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Effect of block periodization on physical fitness during a competitive soccer season

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Abstract

This study examined the effect of block periodization on physical fitness in a professional soccer team. Twenty two male players (21.9 ± 2.3 years) were followed in the course of the 2007-2008 season. The season was divided into five training stages which were further subdivided into three consecutive blocks (Accumulation, Transmutation and Realization) where physical workloads focused on a minimal number of capacities. To examine the training volume, time spent developing physical capacities relevant for soccer´s match performance was compared within each block. To study training intensity, heart rate was recorded during all training sessions and compared within blocks. Measures of physical characteristics and physical fitness were assessed in every training stage. Time spent performing high-intensity aerobic training was predominant (P<0.001) in Accumulation in relation to Transmutation and Realization blocks. In addition, time devoted to speed endurance training was higher (P<0.01) in Transmutation than in Accumulation and Realization, whereas time spent developing speed was superior (P<0.05) in Realization in comparison to Accumulation and Transmutation. Vertical jumping height and 10-m sprinting time improved (P<0.01) in the last training stage in relation to the initial values. The players covered a 26-30% greater distance (P<0.001) in the yo-yo intermittent recovery level-1 test at the end than at the beginning of the competitive period. These results suggest that block periodization can be an alternative design for soccer training.

Keywords: Association football; mesocycle; performance; heart rate; yo-yo intermittent recovery test

1. Introduction

Soccer players´ performance depends on the interaction of tactical, technical, physical and psychological factors (Stolen et al., 2005). Physical performance plays a crucial role in modern soccer, as different studies have reported an increase in the distance covered at high-intensities during a match and have shown that this parameter is related to the standard of competition (Bangsbo et al., 1991; Mohr et al., 2003; Bradley et al., 2009). To be able to cope with the increasing match demands, soccer players must possess an adequate anthropometric and fitness profile, with optimal speed and sport-specific intermittent endurance levels (Hoff, 2005; Reilly, 2005). Furthermore, these capacities

must be maintained during a 9-10 months long competition period (Gamble, 2006). A number of studies (Helgerud et al., 2001; Hoff et al., 2002; Dupont et al., 2004; Gorostiaga et al., 2004; Wisloff et al., 2004; Impellizzeri et al., 2006) have examined the effect of different training regimens on independent physical capacities over a short period of time (8-12 weeks). However, despite the impact that physical performance might have in the final team performance during competition, there is little scientific background about the organization of the physical workloads during an entire soccer season.

Block periodization has been extensively employed with success in individual sports during the last 25 years (Issurin and Kaverin, 1985; Bondarchuk, 1988; Touretski, 1998; Breil et al., 2010). Briefly, this training structure searches for a consecutive development of the motor abilities and skills using highly concentrated loads, with a resultant cumulative and residual effect (Issurin, 2008, 2010). Nevertheless, it is not so evident if this seasonal design is suitable for team sports, characterized by very long competition periods. In a recent study, Mallo (2011) reported the effect of applying block periodization on performance in competition in a professional soccer team over four consecutive competitive seasons. However, this study examined the team success in competition by assessing the number of points obtained by the team in each match in relation to the training block, remaining uncertain the benefits and drawbacks of this planning structure on the physical capacities of the players throughout the entire season.

Therefore, the aim of this study was to examine the effect of block periodization on the physical fitness of the players of a professional soccer team during one competitive season. The hypothesis of this study was that if the physical conditioning of a soccer team was structured following a block periodization model, the physical fitness of the players, assessed periodically with a battery of field tests, would be maintained, or even elevated, in the final stages of the season.

2. Methods

2.1. Participants

Twenty two male subjects, with a mean age of 21.9 ± 2.3 years and an average height of 1.80 ± 0.55 m, were monitored in the course of the 2007-2008 season. All of the players belonged to the second team of an elite soccer Spanish club, ranked as one of the European´s leading clubs, that took part in the National competition (Division Two "B"). All participants were fully informed of experimental procedures associated with the study before giving their written informed consent to participate. The local Institutional Review Board approved the study design and was carried out according to the Declaration of Helsinki.

