity dysfunction, most commonly with knee patients (Bailey et al 2010 & McGovern, Martin, Chrisofretti, Kivlan 2018) Yet the test can be used to assess several nonconformities in hip, pelvis and trunk performances (McGovern et al. 2018, 527)

In the test, tester can observe quality of the movement. Studies has shown that faulty alignment of the knee in sagittal plane can increase risk for anterior cruciate ligament (ACL) injury (Ageberg, Bennell, Hunt, Simic, Roos, Creaby. 2010,2). Single leg mini squat test has shown moderate to excellent reproducibility with children aged 9-10 and 12-14 years. (Junge et al. 2012, 4)

6.3 Passive Mobility test

Passive stretches are beneficial for athletes in sports where extreme flexibility is needed (Seppänen et. al 2010, 111). One of the elements in advanced novice program is move element, where team needs to show different kind of free skating moves. Free skating moves requires extreme flexibility and are not counted if the position doesn't meet the requirements. Depending on how difficult level the team wants to have the more variation there needs to be in the positions (ISU communications No. 2182 SYNCHRONIZED SKATING)



Picture 1. Marigold Ice Unity performing upright extension free skating move. Picture taken by Sari Niskanen

To get upright extension (Picture 1) skater glides either forward or backward, inside or outside edge. Body must be upright with the supported leg and at least 170° angle to the skating leg (ISU communications No.2182 SYNCHRONIZED SKATING).



Picture 2. Helsinki Rockettes performing Biellman free skating move. Picture by Sari Niskanen

In biellman position (Picture 2) skater need to have free foot pulled from behind to a position higher to head and towards to the top of the head, close to the central axis of the skater (ISU Special regulation & Technical rules, synchronized skating, 2018).

6.4 Overhead deep squat

The deep squat test challenges whole body mechanics when performed correctly. Deep squat is used to test bilateral, symmetrical and functional mobility in the hips, knees and ankles. Stick held over head adds assessment of bilateral and symmetrical mobility of the shoulder and the thoracic spine, and stability and motor control of the core muscles (Cook, Burton, Hoogenboom, Voight 2014, 401). Deep squat is an exercise to increase muscle strength, stability, trunk control. It allows the recruitment of multiple muscle groups in a single repetition. Deep squat test is a low-cost, and easy to perform test in different places. (Dos Santos Bunn, Paula Silva, da Silva 2018, 2.) To be able to perform the deep squat test, it requires closed kinetic chain dorsiflexion, flexion of the knees and hips, thoracic spine extension and flexion and abduction of the shoulders. (Cook et al. 2014, 402) The factors that can be evaluated in deep squat are the presence of lateral deviation of the pelvis, range of motion, excessive trunk flexion, elevation of the heels in relation to the ground, hip adduction and equilibrium losses. (Dos Santos Bunn et al. 2018,2.)

7 SPORT SPECIFIC MUSCLE BALANCE TEST-DAY

The movements in the test battery were chosen to test the qualities required from a national-level skater to perform elements clean. In addition to this, the tests aim to evaluate the qualities of the skaters, in order to be able to take part in the required number of training-hours safely without an increased risk of (stress) injury and minimize the risk of injury from e.g. lack of muscle strength and control.

The team was tested during two different days all in total there were 23 skaters. Both days skaters had an on-ice practice before the tests. Tests were held at the ice hall dressing room both times. The skaters came to the testing room one at a time. While one of the skaters was tested, the team's own coach held a light recovery type of training off-ice at the same time. The skaters were asked to take their shoes and socks off. The skaters were told to wear tight leggings, a sports bra or a skin-tight top. The skaters

were told that we were doing a few tests and the testers were going to be speaking to each other during the tests and all the things said would be explained to the whole team after the tests.

In the beginning the skaters were asked their name and age. One tester was instructing the skaters throughout the whole test, and the other tester assisted when needed and wrote the results down to ready-made test sheet.

7.1 Posture

First the skater was asked to march on spot and stop when the tester says. The aim of the marching was to get the skater to relax and stand in a natural posture. The posture was checked by both testers for the natural lordosis and kyphosis of the spine. Also, possible asymmetries were observed. Main aim was to determine possible issues with postural control and factors which could affect the skater's movements.

7.2 Overhead deep squat

The first tested movement was overhead deep squat. This movement was decided to evaluate shoulder, hip and ankle mobility and the quality of the movement control. In synchronized skating, it is important to have good mobility in shoulder area, due to the fact that skaters are holding each other in the program. Tightness in shoulder area can have an effect on the skating posture in a negative way which can lead the skater to compromise the optional skating posture and to use more effort to the posture. Additionally, some of the free skating moves such as biellman demands good mobility from the shoulder joint. Good ankle mobility is needed when performing strokes, cross overs, steps and turns. When skater is in basic skating position there is flexion in the knees and dorsiflexion on the ankles, if ankle mobility is decreased skater needs to find compensation from somewhere else, usually from flexing the hips, in order to get the balance. Skaters need to have good control in pelvic area to be able to maintain good posture. Pelvic control has a great role in controlling whole skating posture and balance.

