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Effects of tapering on maximum aerobic power in indoor soccer players

Efeitos do polimento na potência aeróbia máxima em atletas de indoor soccer

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Abstract – The aim of this study was to analyze the effect of tapering on maximum aerobic power (VO_2max) in young male indoor soccer athletes. Participants were 78 athletes aged 12-17 years randomly divided into experimental (EG) and control group (CG). Both groups did the same training planning until the last three weeks (tapering phase). Only EG performed tapering. Tapering lasted three weeks adopting the linear tapering method. VO_2max was estimated by Yo-Yo intermittent Recovery Level 1 early in the season and in the last week of each. Univariate analysis of covariance (ANCOVA) was conducted for repeated measures to compare VO_2max among groups according to mesocycle. The results presented effect of time ($F_{(4.74)}$= 42.02, p = 0.01) and group ($F_{(2.76)}$ = 35.87, p = 0.01). Overall, the findings of this study suggest that the implementation of the tapering strategy in the last weeks of training is more efficient to improve VO_2max than the constant maintenance of loads.

Key words: Athletic Performance; Athletes; Physical education and training.

Resumo – *O objetivo foi analisar o efeito do polimento na potência aeróbia máxima (VO_{2max}) em jovens atletas de futsal do sexo masculino. Participaram 78 atletas com idade entre 12 e 17 anos, divididos aleatoriamente em grupo experimental (GE) e controle (GC). Ambos os grupos fizeram a mesma planificação de treinamento até as três últimas semanas (fase do polimento). Somente o GE realizou o polimento. O polimento teve duração de 3 semanas, adotando-se o método de polimento linear. O VO_{2max} foi estimado pelo Yo-Yo Intermitent Recovery Level 1 no início da temporada e na última semana da cada. Conduziu-se a análise univariada de covariância (ANCOVA) de medidas repetidas para comparar o $VO2_{máx}$ entre os grupos em função do mesociclo. Os resultados apresentaram efeitos de tempo ($F_{(4, 74)}$ = 42,02, p = 0,01) e grupo ($F_{(2, 76)}$ = 35,87, p = 0,01). De maneira geral, os achados do presente estudo sugerem que a implantação da estratégia de polimento nas últimas semanas de treino é mais eficiente para a melhora do VO_{2max} do que a manutenção constante das cargas.*

Palavras-chave: *Atletas; Desempenho Atlético; Educação física e treinamento.*

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INTRODUCTION

Maximal aerobic power (VO_2max) refers to the maximum capacity of the body to uptake, transport and use oxygen, which can be expressed in absolute form (l / min) or related to body weight (ml / kg / min)[1]. VO_2max is considered very important for athletes of intermittent sports such as indoor soccer to support the duration of the match, as it ensures high level of performance throughout the match.

Indoor soccer, in turn, is a sports modality with high-intensity efforts and short duration (approximately 3 seconds), interspersed with short periods of recovery (about 20 seconds)[2], which requires high participation of aerobic and anaerobic systems for energy supply. In the Brazilian calendar, 3-4 indoor soccer matches are performed per week in shorter competitions, for example, regional games and cups. Therefore, the time interval between games may be insufficient to generate adequate recovery to players. Whereas VO_2max has close relationship with the recovery capacity in athletes[3], it is essential to adopt strategy for the distribution of training loads that results in maximizing VO_2max. In this regard, VO_2max optimization may increase the recovery speed of athletes between matches and during matches.

Researchers stress the importance of using training prescription techniques to optimize factors related to sports performance[4,5]. Thus, training periodization of athletes is considered essential to maximize performance. Periodization involves the manipulation of training loads, training methods and means at specific times with well-defined objectives[4,6]. More specifically in indoor soccer, coaches often use simple or wave periodization[3].

In simple periodization, the coach searches to plan training loads so that athletes achieve their best performance in a single competition at the end of the macrocycle[7]. This type of periodization consists of three stages, namely preparatory, competitive and tapering. The first phase is used to progressively increase the training volume and intensity. In the competitive period, the frequency of high-intensity sessions is increased, while the volume of specific aerobic training is reduced. Tapering, in turn, is used to reduce the volume of all components of the training sessions, while intensity is kept[6]. Studies have shown increased performance of athletes after the tapering stage[7-9], although these investigations have been conducted with athletes of cyclic sports. However, the prescription of tapering does not seem to be unanimity for many coaches[8]. In addition, there is a belief that in the weeks preceding the competition, volume and intensity should be both increased.

