

**Effect of velocity power principle done strength endurance training
for 54 wk training period to adolescent soccer players**

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Degree programme

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<p>The title of your thesis Effect of velocity power principle done strength endurance training for 54 wk training period to adolescent athlete's performance level.</p>	<p>Number of pages and appendices 44 + 4</p>
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<p>Aim of this thesis was to study the effect on adolescent soccer players, how ones a week done strength endurance training with velocity power principle, effect on the player's performance level.</p> <p>With this research was also studied if ones a week strength training is enough, or is there need for more training those how are more developed than others. With this method soccer players trained for 54wk. Same time players did heart rate controlled sport specific training tree to six times a week. To the study participated n=18 adolescent soccer players, all of them participated to the full time period.</p> <p>Results: increase happened on every trained area inside the groups, the results had significant increase in average change pre cent. Significant change was noticed in power and anaerobic capacity. Average change value in half squats total performance power was increased 52, 1% and in average at firs 15 seconds there was found 40, 0% increase.</p> <p>Conclusions: training with velocity power principle the strength endurance and sports specific abilities seem to develop with small increase of body weight. The vertical power performances of the lower extremities tend to increases. The movement economics gets better which gives to the athlete better changes to last longer in the game/event situation.</p>	
<p>Key words Speed, Strength, Power, Velocity power principle</p>	

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1 Introduction

Training studies on soccer with individual training program and control of training intensity are rare. This study will follow Finnish third level boys soccer team (n=18, boys) training for 54 weeks starting with base training period in December to April and finishing it to game season in October. Soccer specific performance tests were carried out for training prescription and for performance follow up. Training program included endurance, speed, jump, strength and soccer specific training. All tests and trainings were manually heart rate (HR) controlled. In this study I examined if heart rate controlled training have benefits to the strength out put.

The soccer game is two 45min periods with 15-20min half time, so half game totally is 90minutes plus 15-20min recovery time between the half's. It has been studied that 75 % of the game is aerobic alactic movement and rest is aerobic lactic, anaerobic alactic and anaerobic lactic. From this remaining 25 % eighth (8 %) present happens on the anaerobic levels. (Bangsbo J; 2003: 57–99) There are studies done from soccer and heart rate in training and in game situation. In Fitness Training in Soccer there was written, the players moved 28% of practises with heart rate 50-115, 68% 115-170 and 9% 170-190 beats per min and in the game 9% 50-115, 68% 115-170 and 28% 170-190 beats per min. So this study leaves out the importance of increasing the maximal performance level. (Bangsbo J 2003, 57–99.) In the study Soccer specific aerobic endurance training written by Hoff J et al (2001), they found that heart rate monitoring in soccer training is valid to achieve the optimal level of increase the VO₂max and to keep the intensity of the training on the right level. (Hoff J 2002, 36, 218–221.)

Finnish study was done on soccer players to see if neuromuscular aspects have affect to the 20-m shuttle run test result. Häkkinen and consociates find out result was that neuromuscular abilities have an affect to the result. (Häkkinen K. et al, 2007). In my on thesis study I try to solve if whit velocity power principle done strength training improves the player's performance capacity. As using maximal speed in the movement, the training pattern involves maximal amount of motor plates. So this training system should improve the neuromuscular capacity.

The major benefits of resistance training for adolescent are following:

Resistance training increased muscular strength, power, and local muscular endurance (i.e., the ability of a muscle or muscles to perform multiple repetitions against a given resistance). Decreased injuries in sports and recreational activities, and also improved performance in sports and recreational activities. (Fleck J. et al, 2004, 288)

On phase of Fleck I have used resistant training on adolescent soccer players and as training methodology velocity power principle and in the study the players fulfilled all three Fleck's major benefit points.

2 Theoretical framework

Almost in every sport increase of strength has led to higher results in last twenty years. From the coaches point of view it is difficult to train strength so that it is sports specific strength. (Häkkinen, Mäkelä & Mero 2004; 251.) The basic element to improve your strength is that your training load over comes enough the normal daily load (Häkkinen K. 1990: 101).

2.1 Physiological demand of soccer

To be successful at creating an optimal training rhythm as Meso-, macro- and micro cycles, and including successful determination of the right training load of different physical and psychological areas, we have to understand soccer training on and off season, the games needs, the research what has been done and think soccer trough other sports as well. Soccer's move patterns have been determined. Players move 28% of practises with heart rate 50-115, 68% 115-170 and 9% 170-190 beats per min and in the game 9% 50-115, 68% 115-170 and 28% 170-190 beats per min. (Bangsbo J 2003, 57–99).

Soccer player's ways of movements have been investigated by different studies, the range of moving ways are standing, walking, jogging, low-speed running, moderate-speed running, high-speed running, sprinting, backwards and lateral movement. (Bangsbo J. 2003, 57-78.) Different soccer contact and sport specific activities such as slide tackling, powerful heading, and long passing does an extra physical load to the player. Training of the elite soccer players should focus on improving their ability to perform intense exercise and to recover rapidly from periods of high intensity exercises.

Sport specific exercises benefits is that training will transfer better into the players sport specific movement patterns and the biggest training benefits occurs when the training stimulus simulates the sport specific movement patterns and physiological demands of the sport (McArdle, Katch, & Katch 1996). There should be an increased emphasis on training with the ball were ever possible (Bangsbo J 1998), as close to the sport related intensity and training load.

2.2 Biomechanics of strength training

Muscle contraction is divided to isometric and dynamic work, which from dynamic muscle contraction is divided to concentric and eccentric muscle contraction.

Isometric muscle work, muscles outside full length won't change, then there is no movement by the joints so outside load won't be moved.

Concentric muscle work, the muscle is shortening which causes movement, which moves the outside load. When antagonist muscle or some outside load stretches the active muscle then the muscle contraction is eccentric. (Häkkinen K. 1990, 22.)

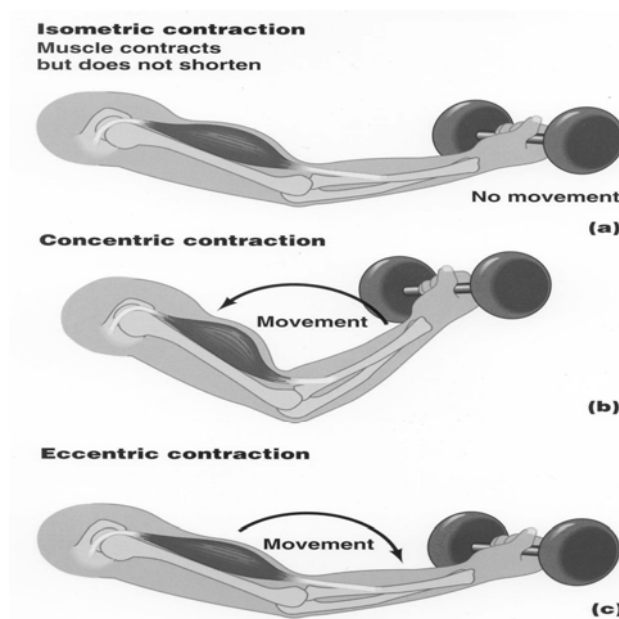


Figure 1 Muscle force generated during (a) isometric (static) action, (b) concentric (shortening), and (c) eccentric (lengthening) muscle action (http://www.baseballfit.com/pitching_training.htm).

2.3 Effect of strength training on body

The neural changes of the strength training originate from learning and from real improvement because of the strength training, the (central) nerves ability to activate the trained muscles even more. The neural change calls for that the training intensity is big enough. When muscles voluntary innervations increase grows also the maximal strength with out hypertrophy changes, so muscles growth isn't inevitably so great. (Häkkinen & Komi 1983; Sale 1988; Häkkinen 1990, 57.)

After strength training you, need less nerves activity to achieve the same level than before. This means that your muscle work has come more efficient; to get that same muscle tension you don't have to activate so many motor units than before training and/or you don't have to use them with the same ignition frequency. (Häkkinen & Komi 1983; Sale 1988; Häkkinen 1990, 56; Åstrand et al 2003, 325.)

Characters of willpower have a crucial meaning. In nerve muscle machinery, it means that we take to use totally new motor units and adding the ignition frequency in those motor units which are already in use. (Mero 1997, 149.)

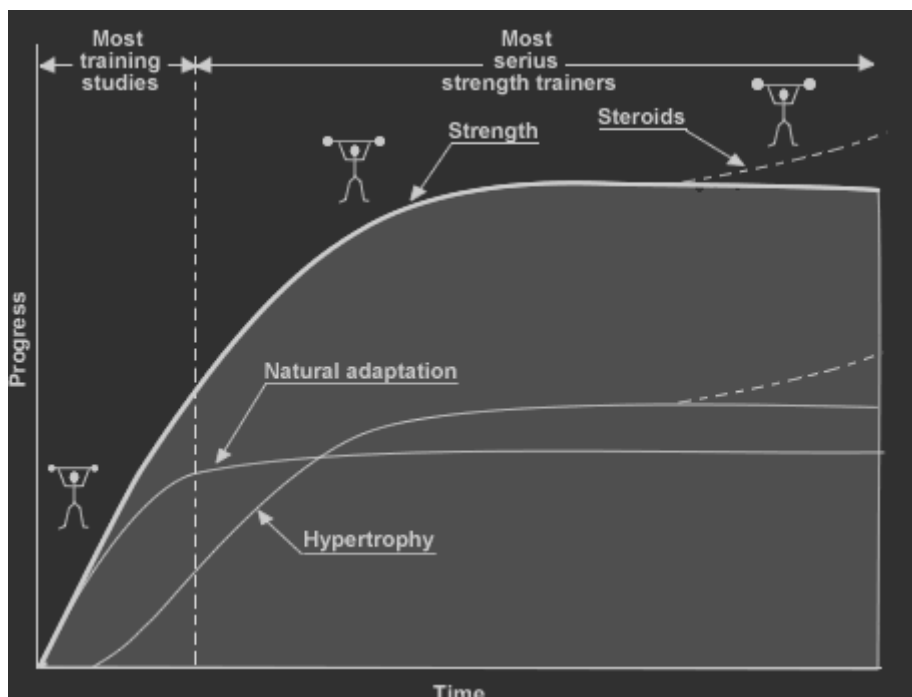


Figure 2 Progress time relationship (correblog.wordpress.com/2008/10/)(McArdle, 2007, 541, figure 22.19.)

