World Congress of Performance Analysis of Sport IX

25 - 28 July 2012
Worcester ENGLAND
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Programme & e-Book of Abstracts

World Congress of Performance Analysis of Sport IX

25th – 28th July 2012, University of Worcester, UK

Edited by Prof. Derek M. Peters & Dr. Peter G. O'Donoghue

Programme

0900 – 1400 **Congress Registration** (Reception St John's Campus, Henwick Grove)

1400 – 1430 **Congress Opening** (EEG089 Yelland Lecture Theatre)

1430 – 1530 **Keynote Speaker** (EEG089 Yelland Lecture Theatre, Chair: Peter O'Donoghue)
Dr Tony Kirkbride: Media channels for performance analysis (sponsored by ISPAS)

1530 – 1615 Exhibition & Refreshments (The Pear Tree)

1615 – 1815 **Poster Session 1:** (MPC, Thomas Telford Building)
POST 1.1 Soccer
POST 1.2 Team Sports
POST 1.3 Performance Analysis & Coaching
POST 1.4 Systems
POST 1.5 Sport Science & Medicine

1930 **Welcome reception** (The Riverside Building, Hylton Road)

Thursday 26th July 2012

0900 – 1000 **Keynote Speaker** (EEG089 Yelland Lecture Theatre, Chair: Derek Peters)
Dr Vicky Tolfrey: The role of performance analysis during wheelchair games play to help inform individualised training strategies

1000 – 1045 Exhibition & Refreshments (The Pear Tree)

1045 – 1245 **Podium Sessions**
Session 1: Basketball (EEG089 Yelland Lecture Theatre)
Session 2: Performance Analysis & Coaching (EEG087 Urwin Lecture Theatre)
Session 3: Team Sports 1 (EE1057)
Session 4: Sport Science & Medicine (EE1061)

1245 – 1345 Lunch

1345 – 1445 **Keynote Speaker** (EEG089 Yelland Lecture Theatre, Chair: Peter O'Donoghue)
Prof. Brian Dawson: Movement patterns in team sports: How to they relate to performance? (sponsored by ISPAS)

1445 – 1530 Exhibition & Refreshments (The Pear Tree)

1530 – 1730 **Podium Sessions**
Session 5: Soccer 1 (EEG089 Yelland Lecture Theatre)
Session 6: Movement Analysis (EEG087 Urwin Lecture Theatre)
Session 7: Racket Sports (EE1057)
Session 8: Handball (EE1061)

1730 – 1830 **ISPAS AGM** (EEG089 Yelland Lecture Theatre)

1930 Free evening

Friday 27th July 2012

0900 – 1000 **Keynote Speaker** (EEG089 Yelland Lecture Theatre, Chair: Peter O'Donoghue)
Dr Barry Drust & Andy Scoulding: Performance analysis in elite soccer – English FA Premier League

1000 – 1045 Exhibition & Refreshments (The Pear Tree)

1045 – 1245 **Podium Sessions**
Session 9:   Soccer 2 (EEG089 Yelland Lecture Theatre)
Session 10: Team Sports 2 (EEG087 Urwin Lecture Theatre)
Session 11: Combat Sports (EE1057)
Session 12: Systems (EE1061)

1245 – 1345 Lunch

1345 – 1445 **Keynote Speaker** (EEG089 Yelland Lecture Theatre, Chair: Peter O'Donoghue)
Dr Wynford Leyshon: Performance analysis in the management of high performance sport – international 400m hurdles

1445 – 1530 Exhibition & Refreshments (The Pear Tree)

1530 – 1730 **Podium Sessions**
Session 13: Soccer 3 (EEG089 Yelland Lecture Theatre)
Session 14: Individual Sports (EEG087 Urwin Lecture Theatre)
Session 15: Rugby (EE1057)
Session 16: Equestrian (EE1061)

1900 **Coach pickups at City Campus & St John's Campus for Congress Dinner**

Saturday 28th July 2012

0900 – 1100 **Poster Session 2:** (MPC, Thomas Telford Building)
POST 2.1 Soccer
POST 2.2 Team Sports
POST 2.3 Individual & Racket Sports
POST 2.4 Sport Performance Psychology
POST 2.5 Sport Science & Medicine

1100 – 1145 Exhibition & Refreshments (The Pear Tree)

1145 – 1245 **Keynote Speaker** (EEG089 Yelland Lecture Theatre, Chair: Peter O'Donoghue)
Prof. Jaime Sampaio: Performance analysis in basketball. (Sponsored by ISPAS)

1245 – 1330 **Congress Awards & Close** (EEG089 Yelland Lecture Theatre)

POST 1.1 SOCCER: (CHAIRS – Ricardo Duarte & Nic James)

POST 1.1.1 **Relative number of outfield players as a constraint on coordination dynamics in futsal**
Bruno Travassos, Luís Vilar, Duarte Araújo & Tim McGarry (Portugal & Canada)

POST 1.1.2 **Small sided games in football with university female players**
Sandra Esteves, Luis Vaz, Nuno Leite, Bruno Gonçalves & Victor Maças (Portugal)

POST 1.1.3 **Do action variables represent success in English Championship Football?**
Gethin Rees, Nic James, Joe Taylor & Goran Vučković (UK & Slovenia)

POST 1.1.4 **Effect of small-sided games on the physical performance of young football players of different ages and levels of practice**
Luís Barnabé, Anna Volossovitch & António Paulo Ferreira (Portugal)

POST 1.1.5 **The influence of manipulating the defensive playing method on team synchrony in association football**
Ricardo Duarte, Bruno Travassos, Duarte Araújo & Michael Richardson (Portugal & USA)

POST 1.2 TEAM SPORTS: (CHAIRS – Ricardo Duarte & Nic James)

POST 1.2.1 **Match analysis and a comparison between winning and losing teams in men's elite level goalball**
Henri Lehto, Mikko Häyrinen, Timo Laitinen & Kevin Collet (Finland)

POST 1.2.2 **Determinants related to the attack tempo in high level male volleyball**
Rui Araújo, Cícero Moraes, Patrícia Coutinho & Isabel Mesquita (Portugal & Brazil)

POST 1.2.3 **Proportion and efficiency of different serve techniques in relation to winning in elite female volleyball**
Mikko Häyrinen, Virpi Inkinen, Tuomas Mikkola & Vesa Linnamo (*Finland)*

POST 1.2.4 **The influence of the area of attack on point success in men's professional beach volleyball**
Jose Manuel Jimenez Olmedo, Alfonso Penichet Tomás, Maria del Mar Silvestre Garcia, Juan José Chinchilla Mira, José Antonio Pérez Turpín, & Concepción Suarez Llorca, (Spain)

POST 1.2.5 **Sporting activities of volleyball players throughout the developmental stages according to competitive level and gender**
Patrícia Coutinho, Rui Araújo & Isabel Mesquita (Portugal)

POST 1.2.6 **Determinants of success in Twenty20 cricket**
Michael Najdan & Matt T. Robins (UK)

POST 1.2.7 **Performance analysis of decision making in team sports**
Megan Lorains, Kevin Ball & Clare MacMahon (Australia)

POST 1.2.8 **The structure of intensity of play in ice hockey**
Tomasz Gabryś, Urszula Szmatlan-Gabrys, Arkadiusz Stanula & Michal Garnys (Poland)

POST 1.2.9 **Notational analysis of three matches from the 'Women's Team Handball European 2010 Qualification Round'**
Manraj S. Sucha & David C. Pears (UK)

POST 1.2.10 **A scoring system for pertinent actions in rugby union**
Edward Burt & Mike Hughes (UK)

POST 1.2.11 **An investigation into clean and un-clean scrums in the 2011 Rugby World Cup**
Stuart Ware & James W. Brouner (UK)

POST 1.2.12 **Scoring profiles in the 2009 RBS Six Nations rugby union championship**
Luis Vaz & Wilbur J. Kraak (Portugal & South Africa)

POST 1.2.13 **Game analysis comparing the final top nations with the others in the 2011 Rugby World Cup**
Kazunari Hayasaka, Yuichi Ueno, Koh Sasaki & Takumi Yamamoto (Japan)

POST 1.3 PERFORMANCE ANALYSIS & COACHING: (CHAIRS – Ricardo Duarte & Nic James)

POST 1.3.1 **Temporal aspects of coach behaviour**
Laura Harry & Peter O'Donoghue (UK)

POST 1.3.2 **Pedagogical supervision in swimming: The influence of retrospective reflection in technical behaviours of coaches' performances**
Samuel Honório & Marco Batista (Portugal)

POST 1.3.3 **Behaviour of academy soccer coaches during training sessions**
Ceri Bowley, Wes Bodden & Peter O'Donoghue (UK)

POST 1.3.4 **The art of sports officiating: Learning how to referee rugby union**
Christopher Baldwin (Australia)

POST 1.3.5 **Path to excellence: A case study with an elite basketball player**
Américo Santos, Amândio Graça & Fernando Tavares (Portugal)

POST 1.3.6 **Functional advantages of informatization for realization of Olympic education**
Pityn Maryan & Briskin Yuriy (Ukraine)

POST 1.4 SYSTEMS: (CHAIRS – Peter O'Donoghue & Arnold Baca)

POST 1.4.1 **Use of barcode scanning for notational analysis**
Donald B. Buchanan, David P. Cook & P. John Seeley (UK)

POST 1.4.2 **An analysis of navigation patterns in rowing**
Alessandro Pezzoli, Antonio Baldacci, Alda Cama, Marcello Faina, Dario Dalla Vedova, Maurizio Besi, Giuseppe Vercelli, Andrea Boscolo, Marco Dalessandro & Elena Cristofori (Italy)

POST 1.4.3 **Predicting sports results using regression and neural models**
Adam Maszczyk, Arkadiusz Stanula, Adam Zając & Robert Roczniok (Poland)

POST 1.4.4 **Comparing results of biomechanical analyses of raw data determined using AutoCAD software with those determined by AutoMatlab software for a number of athletic performances**
Abi R. Al-bakri & Saadallah A. Rashid (Iraq)

POST 1.4.5 **The use of taxonomic tools to analyse national team ice hockey game play**
Robert Roczniok, Adam Maszczyk, Arkadiusz Stanula, Przemysław Pietraszewski & Miłosz Czuba (Poland)

POST 1.4.6 **Feedback technology in performance analysis**
Lucy A. Holmes (UK)

POST 1.4.7 **Analysis of the factors of yield in professional basketball applied to an ACB equipment**
Marcelo Alejandro Jove Tossi, Maria del Mar Silvestre García, Alfonso Penichet Tomás, Jose Manuel Jimenez Olmedo, Eliseo Cabrera Andreu, Concepción Suarez Llorca, Federico Carreres Ponsoda, Carbonell Martínez & Antonio Jose (Spain)

POST 1.4.8 **Using kinematic measures to predict post flight time in the women's artistic gymnastics straight twisting Yurchenko vault**
Rebecca Edginton (UK)

POST 1.4.9 **Non-linear methods to analyze variability of indoor pedaling kinematics**
Juan-Carlos Quintana-Duque (Germany)

POST 1.4.10 **The accuracy of judging compared with objective computerised analysis in trampolining**
Polly E. Johns & James W. Brouner (UK)

POST 1.5 SPORT SCIENCE & MEDICINE: (CHAIRS – Peter O'Donoghue & Arnold Baca)

POST 1.5.1 **A comparison of lower limb strength and static balance in elite gymnasts and wrestlers with non-athletes**
M. Reza Bahadoran, Yasser Ghasemzadeh & Tayebeh Soleimani (Iran)

POST 1.5.2 **The relationships between physical readiness and cardiovascular risk factors**
Marjeta Mišigoj-Duraković, Daniel Bok, Dražan Dizdar, Zijad Duraković, Maroje Sorić, Igor Jukić & Dario Matika (Croatia)

POST 1.5.3 **Biological markers in the pre-competition and competition phases of triathlon**
Blanca R. Rangel-Colmenero, Germán Hernández-Cruz, Fernando A. Ochoa-Ahmed, Adrián Rosas-Taraco, Hugo Zuazua-Aguirre & Oscar Salas-Fraire (México)

POST 1.5.4 **Effect of aging on lung function induced by regular physical activity**
Sridip Chatterjee & Sudip Sundar Das (India)

POST 1.5.5 **Oral contraceptive cycle phase has no effect on fuel oxidation during prolonged exercise in female recreational endurance-trained rowers**
Sille Vaiksaar, Jaak Jürimäe, Jarek Mäestu, Priit Purge & Toivo Jürimäe (Estonia)

POST 1.5.6 **The effect of corrective training on control and correction of tend to head to front in Islamic azad university Dezful branch personnel**
Saeed Tanoorsaz, Lora Chapari, Gholamreza Zourmand & Sara Shamshiri (Iran)

POST 1.5.7 **A retrospective study of injuries in elite women windsurfers**
Alfonso Penichet Tomás, Jose Manuel Jimenez Olmedo, Maria del Mar Silvestre García, Juan José Chinchilla Mira, José Antonio Pérez Turpín, Concepción Suarez Llorca & Eliseo Andreu Cabrera (Spain)

POST 1.5.8 **Training based on testing results: Implications for performance and injury prevention**
Alexandra Mihaela Rusu, Adrian Nagel, Claudiu Avram & Bogdan Almajan-Guta (Romania)

POST 1.5.9 **Analysis of the peak performance age in track and field**
Radek Vobr (Czech Republic)

POST 1.5.10 **Physical ability tests for pregnant women participating in adapted gymnastics**
Irina Nesheva & Emilia Pavlova (Bulgaria)

POST 1.5.11 **The height of female Brazilian beach volleyball players in relation to specialization and court dimensions**
Alexandre Medeiros , George Giatsis , José Manuel Palao, José Afonso, Roberto Lopes & Isabel Mesquita (Portugal, Greece, Spain & Brazil)

<u>**PODIUM SESSION 1: BASKETBALL**</u> (EEG089 YELLAND LECTURE THEATRE)
(CHAIR – Anna Vollosovitch)

POD 1.1 **Comparing critical and normal match episodes in different competitive contexts of the basketball game**
António Paulo Ferreira, Sandro Didier & Anna Volossovitch (Portugal)

POD 1.2 **Competitiveness and uncertainty in the NBA and ACB professional basketball leagues**
Yves de Saá Guerra, Juan Manuel Martín González & Juan Manuel García-Manso (Spain)

POD 1.3 **An analysis of collective performance in Olympic basketball.**
Mariano Latorre Bragion & Dante De Rose Jr. (Brazil)

POD 1.4 **The effect of age on the diversity and efficiency of space creation dynamics and cooperation rates in basketball teams**
Dante De Rose Jr., Leonardo Lamas, Eduardo Rostaiser, Felipe Santana, Valmor Tricoli & Carlos Ugrinowitsch (Brazil)

POD 1.5 **Basketball shooting performance and attentional strategies as a function of induced myopic blur**
Sophie E. Lanham & Matt T. Robins (UK)

POD 1.6 **How a basketball game works: the score.**
Yves de Saá Guerra, Juan Manuel Martín González & Juan Manuel García-Manso (Spain)

<u>**PODIUM SESSION 2: PERFORMANCE ANALYSIS & COACHING**</u> (EEG087 URWIN LECTURE THEATRE)
(CHAIR – Peter O'Donoghue)

POD 2.1 **The use of experience as a performance analyst to aid self-regulated coach development**
William J. Shaw & Graham Turner (UK)

POD 2.2 **Coach behavioral analysis within elite youth football**
Paul Worsfold (UK)

POD 2.3 *Soccer match analysis – A qualitative study with first Portuguese League coaches*
Hugo Sarmento, Antonino Pereira, Jorge Campaniço, Maria Teresa Anguera & José Leitão (Portugal & Spain)

POD 2.4 **Performance analysis in professional football: Player & coach perspectives**
Rob Mackenzie & Chris Cushion (UK)

POD 2.5 **The evaluation of goalkeeping performance analysis support used in senior professional and elite level youth football: An applied perspective**
Andy Elleray & Gareth Jones (UK)

POD 2.6 **The changing role of the performance analyst within a varying competition structure: A comparison of Superleague and International netball competitions**
Sara Horne (UK)

PODIUM SESSION 3: TEAM SPORTS 1 (ROOM EE1057)
(CHAIR – Brian Dawson)

POD 3.1 **From movement patterns to performance analysis tool: A simulated cricket batting innings for testing and training**
Laurence Houghton, Brian Dawson & Jonas Rubenson (Australia)

POD 3.2 **"But I don't get to touch the ball!"…To what extent does a modified netball game (MNG) influence the development of movement skills for 8-10 year olds playing netball?**
Kirsten Spencer (New Zealand)

POD 3.3 **Game movement demands and player performance in the Australian Football League**
Daniel Hiscock, Brian Dawson, Jarryd Heasman & Peter Peeling (Australia)

POD 3.4 **Discriminant power in game-related statistics and game result according to setter position in the 2010 World Volleyball Championship**
Paulo Vicente João, Miguel Silva, Daniel Lacerda & Luis Vaz (Portugal)

POD 3.5 **Defensive strategy and critical match episodes in basketball game: analysing the teams' success**
António Paulo Ferreira, Sandro Didier & Anna Volossovitch (Portugal)

POD 3.6 **The luck of the score: Partition of variance for performance analysis of team sports**
Darren O'Shaughnessy (Australia)

PODIUM SESSION 4: SPORT SCIENCE & MEDICINE (ROOM EE1061)
(CHAIR – Paul Canavan)

POD 4.1 **Monitoring training fatigue with the orthostatic heart rate test during 9 weeks of intensified training in biathletes**
Candice E. Thomas, Laura Karavirta, Hannu Kinnunen & Stewart J. Laing (UK & Finland)

POD 4.2 **The impact of side dominance on hamstring and quadriceps strength in junior footballers**
Michal Lehnert, Josef Urban, Pavel Hap & Jiri Prochazka (Czech Republic)

POD 4.3 **Analysis of the combinations of movements (failure locus) that cause anterior cruciate ligament injury: Implications for prevention**
Paul K. Canavan, Alexander Orsi, Andrew Homyk, Story Wibby, Nicholas Yang & Hamid Nayeb-Hashemi (USA)

POD 4.4 **The effects of temperature, travel and time off on Major League soccer team performance**
Andrew Opatkiewicz, Tyler Williams & Christopher Walters (United States of America)

POD 4.5 **The influence of environmental temperature on home advantage in Qatari international soccer matches**
Franck Brocherie, Olivier Girard & Gregoire P. Millet *(Switzerland & Qatar)*

PODIUM SESSION 5: SOCCER 1 (EEG089 YELLAND LECTURE THEATRE)
(CHAIR – Peter O'Donoghue)

POD 5.1 **Home advantage in derby and non-derby matches in the Serie A Brazilian National Soccer League, from 2007 to 2011**

Jackson Cruz, Anna Volossovitch, Ana Isabel Carita & António Paulo Ferreira. (Portugal)

POD 5.2 **The application of normative performance profiling for talent Identification in youth association football**

Alex Delves & Matt T. Robins (United Kingdom)

POD 5.3 **Identifying individual tactical profiles according to playing position in association football**

Ricardo Duarte, Bruno Travassos, Duarte Araújo, Pedro Marques & Tsuyoshi Taki (Portugal & Japan)

POD 5.4 **An analysis of successful offensive sequences in football**

António Barbosa, Hugo Sarmento, Antoni Planas Anzano & Jorge Campaniço (Spain & Portugal)

POD 5.5 **First goal and home advantage at different levels of play in professional soccer**
Albin Tenga (Norway)

PODIUM SESSION 6: MOVEMENT ANALYSIS (EEGO87 URWIN LECTURE THEATRE)
(CHAIR – Nic James)

POD 6.1 **Analysis of team and player performance using recorded trajectory data**
Robert Timmermann, Michael Dellnitz, Rasmus Jakobsmeyer, Reinhard Schnittker, Per Wilhelm, René Zorn & Hanyi Li (Germany)

POD 6.2 **Distance covered and average speed of movement during the 2012 British Open under 21 real tennis final**
Nic James, Robert Racz, Matthew Ronaldson & Goran Vučković (UK & Slovenia)

POD 6.3 **Running performance analysis in basketball using recorded trajectory data**
Rasmus Jakobsmeyer, Jochen Baumeister, Robert Timmermann, Hanyi Li, Per Wilhelm, René Zorn & Reinhard Schnittker (Germany)

POD 6.4 **The use of Global Positioning Systems in elite rugby union**
Nicola Cahill, Paul Worsfold, & Kevin Lamb (UK)

POD 6.5 **Distance covered, speed of movement and heart rate of the world champion padel player during a relatively easy 2011 pro tour match**
Jesus Ramón-Llin, Jose F. Guzmán, Rafa Martinez-Gallego, Goran Vučković & Nic James (Spain, Slovenia & UK)

POD 6.6 **An analysis of indoor team sports using fast tracking methods on global processing unit and multicore processors**
René Zorn, Hanyi Li, Ulrich Rückert, Reinhard Schnittker, Rasmus Jakobsmeyer & Robert Timmermann (Germany)

PODIUM SESSION 7: RACKET SPORTS (ROOM EE1057)
(CHAIR – Hyongjun Choi)

POD 7.1 **Consistency of key performance indicators for tennis match analysis in Grand Slam tournaments from 2005 to 2011**
Hyongjun Choi (South Korea)

POD 7.2 **The importance of the time duration of ground strokes in tennis**
Hiroo Takahashi, Masahiko Ishihara, Takahiro Morishige, Tetsu Kitamura, Akira Maeda & Hidetsugu Nishizono (Japan)

POD 7.3 **Technical structure and effort intensity in recreational squash**
Urszula Szmatlan-Gabrys, Tomasz Gabryś, Michal Garnys & Arkadiusz Stanula (Poland)

POD 7.4 **Male positive affect explains mixed-doubles badminton tournament rank**
Clare L. Rhoden, Julia West & Derek M. Peters (UK & Norway)

POD 7.5 **A comparison of the distribution of stroke and footwork type in top-level men's vs. women's table tennis**
Ivan Malagoli Lanzoni, Rocco Di Michele & Franco Merni (Italy)

PODIUM SESSION 8: HANDBALL (ROOM EE1061)
(CHAIR – António Ferreira)

POD 8.1 **Team timeout management in handball according to the context of the game**
Fernando Gomes, Anna Volossovitch & António Paulo Ferreira (Portugal)

POD 8.2 **Handball Refereeing: Referees, examiners and reality**
Maria Luísa Estriga, João Carvalho & António T. Ferreira (Portugal)

POD 8.3 **Sport performance profile in men's European handball: discriminant analysis between winners and losers**
Antanas Skarbalius & Kazimieras Pukėnas (Lithuania)

POD 8.4 **Motor skill determinants of performance in handball players**
Parminder Singh (India)

POD 8.5 **A time motion and notational analysis of three matches from the qualification round in the women's 2010 European Handball Championship**
Manraj S. Sucha, Stefan Bauer & David C. Pears (UK)

POD 8.6 **The use of live semi-automatic video content extraction techniques for the accurate evaluation of exertion in elite handball referees**
Maria Luísa Estriga, João Carvalho, António T. Ferreira & Catarina Santiago (Portugal)

PODIUM SESSION 9: SOCCER 2 (EEG089 YELLAND LECTURE THEATRE)
(CHAIRS – Jaime Sampaio & Nic James)

POD 9.1 **An analysis of unsuccessful offensive sequences in two top level football teams**
António Barbosa, Hugo Sarmento, Antoni Planas Anzano & Jorge Campaniço (Spain & Portugal)

POD 9.2 **Notational analysis of long corner kicks in an international youth football tournament**
Stephen Poon, Andrew Douglas & Will G. Hopkins (Qatar & New Zealand)

POD 9.3 **Activity profiles in four different small-sided football games**
Marco Aguiar, Goreti Botelho, Bruno Gonçalves & Jaime Sampaio (Portugal)

POD 9.4 **An analysis of English professional goalkeeper match actions over two competitive seasons: Implications for the coaching process.**
Andy Elleray & Gareth Jones (UK)

POD 9.5 **End of season club ranking in the top five European soccer leagues in season 2010/11 were affected by the number of players released to World Cup 2010**
Otto Kolbinger & Martin Lames (Germany)

POD 9.6 **A comparison of performances in the attacking-third between teams in the K-league, LFP and EPL football leagues**
Joo-Hak Kim, Hyongjun Choi & Jung-Wook Hwang (South Korea)

PODIUM SESSION 10: TEAM SPORTS 2 (EEGO87 URWIN LECTURE THEATRE)
(CHAIR – Joao Vincente)

POD 10.1 **Accuracy of netball umpiring in the British National Super League**
Emily Rose Doherty & Peter O'Donoghue (UK)

POD 10.2 **A comparison between winning and losing teams in women's elite level goalball**
Henri Lehto, Mikko Häyrinen, Timo Laitinen, Kevin Collet & Riikka Juntunen (Finland)

POD 10.3 **Performance analysis of kicking and striking skills in Gaelic sports**
Kevin Ball & Barry Horgan (Australia & Ireland)

POD 10.4 **Differences in game statistics between winning and losing teams in inter university elite male Sepak Takraw Tournaments**
Norasrudin Sulaiman, Rahmat Adnan, Rezian-na Muhammed Kassim & Mahenderan Appukutty (Malaysia)

POD 10.5 **Volleyball defensive performance in relation to scoring skill and player effectiveness**
Paulo Vicente João, Victor Maçãs, Nuno Leite, Luis Vaz & Pedro Pires (Portugal)

POD 10.6 **The effectiveness of Topsport Talent Schools in the Netherlands: A retrospective analysis of performance in sport and education**
Fleur van Rens, Niels Reijgersberg & Agnes Elling (Netherlands)

PODIUM SESSION 11: COMBAT SPORTS (ROOM EE1057)
(CHAIRS – Hyongjun Choi & Peter O'Donoghue)

POD 11.1 **Error in judging Olympic boxing performance: false negative or false positive?**
Umberto Di Felice & Samuele M. Marcora (Italy & UK)

POD 11.2 **A comparative analysis of competition before and after the adoption of the electronic trunk protector in Taekwondo**
Dae-Hyun Kim, Hyongjun Choi, Joo-Hak Kim & Eung-Joon Kim (South Korea)

POD 11.3 **The design and evaluation of a mobile analysis system for Judo competition**
Emily Brown (UK)

POD 11.4 **The standing position in biathlon shooting: Body sway, shooting position and shooting results**
Nico Espig & Dirk Siebert (Germany)

POD 11.5 **A temporal analysis of combinations in professional boxing**
Nicholas Harries & Peter O'Donoghue (UK)

POD 11.6 **A time-motion analysis of elite female foil fencing**
Matthew J. Wylde & Peter G. O'Donoghue (Singapore & UK)

PODIUM SESSION 12: SYSTEMS (ROOM EE1061)
(CHAIR – Arnold Baca)

POD 12.1 **Using spatial metrics to characterize behaviour in small sided games**
António Lopes, Sofia Fonseca, Roland Leser & Arnold Baca (Portugal & Austria)

POD 12.2 **Combined EEG and eye-tracking in sports skills training and performance analysis**
Keith M. Barfoot, Matthew C. Casey & Andrew J.Callaway (UK)

POD 12.3 **Bringing the lab to the field: Potential and challenges of body area networks in sports**
Lindsay Brown, Liam Kilduff, Scott Drawer & Julien Penders (Netherlands & UK)

POD 12.4 **Configure Code Analyse: An iPad application for live match analysis**
Venkat Narayn (India)

POD 12.5 **Towards an automated feedback and analysis system in carom billiards**
Arnold Baca, Philipp Kornfeind & Emanuel Steininger (Austria)

POD 12.6 **Application of three time motion analysis systems in semi-elite soccer match play**
Jason L. Cook (UK)

PODIUM SESSION 13: SOCCER 3 (EEG089 YELLAND LECTURE THEATRE)
(CHAIR – Peter O'Donoghue)

POD 13.1 **Regular patterns of play in the counterattacks of the FC Barcelona and Manchester United FC football teams**
Hugo Sarmento, António Barbosa, Jorge Campaniço, Maria Teresa Anguera & José Leitão (Portugal & Spain)

POD 13.2 **Space creation and restriction in elite soccer**
Martin Lames, Malte Siegle & Peter O'Donoghue (Germany & UK)

POD 13.3 **An analysis of goal scoring patterns during the 2010 FIFA World Cup**
Marcus A. Seaton & Louis Leventer (UK & Sweden)

POD 13.4 **Tactical behaviour in four different small-sided football games**
Marco Aguiar, Goreti Botelho, Bruno Gonçalves & Jaime Sampaio (Portugal)

POD 13.5 **An analysis of goals scored in youth football**
Mathew Pearson, Stephen Poon, & Jonathan Glynn (Qatar)

POD 13.6 **The development of a new approach to performance analysis in British professional soccer**
John Fraser & Nick Lester (UK)

PODIUM SESSION 14: INDIVIDUAL SPORTS (EEG087 URWIN LECTURE THEATRE)
(CHAIR – Anita Hökelmann)

POD 14.1 **Analysing individual performance in golf using the ISOPAR Method**
Michael Stöckl, Peter F. Lamb & Martin Lames (Germany)

POD 14.2 **Exploring the quadratic nature of the relationship between strength & performance in shot putters**
Lawrence W. Judge & David Bellar (USA)

POD 14.3 **Distance covered and velocity of movements of padel players during a closely contested 2011 pro tour match**
Jesus Ramón-Llin, Jose F. Guzmán, Rafa Martinez-Gallego, Goran Vučković, & Nic James (Spain, Slovenia & UK)

POD 14.4 **Changes in performance structure during group competitions in rhythmic gymnastics**
Anita Hökelmann, Tina Breitkreutz & Gaia Liviotti (Germany)

POD 14.5 **Hierarchical organization and performance inequality: Evidence from professional cycling**
Bertrand Candelon & Arnaud Dupuy (Netherlands)

POD 14.6 **The effects of cycle-pack size and order on finishing performance in elite Olympic triathlon**
Rita M. Malcata, Simon Pearson & Will G. Hopkins (New Zealand)

PODIUM SESSION 15: RUGBY (ROOM EE1057)
(CHAIR – Michelle Van Rooyen)

POD 15.1 **A three dimensional analysis of swing motion during kicking in Rugby and Gaelic football players**
Aishwar Dhawan & Cathy Craig (UK)

