EFFECTS OF TWO DIFFERENT TAPERING PROTOCOLS ON FITNESS AND BODY COMPOSITION IN YOUNG SOCCER PLAYERS: POSITIONAL DIFFERENCES

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Abstract
The purpose of the present study was to determine the effects of two different tapering protocols on anthropological status in junior elite soccer players according to playing positions. One-hundred and fifty-eight junior elite soccer players (mean age: 17.07±0.79 years; mean height: 177.85±6.64 cm; mean weight: 71.27±7.96 kg; mean body-mass index: 22.50±1.66 kg/m^2) were randomly selected into two groups: (1) exponential and (2) linear tapering group. Training sessions were conducted 3 times a week per 8 weeks. After 4 weeks of training and 4 weeks of tapering period, participants were measured in morphological characteristics and tested in motor and functional abilities. In both groups, time changes occurred in all tested variables, except in height and sitting height. However, forwards in the exponential group had larger changes in 5, 10 and 30 m sprint and 96369 agility test, while midfielders performed somewhat better in the linear group in repeated sprint ability (ES=0.64). Maximal oxygen uptake significantly increased in both exponential and linear tapering group. However larger mean differences occurred in the exponential group. In conclusion, both tapers produced similar time changes, yet divided by playing positions, players in the exponential group had larger improvements in morphological characteristics and both motor and functional abilities.

Key words*: taper, soccer, youth, effects, performance*

Introduction

Soccer is often defined as a team sport, where players need to achieve high performance, by using primary their motor and functional abilities and technical and tactical skills (Impellizzeri, Rampinini, Coutts, Sassi, & Marcora, 2004). The game is often consisted of short sprints, acceleration and deceleration activities, jumps, tackles and kicks (Bradley & Noakes, 2013). These findings have been obtained in the last 2 decades by using a soccer match system analysis, in order to determine several factors, as distance cover, number of technical and tactical parameters performed in the game and others (Dellal et al., 2010). Specifically, it has been reported, that soccer players make around 1.300 changes of direction (Bangsbo, 1992), more than 1.400 playing activities during the match (Bangsbo, Mohr, & Krustrup, 2006) and approximately 200 sprints (AJ Coutts, Chamari, Rampinini, & Impellizzeri, 2008). Also, this soccer match demands have been analyzed through the different playing positions on the field (Barros et al., 2007; Valter Di Salvo, Gregson, Atkinson, Tordoff, & Drust, 2009). Moreover, it has been shown that players have positional differences, especially in morphological characteristics (P. Wong et al., 2008) and motor and functional abilities (Gil, Gil, Ruiz, Irazusta, & Irazusta, 2007). Specifically, Gil et al. (Gil et al.) reported that forwards had the best time in 30 m sprint and vertical jumps, while goalkeepers had the lowest values in aerobic capacity. Also, it has been reported that goalkeepers are the tallest and heaviest players, who also have the highest amount of muscle-mass, while forwards have the lowest % of fat-mass (Lago-Peñas, Casais, Dellal, Rey, & Domínguez, 2011). Goalkeepers have also been shown to have the lowest values in the aerobic capacity, but the highest results achievements in the vertical jump test, while central defenders are the fastest in the 30 m sprint (Lago-Peñas et al., 2011). It is worthwhile to mention, that results from morphological characteristics and motor and functional abilities vary across the world (V Di Salvo et al., 2007; P.-L. Wong, Chamari, Dellal, & Wisløff, 2009). As been reported by a few previous studies, morphological characteristics and conditional preparedness of the players are of great importance, because they can be considered the basis of technical and tactical development (Chamari et al., 2004).

Previous studies have reported, that changes in the anthropological status of the players, rely on training load reduction (Inigo Mujika & Padilla, 2003). This period of training reduction is in the literature known as the taper (Banister, Calvert, Savage, & Bach, 1975; I Mujika et al., 1996). The main aim of the taper is to reduce negative physiological and psychological impact of daily training (Inigo Mujika & Padilla, 2003). According to existing literature, there has been three tapering systems currently used in sport (Wilson & Wilson, 2008). The first is step tapering, where training load decreases immediately by 50% and maintains during the whole tapering period; the second one is linear progressive tapering, where training load decreases by 5% in the initial stage and keep decreasing by the same amount every workout and exponential tapering, where training load decreases in non-linear values (Wilson & Wilson, 2008). In individual trained athletes, studies have shown that the expected mean performance improvement is between 2-3% (Inigo Mujika & Padilla, 2003). In soccer, in one most recent study, taper has been shown to contribute significantly on physical activity during matches, where the reduction in training load was associated with higher number of sprint ($r=0.65$, $p<0.01$), high-intensity running ($r=0.55$, $p<0.01$) and high-speed running ($r=0.49$, <0.05) (Fessi et al., 2016). Also, another studies have examined the effects of tapering on physiological abilities of soccer players (Dehkordi, Ebrahim, Gaeini, & Gholami, 2014; Freitas et al., 2014; Nikbakht, Keshavarz, & Ebrahim, 2011). Findings from these studies have shown, that tapering may improve time in repeated sprint ability up to 4% (Nikbakht et al., 2011), decrease symptoms of allergy (Freitas et al., 2014), increase testosterone levels and testosterone/cortisol ratio (Dehkordi et al., 2014). In general, one meta-analysis showed that a 2-week taper duration, where the reduction in training load is exponentially decreased by 41-60% without any modification in training frequency and especially training intensity, represents the strategy for performance improvements (Bosquet, Montpetit, Arvisais, & Mujika, 2007).