2.2. Periodization model

The season was divided into five training stages, which integrated the development of all the physical capacities relevant for soccer´s match performance (Bangsbo et al., 2006). According to Issurin (2008, 2010) each training stage was subdivided into three consecutive blocks (mesocycles): Accumulation, Transmutation and Realization (Figure 1). The aim of the Accumulation block was to increase the ability to perform long-

duration high-intensity intermittent exercise and, therefore, this block was based on high-intensity aerobic training. The objective of the Transmutation block was to improve repeated sprint ability and physical conditioning was focused on speed endurance. All the training stages concluded with a Realization block which aimed to develop the capacity to perform maximal-intensity exercise. For instance, this block was focused on the development of speed. Therefore, the specific training drills employed to develop physical capacities were in accordance to the training block to which they belonged.

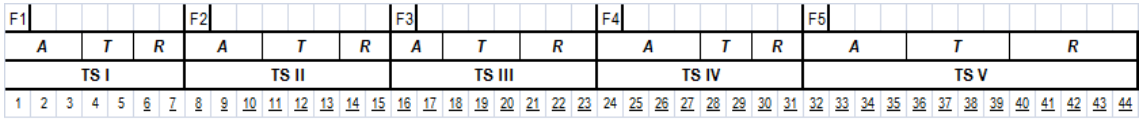

Figure 1. Periodization model of the soccer season. Note: The last row represents the week number. Underlined numbers represent weeks with a competition match. Legend. TS: Training Stage; A: Accumulation; T: Transmutation; R: Realization; F: Fitness test.

The exercise duration was recorded in 1-min intervals during all the matches and training sessions and was categorized into: (i) Competitive official League matches; (ii) Tactical drills: All the friendly matches, playing, attacking or defensive training situations and set plays; (iii) Technical drills: All the situations focused on the technique and where no tactical responses were required on the players; and (iv) Physical conditioning. This training category was subsequently divided into: (a) warm-ups; (b) low-intensity aerobic; (c) high-intensity aerobic; (d) speed endurance; (e) speed; (f) gym based strength; (g) flexibility; and (h) other physical capacities. The reliability of this notational system has been previously reported revealing a high level of agreement between observations (Mallo, 2011).

Heart rate was recorded in every training session in 5-s intervals by means of Polar Team System heart rate monitors (Polar Electro Oy, Kempele, Finland). Ten players (two fullbacks, central defenders, central midfielders, wide midfielders and forwards) wore the heart rate monitors every session. At the end of training the data from the belts were downloaded to a computer and expressed as a percentage of the individual maximum heart rate (%HR_{max}). This value was individually adjusted every month after all the recordings obtained from matches, training sessions and fitness tests. Time spent during training at intensities exceeding 85% HR_{max} was entitled as "high-intensity activity" and was considered for further analysis (Helsen and Bultynck, 2004). Different studies have shown that heart rate monitoring is a valid measure of actual exercise intensity in different types of aerobic soccer-specific interval training (Drust et al., 2000; Hoff et al., 2002)

2.3. Fitness testing procedures

During the season, the players were tested on five occasions, coinciding with the first week of every training stage. Test sessions were undertaken between 09:00 and 11:00, at least 24-h after the previous training session and started with the measurement of the player´s anthropometric characteristics: height (m), body mass (kg) and sum of six

skinfolds thickness (triceps, subscapular, suprailiac, abdominal, front thigh and median calf; Holtain Ltd., Crymych, UK).

Field testing began with a 15-min standardized warm-up which consisted in runs and jumps of increasing intensity. Jumping tests were performed in an indoor facility with players wearing running shoes. Countermovement jumps without arm-swing (CMJ) and with arm-swing (ASCMJ) were performed on a contact platform (Ergo Tester, Globus, Codognè, Italy). Each player performed three maximal CMJ and ASCMJ interspersed with 3-min recovery (5-min between series) and the best height for each was recorded. Five minutes after the jumping test, the players undertook a sprint running test on artificial grass wearing habitual soccer boots. The test consisted of three 10-m maximal sprints, with a 90-s rest period between each sprint. Time was recorded using photocell gates (Ergo Tester, Globus, Codognè, Italy). The players started the sprint when ready from a standing position 0.5-m behind the start. Best time to cover distance was selected for further analysis. Ten minutes after the sprint test, the players performed the yo-yo intensity recovery level-1 test (Krustrup et al., 2003). This test consisted of repeated 2 x 20-m runs at incremental speeds controlled by audio bleeps. Between each running bout the players had a 10-s active recovery period consisting in 2 x 5-m of jogging. The test commenced with four running bouts at 10-13 $km \cdot h^{-1}$ (0-160 m) and another seven runs at 13.5-14 $km \cdot h^{-1}$ (160-440 m); thereafter it continued with stepwise 0.5 $km \cdot h^{-1}$ speed increments after every eight running bouts until exhaustion. When a player twice had failed to reach the finish line in time, the distance covered was recorded as the test result. During the test, heart rate was recorded in 5-s intervals using Polar Team System. Heart rate recorded at the 6^{th} and 9^{th} minute of the test was considered for further analysis. Previous studies (Krustrup et al., 2003; Bangsbo et al., 2008) have shown the physiological response and validity of this test. These tests were selected to assess the fitness of the players as vertical jumping height, 10-m sprinting time and performance in the yo-yo intermittent recovery test have been considered as important soccer´s fitness performance indexes and discriminative variables between standards of competition (Commetti et al., 2001; Krustrup et al., 2003; Mohr et al., 2003; Arnason et al., 2004; Wisloff et al., 2004; Stolen et al., 2005).