There are few studies that have examined the effect of tapering on cardiorespiratory parameters in indoor soccer players. Perhaps, tapering is an effective training periodization strategy used to enhance performance parameters in indoor soccer players, for example, VO_2max. From a practical point of view, this type of research can point the effect of tapering on VO_2max of indoor soccer athletes. Therefore, the findings may be extremely important for coaches of this sport. According to the above, the aim of this study was to analyze the effect of tapering on VO_2max in indoor soccer players. Then, a hypothesis was formulated, based on indications of two systematic reviews[6, 7]: tapering generates increased VO_2max.

METHODOLOGICAL PROCEDURES

Participants

This is a 12-week experimental research developed with young male indoor soccer athletes. The sample was selected in a non-probabilistic way, consisting of 94 volunteers members of the same club aged 12-17 years, participants of the Pernambuco indoor soccer championship categories U-13 (n = 23), U-15 (n = 34) and U-17 (n = 37). Participants were randomly divided into two groups: experimental group (EG, n = 47) and control group (CG, n = 47). No statistical differences were observed for age ($F_{(2.92)} = 3.12$, $p = 0.21$), fat percentage ($F_{(2.92)} = 2.83$, $p = 0.25$) and VO_2max ($F_{(2.92)} = 2.02$, $p = 0.19$) between experimental and control groups prior to investigation.

Athletes trained on average 2h per day five times a week. To be included in the research, athletes should: a) have been indoor soccer athlete for at least two years; b) systematically train indoor soccer for at least 8 hours per week; and c) be registered in the State Indoor soccer Championship, organized by the Pernambuco Indoor soccer Federation.

However, 16 athletes were excluded because they missed more than 5% of training sessions during the study (12 weeks). Therefore, the investigation included a final sample of 78 athletes (EG = 37 and CG = 41).

After receiving information about the procedures they would be submitted to, participants signed the informed consent form. Parents / guardians of athletes signed a free and informed consent form (ICF), agreeing with the methodological procedures of the research. The procedures adopted in this study met standards of Resolution 466/12 of the National Health Council for research with humans. The project was approved by the Ethics and Human Research of the Federal University of Pernambuco (CAE - 05166712.8.0000.5407).

Experimental design

Both groups (EG and CG) did the same training planning up to the tapering phase. The training description can be seen in Table 1. The CG kept training loads constant in the last three weeks of the macrocycle (Table 3). Only GE performed tapering (Table 2). Tapering lasted 3 weeks, adopting the linear tapering method[7]. Thus, only the training volume was reduced: 80% for the first week, 60% for the second and 40% for the third week, according to recommendations of Mujika et al.[5].

The training load was measured by adopting the daily average of the session effort subjective perception method (PSE-session)[10]. After 30 minutes of the end of each training session, athletes answered the question: “How was your workout?”. The athlete was asked to demonstrate the session intensity perception from the 10-point Borg scale (0 = rest 10 = maximum effort), according to method developed by Foster et al.[10].

The product of values demonstrated by the PSE scale and the duration in minutes of each session were calculated, thus expressing the internal load of the training session. The weekly training load was calculated after each microcycle. The weekly training load was obtained from the sum of daily loads divided by five (number of weekly training sessions). The load of each mesocycle (preparatory, competitive and tapering) was calculated from the sum of weekly loads divided by four (amount of microcycles per mesocycle), according to methodology adopted in another research[3]. It is noteworthy that athletes became familiar with the PSE-session method for a period of 30 days prior to the study. The internal load of each mesocycle of EG and CG can be seen in Tables 2 and 3, respectively.

