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Effects of a Plyometric Training Program in Sub-Elite Futsal Players During Pre-Season Period

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ABSTRACT

Background of Study: Plyometric training (PT) programs can improve several motor skills during the pre-season. Even so, its impact during the pre-season specifically in futsal remains unclear. **Objective:** The present observational study examines the impact of a six-week PT program that included varied strength exercises in adult male futsal players. **Method:** Fourteen futsal players from a Portuguese men's sub-elite team that competed in a national championship (mean ± Standard deviation (SD) age: 25.78±7.05 years) were included in this cross-sectional study that analyzed the consequences of a PT program during the pre-season, followed by four weeks of detraining. Players were monitored 3 times: at the beginning, after six weeks of PT and four weeks after the end of PT. **Results:** The current research presented significant mean changes with the application of the training program in the three assessment moments for agility (small to moderate effect), countermovement jump (CMJ) height (trivial to small effect), and sprint performance (trivial to moderate large effect). When assessing the mean differences between pre- and post-training, the differences are more evident in their magnitude (Δ = -12.73 to 3.69%, d = 0.38 to 2.08). Furthermore, the PT program showed the greatest influence on 20 m sprint with a large effect (Δ = -12.73%, d = 2.08), followed by a small and moderate effect for agility (Δ = -6.46%, d = 0.85) and for the 10 m sprint (Δ = -3.53%, d = 0.38). **Conclusions:** These results confirmed the impact of a six-week plyometric training during the pre-season in sub-elite futsal players. This new evidence can be particularly useful in pre-season planning in futsal.

Key words: Futsal, Pre-Season, Plyometric Training, Body Composition, Motor Skills

INTRODUCTION

Futsal is characterized as a modality of mostly intermittent high-intensity characteristics and short duration (Beato et al., 2016; Boullosa et al., 2013), which includes changes of direction, sprints, jumps, dribbles, shots, tackles interspersed with short recovery periods of 20-30s (Álvarez et al., 2009; Castagna & Álvarez, 2010). Furthermore, the constant change of position within the context of the game to carry out offensive and defensive actions emphasizes strength as a key skill to achieve excellent performance (Barbero-Alvarez et al., 2008). These reports corroborate the idea that in addition to good aerobic fitness, (De Freitas et al., 2015; Milanez et al., 2011), the potentiation of neuromuscular skills seems to be fundamental to improve performance during competition (Marques et al., 2022). Thus, considering the characteristics of the modality and the constant request of maximum intensity efforts, it is essential that physical demands are considered in the implementation of training programs for players (Moore et al., 2014). The level of motor skills of these athletes is crucial to ensuring that players withstand competitive demands throughout the season, so it is critical that efficient training methods are applied and prescribed (Gokhan & Aktas, 2013). Indeed, physical conditioning modalities should promote a wide range of athletic performance (i.e., jumping, sprinting and agility performance) with evidence-based effects on effects on neuromuscular systems, sports-based skills and injury