2.4. Statistical analyses

All statistical analyses were conducted using SPSS for Windows version 15.0 (SPSS Inc., Chicago, IL, USA). One-way analysis of variance (ANOVA) was used to examine differences in training categories and heart rate responses between blocks. ANOVA with repeated measures was used to determine the differences on physical fitness between training stages. When a significant *F* value was achieved, appropriate Scheffé *post hoc* testing was used to locate the differences between means. Significance was set at $P<0.05$. Data are presented as means ± standard deviation of the mean.

3. Results

The overall season duration was 44 weeks, in which the team took part in 38 official matches, carried out 254 training sessions and rested 59 days. The average training stage duration was 62 ± 17 days. No significant differences were detected between the length of the Accumulation (24 ± 8 days), Transmutation (20 ± 6 days) and Realization

(17 ± 4 days) blocks. Moreover, the number of official matches, training sessions and rest days was not significantly different between blocks.

Time spent per week in each training category is shown in Table 1. The players carried out more (P<0.001) high-intensity aerobic training in Accumulation than in the remaining blocks. Complementarily, time employed to develop speed endurance was higher (P<0.01) in Transmutation than in Accumulation and Realization. On the other hand, time dedicated to improve speed peaked (P<0.05) in Realization in relation to the other two blocks.

Table 1. Mean time (in minutes) spent per week within each training category and physical capacity during the blocks. Values are means ± SD.

	Accumulation	**Transmutation**	**Realization**
Competition	67.5 ± 39.0	72.0 ± 40.3	90.0 ± 0.0
Tactical	218.6 ± 43.3	256.9 ± 100.6	207.8 ± 45.8
Technical	136.6 ± 48.6	125.0 ± 31.6	103.6 ± 15.8
Physical	213.4 ± 79.3	173.3 ± 27.4	151.5 ± 25.1
Warm-ups	50.8 ± 15.2	48.9 ± 9.4	48.4 ± 7.6
Low-intensity aerobic	10.6 ± 8.2	7.8 ± 4.7	6.8 ± 2.1
High-intensity aerobic	38.9 ± 10.7***	4.0 ± 9.0	0.0 ± 0.0
Speed endurance	0.0 ± 0.0	19.2 ± 12.0**	0.0 ± 0.0
Speed	15.1 ± 8.5	20.9 ± 6.7	37.0 ± 8.2*
Gym-based strength	52.5 ± 42.8	32.1 ± 18.7	20.8 ± 11.9
Flexibility	36.9 ± 13.6	35.3 ± 6.6	30.9 ± 6.8
Other capacities	8.6 ± 3.3	5.1 ± 1.3	7.6 ± 3.6

Legend. Competition: official League matches; Tactical: all the friendly matches, playing, attacking or defensive training situations and set plays; Technical: all the situations focused on the technique and where no tactical responses were required on the players; Physical: physical conditioning. *Significant difference (P<0.05) between Realization and Accumulation and Transmutation. **Significant difference (P<0.01) between Transmutation and Accumulation and Realization. ***Significant difference (P<0.001) between Accumulation and Transmutation and Realization.

