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PHD THESIS SUMMARY:

DEVELOPMENT OF STRENGTH AND POWER BY USING AN INNOVATIVE SIMULATOR IN SPEED SKATING

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THESIS CONTENTS

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SUMMARY STRUCTURE

1. The importance and motivation of choosing topic

The specific basic position, by grouping the body, in combination with the necessary intramuscular forces, makes speed skating have a unique form of movement characteristic only of this sport, the balance between optimal technique and aerodynamics, by minimizing angles between body segments and delay physiological effects due to intense effort, are important factors in order to achieve superior sports results.

Taking into account the technical and material limitations, due to the climatic conditions in our country, with short winters and inconsistent temperatures, but especially the fact that Romania does not have any Olympic-sized track (400m), with natural ice or artificial, for training or competitions, the period of preparation on dry land for speed skaters has a duration of cc. 7-9 months. During these months, the physical, psychological and technical training is carried out, a period in which the trainings must be adapted to the conditions of preparation on land and the available material resources. This is a disadvantage for Romanian skaters due to limited access to specific conditions, a standard rink, compared to skaters in the Netherlands who have - 8 rink, China - 6, Norway - 3, Germany - 5 with artificial rink, etc.

Thus, the need for ice training combined with the lack of access to sports facilities that support obtaining superior performance in skating, influences the progression in the world top ranking of Romanian skaters compared to athletes from the countries mentioned above.

Considering the accumulation of practical experience as a performance athlete during 13 years participating in various large-scale international competitions such as World Junior Championships, World Cups and University World Championships, obtaining good results, 7th place in the 3,000m event, 10th place in the relay test, etc. and numerous titles of absolute national champion on ice and on rollers, in the absence of optimal training conditions, corroborated with the knowledge accumulated during the college years, we wanted as a strategic target the elaboration of the intervention program (dry land preparation) and the use of Skating Fit apparatus to provide a new and effective means for specific technical and physical training, to guide and enhance the efficiency of the training program, aiming at improving the performance of athletes included in research in national and international competitions during the winter season.

From the desire to contribute to the increase of the sports performances of the Romanian skaters, by increasing the efficiency of the specific movement and the development of the dominant motor qualities in speed skating, with emphasis on: speed (reaction, execution,

movement, acceleration capacity), endurance regime. speed, mobility / suppleness, but especially strength (explosive, maximum, endurance), power, starting from scientifically grounded theoretical notions and recent research by Japanese specialists, it is necessary to rethink the structure of technical means of training such as simulators , especially the skating rink, which offers the possibility of specific technical and physical training in conditions analogous to sports events.

The theme of the doctoral thesis, taking into account those mentioned above, focuses on the realization of the Skating Fit device in order to approach the specific technical and physical training on land. The aim is to use and test the device in the training of skaters in order to improve sports performance in the competitive season by increasing physical and motor capacity and an optimal and efficient technique, which can then be transferred to specific conditions on ice.

In recent years, the frequency of using simulators for cyclical sports but also for technical ones such as alpine skiing, bobsled, rowing, etc., or even skating using means that try to imitate the movement made on the ice surface, such as it would be the plate or the treadmill. The Skating Fit device designed is the object around which the thesis is researched, it is a fitness device for the lower segments, called "Skating Fit" which simulates the specific lateral pushing movement on the straight line with emphasis on muscle strength and power development in lower body directly involved in the specific effort and increase the efficiency of the movement, with the aim of improving sports performance in training and competitions.

Since in the specialized literature there are few research studies validated by practical results, which indicate in scientific terms the optimization of the technical training of skaters through the use of simulators, we considered necessary that by addressing this issue and experimental verification could bring a consistent benefit in training of speed skaters.

2. The topicality of the topic and the analysis of its reflection in the specialized literature

The movement technique specific to speed skating is unique compared to other sports that require human propulsion (De Koning, & Van Ingen Schenau, 2008; Fintelman, 2011), because a skater performs lateral thrusts to generate a forward speed. This aspect deserves to be studied both from a physiological point of view and from a biomechanical perspective due

to the unique movement model by adopting a low basic position, which contributes to the increase of the pushing force and the reduction of the air friction, etc.

Therefore, in order to achieve the forward motion, propulsion is required, by performing lateral pushes, of a specific cyclic movement, characteristic of speed skating. In the case of the general model of movement, a distinct difference is observed between technical models between individuals. The peculiarity of this sport is that skaters differ from each other by physical constitution and each seems to have a unique skating technique (Konings et al., 2015). This can confirm the fact that although there is a general technical model, we can also talk about a technical model specific to each athlete depending on the anthropometric characteristics, physical qualities and level of motor skills acquired.

Thus, several studies have focused on the analysis of skaters' movement technique in order to find an optimal model, to improve tehnique and sports performance (Noordhof, Foster, Hoozemans, & de Koning, 2013). It was found that the optimal technique is characterized by a lower basal position but also has a downside due to the physiological disadvantage of restricting blood circulation to the quadriceps muscles directly involved in the specific effort (St-Jean, Walsh, Marois, Gouspillou, & Comtois, 2019).

Recent research by Jong-Hyun, Do-Hoon, & Shin, (2017) has shown that the angles formed at the ankle, knee and hip joint in the pushing phase are important factors for generating a strong and explosive thrust to obtain superior performance. In kinematic analysis, it was confirmed that the angles at the joints of the lower train in the pushing phase are important for generating maximum power (Noordhof, Foster, Hoozemans, & de Koning, 2013).

Learning the right technique is very important. Related to this aspect, the efficiency of the movement also has an important role, which implies the generation of a maximum power optimally distributed along the race (van Ingen Schenau, de Groot & de Boer, 1985). During the specific effort the total power generated is the product of the amount of mechanical work per thrust and the frequency of thrusts (Houdijk, et al., 2003).

According to other studies, the amount of mechanical work per push seems relatively more important than their frequency, since the difference between skaters with higher and lower results was due to the amount of power generated in the push (van Ingen Schenau, de Groot, & de Boer , 1985) and not because of their frequency (van Inghen Schenau, & de Groot, 1983). Although frequency is not a determining factor in achieving performance, it directly influences speed (Houdijk, et al., 2003).

Power is a combination of force and speed, therefore increasing power is needed to increase speed (Lockie, Murphy, & Sprinks, 2003; Murray, 2005). In skating, the speed of

movement increases by adopting a grouped, aerodynamic position to reduce air friction (Chun, 2001). The lower the position, the more laterally the foot extends, the longer the stroke of the pushing foot, thus increasing the duration of the application of force in the ice. In order for the speed of movement to develop optimally, it is important to improve the various technical elements (Lockie, Murphy, & Sprinks, 2003; Murray, 2005), such as directing the lateral push forward, automating the optimal moment of transferring body weight on the support leg, and so on

In the literature, studies have been performed in which the force was measured under specific conditions on ice by the authors: Houdijk, (2000, 2001); Fintelman, (2011) and Van der Kruk, (2016) using a wireless instrument mounted on the the skate (contain three-dimensional force sensors), which measures the constant pushing force in both lateral directions (right / left) as well as in the direction of advance of the skate and in the center of the pressure of these forces. The aforementioned authors, Fintelman and Van Der Kruk, measured force using keyboards and a body position measuring system to assess the force and speed of thrust, and focused primarily on total mechanical power at their own pace.