To the best of author's knowledge and after an extensive literature review (PubMed, Scopus, Google Scholar, Web of Science), there has been only a few studies investigating the effects of taper on physiological characteristics in soccer players, particularly in aerobic performance (Fortes, Vianna, Silva, Gouvêa, & Cyrino, 2016; Nikbakht et al., 2011) and physical match activities (Fessi et al., 2016). However, there has been no study investigating the effect of two different taper protocols on morphological characteristics, motor and functional abilities in youth soccer players. Since both morphological characteristics and conditioning abilities play the important factor for success in soccer (Chamari et al., 2004), it is necessary to investigate, whether different taper protocol may equally or differently contribute to soccer player's improvements in different playing position. Thus, the main purpose of the present study was to determine the effects of two different tapering protocols on anthropological status in junior elite soccer players according to playing positions. We hypothesized, that the exponential taper will produce somewhat larger effect changes, according to different playing positions.

Methods

Experimental Approach to the Problem
Although tapering is a common strategy to increase performance in many sports, the effect of different tapering programs on physical match activities in soccer are limited. Moreover, no data have been published on how tapering may influence fitness parameters and body composition according to playing positions. One hundred and fifty eight elite junior soccer players were randomly selected into the exponential tapering group (ETG) and linear tapering group (LTG). Players followed the same exercise training program for 4 weeks before the tapering period, which lasted four weeks also. Transitive measurement was done 4 week after the initial measurement. After the transitive measurement, both experimental groups underwent different tapering protocols: linear or exponential. Beside body composition, we measured 5, 10 and 30 m sprint, agility test 96369 with turn for 180º, repeated sprint ability test, squat jump and squat jump with arm swing. Maximal oxygen uptake (VO2max) was a test for functional capacity. Results of the measurements before and after the 2 different tapering protocols were statistically compared.

Participants

One-hundred and fifty-eight (N=158) elite Croatian junior soccer players (mean age: 17.07±0.79 yrs; mean height: 177.85±6.64 cm; mean weight: 71.27±7.96 kg; mean body-mass index: 22.50±1.66 kg/m^2, mean training experience: 9.42±1.54 years) were randomly selected into the exponential tapering group and linear tapering group. Randomization was done with replacement, where each participant had equal chance for being selected. There were 14 forwards, 18 defenders, 40 midfielders and 7 goalkeepers in the exponential and 15 forwards, 13 defenders, 45 midfielders and 6 goalkeepers in the linear taper group. Basic descriptive statistics of the study participants in morphological characteristics, motor and functional abilities are presented in tables 2 and 3. Before the study begun, each participant had given an assent and their parents/guardians had given an informed consent to participate in the study. All participants were told about potential risks during the study. During the study, participants were not allowed to be in another training program that could potentially bias the results. All the procedures performed in this study were in accordance to Declaration of Helsinki and were approved by the Institutional Review Board of the Faculty of Kinesiology, University of Split, Croatia.

Testing protocol

In the first phase of the study, in agreement with soccer clubs, all the measurements were done in the morning period between 9.00-12.00 h. Two days before the testing, participants did not have any type of trainings with significant load, which could potentially affect the results. All variables within the study were measured 3 times: initial, transitive and final period. Transitive measurement was done 4 week after the initial measurement. After the transitive measurement, both experimental groups underwent different tapering protocols: linear or exponential. Training for both groups was held 3 sessions per week and was consisted of 4×4 min running exercises with the intensity of 90-95% heart $rate_{max}$ separated with 4 min jogging period of 40% heart $rate_{max}$. Tapering protocol lasted for 4 weeks, followed by final measurement. In total, the whole protocol lasted for 8 weeks. In is worthwhile to mention, that coaches used the same training methods of teaching. Also, all participants had similar levels of physical activity outside the testing period and had similar diet protocols. Detailed protocols of both tapers are presented in table 1.