Table 1. Description of training mesocycles of young indoor soccer players

	EG			CG		
Micro	Physical	Technical	Tactical	Physical	Technical	Tactical
1 to 4	8 x WT	8 x PA	6 x TD	8 x WT	8 x PA	6 x TD
	5 x AC	5 x KI	7 x TO	5 x AC	5 x KI	7 x TO
	5 x CAT	4 x BC		5 x CAT	4 x BC	
	6 x AG	3 x DIS		6 x AG	3 x DIS	
	4 x POT			4 x POT		
5 to 8	6 x WT	5 x PA	8 x TD	6 x WT	5 x PA	8 x TD
	4 x AC	3 x KI	10 x TO	4 x AC	3 x KI	10 x TO
	4 x CAT	3 x BC		4 x CAT	3 x BC	
	8 x AG	2 x DIS		8 x AG	2 x DIS	
	6 x AR			6 x AR		
	6 x POT			6 x POT		
9 to 12	4 x WT	4 x PA	6 x TD	6 x WT	5 x PA	8 x TD
	3 x AC	3 x KI	8 x TO	4 x AC	3 x KI	10 x TO
	2 x CAT	2 x BC		4 x CAT	3 x BC	
	6 x AG	2 x DIS		8 x AG	2 x DIS	
	5 x AR			6 x AR		
	4 x POT			6 x POT		

Micro = microcycles; EG = Experimental group; CG = control group; WT = weight training; AC = aerobic circuit; CAT = continuous aerobic training; AG = agility; POT = alactic anaerobic power; AR = anaerobic resistance; PA = pass; KI = kick; BC = ball control; DIS = disarm; TD = tactical defensive training; TO = tactical offensive training.

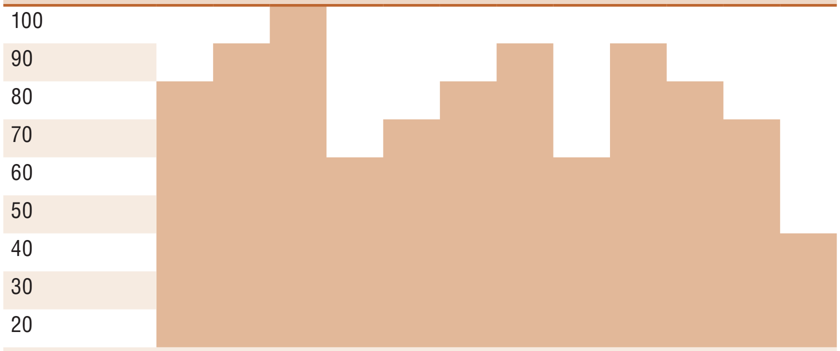
The Yo-Yo intermittent Recovery Level 1 was performed by athletes before the start of the season, which was termed as pre-test and in the last week of each mesocycle [Preparatory, Competitive and Tapering (only EG)].

Instruments

The Yo-Yo intermittent Recovery Level 1 was used for estimating VO_2max [(ml / kg / min) = distance (m) x 0.0084 + 36.4][11]. Each athlete ran as long as possible a distance of 20 meters (round trip) delimited by cones. The rest period between each round trip was 10 seconds, as recommended by Bangsbo et al.[11]. The test ended when the athlete quitted or when he was unable to keep up with the pace determined by the test, committing two errors on the same stage.

Table 2. Training periodization for the experimental group.

Mesocycle	Preparatory				Competitive				Tapering			
Microcycle	1	2	3	4	5	6	7	8	9	10	11	12
Volume (%)												
IL (A.U.)	6.552.21 (±217.85)				9.608.02 (±314.72)[a]				6.731.80 (±274.59)[b]			



IL = Internal training load (mesocycle); A.U. = Arbitrary units; p <0.05 in relation to the preparatory period; bp <0.05 in relation to the competitive period.

Table 3. Training periodization for the control group.

Mesocycle	Preparatory						Competitive					
Microcycle	1	2	3	4	5	6	7	8	9	10	11	12
Volume (%)												
CI (U.A.)	6.493.33 (±254.90)				9.568.14 (±298.62)[a]				9.839 (±260.73)[a]			

IL = Internal training load (mesocycle); A.U. = Arbitrary units; p <0.05 in relation to the preparatory period

Biological maturation was evaluated through somatic maturation. So, weight, stature and trunk-head height were measured. Leg length was obtained by the difference between stature and trunk-head height. These measures, along with the chronological age were used in an equation established by Mirwald et al.[12], which estimates the age of peak growth rate in stature. Since scientific findings have indicated influence of biological maturation on physical fitness variables[13], it was decided to control (statistical techniques) the age of peak growth rate in stature in this study.

Body mass was measured by a portable digital scale with precision of 100g and maximum capacity of 200kg. Portable stadiometer with accuracy of 0.1 cm and maximum height of 2.20m was used to measure the stature of athletes.