For the starting position the tested subject was instructed to take a grip of the dowel approximately shoulder width and straighten arms so that the stick is above head. Tested subject was asked to stand in hip- width position, toes directing straight ahead. When performing the test movement tested subject was asked to squat down while keeping the stick above their head. From this test, we evaluated three main points; can the tested subject maintain contact of heels with the floor while in deep squat position, can the tested subject keep the stick above head throughout the whole movement and how well the tested subject can keep the knee alignment. The observations are done in three different views; front, back and side in order to get proper knowledge of the movement. Test move will be performed six times, so that the tester can observe two times from front view, two from the side and two from the back. As well for the tested to get a little tired and by more tired muscles to show some errors that may not be seen during the first repetition.

7.3 Single leg mini-squat

The second test move was the single leg mini squat. Almost all movements such as walking, running and skating includes mini squat movement. In synchronized skating, skaters need to be able to perform multiple mini squats on one leg for example when performing a step sequence that needs to be done on one leg. Skaters have a lot of running during their off-ice practice, so the amount of repetitions of mini squat movements are high with the skaters.

The skater was asked to lift their other leg up and bend the knee to 90°, then they were asked to squat as if they were sitting down on a chair. The test was done bare foot and hands placed on the hips. Standing leg performed mini squat, non-supporting leg was held in 90 degrees knee flexion at the same time. All the knee angles were evaluated based on the norm's testers agreed on beforehand. Test movement was executed three times each leg, and the tested subject got three practice trials before the test. Tester observe abnormalities in the movement which are arm swing, Trendelenburg's sign, losing control of the pelvic girdle and losing control medially of the standing leg knee.

7.4 Mobility

After the active test, there were the passive mobility tests for both posterior and anterior kinetic chain. It was decided that no exact measuring tools would be used in these tests since during a competition performance the judges only look at the angles in positions from the side of the ice rink. The angle in each test was measured only approximately by looking and based on the norm's testers agreed on before the tests. For mobility test the most demanding positions which require the most flexibility was chosen. Based on the values, test moves were decided by the testers in order to meet the sports' requirements and to be easily tested within small amount of time with a large group. The posterior kinetic chain test was based on the upright extension free skating move, where skater needs to have 170° between supporting leg and the skating leg. The skater was asked to go lay on their back on the plinth and to stay relaxed and let the tester do all the work. The tester brings the straight leg towards the skater's ear as close as it goes without the other leg coming off the plinth's surface, then the second tester checks the angle between the legs to see if it is 170° or more in order to get a pass from this test. For biellman free skating move, the skater needs good mobility from hip extensor muscles. Anterior kinetic chain test aims to evaluate in a sport specific way the flexibility in hip extensors. The skater was asked to turn to prone lying and be as relaxed as possible and let the tester do all the work. Tested sides' knee is flexed while other leg is laying straight on the surface. Tester places one hand under the flexed knee to be able to lift the tested side leg up. The other tester is holding the testers hips stable, by placing both hands approximately to posterior superior iliac spine. Flexed knee was lifted from the surface to meet approximately 45° hip extension.

7.5 Feedback

After the test day we went through the results and main findings together. After we had a clear understanding on the results and main problems, we booked a time with the head coach of the team to discuss and inform what we found in the tests. Feedback was given by one of the authors. The goal in the meeting was to inform coaches with

the main findings and where they should pay attention on when planning and carrying out the training plans for the team.

The feedback for the skates were carried out during practice and all skaters got individual feedback. Skaters were let known the results by what was good, and what needs more focus. Both individual feedback and coaches' feedback was given before the off-season training program, with the idea of them being able to pay attention to the findings as soon as possible.

8 RESULTS

All the data is anonymous, no-one can be recognized from the data published in this thesis. Each of the skaters had to return a written permission from their guardian in order to take part in the testing. One of the hypotheses towards the test results was the absence of gluteal muscle activation and control of the pelvic area due to seeing the skating team during their on-ice training previous to the testing as well as poor hip-knee alignment due to the fact that skating booth passivates ankle muscles. The tests confirmed that the control of the pelvic area was poor, 16 out of 23 skaters had positive Trendelenburg's sign as well as lateral dropping of the hip on the non-supportive side with 20 out of 23 skaters while having their left leg as the supportive leg (Figures 1 and 2). Test confirmed the poor control of the hip – knee alignment, when 10 out of 23 skaters had alignment difficulties (Figures 1 and 2).