Mean heart rate during the Accumulation, Transmutation and Realization blocks averaged 73.5 ± 1.7%, 71.2 ± 1.7% and 70.5 ± 3.2% of HR_{max}, respectively, with no significant differences between blocks. Time spent per week exercising at intensities exceeding 85% HR_{max} was higher during Accumulation (111.2 ± 36.5 min) than in Transmutation (82.2 ± 10.3 min; P<0.05) and Realization (69.0 ± 4.3 min; P<0.01) (Figure 2).

The average body mass of the players was 73.1 ± 5.5 kg with no significant changes observed at any time during the entire season. The sum of skinfolds recorded in the first training stage (52.3 ± 11.1 mm) was higher (P<0.001) than that from the third (46.8 ± 8.3 mm), fourth (47.6 ± 8.4 mm) and fifth (47.4 ± 8.7 mm) training stages. In addition, this value was also superior (P<0.05) in the second training stage (50.1 ± 10.3 mm) than in the fourth and fifth.

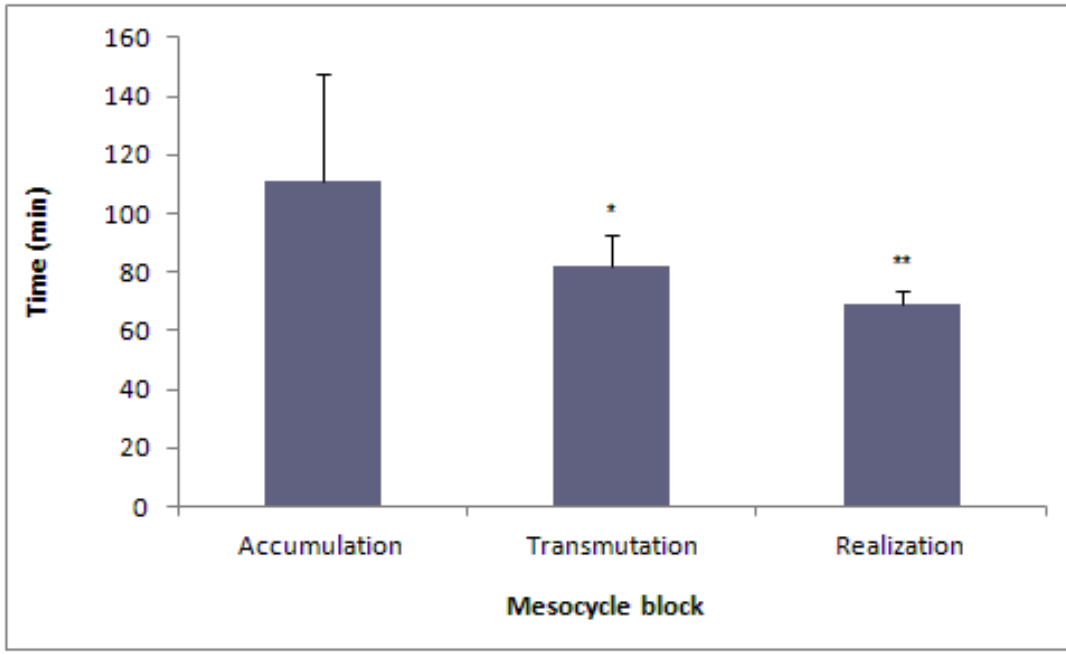

Figure 2. Time spent per week exercising at intensities exceeding 85% HR_{max} during each block. *Significant difference (P<0.05) from Accumulation. **Significant difference (P<0.01) from Accumulation.

There was no significant difference in CMJ height during the experimental period (Table 2). However, the players reached a higher (P<0.01) ASCMJ height in the fifth stage in relation to the first two training stages. The best score in the 10-m sprint test was also achieved in the last training stage were the players were faster (P<0.05) than in the first training stage.

Table 2. Physical fitness of the players during each training stage (TS) of the season. Values are means ± SD.

	TS I	**TS II**	**TS III**	**TS IV**	**TS V**
CMJ (cm)	41.3 ± 4.6	39.4 ± 5.0	41.0 ± 4.7	42.1 ± 5.1	44.1 ± 5.0
ASCMJ (cm)	44.4 ± 3.8	45.5 ± 5.0	47.2 ± 5.8	47.8 ± 5.4	51.8 ± 4.4**
10-m sprint (s)	1.81 ± 0.08	1.79 ± 0.05	1.78 ± 0.05	1.76 ± 0.05	1.75 ±0.04*

Legend. CMJ: Countermovement Jump. ASCMJ: With arm-swing countermovement jump. *Significant difference (P<0.05) between training stage V and I. **Significant difference (P<0.01) between training stage V and I and II.