2.4 Speed-, Strength connection

In sport coaching there have been done strength movement tests with difference loads to measure the condition of neural muscular mechanism. This is it how it have been possible to get information about athletes strength and speed capacity. The results from these tests can be shown with the strength-speed curve, which is got from dynamic work I laboratorial conditions (Haavisto 1979, 111; Mero et al. 1987, 68; Rusko 1989, 50; Häkkinen 1990, 119, 128; Mero 1997, 62, 63). In comprehensive power training (power= strength x speed) should the practises maximum manoeuvres speeds be selected from that part of speed- strength curve

which equate 30-60% maximum isometric strength (Haavisto 1979, 113). Speed training with 30-60% load moves the strength- speed – curve whole up and to the right, but changes in maximum strength are smaller than in typical maximum strength training (Häkkinen 1990, 127). In the figure 2 is shown the different affects to the speed- strength- curve from training with different loads (Mero, et al. 1987, 68.)

Be for training, ---- 8 wk training, Po (%) from maximum strength

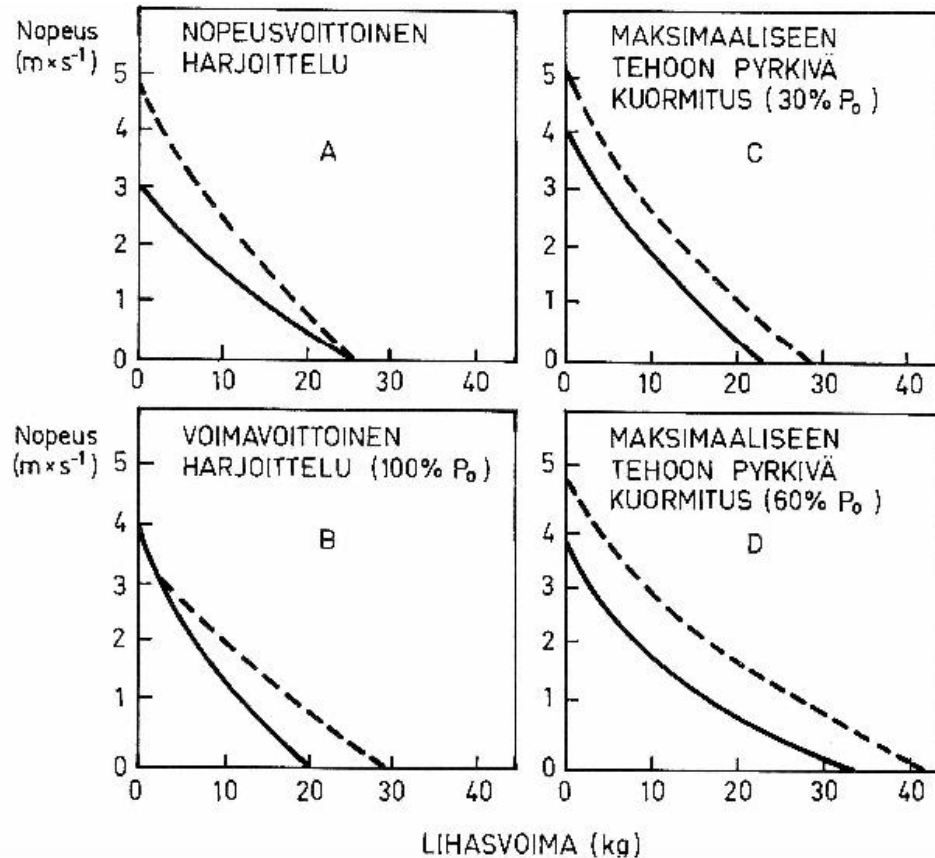


Figure 3 Affects to the speed- strength- curve from training with different loads (Mero et al. 1987, 68). If the weight in training is on speed components and the training is done with small loads, the changes will be seen mainly in speed end of the strength- speed- curve (Häkkinen 1990, 128.)

2.5 Strength- time dependence

Speed strength training might conduct with long time spans aim to changes, in relatively analysed isometric strength-time curve. In this case we can produce for example 30% strength level (measured from the moment's maximum strength) in shorter time than previously, despite that the absolute maximum strength level might have increased faintly at the same time. (Häkkinen 1990,129.)

Speed strength trainings affects differ from typical maximum strength trainings affects distinctly in stretching-shortenings-cycles practises, in these practises is used very high contraction speeds. (Häkkinen 1990, 130.)

2.6 Muscles elastic parts and exploiting those in strength training

According to muscles mechanical design the muscle has a contracting part and elastic part. To the elastic parts includes the body's supportive structures (tendons, connective tissue) and also the contractive components actins and myosin's between crossbridges are elastic components. Elastic components have the ability to restore energy to themselves, when active muscle is stretched the restored energy is released (potential energy) as extra force (movement energy), when muscle contracts fast after the stretch. Requirement for efficient action is that the contraction happens very fast, if this doesn't happen, the elastic energy changes to heat energy. Important elastic components for sports performance are the tendons and crossbridges. As studied the structure and function of the elastic components in a sport performance, they have recovered that elastic components part from power production is about 5- to 15%. Estimations are based on legs extensor muscles actions in vertical directed jump. (Åstrand & Rodahl 1986, 47; Mero et al. 1987, 33; Rusko 1989, 51; Häkkinen 1990, 39; Mero et al. 1997, 62; Fleck & Kraemer 1997, 36.)

Elasticity improves power production and speed, but also elasticity improves the movement's efficiency. The fact that elastic components increase the movement's efficiency is based partly on those elastic components use so small amount of oxygen. It is important to train quantitatively close to competitive intensity. Only this way we can condition our body (for example nerve systems actions) to more demanding development producing procedures. (Viitasalo et al. 1985, 67; Mero et al. 1997, 63, 64.) Also in strength training elastic components property's should be exploit (Bauersfeld 1978, 5c.)

Muscles elastic property's have affect on power production, because by advantaging pre stretching the neuromuscular system can produce more efficiently force than with clean concentric contraction. The slow twisted muscles fibres are mainly active when light muscle work is required and at slow motions performances are done. The Fast twisted muscle fibres activate when comparatively big muscle force and/or speed is needed, or when the slow twisted muscle fibres are fatigued for example in long lasting work. (Surakka 1996, 12.)

2.7 Strength training with under 18-year olds

Supervised resistance training using concentric muscle actions with relatively high repetitions and low resistance improves muscular strength of children and adolescent without adverse effect on bone, muscle, or connective tissue. (McArdle et al 2006, 520.)

The major benefits of resistance training for adolescent are following:

1. Increased muscular strength, power, and local muscular endurance (i.e., the ability of a muscle or muscles to perform multiple repetitions against a given resistance)
 2. Decreased injuries in sports and recreational activities
 3. Improved performance in sports and recreational activities
- (Fleck J et al 2004, 288.)

Studies have shown that strength training, when properly structured with regard to frequency, mode (type of lifting), intensity, and duration of program, can increase strength in preadolescents and adolescents.

(<http://aappolicy.aappublications.org/cgi/content/full/pediatrics;107/6/1470#B1>)

In preadolescents, proper resistance training can enhance strength without concomitant muscle hypertrophy. Such gains in strength can be attributed to neuromuscular "learning," in which training increases the number of motor neurons that will fire with each muscle contraction. Evidence that strength training programs help prevent sports-related musculoskeletal injuries in preadolescents and adolescents is inconclusive.

(<http://aappolicy.aappublications.org/cgi/content/full/pediatrics;107/6/1470#B1>)

2.8 Velocity power principles

Speed strength tests are used to test the muscle group's great speed need for power output and the biggest movement speed (Kempas 1978: 7802 – 411; Suni 1998: 66). Speed strength means ability to produce in short amount of time the biggest possible submaximal or maximal strength level (Suni 1998:66). Differing from the original strength training method it is possible to get advantages, with speed strength training principle done with endurance strength training, which otherwise would had to be trained separately. With all loads we try to get as big as possible contraction speed to get efficient neural training stimulus. (Häkkinen 1990, 214.)

In speed strength training used resistance and movement speed, should be elected just from that point of the strength-, speed – curve what we want to develop (Häkkinen 1990, 213). Speed strength training is divided to two differing ways of procedures; they are express and explosive strength training. Express strength training includes fast tempo and cyclical repetition sets. Explosive strength training includes single maximal performances. Express strength training the loads are with extra weight 30 to 80 % from the maximal strength (1RM) and in one set are six to ten repetitions. Explosive strength training loads are 40 to 60% from 1RM and in one set there are one to five repetitions. (Hirvonen & Aura 1988, 62; Hirvonen & Aura 1989, 221.)

In speed strength training at one single repetition muscles contraction and/or one single manoeuvre performances speed is maximal, when in each repetition the muscles contraction time is really short. (Häkkinen 1990, 87, 90.)

