


Training aimed at the development of power and physical performance of futsal players

Treinamento direcionado ao desenvolvimento de potência e desempenho físico de jogadores de futsal

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Abstract – The aim of the study was to analyze the effect of a training period aimed at the development of lower limb power and physical performance of futsal players. The sample consisted of 10 futsal players from a professional team aged 23.70 ± 5.85 years, 72.33 ± 6.01 kg and 174.40 ± 0.05 cm. Players were monitored for a period of 4 training weeks, corresponding to the beginning of the competitive period. During this period, physical training sought to improve lower limb power. At the beginning and end of the training period, the following tests were performed: Squat jump (SJ), Countermovement jump (CMJ), 15-meter speed (Vel_15m) and Futsal Intermittent Endurance Test (FIET). The training load was monitored by the Session Perceived Exertion method. Weeks 1 and 3 presented higher training load than weeks 2 and 4 ($p < 0.01$). In the post-training period, shorter running time in the Vel_15m test ($p = 0.04$), greater height in SJ ($p < 0.01$) and CMJ ($p < 0.01$) tests, and higher maximal speed in FIET ($p = 0.04$) were observed. It could be concluded that directing training at the beginning of the competitive season to improve power increases the lower limb power of futsal players, with consequent improvement of speed and the ability to perform intermittent actions at high intensities.

Key words: Sports; Monitoring; Exertion; Strength.

Resumo – O objetivo do estudo foi analisar o efeito de um período de treinamento direcionado ao desenvolvimento de potência de membros inferiores no desempenho físico de jogadores de futsal. A amostra foi composta por 10 jogadores de futsal de uma equipe profissional com $23,70 \pm 5,85$ anos, $72,33 \pm 6,01$ kg e $174,40 \pm 0,05$ cm. Os jogadores foram monitorados por um período de 4 semanas de treinamento, correspondente ao início do período competitivo. Neste período, o treinamento físico buscou aperfeiçoar a potência de membros inferiores. No início e ao término do período, foram realizados os testes: Squat jump (SJ), Countermovement jump (CMJ), velocidade de 15 metros (Vel_15m) e Futsal Intermittente Endurance Test (FIET). A carga de treinamento foi monitorada pelo método da percepção subjetiva de esforço da sessão. As semanas 1 e 3 apresentaram maior CTST que as semanas 2 e 4 ($p < 0,01$). No momento pós treinamento, observou-se menor tempo de corrida no teste de Vel_15m ($p = 0,04$), maior altura nos testes SJ ($p < 0,01$) e CMJ ($p < 0,01$), e maior velocidade no FIET ($p = 0,04$). Pode-se concluir que direcionar o treinamento no início da temporada competitiva para melhora da potência proporciona incremento na potência de membros inferiores de jogadores de futsal, com consequente melhora da velocidade e na capacidade de realizar ações intermitentes em alta intensidade.

Palavras-chave: Esporte; Monitoramento; Esforço; força.

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INTRODUCTION

Futsal is a team sport in which multiple sprints and high-intensity actions occur intermittently during matches¹. In addition to running approximately 3000-4000 m at intensity of 85-90% maximal heart rate (HR_{max}), futsal players perform sprint sequences (3-4 sprints) every 20-30s during matches¹⁻⁴. Although much of the energy demand during matches is supplied by the aerobic system^{4,5}, constant sprints, abrupt stops, accelerations, decelerations, changes of direction and finalizations that occur during matches require from players well-trained neuromuscular system and anaerobic energy system⁴⁻⁷. In this way, sessions aimed at strength and power training are fundamental components of the annual training planning for players of this modality.

Similarly to other team modalities, futsal presents short period of preparation and extended competitive period⁸⁻¹⁰. In this way, coaches often direct training loads in the preparatory period for the improvement of players' physical fitness, so that they are able to appropriately deal with the physical requirements of matches¹¹. Previous studies have shown that with the adoption of this strategy in preparatory periods, futsal players can present substantial improvements in physical tests with high aerobic demand (Yo-Yo Intermittent Recovery test, multistage 20-m shuttle-run)^{12,13}, while improvements in strength and power tests are limited^{13,14}. These results are attributed to the effect of concurrent training caused by the large volume of training sessions aimed at the development of aerobic capacity or sessions that substantially require this system (technical-tactical training) and / or the difficulty of directing training loads to the multiple physical needs of the modality during this period^{13,15}. However, a previous study showed that after a preparatory period with reduction of training loads and with sessions aiming at the development of strength and power of lower limbs, futsal players improved performance in power and speed tests¹³. Despite the importance of previous findings, it is necessary to further investigate the physical performance responses of futsal players undergoing training periods with emphasis on strength and power development, as well as studies describing these training sessions in a detailed way so that they can be replicated or modified (in case of negative effect) by coaches.