Not being able to procure such a wireless system mounted on fixed or clap skates and not being the subject of research of the doctoral thesis, measuring strength and power under specific conditions on ice, we will continue to refer strictly to the evaluation and analysis of these qualities on dry land because athletes do not have all the specific facilities in the country.

Given the conditions for speed skating, compared to countries such as the Netherlands, USA, Japan or Germany, the study is limited to assessing the value indices of strength and power by other methods and means adapted to the environment of onshore activity as close as possible to the physiological and biomechanical point of view of the movement model, on plate and on bicycle, activity / results that will be capitalized for the realization of research studies, being reference points in the evaluation of athletes and the design of the device with interface to ensure informational connection between athlete and device.

Most of the technical training, off season is done through special static-dynamic exercises, on rollers and on the slide-board because the skater can reproduce the movement and the feeling of slipping, in case of movement on the slide-board in a small space (Pandy , et al., 2015; Guru, & Kamalesh, 2015; Lee, et al., 2015).

For this reason, one of the means used to evaluate skaters is the slide-board, because the physiological and biomechanical responses are similar compared to the ice skating technique (Kandou, et al., 1987) and can be an alternative method of evaluating the physical ability of speed skaters in the laboratory (Piucco, Connell, Stefanyshyn, & de Lucas, 2016).

One of the disadvantages presented by the authors Lee, et al., (2015) in their study on the biomechanics of plate motion would be: space limitation due to lateral support that influences the thrust with maximum effort (early stopping of the sliding period), repetition speed and changing the angles of extension of the joints that change the kinematic parameters of the straight line step. The advantage is to exercise balance.

The studies that analyzed the movement technique on the simulator, proved that the transfer of different motor actions from the simulation environment (in the conditions of training on land and on the simulator) in the real conditions of movement on ice, were obvious due to familiarity of neuro-motor processes, the decisions made during the action, the volume of similar effort and the relatively correct execution of the movement (de Groot, et al., 2011; Pinder, Renshaw, Davis, & Kerherve, 2011; Del Sal, et al., 2009; Willaert, et al., 2012).

Recent research offers us a starting point in the realization of the model of the proposed simulation device, similar to the slide-board, because current boards on the sports market need a structural model that allows simulation in almost real conditions of the technical model of ice skating, considering - it is necessary to find a way to perform the movement to the side - before for it to be fully efficient (Jong, Do-Hoon, & Shin, 2017). Therefore, in order for the sliding movement on the plate to be fully efficient, the structural limitations imposed should be removed so as to allow free lateral pushes.

In the preparation of dry land skaters, the current means of trying to simulate slipping and the general pattern of movement on the ice are the slide-board and the treadmill (even rollers). The Skating Fit apparatus is a means of evaluating skaters, being the object around which the research will be organized and carried out during the training period on dry land. This, like a fitness device for the lower limbs, called "Skating Fit" focuses on developing the strength and power of the muscles of the lower train directly involved in the specific effort and increase the efficiency of lateral pushing specific to the straight line step.

The means and methods of research used in speed skating have always raised difficulties since the conditions for practicing and performing the movement are difficult to reproduce in the laboratory. Field research is difficult to perform due to the nature of the sport, temperature variations, wind, ice and environmental conditions that make it almost impossible to record valid data. In the case of covered skating rinks, where it is possible to control the conditions, variables such as: ice temperature, air conditioning etc., however speed skating is still a less studied sport compared to those that allow evaluation in the laboratory.

In the Netherlands, researchers have focused over the years on the physiological aspects of speed skating. Interestingly, research in the Netherlands and North America differs considerably. In North America, the subject of the research is aimed at investigating parameters such as strength and anaerobic power, and Dutch research is divided between two broad categories, namely biomechanics and physiological variables related to sports performance. This difference in interests can be explained by the tradition with outstanding results over medium and long distances of the Dutch while the Americans had a tradition in short distances.

Four hundred articles were analyzed, selected from 15 international databases during 2017 - 2019 period. The articles published in the last 10 years with small exceptions were taken into account, of those that presented basic landmarks in the subsequent scientific research on to the skating technique, which have a permanent theoretical character offering specific guidelines on skating technique but also current research studies with information needed to optimize the performance of sports and to give coaches a complete view of the factors involved in training and competitions and important landmarks in the technological development of the means used in the programming of sports training during the summer training period. The research underlying these guidelines refers to high performance sport and there is sufficient evidence specifically associated with the level of performance achieved by the elite athletes surveyed.

Following different aspects, they were grouped as follows: biomechanical analysis in speed skating, kinematics and the optimal technique of pushing on a straight line and corner, energy consumption in the specific effort, measurement of force and power, technical analysis in the laboratory and on ice, pushing efficiency, optimal technical characteristics, real-time response systems regarding skate orientation, thrust frequency and length, etc.

These studies reveal some very important biomechanical aspects that refer to the fact that: the total mechanical power determined by a longer thrust generated the most efficient mechanical work and the decrease in travel speed can be partially attributed to the decrease in efficiency, which reflects a decrease of energy production associated with fatigue. It is also suggested that an increase in the duration of the double support phase or the use of the new model (clap skates) of the blade system gives skaters a prolonged contact time with the ice, resulting in an increase in travel speed and thus achieving superior sports performance.

Also, the extension of the foot is an indirect measure of the extension-flexion of the knee, the degree of inclination of the ankle, the angle of the patina in relation to the ice and more precisely the straight line, and the direction of the patina placed on the ice in the initial phase of pushing. The anatomical limitations and the maximum speed of extension of the leg

at the time of pushing, are part of the constraints of an optimization process. However, the need to perform an explosive push on ice is a variable to be considered for further investigations, as the dynamics of the movement (the thrust is not performed permanently at a fixed point) has a negative effect on the speed of movement (at the moment the appearance of fatigue, the pushes made tend to be made backwards).

3. PROPOSAL OF THE "SKATING FIT" APPARATUS IN THE IMPLEMENTATION OF THE RESEARCH PROJECT

Skating Fit apparatus for the development of specific strength

The research through personal invention refers to the realization of the Skating Fit apparatus which aims to optimize the level of training but also to develop some model parameters that ensure the achievement of the desired performances. It aims at the reproduction of similar fundamental external conditions developed by the athlete normally from the complex sports-environment system, simulating the physical and technical processes of the movement. The device will not only provide similar conditions for reproducing the specific movement but will also provide answers based on the athlete's actions.

The Skating Fit apparatus, with a unique model, is designed for the needs of speed skaters, for specific technical and physical training, ideal for the summer training period, in order to improve their sports performance in national and international competitions during the winter season.

Technical description of the Skating Fit apparatus

The Skating Fit, provides the user with two important functions: a) to simulate the skating technique, the straight line step with emphasis on the pushing phase and b) to optimize the physical capacity by developing the necessary motor qualities (maximum force, explosive force and endurance, execution speed, repetition speed, endurance in force and speed and power). The device will provide real-time monitoring with each push, the variables measured in training on the device can be analyzed in a software designed to meet the needs of coaches in effective training planning and recording the progress made by each athlete.

Skating Fit system components

The device is composed of two functional systems, the mechanical one through the use and construction of the apparatus (Skating Fit) and the electronic one through the use of the microcomputer which through the programmed software offers prompt and maximum precision answers (Tendo). The phenomenon that occurs when performing a force exercise, in the context of imitating the push from skating, is explained as follows: the foot performs a push of a load or a "mass" by applying a force "F" at a speed "v", resulting in the average power “P” measured in Watts “W”.