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prevention (Markovic & Mikulic, 2010). In this sense, one of the methods suggested in the literature is plyometric training (PT), which, although accepted by the community, is less scientifically explored. In fact, PT was previously described as an effective tool for power development, explosive anaerobic power, speed and muscle strength (Gokhan & Aktas, 2013; Markovic & Mikulic, 2010). In this regard, previous research suggests that strength gains resulting from RT programs have similarities compared to other types of training (e.g. resistance training). (MacDonald et al., 2012; Markovic et al., 2007). Furthermore, PT does not require the use of specific equipment, thus translating into a low-cost alternative that can be used transversally in all teams participating in this modality around the word. The PT approaches focused on Stretch-Shortening-Cycle (SSC), involving a negative work and impact or absorption (contraction falls). Upon that, plyometric exercise is negative, static and/or positive stimulus (Dal Pupo et al., 2017; Miller et al., 2006). In addition to the aforementioned benefits, previous studies show the benefit of PT in improving flexibility and body composition indicators, due to the high energy expenditure imposed by the exercises performed, which are mostly actions used during the game game (Bennadja et al., 2018; Karavelioglu et al., 2016; Malisoux et al., 2006; Ozbar, 2015). Also, PT programs promote substantial gains in neuromuscular performance, enhancing mechanical efficiency with the improvement of power-force-speed relationship (Dal Pupo et al., 2017; Jiménez-Reyes et al., 2019). In fact, one of the most important features of TP programs is the possibility of simultaneously improving the athlete's skill patterns (Rezaimanesh et al., 2011). As well, the futsal playeres normally showed a higher theoretical maximum speed and power than other soccer codes due to the game's specific demands inherent to a larger number of accelerations in shorter distances (Jiménez-Reyes et al., 2019). Thus, the pre-season period becomes fundamental to potentiate the motor and fitness skills associated to the high number of accelerations and decelerations in a short time-space, representative of the futsal demands, pitch sizes and ground rules, in order to enhance physical performance and the underlying technical and tactical behaviours (Barbero-Alvarez et al., 2008). Notably, over the course of the pre-season, athletes are exposed to very high training loads. (Jeong et al., 2011), in which numerous physical capacities are developed simultaneously. In fact, the physical skills that are determinant for performance are the target of significant improvements throughout the pre-season, so that later throughout the competitive season they can be maintained or enhanced (Oliveira et al., 2013). (Oliveira et al., 2013). Particularly in futsal, previous studies have emphasized the importance of optimizing different components (i.e. body weight, ability to withstand high-intensity exercise, and muscle power in the lower body) during the pre-season (Berdejo del fresno, 2012; Oliveira et al., 2013). Several authors have already mentioned that pre-season training is usually characterized by a combination of strength exercises and an aerobic component (Amani-Shalamzari et al., 2019; Nogueira et al., 2018), so including a PT program can be effective in improving performance without unwanted side effects (i.e., overreaching) (Coutts et al., 2007; Halson et al., 2002) due to the low volume applied. Even so, any training load administered during this period needs to be managed accurately to prevent performance drops during this sensitive period which is the beginning of the season (i.s., pre-season), which could have negative repercussions during the season (Lago-Fuentes et al., 2020; Miloski et al., 2012). Still, Based on this information, there is still a clear need for further investigation into the changes caused by a PT program during the pre-season in futsal.

Additionally, there is another topic that still needs further clarification and is related to involuntary interruption of training sessions due to external constraints (i.e. illness, injuries, vacations, post-season breaks, among others) can lead to a decrease orcan lead to a decrease or break from the usual level of exercise (Kraemer et al., 2002). These periods were previously defined in the literature as "detraining" (Mujika I, 2000). In this sense, previous studies have indicated that the dimension of the regression may be influenced by the duration of interruption-time. itself and/or on the level of physical capacity previously acquired by the individuals (Izquierdo et al., 2007; Kraemer et al., 2002). The assessment and control of the training process becomes fundamental to understand the evolution of physical fitness and motor skills (Teixeira, Forte, et al., 2021).

Previous studies indicate that a period of twenty-one to forty-two days of interruption of normal activity (i.e., detraining) adversely affect aerobic capacity (Álvarez et al., 2009; De Freitas et al., 2015; Milanez et al., 2011), strength (Branquinho et al., 2020; Izquierdo et al., 2007), neuromuscular activity (Izquierdo et al., 2007), and changes in body mass (Branquinho et al., 2020) in trained populations and particularly in futsal (de Souza et al., 2018). Conversely, a previous study (Diallo et al., 2001) did not identify relevant changes in physical fitness indicators as a consequence of the implementation of a PT program over two months in soccer players, which emphasizes the potential effectiveness of this type of program. of training. The detraining period and its potential impact is still not fully understood in sport in general and mainly in futsal. To date, no studies have specifically investigated the changes resulting from the application of a short-term PT program in a pre-season context in adult futsal players.