The speed strength training concentrates especially to the fast motor unit, that's the reason speed strength trainings generates a small mass increase only in fast twisted muscle fibres. This means practically that, the neural inhibition in every repetition is as big as possible, but at the same time short. (Häkkinen 1990, 90; Nummela 1998, 116.) Time follow up can be used to solve the level of speed strength training. In high speed and cyclical motions it is important to use for advantage the muscles elastically properties, this use of the elastically properties is important to achieve performance level and increases the economics of the movement. Fast strength production enables athlete's move more energy efficiently in the sport performance. (Delecluse 1997.) As developing speed strength with special practises (the intensity should be maximal or at least close to maxim), the concentration point is on dynamic eccentric and concentric muscle works connecting practices. (Kempas 1978, OK 78, 02- 428.) Development of speed strength might lead to sport performances development, because the movement speed has developed and this is because strength production gets more efficient and faster in one single work moment. (Häkkinen 1990, 148.)

Speed strength practices execution and the affects principles:

1. Maximal effort: players have to use all their will power and even inner aggression to get the highest possible intensity. The goal is about 100 to 103 %, which means strong attempt to a new performance level. As following this kind of principle insures that the training impact goes to the fast motor units and muscle fibres. (Mero1997, 151.)
2. Sport specific: The sport specific factor should be notified, sport demanding power out put time, joints angles and the way of muscle contractions. (Mero 1997, 152.)
3. Way of choosing the load: It is smart to use 40 to 60 % loads at the training season, because this ensures high mechanical result. (Mero 1997, 152.)

3 Aim of the study

Aim of the thesis is to find out if heart rate controlled strength training done with velocity power principle and sport specific training has positive affect on 14 to 16 year old soccer player's performance level.

Thesis subject was chosen; because there is evidence that heart rate monitored training will increase the player's performance level and increase of strength has positive affect on performance capacity. Thesis was lacking hear rate monitors so, thesis tried to solve if with heart rate controlled training it is possible to get same kind results, and how big affect it really has if it has any

3.1 Problems of the research

1. How dose ones a week done strength endurance training with velocity power principle, affect on the soccer players performance level?
2. Does manually heart rate controlled strength training done with velocity power principle and sport specific training affect on 14 to 16 year old soccer player's strength performance level. (explosive-, endurance-, speed strength and total power out put)

3. Is it possible to develop 14–16 year old soccer player’s anaerobic performance capacity with maximal heart rate based strength endurance and strength training which done by velocity power principle?

3.2 Group

To this study I selected HIFK soccer B-juniors where 14, 5 to 16, 9 years old boys. All athletes participated to the study where highly motivated and committed to training. All athletes had at least five years background in soccer, some of them had even 14 years experience. Few players where doing extra training in school, usually morning practises. Players weren’t selected by their skill in soccer; they were selected because they had the opportunity to train in this specific group.

4 Measurements

Results were handled as a group and the result were handled individually. Training affect differences were compared between pre training test (T1) and post training test, test four (T4). To the research attended group’s player’s test results were noticed as analysing the test results. From the results were counted the minimum (min), maximum (max), average (AV), change pre cent (change %) also as absolute number (abs num) and standard deviation (SD). The first and the last test results were compared and the absolute change present was counted from these values.

4.1 Basic measurements

The background parameters were age (Y), height (cm), weight (Kg), body mass index (kg/m²). (Fogelholm 2004, 45)

Table 1 Test groups age (Y), weight (Kg), height (cm), body mass index (kg/m²)

		T1				T4		
	n	Age (Y)	Weight (kg)	Hight (cm)	BMI	Weight (kg)	Hight (cm)	BMI
Awarage	18	15,7	61,3	172,8	20,5	65,9	174,9	21,4
Min	18	16,9	73,0	186,0	23,1	80,3	188,0	25,2
Max	18	14,5	49,9	160,0	17,7	48,0	165,0	17,6
SD	18	0,5	7,1	6,3	1,6	8,7	5,9	2,1
Change % T1-T4						7,5	1,3	4,7
Change % SD						21,5	-6,4	31,4

In the basic measurements (age (Y), high (cm), weight (kg), body mass index (kg/m²)) where found small differences with in T1 and T4. Players weight increased as a group average 7, 5% at one year training period. Group's height increased 1, 3% as group's average and the body mass index increased 4, 7% as group's average value. Up on this page are the standard deviation diagrams from high, weight and body mass index which sows the variation inside the group. Inside groups deviation increased at weight 21, 5%, decreased at height -6, 4% and increased at body mass index 31, 4%.

(See also Appendix 1.)

4.2 Endurance test

The 20 m shuttle run tests (SRT) were done for aerobic capacity measurements (performance, maximal speed, VO₂max) in the beginning and at the end of game season periods, because to command problem have been decrees of endurance performance level.

Based on the maximal heart rate (HR_{max}) during tests heart rate zones (86–92%) and recovery limits (68–72%) for soccer, strength, speed and endurance exercises for each player will be defined.

Endurance capacity was tested with the twenty meter (20m) shuttle run test. Test principles: players run continuously for twenty meter (20m) back and forward with continuously increasing speed, they start running from the mark. When the athlete has run the twenty meters, athlete can start running back when the mark was given again. The player will stop running when hi/she has mist the mark three (3) times in a row or because of exhausting. Speed for the running starts from 8km/h which from the next minute will be ran with 9km/h speed, after this the speed will increase with 0,5km/h for every shuttle until exhaustion or three misses in a row. (Soini 1998, 23, 79; Chan 1999.)

4.3 Strength performance capacity test

Strength capacity test (SCT) maximal repeat test for different muscle groups without and with free weights. Capacity index, anaerobic index and total power will be calculated based on SCT. Based on the maximal heart rate (HR_{max}) during tests heart rate zones (86–92%) and recovery limits (68–72%) for soccer, strength, speed and endurance exercises for each player will be defined. Strength tests (squat, sit-ups, puss ups, and pull ups) results will be used to define resistances and repeats for strength endurance and speed-base strength trainings.

From all movements were counted to body mass compared first repetition max index (1RMmax index) which is a good indicator of player's basic strength and strength capacity. (Viitasalo and 1985, 179, 180; Haavisto 1979- 81, 87,88; McArdle et al 2007 510-533, Nummela 1998, 100, 101.)

From all test moves were recorded full performance time, total repetitions, repetitions and power out put was counted in fifteen second (15s) cycles until exhaustion or interruption. Strength endurance test (maximal repetition test) from the resistance, total repetitions and also including the body mass, was counted performance index (kg/kg), which shows the command performance and trainability level. As using the strength endurance tests resistance, total repetitions, and body mass and total performance time results, the anaerobic index (kg/kg/sec) were calculated. From this number we can see the anaerobic performance level and it is also the game endurance indicator. (Petäköski, 2003.)

Test moves were performed as fast as possible and as long as possible until exhaustion or stopped because of movement specific before defined mistakes. Or if the tested person feels not muscle based pain (example: in the joints), or the person wants to stop the test for his/her own reason. The control in the strength endurance is performed with maximal repetition with dynamic muscle work. (Weineck 1982, 112.)

4.3.1 Half squat strength endurance test done by velocity power principle

Half squat test is commonly used movement to solve the player's maximal strength capacity in soccer, because the squat test has many same kind features than the game. Player's performance angle was measured from the ground with in centimetres. The low angle was measured so that the knee angle was 90° decrees, from the ischial tuberoses to the ground. Middle angle was measured in 180° knee angle, from ischial tuberoses to ground. High angle was measured from the level of acromion. With these measurements it was possible to have player specific performance heights. (Petäköski 2003, 46.) Vertical performance height of the trajectory was controlled by using the stall bars, this way it was also possible to control the performance height in training. These measurements were done again if the player had grown more than three centimetres (3cm) between the test times.

Squat performed in the first test (T1) with out weights, for safety reasons, with this load the athlete did perform the strength endurance test with velocity power principle until exhaustion

or until the coach interrupted the test. Reasons for the interruption could have been backs weightings, torsos rotation or upper torsos bending forward. Velocity power principle means every single squat is performed with maximal movement speed and maximal effort.

In the second test four (T4) the players had a small load 10kg this was chosen because of the results had improved during the training periods one and two so much that players needed extra load to get the affect on the neuromuscular area. Also no more weight was available so we had to do the maximum repetition test with 10kg load.

From squat were recorded full performance time, total repetitions, repetitions, power out put was counted in fifteen second (15s) cycles until end of the test. All the results were written to test papers. From the strength endurance test maximal repetition results were the strength endurance training program done. $P = \text{Force} \times \text{Distance} / \text{Time}$ (McArdle et al 2006: 236), power (W) was calculated using following physiological features load, total repetitions, body mass, performance angle and the length of movement (was counted from the 180° knee angle and 90° knee angle, from the difference the movement length was counted), the ability to produce power in watts applied to body mass (W/kg) was also calculated. Ability to produce power was calculated the following cycles: alactic speed strength (<15sec), lactic speed strength (15>30sec), lactic strength endurance (30>45sec), and lactic ability to produce power (45 sec > until exhaustion). (Petäkoski 2003: 53-54.) (See also Appendix 2)

4.4 Heart rate recording in test situation

At the test situation player's heart rate was measured with Polar chest metering system. The measurement happened from the chest with touch to the skin with the devise. Other wise the heart rate was calculated from wrist- or neck arteries heart beats, as counting the firs zero (0) and every beat after that for ten seconds (10 s.).

5 Training

In the next chapter is demonstrated how the training was predicated and what was done in each period. In all training situations it was pursuit to do heart rate control by manual wrist calculation. In bigger perspective, heart rate was controlled by planning the training session so that the physical load was considered in every single practice. To easy up the planning phase the load areas where defined in seven load areas which were: R0, R1, R2, R3, R4, R5 and R6. This ideas background is from Espaniol physical training, where comes the R which means

rhythm. (Martinez Garcia Juan Luis. 2003) Same type training intensity values can be found from McArdle sixth edition page 493 figure 21.19. In this figure is seven load areas, which from four in the middle shows the different optimal training areas, as using 52 % to 92% from maximal heart rate as defining the load.