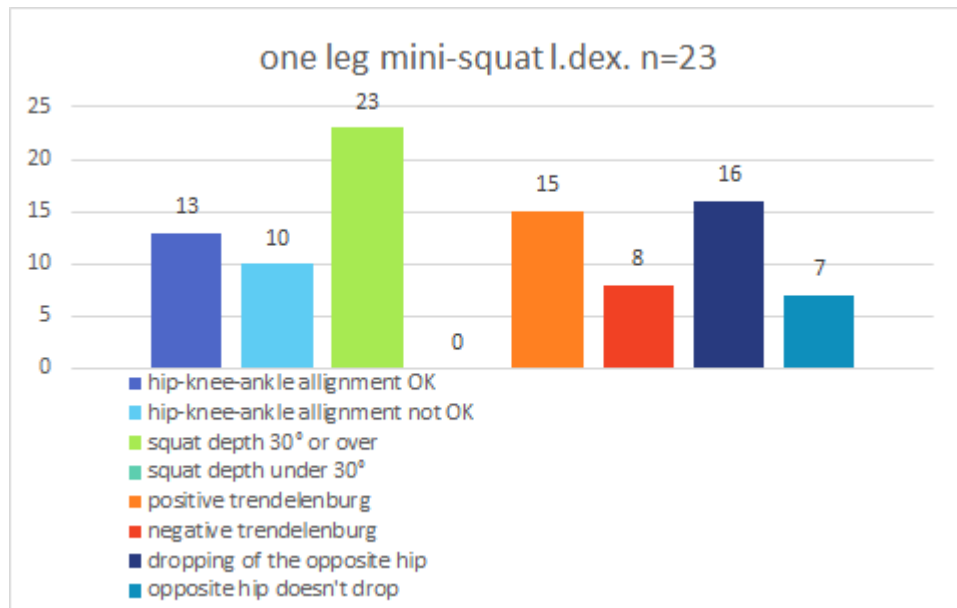


Figure 1.

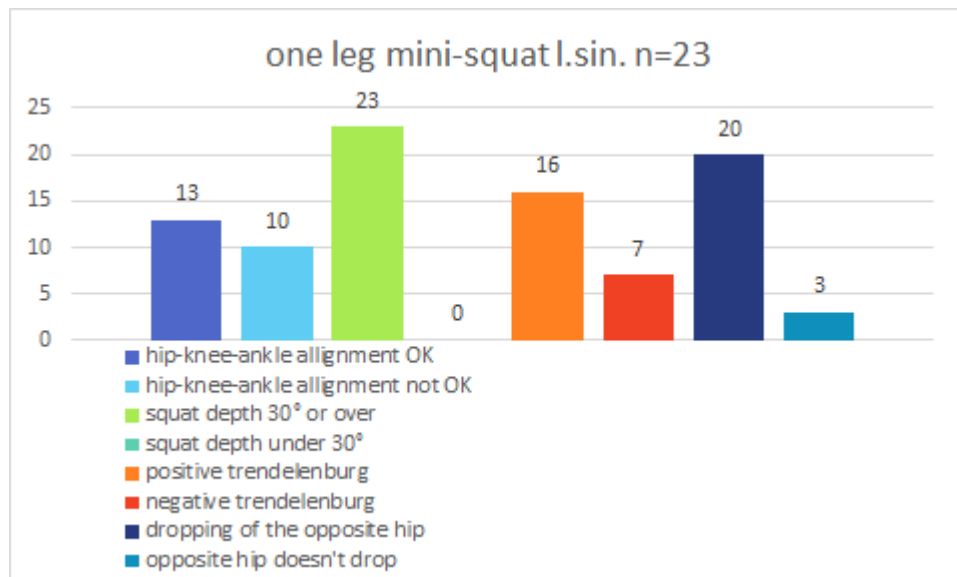


Figure 2.

Before the test day, it was assumed that posterior kinetic chain mobility test would have better results than anterior kinetic chain mobility test. As the results show, only two skaters did not meet the requirements of the anterior kinetic chain test (Figure 3).

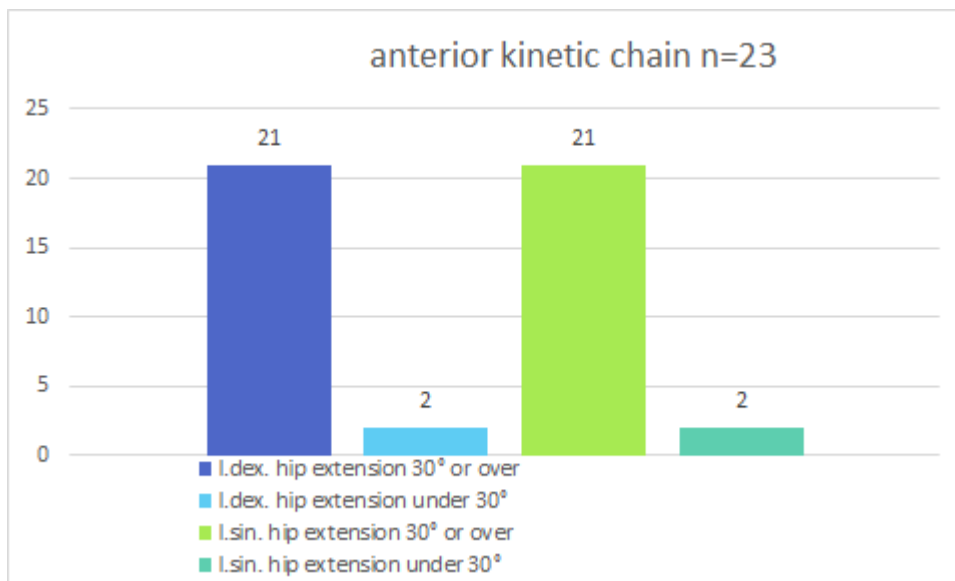


Figure 3.