Thus, the present study investigated the effect of a six-week PT that included explosive strength exercises on body composition, motor skills and aerobic capacity in adult futsal players. In addition, the effects resulting from the interruption of the training program for a period of four weeks were verified. As a hypothesis, it was speculated that the study sample would improve the indicators of body composition, motor skills and aerobic capacity due to the application of a short-term PT program. It was also expected that the PT program would promote benefits in the effects associated with the detraining period.

METHODS

Participants

A group of fourteen futsal players belonging to a Portuguese sub-elite team that participated in a national

men's championship (mean ± SD age: 25.78±7.05 years) volunteered to be part of the study. To calculate the sample, the software G*Power 3.1 was used (Kang, 2021). An a priori analysis was performed that determined that 13 subjects would be needed for the study (Effect size dz:.8, α error probability:.05, power:.85)., Additionally, 1 element was added to the sample as a matter of convenience as there were 14 volunteers to participate in the study. The inclusion criteria in the study were to be futsal practitioners and no exclusio criteria were applied. Before the beginning of the study, volunteers informed that they do not perform any other type of controlled training besides the specific futsal training. The anthropometric characteristics of the group of players analyzed were the following: weight (69.8 ± 7.48 kg), height (1.76 ± 0.06 m) and body mass index (BMI) (22.62 ± 2. 57%). Before the start of the study, the players underwent a set of physical exams administered by the team doctor, who did not identify any clinical problems that prevented full participation. The volunteers and the coach were informed about the genesis and requirements of the study, having completed a questionnaire about the health history where the associated risks were mentioned, and the possibility of abandoning the investigation after having volunteered. In addition, the participants signed a voluntary participation disclaimer. All procedures followed guidelines of the Declaration of Helsinki for research in humans. The research was validated by the Scientific Board of the Higher Institute of Educational Sciences of the Douro (PMTF:2;24.9.2018).

Study Design

To meet the objectives, a quasi experimental design research was used. The training program was applied during the pre-season period and lasted for six weeks, The training program took place at the beginning of the sports season (i.e., pre-season) and lasted for six weeks, followed by a detraining period (i.e., four weeks). Additional knowledge about the characteristics of the detraining period can be useful for increasing knowledge regarding the topic. The standard weekly microcycle consisted of 4 futsal-specific training sessions and an official game. Before starting the application of the training program, all players performed a battery of physical condition tests. Before the start of the study, all volunteers were familiarized with the tests they were going to perform during the investigation. Participants performed a short-term PT program with an emphasis for the lower body as a complement to futsal training. The technical team supported the experimental procedures carried out in order to reduce potential changes in the usual training routine. All evaluations were carried out indoors at the club's facilities between August and October. Participants were evaluated in three different periods (pre-training (M1); post-training (M2); detraining (M3)). In order to verify the impact of the PT program, the following field tests were used: CMJ, agility t test, sprints (i.e., 10 and 20m) and Yo-Yo level 1 intermittent recovery test (Yo-Yo IRT1). The tests were applied on different days to minimize the effect of fatigue in the following order: Day 1: Anthropometric measurements, CMJ and test t agility Day 2: 10 and 20 meter running and Shooting Day 3: (Yo-Yo IE1) These tests were selected because they provide specific indicators related to futsal performance. During the study, BMI, CMJ, Agility test, Sprint and Yo-Yo IRT 1 were considered as dependent variables. The group subjected to the training program was considered an independent variable.