Table 1. Training protocol for both tapers (3×/week, 4×4 min of running to from 90-95% heart $rate_{max}$)

Linear tapering		Exponential tapering	
Weeks	Series × minutes	Weeks	Series × minutes
1	4x4	1	4x4
1	3x4	1	2x4
1	2x4	1	1.5x4
1	1x4	1	1x4
Pause 4 minutes – 40% of heart $rate_{max}$		Pause 4 minutes – 40% of heart $rate_{max}$	

Study variables

For the purpose of this study, we included morphological characteristics of the study participants, along with motor and functional tests and distance covered. Variables included in morphology were: height, weight, body-mass index, sitting height , % body-fat, muscle-mass and water in the body. Percentage of body-fat, muscle-mass and water in the body were assessed by using Tanita TBF 603 model. Motor tests included 5, 10 and 30 m sprint, agility test 96369 with turn for 180º, repeated sprint ability test, squat jump and squat jump with arm swing. Maximal oxygen uptake (VO2max) was a test for functional capacity.

Morphological characteristics:

Height: participant was in standing upright position and head was placed in so called "frankfurt" position. Stadiometer was placed on the participant, where height was read in cm. The accuracy of testing is 0.1 cm.

Sitting height: participant sat on the chair 40 cm in height, where the angle between upper leg and lower leg was 90º. Head was placed in "frankfurt" position and height was read in cm.

Weight: participant stood on a digital scale, barefoot, and in several seconds, the results was presented in kg.

Body-mass index: it is calculated as ratio between weight (kg) and height (m^2).

% body-fat: participant stood on a Tanita scale and held the resilient part of the scale with hands and with 90º based on body stature. He stood like that in several seconds and the scale read off the result.

% water in the body: participant stood on a Tanita scale and held the resilient part of the scale with hands and with 90º based on body stature. He stood like that in several seconds and the scale read off the result.

% muscle-mass: participant stood on a Tanita scale and held the resilient part of the scale with hands and with 90º based on body stature. He stood like that in several seconds and the scale read off the result.

Motor tests:

Sprint 5, 10 and 30 m: participant ran in maximum speed for 30 m. Photo-cells are placed in 5, 10 and 30 m.

96369 agility test with turn for 180º: The players started after the signal and ran 9 m from starting line A to line B (the lines were white, 3 m long, and 5 cm wide). Having touched line B with one foot, they made either a 180° left or right turn. All the following turns had to be made in the same direction. The players then ran 3 m to line C, made another 180° turn, and ran 6 m forward. Then, they made another 180° turn (line D) and ran another 3 m forward (line E), before making the final turn and running the final 9 m to the finish line (line F).

Repeated sprint ability test: Repeated sprint ability test: Test involved 6 repetitions of maximal 215-m shuttle sprints (6 seconds) departing every 20 seconds. During the 14-second recovery between sprints subjects were required to stand passively. Two seconds before starting each sprint, the subjects were asked to assume the start position as detailed for the 10-m sprints and await the start signal from a compact disc. Strong verbal encouragement was provided to each subject during all sprints.

Squat jump: participant stood at the Kistler platform. He came in the position of squat with his hand put on the hips. On the mark, he did a vertical jump with landing on both feet in the same position as starting. The result is calculated in cm.

Squat jump with arm swing: participant stood at the Kistler platform. He came in the position of squat and with addition arm swing, jumped vertically. Landing was with both feet equally touched the ground. The result is calculated in cm.

Functional test

Maximal oxygen uptake (VO2max): participant started to walk from 3 km/h for 2 min, where the trace was continually speeding each minute for 1 km. When reached 8 km, participant started to run slowly. Test lasted from the moment the participant was not able to track the speed of treadmill. Inclination angle was 1.5%.

Data analysis

All variables for all subsamples are presented as mean ± standard deviation. Normality of the variables was tested by using Kolmogorov-Smirnov test. In order to test if the main effect of factor *Group* (exponential vs linear), factor *Position* (goalkeepers vs defenders vs midfielders vs forwards), factor *Time* (pre-test, mid-test and post test) and all possible factorial interactions *Group×Position, Group×Time, Position×Time and Group×Position×Time* were significant, 3-factorial 2×4×3 ANOVA with repeated measures on last factor was used. Homogeneity of variance was tested by using Leven's test and differences between particular groups and trials were determined by using Bonferroni correction. Single data has been identified as outlier if was found to be out of AM ± 2σ interval. Partial-eta squared (partial η^2) was used for effect size assessment. Statistical analyses were performed by using Statistical Package for Social Sciences program (SPSS ver. 23). Difference was considered significant if $p<0.05$.