POD 15.2 **Experienced and novice rugby union players had the same physical exertion during small sided games…but different game performances**
Luis Vaz, Nuno Leite, Paulo Vicente João, Bruno Gonçalves, Victor Maçãs, & Jaime Sampaio (Portugal)

POD 15.3 **A network analysis of the contribution of turnovers to defensive performance in Rugby World Cup 2011**
Koh Sasaki, Takumi Yamamoto, Jun Kuroiwa, Kensuke Iwabuchi, Ryuji Nakatake, Jun Murakami, Hironobu Shimozono, Masahiko Miyao, Takuo Furukawa, Yuichi Ueno, Takashi Katsuta, Ichiro Watanabe & Ichiro Kono (Japan)

POD 15.4 **Tackling in Super 15 Rugby 2011**
Michele van Rooyen (South Africa)

POD 15.5 **The effect of game location on positional profiles during a competitive season in professional rugby union: Implications for the coaching process**
John Francis & Gareth Jones (UK)

POD 15.6 **An analysis of ruck-play during the RBS Six Nations 2010 rugby championship**
Wilbur J. Kraak (South Africa)

PODIUM SESSION 16: EQUESTRIAN (ROOM EE1061)
(CHAIR – Lucy Holmes)

POD 16.1 **Motivational orientation and support perception of young riders in the United Kingdom.**
Samantha Penrice, Charlotte Brigden, Stefanie Tinsley & Jaime Martin (UK)

POD 16.2 **Anthropometric and fitness characteristics of female novice, intermediate and advanced level Event riders**
Jenni-Louise Douglas, Mike Price, & Derek M. Peters (UK & Norway)

POD 16.3 **Timing factors in equestrian performance**
Sophie Arundel & Lucy Holmes (UK)

POD 16.4 **A preliminary investigation into the effects of jumping saddle design on rider posture**
Cassie White & Lauren Birkbeck (UK)

POD 16.5 **The effects of rider specific Pilates on rider position from a lateral view: a six week study**
Eleanor R. Boden, Charlotte Brigden & Hayley Randle (UK)

POST 2.1 SOCCER: (CHAIR – Bruno Travassos)

POST 2.1.1 **Home and away: An analysis of team positioning in the FA Premier League**
Kelvin Beeching & Lisa A. Griffiths (UK)

POST 2.1.2 **Normative performance profiling for the analysis of corner kicks**
Rob Page & Matt T. Robins (UK)

POST 2.1.3 **The influence of the type of goalkeeper action on the offensive patterns of play in association football**
Bruno Travassos, João Sá Pinho, Pedro Marques & Ricardo Duarte (Portugal & UK)

POST 2.1.4 **Analysis of goal scoring opportunities in semi elite female soccer**
Jason L. Cook & Richard Bredice (UK)

POST 2.1.5 **The effect of manipulating the number of touches on the ball in small-sided games of Association football on players' spatial interaction**
Filipe Celikkaya, Sofia Fonseca & Bruno Travassos (Portugal)

POST 2.1.6 **Small sided games in football with University players**
Adérito Alves, Nuno Leite, Bruno Gonçalves, Isabel Gomes, Paulo Vicente João & Victor Maçãs (Portugal)

POST 2.1.7 **Spatial analysis of soccer games for effective coaching**
Veronica Planella & Belaid Moa (Canada)

POST 2.1.8 **Characterising the attacking patterns of football teams using social networks: players and field zones as network nodes**
Luís Freire, Ricardo Duarte, Pedro Marques, & Bruno Travassos (Portugal & UK)

POST 2.1.9 **The impact of game status on the performance of a Premier League football reserve team: Implications for coaches.**
Ashley Manzur & Gareth Jones (UK)

POST 2.1.10 **A corner kick analysis of a League One professional football team**
Rob Page & Matt T. Robins (UK)

POST 2.1.11 **Career analysis of youth talent Brazilian soccer players**
René Drezner, Jose Alberto Aguilar Cortez, Antonio Carlos Simões & L. Dantas (Brazil)

POST 2.1.12 **Relationship between high risk situations and the characteristics of injuries in elite youth football players**
Louis Leventer (Sweden)

POST 2.2 TEAM SPORTS: (CHAIR – Bruno Travassos)

POST 2.2.1 **Differences between winning and losing teams in top-level female beach volleyball**
Mikko Häyrinen & Kostas Tampouratzis (Finland)

POST 2.2.2 **Determinants of serve action in high level male volleyball**
Rui Araújo, Cícero Moraes, Patrícia Coutinho & Isabel Mesquita (Portugal & Brazil)

POST 2.2.3 **The use of serve of men's teams in top beach volleyball competition**
Maria del Mar Silvestre García, Alfonso Penichet Tomás, Jose Manuel Jimenez Olmedo, Juan José Chinchilla Mira, Eliseo Cabrera Andreu, Concepción Suarez Llorca, Federico Carreres Ponsoda, Jose Antonio Martínez Carbonell, Jove Tossi & Marcelo Alejandro (Spain)

POST 2.2.4 **The sport developmental pathway of volleyball players: The nature and type of sport practice**
Patrícia Coutinho, Rui Araújo & Isabel Mesquita (Portugal)

POST 2.2.5 **The use of patterns of movement and displacement and types of shots in handball in the Valencian community**
Martínez Carbonell & Jose Antonio (Spain)

POST 2.2.6 **Temporary structure of ice hockey game**
Arkadiusz Stanula, Urszula Szmatlan-Gabrys, Tomasz Gabryś & Michal Garnys (Poland)

POST 2.2.7 **Tackling effectiveness in professional rugby league**
Nimai C. Parmar & Nic James (UK)

POST 2.2.8 **A statistical profile of twelve-a-side rugby union game in Japan**
Takumi Yamamoto, Yuichi Ueno, Koh Sasaki, Jun Kuroiwa, Masaki Nagamatsu, Kazunari Hayasaka & Shogo Tanaka (Japan & New Zealand)

POST 2.2.9 **Analysis of playing time of elite male water polo players at the 2011 World Championships**
Itaru Enomoto, Masaaki Suga, Yoji Omoto & Akira Hara (Japan)

POST 2.2.10 **Independence of shots in netball**
Catherine Roberts & Peter O'Donoghue (UK)

POST 2.2.11 **How a basketball game works: the time**
Juan Manuel Martín González, Yves de Saá Guerra & Juan Manuel García-Manso (Spain)

POST 2.2.12 **Tendencies of youth basketball defense to offense transition**
Américo Santos, Carlos Ferreira & Fernando Tavares (Portugal)

POST 2.2.13 **Analysis of the influence of the Líbero in different phases of the game in KI and KII volleyball**
Laura Rentero, Paulo Vicente João & Maria Perla Moreno (Portugal & Spain)

POST 2.2.14 **Behavior trends competitive athletes amateur and professional college of futsal teams: a study of the prevalence of variables between them set goals, compete and win**
Antonio Carlos Simões, Jose Alberto Aguilar Cortez, René Drezner, Helio Serassuelo Junior, Sérgio Ricardo de Souza Oliveira & Bruno Holanda Ferreira (Brazil)

POST 2.3 INDIVIDUAL & RACKET SPORTS: (CHAIRS – Peter O'Donoghue & Nic James)

POST 2.3.1 **Strategy in national championship 2000m indoor rowing**
Peter O'Donoghue (UK)

POST 2.3.2 **Performance analysis in individual competitions in rhythmic gymnastics**
Tina Breitkreutz & Anita Hökelmann (Germany)

POST 2.3.3 **A needs analysis of canoe and kayak slalom to identify a coherent performance analysis strategy**
Julia Wells, Nic James, Mike Hughes & Tim Caudrelier (UK)

POST 2.3.4 **The evaluation method for effects of shots in ground strokes of tennis**
Tetsu Kitamura, Hiroo Takahashi, Akira Maeda & Hidetsugu Nishizono (Japan)

POST 2.3.5 **Momentum in tennis matches at Grand Slam tournaments**
Peter O'Donoghue (UK)

POST 2.3.6 **Analysis of distance covered and speed of movement in a Valencia Open 500 elite tennis match**
Rafa Martínez-Gallego, Jesus Ramón-Llin, Jose F. Guzmán, Goran Vučković & Nic James (Spain, Slovenia & UK)

POST 2.3.7 **Investigation of serve and serve return strategies in different elite tennis populations**
Hazuan Hizan, Peter Whipp & Machar Reid (Australia & Malaysia)

POST 2.3.8 **Designing a complex analysis system for real tennis**
Robert Racz, Nic James, Mike Hughes, Henriette Dancs & Goran Vučković (UK, Hungary & Slovenia)

POST 2.3.9 **The effect of changing the scoring system on game related activity in squash**
Stafford Murray, Nic James, Peter Dineen, Mike Hughes & Goran Vučković (UK & Slovenia)

POST 2.4 SPORT PERFORMANCE PSYCHOLOGY: (CHAIRS – Peter O'Donoghue & Nic James)

POST 2.4.1 **Management of psychological preparation in sport**
Valerii Malkin & Liudmila Rogaleva (Russia)

POST 2.4.2 **Mental toughness and social loafing in male elite ice hockey players in Norway**
Rune Høigaard, Stein Rodahl & Derek M. Peters (Norway & UK)

POST 2.4.3 **Analysis of psychological effects of the presence of peers and space perception during the performance of the twelve minutes run test (12-MRT) in estimating maximal oxygen consumption**
Samuel H. Mandengue, Peguy B. Assomo Ndemba, Wiliam R. Guessogo & Laurent S. Etoundi Ngoa (Cameroon)

POST 2.4.4 **Passion motives among top-class referees in football**
Bjørn Tore Johansen & Tommy Haugen (Norway)

POST 2.4.5 **Influence of self-concept among adolescents in respect of sex, loyalty and regional culture**
Somnath Bag (India)

POST 2.4.6 **Effect of worship level in student athletes' mood**
Reza Sadeghi & Gholamreza Zourmand (Iran)

POST 2.4.7 **Individualization psychoforming training in sport**
Valerii Malkin & Liudmila Rogaleva (Russia)

POST 2.4.8 **Examination of three methods of goal setting in sport motivation in student athletes**
Gholamreza Zourmand, Saeed Tanoorsaz, Lora Chapari & Sara Shamshiri (Iran)

POST 2.4.9 **Mental toughness and sport competition anxiety among young swimmers in Norway**
Petter Gramvik, Stein Rodahl, Derek M. Peters & Rune Høigaard (Norway & UK)

POST 2.4.10 **The influence of self-management and self-confidence on performance in Chinese table tennis athletes**
Zheng Yuan-Nan, Won Young-Shin & Adam Sheard (Korea)

POST 2.4.11 **Ideology of leadership of a technical process and football social relations and job performance: a study of the structure of relationships**
Antonio Carlos Simões, Jose Alberto Aguilar Cortez, René Drezner & Bruno Holanda Ferreira (Brazil)

POST 2.5 SPORT SCIENCE & MEDICINE: (CHAIRS – Peter O'Donoghue & Nic James)

POST 2.5.1 **Anaerobic capacity in detraining periods in 11 year old male swimmers**
Jarosław Cholewa, Michał Skóra & Robert Wilk (Poland)

POST 2.5.2 **Frequency of injuries in young swimmers**
Joanna Cholewa, Agnieszka Smykla & Alicja Szostak (Poland)

POST 2.5.3 **Power, speed and anthropometric measures of Portuguese elite junior volleyball players**
Paulo Vicente João, Tine Sattler & Ana Pereira (Portugal & Slovenia)

POST 2.5.4 **The relationship between speed, change of direction speed and reactive agility in soccer players**
Gareth Paterson, Sherman Baatjes & Elizabeth Bressan (South Africa)

POST 2.5.5 **Training models and path selection in the training of Chinese elite athletes**
Baohua Zhang, Wensheng He & Ya Fang (China)

POST 2.5.6 **The effect of water treatment on performance of ACL and PCL in male athletes**
Lora Chapari, Saeed Tanoorsaz, Gholamreza Zourmand & Sara Shamshiri (Iran)

POST 2.5.7 **The examination causes of osteoporosis in 45-65 old females in Dezful city**
Sara Shamshiri, Lora Chapari, Saeed Tanoorsaz & Gholamreza Zourmand (Iran)

POST 2.5.8 **The relationship between muscle bioelectric activity during performance of the acrobatic back handspring and maximal isometric and isotonic muscle contraction**
Viacheslav Shlyakhtov, Alexandr Rumyantsev & Sergey Ivanov (Russia)

POST 2.5.9 **Designing ergometer tests for the calibration of physiological endurance models**
Thorsten Dahmen (Germany)

POST 2.5.10 **Body segmental weights of Indian college age males**

Gora Chand Mallik & Sudarsan Bhowmick (India)

POST 2.5.11 **Morphofunctional survey in adapted gymnastics training for normal pregnancy**
Emilia Pavlova, Irina Nesheva, Alexandra Demireva & Stanislava Demireva (Bulgaria)

POST 2.5.12 **The height of male Brazilian beach volleyball players in relation to specialization and court dimensions**
Alexandre Medeiros, George Giatsis, José Manuel Palao, José Afonso, Roberto Lopes & Isabel Mesquita (Portugal, Greece, Spain & Brazil)

Abstracts

Podium Presentations

SESSION 1: BASKETBALL

POD 1.1
Comparing critical and normal match episodes in different competitive contexts of the basketball game

António Paulo Ferreira, Sandro Didier & Anna Volossovitch

Faculty of Human Kinetics, Technical University of Lisbon, Portugal

Few studies have been focused on the teams' strategy used in the Critical Match Episodes (CME) in different competitive contexts. This study aimed to compare the CME with the Normal Match Episodes (NME) in basketball games according to the match equilibrium and the teams' success. The current score of 80 matches from the Basketball Portuguese League were reconstructed by ball possession. Each match was analyzed according to the model of coach's game practical knowledge (Ferreira et al., 2010). A CME was considered as a transition of the equilibrium state of match score. A NME was defined as an episode in which the current score remained in the same equilibrium state. A total of 319 CME and 318 NME were analyzed. The NME were randomly selected according to a homogeneity criterion with the CME identified in each match. Offensive performance during the CME and NME were registered using an instrument that included six categories: (1) Duration of Ball Possession (DBP), (2) Offensive Phase (OP), (3) Tactical Combination (TC), (4) Field Goals Type/Zone (FG); (5) Offensive Preparation and (6) the End of Ball Possession (EBP). A total of 2665 ball possessions from CME and 2671 from NME have been observed using the referred instrument. Intra and inter-observer ratings were estimated by K-Cohen test and equaled 0,78-0,85. Matches were classified according to the match final score: balanced matches with the final point difference less than 10 points; and unbalanced matches with the final point difference equal or higher than 10 points. The team's success was defined in function of the match outcome - winning and losing teams. CME and NME of winning and losing teams in balanced and unbalanced matches were compared using the χ^2 test. P-value was set at 0.05 and the adjusted standardized residuals were analyzed taking account in the |1.96| boundaries. CME and NME were distinguished by DPB ($\chi^2_{(3, n=956)}$ = 14.001, $\rho \leq 0.01$) in balanced and unbalanced matches. In addition, balanced matches showed differences in FG ($\chi^2_{(10, n=1508)}$ = 23.625, $\rho \leq 0.01$). CME of winning teams presented significant differences in more features: DBP ($\chi^2_{(3, n=1283)}$ = 17.662, $\rho \leq 0.01$), OP ($\chi^2_{(2, n=1283)}$ = 7.902, $\rho \leq 0.01$), TC ($\chi^2_{(4, n=1283)}$ = 13.474, $\rho \leq 0.01$), FG ($\chi^2_{(10, n=1283)}$ = 47.756, $\rho \leq 0.01$) and EBP ($\chi^2_{(12, n=1283)}$ = 23.011, $\rho \leq 0.05$). Losing teams demonstrated located differences in DBP ($\chi^2_{(3, n=124)}$ = 14.676, $\rho \leq 0.001$) and in OP ($\chi^2_{(2, n=1254)}$ = 6.857, $\rho \leq 0.01$). Regarding the contextual factors the CME showed clear differences in the ball possessions with duration between 9 and 12 seconds. It could mean that in basketball game teams tend to provoke CME when the secondary fast break forms are predominant in the offensive play in detriment of the positional forms of attack.

Ferreira, A.P., Volossovitch, A., Gomes, F. & Infante, J. (2010) Dynamics of coach's game practical knowledge in basketball. *International Journal of Sport Psychology*, 41: 68-69.

POD 1.2
Competitiveness and uncertainty in the NBA and ACB professional basketball leagues

Yves de Saá Guerra[1], Juan Manuel Martín González[2] & Juan Manuel García-Manso[1]

[1]*Department of Physical Education, University of Las Palmas de Gran Canaria, Spain*
[2]*Department of Physics, University of Las Palmas de Gran Canaria, Spain*

Most research papers are focus on the game itself (in isolation) (Chatterjee & Yilmaz 1999; McGarry et al. 2002; Lebed 2006; McGarry & Franks 2007). Little researches have been conducted from the perspective of competition between teams (Yilmaz & Chatterjee 2000; Ribeiro et al. 2010; de Saá Guerra et al. 2012). According to this, the main aim of a league should be to preserve a high degree of competitiveness within the championship. We understand competitiveness as both the rivalry among teams and the capacity of the teams participating in a league to compete. The greater and more balanced the competitiveness of these teams, the more the league will be able to attract fans, media, and resources, as well as better players, better coaches, etc. This outcome can translate into an increase in the quality of the league. The degree of league competitiveness can act as an indicator of league performance. It is difficult to assess and quantify all elements that yield the final standing (a complex phenomenon). To further explore this issue, we have carried out a work on the study of the competitiveness of the NBA and ACB leagues based on the concept of entropy as the uncertainty or unpredictability of the outcome (the uncertainty level that might exist for each confrontation). We analyzed the degree of uncertainty and randomness of the competition, as a factor of competitiveness. We studied 18 NBA and 14 ACB regular seasons. Both leagues´ entropy levels are high (NBA mean 0.984; ACB mean 0.979), which indicates high competitiveness, but the entropy of the ACB (from 0.972 to 0.987) shows more seasonal variability than the NBA (from 0.985 to 0.990). This is a possible result of greater sporting gradients in the ACB. A league is more competitive when it is more random, meaning when it is harder to predict the final outcome. If the competition is less random, the degree of competitiveness will therefore decrease significantly. The NBA and ACB are very competitive leagues, whose teams are very balanced within each league. This means there is a high degree of uncertainty in knowing the final result. The use of this methodology has proven useful for investigating competitiveness of sports leagues as well as their underlying variability across time.

Chatterjee, S. & Yilmaz, M.R. (1999) The NBA as an evolving multivariate system. *The American Statistician*, 53(3): 257–262.

Lebed, F. (2006) System approach to games and competitive playing. *European Journal of Sport Science*, 6(1): 33–42.

McGarry, T., et al. (2002) Sport competition as a dynamical self-organizing system. *Journal of Sports Sciences*, 20(10): 771–781.

McGarry, T. & Franks, I.M. (2007) System approach to games and competitive playing: Reply to Lebed (2006). *European Journal of Sport Science*, 7(1): 47–53.

Ribeiro, H.V., Mendes, R.S., Malacarne, L.C., Jr, S.P., et al. (2010) Dynamics of tournaments: the soccer case - A random walk approach modeling soccer leagues. *The European Physical Journal B*, 75(3): 8.

de Saá Guerra, Y., et al. (2012) A model for competitiveness level analysis in sports competitions: Application to basketball. *Physica A: Statistical Mechanics and its Applications*, 391(10): 2997–3004.

Yilmaz, M.R. & Chatterjee, S., 2000. Patterns of NBA team performance from 1950 to 1998. *Journal of Applied Statistics*, 27(5), pp.555–566.

POD 1.3 **An analysis of collective performance in Olympic basketball.**

Mariano Latorre Bragion & Dante De Rose Jr.

School of Sciences, Arts and Humanities, University of Sao Paulo, Brazil

Performance Rate (PR) is one measure based in a set of game indicators that has the purpose to define the level of individual performance of the athletes in basketball. There are different formulas to calculate PR and some studies show that there are no differences among those formulas.

The objectives of the present study, that is part of a research project, was to identify the PR of the athletes that took part in the male World Championship of Basketball, held in Istanbul – 2010 and also to set PR profile according to specific positions in basketball (guards – forwards – centers).

The sample: 287 athletes. According to FIBA official site (www.fiba.com) the athletes were classified as 107 Guards; 115 Forwards; 65 Centers.

The formula used to calculate PR was the same used at Brazilian National League: (pts made+total rebounds+assists+recoveries)-(missed shots+turnovers+personal fouls).

Table 1. PR average (Avg) and standard deviations (Sd) for the total of athletes (T), guards G), forwards (F) and centers (C).

	T	G	F	C
Avg	6.9	6.1	7.2	7.7
Sd	4,9	4,8	5,0	4,6

Table 2. The number of athletes according to different PR ranges and specific positions

PR	T	G	F	C
> 20.0	4	1	2	1
15 - 19.9	12	4	5	3
10.0 - 14.9	60	19	25	16
5.0 - 9.9	97	32	39	26
0.0 - 4.9	102	41	42	19
-0.1 - -2.0	12	10	2	0

Regarding the results we can attest that Centers got the best PR average among the players, while Guards got the worst PR average among the players. The hypotheses that explain this difference are being studied in the sequence of this project.

POD 1.4

The effect of age on the diversity and efficiency of space creation dynamics and cooperation rates in basketball teams

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[2]*School of Sciences, Arts and Humanities, University of Sao Paulo, Brazil*

The skills to perform coordinated actions among players and to define proper strategies during a game depend on a long term process that involves systematic participation in practices and in competitions. Those skills also require athletes with experience and knowledge of the game.

The aim of the present study was to evaluate the effect of competitive experience in the following performance variables: 1) diversity of the Space Creation Dynamics (SCDs); 2) efficiency of the SCDs (successful SCDs/total amount of SCDs); 3) offensive cooperation (i.e. number of passes and assists).

There were analyzed 46 semi-final matches of all ages competing at male championship in the State of Sao Paulo, Brazil (under 12 to seniors).

Measured/ calculated variables: 1) SCDs performed; 2) SCDs efficiency; 3) passes performed on a ball possession; 4) assists performed. Researcher's reliability was tested in three moments, with one week apart each other (Kappa rates: 0.78-0.85). SCDs diversity presented no significant difference for any SCD class among all age groups.

Intra-age analysis against man-to-man defence presented significant prevalence of "Space creation with dribble" for younger players (under 12 to under 15) and of "On ball screen" for older players (under 18 and seniors). Against zone defence, "Space creation without the ball" was significantly more frequent for all age groups in comparison to all others SCDs, except for "Space creation with dribble".

It was not observed significant difference for efficiency of the SCDs at any age group. All age groups presented similar distribution regarding frequencies of number of passes and assist as well.

These results contradicted the preliminary hypothesis, which expected the increase of complexity and diversity of actions together with the increase of players' competitive expertise. These evidences suggest the need of cooperation and collective-focused teaching games methodology.

POD 1.5
Basketball shooting performance and attentional strategies as a function of induced myopic blur

Sophie E. Lanham[1] & Matt T. Robins[2]

[1] *SHAPE Research Group, Nottingham Trent University, Nottingham, UK*
[2] *Chichester Centre for Applied Sport and Exercise Science, University of Chichester, Chichester, UK.*

Interestingly, previous research has indicated that the human movement system can tolerate a substantial level of myopic blur before performance is significantly affected (see Mann *et al.*, 2010). However, the mechanisms underpinning this stabilisation of performance are yet to be identified, a point acknowledged by Mann and co-workers (2007) as a fruitful line of future scientific enquiry. Two potential mechanisms have been theorised; (1) allocation of additional attentional resources, and (2) focus of attention. Therefore, the purpose of this study was to discern which mechanism best explains performance changes with induced myopic blur.

Eight skilled basketball players provided voluntary written informed consent to participate and completed 20 free throws under each of four, counterbalanced visual conditions. All participants met stringent inclusion criteria in terms of task expertise and habitual vision. The four vision conditions were plano, +1.00D, +2.00D and +3.00D causing visual acuities of approximately 6/4-6/6, 6/6-6/12, 6/18-6/24 and 6/60 respectively. Shooting performance was assessed using a 1-8 scale and attentional demands were quantified using a vocal reaction time test. In addition, each participant completed a focus of attention questionnaire after each visual condition. Statistical differences for each dependent variable were examined using a repeated measures analysis of variance ($p \leq 0.05$).

A significant decrease in shooting performance was observed between the plano and +3.00D conditions ($p=0.03$). There was no significant difference in reaction time or focus of attention with respect to myopic blur ($p>0.05$). However, due to large within group variance a multiple single-individual level of analysis was conducted and revealed; (1) a strong positive relationship between percentage change in reaction time and performance between the plano and +3.00D conditions ($r=0.7$, $p=0.05$) and (2) participants self-selected different foci of attention e.g. follow through movement (internal focus), starting position (internal focus), or success of the shot (external focus). Collectively, these results provide the first line of evidence to suggest that stabilisation of performance with induced myopic blur can be achieved by allocating additional attentional resources to the task. Moreover, the adoption of an external focus of attention may further facilitate this stabilisation because participants did not inherently self-select this focus of attention during the performance trials. Therefore, these results highlight the potential utility of attentional training programmes.

Mann, D. L., Ho, N. Y., De Souza, N. J., Watson, D. R. & Taylor, S. J. (2007) Is optimal vision required for the successful execution of an interceptive task? *Human Movement Science,* 26: 343 – 356.

Mann, D. L., Abernethy, B. & Farrow, D. (2010) The resilience of natural interceptive actions to refractive blur. *Human Movement Science,* 29: 386 – 400.

POD 1.6
How a basketball game works: the score.

Yves de Saá Guerra[1], Juan Manuel Martín González[2] & Juan Manuel García-Manso[1]

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[2]Department of Physics,University of Las Palmas de Gran Canaria, Spain

The final score in a basketball game determinate the result of the game. The scoring evolution is a process with a high uncertainty. It is a process highly dynamic and non-linear type. Everything depends upon the equality between teams and the agents which are involved in the system (Chatterjee & Yilmaz 1999; Bar-Yam 2003; Vaz de Melo et al. 2008; Yarrow et al. 2009; Sampaio et al. 2010). The more uncertainty present in the league (equality among teams), the more attractive will be and it will be able to collect more resources (Ziv et al. 2010; de Saá Guerra et al. 2012). A priori, we cannot know the behavior of basketball game scoring, because we do not know, in advance, how big the runs of points will be or how often. The points are supposed to reflect a completely random dynamic (stochastic behavior). We analyzed all the games and the dynamics of the score of these basketball games of five NBA regular seasons (2005-06; 2006-07; 2007-08, 2008-09; 2009-10). 1230 games per season, with a total of 6150 games. These do not behave uniformly, but present more predictable areas. Exists different areas of behavior related with the score and each zone has a different nature. There are points that we can consider as tipping points. The presence of these critical points suggests that there are phase transitions (Vicsek 2002; Amaral & Ottino 2004; Scheffer et al. 2009) where the dynamic scoring of the games varies significantly. Regarding the final result, the most of the games (65%) ended with a difference of between 1 and 11 points, 33% had a difference of between 11 and 28 points, and only 2% did so with a difference of 28 or more points. We can distinguish at least, three areas, in relation to the dynamic of the game: The first one correspond with 0 and 10 points differences. In this case the final result is the most unpredictable. The second one extends from 10 to 28 points differences approximately. The strategy is well defined and is more predictable. Finally, more than 28 points, the game is broken and there exist a clear superiority of a team over the other. The final outcome is pretty predictable.

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Bar-Yam, Y. (2003) Complex Systems and Sports.http://necsi.edu/projects/yaneer/SportsBarYam.pdf

Chatterjee, S. & Yilmaz, M.R. (1999) The NBA as an Evolving Multivariate System. *The American Statistician*, 53(3): 257–262.

Vaz de Melo, P.O.S., Almeida, V.A.F. & Loureiro, A.A.F. (2008) Can complex network metrics predict the behavior of NBA teams? En *Proceedings of the 14th ACM SIGKDD international conference on Knowledge discovery and data mining*. KDD '08. New York, NY, USA: ACM, pp. 695–703. Available at: http://doi.acm.org/10.1145/1401890.1401974 [Accedido diciembre 9, 2011].

de Saá Guerra, Y. et al. (2012) A model for competitiveness level analysis in sports competitions: Application to basketball. *Physica A: Statistical Mechanics and its Applications*, 391(10): 2997–3004.

Sampaio, J. et al. (2010) Effects of starting score-line, game location, and quality of opposition in basketball quarter score. *European Journal of Sport Science*, 10(6): 391–396.

Scheffer, M. et al. (2009). Early-warning signals for critical transitions. *Nature*, 461(7260): 53–59.

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SESSION 2: PERFORMANCE ANALYSIS & COACHING

POD 2.1
The use of experience as a performance analyst to aid self-regulated coach development

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In this case study, a PGA professional golf coach undertook the role of a performance analyst to proactively engage in his own learning process. He then acted as a researcher to review his developmental journey. The aim of the initial project was to work with a county level golfer and his coach to resolve a performance issue, namely improving driving distance. The aim of this study was to outline the developmental journey of the coach/researcher and examine the effect of experience as a performance analyst on his coaching practice.

Retrospective analysis of self regulation specifically demonstrated the efficacy of experience as a performance analyst. The data collection and observation phase had led to increased levels of self-awareness and metacognition of coaching practices. The self-reflection phase had directed the coach/researcher to critique his use of task strategies; his ability to quantify changes in pupil performance; and his use of collaboration. The forethought phase had resulted in changes to the strategic planning used by the coach and was followed by a change to the outcome expectations of the practice structures set for pupils.

In this case study the contribution of experience as a performance analyst to self regulated coach development was specifically demonstrated by the development of: 1) a more precise way to measure changes in performance; and 2) new practice structures to facilitate improved rates of psychological and technical player development.

POD 2.2
Coach behavioral analysis within elite youth football

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The most important variable for the learning of a motor skill is feedback (Schmidt, 1988), therefore the more effective the instruction the greater potential for performance achievement. The interaction between the coach and the athlete has been considered to be of high importance in athlete development. In team sports one factor a coach must also control is participation management including team integration and individual inclusion in training and competition. It has been stated that non-effective or bench players bring difficulties to team management, with non-effective players having a tendency to be treated in a different way than the effective players (Wang, Callahan & Goldfine, 2001).