Exercise Protocol

Warm-up

Before each assessment performed and PT session, a short warm-up was performed according to guidelines previously reported in the literature (van den Tillaar et al., 2019). Warming up requires 60 meter runs with 60 s rest between each run (8 runs in total) for a total duration of 10 minutes. Subjects were instructed to start 1 run with a self-rated intensity of 60% of the estimated maximum running speed, increasing the intensity by 5% with each new run until reaching 95%. Rest periods were performed between each of the 8 runs performed where the subjects were instructed to perform one of the 7 dynamic exercises proposed by the protocol. The proposed dynamic exercises were ankle rotation, arm swing, internal rotation and external rotation, hip flexion/extension, adduction, abduction, knee rotation and hip rotation.

Training program

The PT program assumed two training sessions per week on alternate days with at least 48 hours of rest in between.The program was progressive with gradual increases in intensity over the six weeks to accommodate adaptations. In each of the training sessions performed, four specific exercises were performed (i.e., Sprints, Sprints with change of direction (SCD), countermovement jumps (CMJ) and CMJ to a box (CMJ OTB)). The detailed structure of the PT is explained in Table 1. The PT sessions were carried out in the physical structure of the club before the start of the specific futsal training and lasted approximately 35 minutes under the supervision of a specialized fitness coach. A warm-up lasting approximately 10 minutes was

Table 1. Plyometric training program

Weeks	Session	Sprint	SCD	CMJ	CMJ OTB
Week 1	1	2 x 10m	2 x 10s	2 x 4	2 x 4
	2	2 x 10m	2 x 10s	2 x 4	2 x 4
Week 2	3	3 x 10m	2 x 10s	3 x 4	3 x 4
	4	3 x 10m	3 x 10s	3 x 4	2 x 4
Week 3	5	3 x 10m	3 x 10s	3 x 4	3 x 4
	6	3 x 15m	3 x 10s	3 x 5	3 x 4
Week 4	7	4 x 15m	3 x 10s	3 x 4	3 x 5
	8	4 x 15m	4 x 10s	4 x 4	3 x 5
Week 5	9	3 x 20m	4 x 10s	4 x 4	3 x 5
	10	3 x 20m	4 x 10s	4 x 5	3 x 4
Week 6	11	4 x 20m	4 x 10s	3 x 5	3 x 4
	12	2 x 20m	2 x 10s	3 x 4	2 x 4

CMJ – counter-movement jump; CMJ OTB– countermovement jumps to a box; SCD – Sprints with change of direction

performed before each session (van den Tillaar et al., 2019). Volunteers were encouraged to do their best in all exercises that included 2-minute breaks between each one.

Measurement protocols

Anthropometric characteristics

The sports history in futsal and the usual position on the field were inferred through a questionnaire. Anthropometric variables (i.e., body mass, height and BMI) were measured using a level platform scale (Año Sayol, Barcelona, Spain) with a precision of 0.001 meters and 0.01 kilograms.

Countermovement jump

To measure the CMJ, the flight time was estimated using an Optojump, (Microgate, Bolzano, Italy). The volunteers was instructed to perform three vertical jumps at the maximum possible height, with both hands resting on the hips, a rest period of 30 s was proposed according to a previous protocol (Marques et al., 2013). The average of the 3 jumps performed was considered for analysis.

Sprint

The sprint performance assessment (i.e., 20 and 10 meters) was performed on a covered track using photocells (Brower Timing System, Fairlee, Vermont, USA). At the beginning of each sprint, the subjects were instructed to touch the cell block with their hand, starting at the sound signal given by a whistle. To ensure more accurate results, volunteers were encouraged decelerate only after passing the last beam of photocells. Each subject performed 3 sprints and the best time achieved in each sprint was considered for the analysis (Torres-Torrelo et al., 2017).

T-test

To measure the T-Test time, four "T"-shaped flags were placed, as shown in Figure 1 (Semenick, 1990). The T-test protocol was performed according to guidelines provided by a previous study (Sekulic et al., 2013). Three repetitions were performed with a 3-minute rest period between each one. The result of T-Test was measured using photocells (Brower Timing Systems, USA), the best time of the performed repetitions was considered for observation.