Results

First, we calculated coefficient of variation for every variable measured three times. Results showed small variation between three measurements in height (CV=0.001), sitting height (CV=0.002), weight (CV=0.002), body-mass index (CV=0.004), % of fat-mass (CV=0.006), % water (CV=0.001) and % of muscle mass (CV=0.002). In motor abilities, the results in coefficient of variation showed somewhat larger variation in 5 m sprint (CV=0.083), 10 m sprint (CV=0.059), 30 m sprint (CV=0.025), 96369 agility test (CV=0.023), repeated sprint ability (CV=0.018), squat jump (CV=0.033) and squat jump with arm swing (CV=0.029). Last, in functional abilities, results in VO2max showed small coefficient of variation (CV=0.012). Basic descriptive statistics of the study participants in morphological characteristics are presented in table 2. Results showed that goalkeepers were the tallest and heaviest players, compared to the other players on different playing positions. However, they also had the highest values of muscle-mass, followed by forwards and defenders. Significant time changes (pre- post-measurement) occurred in weight status, body-mass index, % fat-mass and muscle-mass. It is necessary to mention, that no significant differences occurred in pre- measurement between the exponential and the linear group. In body weight, there were significant time differences between pre- and post- measurement ($F=8.796$; $p<0.001$), also between playing positions, where goalkeepers in the exponential group had the largest weight changes (ES=0.08) compared to the other playing positions within the exponential group.

The largest, however trivial effect changes in the linear group had defenders (ES=0.14) and goalkeepers (ES=0.05). Due to weight changes, body-mass index values changed their values during time ($F=6.361$; $p<0.001$). However, no significant interaction between groups (exponential vs. linear), playing positions (forwards, midfielders, defenders and goalkeepers) and time occurred ($F=1.323$; $p=0.247$; $\eta^2=0.003$). The largest reduction in the % of fat-mass occurred in goalkeepers (ES=0.07) in the exponential group and in defenders in the linear group (ES=0.04). Next, % of muscle-mass significantly increased between pre- and post-measurement ($F=55.594$; $p<0.001$; $\eta^2=0.427$) in both exponential and linear group. Also, players at different playing positions had different increment of muscle-mass.

Specifically, the largest, but trivial changes occurred in forwards in the exponential group (ES=0.04) and trivial in forwards (ES=0.02) and small differences in goalkeepers (ES=0.16) in the linear group. Also, the effect for the interaction between groups (exponential vs. linear), playing positions (forwards, midfielders, defenders and goalkeepers) and time was statistically significant ($F=5.546$; $p<0.001$; $\eta^2=0.076$), but no significant differences occurred between two tapering protocols, which means that both protocols brought similar increment of muscle-mass ($p=0.082$).

Table 2. Basic descriptive statistics of the study participants in morphological characteristics (N=158)

Study variables	Exponential group			Linear group		
	Pre	Mid	Post	Pre	Mid	Post
	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD
Weight (kg)						
Forwards	70.46±5.53	70.53±5.60	70.31±5.37	69.41±5.58	69.53±5.65	69.62±5.60
Midfielders	69.71±6.67	69.82±6.80	69.90±6.85	69.50±6.27	69.57±6.20	69.49±6.22
Defenders	76.18±7.53	76.24±7.61	76.21±7.55	73.67±8.71	73.75±8.94	74.94±9.04
Goalkeepers	80.49±7.63	80.92±7.43	81.10±7.53	82.84±6.41	82.94±6.54	83.17±6.58
Body-mass index (kg/m^2)						
Forwards	21.66±1.82	21.74±1.83	21.56±1.88	22.13±1.96	22.22±2.01	22.15±1.88
Midfielders	22.48±2.17	22.50±2.29	22.55±2.28	22.32±1.47	22.40±1.54	22.43±1.60
Defenders	22.71±1.75	22.73±1.80	22.70±1.77	22.48±0.88	22.50±1.26	22.55±1.02
Goalkeepers	23.04±1.81	23.15±1.76	23.21±1.79	23.14±0.90	23.16±0.86	23.22±1.02
% fat-mass						
Forwards	6.29±2.82	6.27±2.80	6.23±2.79	6.18±1.28	6.16±1.26	6.12±1.26
Midfielders	6.13±2.47	6.12±2.45	6.10±2.40	5.97±1.74	5.95±1.70	5.96±1.72
Defenders	6.13±2.77	6.12±2.75	6.11±2.76	6.03±1.52	6.01±1.50	5.97±1.73
Goalkeepers	9.04±1.38	8.96±1.30	8.95±1.32	8.70±1.35	8.73±1.41	8.69±1.37
% water						
Forwards	43.68±4.31	43.32±4.28	43.30±4.15	43.86±2.85	43.85±2.87	43.73±2.91
Midfielders	43.73±3.86	43.74±3.88	43.76±3.90	43.91±4.38	43.93±4.40	43.95±4.43
Defenders	43.51±1.54	43.56±1.60	43.53±1.57	42.63±3.25	42.69±3.22	42.65±3.19
Goalkeepers	45.16±2.68	45.14±2.73	45.12±2.75	47.21±3.27	47.42±3.13	47.46±3.07
% muscle mass						
Forwards	64.10±11.01	64.30±10.98	64.59±11.03	66.86±10.57	66.92±10.59	67.09±10.62
Midfielders	59.38±15.53	59.47±15.60	59.63±15.52	62.92±16.40	62.95±16.34	63.00±16.38
Defenders	62.95±14.29	63.02±14.32	63.16±14.31	58.15±16.15	58.25±16.28	58.36±16.32
Goalkeepers	65.24±8.33	65.40±8.43	65.58±8.50	65.45±9.05	65.75±9.90	66.92±9.78