The purpose of the study was to analyse coaching behaviour within an elite level football club in relation to player selection during two competitive seasons. Following ethical approval, audio and video data were captured from three head coaches from different age groups, during seventy-two training sessions. Twenty-six coach behavioural categories were assessed using an adapted 'Coach Analysis Instrument' (Franks, Johnson & Sinclair, 1988). The data obtained from the coaching sessions were computed and analysed according to the 'Coach Analysis Instrument' framework after the sessions using Sportscode Gamebreaker. From the three squads, forty-eight players were classified as effective and non-effective players based on their competitive match selection and playing time. Significant differences ($p < 0.05$) were identified in the time and amount of information provided to players from each of the coaches. Results identified that coaches interact more, corrected more, provide more positive and negative expressions and provide more information to effective players when compared to non-effective players. The results support previous research in different sports, which conclude that coaching behavior varies in accordance to the players' importance within the team. The results from the present study identify that non-effective players are in a disadvantageous position in relation to their own development within the squad. The findings have implications on individual player progression and talent identification within different aged players within an elite youth English football club.

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POD 2.3
Soccer match analysis – A qualitative study with first Portuguese League coaches

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Analyzing individual and team play is essential when improving performance in football, but identifying the right information and putting it to good use can be difficult (Carling, Williams & Reilly, 2002). This study aims to understand what the coaches observe in the game, and how they evaluate and make their intervention based on this observation.

The participants were 8 experienced First Portuguese League coaches (14.9±8.6 years of experience). Semi-structured interviews (Creswell, 2006) were carried out and the data were analyzed through the technique of content analysis (Bardin, 2008). The elaboration of the categories had been defined *a posteriori*. The software QSR NVivo 9 was used in coding the transcripts of the interviews.

According to these coaches to effectively observe and analyze the game it is crucial to have a detailed knowledge of the game and of the individual characteristics of players. They consider that the most important aspects to observe in the game are: i) the 4 moments of the game (offensive and defensive organization, and transition defense/attack and attack/defense); ii) tactical schemes (corners, free kicks, etc.); iv) individual characteristics of players; v) random aspects of the game. During the course of a game they observe mainly the dynamic of their team and it is usually the assistant coaches who focus on the analysis of opposing teams. Reported that, frequently, the focus of their observation is not the center of the game (the place where the ball is) but the organization of the team members who are away from the center of the game.

Coaches have the perception that over the years their observation has become more effective and they value different aspects in the game. They consider that the factors responsible for the evolution of their observations are: i) the accumulated experience; ii) a better knowledge of the game; iii) the academic formation. However, they recognize that the quality of their observation is influenced mainly by factors such as the expectations, the environment (public/pressure), the emotions, the referees' errors and by their position in the field (on the bench).

These coaches evaluate the teams in a general way focusing mainly on strengths and weaknesses and they follow a specific logic of prioritization for the evaluation of these aspects that is based mainly, in their model of the game. The intervention is done mainly through the adaptation of the training exercises, but also through visual strategies (movies, photos, etc.) and meetings (individual, by sector or in group). They have a great concern with appropriate intervention (body language, appropriate feedback, etc.). To communicate with players during the game, they provide immediate feedback or use target players that serve to convey the message, but consider that half time is the privileged time to talk with the players.

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Creswell, J. (2006) *Qualitative Inquiry & Research Design: Choosing among five approaches* (2nd ed.) London: Sage Publications.

Carling, C.; Williams, A. & Reilly, T. (2002) *Handbook of Soccer Match Analysis,* London: Routledge.

POD 2.4
Performance analysis in professional football: Player & coach perspectives

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Performance analysis (PA) is firmly positioned as an integral part of the coaching process (Carling, Williams & Reilly, 2005; Groom, Cushion & Nelson, 2011; Hodges & Franks, 2002; Lyle, 2002; Stratton, Reilly, Williams & Richardson, 2004). However, PA research in football has tended to focus on the investigation of isolated key performance indicators. This has resulted in a consistent focus on descriptive research examining variables related to 'successful performance' such as; possession and passing patterns (e.g. James, Jones & Mellalieu, 2004; Dawson, Appleby & Stewart, 2005; Hughes & Franks, 2005), score-box possessions (e.g. Tenga et al., 2010; Tenga et al., 2010) and shooting accuracy (e.g. Lago, 2007). There is however, a significant lack of research that has investigated the role of PA in the complex, messy and dynamic coaching process (Cushion et al., 2010). Moreover, research has often neglected the perspectives of practitioners who use PA in applied settings, such as professional football. The purpose of this study was to investigate the role of PA in the coaching process at a professional football club and the perspectives of both professional players and coaches in relation to its use.

A case study approach was adopted (Yin, 2003) presenting both ethnographic data, in the form of participant observation and unstructured interviews (Hammersley & Atkinson, 1994) recorded over the period of one full season. In addition, semi-structured interviews were conducted with both senior professional players (n=8) and members of the senior management team (n=3). The data were subjected to three levels of overlapping analysis using coding techniques (open, axial & selective) taken from grounded theory methodology (Strauss & Corbin, 1998). This allowed for the generation of descriptive themes and concepts relating to the use of PA at the club. A further level of analysis and abstraction allowed the introduction of wider theoretical perspectives. Four main concepts in relation to the use of PA were outlined: *PA as preparation*, *PA as reflection*, *PA as a disciplinary tool* and *PA as a learning resource*.

Data suggested a cultural performance discourse was prevalent at the club, which influenced both player and coach perspectives of PA. In general, players placed a heightened importance on pre match presentations relating to the forthcoming opposition as opposed to post match PA video sessions, which had greater potential to be influenced by social and cultural factors (Foucault, 1972). Coach interview narrative revealed an understanding of the limitations associated with certain forms of PA feedback and suggested that its use in a formal format was often subject to a number of social and contextual factors, such as the dynamic of the group of players at the club, recent results and the 'mood' at the club. This study explored the perspectives of both players and coaches towards PA and demonstrated the influence of cultural and contextual factors on the application of PA in professional sport.

POD 2.5

The evaluation of goalkeeping performance analysis support used in senior professional and elite level youth football: An applied perspective

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Performance analysis support in football has the tendency to be somewhat general in terms of providing specific positional feedback with very few professional clubs having dedicated goalkeeping (GK) analysts at either senior or youth development levels (Elleray, 2011). Previous goalkeeping analysis research such as: Dive technique analysis (Spratford et al., 2009), performance characteristics (Bachi et al., 2007) and distribution tracking (Clemence et al., 2000) is rarely applied to the practice situation indicating a lack of knowledge regarding the implementation of goalkeeping performance analysis systems - especially at the all important youth development level. It is the aim of the present study to evaluate an applied goalkeeping specific performance analysis system from a qualitative perspective at both senior professional and elite youth levels.

The lead author's expertise and experience (MSc, UEFA B Coach – eight years) has led to the development of a number of performance analysis support strategies for goalkeepers that have been implemented at three professional clubs at both senior and youth levels (English Premiership Clubs A & B; English League Two Club C). The development process has involved 'trial and error of systems', interaction with experienced coaches and a comprehensive review where the final goalkeeper specific analysis system was determined. The final system focuses on three selected areas: Distribution; Technique and Match Views & Feedback (Stacked match views, regular analysis of training sessions, match action profiles, accurate shooting and distribution recordings). Fifteen semi-structured interviews were conducted at three professional clubs with the following personnel: Eight Senior coaches along with four senior and three elite youth goalkeepers.

Thematic content analysis highlighted the success of the system. Example quotations: Distribution: 'Distribution analysis was great as it helped to highlight areas in which balls were being played in and our success rates. Being able to see how the goalkeeper used different distributions and where possession was retained was crucial' (Senior GK coach, Club C); Technique: 'Being able to look in detail at goalkeeping techniques was extremely beneficial. Allowing the goalkeepers to review their own sessions to see how they were moving etc gave us a new perspective' (Senior GK coach, Club A); Match Views & Feedback: 'Performance and video analysis for goalkeepers isn't usually available so building this into a development plan was important. The match views opened up a new way to review matches' (elite youth player, Club B).

It is evident that methods are continually being developed to further enhance GK performance at the elite level although the gap between research and practice still needs further bridging. The GK specific performance analysis system developed has been well received by players and coaches and been demonstrated to be an extremely useful tool in monitoring specific GK performance.

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Clemence, R, Thomas, M, Grant & A, Williams, A. (2000) Goalkeeper distribution patterns in the Premier League. *FA Insight*. 3(2): 23-25.
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POD 2.6

The changing role of the performance analyst within a varying competition structure: A comparison of Superleague and International netball competitions

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The Performance Analyst increasingly plays an important role in top level Netball competitions. More recently coaches at both the International and top domestic levels of the sport have turned to performance analysis to assist in their decision-making and provide reliable and accurate information to inform their coaching process. Regardless of the type of competition the role of the performance analyst is to provide key information on performances which can be used to facilitate learning and effect an improvement. However, the nature of the performance analyst's work varies considerably depending on the characteristics of the competition. Thus it is important to highlight the differences and constraints which occur as a result of the competition structure and how they impact the work of the performance analyst. In this case comparison is made between the processes used by the analyst for Superleague versus International competition.

Basic models of the coaching process (e.g. Franks et al, 1983) identify the need and role of the performance analyst within the overall process but in reality the process undertaken by the analyst is more complex with many layers of observation, analysis, interpretation, planning and feedback. The level of analysis conducted is subsequently dictated by the nature of the competition. Within the UK the Superleague is the top domestic Netball competition which generally comprises 16 matches on consecutive weeks with a 2 week break midway through the competition. This structure affords the analyst time to conduct a full analysis of key team, unit and individual parameters and provide relevant statistical and video information. The coach subsequently has time to implement effective feedback and practice sessions to allow development and improvement before the next performance. However, the typical International competition structure which comprises multiple games in a restricted number of days, e.g. 6 games in 7 or 8 days, limits the amount of time available for analysis, feedback and practice. Thus the challenge in the International environment is to provide quality, relevant information at the appropriate time in the most effective way to facilitate improvements in performance within the competition.

In both competition environments the analyst is further challenged to continually ensure the most appropriate information is collected to fully define the performance of the team, units and individuals. At the same time they must ensure the reliability of all information collected and work effectively with the coach in accurately interpreting the analysis output to promote both immediate and long term improvements.

Franks, I.M., Goodman, D., & Miller, G. (1983) Analysis of performance: Qualitative or Quantitative. *SPORTS,* March.

SESSION 3: TEAM SPORTS

POD 3.1
From movement patterns to performance analysis tool: A simulated cricket batting innings for testing and training

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There is limited research on the factors which contribute to fatigue in cricket batting innings (often requiring prolonged, intermittent shuttle running). However, the development of Global Positioning System (GPS) technology has enabled straightforward collection of movement pattern data from matches. A current challenge is how to best apply GPS data for testing and training. Consequently, this paper documents the development of a simulated cricket batting innings (BATEX) with the use of previously collected GPS match data. This paper also presents reference values for performance and physiological data collected from a large number of BATEX trials (n = 68; 21 ± 3 years; 76.7 ± 8.8 kg; batting order number: 4 ± 2).

The running-between-the-wickets demands of BATEX were determined from analysis of World Cup scorecards (2003-2007). Time-motion analysis data of the movement patterns during cricket batting have recently been reported (Petersen et al., 2010). This data was used to demonstrate that the movement patterns during BATEX (assessed using 1Hz GPS units) reflected that of a high-intensity One-day hundred (Houghton et al., 2011). In BATEX, players batted against a bowling machine while running-between-the-wickets, during 6, 5 over (21 min) stages. Balls were delivered every 35 s to simulate the timings of a match. Before each ball an audio cue notified the batsmen of the running-between-the-wicket demands. In stages 1, 3 and 5 batsmen ran at a 'self-selected cruise' pace but in stages 2, 4 and 6 all runs were at maximal effort. An infra-red timing system (Swift, Australia) was used to sample both a 5-m sprint time (over the middle section of the singles) and time to complete 5-m in and out of the turns (5-0-5 m agility). Physiological measures included: heart rates, pre/post jump heights, sweat loss, blood lactate and body temperatures. Also, a subjective rating of % good bat-ball contacts was recorded (Müller & Abernethy, 2008). PitchVision™ technology was used to ensure similar ball delivery characteristics (line, length, speed) in each BATEX test.

The database of physiological responses for each BATEX stage (e.g. mean heart rate was 121 ± 12 beats·min^{-1} in Stage 1 but 144 ± 13 in Stage 4) will assist strength and conditioning coaches to predict exercise-intensities when using the simulation as part of a training program. Moreover, the typical distribution of running-between-the-wicket times and %good bat-ball contacts presented in this paper will allow sport scientists and coaches to gauge batting-specific fitness and ability of a player to effectively execute skill when physically stressed. In summary, this paper provides an example of how GPS data collected in matches can be practically applied to develop a training and performance analysis tool.

Houghton, L., Dawson, B., Rubenson, J., & Tobin, M. (2011) Movement patterns and physical strain during a novel, simulated cricket batting innings (BATEX). *Journal of Sports Sciences, 29:* 801-809.

Müller, S., & Abernethy, B. (2008) Validity and reliability of a simple categorical tool for the assessment of interceptive skill. *Journal of Science and Medicine in Sport, 11:* 549-552.

Petersen, C., Pyne, D., Dawson, B., Portus, M., & Kellett, A. (2010) Movement patterns in cricket vary by both position and game format. *Journal of Sports Sciences, 28:* 45-52.

POD 3.2

"But I don't get to touch the ball!"…To what extent does a modified netball game (MNG) influence the development of movement skills for 8-10 year olds playing netball?

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The purpose of the project was to examine game related differences in the execution of movement patterns and decision-making skills between Netball and a modified netball game (V-ball). Netball in New Zealand has been identified as a game of national and cultural importance (Nauright & Broomhall, 1994). Netball requires the adoption of specific roles for the duration of the game; for example goal shooter is a role that involves ball capture and goal shooting whereas wing defence is a predominantly a blocking or defending role. Zone rules in Netball enforce the use of particular skills and roles as part of successful gameplay. The skill demands and depth of skilled participation in Netball throughout New Zealand may be argued to force early specialisation on young netball players. Whilst successful at a junior level, such a strategy is unlikely to engender the broad scope of skill development demanded by higher performing adult netball play.

Twelve games were video-taped to examine the use of space and various technical decisions made in each of the games by the participants. This research has arisen from a discussion/collaboration with local netball coaches and the area Coaching Unit. As a high-strategy sport, netball demands the precise execution of technical motor skills as well as the application of tactical knowledge when making decisions Bock-Jonathan, Venter, and Bressan (2007). Kidman and Lombardo (2010), suggested that in sport the quality of decision-making has a profound impact on athletes' demonstrated expertise. Hence gameplay or tactics that stifle the development of these skills are to the detriment and long term enjoyment of the game. Internationally, a focus of skill acquisition through the theory of dynamical systems approach has pervaded research (Davids, et al, 2008). From a theoretical perspective it is argued that the adoption of stereotypical movements early in learning constrains the development and expression of skill later on (Chow, et al., 2007). Thus a variety of roles and play types is the best route to higher levels of expertise and performance later on. The research proposed here seeked to examine if long term exposure to netball play does indeed lead to limited expression of key movement skill when compared with exposure to a modified netball game that permits less stereotypical game-play.The current study is a cross sectional – observational design. We gathered information from several games and coded observations of appropriate skill and decision making for netball and V-ball. Independent variables are age group (8-10) and game-type (Netball, MNG). Dependent variables are the movement patterns (6) based upon the Bloomfield Movement Classification model (Bloomfield et al., 2004). Observation as a methodology has predominated in analysing actual decisions (Davids, Button & Bennett, 2008). The present study is also exploratory in nature insofar as specific hypotheses with respect to game-play differences are not presented. Participants were video-recorded for part of ten 20 minute netball, or modified netball games. A five minute period of play (first quarter, second quarter, third quarter or final quarter) was be selected at random and player's movement patterns were coded using the modified Bloomfield Movement Classification criteria with the use of Sportscode Elite[TM] software. Preliminary results of the study have supported the proposal that coaches using MNG created more opportunities for appropriate movement & decision-making opportunities with a higher level of skill execution than the use of traditional games. This would suggest that the use of modified games becomes more prevalent in the sport of netball to enable players to develop their movement & decision-making skills earlier in their career.

POD 3.3
Game movement demands and player performance in the Australian Football League

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[3]*Western Australian Institute of Sport, Australia*

Using global positioning system (GPS) data to quantify athlete movement demands is now prevalent in elite sports. Little is known about the relationship between athlete movement patterns and performance in Australian football. The aim of this study was to quantify movement demands of Australian Football League (AFL) players via GPS and assess their relationship with individual and team performance, within a single team over a full season. The 15-Hz portable GPS units (SPI Pro X, GPSports, Australia) used in the study initially underwent reliability testing for monitoring football specific movement demands. The following variables were then selected for use due to their low typical error values (<10%); distance (m.min^{-1}), V1 distance (m.min^{-1}), velocity load.min^{-1}, and relative velocity change (RVC).hr^{-1}. GPS movement data was collected from 30 AFL players from one club in 17 matches across the 2011 season. Movement demands for time on ground were related to both individual performance indicators (number of possessions and Champion Data$^{©}$ player rankings and pressure points) and team performance (quarter-by-quarter score margins). Factors added to analysis of individual performance were; match venue (home/away), playing conditions (wet/dry), time of day (day/night), days between games (6-12), and years of AFL playing experience. Players were also classified into stationary or nomadic positions; full backs, full forwards, centre half backs or centre half forwards were classified as stationary, all other players as nomadic. Factors used to analyse team performance were quarters 1-4 and quarter (+/-) result. Pearson correlations and stepwise multiple regressions determined the strongest indicators of performance, and one way ANOVA's and independent sample t-tests assessed differences in movement demands and performance.

Overall, individual movement demands mostly had weak, positive relationships (p<0.05) to individual performance measures; Champion Data$^{©}$ points (r=0.11-0.24), pressure points (r=0.15-0.37) and possessions (r=0.14-0.38). When separated into factors, nomadic players had higher (p<0.05) movement demand and individual performance values than stationary players, whilst players with 7+ years' experience recorded lower (p<0.05) movement demand values than 1-3 and 4-6 years, but were only lower in performance in pressure points.min^{-1}. For dry vs. wet, home vs. away, day vs. night and days between games (6-12), generally no differences in movement demands or performance were observed, except for after 12 days turnaround, with performance higher than for any other length of break between games. For team performance, weak, inverse relationships (p<0.05) were found between quarter point's margin and movement demands. For the movement variables distance (m.min^{-1}), V1 (m.min^{-1}), velocity load.min^{-1} and RVC.hr^{-1}, several weak, positive relationships were seen with the individual performance measures; number of possessions, and Champion Data$^{©}$ player rankings and pressure points. Greater movement demand and performance values were seen in nomadic players, 1-3 and 4-6 year players and after 12 days between games. No differences were observed for dry vs. wet, home vs. away and day vs. night for movement demands and performance. Weak, inverse relationships were seen with movement demands and quarter point's margin for team performance. Future research should separate movement demands into time in possession and not in possession, plus when the ball is in dispute, to further understand how movement demands might influence team and individual performance.

POD 3.4

Discriminant power in game-related statistics and game result according to setter position in the 2010 World Volleyball Championship

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The study of the knowledge of the match isn't a recent concern, since one of the biggest challenges of the investigation has been, for a long time, the concern for the interpretation and understanding of the development of the specific knowledge in team sports. The aim of the present study intends to identify the actions of the game which discriminate the result (win/lose), according setter location (attack zone and defense zone).

The sample of this study has been taken from the World Championship of Volleyball Male Seniors – Italy 2010. We analyzed n=24 games, which outcomes the result of 90 sets played throughout the 3rd round, which are the elite matches until the present study. These correspond to 24670 actions, in which 4083 services, 3434 receptions, 4906 attacks (3030 attacks after reception, 1876 attacks in transition), 2109 blocks, 1933 digs and 3299 sets. The Data Volley software was used in this research. Were analyzed the discriminating function (AD) in order to identify, throughout canonical structuring coefficient (CCE), the indicators which contribute the most to establish the maximum difference between the victories and defeats.

We consider as relevant to the interpretation of the linear composite the |CCE| ≥ 0,30 (Tabachnick & Fidell, 1996). The level of significance was established in 5%. The calculation of the results was made by the *software SPSS* version 17.0.

Regarding the results obtained throughout the positioning of the setter (defense zone and attack zone), the discriminating variables were service point, service error, excellent pass, pass error, excellent defense, side out error, counter attack point, attack point, excellent reception, side out point and reception error.

The service point action, they have a probable associate to the success (win). It's very important training the efficacy of this action according the final outcome.
The teams with less error in defense and block movements end up having the most successful result. Outcome, the pass has particular importance in the final outcome of the match when the setter is in offensive zone; the service point is rather important in the victory when the setter is in offensive zone. The counter attack discriminates the final outcome when the setter is in defensive zone; and finally the quality of the reception is determinant regarding the final outcome, when the setter is in defensive zone.

POD 3.5
Defensive strategy and critical match episodes in basketball game: analysing the teams' success

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Tactical variability is an essence of teams' sports competition (Garganta, 2009). The so-called Critical Match Episodes (CME) can be a consequence of these tactical changes, when one team tries to overlap its opponent. This study aimed to investigate the defensive strategies of basketball teams in the CME comparing them with the Normal Match Episodes (NME), when teams achieved different levels of match success.

The current score of 80 matches from the Basketball Portuguese League were reconstructed by ball possession. Each match was analysed according to the model of coach's game practical knowledge (Ferreira et al., 2010). A CME was considered as a transition of the equilibrium match state. A NME was defined as an episode, in which the match remained in the same equilibrium state. A total of 319 CME and 318 NME were determined. The NME were randomly selected respecting a homogeneity criterion with the CME identified in each match. Defensive strategy was analysed in each ball possession during the CME and NME. Seven main categories were considered to analyse the teams' defensive performance: (1) Global Strategy to the Defensive Transition (GSDT), (2) Defensive Pressure to the Outlet (DPO), (3) Ball Pressure in Defensive Transition (BPDT); (4) Defensive Phase (DP); (5) Defensive Type (DT); (6) Opposition Level to the Field Goals (OLFG) and (7) the Ball Recovering (BR). A total of 2665 ball possessions from CME and 2671 from NME were observed; intra and inter-observer ratings, estimated using the K-Cohen test, were 0,78-0,85. Teams were classified according to the match outcome: the winning and the losing teams. A χ^2 test was used to analyse the homogeneity differences between the qualitative characteristics of match episodes.

The comparison between CME and NME of winner teams exhibited differences in BPDT ($\chi^2_{(4, n=1371)}= 11.880$, $\rho \leq 0.01$), DP ($\chi^2_{(2, n=1371)}= 8.690$, $\rho \leq 0.01$), DT ($\chi^2_{(4, n=1371)}= 15.827$, $\rho \leq 0.01$). Losing teams showed more generalized differences when two types of match episodes were compared. Except the OLFG, the comparison between CME and NME in loosing teams showed significant differences in all categories.

Winning teams support their CME using a moderate ball pressure during defensive transition. Although with a low proportion of zone defences, results pointed out that the switching from man-to-man to a kind of zone defence could be an important reason to justify a CME. It can lead to a slight score advantage and help a team to achieve the match success.

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Ferreira, A.P., Volossovitch, A., Gomes, F. & Infante, J. (2010) Dynamics of coach's game practical knowledge in basketball. *International Journal of Sport Psychology*, 41: 68-69.

POD 3.6
The luck of the score: Partition of variance for performance analysis of team sports

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Team sport is won or lost on the scoreboard. Journalists write narratives around the result while fans exit the stadium in a dichotomy of elation or despair. This outcome bias also affects coaches, who are more likely to reinforce their strategy after a win than a loss – even a narrow loss (Lefgren, Platt & Price, 2012). A losing coach with a good grasp of key performance indicators (KPIs) may be able to claim that his team was somewhat unlucky to score less than its opposition, but that reasoning is often dismissed as a self-serving excuse by the sporting public.

In reality, a sports match is a complex process with thousands of natural random effects: the bounce of the ball, a gust of wind or slightly softer turf. When we record qualitative events inside the match, often it is a measurement of a spontaneous symmetry breaking, e.g. Player A takes possession instead of Player B, or Player C kicks the ball into the post not the goal.

Coaches and observers would like to derive a more robust metric of team performance than the scoreboard. This metric must be unbiased, i.e. averaged over a number of matches it should asymptotically approach the scoreboard average. It must also demonstrate lower variance across measurements and predictive power than the raw score.

The method employed in this paper is to segregate various independent KPI events, measure the characteristic size of each event's impact on scoreboard equity (O'Shaughnessy, 2006), and attempt to describe their natural variation using binomial variables. The outcome is a partition of gross score margin into its causes, both structurally on the field and as a best estimate of the 'luck' involved. As a demonstration, Australian Rules Football data is analysed, and a methodology for cricket performance analysis is introduced.

Lefgren, L., Platt, B., Price, J. (2012) Sticking with what (barely) worked: A test of outcome bias. *NBER Working Papers № 17477*.

O'Shaughnessy, D.M. (2006) Possession versus position: Strategic evaluation in AFL. *Proceedings of the 8th Conference on Mathematics and Computers in Sport*. (Published in a condensed form in *Journal of Sports Science and Medicine, 5:* 533-540)

SESSION 4: SPORT SCIENCE & MEDICINE

POD 4.1
Monitoring training fatigue with the orthostatic heart rate test during 9 weeks of intensified training in biathletes

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In monitoring the effects of training and non-training stress on an athlete, parameters that are inexpensive and practical to measure, with minimal disturbance to the training process, are preferred (Urhausen & Kindermann, 2002). Moreover, it is essential that such measures be accurate enough to give athletes and sport coach's scientific feedback on an athletes' preparedness to train; thus facilitating the training process and helping to determine the point at which training becomes maladaptive (Brink *et al.*, 2010). In the present study, the terms overreaching (OR) and overtraining (OT) will be used to express a disturbance in the stress-regeneration balance (Rietjens *et al.,* 2005).

The aim of this investigation was to determine the effectiveness of the orthostatic heart rate (OHR) test when tracking alterations in training stress during 9 weeks of intensified training in biathletes. In order to determine this, previously identified functional, haematological and hormonal markers of OT/ OR were examined during the 9-week period and the results correlated with that of the OHR indices. Eleven trained biathletes (age [mean ±SEM]: Male 22.2 ±0.9 yr, Female 28.2 ± 2.0 yr; height: Male 182.3 ±3.1 cm, Female 163.2 ±3.2 cm; VO_2max: Male 63.9 ±2.7 ml.kg^{-1}.min^{-1}, Female 54.5 ±1.6 ml.kg^{-1}.min^{-1}) underwent intensified training over a 9 week period. Intravenous blood samples, OHR, heart rate variability (HRV) and a 30 minute standardized sub-maximal treadmill test (STT) were undertaken at baseline, during the three training blocks (pre-, mid-, post-; training blocks duration 17 ± 2.2 days) and at the end of the 9 week period.

Training intensity increased during the 9 week period, TRIMP [mean]: (Block 1: 693.5, Block 2: 514.4, Block 3: 1025.12), Training hours [mean ±SEM]: (Block 1: 47.6 ±0.28 Block 2: 30.8 ±0.16 Block 3: 68.8 ±0.55), Average session RPE (Block 1: 14.6 ±0.03, Block 2: 16.7 ±0.03, Block 3: 14.9 ±0.04). During the STT, intensified training periods showed significant signs of overload identified with a decreased submaximal heart rate (HR: $P < 0.05$), decreased submaximal blood lactate (BL: $P < 0.05$), minimal changes in the HRV low frequency output (LF: $P < 0.05$) and low frequency/high frequency ratio (LF:HF: $P < 0.05$), increased cortisol levels ($P < 0.05$) and reduced testosterone ($P < 0.05$) and free testosterone/cortisol ratio levels (FCTR: $P < 0.05$). Furthermore the results showed increased OHR resting heart rate levels (RHR: $P < 0.05$) and a minimally decreased OHR 30 seconds post standing (P30: $P < 0.05$).

When correlated with the RHR index of the OHR test, strong correlations were found for submaximal HR (-0.71), submaximal BL (-0.72), testosterone (-0.86), FTCR (-0.71), as well as haemoglobin (Hb) (-0.88), and haematocrit (Hct) (-0.85) levels over the 9-week training period. Moreover, the P30 index revealed moderate correlations for submaximal HR (0.56), submaximal BL (0.34), LF (0.46), HF (.33), testosterone (0.41), Hb (0.49) and Hct (0.53) over the same training period. However, the peak upon standing (PH) index only produced a moderate correlation with cortisol (0.49) whereas correlations with all other indices were weak; submaximal HR (-0.21), submaximal BL (-0.21), testosterone (-0.17), FTCR (-0.17), haemoglobin (Hb) (-0.07), and haematocrit (Hct) (0.02)
Collectively, these findings suggest that the morning RHR index remains one of the most effective and practical non-invasive tools to use by coaches and athletes when monitoring training status and preparedness to train.

POD 4.2
The impact of side dominance on hamstring and quadriceps strength in junior footballers

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Isokinetic strength diagnostics play an important role in young footballer injury prevention. For this purpose maximum strength of hamstrings (H) and quadriceps (Q) is usually measured and the conventional strength ratio of H and Q (HQR) is often calculated (Dvir, 2004; Lehance, et al., 2009). The result of measurements is not consistent and affected, among others, by the age and speed used in testing (Forbes et al., 2009; Maly, Zahalka & Mala, 2010). The HQR is specific in terms of speed (Rosene, Fogarty & Mahaffey, 2001), but in terms of age and dominance it is not consistent (Forbes et al., 2009; Weir, 2000). The aim of the study is to evaluate the bilateral H and Q strength asymmetry and bilateral HQR differences among highly trained junior footballers.