At the same time only nine skaters with left side and five with right side was able to meet the requirements set to posterior kinetic chain test (Figure 4).

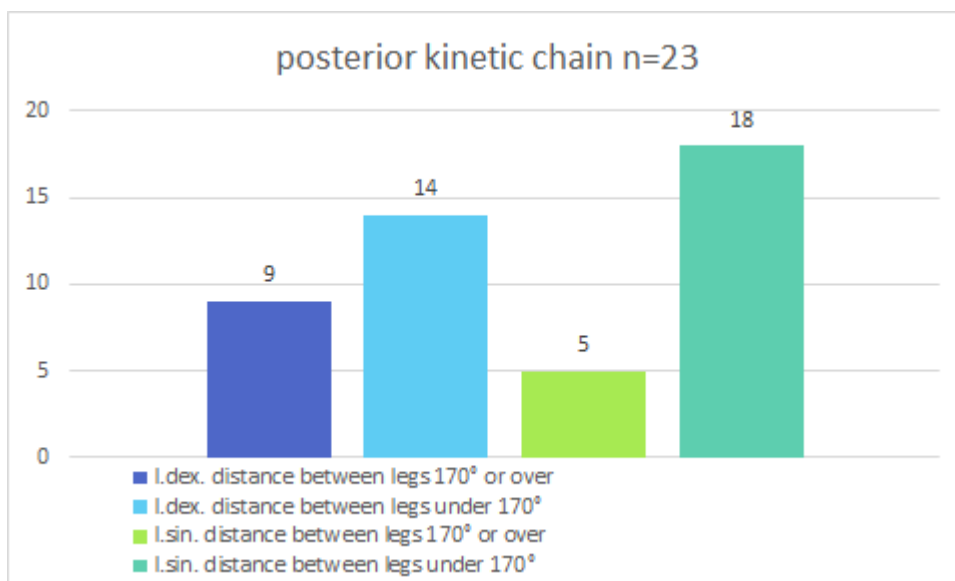


Figure 4.

In overhead deep squat test 21 out of 23 skaters were able to maintain heel contact to the ground, but 17 skaters had difficulties with hip-knee-ankle alignment (Figure 5).

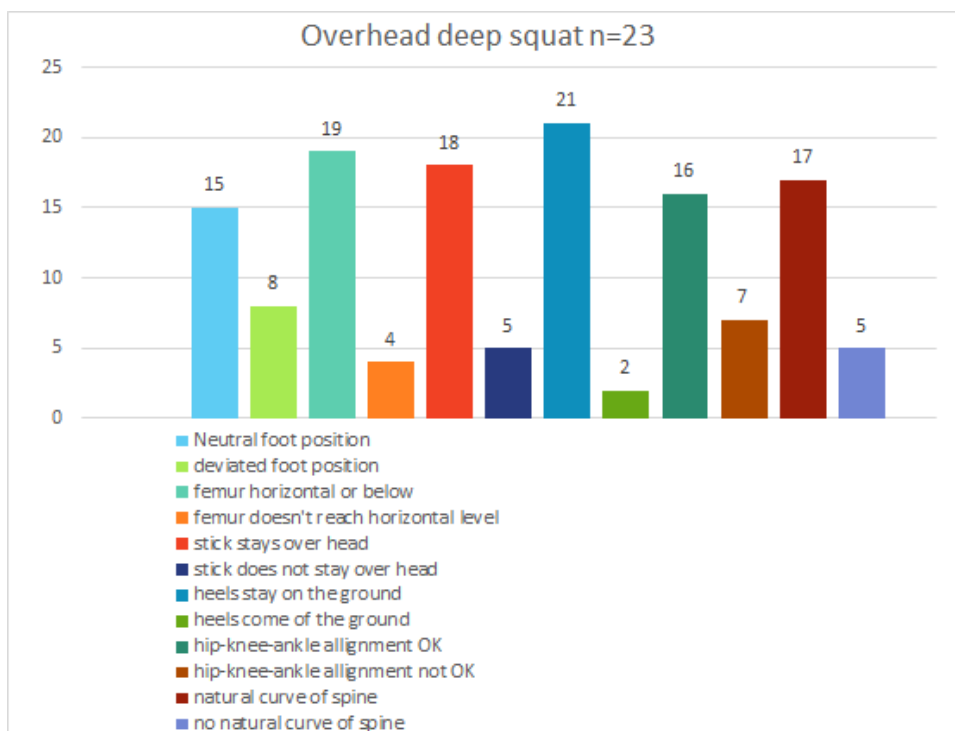


Figure 5.

18 skaters performed overhead deep squat with dowel above head (Figure 5). As assumed all 23 skaters did the single leg mini squat test to the 30° squat depth with both sides (Figures 1 and 2). Some asymmetries were shown in the test results such as left side had more opposite side hip dropping, during single leg mini squat, than in right side (Figures 1 and 2). As well some side differences can be seen in posterior kinetic chain test where on the left side 18 skaters did not meet the requirement while on the right side there were only 14 skaters who did not meet the requirement (Figure 4).