Tendo Power Analyzer microcomputer

General description

The device is a portable device for measuring various parameters used in strength training for an accurate assessment of the athlete's ability in simple or complex strength exercises (Tendo Sports Machines; Trencin, Slovakia software (Tendo Softaware Computer V-5. Version 6.0. 1, Slovakia).

Fig. 15 . Tendo WL Analyzer microcomputer and sensor unit (personal archive).

Measured value indices

Average power - measured in Watts [W], for the entire pushing motion; Maximum power - the highest possible power obtained in a push; Partial average power at a preset motion limit between 0-100% (measuring the power of a certain section of motion); Average speed measured in meters per second [m / s]; Maximum speed - (execution of pushing) the highest speed obtained; Maximum force, measured in Newtons [N]; Pause between repetitions or series measured in sec - min (can be turned on or off in settings);

Skating Fit apparatus

The model is made according to the principle of the rowing machine, which instead of the seat support has designed the sliding support for the active foot with an inclination of 30˚, which allows the simulation / execution of the lateral push, of the straight line step, without a limit support to limit movement, but as much as the length of the lower limbs allows by fully extending to the joints of the lower train, according to the physical constitution of each subject.

The special arms for the support of the hands offer stability but also a comfortable position that facilitates the execution of the movement considering the imposed weight and the need of freedom necessary for the maximum efficiency of the push. The model of the device is designed to allow the movement with maximum amplitude, by full extension at the three joints respectively hip, knee and ankle, so that skaters learn the correct technique, while coaches can observe the execution of the movement, can adjust load and provide accurate guidance based on real-time responses from the monitoring apparatus (see Appendix 2, Skating Fit Apparatus).

Usage protocol

After making the necessary settings in the microcomputer and selecting the weight, the subject sits transversely to the back of the device leaning with his shoulder and hip against it. From the specific skating position, in which the flexion of the knee joints forms an angle of 90˚ degrees (or even smaller) with the torso flexed on the thigh of the lower limbs (forming an angle of approx. 15˚ degrees), the weight is distributed on the supporting leg and the free foot sits on the pushing support with a fixed inclination of 30˚ degrees. The flexed arms firmly enclose the support for the support of the hands. At the signal, a complete extension is made to the joints of the hip, knee and ankle of the free foot, which results in a push similar to that made in a cycle of movement specific to the straight line step. The return of the foot requires maximum control and concentration to achieve the next repetition.

The objective pursued in the strength training on the device is to increase the explosive force necessary to achieve the thrusts, the specific movement in ice conditions. The different methods used in strength training are "connected" precisely to the movement model made particularly on the straight line with the direct involvement of the lower limb muscles and indirect upper train and combined with isokinetic training methods and methods for developing reactive force.

Identify the subject using the custom microchip button by the touch of the microcomputer.

Fig. 17. Initial position of the push on the Skating Fit apparatus (personal archive).

Fig. 19. Finish pushing on the Skating Fit apparatus (personal archive).

Calibration involves the use of an "IButton" for each subject to identify it including information such as name and Id before each use of the device thus knowing the group to which it belongs, name, anthropometric data, exercise, gender and unit of measurement .

The realization of the doctoral thesis comes in response to the needs of athletes and coaches for a specialized training program in dry land training conditions. According to the latest research, it is necessary to restructure the simulator, respectively the slide-board. Starting from these requirements, the realization of an adapted means of specific technical and physical training, reigns in the case of Romanian skaters whose training on land is carried out during 7-9 months per year. This device, in addition to fulfilling the function of developing the dominant

motor qualities in speed skating, also aims at technical training by increasing the efficiency of lateral thrust, in addition, allows control of the equipment by the coach (through the settings made in the menu), thus directions research proposed in this thesis to help achieve the proposed goal.

Part II PRELIMINARY RESEARCH ON OPTIMIZING SPECIFIC PHYSICAL TRAINING BY INTRODUCING SKATING FIT TO JUNIOR SPEED SKATERS

4. OPERATIONAL FRAMEWORK OF THE PRELIMINARY RESEARCH

The premises of the preliminary experimental research

The organization and development of preliminary experimental research started from the general premise that achieving superior sports performance requires a specific physical and technical training during the training period on land, being necessary to optimize the methodology and training of skaters, which aim to: selection and integration in the training of skaters of all specific traditional means but also of modern means; proving the effectiveness of innovative technical means of training and unknown to the public by using the Skating Fit apparatus; monitoring the level of physical training through modern technology.

The purpose of preliminary experimental research

In conducting the preliminary experimental research we plan the following : the use and testing of a new means of preparing the technical and specific physical appliance Skating Fit standardization of the Skating Fit device in the training program for junior speed skaters, in the absence of ice training conditions; recording the efficiency of the implementation of the intervention program oriented towards the optimization of the physical training, which should contribute to the improvement of the performances during the winter competitive season.

Objectives of the preliminary experimental research

General objectives

- Establishing the working methodology adopted by coaches in approaching the physical training of junior speed skaters;
- Establishing specific means of effective physical training for optimizing the training program.

Specific objectives

Use and testing the Skating Fit apparatus during the preparation period on land; Recording of data obtained after working on the device using the Tendo analysis device (Tendo Sports Machines, Trecin, Slovakia); Improving the coordinative capacities respectively: general coordination, spatial-temporal orientation, balance through specific exercises; Testing the general physical capacity of skaters, which aimed to evaluate the parameters: strength, speed and endurance; Carrying out a specific training aimed at improving the performance of the competition season; Analysis of the results obtained following the implementation of the proposed intervention program.

Preliminary experimental research hypotheses

1. A higher level of strength and power will influence the speed of movement in specific conditions (improving sports performance); 2. The higher the level of development of the strength and power of the lower body, the more it will influence the efficiency of the movement under specific conditions; 3. By using the Skating Fit, higher changes in force, speed and power will be induced in the lower body.

Subjects, place and duration of the preliminary experimental research

The research was performed on a sample of 12 subjects aged between 15-19 years, respectively 6 girls and 6 boys, junior speed skaters with double identification at the Sports Clubs CSM Pl. and CSM Sb. (experiment group) and ASC Cor. Bv. and CSM Bv. (control group). The preliminary experimental research took place in the premises of the Youth Park, the Olimpia Hall in Ploiești and the Sports Park, the Grand Fitness Hall in Brașov. For the experiment group, the intervention program lasted 6 months, with 5 -6 trainings / week throughout the research, respectively 01.04. - 01.09.2018, in which the initial and final tests took place.

Subjects, tests and evaluation tools used in conducting preliminary experimental research

Dry land testes (10 samples)

Strength tests

- ✓ Long jump from the spot
- ✓ Three consecutive side jumps

- ✓ Lateral jump
- ✓ High jump (Tendo Sports Machines, Trecin, Slovakia)
- ✓ Charles Poliquin test
- ✓ 1RM test (maximum repetition) Tendo (Tendo Sports Machines, Trecin, Slovakia)
- ✓ Maintaining the isometric position

Speed tests

- ✓ Running speed 50m
- ✓ Running 400m

Endurance tests

- ✓ Cooper test (12min run)

Control test on the Skating Fit apparatus

- ✓ 1RM (Skating Fit and Tendo Tendo Sports Machines, Trecin, Slovakia)

Specific control tests on rollers and on ice

- ✓ On roller skates: Corona Cup and National Roller Speed Skating Championship
- ✓ On ice: Frillensee Cup- 10.11.2018, Inzell (GER); Isu Junior World Cup - 24–25.11.2018, Tomaszow - Mazowiecki (POL); Frillensee Cup - 21.12.2018, Inzell (GER); National Championship on Trials and Poliathlon ed. 2019, 22-24.02.2019, Inzell (GER).