Therefore, the aim of this study is to analyze the effect of a training period aimed at the development of lower limb power, performed at the beginning of the competitive season, on the physical performance of futsal players. The hypothesis raised is that, due to the lower training volume and to the application of loads for the training of lower limb power¹³, there will be an increase in performance in tests that demand this physical capacity (vertical jump and velocity) and performance maintenance in tests with great aerobic demand.

METHOD

Subjects

The sample of this study was composed of 10 futsal players of a professional team from the State of Paraná aged 23.70 ± 5.85 years, 72.33 ± 6.01 kg of

weight and 174.40 ± 0.05 cm of height. Players have participated in official games in the main or base category for a minimum of 3 years. Inclusion criteria were: to be linked to the team involved in this study; 90% attendance in team training; being in full physical condition to participate in training sessions. Exclusion criteria were: presence of lesions; use of ergogenic resources or anti-inflammatory drugs; disconnection from the team during training sessions. Players were instructed by a nutrition professional on how to adjust meals according to individual nutritional needs. However, no nutritional recall was performed. This study was approved by the Ethics Research Committee of the local institution, and players signed a written informed consent prior to the beginning of data collections, informing them about the study procedures.

Experimental design

Players were monitored for a period of 4 weeks of habitual futsal training, corresponding to the beginning of the competitive period. The period immediately followed a 6-week preparatory period. The competition in which the team was participating was the “Gold Series” Championship, the first division of the main futsal championship of the state of Paraná. There have been 3 matches during the 4 weeks of training. During this period, physical training was planned with the aim of improving lower limb power. A one maximal repetition test (1 RM) was performed one week before the start of monitored training. On the first day of training of the first week and after the fourth week (first day of the fifth week), players were submitted to a battery of Physical Tests. Physical tests were: Squat jump (SJ), Countermovement jump (CMJ), 15-meter speed (Vel_{15m}) and Futsal Intermittent Endurance Test (FIET). For this, players performed warm-up exercises with light runs, lateral displacements, displacement with backward runs, small jumps and stretches with duration of approximately 10 minutes. All tests were performed in the gymnasium where training and matches are performed (40x20 m Paviflex[®] type vinyl floor court) and after 48 hours without training. The training load was monitored by means of the session rating of perceived exertion (session-RPE) method¹⁶.

Training Description

Training sessions aimed at technical and tactical improvement were performed in a 40x20 m Paviflex[®] type vinyl floor court. The methodology adopted by the coach was to develop match strategies for the evolution of the following phases: defense, attack, transition and rehearsed ball plays. Neuromuscular training sessions were performed in a gym with strength training equipment. During the 4 weeks, 8 training sessions (2 sessions per week) were carried out with exercises aimed at developing power and strengthening of lower and upper limb muscles (table 2). Exercises were divided into two training sessions: session (A) and session (B). Session A was always held in the first weekly strength training session and session B in the second weekly session. Exercises prescribed in each session (A or B) are described in table 1. Activities were also carried out with a psycholo-

gist specialized in sports psychology. All activities developed in each shift (morning or afternoon) are described in table 2.

In both sessions A and B, athletes performed the following exercises: Leg press, leg extension, abduction machine and adduction machine (table 1). In jumping exercises (Loaded jump squat, Unipodal Jump, Dead lift with jump), players were instructed to jump as high as possible, and the applied load was determined as the one in which players were able to jump at height of approximately 20 cm. Jumping height was visually measured by the coach using an object with height of 20 cm positioned next to the player. If players jumped above or below 20 cm, the load was set at 5%. In lateral jumps and horizontal jumps, players were instructed to jump as high as possible only with body weight. Exercises performed with lateral jumps, horizontal jumps, box jumps, unipodal jumps, jump squat, dead lift and Leg press were performed in 4 sets of 6 jumps per exercise, with intervals of 2 minutes per set. Other exercises were performed with 4 sets of 10 maximal repetitions, with loads of 65% of 1 maximal repetition (RM). Other exercises for upper limbs were added during the 4-week intervention (Table 1).

Table 1. Distribution of power exercises performed in the two weekly sessions, A and B.