9 CONCLUSION

The main aim of this thesis was to determine possible muscle imbalances, dysfunctions of the movements and insufficient mobility with national level novice synchronized skating team. To be able to do this the authors needed to get familiar with the already existing theory concerning our topic and based on the theoretical knowledge and sport specific knowledge we created a sport specific muscle balance test. After performing the test, the authors went through the results and created an off-season program targeting the issues shown in the results.

In early stages of the process it could be seen that there was a need for this thesis. The tested movements were decided by the authors based on literature, based on the basic knowledge of the sports demands and by knowing little background of the tested team skill level.

From the test, it can be seen that there are some majority issues with pelvic area that concerns majority of the team such as poor control of the non- supported hip and positive Trendelenburg sign while performing one leg mini-squat on both sides or poor hip- knee- ankle alignment while performing the overhead deep squat.

Also, easily seen from majority of the tested was sufficient range of motion during the active tests such as overhead deep squat and one leg mini-squat. All skaters could perform the needed knee angle during one leg mini-squat. Also majority of the skaters

were able to maintain the heels in contact with the ground and keep the stick above the head in overhead deep squat.

Passively tested mobility gave results on the differences between anterior kinetic chain and posterior kinetic chain, when only two of the tested group did not meet the needed hip extension in anterior kinetic chain test. While in posterior kinetic chain test showed more tested subjects who did not reach the needed angle between the legs. In addition in posterior kinetic chain test there could be seen some imbalances between the sides when over a third of the tested group couldn't meet the requirements on the right side while only little less than a third of the tested did not meet the requirements on left side.

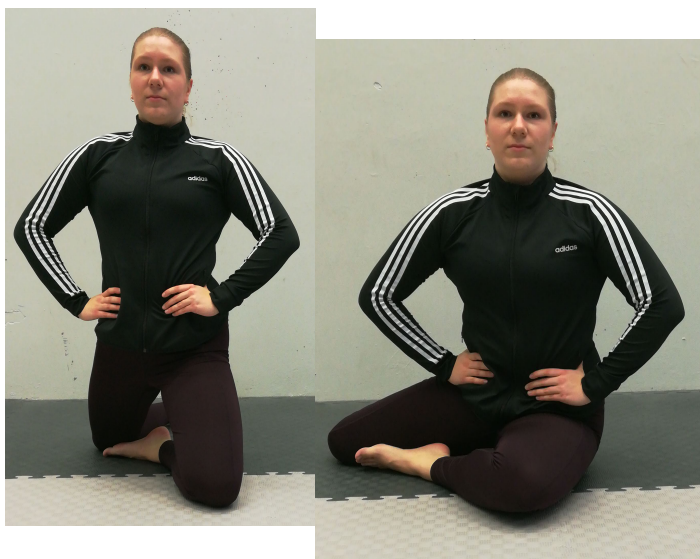
As seen in the results the movements that were tested gave good results and gave authors enough information to be able to create the off-season program.

10 OFF-SEASON TRAINING PROGRAM

Off-season training program was created based on the test results and the movements were targeted on the main problems. Results showed similarities on the weaknesses and majority of the skater had same problems, so all the skaters got the same program.

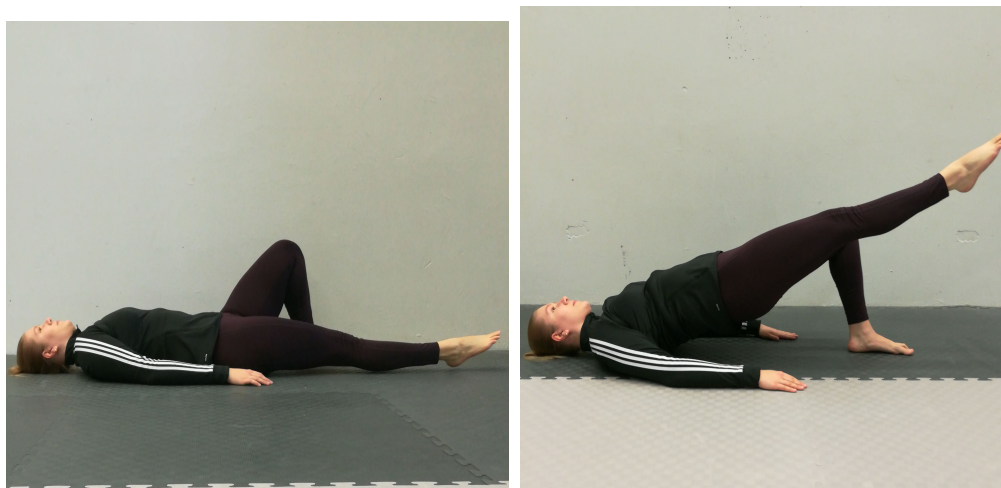
The program is for the skaters' individual off-season period during the summer break that is six weeks all in total. They will do the program once a week. Main goals for the training are to gain more stability on the pelvic area, as well to increase mobility on the upper limbs. Program consists of three parts; one that focuses on the pelvic girdle stability, one is for lower limb mobility and last one is for the upper limb mobility. The training program was taught to the skaters during the first week of their summer training in June 2018. The program was taught by one of the authors. First the aim of the training program was briefly explained to the skaters. After that the program was taught move by move. First it was shown and explained and after that skaters got to test the movements so that they are performed correctly. The movements and instruction were filmed and sent to the skaters, so that the skaters themselves were performing the movements in the videos.