*-significant difference between mid and post; †- Significant difference between groups

Next, our results showed significant improvements in 5, 10 and 30 m sprint in post- measurement compared with pre- measurement ($p<0.001$). Also, significant time x playing position interaction effect occurred in 5 m sprint variable, where the largest improvements had forwards (ES=1.41) and goalkeepers (ES=1.05) in the exponential group and forwards (ES=1.13) in the linear group. There was also a significant effect between the group (exponential vs. linear group) and time interaction ($F=2.952$; $p=0.023$; $\eta^2=0.067$). In 10 m sprint, no significant effect occurred in the interaction between time and group ($F=1.832$; $p=0.165$; $\eta^2=0.032$), time and playing positions ($F=0.658$; $p=0.683$; $\eta^2=0.017$) and group, playing position and time ($F=1.395$; $p=0.218$; $\eta^2=0.036$). However, the largest changes occurred in forwards in the exponential group (ES=1.30), opposed to other playing positions in both exponential and linear tapering group. As mentioned before, no significant differences occurred in pre- measurement between the exponential and tapering group ($p>0.05$). In 30 m sprint, significant effects occurred in the interaction between time and group ($F=4.134$; $p<0.019$; $\eta^2=0.069$). Globally, mean differences within each group (exponential and linear) were larger in the exponential group ($mean_{diff}=0.10$) opposed to the linear group ($mean_{diff}=0.07$). However, no significant effects occurred in the interaction between time, group and playing positions ($F=1.046$; $p=0.396$; $\eta^2=0.030$). Similar time change occurred in forwards, midfielders and defenders in the exponential group, yet in goalkeepers and defenders in the linear group. Significant changes in "96369" agility test occurred only between pre- and post- measurement ($F=10.523$; $p<0.001$; $\eta^2=0.143$), while there was no significant effect in the interaction between time, group and playing position. Nevertheless, forwards in the exponential group showed the largest effect changes (ES=0.61), compared to forwards in the linear group (ES=0.24). As in 96369 agility test, only significant time effect changes occurred between pre- and post- measurement ($p<0.001$). No significant effects occurred in the interaction between time and group, time and playing position and time, group and playing position ($p>0.05$). However, as in previous variables, forwards in the exponential group performed better (ES=0.78) than forwards in the linear tapering group (ES=0.59) while similar effect changes occurred in defenders and goalkeepers between two groups. Midfielders in the linear group performed somewhat better in repeated sprint ability test than the same players in the exponential group (ES=0.64 vs. 0.59). Significant time changes also occurred in variable squat jump ($p<0.001$). Moreover, results showed significant interaction between time, group and playing positions ($F=2.646$; $p=0.016$; $\eta^2=0.078$), yet no significant effects occurred between time and group and time and playing position interaction ($p>0.05$). Mean differences between the first and the third measurement were 1.11 cm within the exponential and 0.56 in the linear group. In the exponential group, the largest changes occurred in forwards (ES=0.53), while similar effects occurred in midfielders and defenders (ES=0.32 and 0.31). In the linear group, forwards had the largest changes between pre- and post- measurement (ES=0.29). In the squat jump with arm swing variable, time effect ($F=12.590$; $p<0.001$; $\eta^2=0.152$) and the interaction between time and group were significant ($F=3.674$; $p=0.036$; $\eta^2=0.063$). Moreover, exponential group as whole performed better ($mean_{diff}$= 1.36 cm) opposed to the linear group ($mean_{diff}$= 1.12 cm)

Table 3. Basic descriptive statistics of the study participants in motor abilities (N=158)