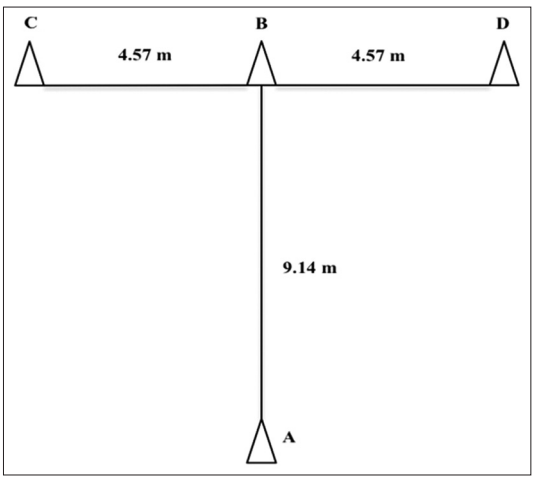

Figure 1. A T-Test diagram
Graphic representation T-test (Semenick 1990)

Yo-yo intermittent recovery test level 1

The Yo-Yo IRT1 was conducted according to a previous protocol (Krustrup et al., 2003). All subjects were instructed to rest for 48 hours before the assessments. Yo-Yo IRT1 was completed in a covered enclosure with an estimated temperature of 15°C to 20°C. The test had a maximum total duration of 25 minutes and the stage, distance traveled and maximum oxygen consumption (VO_2 max) were measured as a result of the test.

Statistical Analysis

Initially, the descriptive statistics of the variables under study were inferred, later the normality of the sample was verified using the Shapiro-Wilk test ($n \leq 30$), later a paired sample t test was performed to compare the outcome variables before and after the TP program. The equivalent Wilcoxon test was applied for non normal variables. Changes between moments was accessed through an equation. The values used to establish the magnitude of the effects were 0.20; small, 0.60; moderate, 1.20; large and 2.00; very large (Batterham & Hopkins, 2006; Hopkins et al., 2009). Statistical analyzes were performed with CI 95%; $p < 0.05$. All procedures were performed with SPSS version 24.0 (SPSS, Inc., Chicago, IL, USA).

RESULTS

The sample characteristic are presented in Table 2. In addiction, three evaluation moments were crossed for analysis, as described in Table 3: M1 vs. M2; M2 vs. M3; M1 vs. M3. BMI values show the absence of significant changes in M1, M2 and M3 ($p > 0.05$) with trivial ($d = 0.01$), ($d = 0.008$) and trivial effect sizes ($d = 0.007$) magnitude, respectively. Regarding the agility test (i.e., T test), it was found that changes in performance occur with the application of the training program with $p < 0.05$ with moderate effect size in M1 vs. M2 ($d = 0.85$), trivial in M2 vs. M3 ($d = 0.20$) and moderate M1 vs. M3 ($d = 0.66$). CMJ's jump height has undergone considerable after PT with $p < 0.05$ with small ($d = 0.43$), trivial ($d = 0.18$) and trivial ($d = 0$) effect sizes for M1 vs. M2; M2 vs. M3; M1 vs. M3. The performance of the 10- and 20-meters sprints, there were significant changes with $p < 0.05$ between M1 vs M2; M2 vs M3, with small effect size ($d = 0.38$), very large ($d = 2.08$), small ($d = 0.38$) and trivial effect size ($d = 0.04$)), respectively. However, for the time M1 vs M3, only statistically significant changes were observed for the 20-meter sprint performance with trivial effect ($p < 0.05$, $d = 0.05$).