Pelvic area stability part has five different movements. First movement is called the mermaid exercise (Picture 3), that targets hip external rotator muscles both mobility and stability. Starting position is sitting on the ground one leg externally rotated from the hip and flexed from the knee, placed in front of the body. Other leg is internally rotated from the hip and knee flexed placed on the side of the body, both shin in contact to the floor. The aim in the movement is to maintain the connection to the ground with the shin while extending hip and move body center of gravity from gluteal area to in line with the lower limbs. From the extended position, the movement is slowly returned to the starting position. Skaters are instructed perform this movement both sides fifteen repetitions and three times.



Picture 3. Mermaid exercise, anterior view.

Second exercise is the pelvic lift or the gluteal bridge exercise for hip extension and transversus abdominis activation (Picture 4). It was decided to perform with one leg to add challenge. Starting position is supine lying, knees and hips flexed and feet on the ground. First part is to activate the transversus abdominis by performing a posterior pelvic tilt that is held through the whole exercise. From this position one leg is lifted from the surface and knee is extended through all repetitions. Following this, hips are extended by the supporting leg. Given instruction is to maintain hips in level both the supported and non-supported side. From the extended position, slowly with good control over the movement returned to the starting position.



Picture 4. Gluteal bridge, side view.

Next movements are variations of star excursion exercise. All the variations are performed in front of a mirror to give instant feedback on the quality of the movement. First variation (Pictures 5 and 6) is done with straight supportive leg, which aims to increase balance and static postural control of the supportive leg as well as challenging the activation of transversus abdominis by maintaining posterior pelvic tilt. Free leg knee is actively extended through whole exercise. In starting position both legs are fully extended but only one leg is in contact with the ground. From this position, free leg is performing a movement to the front by hip flexion and return to the starting position. Next free leg is moved to the side of the body by hip abduction and last behind the body by hip extension. Skaters are instructed to focus on the supportive side pelvic area so that there is no lateral tilt while performing the movements. This exercise is focusing on the movement quality and instructions for the repetitions are so that when skater feel that the quality is not in needed level, there is enough repetitions. Throughout the six weeks period it is assumed that the amount of repetitions is increasing from the first weeks.



Picture 5. Star excursion, side view.



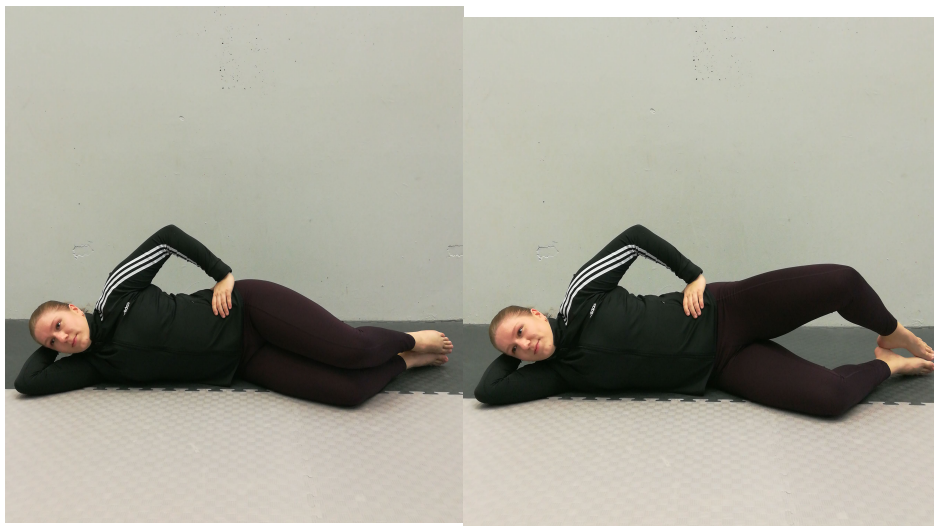
Picture 6. Star excursion, anterior view.

Second variation is star excursion with lunge movement (Picture 7). This variation, one leg is kept in the center of the star and the other one is performing the movement to the front and back. Starting position is in the middle of the star, legs next to each other and hands placed on the hips. First lunge takes place in the front. From this lunge position, the movement returns to the starting position.



Picture 7. Lunge excursion, side view.

The last movement is called the clam exercise (Picture 8). Starting position is side lying, knees flexed approximately to meet 45° . From this position, the upper leg is externally rotated, while keeping feet in contact to each other, and return to the starting position. The main point is to focus on having a good control in pelvic area while doing the external rotation. There shouldn't be any movement in the hips during the exercise. Skaters are instructed to focus on keeping the posterior pelvic tilt during the exercise.