Maximal movement speed improves nerve muscle machinery's workability to recruit fast muscle fibres. Maximal movement speed used with hard rate controlled training creates to the muscles lactic acid, because as source of energy is used immediate energy sources for example ATP (adenosine tri phosphate) and CP (Creative phosphate). The training improves strength, manoeuvre rapidity, lactate endurance and muscle elasticity. (Martinez G. J. L., 2003.)

In strength training, there were used free weights with maximal movement speed; the repetitions to training came from the maximum repetition test (maximum strength endurance performance test, which was done with velocity power principle). From the results of maximal strength endurance tests maximum, repeat test draw up the training programs amount of repetitions so that out of the total repetitions amount was counted 50%. For example if a person does 40 repetitions the training amount is 40 divided with two, which is 20 which is 50 % from the max repeats. Use of fifty percent of the total repeat max gives the best training response based on practical testing. The repeats will be unfinished if used 60% of the repeat max and in other hand if used 40% of the repeat maximum the training impact is too low to improve the athlete.

As counting the repeats in 15 seconds intervals in the test, gives us the picture of the changes in movement speed. Even if the full amount of repeat hasn't increased may the speed of the test been improved (the same amount of repetitions done in less time) which shows that the performance capacity has been improved. At the same time, we can follow how the motion slows down as the test time grows, for example in the first 15 sec, the person does four repeats but in the next 15 sec the person does three.

The use of three series based on the best improvement response, and the last series is the most encumbering because of increasing heart rate and lactate amount. We try to overload the muscle in relation to the tested capacity, to achieve the optimal training response. Between sequences the recovery is 68 % (± 5) from the achieved maximal heart rate from the maximal repetition test. After a set the heart rate should be 86–92% of the maximal heart rate, which is over the anaerobic heart rate limit. This is how we form individual training levels, which direct

movement speed. Last of a training period is from six to twelve weeks, it is optimal as developing characteristics strength. After four to twelve (12) weeks training, changes in endurance- and strength training are seen. (Häkkinen 1990, 56-59; McArdle et al 1996,440.)

5.1 Heart rate control in training

By applying heart rate controlling to the velocity power principle strength endurance training method, we come up with the right training loads for these athletes. For every R level defined a heart rate are where the athletes should be when training at the specific R load, the heart rate area was written by percents from maximal heart rate.

Following values where used in the studies training situation: R0=50–60%, R1=61 -71%, R2=70-78, 5%, R3=75-83, 5%, R4=84-92, 5%, R5=89, 5-99.9%, R6=100-103%

In training head coach, assistant coach or the physical coach had a stop watch and told the athletes when to start counting the heart beats for ten seconds and when to stop counting. As counting and listening for the commands players where moving at the same time, so that the training would not stop in any case.

5.2 Strength trainings practical execution principles

Sports strength and speed trainings principles are:

1. Strength and speed training has to concentrate on those muscles and muscle groups which are used in the sport performance; the chosen movements has to be as sport specific as possible.
2. In strength training you have to use those performance angles which are used in the sport.
3. In strength and speed training the athlete should strive to higher strength and speed levels than in sport performance.
4. In strength training it is pursued to increase repetitions and used strength level, but with out diminishing the speed of power production.
5. Strength training in choosing which training methods is going to use, which supports the best way muscles elastic components progress. So only concentric based movements should be avoided.

6. For developing the speed features the movements should be performed with maximal speed and effort. In practice the best result is received when the maximal effort is not interfering with the relaxation of the movement.
7. Maximal strength can be trained by using big resistance and little repetitions or small resistance and the performance to the exhaustion. (Bauersfeld 1978, 2-8; Nummela 1997, 192.)

5.3 Training with free weights good things are the following

1. Certain manoeuvres (for example in sport specific training) are specific to concentrate to certain joints, when these movements are possible to do 100% right only with free weights or with out weights.
2. Training loads not only the one specific muscle but the entire muscle group including the supportive muscles (so called all round strength training).
3. Strength training is also efficient co-coordinative training.
4. Free weight training most commonly suits the best for top-athletes purposes. (Häkkinen 1990, 200.)

5.4 The disadvantages might be training with free weights

1. The movement paths have to be learnt well, because the movements have to be coordinated.
2. The risk of injury grows especially with big weights.
3. With free weights done strength training should big consideration be done be for choosing this training method, especially with children, in rehabilitation and with sedentary athletes training. (Häkkinen 1990, 200.)

5.5 Training periods

The emphasis is to have through the year balanced training so that all the physical, technical, tactical and psychological aspects are included to all sports specific practises and in power training the sport specific needs have been notified. Also the load of training should be considered carefully trough the year, it is easier in the training period, and much harder on the game/event season. The load should go so that in training season the load is high and the intensity low, and the closer the group comes to the game season the higher intensity rises and lower the load drops. (McArdney et al, 525; J. Fleck et al, 2004, 213.)

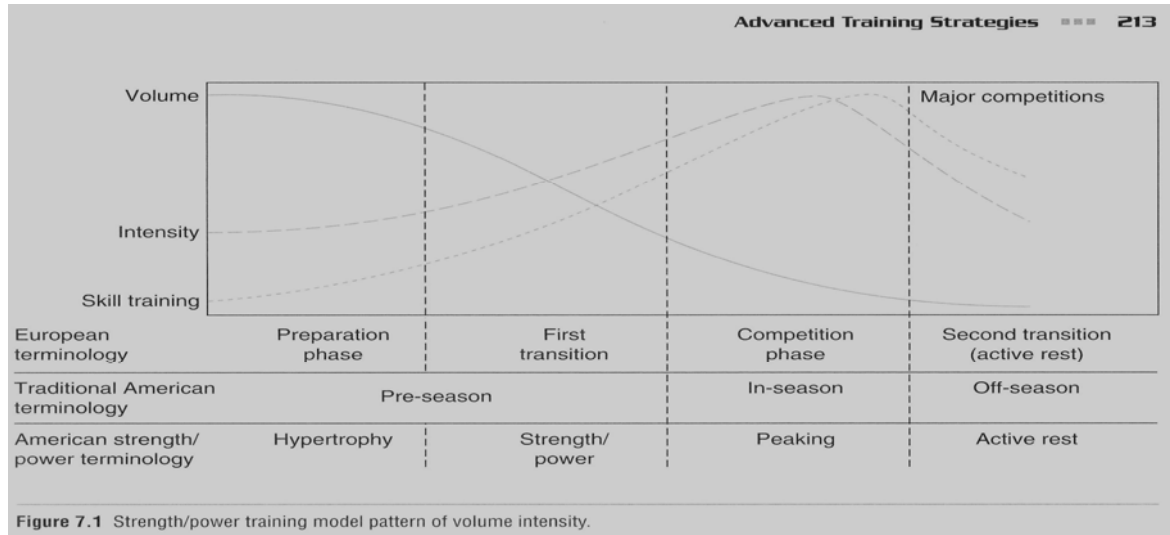


Figure 7.1 Strength/power training model pattern of volume intensity.

Figure 4 Strength/power training model pattern of volume intensity. (Fleck et al, 2004, 213.)

5.6 Half squats strength endurance training

The strength training loads was defined by notifying the group's level of knowledge and ability to do half squat with out daggering them selves to an injury. The first load in test one (T1) was their own body weight also. With this load the athlete performed with velocity power principle the strength endurance test until exhaustion or until the coach break of the test. From this maximal repetition result was the individual training programs formulated. One training period lasted for 9 to 12 weeks, and after that time a new maximum repetition test was performed. Otherwise the athletes did only ones a week the strength training program. To this training session was also included sports specific training, in warm ups, training and cool downs. Also the coach had a stop watch so that the group could control their own heart rates. Strength training included also jumps and other muscle croups than legs, the group performed a set of jumps ones a week as attached to sport specific training.

5.7 First training period

Basic conditioning season one (BC1) starts usually two weeks after the game season has ended, between this times is active rest period, these two weeks are free from sport specific training. There is still training at these two weeks, and that trainings purpose is to energise the player for starting season, it can be programmed or non programme.

Example for soccer players it would be beneficial to play basketball, badminton, swim, do dance/ rhythmic work out or some thing else, but not soccer.

Basic condition seasons purpose is, to great the ground for becoming training periods, so that the players would have good starting position for next training cycle. This is also the time when the head coach will evaluates the players and decide how will stay for next season. This usually causes little more competitive atmosphere to training. Training at this season will be physically and mentally very demanding, because even on the easy week the players were asked for 100 % out put from their performance. This comes from using velocity power principle, this method also teaches players to overcome their own limits mentally, so that they would be ready to train them self's and become the best they can. Training period lasts for nine to twelve weeks, depending on how many brakes there will be and when the team started training.

Training season one starts with maximal performance test, which includes power and endurance testing. Three to five sport specific practises, ones a week performed gym training with own body resistance strength endurance training with velocity power endurance principle and every third week one game. Games weren't the most important, the training was and that the athletes start to unity together as a team.

Physical perspective the focus in player development is on the base condition. Goal is to improve the players VO₂max, performance max, and anaerobic performance capacity, and the elastic components, also were important to improve the motor skills and mobility. When these areas are improved the risk for injury also might get smaller.

Sport specific, the emphasis is on teaching the game system and in all practises having all four areas covert, which are: physical load, psychological, technical and tactical. In worm up there should be something which teaches the player the playing system, select area of technical performance improves, player's communicative skills improve and the tempo is right so players cardiac and oxygen uptake system develops.