Table 2. Sample characteristics

Age	Weight	Height	BMI
25.78±7.05 yrs	69.8±7.48 kg	1.76±0.06 m	22.62±2.57%

BMI=body mass index; kg=kilograms; m=meters; yrs=years

Table 3. Comparison between pre-training, post – training and detraining period

	Pre - Training	Post - Training	Detraining	M1 vs. M2			M2 vs. M3			M1 vs. M3		
	M1	M2	M3	*p*	Δ (%)	d	*p*	Δ (%)	d	*p*	Δ (%)	d
BMI	22.62±2.57	22.59±2.46	22.57±2.49	0.741	-0.13	0.01	0.596	-0.09	0.008	0.594	-0.002	0.007
Agility (T-test)	10.67±0.84	9.98±0.78	10.14±0.75	0.001**	-6.46	0.85	0.001**	1.60	0.20	0.002**	-0.05	0.66
CMJ	35.43±7.48	36.74±7.59	36.14±7.51	0.000**	3.69	0.43	0.000**	-1.63	0.18	0.000**	0.02	0.09
Sprint 10m	1.99±0.18	1.91±0.18	1.98±0.18	0.000**	-3.53	0.38	0.000**	3.66	0.38	0.627	-0.01	0.05
Sprint 20m	3.74±0.24	3.26±0.22	3.30±0.22	0.000**	-12.73	2.08	0.026*	1.23	0.04	0.021*	-0.12	0.05
Yo-Yo IRT 1												
Stage	19.21±5.22	20.21±5.13	19.92±4.90	0.005*	5.20	0.19	0.046*	-0.1.43	0.06	0.013*	0.04	0.14
Distance	768.57±208.83	808.57±205.27	797.14±196.25	0.005*	5.20	0.19	0.046*	-1.41	0.05	0.013*	0.04	0.14
$VO_{2\,Max}$	42.85±1.75	43.18±1.73	43.09±1.65	0.004*	0.77	0.18	0.059	-0.21	0.05	0.010**	0.01	0.14

d – Cohens d; *P* – *P* value; Δ (%) – Pre vs. post change; * indicates *P*<0.01; ** indicates *P*<0.0014

For the Yo-Yo IRT 1 test, no statistically significant differences were found for stage and distance values ($p < 0.05$) between the three time points compared with a trivial effect size for stage ($d = 0.19$; $d = 0.06$ and $d = 0.14$) and distance ($d = 0.19$; d = 0.05 and $d = 0.14$). The same was not observed for the VO2max variable, in which only significant differences were found between moments M1 vs M2 and M1 vs M3 ($p < 0.05$, $d = 0.18$ and $d = 0.14$).

DISCUSSION

This investigation verified the effect of a PT with a duration of 6 weeks that included explosive strength exercises on body composition, motor skills and aerobic indicators in adult futsal players. In addition, the effects resulting from the interruption of the training program for a period of four weeks were verified. The results found confirmed the study hypothesis, given that the application of a PT short-term program caused improvements in the indicators of body composition, motor skills and aerobic capacity. Furthermore, the training program analyzed proved to have a positive impact on the effects associated with the detraining period. However, no significant changes were found between the evaluation moments concerning BMI.

The present research showed significant mean changes with the application of the training program in the three assessment moments (i.e., M1 vs. M2; M2 vs. M3; M1 vs. M3.) in all motor skills, specifically agility (small to moderate effects), CMJ height (trivial to small effects), and sprint performance (trivial to moderately large). When assessing the mean differences between pre- and post-training (i.e., M1 vs. M2), these differences are more evident in their magnitude (Δ = -12.73 to 3.69%, $d = 0.38$ to 2.08). These results are in line with a previously study (Izquierdo et al., 2007), who reported changes in motor skills and sprint performance across 16-week strength training on potency and physiological indicators at rest. Branquinho et al. (Branquinho et al., 2020) also found significant differences for CMJ and sprint performance, when applying an PT program over 8 weeks. Moreover, the 6-week PT program in this study showed a greater influence on the 20 m sprint with a large effect (Δ = -12.73%, $d = 2.08$), followed by a small and moderate effect for agility (Δ = -6.46%, $d = 0.85$) and the 10 m sprint (Δ = -3.53%, $d = 0.38$), respectively. Upon that, the strength gains in the applied PT program are more related to a greater ability to sustain longer high intensity in a shorter time-frame (Beato et al., 2016). This is important evidence, considering the activity and running profile in elite futsal players (Ribeiro et al., 2020; Spyrou et al., 2020). In futsal, average sprints of 10 meters are usually performed every 79 s that have an estimated duration of less than 40 seconds. (Spyrou et al., 2020). Thus, the pre-season should be considered as an optimal phase of the season for the implementation of PT programs with gains in power, muscle strength development, explosive anaerobic power and speed. (Gokhan & Aktas, 2013; Markovic & Mikulic, 2010). In this sense, it improves neuromuscular performance through high-velocity explosive training, manipulating variables such as force, contraction velocity, and power (Bennadja et al., 2018; Karavelioglu et al., 2016; Malisoux et al., 2006; Marques et al., 2013; Ozbar, 2015). In the same line