Players (n=45; age17±1.2 years; height 178.4±5.3 cm, weight 68.5±7.6 kg) were measured at the beginning of a preparatory period. A group was further divided according to age into 3 subgroups – U16, U17, and U18. Concentric strength of H and Q was measured by the isokinetic dynamometer ISOMED 2000 at angular speeds of $60°·s^{-1}$, $180°·s^{-1}$ and $360°·s^{-1}$. The parameter evaluated was the peak torque (PT; Nm) from which a conventional HQR was calculated.

Results of ANOVA showed that within the whole group of players differences in PT of H and Q between DL and NL were insignificant at all speeds (flexion: p=0.19, p=0.71, p=0.49; extension: p=0.33, p=0.46, p=0.84). The differences were not significant even in the particular age categories. Significant differences between the ratio HQR on DL and NL were not found in any speed for the whole group (p=0.72, p=0.68, p=0.49) and for subgroups. The lowest HQR was found in the group U17 at the speed of $60 s^{-1}$ on DL (56%) and on ND (56%), which may indicate the possibility of an increased risk of injury.

The study indicated that in the observed group of junior football players' leg lateral preferences had no effect on the strength of H and Q and HQR.

Lehance, C., Binet, J., Bury, T. & Croisier, J.L. (2009) Muscular strength, functional performances and injury risk in professional and junior elite soccer players, *Scandinavian Journal of Medicine & Science in Sport,* 19: 243-251.

Dvir, Z. (2004) *Isokinetics (Muscle Testing, Interpretation and Clinical Applications)*, Edinburgh: Churchill Livingstone.

Forbes, H., Bullers, A., Lovell, A., McNaughton, L.R., Polman, R.C., & Siegler, J.C. (2009) Relative Torque profiles of elite male youth soccer: effects of age and pubertal development, *International Journal of Sports Medicine, 30*(8): 592-597.

Maly, T., Zahalka, F. & Mala, L. (2010) Iokinetic strength, ipsilateral and bilateral ratio of peak muscle torque in knee flexors and extensors in elite young soccer players, *Acta Kinesiologica, 4*(2): 17-23.

Rosene, J.M., Fogarty, T.D. & Mahaffey, B.L. (2001) Isokinetic hamstrings: quadriceps ratios in intercollegiate athletes, *Journal of Athletic Training, 36*(4): 378-383.

Weir, J.P. (2000) Youth and Isokinetic Testing. In L.E. Brown (Ed.) *Isokinetics in Human Performance* (pp 299-324), Champaign: Human Kinetics.

POD 4.3
Analysis of the combinations of movements (failure locus) that cause anterior cruciate ligament injury: Implications for prevention

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Anterior cruciate ligament (ACL) injury can be a season or career ending injury for athletes from a variety of sports worldwide. In the current literature, the various combinations of movements that cause ACL injury have not been determined. Despite the many ACL injury prevention programs that have been utilized at the collegiate level, ACL injuries have increased over a 16 year period (Hootman et al., 2007). Many researchers have proposed that the mechanism of ACL injury includes the combination of knee valgus and increased femoral external rotation relative to the tibia. (Boden et. al, 2000). However, many individuals do not sustain an MCL with ACL injury and many sustain medial or lateral meniscal injuries, suggesting more than one combination of movements that cause ACL injury (Shelbourne & Nitz, 1991). Frontal plane knee alignment (knee valgus and varus) and the ability to land on a single leg produce different stresses and strains within the knee and may be related to ACL injury (Yang et. al., 2009; Lawrence III et. al, 2008). In the present cutting edge research with real world application, an ACL failure locus, the various combinations of varus and valgus and internal and external rotation of the femur that cause anterior cruciate ligament injury was developed. A subject specific (26 yr, male, 735N, 173cm), 3-D finite element model was created from MRI. The MRI images were digitized using Rhinoceros 3.0 software (Seattle, WA, USA) and a 3D surface geometry of the bones, ligaments, articular cartilage and meniscus was created. The 3 D models were exported into ABAQUS v. 6.8 (Simulia, Providence, R.I., USA). The ACL, PCL, MCL and LCL were modeled as multi-bundled elements. The tibia was fixed, as when the foot is fixed on the ground and the femur was adjusted into varus, valgus, internal and external rotation until the ACL failed at 2160 N. Eighteen simulations were performed to determine the various combinations of movements that caused ACL failure. The results determined that in valgus, the MCL failed prior to complete ACL failure and femoral internal and external rotation had a varied effect on the amount of knee valgus needed to cause ACL failure. In the varus knee orientation, internal and external femoral rotation had little effect on the magnitude of varus angle required for ACL failure.Based upon the findings of this current research, teaching avoidance of a certain combination of movements may make real differences in ACL injury prevention.

Boden B.P., Dean S., Feagin J.A., Garrett W.E., Jr. (2000) Mechanisms of anterior cruciate ligament injury. *Orthopedics,* 23(6): 573-578.

Hootman J.M., Dick R., Age J. (2007) Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives*. J Athl Train,* 42(2): 311-319.

Lawrence III R.K., Kernozek T.W., Miller E.J., Torry M.R., Reuteman P. (2008) Influences of hip external rotation strength on knee mechanics and during single-leg drop landings in females. 23(6): 806-813.

Shelbourne K.D., Nitz P.A. (1991) The O'Donoghue triad revisited: combined knee injuries involving anterior cruciate and medial collateral ligament. *Am J Sports Med,* 19(5): 474-477.

Yang N., Nayeg-Hashemi H., Canavan P. (2009) The combined effect of frontal tibiofemoral knee angle and menisectomy on the cartilage contact stresses and strains. *Ann Biomed Eng* 37(11): 2360-237.

POD 4.4
The effects of temperature, travel and time off on Major League soccer team performance

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The Major League Soccer (MLS) season currently runs March through November, which is unique compared to most international league competitions. Owing largely to the geographic size of North America, MLS clubs from the United States and Canada are submitted to a wide range of playing conditions, including extreme variations of temperature, both natural grass and artificial turf playing surfaces, and long-distance travel which leads to varying rest between matches. With additional competitions (CONCACAF Champions League, US Open Cup, etc.) also included in many MLS clubs' schedules, teams will play as many as three matches in a single week.

This study quantifies the effects of temperature, rest time, and playing surface on MLS match performance. We apply mean comparisons and linear regressions to Prozone's MLS physical, technical and tactical database from 2008-2011, allowing us to look at effects on meaningful variables that are usually hidden behind statistically noisy goal and shot tallies.

We find that cold climate teams play poorly in away matches at high temperatures. There is no such advantage in cold weather games, since few matches take place below 40 °F. As temperature rises, players also run fewer meters and make fewer high speed runs. Teams perform only slightly worse and run a similar amount in matches played on short rest. Traveling across the country lowers winning percentage dramatically in the following week, however. Teams with natural grass fields have strong home *and* away records against artificial turf teams, which suggests that turf type itself has a limited effect. Rather, it seems that "artificial turf" teams are currently just not as good as "grass" teams.

Understanding the independent effects of temperature, turf and time off on the performance of MLS clubs is important, and should be considered in making scheduling and competition format policy. Our collection of results demonstrates that external conditions have important effects on match activity and performance that may have previously been overlooked.
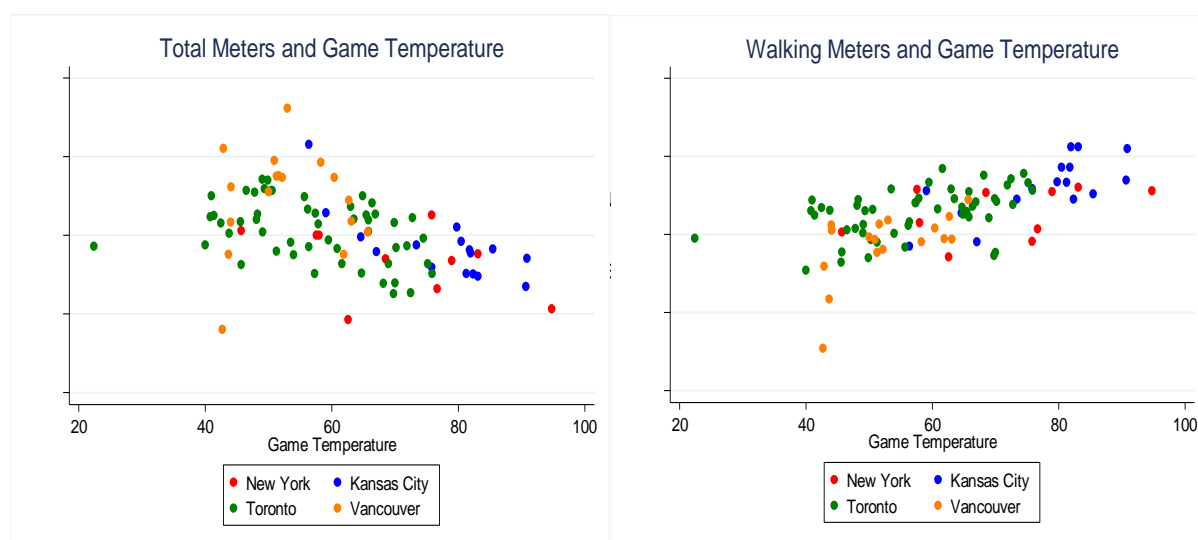
POD 4.5

The influence of environmental temperature on home advantage in Qatari international soccer matches

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The home advantage is a well-described worldwide phenomenon in soccer (Pollard, 2006) that influences the outcome of matches but varies considerably between countries. Several explanations including altitude or territoriality have been proposed to account for this diversity (McSharry, 2007; Pollard, 2006), though none has yet focused on potential environmental temperature influence. The present study examined the influence of environmental temperature on the home advantage for the soccer male national team of Qatar (QAT).

Reliable estimates of home advantage were calculated (% of matches won (W), Drawn (D) or lost (L)) for all the FIFA international matches of QAT against the other Gulf (GCC) countries vs. the other national teams' worldwide (nGCC). Data were obtained for the last 40 years, totaling 346 matches. Average temperatures of the month preceding the matches were collected both in QAT and in all opponents' countries for three different venues: home (H, played in QAT), away (A, played in the opponent' country) or neutral (N, played neither at H or A) and were expressed as difference (ΔT). Analyses of variance (ANOVA) were used.

During QAT games, environmental temperatures were $26.3 \pm 6.7°C$, $22.8 \pm 9.1°C$ and $22.8 \pm 6.3°C$ for H, A and N, respectively. When playing against GCC compared to nGCC, higher environmental temperatures were noted for A ($27.2°$ vs. $20.4°C$; $p<0.05$), but not H ($26.7°$ vs. $26.1°C$) and N ($22.4°$ vs. $23.0°C$) matches. When opponents were pooled, results were significantly affected by temperature (ΔT:$+6.6°$, $+5.8°$, $+9.3°$ for W (44.9%), D (27.9%) and L (27.2%), respectively; $p<0.05$). Against nGCC, H results (47.6%, 24.3% and 28.2% for W, D and L, respectively) were significantly ($p<0.05$) different compared to A (33.3%, 14.0% and 52.6%) and N (35.3%, 27.5% and 37.3%). These results correspond to significantly different ΔT (H: $+8.4°$, $+9.2°$, $+12.0°$; A: $+3.4°$, $+8.4°$, $+7.6°$; N: $+5.0°$, $+13.5°$, $+13.0°C$ for W, D and L, respectively; $p<0.05$). Not surprisingly, no difference was found for ΔT between H ($+1.4°$, $+0.3°$, $+1.9°C$ for W (38.6%), D (36.4%), L (25.0%)) and A ($+1.0°$, $-0.3°$, $+0.3°C$ for W (25.0%), D (21.4%), L (53.6%)) against GCC countries.

The results confirmed the existence of a home advantage for the soccer national team of Qatar. However, it appears that environmental temperature has an influence since at home Qatar won less against GCC countries with similar temperature than against countries with cooler climate. Therefore, since heat alters soccer performance and acclimatization is paramount when playing in hot environment (Dvorak and Racinais, 2010), these results suggests that it will be an important component of the teams' preparation in perspective of the FIFA World Cup 2022.

Dvorak J., Racinais S. (2010) Training and playing football in hot environments. *Scandinavian Journal of Medicine and Science in Sports,* 20(Suppl 3): iv-v.
McSharry P.E. (2007) Effect of altitude on physiological performance: a statistical analysis using results of international football games. *British Medicine Journal,* 335: 1278-1281.
Pollard R (2006) Worldwide regional variations in home advantage in association football. *Journal of Sports Sciences*, 24: 231-240.

SESSION 5: SOCCER 1

POD 5.1

Home advantage in derby and non-derby matches in the Serie A Brazilian National Soccer League, from 2007 to 2011

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Home advantage has been explained by numerous factors related to game location (crowd and travel effect, familiarity), physiological states of players, coaches and referees, etc. (Carron et al., 2005). The aim of this study was to assess the home advantage effect on teams' performance in derby and non-derby matches in different competition contexts characterized according to the quality of opposition, distance travelled and game's assistance in Brazilian professional football. The match was considered to be a derby when a game was played between two local teams.

The sample consisted of 3412 matches (222 derbies and 3190 non-derbies) of Premier Brazilian National League, played in five seasons from 2007 to 2011. Data was collected from www.ogol.com.br and www.cbf.com.br web sites. The teams' performance in each derby and non-derby matches was characterized by the following variables: 1) match outcome, 2) quality of opposition, 4) game attendance and 5) distance travelled by the team. The quality of opposition was determined by the difference between the latest rankings (RD) of the considered team and the opponent, was used. A k-means cluster analysis was performed to identify a cut-off value of RD and classify the quality of opposition into four groups, i.e. much better positioned opposite team, better positioned team, worth positioned team and much worse positioned team. The home advantage has been quantified as a number of matches won at home and expressed as a percentage of the total games played at home and away under a balanced schedule. A t-test was used to compare the magnitude of home advantage in derby and non-derby matches and Chi-squared test was performed to examine the home advantage effect in different competition contexts.

The results confirmed the slight home advantage effect in Brazilian professional Football League. In general 51.1% of all matches were won by home teams. This effect was not consistent through the five seasons, varying from 54.6% in 2008 to 47.1% in 2010 season. The comparative analysis of home advantage in derby and non-derby matches played from 2007 to 2011 has clearly pointed out the decreasing of home advantage magnitude in derby (30%) comparatively to non-derby matches (53%). The quality of opposition revealed the significant impact ($p \leq 0.05$) on the home advantage magnitude, but only in non-derby matches. Chi-square test has revealed the significant association ($p \leq 0.05$) between game attendance and winning percentage of home teams in non-derby matches. The same relationship has been observed regarding distance travelled by the away team. For example, when the team travelled more than 2600km, the winning percentage of home teams increased to 79.6%. The results suggested that to better understand the home advantage effect, it should be studied in relation with other factors that influence teams' performance (like quality of opposition, previous games outcomes, etc.). Further research should consider using complex and dynamic approaches rather that static and linear methods.

Carron, A., Loughhead, T.M. & Bray, S.R. (2005) The home advantage in sport competitions: Courneya and Carron's (1992) conceptual framework a decade later. *Journal of Sports Sciences*, 23(4): 395 – 407.

POD 5.2

The application of normative performance profiling for talent Identification in youth association football

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Talent identification is the process by which an individual is selected based upon judgements made about their future performance potential. Traditionally, professional football clubs rely on the subjective judgements of scouts or coaches when assessing players (see Williams and Reilly, 2000), but Costa *et al.* (2010) have suggested that when selecting and identifying players for future development, skill assessments such as technical components should be emphasised, with a lesser degree of importance placed on physical attributes. One approach that could provide invaluable technical performance insights is the normative performance profiling technique (O'Donoghue, 2005).

Prozone Match-Insight (Prozone Sports Ltd, Leeds, UK) was used to analyse all thirty matches from the 2009/2010 season of a professional football club's U18 academy side. Key position-specific performance indicators (KPI's) were selected for each individual player and cross-validated with the team's coach. Normative performance profiles were then created for each player using the technique proposed by O'Donoghue (2005). Briefly, this entailed comparing the mean, upper quartile and lower quartile for each of the individual player's KPI's against the normative data derived from opponents of the same position.

The results of the current study (Figures 1 and 2) demonstrate the utility of normative performance profiling for talent identification. Normative profiling allows strengths and weaknesses of players to be identified and KPI's to be directly compared to players from the same position. Used in conjunction with traditional maturational factors, analysis of technical performance using such a profiling technique would provide a more holistic account of player potential and more appropriately inform talent identification processes.

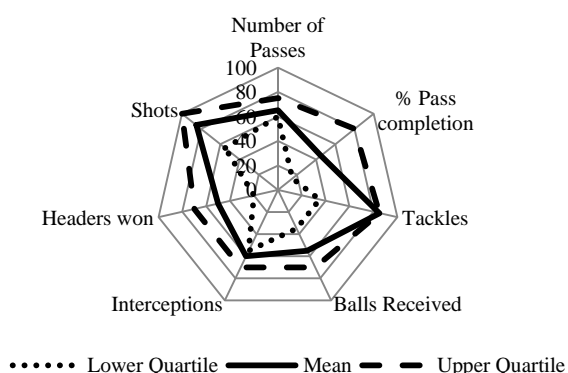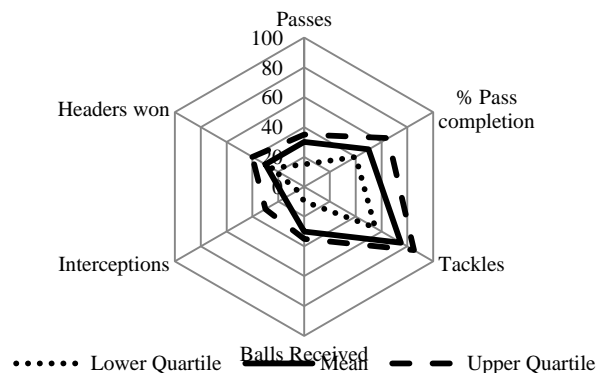Figure 1. Central defender normative performance profile

Figure 2. Central midfielder normative performance profile.

Costa, I.T., Garganta, J., Greco, P.J., Meaquita, I. & Seabra, A. (2010) Influence of relative age effects and quality of tactical behaviour in the performance of youth soccer players. *International Journal of Performance Analysis in Sport*, 10(2): 82-97.

O'Donoghue, P. (2005) Normative profiles of sports performance. *International Journal of Performance Analysis in Sport,* 5: 104-119.

Williams, A. & Reilly, T., (2000) Talent identification and development in soccer. *Journal of Sports Sciences*, 18 (9), 657-667.

POD 5.3
Identifying individual tactical profiles according to playing position in association football

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[4] *Department of Performance Analysis, Manchester City FC, Manchester, UK*
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The understanding on the specificities of how players manage the space and time according to their playing positions remains a challenging task for coaches, researchers and performance analysts. The purpose of this study was to determine the tactical profiles associated to the spatial-temporal relations of players according to their playing positions. More specifically, we aimed to quantify the players' functional space of influence, as well as the number of local spatial interactions with teammates and opponents.

Positional data (2D) from two matches of the English Premier League were obtained with Prozone® tracking system. Using the dominant region method (Taki & Hasegawa, 2000), we calculated: i) the area under the influence of each player over time, ii) the number of intra- and inter-team local spatial interactions of each player and, iii) the percentage of time of dyadic pairing and triadic grouping.

Data indicated a distinct profile in the area under the influence of each player. The midfield players presented low areas than forwards, with the higher values attributed to defenders. The local spatial interactions evolved from high number of intra-team relations for the defending players to high number of inter-team relations to the forwards. Regarding yet the intra-team local interactions, at 70% of time the dyadic pairing revealed different patterns of stability in each team (left panel), while at 40% of time only one team showed triadic grouping (right panel). Those patterns (i.e., dyadic and triadic grouping) were found only in the defender players.
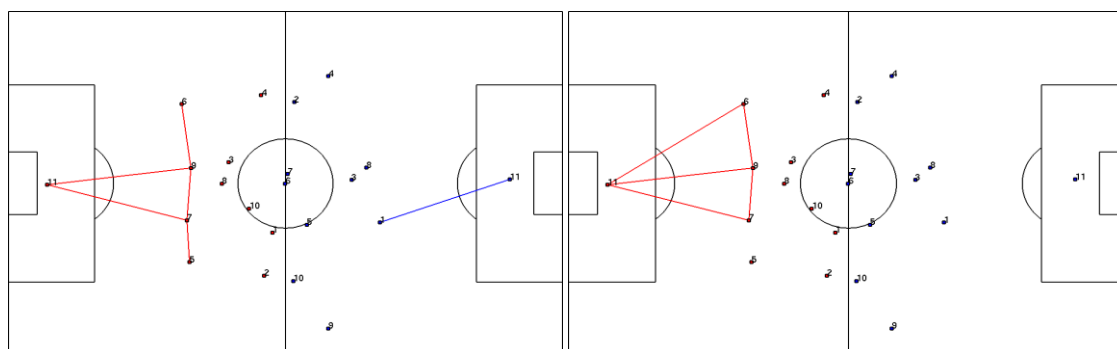
In synthesis, findings suggested that comparing with the forward and midfield players, defenders possess superior values of field space, more quantity and stability of local interactions with teammates and less number of local interactions with opponents. Differences between teams should be interpreted in reference to the specificities of each collective.

Taki, T., & Hasegawa, J. (2000). Visualization of dominant region in team games and its application to teamwork analysis. In: *Proceedings of the International Conference on Computer Graphics* (p.227-235). Jun 19-24, Geneva, Switzerland.

POD 5.4
An analysis of successful offensive sequences in football

António Barbosa[1], Hugo Sarmento[2], Antoni Planas Anzano[1] & Jorge Campaniço[2]

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The main purpose of this study was to investigate the existence of regular behavior patterns regarding the offensive sequences that end in goal. We analyzed two top level teams that share the same coach and the same technical staff. The selected teams are Real Madrid (2010/2011) and International Milan (2009/2010).

To collect data, we used the instrument developed and validated by Sarmento *et al*. (2010). This instrument consists in a specific notation analysis to study the offensive process and its variables.

Several offensive sequences were coded through the observation of 24 games of Inter Milan and Real Madrid, 12 per each team.

In order to verify pattern occurrence, we used the software THÈME 5.0, which is a professional system for detecting and analyzing hidden behavioral patterns, by performing intensive structural analysis of behavioral data. It detects complex repeated patterns that would otherwise remain hidden. The reliability of the data was calculated by the intra and inter observer agreement, and values above 0.95 (Cohen´s kappa) were achieved for all the variables. For pattern detection, we only considered the ones that were repeated 3 times, and the significance level was set at 0.005.

We detected 13 incomplete patterns, regarding the last three actions before scoring. In all recorded patterns the last actions that result in goals occurred in zone 11. We observed a greater activation of left lateral corridor, especially in the action previous to scoring. All patterns recorded, ended on relative numerical inferiority.

The analysis of the T-patterns complements previous research. The finishing zone with scoring is the frontal part of the goalpost Zone11, demonstrating that both teams look for this zone to finish the offensive process. We observed strong influence of the left corridor before finalizing. The teams look for less populated areas, and side corridors to approach the goal. The most often recorded development, before the goal is the pass, increasing the game speed, reducing the time to organize the opponent team. The use of the dribble was only registered in zone 11, the teams seek this risk development in the offensive sector.

We have found that there are principles and sub-principles, patterns, actions that lead to goal achievement. These data help to confirm the existence of a common game model, which is flexible allowing adjustment to different scenarios.

Sarmento, H., Anguera, T. Campaniço, J. & Leitão, J. (2010) Development and validation of a notational system to study the offensive process in football. *Medicina (Kaunas), 46(6):* 401-407.

POD 5.5
First goal and home advantage at different levels of play in professional soccer

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Home advantage (HA) has recently been reported to be frontloaded in the NBA (Jones, 2007) and NHL hockey (Jones, 2009). HA exists in all professional team sports, but is most pronounced in soccer (Pollard, 2006). The purpose of the present study was to investigate whether HA in professional soccer is also frontloaded. Further, the effect of different levels of play and the hypothesis of psychological momentum will also be examined.

Internet data on all goals (N=3423) scored in seasons 2009 and 2010 of Norwegian top league (NTL) and seasons 2008/09 and 2009/10 of English premier league (EPL) were used. HA was calculated using goals scored and was expressed as home goal percentage (HGP). HA will be considered frontloaded if HA in first goals is larger than in subsequent goals and amounts to a large part of HA in complete matches. The significance of the difference between two independent proportions was tested by a chi-square analysis. An alpha value of < 0.05 was used in all tests.

The results showed that HA in first goals (lowest=58.88% in EPL season 2008/09 and highest=61.64% in NTL season 2010) is overwhelmingly significant (P<0.001) in all four seasons. Table 1 shows that mean HA in first goals was consistently larger than in subsequent goals, but the difference was not significant. Mean HA in complete matches was 62.37% in NTL and 60.87% in EPL. Thus, HA in professional soccer is heavily frontloaded as HA in first goals comprises of over 85% of the HA in complete matches. A contribution of HA in first goals to HA at the end of the match was somewhat larger in EPL (88.50%) compared to NTL (86.58%). Further, the momentum hypothesis was rejected in both NTL (P<0.001) and EPL (P=0.004). Only home teams scored more subsequent goals when they scored first goal.

Table 1. Number of goals and home goal percentage (HGP) for first goal and subsequent goal over all two seasons of Norwegian top league (NTL) and English premier league (EPL).

| Variable | N | NTL | | | | N | EPL | | | |
		Home team	Away team	HGP	P[*]		Home team	Away team	HGP	P[*]
Goal type										
First goal	453	275	178	60.71	0.602	686	409	277	59.62	0.702
Subsequent goal	975	577	398	59.18		1309	768	541	58.67	

[*]Fisher's Exact Test.

Jones, M. B. (2007) Home advantage in the NBA as a game-long process. *Journal of Quantitative Analysis in Sports,* 3: 1-14.

Jones, M. B. (2009) Scoring first and home advantage in the NHL. *International Journal of Performance Analysis in Sport,* 9: 320-331.

SESSION 6: MOVEMENT ANALYSIS

POD 6.1
Analysis of team and player performance using recorded trajectory data

Robert Timmermann[1], Michael Dellnitz[1], Rasmus Jakobsmeyer[2], Reinhard Schnittker[2], Per Wilhelm[3], René Zorn[3] & Hanyi Li[3]

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Beginning in the early 1990s a number of tracking systems for team sports have been developed (Santiago et al., 2010). To record the player trajectories, these systems usually rely either on video footage from the games, which is processed using software tools, or on sensors which are attached to the players. The collected data needs to be post-processed to be usable by e.g. players, coaches, or others interested in team or player performance. In this work we will use data recorded by the Sports Performance Analyzer's (SPA) tracking system (Wilhelm et al., 2010) and illustrate its methods for the performance analysis, varying from low level statistical trajectory analysis to higher level play recognition and matching.

The SPA tracking system consists of two overhead cameras in the sports hall which record the game from a bird's eye view point. The video streams are used to track the players offline, and the players' trajectories are available for further analysis (see Wilhelm et al. (2010) for a comprehensive introduction). In this contribution, first we explain a method for the automatic segmentation of a game into action and break phases using the recorded trajectories. Based on this data we can compute the players' covered distance and running time for the *net game time* (i.e. action phases when the game was actually running) and for the complete game including breaks. This data can be further divided into speed classes for a more detailed analysis of the running efforts, and broken down to single players, parts or teams. We are also able to detect so-called *run-phases,* where one team scored several points while the other team did not score at all, and restrict the aforementioned analysis to these phases. Our second analysis technique is the extraction of specific plays from the trajectory data. These plays are stored in a database and similar plays are filtered out using self organizing maps.

We applied the play extraction and matching algorithms to recorded basketball games from the German major league and were able to extract and match single plays. In 18 analysed games from three different seasons, the automatic net-time segmentation was on average 90.0% accurate. The distance and time analysis gives a fast way to extract valuable and easily interpretable information from the trajectory data. The information about running distance and time gives insight into the physical demand on the players in a specific sport. By analysing a series of games we are able to generate a detailed activity profile for the individual players, which could be used to fine tune their training. Being able to extract and match similar plays gives us the possibility to evaluate the performance of a specific play by e.g. computing the average number of points scored in this play.

Santiago, C. B., Sousa, A., Estriga, M.L., Reis, L.P. & Lames, M. (2010) Survey on team tracking techniques applied to sports. *International Conference on Autonomous and Intelligent Systems*, Povoa de Varzim, Portugal.

Wilhelm, P., Thomas, P., Monier, E., Timmermann, R., Dellnitz, M., Werner, F. & Rückert, U. (2010) An integrated monitoring and analysis system for performance data of indoor sport activities. *Proceedings of the 10th Australasian Conference on Mathematics and Computers in Sport,* Darwin, Australia.

POD 6.2
Distance covered and average speed of movement during the 2012 British Open under 21 real tennis final

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Real tennis is the original racket sport from which lawn tennis descended. It is played indoors on a court which is not perfectly symetrical or standard in size (Figure 1). The scoring system (love, 15, 30 , 40, deuce) was copied by lawn tennis although sets are won in real tennis by sudden death to 6 games. Whilst the game's origins are uncertain it is believed to have started in the 12th century and current rules maintain this heritage by regulating that the construction of the racket and balls remain unchanged. This often results in very fast shots being played, which do not bounce very high and are difficult to hit. Consequently it is expected that rallies will be shorter than other racket sports and there is no published data regarding distances and speeds. One match played at the Middlesex university court (96' long, 31'6" wide at the service end, 30' wide at the grille wall) was filmed using 7 HD cameras installed for analysis purposes. The images from the two overhead cameras (centred above each side of the court) were processed using SAGIT software (Perš *et al.*, 2001) to automatically track the players' (both World ranked around no. 50) movements. Rally data tended to be positively skewed with outliers hence Wilcoxon Signed Ranks tests were used to determine differences. The match duration (75m 28s) consisted of 227 rallies (lasting an average of 8.49s (SD=6.75s) resulting in 42.55% ball in play time. The match winner covered a total of 2632m during rallies at an average of 11.59m per rally (SD=9.62m) which was significantly further (z=3.02, p<.01) than the loser (2481m during rallies at an average of 10.93m per rally (SD=10.08m)). This corresponded to a similar difference in velocity (z=3.82, p<.001) with the winner moving at an average velocity of 1.33m/s (SD=0.33m/s) in comparison to the loser (1.20m/s, SD=0.39m/s).
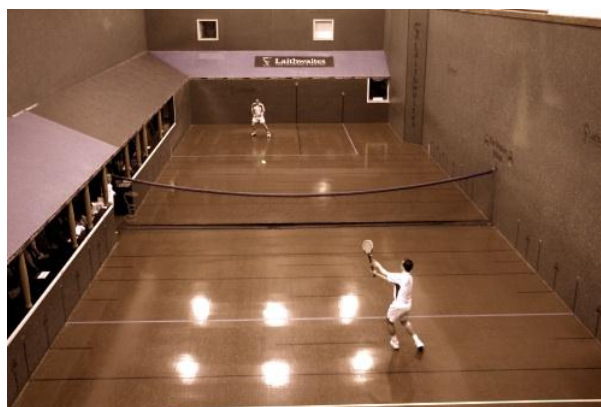

Figure 1: Real tennis court view from behind service side
(Note: Lower back wall contains the grille (right side) and tambour (causes lack of symmetry))

Perš, J., Vučković, G., Kovačič, S. & Dežman, B. (2001). A low-cost real-time tracker of live sport events. In *Proceedings of the 2nd international symposium on image and signal processing and analysis in conjunction with 23rd International conference on information technology interfaces* (edited by S. Lončarić and H. Babić), pp. 362-365. Zagreb: Faculty of Elektrical Engineering and Computing.