Distance covered in the yo-yo intermittent recovery test was greater (P<0.001) in training stages four (2733 ± 246 m) and five (2676 ± 255 m) than in one (2037 ± 264 m) and two (2110 ± 341 m) (Figure 3a). Moreover, distance covered in the third training stage (2459 ± 418 m) was also higher (P<0.01) than at the beginning of the season (stages I and II). Heart rate recorded at the 6th minute of the test was higher in the first training stage (92.5 ± 2.9% HR_{max}) than in the third (87.3 ± 3.9% HR_{max}; P<0.01),

fourth (87.0 ± 3.1% HR_{max}; $P<0.001$) and fifth (88.0 ± 3.4% HR_{max}; $P<0.01$) training stage. Complementarily, mean heart rate during the first 9-min of the test was also higher ($P<0.001$) in the initial training stage (93.8 ± 2.7% HR_{max}) than in training stages three (88.8 ± 3.8% HR_{max}), four (88.4 ± 2.9% HR_{max}) and five (88.7 ± 4.2% HR_{max}) (Figure 3b). Performance in the yo-yo intermittent recovery test was inversely correlated to heart rate recorded at minute 6 (r=-0.59; $P<0.001$; n=85) and to the mean heart rate of the first 9-min of the test (r=-0.61; $P<0.001$; n=85).