Body fat percentage (%BF) was determined by the technique of skinfold thickness using a Lange ©caliper (USA), using the triceps and calf skinfolds, adopting the protocol of Slaughter et al.[14] [% BF = 0.735 x (triceps skinfold + calf skinfold) + 1]. For measurements of skinfolds, the International Society for the Advancement for Kineanthropometry standardizations was used[15].

Demographic data (age, ethnicity, weekly training frequency and daily training hours) were evaluated through questionnaire constructed by researchers for this study.

Procedures

A priori, researchers contacted directors of basic indoor soccer categories of two clubs in the state of Pernambuco / Brazil. Procedures and objectives of the study were properly explained and authorization to develop research with athletes was requested.

Then, a meeting was held with athletes in order to clarify all ethical research procedures. The Informed Consent Form was given to athletes, asking them to take it to parents / guardians and bring signed the next day. Therefore, all athletes signed the ICF, agreeing with their voluntary participation in research.

Data collection was carried out at the training site (indoor soccer court). Body weight, stature and skinfold thickness were measured and then athletes performed the Yo-Yo Test Level 1 before the first microcycle and at the end of each mesocycle (last microcycle of each mesocycle). Athletes received the same instruction to perform the test and doubts were clarified. Athletes were asked not to perform physical exercises 24 hours prior to the test, as recommended in scientific literature[11].

Data analysis

The Shapiro-Wilk test showed no parametric violation of research data for both groups (EG and CG). So, we opted for the use of parametric techniques. ANOVA for repeated measures (two-way Anova) was used to compare the internal load of athletes according to mesocycle (preparatory, competitive and tapering) and group (EG vs CG). The post hoc Bonferroni test was used to identify statistical differences. The independent Student t test was adopted to compare VO_2max, age of peak growth rate in stature, body mass, fat-free mass, stature, % BF, chronological age and training regimen (weekly training frequency x daily training hours) according to group (EG vs. CG) at baseline (pre-test). Univariate analysis of covariance (ANCOVA) for repeated measures was conducted to compare the VO_2max and the distance traveled (meters) in the Yo-Yo intermittent Recovery Level 1 between groups (EG and CG) according to mesocycle (preparatory, competitive and tapering). The Bonferroni post hoc test was used to identify the location of statistical differences. It is noteworthy that the age of peak growth rate in stature and body mass were controlled. Moreover, the size of the Cohen effect, represented by symbol "d" was used to reveal differences from the practical point of view. The following criteria were adopted, according to Thalheimer and Cook[16]: d <0.4 = low effect size, 0.4 ≤ *d* > 0.6 = moderate effect size and d ≥ 0.6 = large size effect. All data were analyzed with SPSS 21.0 software, adopting a margin of error of 5%.

RESULTS

Descriptive data [VO_2max, distance covered in the Yo-Yo intermittent Recovery Level 1, % BF, age and training regimen (weekly training frequency x daily training hours)] can be seen in Table 4. The results showed no statistical significant differences between experimental and control groups in the pretest, according to Table 4.

Table 4. Descriptive values (mean and standard deviation) of study variables

Variables	EG	CG	p
	Mean (SD)	Mean (SD)	
VO_{2max} initial (ml/kg/min)	49.51 (±7.16)	49.42 (±6.93)	0.23
Distance covered (m)	1594.63 (±143.15)	1546.23 (±124.35)	0.21
PGR (years)	12.62 (±0.64)	12.41 (±0.74)	0.34
Body mass (kg)	62.40 (±5.47)	62.18 (±5.83)	0.28
Fat-free mass (kg)	50.02 (±4.81)	50.26 (±4.56)	0.25
Stature (m)	1.74 (±1.05)	1.74 (±1.19)	0.32
%BF	20.10 (±6.52)	20.31 (±7.03)	0.17
Age (years)	14.78 (±1.92)	14.39 (±1.58)	0.29
TR (hours/week)	10.14 (±0.87)	10.16 (±0.75)	0.42

VO_2max = aerobic power; % BF = body fat percentage; EG = experimental group; CG = control group; SD = standard deviation; PGR = age of peak growth rate in stature; TR = training regimen.