Study variables	Exponential group			Linear group		
	Pre	Mid	Post	Pre	Mid	Post
	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD
Sprint 5 m						
Forwards	1.40±0.13	1.32±0.11	1.23±0.11*	1.43±0.16	1.36±0.17	1.26±0.14*
Midfielders	1.41±0.15	1.43±0.16	1.37±0.17*	1.44±0.13	1.38±0.20	1.35±0.20
Defenders	1.45±0.14	1.44±0.15	1.33±0.10*	1.45±0.10	1.38±0.17	1.31±0.15*
Goalkeepers	1.59±0.18	1.53±0.21	1.42±0.14*	1.56±0.08	1.53±0.10	1.45±0.25*
Sprint 10 m						
Forwards	2.15±0.14	2.10±0.07	1.98±0.12*	2.14±0.21	2.13±0.23	2.05±0.21*†
Midfielders	2.15±0.14	2.14±0.15	2.06±0.15*	2.14±0.25	2.12±0.16	2.08±0.18*
Defenders	2.17±0.17	2.13±0.12	2.04±0.16*	2.20±0.16	2.16±0.18	2.08±0.18*†
Goalkeepers	2.28±0.13	2.25±0.16	2.15±0.27*	2.28±0.16	2.27±0.18	2.20±0.11*†
Sprint 30 m						
Forwards	4.50±0.27	4.46±0.25	4.40±0.26*	4.49±0.19	4.47±0.27	4.43±0.21
Midfielders	4.53±0.22	4.52±0.18	4.43±0.22*	4.50±0.18	4.48±0.14	4.45±0.19
Defenders	4.56±0.12	4.54±0.18	4.45±0.16*	4.55±0.18	4.51±0.28	4.48±0.24
Goalkeepers	4.61±0.28	4.59±0.38	4.55±0.20	4.58±0.10	4.55±0.17	4.50±0.15*
96369 agility test						
Forwards	7.43±0.33	7.40±0.30	7.23±0.33*	7.40±0.37	7.38±0.43	7.30±0.44
Midfielders	7.40±0.32	7.38±0.40	7.30±0.35	7.42±0.36	7.41±0.46	7.35±0.40
Defenders	7.47±0.34	7.45±0.25	7.35±0.22*	7.50±0.23	7.49±0.30	7.42±0.37†
Goalkeepers	7.67±0.44	7.64±0.39	7.52±0.29*	7.71±0.86	7.69±0.77	7.61±0.75
Repeated sprint ability						
Forwards	6.90±0.32	6.87±0.29	6.65±0.32*	6.92±0.38	6.90±0.40	6.70±0.36*
Midfielders	6.97±0.32	6.93±0.28	6.80±0.25*	7.01±0.23	6.97±0.26	6.85±0.37*
Defenders	7.07±0.42	7.03±0.44	6.83±0.39*	7.03±0.35	7.01±0.32	6.80±0.40*
Goalkeepers	7.17±0.44	7.12±0.40	6.98±0.36*	7.20±0.86	7.17±0.75	7.05±0.69
Squat jump (m)						
Forwards	42.87±2.94	42.90±2.72	44.50±3.14*	42.51±4.72	43.01±4.69	43.94±4.98
Midfielders	40.79±4.27	40.68±4.03	42.10±4.15*	41.02±4.62	41.03±3.80	41.50±4.13
Defenders	41.16±5.53	41.20±5.60	42.88±5.17*	41.28±5.03	41.26±5.28	41.98±5.19
Goalkeepers	45.44±5.78	45.23±5.30	46.14±5.24	44.62±4.13	44.65±4.30	45.14±4.40
Squat jump with arm swing (m)						
Forwards	53.08±4.48	52.93±4.30	54.06±3.16*	52.99±4.72	53.10±4.56	54.17±4.44*
Midfielders	52.29±5.58	52.40±5.30	53.90±5.45*	52.31±5.02	52.36±4.95	52.96±4.06
Defenders	52.87±4.50	52.96±4.87	54.33±4.57*	52.57±5.53	52.33±5.00	53.88±4.96*
Goalkeepers	53.81±5.47	53.90±6.01	55.15±6.15	54.01±5.79	54.10±5.83	54.97±5.94

*-significant difference between mid and post; †- Significant difference between groups

In VO2max variable, time effect was the only significant one ($F=22.732$; $p<0.001$; $\eta^2=0.243$). In the exponential group, similar effects occurred between playing positions (ES range 0.35 to 0.45). In the linear group, the largest changes occurred in Midfielders (ES=0.49). However, when looking at groups as two independent samples, $mean_{diff}$ was larger in the exponential (1.17 $mlO_2/kg/min$) than linear ($mean_{diff}$= 0.92 $mlO_2/kg/min$).

Table 4. Basic descriptive statistics of the study participants in functional abilities (N=158)

Study variables	**Exponential group**			**Linear group**		
	Pre	**Mid**	**Post**	**Pre**	**Mid**	**Post**
	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD
VO2max $mlO_2/kg/min$)						
Forwards	57.43±2.79	57.55±2.59	58.63±2.49*	57.67±2.31	58.04±2.17	58.79±2.23*
Midfielders	57.93±2.52	58.17±2.94	59.19±3.01*	57.51±2.05	57.76±2.20	58.27±3.10*†
Defenders	56.87±4.80	56.70±5.00	57.50±6.19	56.56±6.05	56.60±5.16	57.20±4.90
Goalkeepers	52.60±4.02	52.76±4.30	54.10±4.58*	52.87±4.80	52.94±5.10	53.89±5.40

*Significantly different from Mid; †significant differences between groups

Discussion

The main purpose of the present study was to determine the effects of two different tapering protocols on anthropological status in junior elite soccer players according to playing positions.