5. RESULTS AND CONCLUSIONS OF PRELIMINARY EXPERIMENTAL RESEARCH

Dry land tests

1. In the experiment group, a higher average was observed by 0.12m compared to the control group at the initial time of testing and an increase in jump length by 0.04m with a progress of 2.2%. In the side jump test, the experiment group can conclude that, at the initial moment of testing, the explosive force is better on the left limb (1.84m) than on the right (1.80m). Subjects who showed a higher power value in a push on the device recorded a side jump with a longer length. For the correlation between the parameters measured on the Skating Fit apparatus, between the 1RM (lateral push) test and the side jump length, we observed an intensely significant correlation between the maximum power and the jump length (r =

0.87; p <0.001), significant between the maximum force and length (*r* = 0.61; p <0.03) and between execution speed and length (*r* = 0.58; p <0.04).

2. The improvement of the explosive force observed by the three consecutive lateral jumps with the right and left limb, shows a difference between the two test moments, the left (m) (0.21m -4.3%) and the right (0.22m - 4, 5%) post intervention with a time difference for the left foot (0.06sec - 3.3%) and the right (0.08sec - 4.3%).
3. The results obtained by the experiment group at the 50m running, pre and post testing are lower (better) compared to the control group, where a lower average of 0.06 sec was observed, having a tendency to decrease the average time by 0.05sec., (0.8%), while in the 400m running test, the results are better compared to the control group, where a difference (an improvement) of time was observed. -1.11 sec. (1.8%) and in the control group an increase of the average time by + 0.32sec. At Cooper test there was an improvement in aerobic capacity in the experiment group between the two test moments, with a difference of 2.22 (ml / kg / min) and (+ 105.84m) - (4.1%) .
4. The results obtained by the experiment group showed an increase in both the maximum force by increasing the total weight by 7.8 kg (8%) and the maximum power by statistically significant differences by increasing the wattage value of a 1RM improving the force in resistance regime observed by the test maintaining the isometric position on the leg for the experiment group shows a difference, for the left limb of + 6.04sec and right + 6.67sec, The differences observed are statistically significant (p <0.05).
5. The sample jump height were tested by the explosive force and the lower train expansion differences were observed statistically significant. Variables registered in experiment group have shown an improvement of the test results for: height of the jump 6.3%); maximum power 9.8% ; maximum speed 10.8%) and for maximum force 16.5%.
6. In the Charles Poliquin test for both experiment and control groups, a dominance of mixed muscle fibers (IIa) was observed, except for two subjects from the control group with fast muscle fibers (IIb). Through this test we wanted to highlight the correlation between the type of muscle fiber (mixed / fast) and the predisposition to a certain distance (500m / 1500m). Thus, we observed a very good correlation between the two variables, for both types of distances, respectively (r = 0.84; p <0.01).

Control test on the Skating Fit apparatus

Parameters recorded at the 1RM control test on the Skating Fit device, for the experiment group showed the improvement of the results between the two test moments at the level of the group average, for each lower limb as follows:

- left +201.1 [W] for maximum power 15.6%); +175.2 [N] for maximum force 16.8%) and +0.8 [m / s] for maximum speed with the highest percentage progress of 40.8% after intervention. Regarding the partial average power predetermined for a certain section in motion (0-50%), in our case the measurement of the power of the first section in lateral thrust made with the left foot was +136.3 [W]. Regarding the maximum force evaluated on the device by the 1 RM test (maximum repetition), the total pre-test weight for the left leg is 54.16 kg compared to the post-test moment of 65.83 kg, a difference of 11.67 kg - 17.8%.
- right post test for the experiment group was observed an improvement of the maximum power with: + 1993.3 [W] for the maximum power 15.6%); +168 [N] for maximum force 16.5%) and +0.58 [m / s] for maximum speed 34.4%) after intervention period**.** The results for the partial average power showed an improvement of +114.3 [W]. The average total weight was the same.

We conclude that there was an improvement in all parameters measured at the level of the whole experiment group: power, force, execution speed and partial average power for the first section of the lateral push. The percentage increase for both lower limbs was higher compared to the initial time of testing but similar in terms of maximum strength, partial strength and strength (left vs. right). Instead, there was a significant improvement in the pushing speed with both limbs (left 0.8 [m / s], (40.8%) vs. dr. 0.58 [m / s], (34.4% This is due to the fact that the subjects were constantly trained, both during strength training and during testing to perform each push at maximum speed, as explosive as possible.

In the 1RM test on the Skating Fit apparatus, we also wanted to see the extent to which there is a correlation between the studied parameters, if: (1) the force has a positive influence on the resulting value of maximum power in a push (F –P), very significant correlation; (2) force-velocity (PV), positive but a weak correlation; (3) power-velocity (P – V), positive, significant correlation; (4) maximum power and partial average power (P – PP)), very significant correlation, (5) partial power and force (PP - F), moderate correlation, (6) execution speed and partial power (V - PP), intensely significant correlation.

Specific test on rollers

Corona Cup: Parameters recorded at the roller control test, for the experiment group showed an improvement of the results between the two test moments at the level of the group average, at the 500m test with -1.53sec. 2.9%; for the 1000m test with -4.27sec. 4% and at the 1500m test with -2.28sec. 1.5%. In the control group the results were similar in the 500m test with 0.77sec and in the 1500m with 0.56sec.

National Speed Skating Championships: At 500m, for the experimental group were significant differences between pre and post with an improvement in the mean with -2,52sec. (5.2%). At the 1000m test, an improvement of the average time at the level of the experiment group between pre and post testing -5.07sec was observed. (5%). At the 1500m test, from the comparative analysis performed, it can be observed in the experiment group a decrease of the average time in the group by -2.7sec. (1.8%); At the 3000m test, the experiment group imporved -5.87sec. (1.8%). The results indicate an overall improvement in the physical fitness of the subjects in the experiment group at this stage of the mid-term evaluation, by decreasing the average time in all planned trials.

Specific control test on ice

Junior World Cup (start of the season): At the first evaluation stage of the series of three on the ice, a significant improvement was observed in terms of time obtained in the average tests in competitions, respectively 1500m and 3000m, compared to the short distnaces, for the experiment group. The results obtained indicate a progress of the two subjects NC and RM (exp.), Aerobic physical capacity, strength and speed in endurance with hereditary influences (mixed muscle fibers IIa) which confirms the predisposition to such tests.

Romanian Cup (mid-season): The differences observed at the second stage of evaluation, with large variations between the test averages is justified by the participation of a smaller number of subjects in the experiment group at the time of testing in all tests, except for the 500m. In the light of these differences in averages, the progress made by the subjects cannot be ignored, where the comparative analysis could be performed, respectively at the 1000m test: AF (-2.56sec.) And MR (-2.79sec.), 1500m: RM (-3.21) sec. and RV (-1.43sec.) and at 3000m: NC (-4.5sec.).

