18. HIGH INTENSITY TRAINING

O-105 Physiological determinants of an intermittent football-specific high-intensity test

Carlo Castagna[1]✉, Juan Granda Vera[2], Stefano D'Ottavio[1] and Josè Carlos Barbero Álvarez[2]
[1] Corso di Laurea in Scienze Motorie, Facoltà di Medicina E Chirurgia, Università di Roma Tor Vergata, Roma, Italy, [2] Facultad de Educación Y Humanidades de Melilla, Departamento de Educación Física y Deportiva Universidad de Granada, Melilla, Spain.

OBJECTIVE In Football the ability to repeat bouts of high intensity exercise over prolonged period of time is considered to be an important component of performance (Barbero Álvarez et al., 2004). Recently a match-analysis derived test (Football Intermittent Endurance Test, FIET) has been introduced to assess specific-endurance in Football (Barbero Álvarez et al., 2005). However no research has been undertaken to evaluate the physiological demands of FIET. Information in this context may result useful for testing and training in football. The aim of this study was to examine the relationship between the FIET performance (distance covered) and aerobic-fitness parameters in Football-players.

METHODS Eighteen well trained Futsal players in the Spanish Futsal League (n=18, 20.6±3.1 years, weight 71.6±8.5 kg, height 175±7.9 cm), performed the FIET and a progressive continuous test (1 km h^{-1} min^{-1}speed increment until exhaustion) on a level-treadmill (TM) in random order.

RESULTS Treadmill and FIET physiological responses are given on Table 1. Significant correlations were detected between FIET performance and TM speeds at VO_2max and Ventilatory Threshold (VT, r=0.61 and 0.60, p< 0.01, respectively).

Table 1. Physiological responses observed during the FIET test. RE=VO_2 at 8 Kmh^{-1}; **=P<0.01.

Variable	Treadmill	FIET
VO_{2max} (mL kg^{-1} min^{-1})	65.1 (6.2)	61.6 (4.6) **
RE (mL kg^{-1} min^{-1})	35.6 (3.4)	
VT (mL kg^{-1} min^{-1})	45.2 (4.6)	
Peak Blood Lactate (mmol L^{-1})	12 (2.9)	12.6 (2.3)
HR_{max} (beat min^{-1})	193 (8)	191 (7)
RER	1.15 (0.01)	1.14 (0.01)
Ventilation (L min^{-1})	162 (16)	177 (25**)

DISCUSSION The results of this study showed that FIET is an intermittent high intensity test that heavily taxes aerobic power and anaerobic capacity in futsal players. Being the physiological demands imposed to Futsal players in crucial moment of the game FIET may be considered as an endurance specific test in Futsal. Direct validity needs to be assessed with sound match analysis.

REFERENCES
Barbero Alvarez et al. (2004) *Jounal of Sports Sciences* **22**, 500-501.
Barbero Alvaréz, et al. (2005) *Journal of Sports Sciences* **23** 11-12.

KEY WORDS 5-a-side soccer, physiology, high-intensity exercise, intermittent exercise, field testing.

O-106 Strength training for young soccer players

Massimo Venturelli[1,2]✉, Fabio Trentin[2] and Massimo Bucci[2]
[1] Università Degli Studi di Verona Facoltà di Scienze Motorie, [2] Ac Chievo Verona.

OBJECTIVE During a soccer match, the most interesting actions are represented by high intensity work, such as sprints, jumps and shots. A significant relationship has been observed between 1RM and acceleration, jump test and 30 m sprint results and a variety of training methods are used to increase strength and power, in sports demanding explosive force development (Bangsbo et al., 1988; De Proft et al., 1988; Wisløff et al., 2004; Diallo, et al., 2001). Knowledge concerning the strength training methods for young soccer players was scarcely documented to show if different methods induced diverse results. Many authors empathize the importance of strength for soccer players (Hoff, et al., 2004; Cometti, et al., 1988; Gauffin, et al., 1989), but we never find a similar training approach, any studies had showed if a different strength straining methods induced diverse results. The aim of these study was to evaluate witch are the best strength straining methods for young soccer players and analyze the differences in 1RM, 20 m sprint, jump, after 8 weeks of training conduced in 3 different methods: GrA=incremental overloads, GrB=free weight, GrC=combined overloads and free weight.

METHODS 21 elite soccer players, selected form team Chievo Verona, mean age 17,6 ± 0,4 was randomly assigned to GrA=7 or GrB=7 otherwise in GrC=7. GrA training was based on incremental exercise by leg press, leg extension at 60-90% 1RM-12 to 4 rep. GrB training was based on 8-10 series of plyometric training, jumps and 20m sprint on steep street. GrC training was based on exercise by leg press, leg extension, jumps and 20m sprint on steep street. One way ANOVA & t-test was used to examine differences from groups and training effect.