Results from our study showed significant time changes between pre- and post- measurement in all morphological variables, except for height and sitting height. Specifically, we found that weight of the participants significantly changed during a taper protocol. These changes might occur because of the physiological changes (Inigo Mujika & Padilla, 2003). According to some previous results, training load reduction may increase red cell volume and both hemoglobin levels (Shepley et al., 1992; Yamamoto, Mutoh, & Miyashita, 1988). Also, both tapers produced neuromuscular benefits, such as muscle power development, muscle contraction properties and the stretch-shortening (plyometric) cycle of the specific muscles used for specific sport (Noakes, 2000). Moreover, previous findings have reported that between 13-34% of tapering induced increase muscle glycogen and its' distribution in both men and women (Neary, Martin, & Quinney, 2003), which can potentially lead to better carbohydrate spare by using fatty acids as energy supstrate and lowering % of fat-mass (Izquierdo et al., 2007). When we analyze results by playing positions, weight status, % of fat-mass and % muscle-mass changed in all the players on different playing positions in both exponential and linear group. However, goalkeepers had significantly larger increment of weight and % of muscle-mass than the other players and decrement in the % of fat-mass. These findings may be explained by the fact, that goalkeepers have specific playing role on the field, such as jumps, sudden throws and powerful kicks, however do not have such high-intensity activities like the players from the other playing positions (R Matković et al., 2003). Also, findings have reported, that goalkeepers have the lowest values of maximal oxygen uptake (VO2max), opposed to the other players (Lago-Peñas et al., 2011). Since our tapering protocol was consisted of 4x4 min running exercises with the intensity of 90-95% heart $rate_{max}$ separated with 4 min jogging period of 40% heart $rate_{max}$ (the combination of both aerobic and anaerobic activity), it is possible that goalkeepers improved their VO2max, due to activation of the PGC-1α complex, which is directly associated with control of carbohydrates and fats, enhancing fat and glucose oxidation, which can potentially improve aerobic endurance and decrease the % of fat-mass (Silva & Araújo, 2015). Similar time changes in other players on different playing positions may be explained with similar values at the beginning of the study and since all the players had similar training protocol, it is possible that this kind of training protocol produced similar physiological effects that could potentially lead to decrement of % of fat-mass and increment of % of muscle-mass.

Next, our results showed that forwards had statistically larger increment in 5, 10 and 30 m sprint than the players on the other playing positions. In general, players playing at forward positions have more sprinting-type activities (Malina et al., 2000) and are faster than the other players (Pivovarniček, Pupiš, Švantner, & Kitka, 2014). It can be explained by the fact that forwards are often included in offensive and impulsive activities, mostly for short distances and recovery periods during the defensive phase (Pivovarniček et al., 2014). Also, forwards are in general shorter and lighter than the other players. Our results showed significant effect interaction between time and group (exponential vs. linear), where exponential taper group showed somewhat better values in 30 m sprint. Previous studies have shown, that progressive training load significantly decrease sprint time improve vertical jumping performance (Aaron Coutts, Reaburn, Piva, & Murphy, 2007; Elloumi et al., 2012). Coutts et al. (Aaron Coutts et al.) found a significant decrease in 10 m sprint for 2.1% and a non-significant decrease in 40 m sprint for 0.37% in team sport players. Similar, Elloumi et al. (Elloumi et al.) showed significant decrease in sprint time over 10, 20 and 40 m for 3.2%, 2.2% and 2.5%. Several mechanisms may be related to such results.

First, tapering period may significantly increase the proportion of fast myosin heavy chains and a shift towards faster twich type IIX, which physiologically produce twice as much contraction than IIA fibers (De Lacey, Brughelli, McGuigan, & Hansen, 2014). This may explain sprinting and jumping performance improvements, since sprinting and jumping activities are fast and very high velocity movement activities (Larsson & Moss, 1993). Our results also showed that goalkeepers performed the best in jump tests. Previous findings have shown, that body-mass index represents the most significant predictor of vertical jump performance (Malina et al., 2000). In that way, a high body-mass index at an equivalent body-fat and height content causes a higher lean body and muscular mass (P.-L. Wong et al., 2009). Results in repeated-sprint ability showed similar effects of both exponential and linear taper protocol in soccer players. A study by Mujika (I Mujika et al.) concluded that these changes may occur due to neuromuscular and muscle-specific changes during the taper period than to change in metabolic processes. Also, an enhanced performance in repeated- sprint ability may be explained with the increment of VO2max in both exponential and taper group, since previous studies have suggested that aerobic performance is positively linked with anaerobic performance during intermittent activities (Tomlin & Wenger, 2001). Moreover, a few studies have reported that aerobic energy is more important than the anaerobic one, especially in power output maintenance during a long series of repeated sprints (Gaitanos, Williams, Boobis, & Brooks, 1993; Nikbakht et al., 2011).