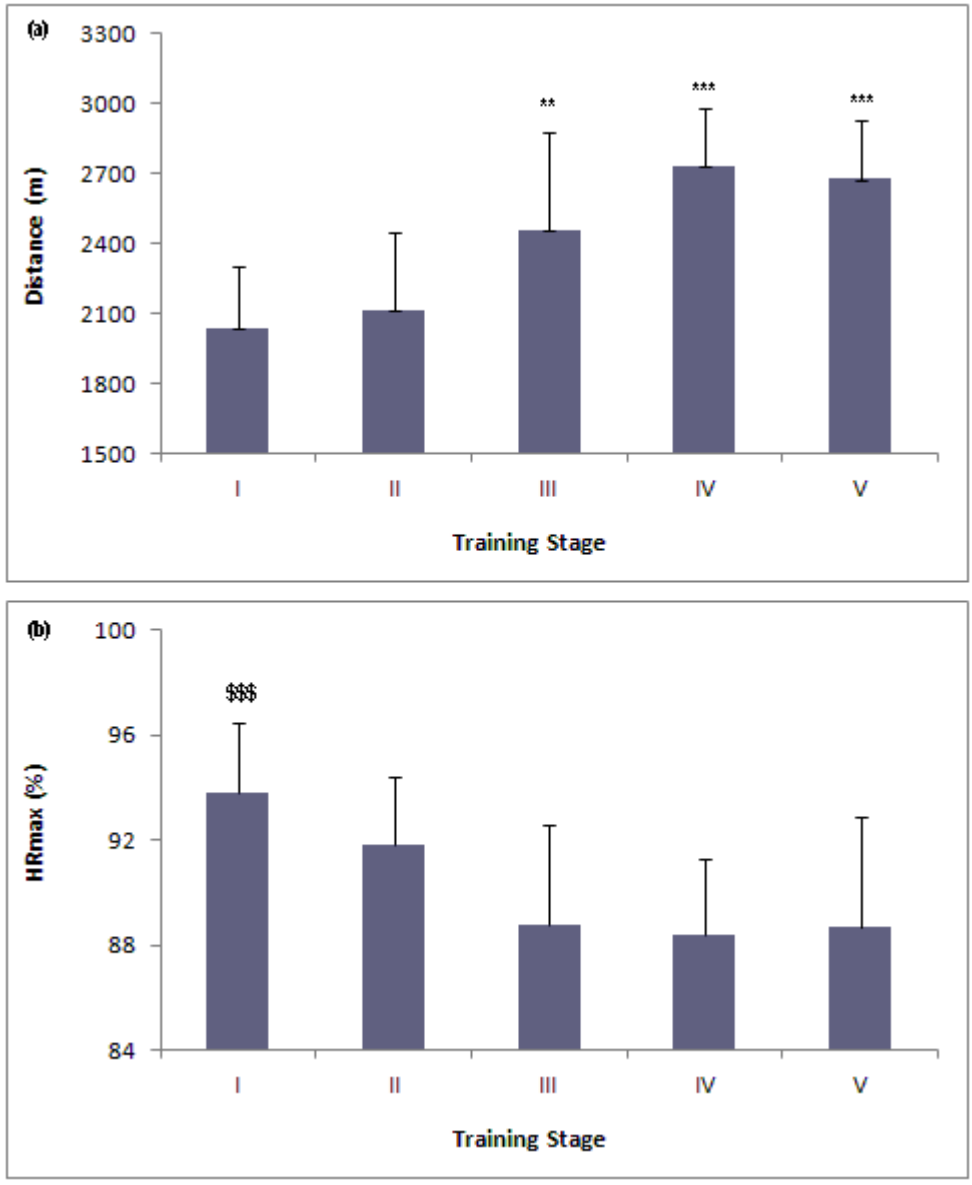

Figure 3. Seasonal changes in (a) Yo-yo intermittent recovery level-1 test performance and (b) Mean heart rate, expressed as % of maximal heart rate, after 9-min of the Yo-yo intermittent recovery test. **Significant difference ($P<0.01$) between training stage III and I and II. ***Significant difference ($P<0.001$) between training stage IV and V and I and II. $$$Significant difference ($P<0.001$) between training stage I and III, IV and V.

4. Discussion

This study has examined the incidence of block periodization on physical fitness over a competitive season in a professional soccer team. The season was divided into five training stages, where the physical capacities were developed following a block periodization model. Accumulation blocks were focused on high-intensity aerobic, Transmutation on speed endurance and Realization on speed training. This structure allowed the players to maintain the vertical jumping explosive force, 10-m sprinting and soccer-specific intermittent endurance performances during the entire season. Specifically, the best scores on the fitness tests were achieved during the last training stage. Altogether, the results of the study suggest that block periodization might be an alternative training design for soccer teams that are exposed to a long competition period.

The planning structure presented in this study is an alternative to the classical periodization models adopted in team sports. It has been unanimously accepted in the literature that soccer´s physical performance is related to the athlete´s ability to repeatedly perform intense exercise and that the amount of high-intensity exercise declines towards the end of the match (Bangsbo et al., 1991; Mohr et al., 2003). For this reason, every training stage commenced with an Accumulation block, dedicated to improve the capacity to perform long-duration high-intensity intermittent exercise. During this block, the players spent around 110-min per week exercising at intensities exceeding 85% of the individual HR_{max}, which could be considered as the average match-play heart rate intensity and close to a soccer player´s anaerobic threshold (Stolen et al., 2005). To our knowledge, there is little information regarding soccer heart rate monitoring over long training periods. Bangsbo et al. (2006) reported that Danish National team soccer players spent between 41-144 min per week exercising at intensities higher than 90% HR_{max} (128-300 min >80%HR_{max}) during the first part of the preparation period for the 2002 World Cup. These players carried out 9-11 sessions per week with an overall volume of 687-905-min, which are slightly higher values than the observed in the present study, probably due to the fact that in the current study the team played an official match every week during the competition period. The second of the blocks –Transmutation- was oriented to develop repeated sprint ability, where the rate of anaerobic energy turnover, through glycolysis, is high for short periods of time (Bangsbo et al., 2006). Therefore, special consideration should be paid to this kind of training during the competitive weeks as it can induce the players to a higher fatigue (Issurin, 2010) and eventually lead to a lower team performance in competition (Mallo, 2011). All the training stages concluded with a Realization block, focused on the improvement of speed. The overall training volume and intensity was lower than in the previous block in order to allow supercompensation from the previous physical workloads.

Mallo (2011) examined the effects of block periodization on team performance in competition and showed that the highest success was achieved when the games were played coinciding with the Realization blocks. However, the effects of this training organization on the physical fitness of the players throughout the season were not assessed. In the present study, the average results of the fitness tests were in the range of data previously reported for professional players: 42-47 cm in the CMJ and ASCMJ