5.8 Second training period

Second basic condition seasons (BCS 2) purpose is to build up the strength and explosive strength capacity, also to build up the endurance capacity. Training at this season was physically and mentally even more demanding that training at season one, because it was the time for the player to show how well they can cross the limits.

Training season twos loads are increased and the tempo is held in max, concentrating as doing every thing to the exhaustion. Role of the load played a big role at training season two, as the loads were big, but demands for speeds were even higher, at this season the player's had to do

training with small loads. Idea was that training felt hard but explosive, when the player's went to play, the games felt easy. Sport specific training had a bigger emphasis now, because the players should start to have the knowledge how they should move in different situations on the field. This training period lasted from nine to twelve weeks, depending on how many breaks there were and when the team started training with the season two.

Second basic condition seasons were starts with maximal performance tests, which include power and endurance testing. Three to five sport specific practises and one game every third week, ones a week performed gym training with small weight. Games weren't the most important at this time of year, the training were.

Physical perspective, focus in player's development was on the base condition. Goal was to improve the players VO₂max, performance max, and anaerobic performance capacity, also was important to improve the motor skills and mobility. At the training season two the emphasis was on plyomeric training, player's had more jumps and direction changes included to training. As these areas were developing the risk for injury also got smaller and the game speed ingress. Sport specific training emphasizes on speed endurance and lactate endurance development, as theses properties improve the player has more capacity to play longer on the maximal performance level.

Sport specific, emphasis of teaching was on the game system, more intense training and at game position movements. Training period had the focus on that all practises have all four areas covert, which are: physical load, psychological, technical and tactical. To make these practises happen the coach had to plan the practises well and also have one to three assistant coaches, each coach had their own strong area.

Second training period the mental toughness, team unity and the team rules were in big roll. Mental training is hard, because you never really know what the players are thinking, but also that's why trust and speaking the trough is very important in a team.

5.9 Third training period (preparing for game season)

This training period starts to be more on the game performance than in practises, but still this was also the time when coach really shouldn't easy up training too much, otherwise your player's wont have the physical capacity to play a full season. Training converts to easier from the load, but the intensity will be lifted to max and to 110 % performance. So that the full

training load was actually quit the same as training season two. The way of the loading differed at this season; as compared to the season two was by repetitions and movement patterns.

Training season tree started with maximal performance test, which includes power and endurance testing. Three to five sport specific practises and one game every second or every week, ones a week performed gym training with small free weights. Strength training was adapted to the game rhythm. Games were the most important at this time of year, the training was important also, but the weight is on game systems and game performance. This was the time of the year when coach should get the team play to getter as one.

Physical aspect: building up aerobic capacity, speed endurance, lactate resistance, explosive strength, plyometrics, and power out put. The emphasis was really on doing every practise as hard and as fast they can, if it wasn't about learning the game system. Important was also to do well warm ups and cool downs, these are really important always.

Coach should avoid showing or telling what players did wrong, because these negative evocative are so strong, that they will stay on unconscious level more easily. Time from training was used also for training player's self awareness and the two way communication. So that the player's would starts to knowledge features from the game and how it's played and how he can make him self better.

5.10 Fourth training period (Game season one and two)

This was it; this was why the player's had trained whole winter and spring. In the beginning of the season coach did small changes in the playing style, but found the right way to play quit soon. In the end of game season two the coach took all out from the team and tested the player's physical fitness, to see how the training had worked.

It was more than crucial to have recovery training sessions and preparing training session, because those were the trainings which showed to the coach, in what condition the team were. The training varied so that every game and every brake was taken in notice and the level of the physical load was adapted to game and rest rhythm. Also if there was coming up a very important game it was seen also in training two weeks before the game.

Physically this period wasn't the most demanding or easiest, because there was big mental pressure from succeeding and there were lot's of games and training session. As the coach had done the planning well there were enough rest and training, and this way the athlete's performance capacity actually developed through the game period.

Game specific, all training includes max amount of player specific and team tactics also included the relaxation, ball control and scoring drills, games and practises and physical training. Most important was that the players had fun and a high motivation to train and play. (See also Appendix 3 and Appendix 4)

6 Results of the study

In the tables and diagrams used abbreviations are the following: the pre training measurements (T1) the post training measurements (T4), the size of the group (n), the average (AV), minimum (min), maximum (max), standard deviation(SD), change present (change %). At T1 and T4 was tested the maximum repetition in squat manoeuvre which shows us this groups strength endurance capacity and how it varies in the group. Repetition results can be compared inside the group and if we would have a group B then we could compare them. No individual comparing should be done between athletes.

From the results T1 and T4 can be calculated the performance index, which is repetitions multiplied with the load and divided with tested persons mass (kg) (reps./kg/kg). Performance index shows the athletes and the group's performance level. With the anaerobic performance index which is repetitions multiplied by load divided with tested persons mass (kg) which is divided with performance time, this way we get performance level compared to time. This value reflects to us the anaerobic performance capacity which enables the fast movements. Also total power (W) is calculated.

As recording the performance index and anaerobic index and the power out put comparing can be done between the individuals inside the group.

6.1 Total repetitions in strength endurance squat T1 and T4

Strength endurance test maximal repetition results there were fairly a big variable between T1 and T4. All the athletes did the test until exhaustion, and zero (0) injuries were recorded as doing this test. One reason for this variable is the fact that in test one (T1) the load was own body weight plus 0kg and in T4 the load was 10kg plus own weight. Reason for that T1 was performed with 0kg load was that injury risk wanted to be minimal. Reason for that T4 was performed with a 10kg load, is that, to develop power and strength capacity you have to have a resistance or a load to activate all muscle tissue and neurone motor plates.(McArdle et al, 2007.)

Table 2 Repetitions from strength endurance squat T1 and T4

Repetitions				
		T1	T4	T1-T4
	n	Load 0 Kg	Load 10Kg	change %
Average	18	208,0	212,7	2,3 %
Maximum	18	305	340	11,5 %
Minimum	18	101	120	18,8 %
SD	18	45,4	60,7	33,7 %

Participant to the test where 18 (n=18), in total repetitions there is no significant change in groups average percents 2,3%, the 7, 1% increase in average shows that 10kg load didn't have significant impact on groups total repetition average. The groups max and min values changes are significant as comparing inside the group, because the changes are 11, 5% and 18, 8%. Group's standard deviation has increased 33.7 %, from these we can interpret that the groups inside differences between test T1 and T4 has increased significantly.

6.2 Half squats test relative power production results in T1 and T4

To the T1 and T4 attended 18 persons (n=18). Maximum power output was calculated from the squat, which was performed to lowest point, angle from knee 90°, middle angle from knees 180° and high point from shoulder to co-ordinate the athlete's trajectory. For all tested players own performance angles, weight and -heights were measured before starting the test.

Table 3 half squats relative power results in T1 and T4

Power W				
		T1	T4	T1-T4
	n	W	W	change %
Average	18	1333	2027	52,1
Maximum	18	1762	2528	43,5
Minimum	18	1083	1385	27,9
SD	18	215	280	30,0

Inside the test group significant change happened between T1 and T4 in group's average. Average values change percent was 52, 1%, group's total power out put average increased significantly inside the group. Group's individual maximum increased significantly, 43, 5% from the

test one (T1). All performance level had perceptually great changes to the strength endurance half squat test, which was performed with velocity power principle. Standard deviation increased between the test by 30, 0%, which is close to the increase in repetitions standard deviation.

6.2.1 Relative power production results in 0<15sec intervals

In the test group there was 18 players (n=18), a lactic speed strength capacity <15sec as W/Kg. Inside the group the average from power production improved 40% as absolute number (abs. Num.) 9,86W/kg. The average at test one T1 was 24, 7 W/kg and the standard deviation (SD) was $\pm 3,24$ W/kg and at end test T4 average was 34, 7W/kg and the standard deviation was $\pm 3,53$ W/kg in the first 15 seconds. As absolute number the SD increased 0, 21 and as per cents 9%.

6.2.2 Relative power production results in 15>30sec intervals

Lactic speed strength capacity 15>30sec as W/kg, the groups average at power production improved 40, 2% as absolute number (abs. Num.) 9,33W/kg. The average at test one T1 was 23, 2 W/kg and the standard deviation (SD) was $\pm 3,66$ W/kg and at end test T4 average was 32, 5W/kg and the standard deviation was $\pm 3,38$ W/kg at the 15 to 30 seconds, as absolute number the SD decreased -0, 20 and as per cents -7, 8%.

6.2.3 Relative power production results in 30>45sec intervals

Lactic strength endurance 30>45sec as W/kg, the groups average at power production improved 39, 4% as absolute number (abs. Num.) 9,26W/kg. The average at test one T1 was 23,5 W/kg and the standard deviation (SD) was $\pm 3,69$ W/kg and at end test T4 average was 32,8W/kg and the standard deviation was $\pm 3,25$ W/kg at the 30 to45 seconds, as absolute number the SD decreased -0, 31 and as percents -11, 8%.

6.2.4 Relative power production results in 45>60sec intervals

Lactic strength endurance power capacity 45 sec > 60 seconds as W/kg, the groups average at power production improved 38, 2% as absolute number (abs. Num.) 8, 60W/kg. The average at test one T1 was 22,5 W/kg and the standard deviation (SD) was $\pm 3, 55$ W/kg and at end

test T4 average was 31,1W/kg and the standard deviation was $\pm 3,88$ W/kg at the 45 to 60 seconds, as absolute number the SD increased 0, 24 and as percents 9, 4%.