Exercises	Sessions	Intensity	Series	Repetitions
Loaded jump squat	A	20 cm	4	6
Unipodal Jump	A	20 cm	4	6
Dead lift with jump	A	20 cm	4	6
Lateral jump	B	Max (Body weight)	4	6
Box jump	B	60 cm (Body weight)	4	6
Horizontal jump	B	Max (Body weight)	4	6
Leg Press	A-B	80% 1RM	4	6
Adduction machine	A-B	65% 1RM	4	10
Abduction machine	A-B	65% 1RM	4	10
Leg extension	A-B	65% 1RM	4	10
Bench press in guided bar	A	65% 1RM	4	10
Incline bench in guided bar	A	65% 1RM	4	10
Arm curl	A	65% 1RM	4	10
Biceps Pulley	A	65% 1RM	4	10
Overhead press	A	65% 1RM	4	10
Dumbbell lateral raise	A	65% 1RM	4	10
Lat pull down	B	65% 1RM	4	10
Upper back Row	B	65% 1RM	4	10
Pulley triceps (Bar)	B	65% 1RM	4	10
Pulley triceps (Rope)	B	65% 1RM	4	10
Abdominal crunch	A-B	Body weight	4	25

Instruments

- **1 maximum repetition test**

The 1 maximum repetition test (1RM) was performed with all players in

Table 2. Training distribution during the training period analyzed.

		Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 1	Morning	TF	TP	TT	TP	F	R	F
	Afternoon	TT	TT	TT	AP/TT	TT	J	F
Week 2	Morning	F	TP	TT	TP	TT/R	F	F
	Afternoon	F	TT	TT	AP/TT	F	J	F
Week 3	Morning	F	TP	TT	TP	F	TT	F
	Afternoon	F	TT	TT	AP/TT	TT	TT	F
Week 4	Morning	R	F	TP	TT	TP	F	F
	Afternoon	J	F	TT	AP/TT	TT	F	F
Week 5	Morning	TF						

Note. Objectives: TT= Technical / Tactical; TP= Strength/Power; AP= Activity with Psychologist; R= Recreation; J= Match; F= Rest; TF= Physical tests.

each of the exercises in which the load was calculated using this variable (table 1). In this test, players should perform an eccentric action followed by a concentric one. Load was increased by 5% for the next execution if it was not possible to perform a second concentric action, and decreased by 5% if it was not possible to perform a single repetition. Up to 5 attempts were made to identify the maximum load that the player could lift on one repetition for the same test day, considering 2-5 minutes as a rest interval. The first attempt was made with self-selected load.

• Lower limb power test

To infer the lower limb power, Squat jump (SJ) and Countermovement jump (CMJ) tests were used. These tests were performed in a contact platform (Cefise, Nova Odessa, SP, Brazil) with interface with the Jump system 1.0 software (Cefise, Nova Odessa, SP, Brazil). Three attempts were made and the best jump was considered. The first test performed was the SJ, in which athletes should start from a crouched position at an angle close to 90° in the knee joint. Then, the CMJ test was performed, which was started from the orthostatic position, with hands at the waist, performing countermovement near 90°.

• Speed test

The speed of players was tested in a 15-m course. The test was performed on a straight course, in which players should travel in the shortest possible time. To verify the running time, a photocell was used (Cefise Biotecnologia esportiva, Speed Test fit, Brazil). Three attempts were made and the shortest time was considered as the performance variable.

• Futsal Intermittent Endurance Test (FIET)

The Futsal Intermittent Endurance Test (FIET) was used to assess the ability of players to perform high-intensity actions¹⁷. FIET consists of 45-meter shuttle runs (3 x 15 meters), which are interspersed by 10 seconds of active recovery. The test consists of 6 blocks, the first with 9 repetitions of 45 m and the others with 8 repetitions. A 30-s interval is respected between blocks. The test starts at 9 km / h and is increased by 0.33 km / h every 45

seconds in the first block. In the other blocks, speed is increased by 0.20 km / h. The test is discontinued when the athlete reached exhaustion or is unable to reach the distances determined during the test (demarcated 3 m before the 15-meter line) for two consecutive times. The highest speed achieved in FIET was considered as performance value (PV_FIET).

- **Session rating of perceived exertion (session-RPE)**

Session subjective exertion perception (session-RPE) was measured using the Subjective Exertion Perception Scale CR-10 (18), 30 minutes after each training session. The value obtained in the scale was multiplied by the training time in minutes to quantify the session training load¹⁶. The load of all weekly sessions was summed up, and thus, the total weekly training load (TWTL) was quantified.

Statistical analysis

To test data normality, the Shapiro-Wilk test was used. Vel_15m and SJ were not normally distributed and were analyzed by the paired Wilcoxon test. Variables TWTL, CMJ and PV_FIET presented normal distribution. Therefore, TWTL was analyzed using the ANOVA test for repeated measures with Tukey *Post Hoc*. CMJ and VM_FIET were analyzed using the Test-t for dependent samples. The software used was Statistica (v.8.0, StatSoft®, Tulsa, Ok) considering difference $p < 0.05$.