Regarding the internal training load, the findings showed stage ($F_{(4.74)}$ = 58.36, p = 0.01) and group effects ($F_{(2.76)}$ = 29.42, p = 0.01). The competitive period showed greater internal load compared to the preparatory period both in EG ($F_{(2.35)}$ = 32.82, p = 0.01, d = 0.6) and CG ($F_{(2.39)}$ = 35.91, p = 0.01, d = 0.6). Statistically significant difference was found in the internal load when the tapering stage and the preparatory period were compared in CG ($F_{(2.39)}$ = 38.45, p = 0.01, d = 0.6), which was not observed in EG ($F_{(2.35)}$ = 4.22, p = 0.14, d = 0.1). The internal load in the tapering stage did not differ from the competitive period in the CG ($F_{(2.39)}$ = 1.79, p = 0.28, d = 0.1), but statistical differences were found in the EG ($F_{(2.35)}$ = 42.91, p = 0.01, d = 0.6). There were no significant differences between experimental and control groups in the preparatory ($F_{(2.76)}$ = 2.39, p = 0.23, d = 0.1) and competitive periods ($F_{(2.76)}$ = 3.05, p = 0.20, d = 0.1). Moreover, the findings showed significant differences of internal load between experimental and control groups in the tapering stage ($F_{(2.76)}$ = 31.19, p = 0.01, d = 0.5).

The results for distance traveled (m) in the yo-yo intermittent Recovery Level 1 showed effect of time ($F_{(4.74)}$ = 41.93, p = 0.01) and group ($F_{(2.76)}$ = 34 51, p = 0.01) that are worth mentioning (Table 5): a) the findings showed that the distance (meters) in the Yo-Yo Test Level 1 increased from the pre-season up to the end of the preparatory period both in the EG ($F_{(2.35)}$ = 35.24, p = 0.01) and in the CG ($F_{(2.39)}$ = 22.50, p = 0.01), with no significant differences between groups ($F_{(2.76)}$ = 4.01, p = 0.18, d = 0.1); b) ANCOVA revealed no effect of time ($F_{(2.76)}$ = 1.88, p = 0.25) and group ($F_{(2.76)}$ = 1.97, p = 0.29, d = 0.1) for distance traveled (m) in the yo-yo Test Level 1 when competitive and preparatory periods were compared and; c) the distance traveled (meters) in the Yo-Yo Test Level 1 increased from the competitive period to the tapering stage in the EG ($F_{(2.35)}$ = 40.46, p = 0.001), which was not observed in the CG ($F_{(2.39)}$ = 3.19, p = 0.18). Moreover, significant difference was found for the distance traveled (meters) in the Yo-Yo Test Level 1 between EG and CG in the tapering stage ($F_{(2.76)}$ = 29.07, p = 0.01, d = 0.5), according to Table 5. Finally, the results indicated relationship between age of peak growth rate in stature and distance covered (meters) in the Yo-Yo Test Level 1 in all stages ($F_{(4.74)}$ = 64, 26, p = 0.001), but not for body mass ($F_{(4.74)}$ = 2.96, p = 0.15).

The results for VO_2max revealed effects of time ($F_{(4.74)}$ = 42.02, p = 0.01) and group ($F_{(2.76)}$ = 35.87, p = 0.01): a) the results showed that VO_2max increased from pre-season up to the end of the preparatory stage both in the EG ($F_{(2.35)}$ = 35.90, p = 0.01) and in the CG ($F_{(2.39)}$ = 22.83, p = 0.01), with no significant difference between groups ($F_{(2.76)}$ = 3.84, p = 0.18, d = 0.1); b) ANCOVA showed no effect of time ($F_{(2.76)}$ = 1.76, p = 0.26) and group ($F_{(2.76)}$ = 1.95, p = 0.30, d = 0.1) for VO_2max when competitive and preparatory stages were compared and; c) VO_2max increased from the competitive to the tapering stage in the EG ($F_{(2.35)}$ = 40.11, p = 0.001), which was not observed in the CG ($F_{(2.39)}$ = 3.09, p = 0.17). Furthermore, significant differences of VO_2max between EG and CG were observed in the tapering stage ($F_{(2.76)}$ = 28.66, p = 0.01, d = 0.5), according to Table 5. It is noteworthy that the results indicated relationship between age of peak growth rate in stature and VO_2max at all stages ($F_{(4.74)}$ = 61.42, p = 0.001), but not for body mass ($F_{(4.74)}$ = 3.05, p = 0.17).