Table 4 Half squats tests relative power production results in T1 and T4 in 15sec intervals from 15sec. to 60 sec. (W/kg)

	15 sec. W/kg		30 sec. W/kg		45 sec. W/kg		60 sec. W/kg	
	T1	T4	T1	T4	T1	T4	T1	T4
Average	24,7	34,5	23,2	32,5	23,5	32,8	22,5	31,1
SD	3,2	3,5	3,7	3,4	3,7	3,3	3,6	3,9
Change T1-T4 %		40,0 %		40,2 %		39,4 %		38,2 %

6.2.5 Relative power production results in 60>75sec intervals

Power endurance capacity 60 sec > 75 seconds as W/kg, the groups average at power production improved 35, 3% as absolute number (abs. Num.) 8, 07W/kg. The average at test one T1 was 22,9 W/kg and the standard deviation (SD) was $\pm 3, 47$ W/kg and at end test T4 average was 31,0W/kg and the standard deviation was $\pm 3,27$ W/kg at the 60 to 75 seconds, as absolute number the SD decreased 0, 14 and as percents -5, 7%.

6.2.6 Relative power production results in 75>90sec intervals

Power endurance capacity 75 sec > 90 seconds as W/kg, the groups average at power production improved 35, 2% as absolute number (abs. Num.) 7, 81W/kg. The average at test one T1 was 22, 2 W/kg and the standard deviation (SD) was $\pm 3, 84$ W/kg and at end test T4 average was 30,0W/kg and the standard deviation was $\pm 4,12$ W/kg at the 75sec to 90 seconds, as absolute number the SD increased 0, 20 and as percents 7, 3%.

6.2.7 Relative power production results in 90>105sec intervals

Endurance capacity 90sec. > 105seconds as W/kg, the groups average at power production improved 38, 9% as absolute number (abs. Num.) 8, 36W/kg. The average at test one T1 was 21, 5 W/kg and the standard deviation (SD) was $\pm 3, 80$ W/kg and at end test T4 average was 29,9W/kg and the standard deviation was $\pm 4, 26$ W/kg at the 90sec to 105 seconds, as absolute number the SD increased 0, 33 and as percents 12, 2%.

6.2.8 Relative power production results in 105>120sec intervals

Endurance capacity 105sec. > 120 seconds as W/kg, the groups average at power production improved 36, 7% as absolute number (abs. Num.) 7, 77W/kg. The average at test one T1 was 21, 2 W/kg and the standard deviation (SD) was $\pm 3, 53$ W/kg and at end test T4 average was 29, 0W/kg and the standard deviation was $\pm 4, 47$ W/kg at the 105sec to 120 seconds, as absolute number the SD increased 0, 66 and as percents 26, 6%.

Table 5 Half squats tests relative power production results in T1 and T4 in 15sec intervals from 75sec. to 120 sec. (W/kg)

	75 sec. W/kg		90 sec. W/kg		105 sec. W/kg		120 sec. W/kg	
	T1	T4	T1	T4	T1	T4	T1	T4
Average	22,9	31,0	22,2	30,0	21,5	29,9	21,2	29,0
SD	3,5	3,3	3,8	4,1	3,8	4,3	3,5	4,5
Change T1-T4 %		35,3 %		35,2 %		38,9 %		36,7 %

6.2.9 Relative power production results average 0 to 120seconds in 15 second intervals

Relative power production results average 0 seconds to 120seconds as W/kg, the group's averages average at power production improved 38, 0% as absolute number (abs. Num.) 8,63W/kg. The average at test one T1 was 22, 71 W/kg and the standard deviation (SD) was $\pm 3, 08$ W/kg and at end test T4 average was 31, 35W/kg and the standard deviation was $\pm 3, 50$ W/kg from 0sec to 120 seconds, as absolute number the SD increased 0, 30 and as percents 13, 8%.

Table 6 half squats tests relative power production groups two minutes averages from 0 seconds to 120seconds (W/kg)

	Power average 15-120sec.	
	T1	T4
Average	22,71	31,35
SD	3,08	3,50
Change T1-T4 %		38,0 %

6.3 Anaerobic performance results from T1 and T4

Anaerobic performance level reflects to the group's performance ability at fast speed and athlete's lactic acid production. This figures show how fast, explosive strength capacity is and how good their lactate tolerance is. This value is important because it shows how trainable the group is.

Table 7 anaerobic performance results from T1 and T4

Anaerobic performance level Kg/Kg/Sek				
		T1	T4	T1-T4
	n	Kg/Kg/Sek	Kg/Kg/Sek	change %
Average	18	1,11	1,24	11,55
Maximum	18	1,39	1,46	4,98
Minimum	18	0,84	0,96	14,01
SD	18	0,15	0,13	-13,04

Group's average changed 11, 55% which is considerable increase as perceptually value, in anaerobic capacity. The standard deviation has decrease -13, 04% this has statistical value. This means that the group is more united on this performance area. Group's maximum was 4, 98% increase in anaerobic capacity, this is not a considerable increase, and it has only a small affect on performance level.

7 Discussion

Main findings of this thesis were that as doing ones a week physical training with power velocity principle increases the adolescent soccer player's physical performance capacity. Soccer player's performance capacity increased quickly, this was shown in the second test, and in the end test T4. Performance capacity inside the group had increased during one year average 52, 1% and the first fifteen second cycle power out put 40%. This quick increase in performance capacity can help teams to be more united because team's performance level can be lifted in sort time period. It should be member that the soccer players were at adolescent age, so they have high potential in aerobic capacity, speed and strength improvement.

First problem was the time period. First it was planet just for the basic condition training period; the period was planet to last for 9-12 weeks. Training continued longer with the same group, totally for one year. During the one year training period there was done two tests to optimize the training load during game preparation season and game season. In the beginning the group included 27 athletes, but during the season it diminished to 18 athletes. All the 18 athletes did perform the test one and the fourth test. Even as the result time period is so long it gave a great opportunity to study athlete's development during off-season and on game season. Also it gave the same starting point for the T1 and T4 because bought of these test were done in the end of the game season. There were no player's injured because of the chosen training methods, the actual yearly injury numbers decreased as compared to other years.

Comparing the results, problem in beginning was that most of the athletes didn't have experience from squat move even with out weights.

Supervised resistance training using concentric-only muscle action with relatively high repetitions and low resistance improves muscular strength of children and adolescents without adverse effect on bone, muscle, or connective tissue. More than likely, learning and enhanced neuromuscular activation rather than substantial increases in muscle size account for children's strength gains. (McArdle et al, 2007, sixth edition, page 520.)

As in strength training literature it mentions, that if players don't have experience on weight training the weight training should be started with as small weights as possible. For this reason the testing couldn't be started with extra weight. The first test showed right a way that this groups players have more strength at legs than on the abdominal region. Players have enough strength capacity in leg muscles to do the test with velocity power principle as using small

weight, but the abdominal region was so weak that the testing started with out weights, with abdominal region we had to be highly accurate, so that no injury's happens. There is always a window for injury as doing maximal performance.

From the basic condition period most of the time went to training the right movement, (motor skills), the load weren't optimal for this group even as the result were good after the first training period.

The major benefits of resistance training are following:

1. Increased muscular strength, power, and local muscular endurance (i.e., the ability of a muscle or muscles to perform multiple repetitions against a given resistance)
2. Decreased injuries in sports and recreational activities
3. Improved performance in sports and recreational activities

(Fleck J. et al, 2004, 288.)

As the players were adolescence we didn't want to take any risks to injury them. Also the literature points out that adolescent players are most receptive to train physical property's and the development in performance capacity will happen even with out big resistance training loads.

Test one results also improved that 14 to 16 year old athletes should all ready do strength training with extra weights, to optimise the training adaptations, which are adjusted to the athletes own capacity, this is supported by the literature in (Steven J Fleck et al, 2004, 288).

Test one indicated that players should have more effective core muscle training before their reach the puberty. By more effective I mean that the training teaches the players to activate all core muscles and use those muscles also which are helping and connective muscles to the core area.

Usually athletes have their growth spurt ant puberty and their core muscles won't support as well before them, because body mass usually crown as the player has grown more height and the body's gravitation point can change a little. As using extra weights the physical training levels can be optimised and individualised. These adolescent boys have lots of growth hormones and testosterones in their body, their performance development possibility's are greater that athletes how use doping. Adolescent grow usually faster, so their body mass will increase and their nervous system will have longer path ways to recruit motor units. Motor units have

more muscles mass to recruit. As training strength and nervous systems ability to recruit more muscle motor units will the athlete cope the changes in his/hers body more easily.

To training intensity and planning, often it is thought that load is some outside load which is brought to the training. Load can be understood as intensity time's repetitions, taking to concern the recovery time. With young players and even adolescent players this is good to remember, because some adolescent players may grow so much that their fine motor skills diminish. Then it is extremely important to train this area, by using the right sport specific movement patterns and enough high intensity this player can develop singularly.

Heart rate controlling the sport specific- and strength training, maximal heart rates was measured by using Polar chest metering system. When the physical trainer was present there was used Polar chest heart rate monitoring system, when physical trainer was not present heart rate monitoring was left mainly to the players own responsibility to stay in right heart rate zones. The literature supports the heart rate monitoring /controlling in soccer training, (Bangsbo J; 2003). Bangsbo in his texts has a bigger weight on the aerobic capacity development than endeavour towards over all trainings optimising of every area of the training.

In Steven J Fleck's et al (2004, 288) book designing resistant training, at endurance training part there is a paragraph which indicates that with resistant training it is possible to improve the aerobic capacity, because resistant training increases the number of mitochondria's in muscle cells. The text stated also that the resistant training should be done with high intensity, that supports the speed strength curves in the beginning of this thesis, by selecting the right load and training intensity from that curve including the sports demands you can train more than one physical area at ones.