RESULTS

The four-week TWTL is described in figure 1. Week 1 presented higher TWTL compared to week 2 ($p < 0.01$) and week 4 ($p < 0.01$). Week 3 presented higher TWTL compared to weeks 2 ($p < 0.01$) and 4 ($p < 0.01$), but was not different from week 1 ($p = 0.99$). Weeks 2 and 4 presented similar TWTL value ($p = 0.39$).

At post-training period, players had shorter time in the Vel_15m test ($p = 0.04$), greater height in the SJ ($p < 0.01$) and in the CMJ tests ($p < 0.01$) and higher speed in FIET ($p = 0.04$; / Figure 2).

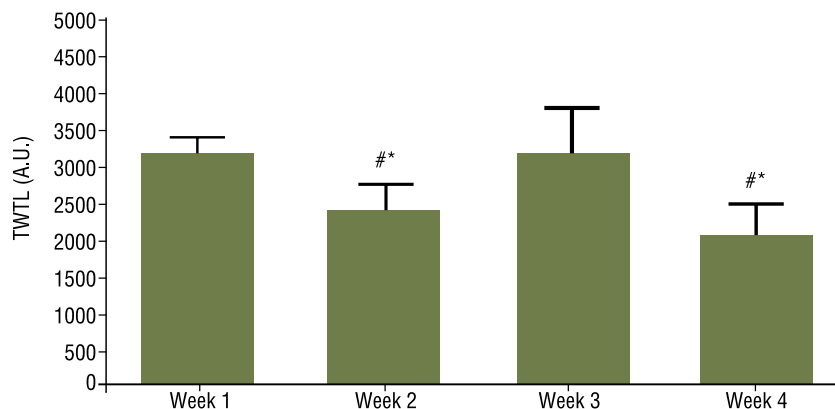


Figure 1. Total weekly training load (TWTL) from weeks 1 to 4. * $p < 0.01$ different from week 1. # $p < 0.01$ - different from week 3.

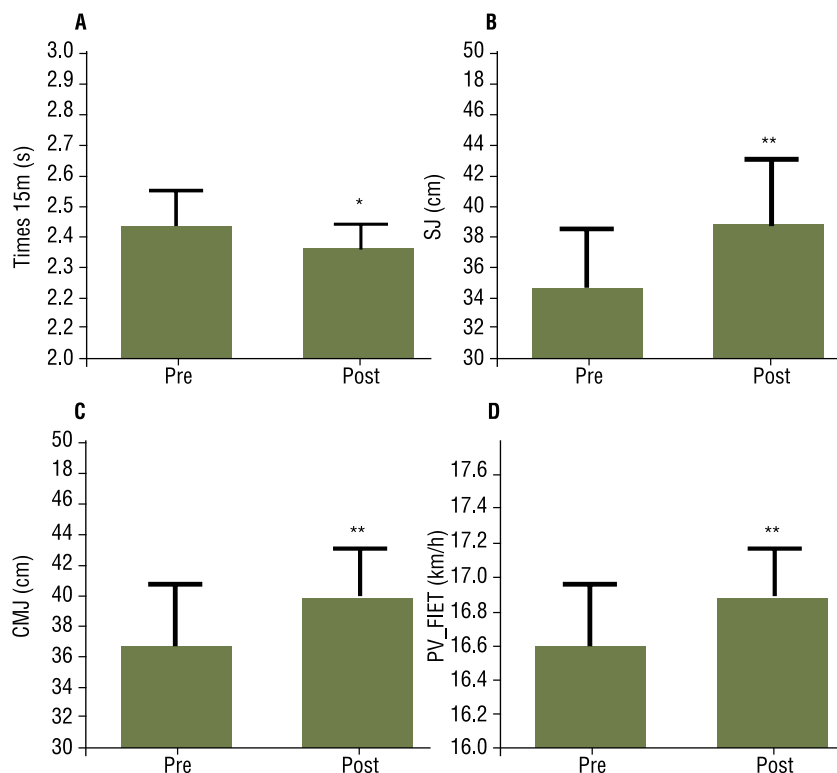


Figure 2. Performance in 15-meter speed tests (A), squat jump (B), countermovement jump (C) and FIET (D) at pre and post training moments. * $p < 0.05$, ** $p < 0.01$ - difference in the comparisons between pre and post moments.