Picture 8. Clam exercise, anterior view.

The other part for the program was flexibility exercises. As seen in the results skaters had tightness in the posterior kinetic chain, it was decided to include stretching to the individual program. First one was dynamic stretching for hamstring muscles (Picture 9). Starting position is feet mildly apart from each other, upright position. From the starting position, hips are flexed, upper body bends down, legs extend, and one leg takes small step forward. While in the stretching position skaters are instructed to perform small pumping movement. Skaters perform approximately eight to ten steps all in total.



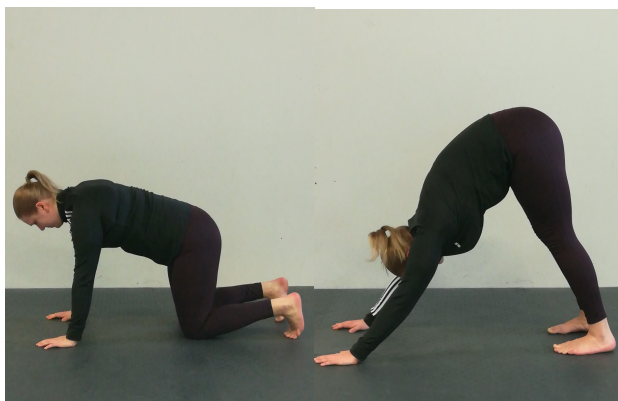
Picture 9. Dynamic hamstring stretch, side view.

Next stretching position was a split (Picture 10). This one was decided to add more sports specific way to add flexibility. It was instructed to be done always after proper warm up and to do the stretching both with arm support and without it. In split position one leg is placed anteriorly to the body and other is placed posteriorly to the body. Center of gravity should be in the middle of the legs. Both legs should be knees extended and trunk extended. Front side hip should be in flexion and ankle in dorsiflexion. Posterior side hip in extension and ankle in plantar flexion.



Picture 10. Split, side view.

In addition to poor posterior kinetic chain flexibility it was decided to include calf muscle stretches (Picture 11). Main aim is to add flexibility to gastrocnemius muscle and soleus muscle as well as to add flexibility to whole posterior kinetic chain. The starting position is on all- fours, from this position one extends both arms and legs and flexes hips. Ankles stays in dorsi flexion and the main aim is to keep heels in contact with the floor.



Picture 11. Calf muscle stretch, side view.

11 THESIS PROCESS AND METHODS

This thesis process started with the opportunity to work together with Turun riennon taitoluistelu (TRT). It was decided together with TRT to do testing and then create an off-season training program for the team Filiae Aboenses based on the results of the tests. In the beginning of the process the authors read theory on different muscle balance tests, fitness tests, synchronized skating as a sport and most common injuries among synchronized skaters. A study plan was created and presented to the authors' peers and teachers. When the study plan was accepted, the authors started looking for and writing more specific theory which would be the base of our thesis. The test movements were decided by concluding which were the best for the test battery and the plan on how the test days would be conducted was created. The schedule and plan for the test days were quite strict due to the times suitable for testing being very limited and the sample size being relatively large. Next, the test results were gone through with the skaters and the planning and working on the off-season training program begun. Before the skaters finished their season, the off-season program was gone through with

the whole team. When the whole practical part was done, the authors started writing the practical part out and the rest of the theory.

Table 1. Working phases and timeline of the thesis process

Work phases	Timeline
Deciding the topic of the thesis	January 2018
Accepted study plan and signed thesis agreement	January - February 2018
Reading and writing theory	January – June 2018
Deciding the test battery movements	January - February 2018
Test days in Turku	February 2018
Going through test results	March - April 2018
Creating an off-season training program based on the test results	May 2018
Going through the off-season program with the team	June 2018
Writing the practical part and rest of the theory	August 2018 – April 2019
Presenting the thesis	April 2019
Maturity exam	April 2019

The thesis is a practical thesis. A practical thesis includes a product which can be a leaflet, video, event, guide or something else. A practical thesis also includes a report or a written part where the process is documented. The practical and written part go hand in hand throughout the whole thesis process. (Airaksinen 2009.)

Theory and information used were found in studies and literature. All the data is anonymous, and no skaters can be linked personally to any data shown in the thesis. The subject in the pictures of the training program is one of the authors and the pictures were taken by the authors.

12 DISCUSSION

As a learning process, the combination of getting know to the sport and creating a test battery to match team's level and demands and by the results creating a training program challenged the authors to develop their theoretical knowledge towards the topic. Only one of the authors was familiar with the sport beforehand, which created a slight challenge in the beginning of the process, it was also a good thing because it gave a new fresh view on things. The practical part gave the authors valuable experience in carrying out whole test from beginning to the end with feedback meeting and analyzing the results. A lot was learned from the skaters, how to interact with that group of 11-15-year-old girls in a situation they are not familiar with. The authors' practical skills were in needed level when performing the test and so it was possible to get similar results from each skater.