Table 5. Mean and standard error of VO2max and distance traveled (meters) in the Yo-Yo intermittent Recovery Level 1 according to group (EG vs CG) and periodization stage (preparatory, competitive and tapering)

Stage	EG	CG
	VO_{2max}	
	Mean (SE)	Mean (SE)
Pre-season	49.41 (±2.42)[d]	49.63 (±2.33)[d]
Preparatory	50.86 (±2.71)[a]	50.45 (±2.53)[a]
Competitive	50.28 (±2.68)[a.d]	50.11 (±2.40)[a]
Tapering	52.90 (±2.26)*	50.39 (±2.49)
Distance traveled (meters) in the Yo-Yo Intermittent Recovery Level 1		
	Mean (SE)	Mean (SE)
Pre-season	1548.80 (±78.40)[d]	1575.02 (±62.33)[d]
Preparatory	1721.42 (±92.03)[a]	1672.69 (±86.75)[a]
Competitive	1652.38 (±96.29)[a.d]	1632.14 (±95.04)[a]
Tapering	1964.28 (±114.38)*	1665.47 (±100.82)

EG = Experimental group; CG = control group; SE = standard error p <0.05 in relation to "Pre-Season"; [b]p<0.05 in relation to "Preparation"; [d]p <0.05 in relation to "tapering"; * P <0.05 difference between EG and CG.

DISCUSSION

The aim of this study was to analyze the effect of tapering on VO_2max in young male indoor soccer players, given the importance of this variable for performance in this sports modality. Overall, the results of this study revealed that the tapering strategy increased VO_2max in the EG, while maintaining the training loads did not change VO_2max in the CG, confirming the initial hypotheses. It was observed, however, that some comparisons with scientific literature become unviable because studies have that adopted tapering as an intervention method used endurance athletes[5-9].

Regarding the internal load, the results of this study indicate similarities in the preparatory and competitive stages between EG and CG. Moreover, the findings revealed that the CG showed greater internal load when compared to the EG in the tapering stage. Thus, it seems that the PSE-session method is sensitive to reducing the external training load, more specifically, the attenuation of the training volume. According to Foster et al.[10], the PSE-session method is inexpensive and easy to apply, in addition to revealing sensitivity to changes in training loads. Corroborating the results obtained by Foster et al,[10] Miloski et al.[3] showed that the internal training load analyzed by the PSE-session method varied depending on the external training load throughout the season in indoor soccer players. Therefore, considering that the findings of this study for the tapering stage showed decreased internal load for the EG, it could be inferred that the linear tapering strategy can be effective in reducing the stress generated by training young indoor soccer athletes.

Considering the distance traveled (meters) in the Yo-Yo intermittent Recovery Level 1, the findings indicated an increase in the preparatory stage compared to the pre-season for both groups. Two explanations for the increased capacity to perform sprints at moderate speed with short rest intervals are the increased oxygen uptake and utilization in muscles and optimization of the metabolic acidosis removal rate[7].

No statistical difference was found in the distance traveled in the Yo-Yo intermittent Recovery Level 1 between preparatory and competitive stages both in EG and CG. Researchers point out that the ability to perform sprints at moderate intensity with short rest intervals is not modified or may even be reduced after intensified training phase[8,9], which may explain the results of this study. According to Miloski et al.[3], physical training intensification period, which usually generates overreaching process, could cause damage to the muscle structure, which, in turn, may trigger attenuation of the recruitment speed of muscle fibers.

Regarding the last periodization stage (tapering), the results showed increased distance traveled in the Yo-Yo intermittent Recovery Level 1 only for the EG, while the distance traveled in the Yo-Yo intermittent Recovery Level 1 was maintained for the CG. Moderate size effect regarding the difference of the distance traveled in the Yo-Yo intermittent Recovery Level 1 between EG and CG in the tapering phase was identified. According to Hellard et al.[9], linear tapering increases the amount and thickness of capillaries around the muscle fibers, promoting the flow of metabolic acidosis produced during physical exercise performed until exhaustion, which, in some way, may explain the findings for the optimization of the distance traveled in the Yo-Yo intermittent Recovery Level 1 after the tapering stage in the EG.