DISCUSSION

The results obtained are in agreement with the hypothesis raised, since training aimed at the development of lower limb power, performed at the beginning of the competitive season, provided improvement in speed and vertical jump tests. In addition, an increase in performance was observed in test with high aerobic demand (ability to perform high-intensity actions specific of futsal matches). Thus, the results demonstrate that the applied training improved performance in all physical tests (vertical jump, speed and FIET).

Increased performance in vertical jump tests at the beginning of the competitive season has been demonstrated in previous studies, corroborating results of this study^{11,13}. A possible factor that may justify the increase in lower limb power observed in this study is the reduction of training volume aimed at other physical abilities, usually observed during the preparation period^{13,15}. Due to the short preparation period in collective sports, training sessions in this period are aimed at the development of many motor skills, which may lead to competition in adaptations caused by training^{13,15}. In addition, loads aimed at lower limb power training seems to be another important factor for improving this physical capacity^{13,19}. In soccer players, for example, training sessions in a preparation period aimed at the development of strength and power were suggested as possible responsible for improvements of performance in lower limb power tests, despite the high volume of trained skills¹⁹. In the same study, the lack of sessions aimed at strength

training was suggested as responsible for stagnation of this physical capacity during the competitive season¹⁹. Improvement of lower limb power was also observed during the preparation of young volleyball players when training loads were aimed at increasing power²⁰. In this way, training sessions aimed at few skills, as well as the training to improve lower limb power seems to be an important factor for the improvement of this physical capacity.

The improvement observed in lower limb power seems to be related to the improvement observed in the 15-m speed test. Apparently, speed in short-speed runs (<50 m, acceleration phase) is related to the capacity to produce force in the soil both horizontally and vertically²¹. A previous study showed that performance in tests performed in the optimum power zone (e.g., hip-thrust and jump after back squat) showed very large or near perfect correlation with performance in sprint tests at different speeds (10-, 20-, 40-, 60-, 100-, 150-m). In addition, additional vertical and horizontal plyometric training in the training routine of U-20 soccer players provided speed improvements in 0-20m tests²². Jumping exercises, both vertically and horizontally, were added to the training routine of futsal players of the present study, and according to results shown in other studies, these exercises are related to the improved speed of players observed in this study. Increasing speed over short distances is important for futsal players, as these are actions taken at crucial moments of the match such as attack, counter-attack, defensive return. Thus, the present study encourages the addition of training aimed at power development to increase the speed of futsal players.

FIET is an intermittent high-intensity field test that requires both anaerobic and aerobic systems¹⁷. In a previous study, in which reduction in the total training volume during the competitive period (compared to the training period) was also observed, as well as the directing of training loads for strength and power, performance of futsal players in the multistage shuttle-run test did not change¹³. It is believed that the short distance traveled (15m) and the large number of changes of direction movements during the match makes the anaerobic system, as well as neuromuscular components, to have great effect on FIET¹⁷. Previous study have shown that a twelve-week field training combining strength and power increased performance in the Yo-Yo intermittent endurance run test, without significant changes in the maximum oxygen uptake of young soccer players²³. Thus, it is believed that training aimed at the improvement of lower limb power may have contributed to the improvement in decelerations and accelerations involved in the constant changes of direction during FIET, as well as in moments of high intensities in the test, justifying performance improvement. This result reinforces the application of periods with this training characteristic.

The main limitation of this study is the absence of a control group. Certainly, a control group could strengthen the results demonstrated in this study, proving that the results found were due to the directing of training loads for the improvement of strength and power. However, the results found here deserve attention, since they have a positive effect on all physical tests performed, which suggests a positive effect of the training

applied. One factor that could justify the absence of control group would be the low number of athletes in a futsal team, participating in important state-level championships. Further studies should be performed with the presence of a control group to confirm the results found here.

CONCLUSION

Based on the results found, it could be concluded that training at the beginning of the competitive season aimed at improving power provides an increase in the lower limb power of futsal players, with consequent improvement in speed and in the ability to intermittently perform high-intensity actions. Moreover, these results demonstrate that training aimed at to lower limb power applied at the beginning of the competitive period may complement results usually observed in the preparation period¹³, since it usually has short duration.

COMPLIANCE WITH ETHICAL STANDARDS

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Ethical approval

Ethical approval was obtained from the local Human Research Ethics Committee – Integrado College and the protocol (No. 1.982.224) was written in accordance with standards set by the Declaration of Helsinki.

Conflict of interest statement

The authors have no conflict of interests to declare.

Author Contributions

Conceived and designed the experiments: V. H. de F. Performed the experiments: G. G. T., M. R.. Analyzed data: V. H. de F. Contributed with reagents/materials/analysis tools: S. de P. R.. Wrote the paper: V. H. de F., G. T., M. R., S. de P. R., B. M..

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