RESULTS GrA = SJ+2% ($p>.05$), CMSJ+3% ($p>.05$), 1RM+30% ($p<.05$), 20mSprint+3% ($p<.05$).. GrB = SJ+4% ($p>.05$), CMSJ+6% ($p>.05$), 1RM+5% ($p>.05$), 20mSprint+3% ($p>.05$). GrC = SJ+18% ($p<.05$), CMSJ+13% ($p<.05$), 1RM+37% ($p<.05$), 20mSprint+3% ($p<.05$). The diverse training induced no statistical differences in 20m sprint result ($F=0.08$; $p=.949$). In SJ and CMSJ tests there was significant differences from GrC Vs GrA & GrB ($F=10.9$; $p=.001$) & ($F=4.3$; $p=.029$). In 1RM GrA and GrC saw a statistical differences to GrB ($F=5.79$; $p=.011$).

Table 1: Data is represented as mean and standard deviations after and before training

		SQUAT JUMP (cm)	COUNTER MOVE-MENT JUMP (cm)	1RM LEG PRESS (kg)	Sprint 20 m (sec)
GrA	PRE	36.3 (2.2)	37.8 (2.5)	281.5 (38.5)	3.05 (0.2)
	POST	36.9 (2.5)	38.9 (2.7)	366.4 (59.7) *	2.97 (0.2) *
GrB	PRE	37.1 (2.1)	38.6 (3.3)	296.5 (56.1)	2.64 (0.1)
	POST	38.6 (2.2)	41.1 (2.1)	312.3 (76.3)	2.56 (0.1) *
GrC	PRE	36.7 (2.2)	38.6 (2.1)	224.2 (52.6)	3.03 (0.1)
	POST	43.2 (3.4) *§	43.8 (3.8)*§	307.1 (60.5) *	2.94 (0.2) *

* = Simple Student t-test, $p<.05$ Pre Vs Post within group.
§ = One Way Anova, $p< 0.05$ and post hoc multiple comparisons Scheffe test.

DISCUSSION The results of this study suggested that a 8 weeks of combined training based on exercise by leg press, leg extension at 80% 1RM, 4-6 series of jumps and sprints on steep street, improved squat jump, counter movement squat jump, 1RM and 20m sprint tests. For young elite soccer players these training seem to be better than free weight training and incremental overload training in gym. These results are diverse from precedents studies (Hoff, et al., 2004; Hoffman, et al., 2005; Whitney, et al., 2005; Wisløff, et al., 1998) and underline that for young soccer players is better a multilateral training for improving strength. The differences among the training are probably induced by the bigger muscle recruitment on the combined training. A combination of general and specific resistance-training methods can be recommended to develop the neuromuscular factors contributing to sports skills requiring strength and power (Kotzamanidis, et al., 2005).

REFERENCES

Bangsbo et al. (1988) *Canadian Journal of Sport Science* **16**, 110–116.
Cometti (1988) La Pliométrie, Compte-Rendu Du Colloqui De Février. A L'ufr Staps De Dijon, Ed Università De Bourgogne.
De Proft et al. (1988) *Science and Football*. London: Spon. 108-13.
Diallo et al. (2001) *Journal of Sports and Medical Physiology & Fitness* **41**, 342-8.
Gauffin et al. (1989) *Journal of Human Moviment Studies* **16**, 159-76.
Hoff et al. (2004) *Sports Medicine* **34**, 165-180.
Hoffman et al. (2005) *The Journal of Strength and Conditioning Research* **19**, 810–815.
Kotzamanidis et al. (2005) *The Journal of Strength and Conditioning Research* **19**, 369–375.
Wisløff et al. (2004) *British Journal of Sports Medicine* **8**, 285-8.
Whitney et al. (2005) *The Journal of Strength and Conditioning Research* **19**, 791–798.

KEY WORDS Combined training, strength, young soccer players.

O-107 Intensity of four types of elite soccer training sessions

Matheus Fontes [1], Lucas Mortimer[1], Luciano Condessa[1], Alessandra Garcia[2], Leszek Szmuchrowski[1] and Emerson Garcia[1] ✉
[1]Universidade Federal de Minas Gerais, [2]Centro Universitário de Belo Horizonte - Uni-BH.

OBJECTIVE Several researchers have been studying the physiology of soccer. However, most studies have focused on official and friendly games and few have analyzed the intensity of training sessions. Specific soccer training has been used to train technical and tactical aspects of soccer. Nevertheless, these kinds of training also impose a significant workload on the cardiovascular and metabolic systems.