POD 6.3
Running performance analysis in basketball using recorded trajectory data

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[2] *Chair of Applied Mathematics, University of Paderborn, Germany*
[3] *Cognitronics and Sensor System Group, CITEC, Bielefeld University, Germany*

The aim of this explorative study was to investigate the activity profile in basketball during competition, for the first time taking into account both teams at once. It is also the first application of the Sports Performance Analyzer (SPA) to analyse both teams on court, comparing winner to loser. We discuss the performance of offence and defence separately. While McInnes et al. (1995) found no changes in high intensity activities between quarters, Ben Abdelkrim et al. (2010) identified significant decreases from quarter one to two and quarter three to four. Solving this contradiction seems to be important to quantify on-court running performance, find reasonable performance requirement estimations and specify instructions for training.

A sample of four games of the German Pro-A-League during the season 2010/2011 was evaluated using the automatic tracking system SPA (Wilhelm et al., 2010). For the first time we used particle-filter based tracking instead of template tracking. Running performance of eight teams (70 players; average age 25) was analysed. All players were tracked to generate individual activity profiles composed of running distances and intensities according to net and gross time. Intensities were *Standing* (<0.7 km/h), *Walking* (0.7-7.2 km/h), *Jogging* (7.2-14.4 km/h), *Running* (14.4-19.8 km/h) and *Sprinting* (>19.8 km/h).

No significant difference between running performance of winner and loser was found. Running intensity and distance differed between offence and defence, running and sprinting efforts are greater in offence than in defence. A significant decrease of on-court performance was determined for quarter one to two and for quarter three to four. Dividing the games in two halves the performance also decreases in the second half.

This study provides novel information with practical relevance for players, coaches and researchers in basketball. They increase the understanding of requirements and demands in competition. Further information of specific problems and aspects in basketball competition is added. This investigation enhances the knowledge on specific terms in basketball games, especially differences in running performance among quarters. The used particle-filter based tracking algorithm is faster and more error-prone than template tracking, thus making the Sports Performance Analyzer more reliable and easier to use.

Ben Abdelkrim, N., Castagna, C., El Fazaa, S. & El Ati, J. (2010) The effect of players' standard and tactical strategy on game demands in men's basketball. *Journal of Strength and Conditioning Research,* 24 (10): 2652–2662.

McInnes, S.E., Carlson J.S., Jones C.J. &. McKenna M.J. (1995) The physiological load imposed on basketball players during competition. *Journal of Sport Sciences,* 13: 387–397.

Wilhelm, P., Thomas, P., Monier, E., Timmermann, R., Dellnitz, M., Werner, F. & Rückert, U. (2010) An integrated monitoring and analysis system for performance data of indoor sport activities. *Proceedings of the 10th Australasian Conference on Mathematics and Computers in Sport,* Darwin, Australia.

POD 6.4
The use of Global Positioning Systems in elite rugby union

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Recent research has suggested that decrements in performance among team sports players towards the latter parts of matches are attributed to the onset of fatigue (Aughey, 2010; Austin & Kelly, 2012), which has the added cost of increasing their susceptibility to injury (Brookes et al., 2008). To date, however, little objective evidence exists on whether such decrements, particularly in terms of locomotive actions, occur in the sport of rugby union, which has one of the highest injury rates across all team sports (Brookes et al., 2005). Therefore the aim of this investigation was to identify whether notable changes occurred in important locomotive variables between the first and second halves and between the four quarters of matches played throughout the English Premiership.

Following ethical approval, 98 elite rugby union players (age 27.0 ± 4.0 y; body mass 104.0 ± 13.0 kg; stature 1.87 ± 0.07 m) from 8 English Premiership Clubs were tracked using GPS SPI Pro 5 Hz units during 44 competitive Premiership matches played in the 2010/2011 season. Overall, 276 GPS data files compiled from these matches were analysed with GPSports Team AMS software. Locomotive performance was quantified for each player during the first and second halves of match play, and during each quarter via measures of metres covered per minute ($m.min^{-1}$), maximum speed ($km.h^{-1}$), and percentage of total distance covered whilst sprinting, striding, cruising, jogging and walking. The data were analysed by two positional groupings (Forwards/Backs and separately Front Row/Second Row/Back Row/Scrum Half/Inside Backs/Outside Backs) across the specified match periods using non-parametric statistics. The results highlighted significant ($p < 0.05$) reductions among all positional groups except Scrum Half in relative distance covered from the 1st to 4th quarter (as much as -13.5% for the Back Row and -12% for Front and Second Rows). Peak speed between the 1st and 4th quarter was also found to decrease among the Front Row (-11.6%) and Second Row (-10.2%) groups, but not among any other positional groups. These findings endorse those of Austin and Kelly (2012) who analysed 10-minute segments of a rugby league match, and, importantly, provide tangible support for the notion that movement-related fatigue is evident in the latter aspects of elite level rugby union matches. Such knowledge should be accommodated by coaches in their preparation and recovery schedules, and substitution policies.

Aughey, R.J. (2010) Australian football player workrate: Evidence of fatigue and pacing? *International Journal of Sports Physiology & Performance 5:* 394-405.

Austin, D., & Kelly, S. (2012) Positional differences in professional rugby league match-play through the use of global positioning systems. *Journal of Strength and Conditioning Research.* DOI: 10.1519/JSC.0b013e3184e108c.

Brookes, J., Fuller, C., & Kemp, S. (2008) An assessment of training volume in professional rugby union and its impact on the incidence, severity, and nature of match and training injuries. *Journal of Sports Sciences, 26:* 863-873.

Brookes, J., Fuller, C., Kemp, S., & Reddin, D. (2005) Epidemiology of injuries in English professional rugby union: part 1 match injuries. *British Journal of Sports Medicine, 39:* 757-66.

POD 6.5

Distance covered, speed of movement and heart rate of the world champion padel player during a relatively easy 2011 pro tour match

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[3]*Middlesex University, London, UK*

Padel is an extremely popular participation sport in South America and Spain, similar to tennis but always doubles, and has also become a major social interest topic referred to as the "paddle phenomenon". However, physical activity parameters of elite players of this relatively new sport have not, to the authors' knowledge, been analysed previously; information of which could help coaches to improve the specificity of training. One match during a Padel Pro tour event in Valencia (November, 2011) was recorded using a video camera placed above the central point of the court. Distance covered and the speed of movements were calculated using the SAGIT software (Perš *et al.*, 2001) whilst the heart rate of one player (age = 31), world ranked number one by the International Padel Federation, was monitored using the Polar RS 800 unit and analyzed with the Polar Pro Trainer 5 software. All data was transferred to Microsoft Excel for analysis. The results for total distance, average and maximum velocity and heart rate were calculated for the total match time as well as the active and passive phases of the match (Table 1). The average heart rate was very similar to that found in a previous study of padel (Carrasco et al., 2011) but the maximum was higher than previously found even though the players in the previous study were elite players but almost 15 years younger (16.57 ± 1.51). 71.72% of the time was passive (between rallies) and hence accounted for a significant proportion of the distance covered. The average heart rate during the active phase (157.5) suggested that the work intensity was typically anaerobic in nature (maximum 199) but the relatively long rest periods allowed the player's heart rate to decrease somewhat.

Table 1: Activity parameters for World No. 1 player during a 6/1/6/1 Pro Tour match win

	TOTAL	ACTIVE	PASSIVE	MAXIMUM
DISTANCE (m)	2005	963	1042	
VELOCITY (m/s)	0.71	1.22	0.5	4.92
TIME (s)	2818	791	2021	
HEART RATE (beat/min)	149	157.5	145.7	199

Carrasco, L., Romero, S., Sañudo, B. & de Hoyo, M. (2011) Game analysis an energy requirements of paddle tennis competition. *Science & Sports*, 26(6): 338-44.

Perš, J., Vučković, G., Kovačič, S. & Dežman, B. (2001). A low-cost real-time tracker of live sport events. In *Proceedings of the 2nd international symposium on image and signal processing and analysis in conjunction with 23rd International conference on information technology interfaces* (edited by S. Lončarić and H. Babić), pp. 362-365. Zagreb: Faculty of Elektrical Engineering and Computing.

POD 6.6
An analysis of indoor team sports using fast tracking methods on global processing unit and multicore processors

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[3]*Chair of Applied Mathematics, University of Paderborn, Germany*

The Sports Performance Analyzer (SPA) is a system for evaluation and analysis of team athletes' performance data. The SPA monitors players with two cameras which are installed under the sports hall ceiling. The video data is processed automatically, and the players' positions on the field are determined continuously for the whole game (Wilhelm et al., 2008). Fast processing and low error rate of the player tracking are two key aspects for the coaches and researchers in sport and coaching science. There is also a high demand for getting accurate performance data fast enough for real time scenarios. The core features of the SPA system are pre-processing of image data, tracking algorithms, as well as processing of the tracked data. The newest tracking algorithm in the SPA system is based on particle filter techniques which are implemented in order to reduce tracking errors. Graphics processing units (GPUs) and multi-core processors are used to accelerate pre-processing operations.

The image pre-processing in SPA includes algorithms for colour space interpolation, geometric and perspective transformation (e.g. fisheye lens distortions). Performance gains are achieved by reducing the runtime of these algorithms using parallel processing and closed world assumption is used to reduce errors in tracking. A dynamic player model and a colour-based likelihood function (Bhattacharyya distance between the state histogram and the reference histogram) are implemented for the particle filter-based player tracking in SPA (Monier, 2011).

The maximal speedup of pre-processing is 3.02x using multi processors and 7.57x running our algorithms on the GPU (using a test system with an Intel Core i7-950 CPU @ 3GHz combined with a state of the art graphics card). There are two important parameters of the particle-filter based tracking algorithm: the number of particles and the number of histogram bins for each colour channel. Experiments have been conducted in order to find for a suitable number of histogram bins the optimal number of particles. The previously used algorithm (template matching) leads to an average of 3.3 corrections per player and minute while the new particle-filter based algorithm reduces the rate to 0.5 corrections per minute and player (Monier, 2011).

The results show that the speedup of pre-processing is remarkable. The particle-filter based algorithm provides lower error rate in tracking. Faster image processing and higher tracking accuracy increase the efficiency of team performance analysis (e.g. for coaches, researchers and media). In future work the acceleration of the particle-filter based algorithm will also be done using parallel hardware platforms.

Monier, E. (2011) *Vision Based Tracking in Team Sports*. Heinz Nixdorf Institute, University of Paderborn, PhD Thesis.

Wilhelm, P., Monier, E., Xu, F. & Witkowski, U. (2008) Analysis of indoor team sports using video tracking and wireless sensor network. In: *World Congress of Performance Analysis of Sport VIII*, S. 165-169, Magdeburg, Germany, 3-6th September.

SESSION 7: RACKET SPORTS

POD 7.1

Consistency of key performance indicators for tennis match analysis in Grand Slam tournaments from 2005 to 2011

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The purpose of this study was to compare the differences of identification of performance indicators which were distinguishing the winning and losing performances in Tennis Gland Slam competitions. Especially, the consistencies of identification on Performance Indicators through statistical comparisons using Wilcoxon Signed Ranks tests were considered. For this study, 1,929 matches and 6,888 sets were selected as subjects in 4 Grand Slam tennis competitions (from 2005 to 2011). Totally, 10 performance indicators were selected from the official stats of 4 Grand Slam tennis championships as independent variables for this study that they were % of 1st serves succeed, aces, double faults, unforced errors, winning % of successful 1st serve, winning % of successful 2nd serve, winners(included serves), receiving points won, break points conversions and % of net approaches. As results of the study, there were 3 summarised findings as following below;

Firstly, there were significant differences of all 10 performance indicators between winning and losing where the data were arranged as match results ($p<.05$). Likely, there were also significant differences of 10 performance indicators between winning and losing where the set data were used for comparisons ($p<.05$).

Secondly, there were significant differences on 5 performance indicators distinguishing winning and losing where matches' data were used in the comparisons between championships separately ($p<.05$). The performance indicators were winning % of successful 1st serve, winning % of successful 2nd serve, winners (included serves), receiving points won, and break points conversions.

Thirdly, there were significant differences on only 2 performance indicators distinguishing winning and losing where sets' data were used in the comparisons between championships separately ($p<.05$). The performance indicators were % of 1st serves and receiving points won.

Consequently, this study was shown that there were different results of distinguishing between winning and losing performances in massive size of data. However, there were also similar findings between championships that it would be Key Performance Indicators where the data was critically huge. It intended that those Key Performance Indicators would be used for prediction modelling, coaching feedback and comparisons of winning and losing performances individually. Further researches are required that the development of the systematic structures of identification for KPI, consideration of identifications of Key Performance Indicators for double games and application for a real-time analysis system.

POD 7.2
The importance of the time duration of ground strokes in tennis

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[2] *Kota town office, Aichi, JAPAN*
[3] *Chukyo University, Toyota, JAPAN*
[4] *University of Tsukuba, Tsukuba, JAPAN*

The purpose of this study was to clarify the importance of time duration of ground strokes. We analysed ladies' singles matches held in 2005 and 2006 U. S. Open. The rallies finished on ground strokes were analysed in this study. Total numbers of rallies in this study were 567.

Time duration of ground strokes in each rally were plotted as line graphs (Figure 1). The X-axis showed the numbers of shots in rallies and the Y-axis showed time duration of ground strokes in each shot. It was found that time duration of ground strokes showed longer or shorter than one shot before. Time duration of ground strokes showed shorter in the server because the rally was started by serve and the server usually controlled the rally (Takahashi et al., 2008). It was also found that the lines in graph showed up and down regularly or irregularly. The numbers of regular pattern was 243 rallies and irregular pattern was 324 rallies. We also analysed the relationships between the patterns of graphs and the actual rallies. It was found that the strokes in short time duration were evaluated as aggressive shots and the strokes in long time duration were evaluated as defensive shots. It was also found that the rallies shown as irregular pattern had the situation of changing control between the players. Those results suggested that we could evaluate which players controlled the rally by analyzing the time duration of ground strokes.
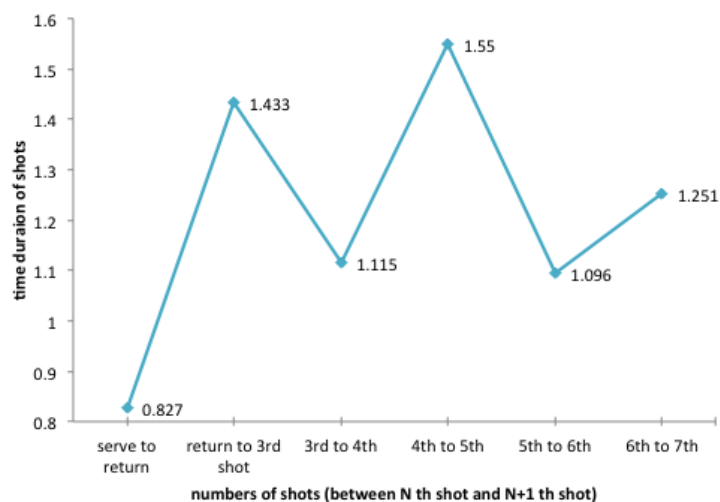

Fig. 1 The example of a line graph of time duration of ground strokes in a rally

Takahashi, H., Wada, T., Maeda, A., Kodama, M. & Nishizono, H. (2008) An analysis of the time duration of ground strokes in Grand Slam men's singles using the computerised scorebook for tennis. *International Journal of Performance Analysis in Sport*, 8(3): 96-103.

POD 7.3
Technical structure and effort intensity in recreational squash

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[2]*4SportLab Laboratory of Physical Preparation, Warsaw, Poland*
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Squash, regardless of the level of player, is a sport of moderate and high intensity [Lynch et al. 1992]. Gilliam's research (1988) shows that the average frequency of heart contractions of professional and amateur players after the game is about 70-80% of maximum value. The structure of dynamic movements of the players has effect on the game's result and is different between the winners and the losers (Hughes, Franks 1994). The research aimed to analyse the dynamics of physiological parameters characterising the structure of movements recorded during a game in recreational squash players.

The research was conducted among the group of 12 men (22-29 years old , 184±5,6 cm body height, 90±12 kg body mass) engaged in recreational squash games. It was used during the game gas analyzer K4b2 (Cosmed, Italy) and were recorded parameters VO_2, VCO_2, VE, BF. Using Polar Team Sport Tester (Polar OY, Finland) was recorded HR. During the game the activities undertaken by the tested player were recording by digital video camera. The following activities were registered: forehand, backhand, volley, drop, lob, boast, kill, serves. Material of research was analyzed by program Statistica 8.0 (StatSoft U.S.A.).

Effort undertaken by the player on the court during a match has an aerobic character, while together with speed element the effort has anaerobic non-lactic acid character plus anaerobic glycolyctic metabolism participation, which requires a high degree of tolerance to increasing acidification during the match. The most commonly stroke used in the game is forehand (straight and diagonal). It amounts approximately 30-35% of all the strokes during the match. The number of backhand beats (straight and diagonal) in the match is in the range of 20-25% of all beats in squash match. The number of technical final strokes (lob, kill, volley, drop, boast) reaches a value below 10%. For example, volleys stand at 8% and kills at less than 3% during the entire match. The examined amateur players achieved the results in the range of 50-70 forehand strokes during the match. In the case of backhand and other beats, these values were significantly higher for professionals than for amateurs. Motoric preparation level also points the better preparation of professionals. HR and VO_2 values are higher and the difference between the best amateurs and professional players reaches 15-30%.

Lynch, T. et al. (1992) Metabolic changes during serial squash matches in older man. *Can. J.Sport Sciences,* 17 (2): 110-113.

Hughes M. & Franks I. (1994) Dynamic patterns of movement of squash players of different standards in winning and losing rallies. *Ergonomics*, 37: 23-29.

Gillam I. et al. (1988) The on-court energy demands of squash in elite level players. *Phillip Institute of Technology*, Victoria, Australia: 1-22.

POD 7.4
Male positive affect explains mixed-doubles badminton tournament rank

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In mixed sports, performance analysis necessitates the consideration of both male and female psychological profiles (Stuntz et al., 2011). Affect has been related to sports performance (Sanchez et al., 2010) yet findings in relation to gender discrepancy have been inconsistent (Watson 2000; Hülya et al., 2006). Hence, the aim of this study was to investigate the role of gender and affect on performance in a mixed-doubles badminton tournament.

Eight mixed pairs of county standard players (age 25±7.4yrs) played in two groups, with each pair playing three group matches (best of 3 games) and one final position determining play-off match. Ten minutes prior to each match, participants completed the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) which provided positive affect (PA) and negative affect (NA) levels across the tournament. Affect variables were analysed at the individual (male & female) and pair levels (pair total affect; and pair affect discrepancy).

In the four top ranked pairs, males consistently had higher levels of PA than their female partner with this reaching statistical significance in match 2 (mean rank males = 6.5, females = 2.5, $z = -2.309$, $p = 0.021$) and match 4, the play-off match (mean rank males = 6.5, females = 2.5, $z = -2.323$, $p = 0.02$). Inconsistent PA scores across the four matches were observed for males in the four bottom ranked pairs and no significant differences were observed between these males and their female partners affect scores. Male player's PA before match 2 (rho = -0.85, $p<0.05$, explained variance = 72%), match 3 (rho = -0.74, $p < 0.05$, explained variance = 54%) and match 4 (rho = 0.79, $p<0.05$, explained variance = 62%) was significantly correlated to final tournament ranking, identifying that higher male PA was strongly predictive of final tournament position. Conversely, lower tournament position was characterised by lower male PA, less discrepancy in affect between the pairs, and at times, lower male positive affect scores than their doubles partners.

Whilst clearly highlighting within tournament variability in affect, and notable gender discrepancy even though pairs ultimately experience identical match outcomes (win/loss), this research emphasises the importance of male positive affect within a mixed doubles pair and its significant relationship to overall tournament position. Practical sport psychology and performance analysis outcomes for mixed doubles sports include the need to maximise male positive affect and incorporate coaching strategies to consider the affect profiles within pairs.

Hülya Aşçi, F., Dermirhan, G., Koca, C. & Cem Dinç, S., (2006) Precompetitive anxiety and affective states of climbers in indoor climbing competition. *Perceptual and Motor Skills,* 102: 395-405.

Sanchez, X., Boschker, M.S.J., & Llewellyn, D.J. (2010) Pre-performance psychological states and performance in an elite climbing competition. *Scandanavian Journal of Medicine and Science in Sport,* 20: 356-363.

Stuntz, C.P., Sayles, J.K. & McDermott, E.L. (2011) Same-sex and mixed-sex sport teams: How the social environment relates to sources of social support and perceived competence. *Journal of Sport Behaviour,* 34:98-120.

Watson, D., Clark, L.A. & Tellegen, A. (1988) Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology,* 54: 1063-1070

Watson, D. (2000) *Mood and Temperament,* New York: The Guilford Press.

A comparison of the distribution of stroke and footwork type in top-level men's vs. women's table tennis

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[2] *Faculty of Exercise and Sport Science, University of Bologna, Italy*

Technical and tactical skills play a crucial role as determinants of performance in table tennis. A method well-recognized as effective for technical and tactical evaluation in racket sports is notational analysis (Hughes, 1998), in which relevant aspects of the actions performed by the players during play are collected and summarized using specific indicators. The most used technical and tactical indicators in net games are descriptors of shot characteristics, such as the distribution of shot types and of shot outcomes (Hughes & Bartlett, 2002). Another important characteristic of a shot is the footwork performed before the hit, as using a proper footwork allows the player to be in the most favorable position to hit the ball effectively (Malagoli Lanzoni et al., 2007). The purpose of this study was to compare top-level men's and women's matches with respect to the distribution of footwork and stroke types used by the players.

Ten men's (M) and five women's (W) matches were selected in which both the opponents were in the top 30 of the male/female world ranking. Video recordings were analyzed in slow motion with the software Kinovea by an operator who, while watching the match, recorded on a spreadsheet the footwork technique and the stroke type used for each shot.

Chi-square tests showed significant differences ($p < 0.001$) between M and W in the distribution of both footworks and strokes. The percentage of serves was slightly higher in M (19.4 %) than W (16.0 %), indicating a lower number of shots per rally in M. The push, used in most cases to counter the serve, represented 15.8 % and 13.0 % of total strokes in M and W, respectively. The top spin was the most frequent stroke type in both M (25.4%) and W (28.8%). A relevant difference between M and W concerned the strokes used to continue the rally after the initial exchanges. In fact, male players adopted more often the "top spin counter top spin" stroke type (M: 15.4 % vs. W: 7.4 %), reflecting their preference for a counterattacking strategy. Conversely, female players used mostly passive and defensive strokes as the block (20.9% vs. M: 13.9%), and the drive (10.1 % vs. M: 0.1%). The "one step" footwork was the most frequent in M (31.9% vs. W:19.8 %), followed by the chassè (24.0 % vs. W: 19.3 %). The pivot, associated to attacking shots, was more frequent in M (13.1 %) than W (7.9 %), similarly to the crossover (M: 9.7%, W: 3.8%). In the majority of cases, female players hit the ball without performing any footwork (43.5% vs. M: 18.2%). In conclusion, male players showed a more aggressive style of play than female players, with a wider use of offensive strokes and footworks.

Hughes, M. (1998) The application of notational analysis to racket sports, in T. Reilly, M.D. Hughes, A. Lees, & I. Maynard (eds.), *Science and Racket Sports II*, London: E. & F.N. Spon., 211-220.

Hughes, M. & Barlett, R. (2002), The use of performance indicators in performance analysis, *Journal of Sports Sciences*, 20: 739-754.

Malagoli Lanzoni, I., Lobietti, R. & Merni, F. (2007). Footwork techniques used in table tennis: a qualitative analysis. *Proceedings of the 10th ITTF Sports Science Congress*, Zagreb: University of Zagreb, 401-408.

SESSION 8: HANDBALL

POD 8.1
Team timeout management in handball according to the context of the game

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In team handball, the coach is entitled to call one team timeout during each part of game, and therefore this decision must be carefully thought. Although the importance of the time out decision, its impact does not have repercussion in handball field research and no empirical research is available.

The aim of the study was to characterize the different contexts of the team timeout calling in handball according to the following variables: 1) match status (current score difference), 2) match location, 3) game period, 4) last offensive action, 5) last defensive action, 6) pace of the match. The sample consisted of 344 team timeouts registered from 120 match reports of official statistics of the ASOBAL League, season 2009/2010.

Cluster analysis (method k-means) was applied to classify the match status at the moment of timeout calling in four groups: unbalance losing (-10 to -7 goals), losing (-6 to -3 goals), balance (-2 to +1 goals) and winning (+2 to +6 goals). The variables in analysis was:

Game Period: The moment, in period of 5 minutes, when the team timeout was called;

Last Defensive Action: The register of last defensive action before the team timeout was called;

Last Offensive Action: The register of last offensive action before the team timeout was called;

The *Chi-Square* test was used to verify whether there were significant differences between the timeouts called in different match status situations.

For the team timeout balance the percentages of victory in the end of the game are 39,5%, the draws are 27,1% and loss 33,3%. It is possible to identify the positive effect of team timeout in final result of the game in 18,7% on the team timeout losing and the negative effect in team timeout wining in a 24,3%.

The value of 4,2% for the last 5 min in cluster losing, indict the perception for 3 goals as recoverable in last 5 min. The cluster wining have 57,7% in the last 5 min of the part one, but the distribution in second part are different, e have more call team timeout between 30 and 55 min.

POD 8.2
Handball Refereeing: Referees, examiners and reality

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Handball referee's are regularly under scrutiny by delegates and accredited examiners during matches. The results of these evaluations are mainly used to give post-game feedback to the referees as well as to classify and rank them. However, published knowledge about referees' (and examiners') performance is quite modest. The main purpose of this work was to quantify the accuracy of the Portuguese elite Handball referees and also of the accredited examiners. The correlation of the judging errors' type and frequency with match time, score result, field place and favored teams was also investigated.

Ten elite Portuguese handball referees and four highly experienced examiners (former international referees and one non-Portuguese EHF referees' examiner) were involved in this study. Data was collected during the final phase of the Portuguese Men Supertaça (2011) - a set of 9 matches between 6 teams in 3 days on a neutral court, were the winner gets a position in an European team competition. Each match was recorded by three HD cameras from elevated positions. Two were at the top of the playing court on opposing sides to provide a detailed close view of the action near the goal and a third one was located at middle court to get a wide-angle view of court. At each game all four examiners were simultaneously but independently at work and individual video and audio records of each one were also taken. All obtained videos from the different cameras were time synchronized. Immediately after the matches, these records were first analyzed by two of the investigators who produced shorter video sequences (with multiple angle, HD, zoom and slow motion) containing all the non consensual ruling situations including the doubtful absence of intervention situations. Afterwards, both referees and examiners reviewed individually these and their opinions were registered. Finally the correctness of each ruling decision was determined based on a consensus of the off-line analysis or, in the lack of it, the original live decisions were considered correct.

in 9 matches, 1476 refereeing decisions were made, 98 of which were considered incorrect and 97 were identified as an oversight of intervention. Of these, 80 were "serious" errors (e.g. all errors directly affecting the score, 7m throws, 2' suspensions, exclusions) while the others were "minor" and inconsequential errors (e.g. players position during reposition throw). The incorrect decisions (including intervention and lack of intervention) concentrated on the ruling of the 9 meters faults, advantage rule, 2 min of suspension and 7-m throw. Computing which team was "favored" in each referee's error and testing for the randomness of this with a binomial distribution, we concluded that no team was significantly "favored" ($p > 5\%$). So we have 8 to 9 "serious" errors per match but with a random uniform distribution not favoring any team. Of the 369 situations that were off-line reviewed, consensus was never obtained in 25% of them, even with ample technological aids and time to use them. This means that about 10 situations per match are very likely evaluated wrongly by the examiners.

In summary we observed that the number of "serious" errors per match is similar to the number of non-consensual observations made by experts. As the examiners are a tool to rank and develop the referees, both need to develop at the same time. A uniform comparison with the international situation will follow.

POD 8.3
Sport performance profile in men's European handball: discriminant analysis between winners and losers

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Europeans have won olympic and world gold medals since modern indoor men' s handball became an international sport (1938) and an olympic sport (1972). The main method of objectifying the process in sports games is the use of notational analysis (O'Donoghue, 2005). The aim of this study was to illustrate discriminate indicators of sport performance between winners and losers in European men's modern handball match activities.

The data sets gathered from the publically available EHF website (http://eurohandball.com./activitiesnew/analysis) cover the five European Men's Handball Championships (EMHC) held in 2002–2010. Each match was classified for each team as successful (won match and draw – for both teams) and non-successful. A discriminant analysis was employed to identify a subset of game-related statistics of 28 variables that discriminated between winning and losing teams in each of the five EMHC. The indicators were compared across EMHC'2002–2010, using a general linear model analysis of variance (ANOVA), with Tukey Post Hoc test, the ANOVA was evaluated as significant when there was a < 5% chance of making a type I error.