tests, respectively, 1.78-s in the 10-m shuttle test and 2411-m in the yo-yo intermittent level-1 test (Cometti et al., 2001; Helgerud et al., 2001; Mohr et al., 2003; Arnason et al., 2004; Wisloff et al., 2004; Mujika et al., 2009). Interestingly, performance in all the tests peaked towards the end of the season, where the players presented a decreased sum of skinfolds, and indirectly a reduced body fat percentage, and reached the highest jumping height and fastest sprint times. In addition, the players covered a 26-30% greater distance at the end (last two training stages) than at the beginning (training stage II) of the competition period, suggesting that the ability to repeatedly perform intense exercise can be increased in the course of the season. Heart rate, expressed as a percentage of individual maximal values, obtained after the 6th minute and mean heart rate during the first 9-min of the test decreased during the season, representing an improved work efficiency. Furthermore, as performance in this test is closely related to match performance in soccer (Krustrup et al., 2003) it could be expected that the players would produce a higher amount of intense exercise during the final competitive matches of the season. Altogether, these data suggest that the use of undulating training workloads may be more effective than the classical linear stimulation of the physical capacities, which have been reported to led to minor changes, or even reductions, in physical fitness during the competition period in different team sports (Hakkinen, 1993; Schneider et al., 1998; Astorino et al., 2004; Kraemer et al., 2004; Gorostiaga et al., 2006). At the same time, as the training structure is cyclically repeated in the course of the season, injured or non-habitual players can be easily re-introduced into the schedule.

Finally, it is important to acknowledge the limitations of this kind of studies. The fact that the experimental design was carried out during a professional competitive season did not allowed to examine as many variables as it would have been desirable, neither establishing a control group to test the hypothesis. As performance in soccer is multi-factorial, complementary studies should be carried out to bridge the gap between the theory and practice of training periodization.

5. Conclusions

The findings of this study suggest that block periodization can be an alternative planning model for soccer. This training design allowed that the physical fitness of the players (vertical jumping explosive force, 10-m sprinting and soccer-specific intermittent endurance performances) were maintained, or even improved, during a 38-week competition period.

6. References

Arnason, A., Sigurdsson S.B., Gudmundsson, A., Holme, I., Engebretsen, L. and Bahr, R. (2004). Physical fitness, injuries and team performance in soccer. **Medicine and Science in Sports and Exercise**, 36, 278-285.

Astorino, T., Tam, P.A., Rietschel, J.C., Johnson, S.M. and Freedman, T.P. (2004). Changes in physical fitness parameters during a competitive field hockey season. **Journal of Strength and Conditioning Research**, 18, 850-854.

Bangsbo, J., Norregaard, L. and Thorsoe, F. (1991). Activity profile of competition soccer. **Canadian Journal of Sports Sciences**, 16, 110-116.

Bangsbo, J., Mohr, M. and Krustrup, P. (2006). Physical and metabolic demands of training and match-play in the elite football players. **Journal of Sports Sciences,** 24, 665-674.

Bangsbo, J., Iaia, M. and Krustrup, P. (2008). The yo-yo intermittent recovery test. A useful tool for evaluation of physical performance in intermittent sports. **Sports Medicine**, 38, 37-51.

Bondarchuk, A.P. (1988) Constructing a training system. **Track Technique**, 102, 254-269.

Bradley, P.S., Sheldon, W., Wooster, B., Olsen, P., Boanas, P. and Krustrup, P. (2009). High-intensity running in English FA Premier League soccer matches. **Journal of Sports Sciences**, 27, 159-168.

Breil, F.A, Weber, S.N., Koller, S., Hoppeler, H. and Vogt, M. (2010). Block training periodization in alpine skiing: effects of 11-day HIT on VO2max and performance. **European Journal of Applied Physiology**, 109, 1077-1086.

Cometti, G., Maffiuletti, N.A., Pousson, M., Chatard, J.C. and Maffulli, N. (2001). Isokinetic strength and anaerobic power of elite, subelite and amateur French soccer players. **International Journal of Sports Medicine**, 22, 45-51.

Drust, B., Reilly, T. and Cable, N.T. (2000). Physiological responses to laboratory-based soccer-specific intermittent and continuous exercise. *Journal* **of Sports Sciences**, 18, 895-892.

Dupont, G., Akapo, K. and Berthoin, S. (2004). The effect of in-season high-intensity interval training in soccer players. **Journal of Strength and Conditioning Research**, 18, 584-589.

Gamble, P. (2006). Periodization training for team sports athletes. **Strength and Conditioning Journal**, 28, 56-66.