National Speed Skating Championship (end of season) : At the last stage of the series of ice testing events, end of season, there were large differences in the 3000m race and less obvious in the other events. These results confirm significant progress for junior subjects EN, NC, RV and AF in all distances particularly in the 1000m, 1500m and 3000m samples. At the level of the experiment group, a trend of progress towards the average samples was observed, 1500m

and 3000m. We can conclude that following the intervention program we achieved our goals, developing simple and combined motor skills, characteristic of speed skating: maximum force, explosive force, endurance regime, endurance in force regime and speed and increase movement efficiency (efficient and economical) components that helped to obtain results superior to those of the season prior to our intervention, both in the targeted distances 500m, 1000m, 1500m, and in the long distances considered for juniors respectively, 3000m.

Part III RESEARCH ON THE EFFECTS OF USING SKATING FIT ON PHYSICAL CAPACITY AND SPORTS PERFORMANCE AT JUNIOR SPEED SKATERS

6. THE OPERATIONAL FRAMEWORK OF THE EXPERIMENTAL RESEARCH

The purpose of experimental research

The general purpose in the conducting of experimental research is to establish effective methods and means to optimize the training of junior skaters in particular the use of the Skating Fit apparatus in order to improve the effort capacity. From here derive other equally important goals by introducing the Skating Fit apparatus in the intervention program which refers to:

- increasing physical capacity by developing the strength, power and muscular endurance directly involved in the specific effort;
- increasing the efficiency of the straight line step with emphasis on lateral pushing;
- optimization of physical condition to improve sports performance.

The objectives and activities of the experimental research

General objectives

- Optimizing and modernizing the means of training in sports training during the training period on land;
- Optimizing the training of junior skaters in the direction of improving motor capacity;

The hypotheses of the experimental research

Considering the two directions pursued in our work in achieving experimental research we formulated the following hypotheses:

- E*valuation of strength, speed and power can highlight the contribution of these parameters in optimizing physical capacity;*

- *Specific training on the Skating Fit device will contribute to the development of the strength and power of the lower body;*
- *Training on the Skating Fit device will contribute to the improvement of the sports performances of the speed skaters in specific evaluation conditions;*

Subjects and the framework of the experimental research

In carrying out the actual experimental research we continued with the same sample of subjects aged between 16-20 years, of which 6 girls and 6 boys, junior speed skaters with double identification at the Sports Clubs CSM Pl. and CSM Sb. (experiment group) and ASC Cor. Bv. and CSM Bv. (control group). The small number of researched subjects is due to the fact that at the level of the national team are included only a small number of athletes, qualifying for participation in international competitions including World Cups and World Championships.

The experimental research was carried out within two evaluation periods carried out inside the sports bases Youth Park and Olympic Sports Hall from Ploiești / Sport Park and Grand Fitness Hall from Brașov. For the experiment group, the intervention program had a duration of 6 months, with 6 - 9 trainings / week throughout the study 01.04. - 01.10.2019 in which the initial and final tests for the land and specific roller control tests took place.

Subjects, tests and evaluation tools used in conducting experimental research

The set of dry land tests applied to the subjects of the two groups consists of 10 tests of which seven aim to evaluate the explosive force alternately for the left and right limb and for both limbs, the maximum force, relaxation, resistance force, two samples for speed and one for endurance. In addition, we performed 5 land control tests, for two of them the monitoring and evaluation was performed using the Tendo analysis device (Tendo Sports Machines, Trecin, Slovakia) and the interpretation of the data using the software (Tendo Softaware Computer V-5. Version 6.0.1, Slovakia).

Another element of originality of this research is the realization and introduction in the training of athletes of the Skating Fit apparatus and the application of the 1RM test (maximum repetition). The specific tests consisted in evaluating skaters in official stage competitions of the National Speed Skating Championship on rollers and on ice in national and international competitions such as the opening competition of the season "Internationales Rennen" and Tatra Cup, determining the level of sports performance and comparing them in different events such as: 500m, 1,000m, 1,500m and 3,000m.

Specific physical training program to improve the sports performance of junior speed skaters

The intervention program is structured for the general and specific development of physical condition with emphasis on the development of simple and combined motor qualities, strength and speed of the lower train muscles introducing in the athletes' training the Skating Fit apparatus and means of correcting and increasing the efficiency of the step movement in straight line with emphasis on the pushing phase.

The first objective during the land preparation period is to increase the general physical capacity which will subsequently support the high intensity effort during the specific training and competition period. The second planned objective is to increase the specific strength of the muscle group aspect achieved by performing workouts on rollers, plate, strength, special exercises, on the Skating Fit device, etc.

In designing the training program, specific means were used that target both the specific mechanism of movement and the energy systems targeted in the samples run. According to the three periods in which the intervention program was organized, in the first part, the general physical training lasted 2 months (April - May) the percentage of the total workload is approx. 70% while the intensity (30%) remained relatively moderate with variations, following that in the second period of specific physical training the volume-intensity share to be relatively equal to a disproportionate increase as the competitive period approaches. Obviously, during the specific training period, the percentage of effort and technique intensity is higher with a frequency higher than 3 x per week, respectively, the general attention being directed towards adapting the specific processes.

For each period, the methods and means used in the preparation of the experiment group are exemplified. Thus, in the preparatory period a micro-cycle takes place with 2-3 peaks of higher intensity, depending on the period and the planned competitions. In the intervention program are planned 6 - 9 workouts per week with 1-2 strength trainings depending on the training period with 1-2 days break. With the completion of the competitive stages I on rollers and III on ice, 7 and 14 active days of rest are planned.

7. RESULTS AND CONCLUSIONS OF THE EXPERIMENTAL RESEARCH

Dry land tests

Strength test

For the strength and power test, a number of 7 control tests were planned, so for the first, the long jump on the experiment group was observed a difference of + 29cm, which is statistically significant and where the calculated percentage progress is 11.3%. For a deeper evaluation, the correlational analysis performed between the long and high jump proved to be an intensely significant one where (r = 0.95), so we can conclude that the explosive force is manifested both in longitudinal and vertical direction.

The improvement of the explosive force was also highlighted in the lateral jump (of the skater, by imitating the straight line step with jump), both in the lower limb tightened with an increase of the distance of + 23cm and in the right one of + 22cm, statistically significant calculated is 10.8% and 10.5%. The correlational analysis between the jump length and the maximum power (r = 0.90) and the maximum force (r = 0.81) (parameters evaluated on the Skating Fit apparatus) shows an intensely significant correlation index, so we can say that these two variables directly influence the side jump length. .

Similar results were observed in the test three side jumps where we can say that there is a statistically significant progress of the experiment group following the training program, proving its effectiveness, reflected in the outstanding results obtained by the researched subjects. In this test it can be highlighted that in the left limb the progress is higher respectively, + 23cm with an improvement of time of -0.10sec. The progress being 4.5% and 5.5% compared to the right + 24cm with -0.09sec. Even if the difference in the latter is greater, the final results are better in the left limb. It is stronger due to the intense load on the turntable, thus developing an asymmetry between the two limbs, the efficiency of the left one increasing due to the greater force.

Following the intervention program, an increase was observed in the experiment group of the values of all parameters measured at the high jump test, which tested the explosive force and the detonation of the lower train. These differences are statistically significant, respectively: the increase of the jump height by +4.3 (cm) with a percentage increase of 11.1%, of the maximum power value by +537 (W) 19%, of the maximum detachment speed of 0.43 (m/s) 11% and an increase in the value of the maximum force by +369 (N) with the highest percentage progress recorded of 20.7%.