Between 28 variables of sport performance 15 key indicators only with significant discriminant between winners and losers at least in one EMHC were considered. Winners were better ($P < 0.05$) than losers in 6 indicators throughout EMHC'2002–2010. Winners scored more goals ($P < 0.01$), were better in efficiency of total attacks ($P < 0.001$) and positional attacks ($P < 0.01$), performed more efficiently in shooting total ($P < 0.001$) and shooting from long distance ($P < 0.01$), and goalkeepers saved more throws ($P < 0.05$).

Findings indicate that winning and losing teams played in the same pattern. The phenomenon is that teams scored more goals in the second half than in the first. Six indicators – goals scored, efficiency of total attacks and positional attacks, efficiency of total shots, shots efficiency from long distance, and shots saved by goalkeepers – are the key indicators of discriminant winners at the EMHC'2002–2010. Performance indicators such as efficiency of individual attacks, shots from wings and 7 m penalties, and efficiency in minority might be considered as the key indicators of temporal pattern at the EMHC'2002–2010. The normative profile of winners identified can help coaches and players to create performance profiles according to team quality (O'Donoghue, 2005; Sampaio et al., 2010). Therefore, handball coaches will benefit from awareness of these results, particularly when designing game strategies and making tactical decisions.

O'Donoghue, P. (2005) Normative profiles of sports performance. *International Journal of Performance Analysis in Sport*, 4(1): 67–76.

Sampaio, J., Drinkwater, E.J. & Leite, N.M. (2010) Effects of season period, team quality, and playing time of basketball players' game related statistics. *European Journal of Sport Science,* 10(2): 141–149.

POD 8.4
Motor skill determinants of performance in handball players

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A study was conducted on a group of 108 handball players in the age group of 17-25 years from Universities of Punjab and Chandigarh to determine motor fitness profile of inter college level handball players and their relationship with playing ability. Independent motor fitness variable were Dribbling, Passing, Defense, Throwing Accuracy, Throwing Ability and Handball Throw for Distance. These variables contribute to the overall performance of the handball player, further the tests applied were valid and reliable and the results gave numerical data which was analyzed by applying regression analysis statistical technique.

Playing Ability: The playing ability of the subjects was measured by the panel of three expert judges during inter college competition on five point scale, on the basis of their all round performance. The average of three judges was considered as final score.

Motor skill measurements: The following standardized tests were conducted to measure the skill performance of selected variables and the data pertaining to frequency was obtained:

1. Handball throw for distance: Handball throws.
2. Throwing accuracy: Service placement test.
3. Throwing ability: Wall-volley test.
4. Dribbling: AAHPERD control dribble test item.
5. Passing: AAHPERD passing test item.
6. Defense: AAHPERD defensive movements test item.

After applying correlation and regression analysis the result shows that passing, handball throw, throwing ability of dominant as well as non- dominant hand and service accuracy were positively correlated with playing ability. When the combined contribution was calculated five motor fitness variables namely - passing, handball throw, dominant hand throwing ability, throwing accuracy and defensive movements' motor skill variables were found significantly important in the final equation of step- wise regression.

POD 8.5
A time motion and notational analysis of three matches from the qualification round in the women's 2010 European Handball Championship

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The aim of this research was to compare the performance of the winning teams against the losing teams from three competitive matches played during the 'Women's Team Handball European 2010 Qualification'.

There is some current research available on time motion analysis in handball for male athletes (Sibila *et al.,* 2004; Boraczyñski *et al.,* 2008; Zapartidis *et al.,* 2009; Sporis *et al.,* 2010); however there appears to be very little academic time motion analysis research involving female athletes (Granados *et al.,* 2007). Women's elite handball could benefit from specific time motion analysis in order to enhance performance and develop match specific training.

Three women's handball games were analysed by means of time motion analysis (participants n=69). Individual player and team statistics were collated using Trak Performance (version 3.1g2) software to perform time motion analysis. Inferential (regression) and descriptive statistics were used to analyse the data. Overall 'distance covered' in a game (B = 0.964, $p < 0.001$) and 'time fast running' (B = 0.565, $p < 0.05$) were found to be significant in the final outcome of a match for all players.

This research goes someway to providing data on the physiological needs of successful elite female handball players. Further research is required to validate these findings and complete a better overall picture for strategies, tactics and the physiological needs in women's handball.

Boraczyñski, T. & Urniaz, J. (2008) The influence of physical training on anaerobic fitness of elite handball players. *Medsportpress,* 14(2): 69 - 73.

Granados, C., Izquierdo, M., Ibanez, J., Ruesta, M. & Gorostiaga, E.M. (2007) Effects of an entire season on physical fitness in elite female handball players*. Research, Studies and Sport Medicine Center, Government of Navarra, Pamplona, SPAIN; Copyright American College of Sports Medicine.*

Sibila, M., Vuleta, D. & Pori, P. (2004) Position-related differences in volume and intensity of large-scale cyclic movements in handball. *Kinesiology,* 36 (1): 58-68.

Sporis, G., Vuleta, D., Vuleta Jr., D. & Milanovic, D. (2010) Fitness profiling in handball: Physical and physiological characteristics of elite players. *Collegium Antropologicum,* 34 (3): 1009–1014.

Zapartidis, I., Vareltzis, I., Gouvali, M. & Kororos, P. (2009) Physical fitness and anthropometric characteristics in different levels of young team handball players. *The Open Sports Sciences Journal,* 2: 22-28.

POD 8.6

The use of live semi-automatic video content extraction techniques for the accurate evaluation of exertion in elite handball referees

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[4]*INESC-Porto, Porto, Portugal*

We developed and implemented a new method for almost real-time video content extraction, with a spatial precision of 16 cm. This method was applied to the study of the handball referee's field location over time, by processing the feeds from two overhead mounted cameras (1024x768/24bit/30 fps) in the final 9 matches of the Portuguese Supertaça (2011). Each referee was also equipped with a tri-axial accelerometer (10bit/128Hz) and a commercial two channel ECG device (10bit/256Hz). The results show a bi or tri-modal modal velocity distribution with peaks around 0 km/h (stand still), 4.5 km/h (walk) and 13 km/h (run). Average displacement is 5km, in accordance with other published results.

A comparison between the usual exertion metrics (heart rate, accelerometry) and the effective displacement velocity show that the former are very bad exertion indicators (Kendall tau=0.38). During 46% of the match time the heart rate is above that observed during an exercise at the anaerobic threshold while the real exertion is, during 88% of the time, well below that. The referees were also submitted to additional laboratory tests (lactate anaerobic threshold, VO2max) after the tournament. These were combined with sleep and daily life monitoring data as well as in-field results (heart rate and physical exertion) to show the importance of stress in the heart rate response (Figure 1).

Finally, these results, commissioned by the Portuguese Handball Federation - used to develop and propose conditional evaluation procedures to the European Handball Federation as well as training programs for the Portuguese elite referees - emphasize the need for a strategy to deal with these high levels of stress.
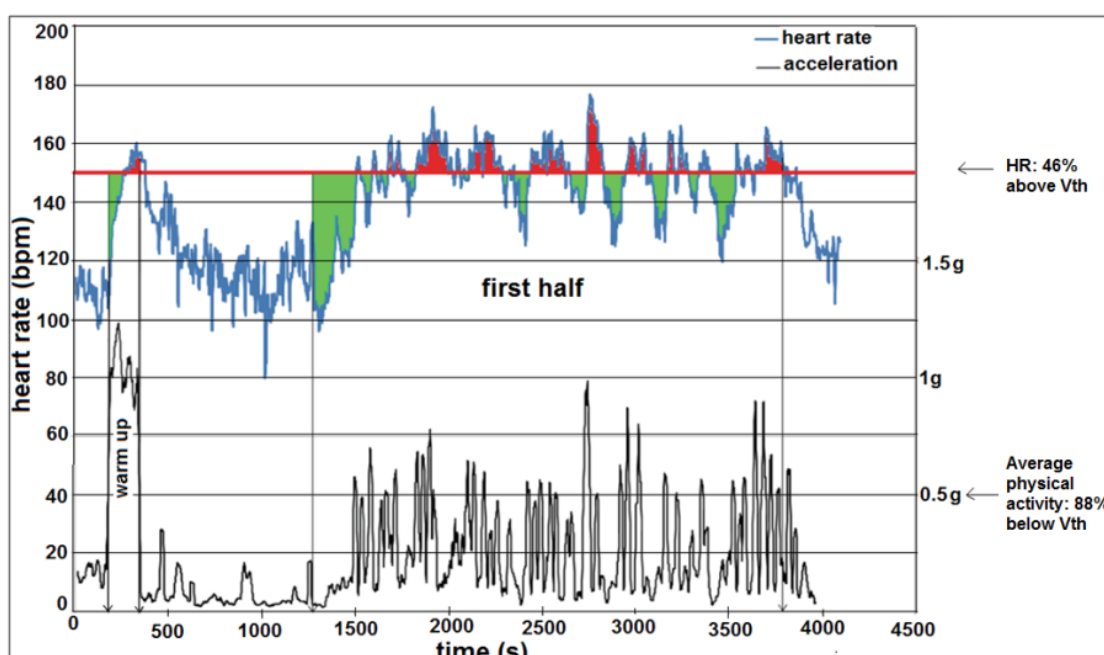

Figure1. Relationship between heart rate response and physical exertion.

SESSION 9: SOCCER 2

POD 9.1
An analysis of unsuccessful offensive sequences in two top level football teams

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The main purpose of this study was to investigate the existence of regular behavior patterns regarding the offensive sequences that ended unsuccessfully. For that, we analyzed two top level teams (Real Madrid, 2010/2011, and International Milan, 2009/2010) that share the same coach and the same technical staff.

To collect data, we used the instrument developed and validated by Sarmento *et al*. (2010). This instrument consists in a specific notation analysis to study the offensive process and its variables. Several offensive sequences were coded through the observation of 24 games of Inter Milan and Real Madrid (12 per each team).

In order to verify pattern occurrence, we used the software THÈME 5.0, which is a professional system for detecting and analyzing hidden behavioral patterns, by performing intensive structural analysis of behavioral data. It detects complex repeated patterns that would otherwise remain hidden. The reliability of the data was calculated by the intra and inter observer agreement, and values above 0.95 were achieved for all the variables. For pattern detection, we only considered the ones that were repeated, at least, 9 times, and the significance level was set at 0.005.

We detected 11659 T-patterns, of which 4 are complete t-patterns, regarding seven length distribution, from ball recovery until the end of the offensive process (O.P.). In all recorded patterns the last actions occurred in the central zone of the offensive third (zone 11), in an interaction context of relative numerical inferiority. We observed a greater activation of central and right corridor in the offensive midfield.

The analysis of the T-patterns complements previous research. We analyzed the three actions preceding the end of the offensive process, and verified the occurrence of at least two actions in the central corridor, in the offensive midfield. The ball only enters in the offensive sector when the offensive process ends. The patterns reflect the use close field zones using a short game. The tree actions before losing the ball possession occurred more often in the right and central corridors. These facts increase the time for the opponent to develop a correct defensive organization placing more players involved in the process. None of the observed the patterns had the actions dribble or ball conduction. In all patterns analyzed the loss of possession occurs in the central zone of the offensive third (zone 11), and in a context of numerical inferiority. The failure occurred above seems to reflect the importance, of using quick pace making use of long pass, play with fewer touches on the ball, ball conduction, dribble and the increase number of players involved in the O.P.. None of the referred to actions occur prior to the end of the offending process.

Sarmento, H., Anguera, T.; Campaniço, J. & Leitão, J. (2010) Development and validation of a notational system to study the offensive process in football. Medicina *(Kaunas),* 46(6): 401-407.

POD 9.2
Notational analysis of long corner kicks in an international youth football tournament

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Corner kicks provide an important opportunity for scoring goals in professional football, but their effectiveness at the youth level has not been described previously. This study presents an analysis of long corner kicks from an international Under-17 football tournament hosted in Qatar, 2012.

Broadcast TV footage of all 19 matches from the tournament was analyzed using the match analysis software Sportscode Pro. The matches were played between 10 teams in group stages and subsequent ranking play-offs. Every corner kick was characterized by the area of the pitch (Figure 1) where first contact was made by a player and then by the subsequent action. Throughout the tournament there were 141 long corner kicks and 50 short corner kicks, both types resulting in only 1 goal each. Analysis of the long corner kicks is presented here.

Most long corner kicks were delivered to Areas 1 and 2, and about 22% of the plays resulted in an attempt on goal (Figure 1). Slightly more attempts were on target from Area 2 than from Area 1 (33% vs 26%). However, there were no clear differences between the zones for attempt on target as a proportion of attempts. Only Area 5 showed clear differences from the other areas in proportions of attempts and of attempts on target.

The proportions of attempts and of attempts on target in Area 1 and 2 in this youth tournament were lower than in professional games (Taylor et al, 2005). Further research could focus on the change in outcome of corner kicks as players progress through the age groups.

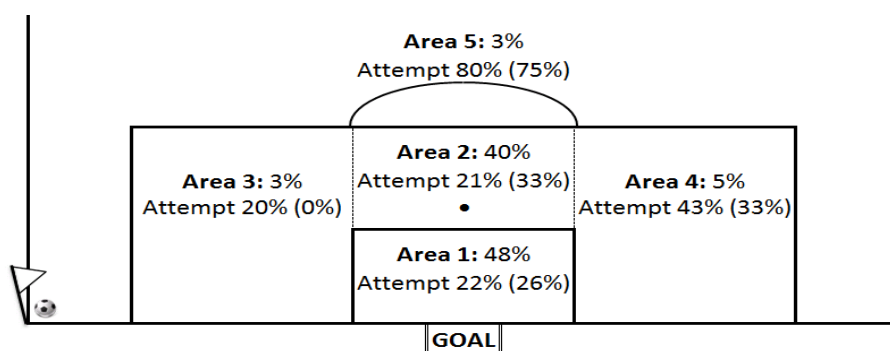Figure 1: Percentage of the long corner kicks distribution and attempt on goal from each area (percentage of attempts on target in brackets). All kicks shown were standardized as taken from left side of goal.

Taylor, J.B., James, N. & Mellalieu, S.D. (2005) Notational analysis of corner kicks in English Premier League Soccer. *Science and Football V: The Proceedings of the 5th World Congress on Science and Football*: 225 – 230.

POD 9.3
Activity profiles in four different small-sided football games

Marco Aguiar[1], Goreti Botelho[2], Bruno Gonçalves[1] & Jaime Sampaio[1]

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The aim of this study was to identify the physiological and activity profiles of 4 football small-sided games (SSG) formats. Ten professional football players participated in 4 variations of SSG (2-, 3-, 4- and 5-a-side) with an intermittent regime involving 3×6 minute bouts with 1 minute of passive planned rest. Player's activity, rating of perceived exertion (RPE) and heart rate (HR) profiles during the SSG were measured using portable global positioning system units at 5 Hz. The HR monitors were also used during the Yo-Yo intermittent recovery test level 2 (Bangsbo et al., 2008) to determine each player's maximum HR (HR_{max}). Statistically significant differences among SSG formats in the $\%HR_{max}$ ($p = 0.001$) were found, as well as, between SSG formats in all times spent in HR zones, exception made in time spent at 75-84 $\%HR_{max}$. Moreover, statistically significant differences ($p < 0.001$) between RPE values in the SSG formats were found. Statistically significant differences among SSG formats to total distance performed ($p < 0.001$) and between the number of sprints performed in each SSG ($p < 0.001$) were found. By other side, there were no statistical significant differences among the SSG formats in the total number of impacts and in the number of impacts per minute. However, when compared the number of impacts per minute on each zone, statistical significant differences among SSG in 8.1 - 10.0 G impacts ($p = 0.021$) and in impacts upper than 10.1 G ($p =0.002$) were found. The results showed that smaller game formats elicit higher mean HR, RPE, and that players spent more time in higher %HR zones. By this, smaller game formats may be useful for training to improve aerobic fitness in football players. Contrary to what one would expect, players' number does not influence significantly the body load and the number of impacts.

Bangsbo, J., Iaia, F.M. & 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.

POD 9.4

An analysis of English professional goalkeeper match actions over two competitive seasons: Implications for the coaching process

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Traditionally the goalkeeper's contribution to a football game has been associated with handling skills such as shot stopping and catching crosses. Previous studies within goalkeeping have predominantly focused on activity profiles (Di Salvo et al., 2008;) diving techniques (Spratford et al., 2009), penalty kicks and defensive technical actions within major tournaments, (Bar-Eli et al.,2006). However, as part of their new goalkeeping initiatives, FIFA have investigated goalkeeper's 'interventions' (FIFA, 2012). The study has scrutinsed forty three high profile competitive matches, discovering that 66% of the goalkeeper's interventions involved their feet e.g: distributions from dead ball situations, back passes and kicking the ball from their hands.

Very little research has been carried out in this area of goalkeeper match profiling and therefore it is the aim of the present study to further add to the limited evidence available and to consider implications for the coaching process.

Match analysis: Ninety two games of a professional English football League Two level team, over two whole seasons, were analysed and the following parameters considered: Interventions with feet (Dribble and Drive; Goal Kick; Back Pass; Hand Kick); Interventions with hands (Save; Dealing with Crosses; Throw Out; Through Ball).

Training analysis: A typical week of professional goalkeeper training was also examined through observation. The various training activities were monitored and the time allocated to each area calculated as a percentage.

Match analysis: Goalkeepers intervened over twice as much with their feet as with their hands. Results for the 2009/10 season were: Interventions with feet 69% (Dribble and Drive 7%; Goal Kick 16%; Back Pass 24%; Hand Kick 22%); Interventions with hands 31% (Saves 16%; Cross 8%; Throw Out 2%; Through Ball 5%). The following season 2010/11 results reported: Interventions with feet 70% (Dribble and Drive 6%; Goal Kick 14%; Back Pass 29%; Hand Kick 21%); Interventions with hands 30% (Saves 14%; Cross 7%; Throw Out 5%; Through Balls 4%).

Observational training analysis: The 'typical week's training' included time spent in the following activities: Intervention with hands specific training (specific shot stopping and handling sessions, 36%); Interventions with both hands and feet (Team based shooting, phase of play sessions, team shape and small sided games, 36%) and gym based sessions (28%).

It is evident from the results that there is a clear discrepancy between what the goalkeepers actually do within a competitive situation and within training scenarios. Implications for coaches include: Structure of the training sessions need to reflect time devoted to specific match actions in order to create more realistic training environments; Further emphasis required on certain areas of the game (distribution as opposed to shot stopping and reaction training).

Bar-Eli, M & Azar, O.H. (2009) Penalty kicks in soccer: an empirical analysis of shooting strategies and goalkeepers' preferences. *Soccer & Society*, 10(2): 183-191.
Di-Salvo, V., Benito, P., Calderon, F.J & Pigozzi, F. (2008) Activity profile of elite goalkeepers during match play. *Journal of Sports Medicine & Physical Fitness*, 48(4): 443-446.
FIFA. (2012) The Special Ones. *FIFA World Magazine,* 26: 53-55.
Spratford, A, Mellifont, R & Burkett, B. (2009) The influence of dive direction on the movement characteristics for elite football goalkeepers. *Sports Biomechanics, 8* (3): 235–244.

POD 9.5

End of season club ranking in the top five European soccer leagues in season 2010/11 were affected by the number of players released to World Cup 2010

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The Bundesliga season 2010/2011 was marked by many top teams stumbling, especially at the beginning, while "minor" clubs started with a series of wins. Many experts assumed this was caused by the negatively affected clubs having released many players to the FIFA World Cup 2010 whereas the positives sent comparably few. Lames and Kolbinger (2011) developed scientific methods to verify this phenomenon empirically for the first round of German Bundesliga 2010/2011. The current investigation used these methods to prove the findings for the complete seasons of the five European top leagues.

In order to do that, the number of players participating in the World Cup was obtained for each club of the five European top leagues (Germany, England, France, Italy and Spain) and correlated with the position in the league on each day of play for the season 2010/2011. This correlation was compared with the one found for the last day of play before the World Cup. Statistical significance and effect size for differences of correlation coefficients according to Cohen (1988) were taken as criteria of evidence.

As expected, it turns out that before the World Cup, the clubs in all leagues performed the better, the more World Cup internationals they had. After the tournament, however, we find a sharp drop in this correlation except for Spain. In Germany the correlation even turns into a negative one, the clubs with more released players to the World Cup at times even lagged behind in the league. The extent to which the leagues recovered from World Cup induced setbacks varies. Spain was not affected at all, in Italy conditions normalized within a few days of play, for England and France the effects could be proved for most of the season and the German league did not recover at all from the perturbations at the beginning. Possible explanations are the number of players sent to the World Cup, their distribution within the league and the date at which the season starts in each of the countries.

Summing up, there is clear evidence that releasing players to the World Cup has a negative effect on the clubs' performance in the following season. It has to be assumed that, for example by not qualifying for the Champions League, some of the top clubs suffer considerable losses, that the FIFA compensation by far cannot even out. This problem could be avoided in the future if the long term schedule allowed for reasonable recovery time and preseason after a World Cup or the European Championship.

Lames M. & Kolbinger, O. (2011) German Bundesliga Club's rankings in season 2010/11 are significantly affected by the number of players released to World Cup 2010. *International Journal of Performance Analysis in Sport, 11:* 309-314.

Cohen, J. (1988) *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Earlbaum Associates.

POD 9.6

A comparison of performances in the attacking-third between teams in the K-league, LFP and EPL football leagues

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This study was to compare differences of performances in the attacking-third between K-league, LFP and EPL within 2010-2011 seasons. Totally, 60 games (20 K-league matches, 20 LFP matches and 20 EPL matches) were considered. In order to compare the performances in the attacking-third, characteristics of penetration, different types of playing events and results of attacks were compared. Additionally, the chi-square and one-way ANOVA were used for statistical comparisons.

The summarised results of the study were as below;

1. There were significant differences of the characteristics of penetration in attacking-third (the situation, the strategy, the start location, the method, and the direction of penetration in attacking-third) between leagues (p<.05). In addition, the filed play from situation, 0-15, 61-75 from time zone, a count-attack from the strategy, the defence area from the start location, a low pass from the method and the side from direction of penetration in attacking-third were significant different.
2. There were significant differences on the playing events of attacking-third (the pass, the dribble, the cross, the penetration of penalty area, the shoot and the shooting location of playing events in attacking-third) between leagues (p<.05). The frequencies of the successful pass · failed pass · pass attempts from the pass, successful dribble · failed dribble · dribble attempts from the dribble, foul from the foul, penetration of penalty area from the penetration of penalty area, shoot on target from the shoot, shooting inside penalty area and the shooting outside penalty area were significant different in the results of one-way ANOVA.
3. There were significant differences of the results of played between leagues (p<.05). Especially, the intercept · the back pass from the result of played, the playing time in attacking-third were also significant different statistically.

Consequently, the study was shown that there was still gap of performance level between leagues. Further studies are required whether or not the reason of reducing attendances in K-leagues might be caused by the performances in attack-third.

SESSION 10: TEAM SPORTS 2

POD 10.1
Accuracy of netball umpiring in the British National Super League

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The role of the officials in sports contests is to maintain a moral balance within games (Fleming and Jones, 2010). There is often speculation that officials may be bias and have a large influence on the outcome of games. The purpose of the current investigation to analyse the decisions made by netball umpires and compare these with correct decisions based on lapse time reviewing of match incidents and the regulations of the sport.

Video recordings of 28 British National Super League matches were observed with incidents being classified as correctly judged by umpires, missed by the umpires or incorrect decisions made. Two observers applied the manual notation system independently on 3 occasions to a match with the number of disagreements in classifying umpire decisions being 2 for a match. This was equivalent to a percentage error of 0.4% which was deemed acceptable for the investigation. A "missed" incident was recorded where one team violated game regulations without the umpires awarding a free or a penalty to the opposing team. Incorrect decisions included (a) frees or penalties being awarded to the incorrect team when rules were violated, (b) frees and penalties being awarded when no regulations were violated and (c) situations umpires awarded frees or penalties for rules other than those that were actually violated.

The umpires made correct decisions for 72.8% of incidents, missing rule violations on 21.4% of incidents with incorrect decisions being made on 5.8% of incidents (3.6% where play should have been allows to continue, 1.1% where the free or penalty was awarded to the wrong team and 1.0% where something else should have been penalised other than the foul identified by the umpires). Mann Whitney U tests found no significant bias in favour of teams in the top or bottom half of the league (p = 0.706) or for home or away teams (p = 0.682). A Friedman test found no significant score-line effect on the correctness of umpire decisions (p = 0.097). In conclusion, netball is a fast moving game which is difficult to umpire with many rule infringements being missed by umpires. However, any claims that umpiring may be biased are based on misperceptions.

Fleming, S. & Jones, C. (2010) The 'enforcer' in elite-level sport: a conceptual critique. *Sport, Ethics and Philosophy*, 4(3): 306-318.

POD 10.2
A comparison between winning and losing teams in women's elite level goalball

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Goalball is a Paralympic sport for persons with visual impairment in which only few studies has been published and no comparison between the winning and losing teams has been made. Thus, the purpose of this study was to analyze the key technical aspects of the game and to determine which skills have the biggest effect on winning in women's elite level goalball.

15 women's matches from Goalball European Championships 2011 and IBSA World Games 2011 were recorded and analyzed with Data Volley -software. The analyzed variables were: throws (all/normal/penalty), type of throws (flat/bounce/curve), errors (high ball/long ball), goals (all/from normal throws/from penalties) and blocks (hands/torso/legs). The means and SDs of the analyzed variables were calculated and either t-test for paired samples or Wilcoxon signed-rank test was used to compare the winning and losing teams.

On average, 92.7 throws were thrown during a match. From these, 3.3 goals were scored and 1.2 errors thrown. From the normal throws during live game, 72.1% were flat throws, 15.7% bounces and 11.7% curves. From the goals, 92.9% were scored from normal throws and 7.1% from penalties. From the goals scored with normal throws, 62.6% were from flat throws, 21.2 % from bounces and 16.2% from curves. Curve was the most effective type of throw as 5.0% of the curves led to a goal. The error percentage was highest in flat throws (1.5%). 44.4% of the goals were conceded from legs, 36.4% from hands and 19.2% from torso. The error percentage of blocks was highest from hands (6.5%).

The teams that won the matches had a significantly higher success percentage (more goals) (success% 4.6% vs. 2.6%, p<.01) and smaller error percentage in all throws (1.0% vs. 1.5%, p<.01). The winners also excelled in normal throws during live game as their success percentage (4.3% vs. 2.5%, p<.01) was higher and error percentage smaller (1.0% vs. 1.4%, p<.01). The winners were especially better in their flat throws (success% 4.0% vs. 1.5%, p<.01). They also scored a higher proportion of their goals with flats (71.5% vs. 47.0%, p<.05). Furthermore, the error percentage in all blocks was significantly smaller in winners (2.9% vs. 5.1%, p<.001). In the winning teams the error percentage in blocks was smaller especially in hands (2.8% vs. 11.9%) and legs (3.4% vs. 5.9%), but these differences did not reach statistical significance.

Based on the results it can be concluded that especially the ability to throw powerful and accurate flat throws is an important skill considering winning in women's elite level goalball. In general, the differences between winners and losers were small in most of the technical skills and thus it seems that the games are often decided by individual offensive skill executions and individual errors.

POD 10.3
Performance analysis of kicking and striking skills in Gaelic sports

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Detailed skill analysis can assist with planning for training and for guiding biomechanical analyses. The aims of this study were to evaluate kicking and striking in Gaelic football and hurling. Every hit and kick in four all-Ireland championship and league games of each code were notated using a custom developed excel macro. Each performance was evaluated on 12 parameters centred on three key areas; Game context (game-time, score difference, pressure on the performer, position on ground at which the hit/kick occurred), technical factors (type of hit/kick, intended aim, distance hit/kick, approach speed, approach angle relative to ball flight, number of approach steps, angle to goals for goalshots) and result (goal, turnover etc).

For hurling, on average 270 hits were performed in a game with an overall success rate of 61%. Strikes comprised of 68% general play, 6% from the sideline, 10% free hits and 17% from puckouts. Eighty one percent of strikes were performed from the hand (the sliothar or ball is released from the hand and struck while in the air), 11% flicked up from the ground and struck with the remaining 8% struck directly from the ground. Approach speeds were spread evenly between slow (walk-jog), medium (jog-stride) and fast (stride-sprint) with three steps the most common. More than half of the kicks were under high pressure (52%, an opposition player within 1 m and influencing the player with possession) and this was 60% for general play. Players most commonly approached the strike at zero degrees (running in the same direction as the hit, 32%) and 90 degrees (21%).

For football, on average 205 kicks were performed in a game with an overall success rate of 55%. Kicks comprised 74% general play, 20% frees and 6% sideline kicks. Fifty percent of these were hook kicks, 29% punt kicks and 21% were off the ground. Approach speed was most commonly moderate (41%) followed by slow (33%) and fast (26%). Only 22% of kicks were under high pressure but 60% were under high or medium pressure. Of interest, similar patterns existed when examining general play and goal-shots separately. The most common approach angle was 30 degrees (35%) using five steps.

This descriptive data of the main skills in GAA has a number of uses. It can provide a guide to training specificity for GAA sports. It is a powerful tool for individual coaching in identifying performance patterns/errors for players (e.g. technical differences between good and bad kicks) as used in Australian football (e.g. Ball, 2003). Finally it can be used to guide biomechanical analyses examining these skills, with the combined approach of game-based and lab-based technical evaluation addressing the limitations of each noted by Glazier (2010). The identification of the most common performances (e.g. kick type, approach angle/speed) is a sound scientific method of choosing the task for evaluation.

Ball, K. (2003) Kick evaluation of individual players in Australia Football games. *Technical report for Fremantle Football Club*, Fremantle Australia.

Glazier, P. (2010) Game, set and match: Substantive issues and future directions in performance analysis. *Sports Medicine*, 40: 625-634.