This supports the velocity power principle, because this test method measures your total performance level, not only one minute which is commonly used at the team sports field. Because there are many universal tables where you can do comparing from the results and they are easy to do with big mass. The challenges with teams are, that the coach should first think how hi/she can do the individual optimization. After the coach has figured this out, hi/she can start planning from meso- to micro cycle's sport specific training.

Players were thought how to count their own heart rate from wrist or neck artery in move. The players were kept moving so that the heart rate would stay as close to maximum as possible, and to simulate the game situations recovery. Because there were no heart rate monitors in use

the heart rate values were just hypothetical. Still as using these hypothetical values, it could be seen that athlete's aerobic performance improved measurably. During the game seasons beginning and half way of the end of the game season there were done the 20meter shuttle run test, and the results average improved approximately one minute. Beginning average was about 11.07min and at the second test it was about 12.10min. Significant improvement was discovered in running time.

Main responsibility from heart rate controlling at sport specific trainings sessions was on the head coach. He was given guide lines how to load the players in different physical ways and how it should be seen in hear rate. Also the week rhythms were carefully thought out. Controlling the range of movement at the training situation was resolved by using stall bars and doing the half squats in pairs. Other player was following the performance that it was correctly done and the other was doing the half squats as instructed. Controlling the range of motion at the squat is one of the most important things at the training. If the player does wrong, the load differs from the training program and then the training program won't develop the athlete as planet.

To the physical training was included also abdominal- and back moves, pus ups, chin ups and some jumps. In the beginning the abdominal regions results were quit inadequate as taking to concern the sports needs. At the T4 result were good, the athletes strength performance levels had risen significantly, one of the biggest developments were close to five times the first result.

In soccer, the physical demands of a player during a match are influenced by several factors, such as the player's tactical role and technical standard. Therefore player in teams have differing needs. A part of the fitness training may therefore be performed on an individual basis. (Bangsbo J., 2003, 109.)

So big group as in this thesis, illustrated fact that player's having differing backgrounds demands the training to be more individually thought out. Because the training routines and physical loads of the training periods usually differ between teams.

At Bangsbo's literature Fitness Training in soccer at the part training young players there is a figure which shows the development of young soccer player how did do any physical training. At the point of fourteen to sixteen years the player's performance level decreased. (Bangsbo

2003, 110.) This indicates that white players how are in their early adolescent stage, by physical age, should be done systematic, individual physical training, which supports the sport. In the thesis the group was just at this age fourteen (14) to sixteen (16) year old boys, group average 15, 7 years. The test results indicated in the beginning that some of the players were lacking core muscle strength and ability to produce power fast. Player's ability to produce power fast in the first 15 second increased 40, 0%, after one year training period as doing strength training ones a week. This improvement was noticed by the head coach as game performance. 15-30second power production increased average 40, 2% and 30-45second power production increased average 39, 4%.

Test results increase as total absolute numbers and average percents at every trained area. Significant change was noticed in power and anaerobic capacity. Squat test average total power output value increased 52, 1%. 40% increase average in 15sec W/kg power production shows us that not only the endurance capacity have developed but also the explosive and speed strength properties. From this result we can see that the chosen training method has been beneficial for the athlete for this sport, soccer. Also worth noticing was the increase in anaerobic average and in repetition average, because the load in test four T4 was 10kg so the total load of the performance was much bigger than before.

Players had just ended their season when they came to the test; this should be taken to consideration as reading the results.

Anaerobic performance index had significant in group average and at standard deviation. These values show that the groups trainability has increased, the players are more capable to absorb information at training, as motor skills and tactical knowledge. Group's average improved 11, 6% and the standard deviation decreased 13, 0%. Anaerobic values indicate player's ability to recover from physical performance. If player has a high physical maximal performance level usually it support the psychological side also, if the muscles use less oxygen to performance, there is more oxygen for the brain and in sport like soccer you have to be able to think during the performance. These percent improvements are significant, inside the group; these values can't be compared to other groups, because the group size was too small.

Some player had attitude problems in the beginning, but this problem was solved quickly because as rules for the team was clear and for the athletes was shown that the team is really trying to develop as a unit. Hard physical training as using individual values and same movement through out the group improved the group dynamics. In the physical literature is mentioned

that to get 100-103% performance the athlete have to be 100% ready to give his/hers all to reach that performance level. This physical training method trains this quality even on resting week.

Also at the T1 one player was suffering back problems so hi couldn't do the normal sit up movement, for him there was thought out own compensatory moves for abdominals and back muscles. This player performed the training system otherwise as other in the thesis group; at the T4 this player was capable to do normal abdominals. This player wasn't in the thesis test results. As applying the velocity power principle to other moves, it seems that it is possible to reinforce the muscles so that player's functions can be reinforced to normal.

Scoring statics improved dramatically. The group was with out injures which would have been caused the training for the whole year. It is noticeable that the adolescent boys body mass index did change, average 7, 5 %, this can be explained by the normal daily variation. Heights total change average was 1, 3% which also can be explained by daily variation. There where some information for the players, how they should eat, and what to do with their free time. Some information packages have been done now but, still if we want to do professional sports coaching, we should have the recourses to do it.

This study shows that heart rate equipment isn't necessary to do heart rate controlled training, but the equipment prigs accuracy and certainty to athletes development. The hardest thing is the data analysing and where do you need that information, and even if you do needed do you know how to supply to your sport.

Problems: of the research was no heart rate monitors the heart rate controlled training had to bee done by manual counting from the wrist. It was problematical to define the affect to the sport specific results and injury minority, also hard to control all training and get always the best result.

More research should be done to discover more accurately what affects dos velocity power principle strength training has to soccer players. What affects dos have accurate heart rate controlled sport specific aerobic and anaerobic training have in VO2max

7.1 Own inclusions

The velocity power principle can lower the number of injury risk during the training season and the game season. This might be because the training effect concentrates on the neuromuscular tissue and increases the neurone -motor plate's action potential and possibly increases the number of motor plates.

Training with velocity power principle the strength endurance and sports specific abilities developed with small increase of body mass. From this there is great advantage to those sports where body mass plays a role, for example in performance level, also it can be seen as advantage to develop speed endurance and endurance property's.

Power out put increases also by training with velocity power principle and the movement economics gets better which gives for the athlete better changes to last longer in the game/event situation.

It seems that ones a week done strength training is enough to develop adolescent soccer player's physical performance level. Explanation for this can be found from the individual strength training programs and personal hear rate training levels.

Some of the development can be explained with the players age, but 52, 1% development in total power production average is so big that it can't be only because of the player's normal physiological development.

From increased repetitions intensity we can make a supposition, that the players could play longer with higher tempo, because the resistance had increased but the number of repetitions hadn't changed than 2, 3%. Power out put had increased in first fifteen seconds 0-15sec. 40, 0% and in 105-120 second it had increased 36, 7%.

Strength endurance training done by the velocity power principle is psychological training, because you have to give all out of your maximal performance level to get the best result from the training. This was show quit hard for some of the test persons, but when they learnt how to motivate them selves; they got more out of them self, they started to enjoy the hard training, also because the players could see them selves develop. The player's effort transferred also to other aspect of life, for example, school grades increased.

The hard training united the athletes, because they had to pus and help each other over their limits, and of the comfort zone.

7.2 Development study proposals

More research should be done, regarding to velocity power principle training and heart rate monitored strength training. Also it is recommended to do valid accurate heart rate controlled sport specific training studies and follow ups that if it can be shown that heart rate monitored strength training has a positive affect on aerobic capacity.

More studies on strength speed relation ship to endurance abilities at different age groups, children, adolescent and young adults should be done.

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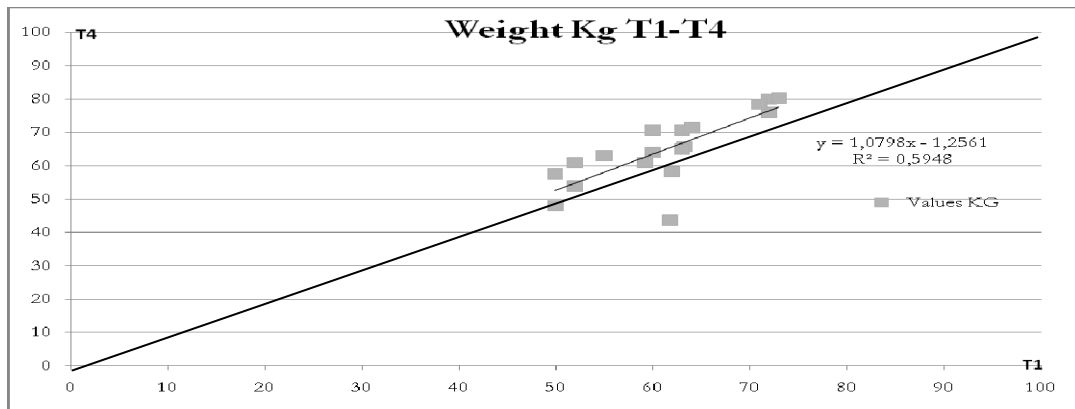