Gorostiaga, E.M., Granados, C., Ibáñez, J., González-Badillo, J.J. and Izquierdo, M. (2006). Effects of an entire season on physical fitness changes in elite male handball players. **Medicine and Science in Sports and Exercise**, 38, 357-366.

Gorostiaga, E.M., Izquierdo, M., Ruesta, M., Iribarren, J., González-Badillo, J.J. and Ibáñez, J. (2004). Strength training effects on physical performance and serum hormones in young soccer players. **European Journal of Applied Physiology,** 91, 698-707.

Häkkinen, K. (1993). Changes in physical fitness profile in female volleyball players during the competitive season. **Journal of Sports Medicine and Physical Fitness**, 33, 223-232.

Helsen, W.F. and Bultynck, J.B. (2004). Physical and perceptual-cognitive demands of top-class refereeing in association football. **Journal of Sports Sciences**, 22, 179-189.

Helgerud, J., Engen, L.C., Wisloff, U. and Hoff, J. (2001). Aerobic endurance training improves soccer performance. **Medicine and Science in Sports and Exercise**, 33, 1925-1931.

Hoff, J. (2005). Training and testing physical capacities for elite soccer players. **Journal of Sports Sciences**, 23, 573-582.

Hoff, J., Wisloff, U., Engen, L.C., Kemi, O.J. and Helgerud, J. (2002). Soccer specific aerobic endurance training. **British Journal of Sports Medicine**, 36, 218-221.

Impellizzeri, F.M., Marcora, S.M., Castagna, C., Reilly, T., Sassi, A., Iaia, F.M. and Rampinini, E. (2006). Physiological and performance effects of generic versus specific aerobic training in soccer players. **International Journal of Sports Medicine**, 27, 483-492.

Issurin, V. (2008). Block periodization versus traditional training theory: a review. **Journal of Sports Medicine and Physical Fitness**, 48, 65-75.

Issurin, V. (2010). New horizons for the methodology and physiology of training periodization. **Sports Medicine**, 40, 189-206.

Issurin, V. and Kaverin, V. (1985). **Planning and design of annual preparation cycle in canoe-kayak paddling**. Moscow: Grebnoj Sport.

Kraemer, W.J., French, D.N., Paxton, N.J., Häkkinen, K., Volek, J.S., Sebastianelli, W.J., Putukian, M., Newton, R.U., Rubin, M.R., Gómez, A.l., Vescovi, J.D., Ratamess, N.A., Fleck, S.J., Lynch, J.M. and Knuttgen, H.G. (2004). Changes in exercise performance and hormonal concentrations over a big ten soccer season in starters and nonstarters. **Journal of Strength and Conditioning Research**, 18, 121-128.

Krustrup, P., Mohr, M., Amstrup, T., Rysgaard, T., Johansen, J., Steensberg, A., Pedersen, P.K. and Bangsbo, J. (2003). The yo-yo intermittent recovery test: Physiological response, reliability and validity. **Medicine and Science in Sports and Exercise**, 35, 697-705.

Mallo, J. (2011). Effect of block periodization on performance in competition in a soccer team during four consecutive competitive seasons: A case study. **International Journal of Performance Analysis in Sport**, 11, 476-485.

Mohr, M., Krustrup, P. and Bangsbo, J. (2003). Match performance of high-standard soccer players with special reference to development of fatigue. **Journal of Sports Sciences**, 21, 439-449.

Mújika, I., Santisteban, J., Impellizzeri, F.M. and Castagna, C. (2009). Fitness determinants of success in men´s and women´s football. **Journal of Sports Sciences**, 27, 107-114.

Reilly, T. (2005). An ergonomics model of the soccer training process. **Journal of Sports Sciences**, 23, 561-572.

Schneider, V., Arnold, B., Martin, K., Bell, D. and Crocker, P. (1998). Detraining effect in college football players during the competitive season. **Strength and Conditioning Journal,** 12, 42-45.

Stolen, T., Chamari, K., Castagna, C. and Wisloff, U. (2005). Physiology of soccer. An update. **Sports Medicine**, 35, 501-536.

Touretski, G. **Preparation of sprints events**. (1998). 1998 ASCTA Convention. Canberra: Australian Institute of Sport.

Wisloff, U., Castagna, C., Helgerud, J., Jones, R. and Hoff, J. (2004). Maximal squat strength is strongly correlated to sprint-performance and vertical jump height in elite soccer players. **British Journal of Sports Medicine**, 38, 285-288.

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