of thought, several studies have reported similar strength gains in PT programs when compared to complex training to and traditional resistance training (e.g., standing calf raise, fiber strength Romanian dead lift strength, triceps sure girth, quadriceps girth), having demonstrated more evident improvements in the development of explosive actions and strenght when compared to the traditional methods usually used for maximum strength training using weights. (Markovic & Mikulic, 2010). On the other hand, training with plyometric exercises and maximal effort stretch-shortening cycles can improve single-fiber contraction performance via fiber strength, contraction velocity, and power. (MacDonald et al., 2012; Markovic et al., 2007). Emphasizing neuromuscular performance to improve rapid and explosive strength on the basis of motor skills allows for better individual preparation for the worst-case scenario (or most demanding scenarios) from a physical performance perspective (Illa et al., 2021). Furthermore, sprint, agility, and power development can be transferred to sport-specific skills, such as kicking and dribbling performance (Branquinho et al., 2020; M. C. Marques et al., 2013).

Yo-Yo IRT 1 showed significant differences for stage and distance between the three compared moments with trivial effect (Δ = -1.43 to 5.20%, d = 0.05 to 0.19). A previous study (Álvarez et al., 2009) identified VO2max as a physical variable that is directly dependent and related to the competitive level of futsal players. Match-play in elite futsal was characterized by showing a VO_2max above 60 $mL \cdot kg^{-1} \cdot min^{-1}$ which corresponds to an estimated intensity of ±80% VO2max, with decreases when comparing to the two game parts (Illa et al., 2021). Aerobic fitness is important for replacement glycolytic-derived substrates associated with anaerobic metabolism (Sekulic et al., 2013). Nonetheless, $VO_{2\ max}$ showed trivial mean changes for M1 vs M2 (Δ = 0.77%, d = 0.18) and M1 vs M3 (Δ = 0.01%, d = 0.14). Likewise, Boullosa et al. (Beato et al., 2016; Boullosa et al., 2013) reported an un-correlation measure between VO_{2max} and Yo-Yo performance. Diallo et al. (Diallo et al., 2001) also described insignificant changes in physical fitness indicators after an eight-week PT training program in soccer. Nevertheless, Milanez et al. (Milanez et al., 2011) determined a key role for VO_2max in individual perceived exertion during futsal training sessions, confirming a psychophysiological impact on aerobic fitness (Ferraz et al., 2020). Also, when comparing pre-training and post training there is a non-significance, which can be due to the fact that VO_{2max} depends on other factors such as genetic, training status, gender, and body composition. Regarding body composition, this study did not present significant mean changes for the three assessment moments. In contrast, other specific futsal training programs reported a decrease in body composition, and not only in motor skills and anaerobic capacity (Barbieri et al., 2016; Berdejo del fresno, 2012). In addition, BMI presents some accuracy problems in measuring anthropometric indicators in athletes (i.e., body composition). Therefore, fat mass percentage should be assessed by other indicators (i.e., body fat percentage, skinfold thicknesses or corporal density) (Barbieri et al., 2016). As this is a program applied to elite futsal players, variations in anthropometric parameters tend to be more unstable, so the focus should be on strength, aerobic capacity, (Branquinho et al., 2020; Izquierdo et al., 2007), and neuromuscular performance (Izquierdo et al., 2007). The same assumption cannot be verified for the detraining period even for trained players (Branquinho et al., 2020; Izquierdo et al., 2007).