In the correlation analysis at the same test between the parameters mentioned above, respectively maximum power and maximum force (r = 0.973), maximum power and jump height (r = 0.98) and the latter between maximum force and maximum execution speed (r = 0.72) it has been observed that the force is a good indicator of strength and vice versa, the power contributes and influences the achievement of a jump with a higher height and the higher the maximum force the shorter the time required to detach from the support surface and longer flight time.

Our intervention also aimed at developing maximum strength through one of the methods, for example positive dynamic weight training (<80% of 1RM). The results obtained by the experiment group showed an increase in both the maximum force by increasing the high total weight + 15.7kg, with a percentage increase of 14% and the power by increasing the watt value of a 1RM (maximum repetitions) by +222 (W) respectively a progress of 12.1%. The relationship between these two variables is reciprocal (r = 0.980). The second relationship studied is often debated in the literature between 1RM (kg) and the height of the vertical jump so the subjects who lifted a higher maximum weight showed a high level of power which contributed to a better result by increasing jump height (r = 0.915). There are considerable individual differences that indicate that the load that maximizes maximum power varies between individuals. Regular individual load determination is desirable to ensure that an athlete develops maximum strength (as a secondary goal).

As the improving labor under resistance observed by maintaining the position of the sample is statistically significant difference isometric leg left with + 10.62sec., 12.6% and for the righteous + 10.59sec. with 12.7%. Even after our intervention with a higher total workload for the right limb, the left one is stronger.

Following the identification of the muscular dominance of the subjects, in the Charles Poliquin test, respectively the classification in one of the two / three types of fibers, we noticed that most are classified in the group of mixed muscle fibers (IIa), except for three of the subjects (with IIb). To see the influence of muscle fibers in sports performance in the 500m and 1500m we performed a correlational analysis which shows a close link between the fast and the short and the mixed and the medium (r = 0.971). The fiber determination test was simply limited to the correlation action to identify possible variables that influence sports performance.

Speed testing

In the 50m distance running test, the results confirm in the experiment group a statistically significant decrease (improvement) trend of the time obtained with -0.28sec, with

a percentage progress of 4.2%. In the case of the speed evaluation test in the 400m test endurance regime, a decrease of -4.63sec is also observed with a percentage of 7%., significant for all subjects of the experiment group. The data allow us to conclude that the endurance speed of the subjects in the experiment group is better than that observed in the control group.

Resistance testing

In the endurance test, the Cooper test (running 12 min.) Shows an improvement in aerobic capacity in the experiment group by increasing the VO_2max value and the distance traveled by 2.9 ml / kg / min and an increase in distance by + 274m, the percentage progress calculated for VO_2max being 5.5% and for distance (m) 4.4%. The results obtained in the test for determining the exercise capacity show us that the skaters of the experiment group have a superior aerobic exercise capacity, to the detriment of those from the control group. The higher effort capacity is correlated with the greater distance (m).

Control test on the Skating Fit apparatus

Planning 1RM test (one repetition maximum) on Skating Fit apparatus was possible to analyze and evaluate progress positively or negatively depending on the results obtained from the test subjects of several parameters in one sample representing the quality of the basic motor qualities in speed skating. Moreover, we were able to evaluate the efficiency of the Skating Fit apparatus in training of Romanian skaters and the extent to which its use is reflected in the results obtained in ice competitions during the winter season. The main objective pursued in their preparation was the development of the explosive force, the maximum force and the strength of the lower limbs having as a means of preparation a unique and specially designed device for this purpose.

Thus, following our intervention by planning 1-3 strength training sessions per week and the evaluation test on the Skating Fit apparatus we can conclude that there was a statistically significant difference (improvement) of all parameters measured in the whole experiment group, power, strength and speed of execution. The differences in the mean scores, summarized in a progression between the two test moments, were similar for both lower limbs, although at the initial time of testing the left lower limb had higher values. The difference can be observed for each parameter analyzed as follows:

Comparative analysis: *Maximum power:* An improvement of the power was observed both for the left limb with +218 (W) with a percentage of 14.9% but also with the right one but with a

smaller difference respectively +215 (W) 14.8%; *Maximum force:* The difference observed is similar between the two members where, the left shows an improvement of +152 (N) 12.9% and for the right of +151 (N) 13.1%; *Maximum speed:* As for the execution speed, we can state an increase similar to the other two parameters evaluated for the left limb +0.68 (m / s) 35.7% and for the right one +0.59 (m / s) by 32.1%.

However, we noticed that the greatest progress was made by the subjects in terms of speed execution, the main reason behind this result is the execution / explosive work on the apparatus as well as in exercises performed on dry land so that subjects increasing the power and force, developing the ability to apply / generate these forces in a shorter time, we also support this idea through the well-known reciprocal relationship between these three parameters researched by many authors in the literature.

For both members the percentage progress was similar within the Exp. group, but much higher compared to that observed in group C., at all parameters evaluated during a push with maximum weight on the Skating Fit. These are different from those obtained by the subjects of the Exp. group. between the two periods of preliminary and final research, respectively, for the maximum power: 15.6% vs. 14.9%, maximum force 16.8% vs. 12.9% and for the maximum speed 34.4% vs. 35.7% for the same left limb which proved stronger for each subject tested.

The parameters that were not taken into account in this test, although they were evaluated for each individual, are the indicative parameters respectively the distance of the pushing support, for certain reasons, namely the fact that it is an unchanged parameter or with small variations being greatly influenced by the anatomy of the athlete's body (the length of the lower segments and the power to move the weight) and the eccentric speed which represents the speed of return of the foot after performing the lateral push, the most important in our case being the push speed for the development of explosive force.

1RM (kg) and partial average power (average power)

Regarding the absolute force evaluated on the device by the 1RM test (maximum repetition) the total weight lifted at the initial moment was for both lower limbs of 60.8kg compared to the post-intervention moment of 73.3kg, with a significant difference of 12.5kg at the level of the experiment group, which represents a percentage increase of 17.1%.

The lower left limb proved in multiple tests in our research stronger than the right, even so the weight used in the 1RM test on the device is the same for both limbs. Since the

possible incremental weight used by the subjects is 5 to 5 kg, such an obvious difference in the maximum total weight between the two limbs would not have been possible.

Partial average calculated by the software of the Tendo device, measures the average value of power on a certain section of the movement from its beginning to a certain defined percentage of movement, lateral thrust (value recommended by the manufacturer being (0-50%) Following the comparative analysis, an improvement of power was observed by increasing its value for the left limb by +141 (W) with a percentage increase of 18.9% and for the right one with an increase of +153 (W) respectively 20.4%.

Correlational analysis: In the same test on the Skating Fit apparatus we established a series of six correlations between the measured parameters (for the lateral push exercise), analysis composed of the results obtained by the subjects of both groups to see the influence of one parameter on another.

The first presumed correlation is between the maximum power (W) and the maximum force (N) where a very significant correlation was observed for the left lower limb, (r = 0.93) thus, the skaters with a high power level performed the lateral pushing with a higher force which in the end will increase the speed in the specific conditions of the movement (on ice or rollers).