POD 10.4

Differences in game statistics between winning and losing teams in inter university elite male Sepak Takraw Tournaments

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The purpose of the study is to analyze and investigate the differences in male *Sepak Takraw* game statistics between winning and losing teams. Data were collected from 2012 elite male inter univarsity Sepak Takraw tournament. Seven (7) games starting from quarter final match until final match were analyzed. There were 11 performance indicators have been selected as the variables in this study (service in, service out, service ace, success first ball, unsuccessful first ball, successful feeding, unsuccessfully feeding, success strike, unsuccessfully strikes, successful blocking and unsuccessfully blocking). A descriptive and nonparametric analysis (Wilcoxon signed-ranks test) were performed which significant value is set at p≤0.05. Analysis shows only one (1) performance indicator have shown a significant different between winning team and loosing team which is service out (z=-2.47, p=0.013, p<0.05). Another ten (10) performance indicators shows there are no significant different between winning and loosing team (success first ball, z =-1.23, p= 0.218, p>0.05; unsuccessful first ball, z =-1.91, p=0.057, p>0.05; success feeding, z =-1.75, p=0.79, p>0.05; service in, z =-1.09, p=0.274, p>0.05; service ace, z =-1.54, p=0.122, p>0.05; unsuccessful feeding, z=-0.60, p=.549, p>0.05; success spike, z=-.736, p=.462, p>.05; unsuccessful spike, z =-.736. p=.462, p>0.05; successful blocking, z=-1.44, p=.149, p> .05 and; unsuccessful blocking, z=-.983, p=.325 , p>0.05). The values presented in this study can be used as a reference for coaches to determine teams' weaknesses and strength in designing a training program, which useful for higher level competition. Coaches need to focus on the significant performance indicator during training in order to achieve success in *Sepak Takraw* inter university tournament.

POD 10.5
Volleyball defensive performance in relation to scoring skill and player effectiveness

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Match Analysis is of particular importance in the process team's preparation, to the extent to increase the chances of coach's success to enhance their knowledge on skills teams' performance. We won't to identify possible constraints assigned to the defensive game procedures (in KII) according scoring skills and players effectiveness.

The sample was composed by 482 defense actions, belonging to 5 games of Play-off of the Portuguese National Championship 2009-2010. The dependent variables considered were the defense effectiveness, the intervenient player at the reception, the service type, the defense player intervenient; the defense area and the attack zone were the independent variables. The statistical procedures used were the descriptive statistics and the multinomial logistic regression to obtain the estimated probability of occurrence of the dependent variable, based on values of the independent variables. The reliability intra and inter-observer were cleared using the (Cohen's kappa values).

The results showed that the player who has done more defenses that allow all the attack options was the Libero, proving its importance in the offensive organization of team in KII. The areas' most exploited by attacks opponents were the defensive zone respectively. In this sense when training the team should aim to increase the effectiveness of defensive procedures in zone 1 and zone 6.

It's very important to considered the effective coordination of the line of team's defense and priority to increase the levels of effectiveness of defensive procedures in KII, training routines must be established at the level of the block, which difficult the attack in zone 1, thus freeing the setter for the implementation of distribution action (Monteiro at al., 2009). We can see the importance of the setter intervention in defense for counterattack and the distribution by libero in KII. The most efficacies in defense are the Libero, after setter and opposite player. For the training we need liberty the defense setter in zone 1for organization the offensive strategy during penetration.

Monteiro, R., Mesquita, I. & Marcelino, R. (2009) Relationship between the set outcome and the dig and attack efficacy in elite male Volleyball game, *International Journal of Performance Analysis in Sport*, 3: 294 - 305.

POD 10.6

The effectiveness of Topsport Talent Schools in the Netherlands: A retrospective analysis of performance in sport and education

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Combining school and sport is difficult for many aspiring elite athletes. In addition to dedication to their sport these talented athletes will have to meet the standards of the Dutch educational law, which includes attending school for 1040 hours per year. To help aspiring elite athletes achieve the highest possible level in both their sport and education Topsport Talent Schools (TTS) were founded in the Netherlands, similar to the development of Elite Schools of Sports (ESS) in other countries. TTS offer several facilities to talented athletes, including dispensation from courses, a flexible timetable, and guidance of a coordinator at school. Studies of ESS in Germany and Flanders showed that attending a TTS might slightly positively influence their sports achievements, but may lead to a lower educational degree (De Bosscher & de Croock, 2008; Emrich, Fröhlich, Klein & Pitsch, 2000).

The purpose of the research is to analyze the influence of TTS on sport and school sport performance of aspiring elite athletes. A retrospective study was conducted amongst (former) athletes who were identified as 'talents' during the years 2004-2008 by seven selected national sports federations. These talents were invited to participate in an on line questionnaire. Only those talents that had finished their secondary school were included in the analyses (N=242). 30 percent of this group had attended a TTS.

Results indicated that athletes who have attended a TTS do *not* attain a significant higher sport performance level compared to those who attended a mainstream secondary school. Irrespective of the type of school attended, nearly half of the talent group had completely dropped out from high level competitive sports. A third of the talents was still active at a national level. Of those attending TTS, 24 percent participated at an international level, of whom nine percent at top level; of those attending mainstream schools these numbers were 23 and 13 percent respectively. Similar to the distribution within the total talent group, 32 percent of de medal winners on European Championships and World Championships attended a TTS. Talents who have attended TTS are significantly less likely to attain the highest level in secundary education in the Netherlands. Talents who attended TTS were however more satisfied about the support they received in balancing school and sport during adolescence.

Bosscher, de V., & Croock, de S. (2010) *De effectiviteit van de topsportscholen in Vlaanderen: een vergelijking van het loopbaantraject van topsporters al dan niet in een context van een topsportschool. [The effectiveness of elite schools of sport in Flanders: a comparison of the career of the elite athlete, whether or not affiliated with an elite school of sport],* Brussel: Vrije Universiteit Brussel.

Emrich, E., Fröhlich, M., Klein, M., & Pitsch, W. (2009) Evaluation of the elite schools of sport. *International Rreview for the Sociology of Sport,* 44(2): 151-171.

Oakley, B., & Green, M. (2001) The production of Olympic champions: International perspectives on elite sport development system. *European Journal for Sport Management*, 8: 83-105.

SESSION 11: COMBAT SPORTS

POD 11.1
Error in judging Olympic boxing performance: false negative or false positive?

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To elect the winner in amateur boxing, five expert judges observe the boxers to assign "correct hits". These hits are then processed by the automated Scoring Machine System (SMS) to assign scores to each boxer. Because it is based on quick human observation under pressure, this system is prone to error. The purpose of this investigation was to identify the nature of this error defined either as false positive (point assigned to an incorrect hit) or false negative (point not assigned to a correct hit).

We analysed videos (25 fps) of 10 boxing bouts performed during the 2008 Beijing Olympic Games using a specialized software for boxing match analysis (www.dfanalysis.com). Slow motion and replay modes were used by an expert in boxing match analysis to establish true correct hits based on the Amateur International Boxing Association's guidelines. True correct hits were then compared to "correct hits" assigned by the SMS to identify false positives and false negatives.

On average, 11.1 ± 3.3 "correct hits" (mean ± SD) were assigned by the SMS. This score was significantly lower than the number of true correct hits established with boxing match analysis (22.9 ± 9.3, $P<0.01$). Comparison of SMS and boxing match analysis revealed 5.1 ± 1.4 false positives and 16.9 ± 8.4 false negatives.

In conclusion, boxing match analysis revealed that SMS significantly underestimates the number of true correct hits because of a high number of false negatives. New training methods to improve judges' ability to assign true correct hits and/or changes in the SMS threshold to assign a score should be tested in order to reduce the number of false negatives without increasing the number of false positives.

POD 11.2

A comparative analysis of competition before and after the adoption of the electronic trunk protector in Taekwondo

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This study was to compare the application, adaptation and efficiency in the development of techniques of Taekwondo competition before and after the adoption of the electronic trunk protector. Comparisons on attacking skills, techniques for scoring, comparisons by rounds, scoring style per attacking, attacking skills by scoring, scoring types between the winner and loser were considered. The matches before the adoption of the electronic trunk protector in the 2008 Beijing Olympics and 2012 London Olympics qualifications, and the matches after the adoption of the electronic trunk protector in the 2009 World Taekwondo Federation's World Cup and 2011 Gyeongju World Championship were used for the study. Additionally, Independent sample T-tests and chi-square comparisons were used for statistical comparisons.

As summaries of results, there was significant difference between before and after the adoption of the electronic trunk protector as below;

1. The pushing kick attack (t=-2.784, p<.05) and fast turning kick attack (t=-3.040) for the attacking in the male matches were significant differences. Also, the spin kick attack (t=2.474, p<.05) in the attacking for the female players were significant differences between before and after the adoption although the fast-turning kick and pushing-kick attacks in female players have not shown any differences.
2. The ratio of turning kicks for male and female players for scoring were greater than other skills. However, the turning kick, downward kicks and pushing kick were increased comparing to before the adoption.
3. There was significant differences on attacking skills between winners and losers by male matches that the fast kicks (t=-2.884, p<.05) for winners and pushing-kicks (t=-2.871, p<.05) for losers were different on the comparison between before and after the adoption. In the female matches, there were no significant differences found.
4. There were no significant differences of skills in attacks at each round between before and after the adoption for male matches. However, there were significant differences of skills in attacks at each round in female matches (X^2=27.22, P<.05).
5. There were no differences of scoring types in both male and female matches between before and after the adoption of the electronic trunk protector.
6. There no differences of frequencies of first attacks in both male and female matches between before and after the adoption

Consequently, this study presented that the revised strategies of attacks and defences would be required in order to win a match after the adoption. Further research is required on the effectiveness of using the electronic trunk protector and human-referring has to be compared.

POD 11.3
The design and evaluation of a mobile analysis system for Judo competition

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The advancements of technology have allowed for faster more accurate analysis systems to be developed to capture information previously deemed too difficult to notate. Due to the speed, analytical content and the nature of sport it is difficult to notate contests live reliably in combat sports such as Judo (Hughes & Franks, 2008). The purpose of this study is to design a computerised notational analysis system utilising new software available which can also be used on mobile devises such as the iPad or Smartphones to investigate if reliable real time analysis is achievable as there is a greater impact for performance analysis as it provides a more explicit message to players and coaches at critical times.

Initial discussions with the Welsh National Judo Coach assisted in the identification of performance indicators which could be advantageous in terms of data, utilising this information an analysis system was designed and developed in Dartfish™ EasyTag and using an iterative approach the system was refined to suit the needs of the analyst, coach and players.

The Initial set up of the system proved challenging due to the constraints of the software leading to the re-definition of events, labels and categories to allow for the correct data output from the system. The layout of the buttons were changed following initial testing to create the most logical and user friendly version which would assist in increasing the strength of reliability on data input.

The main functions of the system include tagging, analysis of data, linking data to video, further more in-depth analysis of footage post match and interactive video clip selection and review which are all useful in the coaching.

POD 11.4
The standing position in biathlon shooting: Body sway, shooting position and shooting results

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The importance of shooting performance in relation to the complex performance in biathlon is increasing due to the introduction of new competition variants with proportionately more bouts of shooting compared to skiing. Besides shooting position, targeting, breathing technique and triggering (Nitzsche, 1998), body sway (e.g. Bozsik & Bretz, 1994) and stance stability (Sattlecker et al., 2009) can be considered as main performance variables. The aim of the current study is to analyse the relationship between body sway, various body angles and shooting position as well as their influence on the muzzle movements and shooting results. Therefore a specific measuring station was developed. In previous projects (e.g. Nitzsche, 2009), specific sensors were used, to measure forces between athlete and rifle (e.g. forces on the trigger and on the butt plate) as well as movements and accelerations on the muzzle. In the current study, a stabilometric platform (footscan® by RSscan) and a 2D video analysis system (Simi Motion) were integrated. Through synchronization of all three constituent parts of the measuring station by determining the exact moment of the shot using a piezoelectric sensor, it is possible to analyse the relation of all measured variables. Therefore, the data were processed by merger.biathlon (WiFa, University of Leipzig). In the current study, 117 German biathletes from all age groups were analysed. Each biathlete had to shoot 4 series in standing position, 2 without and 2 with physical load. Analysed variables of body sway were the deviation of the centre of pressure (COP) in shooting direction (COP_X, mm) and 90° to shooting direction (COP_Y, mm), as well as the load distribution between front/rear foot (LD_FR, %) and heels/toes (LD_HT, %) over one second before the shot. These variables were set in relation to shooting score (1-10) depending on age and physical load. With physical load, the results showed significant dependencies between age and body sway in both motion axis (COP_X -0,221; $p = 0,018$; COP_Y -0,297; $p = 0,001$). Body sway in younger athletes is significantly greater than in older athletes. For body sway in comparison with shooting results under physical load, the results show correlations in both motion axis (COP_X -0,201; $p = 0,032$; COP_Y -0,366; $p < 0,001$). Higher body sway in both motion axis leads to lower shooting scores. Also, the results showed less body sway with greater load distribution on the front foot (-0,322; $p < 0,001$). Even though the correlations are low (e.g. due to the complexity of biathlon shooting), the measuring station has proven to be very useful in order to quantify the main performance variables of shooting and their relation to each other as well as their influence on the shooting results.

Bozsik, A., & Bretz, K. K. R. J. (1994) Body Sway in Biathlon Shooting, *from Hungarian Ski Federation, Hungarian University of Physical Education,* 164–166, Klopfer GmbH.

Nitzsche, K. (Ed.) (1998) *Biathlon: Performance - Training - Competition*. Wiesbaden: Limpert. (In German)

Nitzsche, K. (2009) Biathlon measuring station. Possibilities in objectification of shooting performance in biathlon*, Research Report*, University of Leipzig. (In German)

Sattlecker, G., Müller, E., & Lindinger, S. (2009) Biomechanical factors of biathlon shooting in youth, junior and elite athletes. In *14th annual Congress of the European College of Sport Science, Oslo/Norway, June 24-27, 2009, Book of Abstracts* (p. 169).

POD 11.5
A temporal analysis of combinations in professional boxing

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Previous analysis of boxing performance has shown frequencies of different punch types that are thrown (Hughes and Franks, 1997). However, the frequency profiles of punch types do not provide information on combinations that are used. Therefore, the purpose of the current investigation was to investigate temporal patterns in combinations of 2, 3 and 4 punches used by boxers of three different weight divisions; bantam weight, middle weight and heavy weight. A manual notation system was developed to record single punches and combinations of punched during 8 bouts from each weight division.

Punches were classified into 9 different types; jabs (J), left (L), right (R), straight (S), uppercut (U), left to the body (LB), right to the body (RB), jab to the body (JB) and straight to the body (SB). The outcome of each punch was classified as hitting or missing the opponent. There was very good inter-operator reliability for the type of punch thrown (κ = 0.958) and the outcome of the punch (κ = 0.923). A spreadsheet was programmed to identify different types of combinations that occurred and a pivot table was used to obtain frequencies of these within each match. Some contests were less than 12 rounds and so values were scaled to allow a meaningful comparison between weight divisions.

With 9 punch types, there are a possible $9^2 + 9^3 + 9^4$ = 7371 different types of combination. However, over half of the combinations observed fell into the 12 types shown in Table 1. These 12 combination types covered 43.0$\pm$9.9% of combinations used by bantam weights, 57.9$\pm$19.8% for middle weights and 64.1$\pm$10.7% for heavy weights. A Kruskal Wallis H test revealed that the percentage of combinations that were included in these 12 types significantly differed between the three weight categories (p = 0.012). A Wilcoxon signed ranks test revealed that L was significantly more likely to hit the target when used in a combination than in isolation (48.8$\pm$24.9% v 45.4$\pm$21.2%, p < 0.05).

Table 1. Combination types per 12 rounds.

Weight	J.S	J.J	L.R	R.L	J.R	L.S	J.L	S.L	U.L	J.S.J	J.U	J.J.S
Bantam	21.5	9.6	5.2	4.0	3.9	1.1	3.9	1.3	1.0	1.7	1.5	1.1
Middle	25.3	26.9	7.1	6.9	3.9	7.1	3.2	5.2	3.7	2.8	3.0	1.6
Heavy	20.5	19.0	7.9	5.6	3.5	2.9	3.8	2.4	3.9	1.8	1.7	3.4

The results show that there are commonly used combinations in boxing with lighter weight boxers tending to use a greater variety of combination types during bouts. The modal combination was J.S. However, J.J was the modal combination for middle-weight boxers. Further research applying temporal analysis is recommended to analyse combinations used in other weight divisions.

POD 11.6
A time-motion analysis of elite female foil fencing

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A published review of literature has highlighted that there is at present a lack of published scientific research on the sport of fencing (Roi and Bianchedi, 2008). It has been suggested that further research, including time-motion analysis and evaluation of competitive scenarios, is required to better inform coaches on the physical demands being placed on elite fencers (Bottoms *et al.*, 2011). This study sought to carry out a comprehensive time-motion analysis of elite female foil fencing to understand the demands being placed on fencers in elite competition. A key part of this study was to identify the differences between the various types of bouts; 15-touch, 5-touch and team bouts.

A total of 100 international female foil fencing bouts were analysed, based on video recorded by and obtained with the permission of the Singapore Sports Institute. A total of seven movement classifications were used during the data collection, which were consolidated into three categories of varying intensities (Low, Moderate and High) for analysis. The differences between the types of bouts and movement categories were assessed using magnitude-based Cohen's effect sizes (ES), with modified qualitative descriptors.

The results from this study found that high-intensity movement accounted for 6.2 ± 2.5 % of total bout time in elite female foil fencing. These high-intensity movements had a mean duration of 0.7 ± 0.1 s with a mean recovery period between these movements of 10.4 ± 3.3 s. Using the repeated work bouts definition of two or more bouts separated by a recovery of less than 20 s (O'Donoghue *et al.*, 2005), 87% of high-intensity movements would be classified as repeated work bouts. If the high-intensity movements were classified as "work" and the low- and moderate-intensity movements classified as "recovery", these results would equate to a work:recovery ratio of 1:16. The only "large" difference between the bouts was found for the mean duration of the low-intensity movement in the 15-touch bouts compared to the 5-touch and team bouts. All other differences were "moderate", "small" or "trivial". **Conclusion:** These results demonstrated that similar training plans could be used to physically prepare female fencers for 15-touch, 5-touch and team bouts. Conditioning programmes for elite female foil fencers should consist of primarily anaerobic alactic activities with an additional aerobic component to aid recovery between bouts and ensure that fatigue does not become a limiting factor to performance.

Bottoms, L.M., Sinclair, J., Gabrysz, T., Szmantlan-Gabrysz, U. & Price, M.J. (2011) Physiological responses and energy expenditure to simulated epee fencing in elite fencers, *Serbian Journal of Sports Sciences,* 5: 17-20.

O'Donoghue, P.G., Hughes, M.D., Rudkin, S., Bloomfield, J., Cairns, G. & Powell, S. (2005) Work-rate analysis using the POWER (Periods of Work Efforts and Recoveries) System, *International Journal of Performance Analysis in Spor*, 5: 5-21.

Roi, G.S. & Bianchedi, D. (2008) The science of fencing, implications for performance and injury prevention, *Sports Medicine*, 38: 465-481.

SESSION 12: SYSTEMS

POD 12.1
Using spatial metrics to characterize behaviour in small sided games

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The analysis of behaviour in team sports as a dynamical system is an issue of growing interest in sport science research. Special attention is given the aspect of space-time dynamics of team configurations in order to describe playing behaviour (McGarry, 2009). This work presents an approach to use geometrical forms of player configurations for team tactical analyses in small sided soccer.

An indoor small-sided soccer match (5 vs. 5)was performed and the positions of all players were captured by means of the Ubisense location system (Leser, Baca, & Ogris, 2011). The following parameters were analysed: convex hull (Frencken, Lemmink, Delleman, & Visscher, 2011), bounding rectangle and generalised Voronoi diagrams (Fonseca, Milho, Travassos, & Araújo, n.d.). The regularity of these surface areas was measured in both teams using a normalised measure of approximate entropy (Fonseca, Milho, Passos, Araújo, & Davids, n.d.). The Pearson coefficient was calculated to assess the correlation between the team areas (Frencken et al., 2011).

Although the applied metrics assess different properties of team behaviour, the measured entropy indicate that the system under study is highly complex as the areas across time present low predictability. However, the negative linear relation expected between teams was only captured by the Voronoi areas. Further research on the associations between the space-time dynamics and important game behaviours, such as shot attempts at the goal are required and ought to be considered.

Fonseca, S., Milho, J., Passos, P., Araújo, D., & Davids, K. (n.d.) Approximated entropy normalized measures for analyzing social neurobiological systems. *Human Movement Science*.

Fonseca, S., Milho, J., Travassos, B., & Araújo, D. (n.d.) Spatial dynamics of team sports using Voronoi diagrams. *Human Movement Science*.

Frencken, W., Lemmink, K., Delleman, N., & Visscher, C. (2011) Oscillations of centroid position and surface area of soccer teams in small-sided games. *European Journal of Sport Science*, *11*(4): 215-223. doi:10.1080/17461391.2010.499967.

Leser, R., Baca, A., & Ogris, G. (2011) Local Positioning Systems in (Game) Sports. *Sensors*, *11:* 9778-9797. doi:10.3390/s111009778.

McGarry, T. (2009) Applied and theoretical perspectives of performance analysis in sport: Scientific issues and challenges. *International Journal of Performance Analysis in Sport*, *9*(1): 128-140.

POD 12.2
Combined EEG and eye-tracking in sports skills training and performance analysis

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[3]*Centre for Event and Sport Research, Bournemouth University, Poole, UK*

The use of mobile EEG brainwave monitoring and eye-tracking recorded synchronously during the training of sports skills offers significant opportunities but creates challenges.

Opportunities:

♦ Measuring neurocognitive activity and visual focus in real time which can be used to provide immediate feedback to the coach, in 'real world' settings, for optimising training protocols for the individual athlete.
♦ Use of sound output ('sonification') in proportion to EEG regions of interest as a neurofeedback mechanism for athlete self-training.
♦ Application of visualisation protocols and 'EEG-driven' PC games where game feedback based on state of mind is used to optimise mental state prior to performance.
♦ Examining the relationship between eye movement and neuro activity (e.g. saccades and gamma waves) and in athlete coaching interventions such as sports visual scanning strategies, Eye Movement Desensitisation & Reprocessing (EMDR) therapy, focussed relaxation, etc.

Challenges:

♦ The recording of EEG during gross motor behaviour is subject to non-brain artefacts in the raw (time-domain) EEG, due to the much larger (than EEG) electrical voltages arising from muscle and eye movements. Practical approaches and signal processing (frequency domain spectrum) techniques to address these problems will be discussed.
♦ The synchronisation of data recorded on different types of equipment (e.g. EEG, eye-tracker, video, sound, EMG, etc.) with different 'clocks' and diverse data formats is difficult – both in terms of time-stamping the original recordings across all the systems and playing them back synchronously for subsequent performance analysis. Progress on creating real-time data export methods which allow synchronous data recording and playback will be reported.

Examples of studies carried out in archery, golf, motorsport, football and skiing will be discussed, with a focus on archery where:

♦ Measurements were taken from intermediate, county level, near elite and elite archers.
♦ Archery was chosen to demonstrate the real-time and in-situ quantification of neural activity compared with target-based measures of performance that archery provides, over a range of time-spans and skills.
♦ Results demonstrate that there are significant and measurable changes in EEG patterns during a shot with evidence suggesting that the patterns vary as a function of skill level, but not simply as a function of score.

Significance of each of these studies for goal-directed learning and performance enhancement are discussed.

POD 12.3
Bringing the lab to the field: Potential and challenges of body area networks in sports

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Today's technologies for monitoring physiological parameters associated with overtraining are largely limited to cumbersome lab-based measurements (Bandyopadhyay & Bhattacharjee 2012), with few real-time, on-the-field measures available. The application of body area networks in sports presents a unique opportunity to monitor athletes in their natural environment. The miniaturized wearable sensors enable the athlete to be monitored in their natural training and competition environment, enhancing the accuracy of the measures. However use during sports presents challenges that body area networks must overcome to be effective.

Here, the potential and challenges of body area networks during sports is investigated. A study comparing imec's body area network ECG necklace (Penders et al., 2011) with 2 commercial heart rate sensors (Polar CX800 during stationary cycling and Hidalgo Equivital during general fitness activities) was performed as an example. Correlation of the imec ECG necklace's RR intervals with those of the Polar device was 0.97, while the imec ECG necklace maintained a Sensitivity and Positive Predictivity (Se+PP) sum of greater than 199.42 compared with the Hidalgo Se+PP of 195.38 at estimated SNR of greater than 0dB. The study highlights some important considerations when designing body area network sensors for use during sports: the need to take a holistic approach (Romero et al., 2011) to motion artifact reduction to handle the variable situations during sports; the need to take advantage of new system level integration technology to improve wearability and comfort; and the need to continue development of multi-parameter sensors towards other physiological parameters not considered when designing body area network sensors for healthcare. Through taking advantage of today's body area network sensors and overcoming the challenges in sports situations with enhanced system integration, and combining with existing wearable movement sensors and new equipment-based ergometry sensors, a greater understanding of the athlete in their training and competition environment can be gained.

Bandyopadhyay A., and Bhattacharjee I. (2012) Physiological perspective of endurance overtraining – A comprehensive update. *Journal of Medicine (Cincinnati)*, 5: 7-20

Penders J., Altini M., Van de Molengraft J., Romero I., Yazicioglu F. & Van Hoof C. (2011) A low-power wireless ECG necklace for reliable cardiac activity monitoring on-the-move. *Proc. Int. Conf. IEEE EMBS,* Boston, USA.

Romero I., Berset T., Buxi D., Brown L., Penders J., Kim S., Van Helleputte N., Kim H., Van Hoof C. & Yazicioglu R.F. (2011) Motion artifact reduction in ambulatory ECG monitoring: an integrated system approach. *Proc. Wireless Health*, San Diego USA.

POD 12.4
Configure Code Analyse: An iPad application for live match analysis

Venkat Narayn

Narayn SPAS, Bangalore/India & Ulm/Germany

The presentation is about an iPad App for Live Match Analysis. The App is named as CCA Live Match Analysis, where CCA stands for Configure, Code and Analyse. The App is designed to enable user to configure activities, collect stats about them and analyse the results all in a single tool. The App does not include video capture or video editing options.

The purpose of the software is to provide 3 important functionalities:

1. *Configure*: The App shall enable users to specify events and attributes.
2. *Code*: The App shall enable users to collect stats on each of the configured data.
3. *Analyse*: The App shall enable users to see the results of the coded data in the form of tables and graphs.

The CCA modular structure is key to App design. The division of functionality in to Configure, Code and Analyse brings clarity and enhances process flow. Each of the modules is self contained and does its function independent of other modules. This means the user could choose to use tool like excel to do the analysis by exporting the coded data.

The module structure is also designed with the intention to cater to different users like coach, assistant coach and analyst. Because the coach might only be interested in analysis module while analyst might focus on configure and code modules. By separating the functionalities users get the option to focus on relevant modules.

The presentation shows the general working of the App and a sample match analysed using the App. Also presenting the results produced by the app and a discussion on how the results could be used in the coaching process during live match.

The presentation also serves as a platform to discuss the advantages and disadvantages of a modular structure and its scope in future analysis tools.

The App is developed keeping in mind games like Basketball, Netball and Handball.

POD 12.5
Towards an automated feedback and analysis system in carom billiards

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Systems for simulating shots may assist players interested in understanding and learning cue sports. The physics of the simulation often agrees well with real conditions. We are not aware of feedback systems, which automatically advice players during the game on how to perform a shot in order to score and, moreover, to obtain ball positions for an easily to execute consecutive shot. There are, however, some promising approaches going into this direction (cf. Landry, Dussault and Mahey, 2012). Our intention is to develop a system for carom billiards, which provides players with recommendations on how to play one's own cue ball (cue offset, cue stick elevation/orientation, initial velocity) depending on the current ball constellation, and which analyses, how this has been put into practice by the player. Hence, an inverse approach is required: Based on the desired outcome (in case of recommendation) or the observed ball trajectories (in case of analysis), the player's input has to be determined. In a first step, a video-based system for reconstructing ball trajectories in almost real-time was developed (Steininger, 2011). A high-speed camera (Basler piA640-210gm/gc, Ahrensburg, Germany) is mounted on the ceiling above the billiard table (dimensions: 210 × 105 cm). In order to increase the spatial homogeneity and to stabilize the lighting situation on the cloth, a special illumination system has been constructed. Ball motions are recorded with a frame rate of 100 Hz. The software for ball tracking has been programmed in LabVIEW (National Instruments, Austin, Texas, USA). Initially, templates of each ball are created. Tracking is then performed frame by frame in two separate steps. First, a color matching process identifies the balls, thereby estimating their approximate positions. Afterwards, a shape matching algorithm detects the image positions more accurately. Object space coordinates and trajectories are finally calculated based on calibration results obtained from recording a dot pattern. Reconstructed trajectories for one exemplary shot are shown in Fig. 1. For the current implementation of the method a mean error of 0.39 cm in the reconstructed positions has been observed.
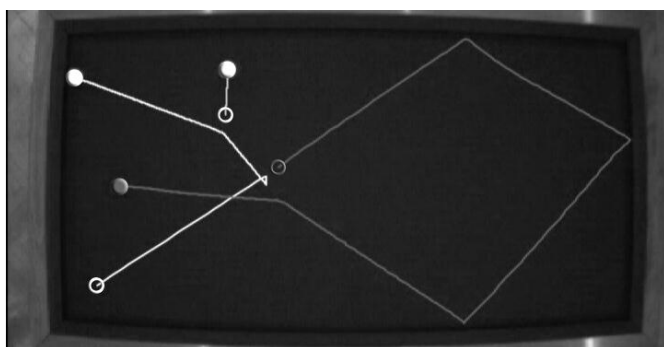
Figure 1. Example for reconstructed trajectories.

Landry, J.-F., Dussault, J.-P., & Mahey, P. (2012). A robust controller for a two-layered approach applied to the game of billiards, *Entertainment Computing*. Retrieved February 27, 2012 from http://www.sciencedirect.com/science/article/pii/S1875952112000031

Steininger, E. (2011) *Development of a video-based system for an automated acquisition of ball trajectories in carom billards* [in German], Master Thesis, University of Applied Science Technikum Wien.