Figure Test groups weight (kg) deviation diagram

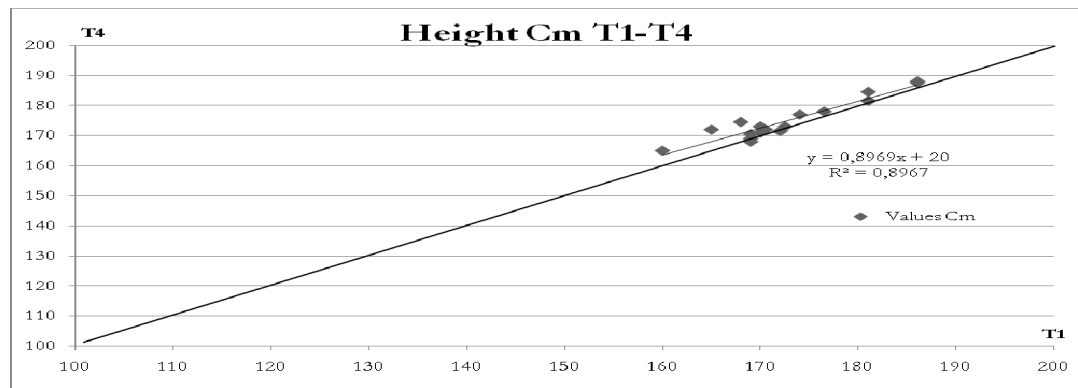


Figure Test group's height (Cm) deviation diagram

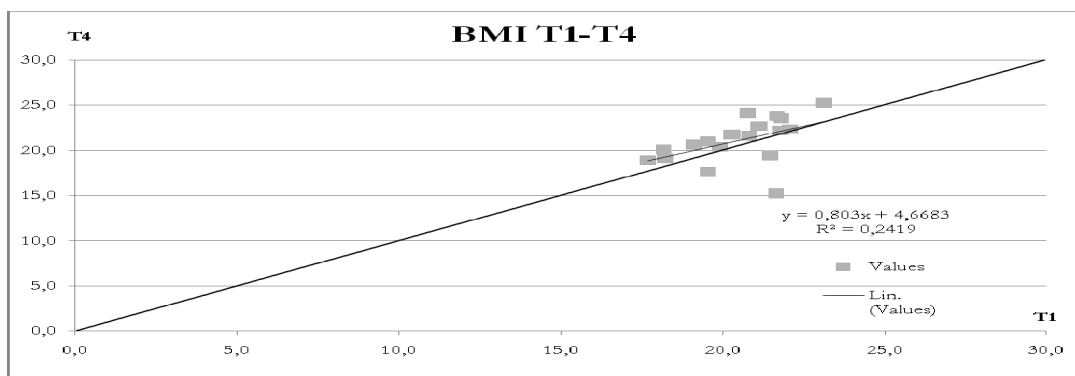


Figure Test groups body mass index (BMI) deviation diagram

Table The test cycle process.

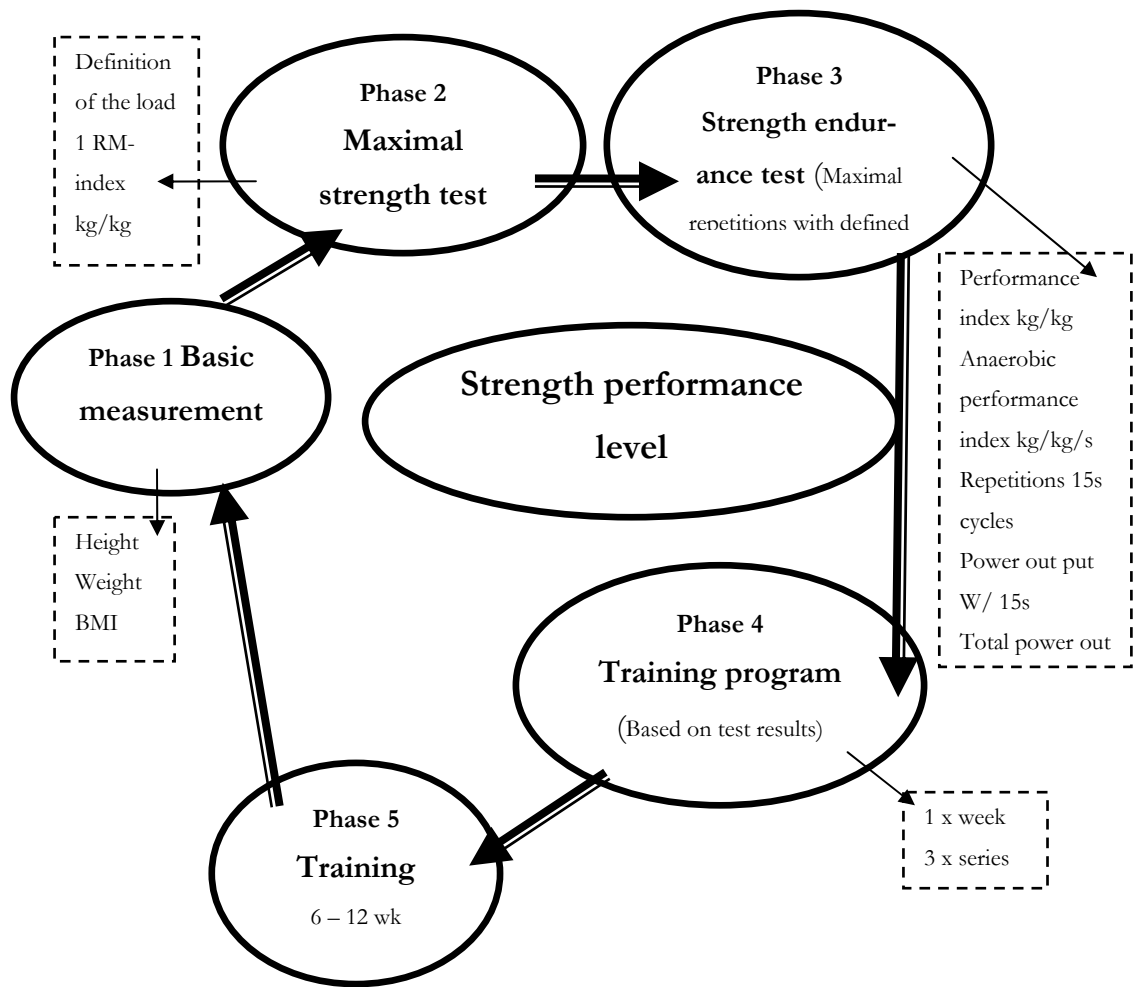


Table Macro cycle one and two, from basic training periods

	Joulu	Tammi	Helmi	Maalis	Huhti
Taktiikka			Hiihto		Pääsi
Hyökkäys					
Hidas	xx	xx	x	x	x
Puolinopea			xx	x	x
Nopea				xx	x
Vastaisku					xx
Kombinaatiot		x	x	x	xx
Maalinteko	x	x	x	x	x
Puolustus					
Hidas	x	x	x	x	x
Prässi			xx	xx	x
Vastaisku					xx
Oma boxi					xx
Maalivahti		x	x	x	x
Erikoistilanteet		x	x	x	x
Tekniikka					
Syöttö + 1K	xx	xx	x	x	x
Suojaus		x	x	x	x
Potkut			xx	xx	x
Käännökset					xx
Harhautukset					xx
Haltuunotot				xx	
Pallon hallinta	xxx	xxx	xxx	xxx	xxx
Fysiikka					
Peruskunto	xxxx	xxxx			
R3	xx	xx			
R4			xx	xx	
R5					xx
Koordinaatio	xx	xx	xx	xx	xx
Hypyt	x	x	xx	xx	xx
Ketteryyys	xx	xx	xx	xx	xx
Henkinen					
Säännöt	x	xx	xxx	xxxx	xxxx
Yhtenäisyys	xxxx	x	x	x	x
HIFK-ylpeys	x	x	xxx	xxx	xxx
Voittaminen			x	xx	xxx
Tavoitteet		xxxx			xxxx

Table Basic training period one physical program

LIHASKESTÄVYYSHARJOITUS								
Nimi			Pk 1 2008			2:1 12 vkoa	1x vko	
AlkuVr	Min		Vedot (kpl*sek)					
	15	+	3		10	Kiihdytys		
Harjoitusyke	141	150			palautus	kävellen		
Paikkaharjoitus	Sarja kpl	Toistot kpl	Vastus Kg		Harjoitusyke Lm		Palautus Lm (± 5)	Kg Yhteensä
KYYKKY	3	116	0,0		170	182		0,0
kaikki suoritukset päkiälle								
sarjan jälkeen vuorotellen								
Staatinen hyppy	3	10	0				135	
							2 min	
VATSALIIKE	3	52	0		132	141		0,0
sarjan jälkeen vuorotellen								
vatsaliike tuki nilkasta	3	10	0				95	
							2 min	
PUNNERRUS	3	28	0		140	150		0,0
sarjan jälkeen vuorotellen								
Polvipunnerrus	3	10	0				101	
							2 min	
SELKÄLIIKE	3	52	0		142	152		0,00
sarjan jälkeen vuorotellen								
Selkäliike tuki nilkasta	3	10	0				95	
							2 min	
LEUANVETO	3	1	0		124	132	89	0,0
myötäote		90 ast kulma					2 min	
YHTEENSÄ								0,0
LoppuVr	Min		Vedot (kpl*sek)					
	10	+	3		10	KR		
Harjoitusyke	135	143			palautus	kävellen		
Harjoitusrytmitys on 2 kovaa viikko ja yksi kevyt viikko. Kovan viikon ohjelma yläpuolella								
Kevyellä viikolla sarjoja tehdään sama määrä kuin kovalla viikolla. Toistoja tehdään puolet								
Mikäli toistoja tulee esim. 11.5, niin se pyöristetään lähimpää täyteen lukuun ylöspäin								
Harjoitus- ja palautussykkeet ovat molemilla viikoilla samat.								
Kiihdytys = vauhti kiihtyy joka askeleella. KR= Kiihdytys 5 sek vauhti säilyy 5 sek								

Basic training period one. Training was programmed by following table. It was performed ones a week and in ration of two hard training weeks and one easy.