The second correlation studied is between the maximum power (W) and the maximum execution speed (m / s) there is a significant positive relationship for the right limb (r = 0.73). We can conclude that the skaters who obtained a higher power value, performed the lateral pushing with a higher execution speed, essential components that must be taken into account in planning the preparation of specific movements on land for juniors with transfer in ice sprints.

The third relationship analyzed between the maximum power (W) and the average power (W) is intensely significant for the right lower limb (r = 0.93), the latter value derives from the integer value of the maximum power and explains quite clearly this connection. Value better expresses the parameter and the way of evaluating the ability of a skater to perform the specific movement with maximum effort. This is just as important as completing the side push in an explosive manner.

The fourth established correlation is between the average power (W) and the maximum speed (m / s), a moderately significant correlation was observed for the left limb (r = 0.61). The moderate relationship between the two variables is rather due to the distance of measuring the average power representing the value on the first half of the part of the trajectory of the movement while the speed cannot be developed to the maximum in this interval although the intention of execution is explosive.

The fifth relationship studied is between the maximum execution speed (m / s) and the maximum force (N) where there is a significant correlation for the right lower limb (r = 0.73), we can say that an increase in the force level leads to improved speed execution, but it is essential that these parameters be targeted in the specific motor structure with an optimal technique especially for junior skaters.

The last relationship we wanted to evaluate is between the average power (W) and the maximum force (N) was observed for the lower limb as a very significant correlation (r = 0.89) we can say that force is a precursor to the development of power where the average power also derives, so the connection is very significant and worth studying because it presents information about the weaknesses and strengths of each subject evaluated. Skaters with a high level of strength have higher values than the average power value, the relationship being indirectly reciprocal.

Specific test on rollers

Crown Cup

Due to the unfavorable climatic conditions for the safe conduct of the competition, the Corona Cup was canceled, being unable to analyze the results of the skaters in our study at the pre-training season 2018 - 2019 vs. post testing from 2019 - 2020.

National Speed Skating Championship on Roller

This competition was chosen as a test of control due to the importance given by the coaches, being a reference point for evaluating the progress of sports performance for both research groups, during the off-season.

Regarding the experiment group, at the 500m test, an improvement of the average time was observed at the level of the group of -3.62sec. Statistically significant difference, which represents a percentage progress of 7.6% where the group C. is -0.50sec.

At the 1000m test, the time difference in the experiment group is -4.86sec., presenting a percentage progress of 5.1%, while group C. recorded a small regression of + 0.13sec. comparing to the initial time of evaluation.

At the 1500m test, the improvement of the average time at the level of the experiment group is -6.05sec. Calculated percentage progress being 4.1%, and the group C. presents a difference of only -2.05sec.

At the 3000m test, for the experiment group was observed the largest difference one, statistically significant obtained between pre and post intervention of -15.46sec., With a percentage progress of 4.8%., Where again group C. shows a regression of + 0.95sec.

Following the results presented and the time differences calculated for the experiment and control groups, we can conclude that the skaters to whom the intervention program was applied showed special results at this intermediate stage of the off-season, specific on rollers, both short and endurance, observing a progressive increase of the time difference as the distance of the test increases, culminating with a significant progress both from a practical and statistical point of view at the 3000m test.

The outstanding results at the National Championship on Roller skates reflect the achievement of the proposed objectives as well as the quality of the land preparation program, so that two of the subjects of the experiment group achieved national records as follows for: junior category A. subject RM (exp.) 500m, 1000m, 1500m, 3000m and general classification with the score (182,753) and the junior category B., EN at the 500m, 1000m, 1500m, 2000m and general classification with the score (190,193).

Specific test on ice

International Competition (start of season)

The International Competition for the season opening 2019-2020 took place in Inzell Germany and hosted athletes from 18 countries with over 215 athletes, being one of the major events organized by the skating rink and planned in the competitive calendar of the paper for analysis.

The subjects started at different tests and times according to the entries by the club coaches so that the time differences calculated at the level of the experiment and control groups are transposed in progress or regress and presented for each test as follows:

Analyzing the results obtained by the subjects of the researched groups between the two competitions, the Junior World Cup and the International Competition, at the 500m event, for the beginning stage of the season, an improvement of the time was observed in the experiment group with -0.62sec. the percentage increase of 1.5% and group C., a decline of + 0.20sec.

For the 1000m test, after the intervention group, the experiment group registered a difference of -0.83sec., the percentage progress of 1%, and the group C. with only -0.02sec. At the 1500m test, at the level of the experiment group there was a difference at the time after the intervention of -4.12sec., with a progress of 3.3%, and group C. with a difference of more than - 5.11sec. At the 3000m test, the absence of several subjects from the two groups was observed. The time difference calculated only for the subjects of the experiment group shows - 35.11sec., Which shows a percentage progress of 11.7 %. This difference is explained by the fact that at

the initial time of testing only one subject got started compared to the time after testing in which two other subjects participated. In group C., the situation is different and no individual changes could be reported due to the fact that they did not start, except for one post-test subject.

We can say that at the first stage of specific evaluation on ice, beginning of the season, regarding the experiment group, a more obvious improvement of the results is observed in the medium and long test. This explains why athletes come with a high level of general and specific physical training on rollers (where climatic conditions often influence the perceived intensity of effort) that supports specific physical training on ice and which manifests itself especially in endurance increasing the body's capacity in effort where workload is higher and intensity is moderate.

Because the evaluation of sports performances took place after 2-3 weeks of specific training on the ice during which time specific training was conducted and can explain why the subjects obtained less progress in the 500m and 1000m short trials. To develop a sense of ice and speed despite the level of development of strength or power, it takes time and effort (in which the training program involves intercalating the effort of endurance and speed but with a higher share of trace) under specific conditions, plays an essential role.

Tatra Cup (mid-season)

The subjects of the experiment group at the initial moment of the testing had a different degree of participation due to the financial resources allocated to the section by the sports club. At the final moment of the intervention, all the subjects of the experiment and control group started the 500m, 1000m and 1500m events, except for one subject. The difference observed between pre and post intervention for the two groups is:

At the 500m test, regarding the experiment group, an improvement of time was observed with -0.66sec., the calculated percentage progress is 1.6%. The control group has a difference of -0.16sec. At the 1000m test for the experiment group, the highest progress of -3.04sec. Was registered, with 3.6%, and the control group registered a similar progress with the one observed at the 500m test, respectively -0.41sec. The only test in which a positive change was observed for the experiment group is the 1500m with + 3.20sec. At the 3000m test, a comparative analysis could be performed only at the initial time of testing, thus a significant difference was observed between the experiment and control group of 16.13sec. At the time of post-testing, the comparative analysis could not be performed because no values were recorded for any of the groups.

In the second stage of evaluating the sports performances, the extended analysis between the two test periods highlights the improvement of the average time in the experiment group for the short trials, respectively, 500m and 1000m. The difference can be attributed to both the high level of general physical training and the specific physical training on ice with a higher weight (with a longer duration), which support the achievement of good results despite the conditions of the evaluation. Given that the skating rink is discovered, the time difference in short trials is smaller (usually) compared to long trials where wind, rain can definitely affect performance, by consuming high energy resources and decreasing movement efficiency. , with effect on the final time of the race.

The fact that in the 1500m test there was a regression from the initial moment, is due to the different number of subjects who participated influencing the group average, if at the pre time there were three of the post-test subjects there were five, of which only two could calculate the time difference.