METHODS The participants were 10 professional players of a first division Brazilian Soccer club. Heart Rate (HR) was monitored during three of each type of training sessions: technical drills (TEC), tactical drills (TAC), modified games (MG) and practice games (PG). HRmax was determined during a field test (3x600m increasing intensity). The 4mM (Heck et al., 1985) anaerobic threshold (AT), was determined by linear interpolation. Comparisons were made using a one-way ANOVA and the differences were identified through Tukey's post-hoc. The significance level was set at $p<0.05$.

RESULTS The players had a mean HRmax of 192 ± 11 bpm and mean AT of 176 ± 10 bpm (91.7 ± 1.4 %HRmax). The TEC was significantly less intense than TAC, MG and PG (Table 1). No differences were found between TAC, RFG and FG.

Table 1. Intensity of the four types of training analyzed expressed as mean (SD).

	Technical		Tactical		Modified Game		Practice Game	
%HR_{max}	71.1	(4.5)*	78.5	(4.4)	77.7	(5.5)	79.6	(3.2)
%AT	77.6	(5.1)*	85.7	(5.2)	84.8	(6.1)	86.9	(4.4)

* $P < 0.05$.

DISCUSSION This study showed that the TEC had a lower intensity when compared to the other types of training sessions. This result corroborates with the findings of Eniseler (2005). We speculated that the MG would have a higher intensity than the other types of training sessions analyzed. However, even though the field size was reduced, increasing the contact with the ball, the intensity may have been lower because the number of high intensity activities were reduced.

REFERENCES

Eniseler (2005) *J Str Cond Res* **19,** 799-804
Heck et al, (1985) *Int J Sports Med* **61**, 219-24

KEY WORDS Soccer, anaerobic threshold, heart rate, intensity.

O-108 Improving repeated-sprint ability

David Bishop
School of Human Movement and Exercise Science, and Fremantle Football Club.

OBJECTIVE High-intensity sprints of short duration, interspersed with short recoveries, are common during most team sports 1. Therefore, the ability to recover and to reproduce a high power output in subsequent sprints is an important fitness requirement of team-sport athletes and has been termed repeated-sprint ability (RSA). However, little is known about what limits RSA and how best to improve RSA. The aim of this study was to analyze recent research that have developed methods to improve RSA..

METHODS While the recovery of 30-s sprint performance has been correlated with PCr resynthesis 3, we have not found the same relationship with the recovery of 4-s sprint performance (r=0.24). If PCr resynthesis is important for RSA, it is important to know how to improve PCr resynthesis. A cross-sectional research suggested that an elevated aerobic fitness was associated with faster PCr resynthesis.

RESULTS However, a 20% increase in aerobic fitness with training was not accompanied by an increase in PCr resynthesis rate. A decrease in muscle pH (pH) may also be an important limiting factor to the performance of repeated-sprint exercise 5,6. The extent of the decrease in pH during muscular activity is dependent upon both the production of hydrogen ions (H+) and on muscle buffer capacity (ßm).

DISCUSSION It appears that high-intensity training is required to increase ßm. However, our research suggests that training too intensely could actually decrease ßm. While further research is required, it appears that the optimal intensity to improve ßm is approximately 100% VO2max. Furthermore, despite similar changes in aerobic fitness, training also increases ßm greater than changes in RSA.

KEY WORDS Repeated-sprint ability, phosphocreatine, muscle buffer capacity.

O-109 Ground reaction force of a drop jump on different kinds of artificial turf

Rudy Verhelst⌧, Philippe Malcolm, Patricia Verleysen, Joris Degrieck, Dirk De Clercq and Renaat Philippaerts
Ghent University, Belgium

OBJECTIVE Recently third generation artificial turf has started to find acceptance in soccer. Several types of infill have been developed, aiming at minimising injury rates and enhancing performance. In the past, playing surfaces were mostly tested by means of mechanical tests. Currently biomechanical tests with actual players have become more popular because they provide better external validity (Meijer, 2006). The aim of this study was to compare the effect of different surfaces on the external forces when performing a 50cm drop from a platform immediately followed by a maximal vertical jump (Durá, 1999)(similar to jumping for a header). A testing rig that could be equipped with different surfaces was developed. Several relevant parameters were selected for statistical comparison of these surfaces.

METHODS 7 male recreational football players (shoe size EUR 44, weight 71.9±6.7kg, height 1.79±0.16m, age 26.0±1.8 years) performed 5 drop jumps on 2 artificial turf surfaces (Desso DD Challenge Pro), one with 3cm SBR rubber infill, and one with 3cm TPE infill. Force data were recorded with a Kistler force plate at 1000Hz. Statistical analysis was done with SPSS 12.0.

RESULTS From the force data, several parameters were obtained (Table 1). Most parameters showed good repeatability (ICC>.70). Nonparametric Wilcoxon tests revealed no significant differences between the surfaces for any of the parameters although there was a trend towards significantly higher maximal and average load rates in the force peak of the second impact on the TPE infill surface.