Regarding the VO_2max, the findings revealed increased preparatory stage compared to pre-season in both groups. Studies have shown improved oxygen uptake and utilization in the muscular system after periods of physical training[2,17,18]. Moreover, it seems that muscle oxygenation system capacity can be optimized for athletes after a few weeks of physical training at the beginning of the competitive season[19] which, in a way, corroborates the results of this research. According to Silva and Araújo [1], one explanation for the increased VO_2max arising from physical training is the activation of the PGC-1α complex, which has the function of controlling the metabolism of carbohydrates and fats, including some metabolic processes such as hepatic gluconeogenesis and lipoprotein metabolism. Furthermore, increased VO_2max may occur due to increased mitochondrial density in muscle, enhancing fat and glucose oxidation, which in turn improves aerobic energy oxidative production[20]. In addition, the resulting arteriovenous difference of O_2 can also optimize VO_2max[1]. Thus, the muscle tissue increases the O_2 extraction capacity, which affects the VO_2max potentiation[1].

However, there was no difference in VO_2max between preparatory and competitive stages for both groups. This finding indicates that the intensification phase of training was not able to generate effects on VO_2max of young indoor soccer athletes. According to Roonestad et al.[4], the ability to uptake, transport and use oxygen in the muscle system can attenuate or be maintained after shock microcycles (high training load). Moreover, Clemente Martins and Mendes[18] reported that the aerobic fitness of soccer players is not changed during periods with high training loads, which may explain the findings of this study.

Regarding the last periodization stage (tapering), the results showed increased VO_2max only for the EG, while VO_2max was maintained in the CG. Thus, the reduction in the training volume in the EG caused effect related to the principle of overcompensation[7]. Therefore, this finding demonstrates that the progressive reduction in the training volume was effective to optimize VO_2max in the EG, while maintaining the training load (volume and intensity) did not cause changes in VO_2max in the CG. Moderate effect size regarding the VO_2max difference between experimental and control groups was also identified in the tapering phase, indicating reasonable probability of this result to occurs in other studies with young male indoor soccer athletes. According to Pyne et al.[8], linear tapering generates positive effects on physical performance parameters in athletes. Similarly, Bosquet et al.[7] reported that the tapering stage is essential to maximize aerobic fitness in athletes, which may explain the results found for the EG. In contrast, Le Meur et al.[6] point out that the maintenance of the training volume in competition eve may deteriorate or simply not improve physiological variables related to sports performance, a fact revealed for the CG in this study.

Considering the comparisons between groups (EG vs CG), the results of the present study showed no differences before the competitive season (pre-season) or in the first two periodization stages (preparatory and competitive). These findings can be explained because the training loads of both groups are identical up to the end of the competitive period. Thus, the periodization effects of training on VO_2max were similar in both groups.

It is noteworthy that VO_2max is an important component of physical fitness that is positively related to sports performance[17,18]. Researches of sports training area emphasize that athletes of intermittent modalities need to maximize VO_2max so they can withstand the physiological demands of a match. Therefore, the training periodization strategies that seek to improve physical fitness components of athletes are considered extremely important. However, there are no studies that have sought to analyze the effect of tapering on the physical performance parameters in indoor soccer athletes.

It is noteworthy that few studies have been developed in order to investigate the effects of training periodization on performance parameters[2, 9]. More specifically, although tapering is known worldwide, few studies have been conducted to evaluate its effects on physiological variables[6, 7].

Although this research has found novel and important results, it shows limitations that are worth mentioning. The diet of athletes was not controlled, which may have affected the results of the study. In addition, the use of doubly indirect method (skinfolds) to evaluate fat percentage is also a limitation. The lack of data regarding the distance covered by athletes in each training session can also be considered as a limitation. According to Bangsbo et al.[11], the Yo-Yo intermittent Recovery Level 1 shows variation coefficient around 5%. In this sense, the increased VO_2max observed during the training period (~ 6.6%) and after tapering (~ 3%) may be associated with the variation coefficient of the Yo-Yo intermittent Recovery Level 1. Therefore, the findings of this research should be analyzed with caution. Despite these limitations, this research shows interesting results that deserve to be discussed in the scientific literature in the field of sports sciences.

CONCLUSION

The results of this study showed that tapering was effective in improving VO_2max and the distance traveled in the Yo-Yo intermittent Recovery Level 1 by young indoor soccer players from U-13, U-15 and U-17 categories. Finally, further investigations should be carried out to confirm these results.

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