When planning the test movements, the environment needed to be taken into consideration. The movements needed to be simple enough to perform because there was limitation with the equipment that we could have at the test room since the test were held in a dressing room. During the test there was a little concern over the implementation within two different days. Skaters were informed not to talk about the test moves so that all the skaters could have the same starting point when coming to the test situation, but two different days created an opportunity to talk about the test during their free time. Overall the skaters talked very little about the test or how they performed in it to each other, between the two test days.

The co-operation with the authors of this thesis worked well trough out the whole process. It was clear for both which areas of practical part and writing they were responsible for. During the test days the roles were clear, while the other was carrying out the tests, other was assisting and writing down the notes. When giving the feedback, both had a mutual understanding what was informed to the coaches and skaters and who was supposed to carry out the feedback meetings. Different sport backgrounds of the authors gave good discussions and ideas while creating the training program, so

that it could be as versatile as possible. The authors of this thesis worked most efficiently while being in the same room with each other or being in contact through a phone call while writing. This created an issue due to the authors' daily schedules overlapping and them living too far away from each other to have had face to face meetings regularly.

The tests carried out were first test that the team has had, and it can be seen in the results that the tests were needed. By the results the test gave it could be seen that there were some issues almost all skaters struggled with and needed intervention training program. Timing of the test was a challenging because it needed to be carried before the new season starts, which left the authors with the only a few weeks break from competitions. The fact that test was carried out during a competition season could influence the results. Also, the fact that skaters had ice practice before test could have an impact on the results and create some differences between skaters, because there is no guarantee that the previous practice has been the exact same and the training intensity has been similar both days.

Synchronized skating is a young sport and has very little research done, and there is no existing test pattern/battery for synchronized skaters which created some difficulties in gathering the theory part for the thesis. It was needed to look a lot to the demands of the sport and what is required from the novice skaters during the competition program in order to decide the needed test moves. The use of rule book and list of technical requirements was necessary to get strict information from the sport's demands. The authors used theoretical knowledge outside of the sport and implemented it to suit our demands and goals. The authors had to make clear goals on what was wanted to achieve from the test moves in order to keep the number of movements at a reasonable amount which could be done with a large group in a limited amount of time.

The aim was to have a test pattern that gives us enough information on most used movements or postures in skating. The idea was to have few movements to show clear movement control or alignment difficulties in easy to perform way. In addition to this the authors wanted to test the skater's flexibility in certain movements that with the co-

operation and discussions with the team coaches we knew would be trained the following season. For movement control test moves there were a lot of different movements that measures the wanted qualities but did not meet the basic requirements of the sports. Finally, the authors needed to compromise with the movements and make small changes to the way the tests were carried out, so that they would match the level the tested skaters were at. The outcome of the test moves that measured the movement quality was good and gave the results that were wanted and expected. For mobility testing the rules of free skating moves were strictly followed since the flexibility tests that already exist do not meet the needed angle of degrees in flexibility and would not give the needed result. Number of tested skaters was relatively large (n=23) and the time the authors had was limited to two days creating a need to have well scheduled test days.

One of the aims of the thesis was to create an off-season training program based on the test results. By the results test gave, it can be agreed that the test moves were adequate and gave good information that could be used when creating the training program. The results gave information concerning skater's movement control deficiency and muscle imbalances. After the authors had gone through the test results and based on the findings, the movements for the training program were decided on. When deciding the movements, there was a need to consider the level of the skaters. Movements and exercises needed to be suitable for them to perform without guidance and instructing but they need to be demanding and challenging enough. The off-season training is usually executed in home settings or in summer cottages without any specific equipment, and that was one more factor to take into consideration. Based on the results it can be acknowledged that there was a need for this study.

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Suostumuslomake lihastasapainokartoitukseen

Hei,

Opiskelemme Satakunnan ammattikorkeakoulussa fysioterapiaa ja teemme yhteistyössä Turun Riennon Taitoluistelun kanssa opinnäytetyön Filiae Aboensesin lihastasapainokartoituksesta ja kesäharjoitteluohjelmasta. Kartoitus sisältää nopean ryhtitarkastuksen, lihastasapainoa mittaavia liikkeitä, sekä venyvyys osion. Tarkoituksena on saada tietoa luistelijoiden valmiuksista tulevien kausien, sekä ohjelmien sisältöön ja sitä myötä luoda turvallinen ja kehittävä kesäharjoitusohjelma.

Kartoitukset suoritetaan 18.2.2018 tai myöhempänä ajankohtana, jos ko. päivänä ei ole paikalla kuitenkin ennen kauden vaihtoa. Testeihin osallistuminen vaatii suostumuslomakkeen täytön ja palauttamisen testeihin tullessa. Toivomme että kaikki osallistuvat kartoituksiin. Opinnäytetyötä ohjaavat (ft. TtM) Maija Kangasperko ja (ft. TtM) Mari Törne. Jos heräsi jotain kysyttävää ottakaa rohkeasti yhteyttä.

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() Huollettavani _____ saa osallistua Satakunnan ammattikorkeakoulun fysioterapian opinnäytetyön kartoituksiin keväällä 2018.

Allekirjoitus ja nimen selvennys

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