Finally, results from the present study showed significant time changes between pre- and post-measurement in VO2max. As mentioned by the previous studies, goalkeepers have the lowest values of VO2max, due to their playing role on the field. Also, midfielders in our study had the highest VO2max value before the intervention, which is in accordance with some previous findings (Gil et al., 2007). However, similar changes occurred between playing positions in the exponential group, yet forwards in the linear group produced somewhat larger effects. According to some previous findings, no significant physiological differences occur between playing positions (Lago-Peñas et al., 2011). According to one previous study, increment in VO2max may occur due to increased mitochondrial density inside the muscles, enhancing fat and glucose oxidation, which can improve aerobic energy production (Fortes et al., 2016; Turnes et al., 2015).

Our study has several limitations. First, we did not control for diet and other physical activities of the participants during the tapering period, which may potentially lead to bias. However, all the participants were instructed prior the study to have somewhat similar diet and not to participate in other sport activities.

In conclusion, our results show significant improvements in morphological characteristics and motor and functional abilities following a taper protocol in youth soccer players according to different playing positions. However, exponential taper group produced somewhat better results in most of the analyzed variables, compared to the linear group. Also, we found that forwards had the largest change in almost every variable. This is not surprising, while previous findings have reported, that forwards perform the most maximal sprints and for longer durations, along with higher levels of stopping and faster deceleration activities (Bloomfield, Polman, & O'Donoghue, 2007). Also, forwards are more engaged in actions that require specific activities, like jumping and heading the ball (Reilly, 2003). It is possible that forwards improved their performance, since studies have shown that velocity, agility and speed represent the most important characteristics during a soccer match (Gil et al., 2007). Also, morphologically, they are much leaner and stronger players with somewhat better physiological characteristics than the other players on playing positions, pointing out that the result of the game primary depends on forwards group (Gil et al., 2007). However, both tapering protocol have been shown to produce similar effects in morphological characteristics and motor and functional abilities in youth soccer players.

PRACTICAL APPLICATIONS

Avoiding overtraining and optimizing performance could be achieved through the logical variation of training methods and volume loads. As mentioned earlier, a taper involves a reduction in the physiological and psychological stress which could potentially enhance performance. Our results showed that decreasing the 5% of initial values or 5% of the previous session values in every forthcoming workout had similar effects on body composition and fitness parameters. The novel finding in the current study is that there were no positional differences following different tapering protocols in junior soccer players. Our results confirmed the reports of others which suggest that volume is the optimal variable to manipulate exponentially reducing the volume of training while maintaining both the intensity and the frequency of sessions.

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UČINAK LINEARNOG I EKSPONENCIJALNOG TEMPIRANJA SPORTSKE FORME NA MORFOLOŠKA OBILJEŽJA, MOTORIČKE I FUNKCIONALNE SPOSOBNOSTI KOD NOGOMETAŠA JUNIORA : RAZLIKE U IGRAČKIM POZICIJAMA

Sažetak

Osnovni cilj ovog istraživanja je bio da se utvrde efekti dva različita tapering protokola na antropološka obilježja kod elitnih nogometaša juniora prema različitim igračkim pozicijama. Stotinu i pedeset osam elitnih nogometaša juniora (srednja dob: 17,07 ± 0,79 godina, prosječna visina; 177,85 ± 6,64 cm; prosječna težina: 71,27 ± 7,96 kg; prosječni indeks tjelesne mase: 22,50 ± 1,66 kg / m2) su slučajnim odabirom podijeljeni u dvije grupe: (1) eksponencijalnu i (2) linearnu. Treninzi su se provodili tri puta tjedno u periodu od osam tjedana. Nakon 4 tjedna treninga i 4 tjedna provođenja taperinga, ispitanici su testirani u: morfološkim obilježjima, zatim motoričkim i funkcionalnim sposobnostima. U svim varijablama došlo je do poboljšanja rezultata, osim u varijablama visina tijela i sjedeća visina. Međutim, kod eksponencijalne grupe bolji rezultati su ostvareni u testovima sprint na 5, 10 i 30 metara, te 96369 testa agilnosti, dok su vezni igrači pokazali nešto bolje rezultate kod linearne grupe u testu RSA (ES=0.64). Maksimalni primitak kisika se značajno povećao u obe tapering grupe, dok je veća razlika zabilježena kod eksponencijalne grupe. U zaključku, oba tapering protokola su pokazala slične promjene s obzirom na različite igračke pozicije. Ispitanici u eksponencijalnoj grupi su imali veća poboljšanja rezultata u morfološkim obilježjima, zatim motoričkim i funkcionalnim sposobnostima.

Ključne riječi*: taper, nogomet, mladi, efekti, izvedba*

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