Detraining periods between three and six weeks have negative effects on aerobic capacity (Álvarez et al., 2009; De Freitas et al., 2015; Milanez et al., 2011), neuromuscular activity (Izquierdo et al., 2007), strength (Branquinho et al., 2020; Izquierdo et al., 2007), and body composition (Branquinho et al., 2020). Consequently, traditional pre-season training tends to prioritize aerobic and strength components through a PT program (Amani-Shalamzari et al., 2019; Nogueira et al., 2018). The reason for prioritizing PT training programs is that explosive strength can be improved using a low volume and without unwanted side effects such as overuse or overload injuries (Beato et al., 2021; Coutts et al., 2007; Halson et al., 2002). All the variables analyzed in this study showed significant mean changes when comparing detraining with other evaluated moments, except for BMI in the comparison M2 vs. M3, 10 m sprint in the comparison M1 vs. M3 and VO_{2max} in the comparison M1 vs M3. The literature demonstrates that the size of the aerobic reduction, strength, and agility depends on the duration of the detraining period and/or on the levels of physical capacity previously acquired by the individuals (Izquierdo et al., 2007; Kraemer et al., 2002; Marques & González-Badillo, 2006). On that basis, pre-season represents a key seasonal phase to improve aerobic fitness, motor skills, and anaerobic capacities (Lago-Fuentes et al., 2020; Miloski et al., 2012). In addition, periods of competitive break and congested schedules should also be considered in order to mitigate detraining and overreaching phenomena (Marques et al., 2022). Off-season may represent windows of opportunity to prevent the effects of detraining and maintaining higher baseline levels for aerobic fitness, motor skills (i.e., sprint and agility), and body composition (A. P. Marques et al., 2022; Milanez et al., 2011; Moore et al., 2014). Further research should include the assessment of other physical abilities, such as flexibility, SCD, and acceleration distances (van den Tillaar et al., 2019). Additionally, the relationship between training load monitoring and physical assessment can be explored without neglecting match-related contextual factors (Teixeira, Forte, et al., 2021; Teixeira, Leal, et al., 2021). Thus, it becomes pertinent to compare the PT programs with other training methodology as there is a research gap in futsal knowledge such as repeated sprint ability and complex training (MacDonald et al., 2012; Markovic et al., 2007). Even so, this study is not without limitations, we can in fact highlight the small sample, the fact that a single team was analyzed without resorting to a control group, that another type of complementary statistical analysis could have been carried out and, Finally, the lack of studies during the pre-season to help fully justify the results found by our study. This was the first study that investigated the effects of PT program during the pre-season in sub-elite futsal players.

Bearing in mind the common financial limitations of teams at this competitive level, the use of this type of programs can be extremely useful to the detriment of the use of other more

expensive approaches (i.e., gyms) in order to improve body composition indicators, motor skills and aerobic capacity.

CONCLUSIONS

The present research has confirmed an effect of a six-week PT program in aerobic fitness, motor skills (i.e., speed, agility), and anaerobic capacity (e.g., sprints and jumps) in adult male futsal players, however, no significant changes were found in BMI. Detraining showed associated effects on all physical abilities, except BMI, 10 m sprint and VO_{2max}. This new evidence is of particular importance to coaches and researchers, given the potential utility for prescribing PT training in futsal. In fact, the inclusion of a plyometric training program during the first weeks of the season seems to be extremely useful for enhancing the players' abilities.

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