Table 1 Analysed parameters for the drop jump on artificial turf with TPE and SBR infill.

	TPE infill		**SBR infill**		**Correlation r (ICC)**		
	Mean	SD	Mean	SD	TPE infill	SBR infill	p-value
flight time [s]	0.497	(0.032)	0.499	(0.037)	0,955	0,954	**1,000**
load time 1 [s]	0.056	(0.007)	0.054	(.011)	0,858	0,798	**0,735**
load time 2 [s]	0.058	(0.010)	0.062	(.007)	**0,686**	0,733	**0,128**
contact time [s]	0.484	(0.187)	0.5	(.169)	0,992	0,990	**0,310**
max load 1 [N]	2873	(887)	2724	(628)	0,857	0,756	**0,866**
max load 2 [N]	4067	(1186)	3976	(1216)	0,771	0,903	**0,398**
max LR Fz peak 1 [N/s]	166133	(85249)	121850	(29661)	0,807	0,797	**0,237**
av LR Fz peak 1 [N/s]	59326	(25085)	54111	(15901)	0,911	0,731	**0,398**
max LR Fz peak 2 [N/s]	319203	(145676)	271608	(127299)	0,716	0,775	**0,091**
av LR Fz peak 2 [N/s]	80239	(33683)	70335	(24804)	0,734	0,859	**0,091**
active impulse Fz [Ns]	351	(20)	359	(32)	**0,636**	0,969	**0,612**

DISCUSSION The high repeatability shows that the presented experimental setup was a good alternative for material tests. Further tests with more subjects and probably also other soccer specific movements are required in order to examine whether TPE infill really leads to a higher risk for overload injuries or not.

REFERENCES
Meijer et al., (2006) *The engineering of sport* **6,** 29-34.
Durá et al., (1999) *Sports engineering* **2,** 103-108.

KEY WORDS Artificial turf, soccer, shock absorption, jump

O-110 Possibilities of evaluating complex training load influence in junior soccer players

Katrin Kaarna✉ and Ants Nurmekivi
Institute of Sport Pedagogy and Coaching Science, University of Tartu, Estonia

OBJECTIVE Soccer imposes demands on aerobic and anaerobic systems (Reilly, 1999). The assessment of player's aerobic performance could be of interest for coaches in order to evaluate and programme their training. Aerobic capacity can be developed by exercises with or without a ball. A widespread exercise with a ball is small game 3v3, 4v4 etc. (Balsom, 1998). It is important to vary training loads in youth training. According to this the aim of the study was to provide a comparative evaluation of the effect of complex training (game + running load + game) on player's aerobic capacity and establish connections between objective (HR, BLA) and subjective (PE, PRR) criteria in evaluating the effect of different loads.

METHODS The subjects were 20 male soccer players. The test consisted of an 8-min game 4vs4, an 8-min running load and game of 8-min. HR was measured with Polar sport tester (Finland). BLA samples were obtained after loads and analysed with Lactate analyser (Japan). For evaluating the PE after loads the Borg CR 10 scale was applied. PRR Scale (Karu et al., 2000) was used to obtain readiness ratings for next load.

RESULTS Mean HR values after 1st game and running were similar and on anaerobic threshold level. Whereas, mean BLA concentrations after 1st game and running, differed significantly (7.0±2.9 and 5.0±2.1mmol•l^{-1}; $p<0.05$) (Table 1). Higher BLA concentrations after 1st game and running imposed readiness for the next load ($r=-0.71$ and -0.85; $p<0.05$).

Table 1. Measures of some physical parameters for junior soccer players.

	1^{st} small game	Running load	2^{nd} small game
Mean HR (beats·min^{-1}) after exercise	176.6 (11.4)	177.3 (10.0)	180.0 (11.1)
Mean BLA concentration (mmol·l^{-1}) after exercise	7.0 (2.9)	5.0 (2.1)	5.4 (2.4)
Perceived exertion ratings	3.4 (1.1)	3.7 (1.6)	3.8 (1.3)
Perceived readiness ratings	4.1 (0.3)	4.2 (0.6)	3.9 (0.5)

DISCUSSION In almost the same HR the metabolic reaction to the loads differed significantly. So, to proceed only from HR metabolic shifts in organism may be underestimated. So, using complex objective (HR, BLA) and subjective (PE, PRR) markers to evaluate the loads the changes in the organism of players could be specified and the development of their aerobic endurance could be managed better.

REFERENCES
Balsom (1998) Kunnon jalkapallokirja, Suomen Palloliitto, Jyväskylä.
Karu et al, (2000) *J Med Sci Sports* ***1*0**, 33-36.
Reilly (1999) *Science and Football*. A. Kin. Univ. Tartuensis **4,** 7-26.

KEY WORDS Heart rate, blood lactate, perceived exertion, perceived readiness ratings, complex training load.