National Skating Championship - Speed (end of season, on ice)

The last stage of evaluation on ice is another important moment of our research because it reflects the efficiency of training and the quality of the intervention program on land and the slope of progress made during a training season (on ice) in sports performance in competitions of the subjects of the experiment group to which they started according to the schedule. For each test the progress is presented as follows:

At the 500m test, at the level of the experiment group, a time difference was observed between pre- and post-intervention of -1.75sec. These represents a percentage progress of 4.2%, and the control group registered a difference of -0.40sec., in 1000m, the subjects of the experiment group show a statistically significant improvement of the average time of -3.06sec., with a percentage progress of -3.7%. The control group shows a regression at the group level of + 1.6sec. At the 1500m test, there is a decrease in the average time in the experiment group by -6.67sec. The calculated percentage progress being 5.1%. The difference in the control group is much smaller with a progress between the two test periods of -1.24sec. At the 3000m test, the experiment group registered a statistically significant difference, respectively an improvement of the results obtained in competition at the group level with -8.98sec, where the calculated percentage progress is 3.3%. The difference observed in the control group even shows a setback compared to the previous season with + 1.86sec.

According to the differences presented previously at the National Ice Championship, we can say that the subjects of the experiment group made a general progress in all four tests

they started, in which the individual progress is significant both practically and statistically and in the level of the group for two of the tests, 1000m and 3000m, but no less obvious in the other two tests, 500m ($p = 0.15$) and 1500m ($p = 0.06$). The progress was increasing as the distance increased: -1.75sec, -3.06sec., -6.67sec. and -8.98sec., between pre and post intervention.

We can say that the intervention program could have contributed to obtaining outstanding results at the National Championship as a top competition (but also at other competitions planned for analysis) in addition to other material or physiological factors such as financial resources that allowed a longer duration of specific training on ice or intense growing period. All these external and internal factors supported the achievement of the objectives and the achievement of new national records for one of the subjects of the experiment group in the 1500m test with a time of 1.59.50 and for three of them in the team sprint test with a time of 1.33.07.

8. GENERAL CONCLUSIONS

Following the preliminary research and analysis of the data, the instruments, samples and test conditions were validated. The results obtained at the control test on the Skating Fit device as well as those on land and specific, validate the formulated hypotheses that have been confirmed with the possibility of continuing the organization and conduct of the final research.

1. The intervention program designed to improve the physical capacity of skaters has led to the achievement of the objectives imposed by the need for specific training, traditional and modern means and methods used.

- Following the application of the two intervention programs within the research, it was observed that the evaluation of the general physical capacity analyzed by the T-Test values, demonstrates significant increases in explosive force, maximum force, maximum power value, execution speed, speed in resistance to a significance threshold of $p < 0.01$, with significant changes in adaptation to effort as well as in the lower limbs.

2. The mechanical specificity of the sample on the device refers to the kinetic and kinematic similarity of the movement performed under specific conditions. The evaluation on the device is not limited to this but includes parameters such as strength and power, speed of execution, lateral thrust movement model, type of muscle action, range of motion, its duration, etc. The degree of transfer of training on the device is

higher when the exercise is similar in motor structure to the specific movement. The high load used (> 60%) increases the maximum strength and power by 14.8% and 13.1% after 6 months of training, in addition we showed that fast / mixed muscle fibers generate a higher value of strength, also demonstrating a close relationship between strength, speed and power.

- Development of strength and power was achieved through specific means (eg. Skating Fit, plyometric exercises similar to the motor structure of specific movement from the fundamental position and its derivatives) and methods aimed at development: maximum force, explosives, force in speed and strength, maximum power, etc.
- Quantitative and qualitative analysis of the data recorded by the subjects at the control test on the Skating Fit device to determine the level of strength, (speed) and strength of the lower limbs contributed to providing objective information of the level of training, variables with a high degree of transferability in specific preparation conditions (on ice).
- The research results showed that training on the Skating Fit with different loads has a positive and significant influence on the strength and power of the lower limb muscles directly involved in the specific effort, its use resulting in an increase in maximum strength, maximum speed and power maximum after a period of 6 months of training.

3. The fact that the evaluation of the intervention program culminates with the testing of subjects on ice is not accidental because it confirmed the quality of the training program, efficiency and usefulness of the device and the hypotheses in which we assumed a relationship between muscle strength and speed, between muscle strength and movement efficiency. The last and most important refers to the use of the Skating Fit device, so its introduction in the preparation of the subjects of the experiment group produced positive changes in the combined motor qualities maximum force, explosive force, endurance regime, endurance strength regime and speed and increase the efficiency of lateral pushing but more than that these changes are reflected in the results obtained in official national and international competitions.

- The comparative values between the two test moments show significant increases between the initial and final values of the results obtained in national and international competitions by improving sports performance in specific conditions due to the intervention program, optimal training conditions and many order factors, inter and external that contributed to the achievement of national records on rollers and ice by two of the subjects of the experiment group.

- Regarding the analysis of the results obtained in specific evaluation conditions, a significant progress was demonstrated during the two seasons of preparation and competition with the obvious improvement of the times at the 500m and 1000m samples, with an increasing trend as the distance of the sample increases.
- By increasing the strength and power and efficiency of the movement which aimed to maintain a correct alignment between shoulder-hip-ankle, low position, timely transfer of body weight and direction of lateral thrust, significant individual progress could be achieved.

The skaters included in our study obtained multiple individual national titles at the National Champions in their age group, for two of the subjects in the experiment group the outstanding results were completed with multiple national records on rollers and ice:

- Categ. Jun. A., RM (exp.): 500m, 1000m, 1500m, 3000m and General classification score (182,753), on roller skates;
- Categ. Jun. B., EN: 500m, 1000m, 1500m, 2000m and General classification with the score (190.193), on roller skates;
- Jun.B.,EN:1500m,on ice;
- Team sprint test: RM, AF and EN: with a time of 1.33.07 at the Enschede World Cup (NED).

Our hypotheses argue the need to develop and experiment with tests specific to the motor structure and the areas of intensity in the specific effort. We can say that the hypotheses were admitted and the subjects present homogeneous adaptive changes of strength and power justifying the importance and effectiveness of the intervention programs that we introduced in improving sports performance, as follows:

1. From the analysis of the results obtained from the land control tests, we can conclude that "the *evaluation of strength, speed and power can highlight the contribution of those parameters in optimizing physical capacity"*, hypothesis 1 of the final research being confirmed.
2. From the analysis of the parameters measured on the Skating Fit device, we can conclude that "the *specific training on the Skating Fit device contributed to the development of the strength and power of the lower train"* hypothesis 2 of the final research being confirmed.
3. From the analysis of the results obtained in competitions we can conclude that *"the training on the Skating Fit device contributed to the improvement of the sports*

performances of the speed skaters in specific evaluation conditions" hypothesis 3 of the final research is confirmed.

9. ELEMENTS OF ORIGINALITY

As far as the organization and conducting research as constituting elements of originality we consider the following:

- Design and personal realization of the device that I called Skating Fit (Skating = skating, fit = fit);
- Using Skate Fit apparatus in intervention program of the experiment group;
- Specificity of the means and methods used in the planning of the intervention program;
- Testing skaters with the Tendo WL Analyzer (Tendo Sport Machines, Trecin, Slovakia);
- Specific tests on dry land (5) and specific test on the Skating Fit apparatus (1RM);
- Establishing correlations between the levels of parameters measured at different tests and ice sports performance.

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