POD 12.6
Application of three time motion analysis systems in semi-elite soccer match play

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Time motion analysis systems have been utilised in elite level soccer to elucidate the demands of match play via distances covered, running intensity and activity patterns (Di Salvo et al., 2007). Discrepancies between differing time motion analysis systems used in elite level soccer to predict absolute distance covered have been identified (Randers et al., 2010). Work rate demands of semi elite soccer match play have yet to be quantified, furthermore the application of contrasting time motion analysis systems at this level of soccer have yet to be investigated. Therefore the purpose of the study was to investigate the application of three motion analysis systems in monitoring the physiological demands of semi elite soccer match play. After gaining local ethics and governance clearance, five male semi elite soccer players (age 24 ± 0.4 years, body mass 77.2 ± 1.4 kg, height 1.78 ± 0.06 m) were recruited and examined in four competitive match play situations via three time motion analysis systems, GPS (SPI Pro 5Hz, GPSports, Canberra, Australia), manual tracking (Trak Performance v 3.2, Sportstec, Australia) and video based analysis systems (SportsCode Pro v 8.0, Sportstec, Australia). Five categories of intensity were considered during the study, 0-11 km/h (standing, walking, jogging); 11.1-14 km/h (low speed running); 14.1-19 km/h (moderate speed running); 19.1-23 km/h (high speed running); > 23.1 km/h (sprinting). For the video based analysis electronic timing gates (IRD T175 system, Brower, USA) were used to calculate players speed in each movement category and subsequently the distances in each defined speed zone were estimated. The total distance covered in five selected categories of intensity were analysed via each time motion analysis system. Mean total distance covered during match play according to GPS (10799.5 ± 396.7 m), manual tracking (10665.2 ± 666.9 m) and video analysis (10932.1 ± 683.0 m) systems were not significantly different ($P > 0.05$). The mean distance covered during moderate speed running was found to be significantly greater ($P < 0.05$) when using the video analysis system (2327.0 ± 239.2 m) than the manual tracking system (2026.6 ± 142.1 m), no significant differences ($P > 0.05$) were discovered when comparing these systems with the GPS system (2285.0 ± 153.1 m). Manual tracking software (258.6 ± 98.7 m) was found to predict significantly greater mean distance covered than GPS software (99.2 ± 91.9 m) in the sprinting speed zone ($P < 0.05$), no significant differences ($P > 0.05$) were found when comparing these systems with video analysis (117.0 ± 91.0 m). In relation to all other speed zones no significant differences were found between any of the three systems ($P > 0.05$). The results suggest that the three systems were able to detect similar work rate demands of semi elite soccer match play. Although the three systems presented similar absolute distances covered during match play, discrepancies were present at moderate speed running and sprinting speeds. Future studies should focus on one specific system to identify work rate demands of semi elite soccer and care should be taken if using systems interchangeably due to discrepancies at moderate speed running and sprinting speeds.

Di Salvo, V., Baron, R., Tschan, H., Calderon Montero, F.J., Bachl, N. & Pigozzi, F. (2007) Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine,* 28(3): 222-227.

Randers, M.B., Mujika, I., Hewitt, A., Santisteban, J., Bischoff, R., Solano, R., Zubillaga, A., Peltola, E., Krustrup, P. & Mohr, M. (2010) Application of four different football match analysis systems: A comparative study. *Journal of Sports Sciences,* 28(2): 171-182.

SESSION 13: SOCCER 3

POD 13.1
Regular patterns of play in the counterattacks of the FC Barcelona and Manchester United FC football teams

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The aim of the present study is to demonstrate the potential of the software THÈME 5.0, for the detection of behavior temporal patterns (T-pattern) in the football game, more specifically, in the actions of counterattack of the FC Barcelona (FCB) and Manchester United (MU).

The sample consisted of 24 football games (12 per team) of domestic competitions that were analyzed by systematic observation, using the observational instrument developed by Sarmento et al. (2010). The study of the data reliability was calculated by the intra and inter observer agreement and values above .90 were achieved for all the criteria. The data were analyzed through the use of the software THÈME 5.0.

The results show that many temporal patterns exist in soccer. The number, frequency and complexity of the detected patterns indicate that sport behavior is more synchronized than the human eye can detect. We selected 8 t-patterns (4 per team), in relation to different phases of the counterattack that were analyzed in a detailed way during the presentation.

We can conclude, in a general way, that there is a similar feature in the selected BA t-patterns, i.e., the sequences start through an interception of the ball in the left corridor (zone 6) in terms of numerical superiority, after that, there was a quick transfer of the game center, from the right to the left, trying to take advantage, probably, of the imbalance of the opposing defensive structure (numerical equality). The sequences are developed through actions like the conduction of the ball with the intention of displacing the center of the game in the field of the game, to the areas close to the penalty area. In relation to the analysis of the sequences that end through a shot with a scored goal allowed us to understand (beyond the fact that these sequences are developed by the left corridor) that these shots are performed in the central zone of the offensive sector (zone 11) in conditions of numerical inferiority.

In a similar way, the selected MU T-patterns showed that the sequences of the counter-attacks start in the central zone of the defensive midfield (zone 5), in a context of numerical superiority, and are developed in the left corridor through actions like the short pass to forward, the diagonal pass forward, and reception/control of the ball, in contexts of numerical equality. The last pass came from the left corridor (zone 7), and the sequences finished in the central zone of the offensive midfielder (zone 8 and 11), through a shot inside or a shot with a scored goal.

This type of analysis allows us to know and to characterize the regular structures of offensive sequences in football teams. The t-patterns detected in these successful teams allowed us to know how that process is developed in an effective way. This information is relevant, on the one hand for the team itself because it makes it possible to conceive training exercises in order to increase this efficiency, and on the other hand it allows, for example, that the opposing coaches can develop strategies to prevent that the BA and MU teams perform these transitions effectively.

Sarmento, H., Anguera, T., Campaniço, J. & Leitão, J. (2010). Development and Validation of a Notational System to Study the Offensive Process in Football. *Medicina (Kaunas)*, 46(6), 401-407.

POD 13.2
Space creation and restriction in elite soccer

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Soccer matches involve two teams interacting as they contest the match. When one team has possession of the ball, the other team must compete to prevent scoring opportunities and to regain the ball. Therefore, many performance variables reflect one team's attacking play and the other team's defensive play. When in possession of the ball teams try to create space (Bangsbo and Peitersen, 2004) while the defending team tries to deny space (Bangsbo and Peitersen, 2002). The purpose of the current investigation was to determine if variables relating to space distinguish between possessions with different outcomes. Two types of data from the first half of a Bundesliga match were used in the current investigation; player position data generated by an automatic player tracking system and notation data for possession details. The first half of the match contained 107 possessions; there were 16 possessions that lead to a scoring opportunity (2 goals, 11 shots on target and 3 shots off target), 25 additional positions where the team in possession entered the attacking third and 66 possessions where they did not. A system was developed in Matlab version 7.1.0.246 (The Matworks Inc., Natick, MA) to determine mean distance variables from nearest opponents for the team in possession. This was done for the forward most 1 to 10 players in the team for the first and last 3s, 4s and 5s of possessions as well as the difference in mean space between the beginning and the end of the possessions. This gave a total of 90 (10 x 3 x 3) space variables that were compared between possessions of the 3 outcome types using a series of Kruskal Wallis H tests. There were no significant differences between possession types for space at the beginning of possessions ($p > 0.05$) or the difference in space between the beginning and end of possessions ($p > 0.05$). However, 8 of the 30 combinations of forward most player numbers and time at the end of possession were significantly different between the three types of possession ($p < 0.05$). The most significant variable was the mean space for the 10 outfield players during the final 5s of the possession ($p = 0.007$). The mean distance to the nearest opponent of 7.9 ± 1.1m for possessions that did not enter the attacking third and the 7.6 ± 1.1m for those that did were both significantly greater than when possessions lead to a scoring opportunity ($p < 0.05$). The mean distance to the nearest opponent was 7.5 ± 1.4m during the last 5s when the 2 goals were scored, 6.4 ± 0.8m when there was a shot on target and 6.1 ± 0.2m when there was a shot off target. This variable may be a useful indicator one team's ability to create space when in possession and another team's ability to restrict space when defending.

Bangsbo, J. & Peitersen, B. (2002) *Defensive Soccer Tactics: How to stop players and teams from scoring*. Champaign, Il: Human Kinetics.

Bangsbo, J. & Peitersen, B. (2004) *Offensive Soccer Tactics: How to control possession and score more goals*. Champaign, Il: Human Kinetics.

POD 13.3
An analysis of goal scoring patterns during the 2010 FIFA World Cup

Marcus A. Seaton & Louis Leventer

The aim of the present study is to describe the characteristics of goal scoring patterns at the 2010 FIFA World Cup. All goals (n = 145) excluding penalties were analysed by a computerized notation system. Inter and intra observed reliability was calculated with the Kappa statistic. Chi-square and cross-tabulation methods were used for the data analysis and the level of significant was set at $p<0.05$. Inter and mean intra-observer reliability was 0.91 and 0.88 respectively.

A uniform distribution of goals through the 15min time intervals was not observed, as significantly more goals were scored in the later part of each match half's (χ^2 = 49.3, df = 7, $p<0.001$). This resulted in more goals being scored in the second half compared to the first half of the match 58% to 42%, (p=0.06). As expected significantly more of goals were scored by strikers (51.5%), while midfielders and defenders scored 35.5% and 13% respectively (χ^2 = 30.1, df = 2, $p<0.001$). During the first half of games defenders scored significant more goals (80%) from headers (30%, χ^2 = 16.3, df = 2, $p<0.001$). In addition more goals were scored from headers inside the six yard box at stage two of the tournament (60%) compared to the group stage (29%). Goals from organized offense pattern of play (60%) were significantly (χ^2 = 44.0, df = 2, $p<0.001$) the most frequent compared to counter-attack and set-pieces 15% and 25% respectively. Most goals had been scored from a combination play (58%), while individual action resulted in 47% of goals (χ^2 = 40.0, df = 2, $p<0.001$). Significantly more goals were scored from inside the penalty area (χ^2 = 25.6, df = 2, $p<0.001$) 54% compared to inside the 6 yard box 25% and outside the penalty area 21%. Analysis of goals from set-piece show that the majority were scored from free-kicks (50%), compared to corners (38%) and throw-ins (12%; χ^2 = 7.8, df = 2, $p<0.05$). Slightly more of these were scored during the first half, but this was not significant.

These results follow the expected patterns of previous World Cups analysis (Acar et al., 2007; Armatas, Yiannakos, & Sileloglou, 2007) especially with regards to the increased probability of a goal being scored the match progresses. As these authors stated justification come from fatigue, possibly exasperated at this tournament due to games being played at altitude, which lead to reduced capacity for players to repeat high intensity work, thereby reducing work rates and increasing lapses in concentration, which consequently lead to goals being scored.
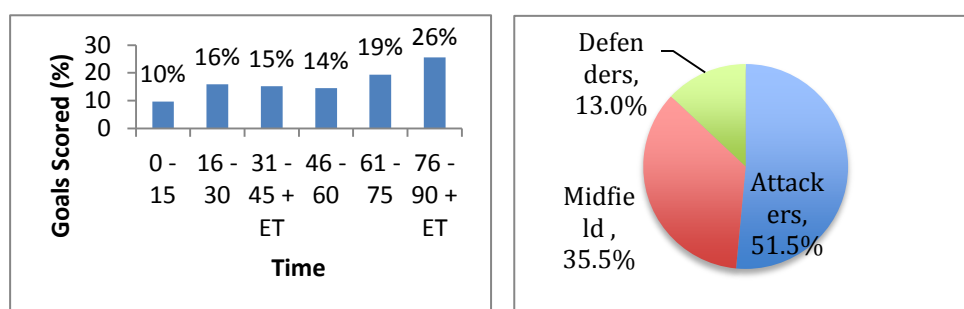
Figure 1 Distribution of goals scored during games.   Figure 2 Distribution of goals by playing position

Acar, M. F., Yapicioglu, B., Arikan, N., Yalcin, S., Ates, N., & Ergun, M. (2007) Analysis of goals scored in the 2006 World Cup. In T. Reilly & F. Korkusaz (Eds.) *Science and Football VI* (pp. 235-242). New York USA: Routledge.

Armatas, V., Yiannakos, A., & Sileloglou, P. (2007) Relationship between time and goal scoring in soccer games: Analysis of three World Cups. *International Journal of Performance Analysis in Sport*, 7: 45-58.

POD 13.4
Tactical behaviour in four different small-sided football games

Marco Aguiar[1], Goreti Botelho[2], Bruno Gonçalves[1] & Jaime Sampaio[1]

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Football players' dynamic positional data can be used to assess tactical behaviour (Sampaio and Maçãs, 2012). The aim of this study was to describe tactical behaviour in football players' small-sided games (SSG) by using dynamic positional data (spatial x and y coordinates). Ten professional football players participated in 4 variations of SSG (2-, 3-, 4- and 5-a-side) with an intermittent regime involving 3×6 min bouts with 1 min of passive planned rest. Player's activity profiles during the SSG were measured using portable global positioning system units at 5 Hz. The positional data (x,y) was used to calculate the geometric centre of the team, the distance between each player and this centre and the stretch index. Approximate entropy (ApEn) and relative phase were used, respectively, to identify the time series complexity and to access inter-player coordination. Statistically significant differences between SSG were found in the distance and ApEn of each player to the geometric centre of own team and opposite team. These values increased from the 1st to the 3rd bout, as well as, in the larger SSG formats. The ApEn values increased from the 1st to the 3rd bout, but smaller SSG formats presented higher ApEn values than the larger formats. Stretch index values increase from the 1st to the 3rd bout in all SSG formats except in 5-a-side format. Moreover, statistically significant differences to stretch index and respective ApEn among SSG formats were found. The stretch index value increases with the enlargement of the players' number in SSG.

Sampaio, J. & Maçãs, V. (2012 in press) Measuring football tactical behaviour. *International Journal of Sports Medicine*.

POD 13.5
An analysis of goals scored in youth football

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ASPIRE Academy for Sports Excellence, Doha, Qatar

Performance analysis of goal scoring has predominately been focused on senior football as opposed to youth. (Hughes and Franks, 2005). Further knowledge of how goals are scored in youth football can aid the coaching process and development of youth football. The purpose of this study was to assess how goals were scored in an elite youth academy and to compare this to other youth academies (opponents) as well as professional football.

Forty one ASPIRE Academy games were analysed involving U12-U17 age groups (range of games 6-12). These games were recorded on digital video and analysed using Sportscode Pro. Goals and attempts were edited and added to a database. Key performance indicators for goals scored were identified and included: number of touches to score (1, 2 or 3+); body contact (right foot, left foot or headed); open vs. set-play; in vs. out of penalty area and time period scored in. Set-plays were further broken down into corner, free-kick or penalty and games were broken down into 6 equal periods. The ratio of goals to attempts was also analysed to assess shooting efficiency. Results were analysed for ASPIRE vs. Opponent goals.

The average number of goals per game was 2.0 vs. 2.1, with a ratio of goals:attempts of 1:4.9 vs. 1:7.3 for ASPIRE vs. opponents. Number of touches to score was 48; 30; 22 vs. 63; 21; 16% for 1; 2; 3+ respectively and contact to score was 59 vs. 54% right foot, 37 vs. 29% left foot and 4 vs. 17% head. ASPIRE scored 83% open play goals vs. 67%. Set-play breakdown resulted in 0; 36; 64 vs. 52, 28, 21% of set-play goals coming from corners, free-kicks and penalties respectively. Goals scored within the penalty area resulted in 78% for both ASPIRE and opponents. The number of goals scored across 6 equal time periods for ASPIRE were 6;11;14;12;18;22 and opponents 14;14;12;14;14;18.

ASPIRE demonstrated a lower number of 1 touch goals compared to opponents, this is also lower than 1 touch goals scored in the English Premier League (70%; Prozone data). ASPIRE scored a lower number of headed goals, which may be linked to a lower number of goals scored from set-plays compared to opponents and also professional football. ASPIRE also appear to score less goals in the opening periods of games, but score more in the final period, consistent with professional football (Abt et al., 2002). In relation to the training environment the analysis can be applied to evaluate the frequency, type and effectiveness of attempts on goal in relation to the technique used and success rate.

Hughes, M. & Franks, I. (2005) Analysis of passing sequences, shots and goals in soccer. *Journal of Sports Sciences*, 23(5): 509-514.

Abt, G.A., Dickson, G. & Mummary, W.K. (2002) Goal scoring patterns over the course of a match: an analysis of the Australian National Soccer League. In *Science and Football IV* (edited by W. Spinks, T. Reilly and A. Murphy), pp.151-156. London: Routledge.

POD 13.6
The development of a new approach to performance analysis in British professional soccer

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TACTICIAN Coaching & Analysis, UK

This study explores the use of analytical methodologies as applied to performance characteristics of clubs involved in the Barclays Premier League for the 2008/ 09 season. The approach taken was to apply Ordinal Logistic Regression in order to establish relationships between various variables recorded and the result outcome of games. The data used was derived from a data supplier to the Barclays Premier League. The project not only demonstrated the results achievable but also the potential for a more rounded, statistically based view of the outputs of games and the value to clubs in adopting a more holistic approach to data analysis. Although there are potential differences in the interpretation of the outputs from the statistical outputs from the games, there were also some key observations made. The implications and strategy adopted by the approach in this paper are borne out with the results as outlined in this study and further supports the benefits of a carefully thought through statistical programme to supplement the management and coaching resource within Barclays Premier League clubs. It should be noted that this study is very much an exploratory approach and that there is scope for further development.

SESSION 14: INDIVIDUAL SPORTS

POD 14.1
Analysing individual performance in golf using the ISOPAR Method

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Conventional performance analysis in golf relies on performance indicators which are defined by classifying shots based on the distance to the hole. This method of classifying ignores most of the factors which make up the difficulty of any shot. Moreover, these performance indicators do not take into account that a shot is only a single event in a chain of events, the sequence of shots taken on a hole. Thus, the starting conditions of a shot are determined by the ending conditions of the previous shot. The ISOPAR project provides new performance indicators which are independent from the other shots played on the hole. The name comes from an analogy to isobars in meteorology. In the ISOPAR Method ISOPAR lines are lines of equal average number of strokes which are needed to hole out and can be visualised on a map of the hole.

Our research group has been given access to the ShotLink database which includes data from tournaments on the PGA TOUR. The ISOPAR method relies on ball locations and the corresponding number of required shots to hole out. The method smoothes the number of remaining shots using an exponential smoothing algorithm and interpolates the smoothed representation of the performance of the field for all possible ball locations on a hole by means of a spline interpolation.

The method allows defining new performance indicators: Shot Quality and Shots Saved. Shot Quality is defined as the difference between the ISOPAR value at the starting position and the ISOPAR value at the finishing position of a shot. The indicator Shots Saved is derived from Shot Quality and describes the difference between a shot and the average performance of the field. Using these performance indicators we analysed the PGA tournament 'THE PLAYERS' 2011 with respect to five shot types: Drives, long approach shots, short approach shots, around the green shots, and putts. The winner of this tournament, K.J. Choi, performed better than the average of the field in all shot types except long approach shots. Compared to his performance for the rest of 2011 Choi performed better in driving and short approach shots and substantially better in putting, but also performed worse in long approach shots and around the green shots. Choi's victory came in a one hole playoff against David Toms. An analysis of Toms' shots showed that he gained his advantage on the field playing excelling in different types of shots than Choi. Whereas Choi was much better than Toms in putting and around the green shots, Toms was much better in driving and long approach shots. Both performed quite similar in short approach shots.

The ISOPAR Method provides measures of performance for individual shots which account for each unique shot and describe the contribution of each shot to a player's overall performance. Using these performance indicators players' performance can be analysed with respect to different shot types. Future studies should aim for analysing if and how performance of a certain shot influences overall performance in tournaments.

POD 14.2
Exploring the quadratic nature of the relationship between strength & performance in shot putters

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Power is the mechanical quantity that expresses the rate of performing work and is largely dependent upon peak force production (i.e., maximum strength) (Stone et al., 2003). Although the value of strength to shot putting appears undisputable, several authors have recommended that explosive power is actually a more important physical characteristic (Bartonietz et al., 1997). The purpose of this study was to investigate the relationship of the 1RM in the power clean to shot put event performance.

A survey instrument was developed to collect data regarding national level collegiate shot putters in the United States. The 24 males (22.2 ± 2.2 years) and 29 females (22.5 ± 2.8 years) athletes had a mean personal best performance of 16.93 ± 2.45 meters for the men and the women 15.24 ± 2.85 meters. The sample included several national qualifiers, two national champions in shot put and three Olympians. Trends in the relationship between 1RM power clean and personal best in the shot put for male and female athletes were assessed via general linear model polynomial contrast analysis, and subsequent polynomial regression.

General linear model analysis revealed both significant omnibus tests of the models (male likelihood ratio χ^2 = 56.716, p≤0.001, female likelihood ratio χ^2 = 102.516, p≤0.001) and significant linear and quadratic trends in the data for male and female shot put athletes when comparing 1RM power clean to personal best distance (male: Wald χ^2 = 179.937, p≤0.001 linear, Wald χ^2 = 8.598, p=0.003 quadratic; female: Wald χ^2 = 738.577, p≤0.001 linear, Wald χ^2 = 134.864, p≤0.001 quadratic). Quadratic regression analysis resulted in strong curve fitting with both male (r=0.873, F=33.496, p≤0.001) and female (r=0.904, F=55.867, p≤0.001) athletes data.

The understanding that there are both linear and curvilinear trends in the association between strength and performance potentially can enrich the understanding of this association. The quadratic regression analysis revealed that athletes towards the outer ranges of performance in the shot put require greater levels of increasing strength in order to obtain the associated distances.

Bartonietz, K., et al. (1997) Characteristics of top performances in the women's hammer throw: Basics and technique of the world's best athletes. *New Studies in Athletics*, 12: 101-109.

Stone, M.H., et al. (2003) Maximum strength-power-performance relationships in collegiate throwers. *Journal of Strength and Conditioning Research*, 17(4): 739-745.

POD 14.3
Distance covered and velocity of movements of padel players during a closely contested 2011 pro tour match

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Padel is a relatively new sport, similar to tennis, played by teams of two players (doubles). It is now one of the most popular sports in South America and Spain where there is a desire to increase the number and level of tournaments. In order to improve performance levels players and coaches are interested in improving the specificity of training by knowing more about distance and velocity of movements during matches. Currently there is no published research related to the top world level padel players, necessitating the current study. One match during a Padel Pro tour event in Valencia (November, 2011) was recorded using a video camera placed above the central point of the court. The distance and velocity of movements for two teams (ranked 1 and 6 in the world by the International Padel Federation) were calculated using the SAGIT software (Perš *et al.*, 2001) and analysed in Microsoft Excel. Table 1 shows the distance covered and average velocity of movements for the whole match (WM) during the point (active phase, AP) and outside of the point (passive phase, PP). The maximum velocity value (Max) is also showed. Times were calculated as 8005s (WM), 5547s (PP) and 2458s (AP). The distance covered and average velocities were higher than found previously (Ramón-Llin et al., 2010) probably due to the match having longer and more intense rallies as a consequence of their higher skill level.

Table 1: Distance and velocity for World ranked 1 and 6 teams during a 6/7 6/3 6/1 Pro Tour match

		Winner 1	Winner 2	Loser 1	Loser 2
DISTANCE (m)	WM	6516	6156	6007	6220
	AP	2826	3004	2930	2907
	PP	3690	3152	3137	3313
VELOCITY (m/s)	WM	0.81	0.77	0.75	0.78
	AP	1.15	1.22	1.19	1.18
	PP	0.66	0.57	0.55	0.60
	Max	6.90	6.90	7.20	7.10

Perš, J., Vučković, G., Kovačič, S. & Dežman, B. (2001) A low-cost real-time tracker of live sport events. In *Proceedings of the 2nd international symposium on image and signal processing and analysis in conjunction with 23rd International conference on information technology interfaces* (edited by S. Lončarić and H. Babić), pp. 362-365. Zagreb: Faculty of Elektrical Engineering and Computing.

Ramón-Llin, J., Guzmán, J.F., Vučković, G., Llana, S. & James, N. (2010) Players' covered distance according playing level and balance between teams: a preliminary analysis in padel. In M. Hughes (ed.) *Research in Sports Science 6.* Szombathely: West-Hungary University, Hungary, pp. 188-193.

POD 14.4
Changes in performance structure during group competitions in rhythmic gymnastics

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Group competitions in Rhythmic Gymnastics are by characterised difficult body movement elements (jumps and leaps, balances, flexibilities and waves, pivots) and apparatus techniques of ball, hoop, ribbon, rope or clubs, plus an aesthetic and artistic aspect. Additionally, collaboration and synchronicity of the 5 gymnasts effect the group performance. Thus, performances in Rhythmic Gymnastics are influenced by quantitative and qualitative factors. Qualitative factors are difficult to analyse as they are highly dependent of subjective perceptions. Quantitative factors are more objective and as a consequence, more suitable for performance analysis.

The aim of the study was to define tendencies in performance development in international elite level group competitions in Rhythmic Gymnastics and therefore, derive recommendations for the specific coaching process.

Group finals of the World Championships 2009 (Mie, Japan), the European Championships 2010 (Bremen, Germany), and the World Championship 2011 (Montpellier, France) were analysed post-event, based on video footage. Videos were recorded at 25Hz and showed the entire gymnastics mat from the perspective of the jury desk. The analysis was performed utilising the notational software SimiScout (Simi GmbH, Germany) and Utilius vs. (CCC-Software, Germany). Finally, an explorative factor analysis was carried out to discover the most influencing factors in performance in Rhythmic Gymnastics.

Factor analysis for the routines of the World Championships 2009 displayed that the performance structure of the routines were determined the most by the factors a) Synchronicity, b) Body Movement Elements and Number of Formation, and least determined c) Apparatus Techniques. For the European Championships 2010 it was found that the factors a) Body Movement Elements and Space Utilisation were the most determining for successful performances in this particular competition. Followed by the factors b) Apparatus Techniques and c) Synchronicity.

The performance structure of the routines demonstrated at the World Championships 2011 tend to be determined by: a) Apparatus Techniques, b) Body Movements Elements and Synchronicity, and Space Utilisation.

Concluding, it can be stated that the performance structure in the final routines during the last three international competitions in Rhythmic Gymnastics seem to be determined by the following main factors: Body Movement Elements, Apparatus Techniques, Synchronicity and Space Utilisation. However, due to the results of the factor analyses of the different routines it can be assumed that the mastery of the apparatus techniques become more important than the performance of body movement elements and synchronicity. As in 2009 the number of Formations and Synchronicity were two of the most determining factors of performance structure and these factors became less important in 2011. This may be due to the fact that formations and synchronicity are influencing each other. Most formations require synchronicity. As formations become less important than complex collaborations and interactions between the gymnasts, synchronicity also loses importance. Another change in performance structure in recent past years occurred in terms of body movement elements and apparatus techniques. As in 2009 apparatus techniques were the less determining factor. It became the most crucial in 2011. This can be justified by the limit of physical performances in terms of developing more difficult and complex body movement elements. These limits seem not to be reached for the mastery of original apparatus techniques until now.

POD 14.5
Hierarchical organization and performance inequality: Evidence from professional cycling

Bertrand Candelon & Arnaud Dupuy

In this study, we elaborate a theoretical model of professional road cycling. In this model, the distribution of roles (leaders, helpers and self- production), the assignment of leaders to helpers, and the distribution of payoffs within team are endogenously determined. We show that under mild conditions the equilibrium assignment is such that i) within teams the better rider becomes the leader, ii) better helpers are matched with better leaders and iii) some form of stratification arises: more able riders either become leaders or helpers and less able riders either become helpers or ride individually. The model makes important predictions about performance inequality and hierarchical organization: relative to autarky (when riders are selfish), hierarchical organization leads to greater performance inequality.

We test the predictions of the model using data from the Tour de France since 1947. Since the end of the 60s the performance inequality in the final classification has been growing sharply (multiplied by a factor of 2) and that both between and within team.

In addition to the final classification, we use data from the Prologues that are short time trials where riders ride alone against the clock. The velocity of a rider during such a stage reflects his true individual ability and not the organization within team. It follows that the difference in velocity between the leader of a team and his helpers during the prologue reflects the pure ability differences between riders within a team. This contrasts with the inequality within team at the final classification that reflects both the team composition and the help intensity (organization). This allows us to identify the help intensity within teams over time.

Our empirical results show that, since the beginning of the 70s, the help intensity within team has increased sharply in the peloton of the Tour de France (multiplied by a factor of 2). This increase is significantly related to changes in the incentives to organize hierarchically within teams (convexification of the payoffs by rank over time). Indeed, the average help intensity over time correlates significantly with the (deflated) money prices allocated to the winner of the Tour or its share in total money prices distributed during the Tour, which clearly indicates that our measure of help intensity is significantly related with variables that are, according to our model's predictions, linked to the incentives to organize hierarchically within teams. In fact, these two variables alone explain about 57% and 15% respectively of the variance in our measure of help intensity over time.

In turn, we show that the observed rise in performance inequality in the peloton since the 1970s is merely due to this increase in help intensity. Our estimates indicate that an increase of help intensity leading to an increase of 1km/h in the velocity of a leader relative to that of his (average) helper leads to an increase of about 1km/h in the overall inequality in the peloton.

POD 14.6
The effects of cycle-pack size and order on finishing performance in elite Olympic triathlon

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"Which is the best cycle pack to be in?" is an important question when triathletes choose between trying a breakaway, chasing a breakaway, or simply staying put in the peloton. Cycling in a larger pack provides more competition in the running phase but requires less energy, and more competition is of less concern to better triathletes. The best pack to ride in is therefore unclear. We have investigated this problem by analysing international Olympic-distance triathlon races.

Split and finish times of 559 female and 770 male triathletes competing in 151 and 154 races of the World Championships, World Cup series, European Championship and Olympic Games between 2000 and 2011 were obtained from triathlon.org. Size of cycle packs was determined from split times at the end of the cycle phase. Percent chances of winning any medal were predicted using a logistic regression model. Predictors in the full factorial model were pack size (solo, 1 cyclist; very small, 2-3 cyclists; small 4-5 cyclists; moderate, 6-10 cyclists; and large, >10 cyclists), order of cycle pack (1st through 6th), and athlete's running ability (mean run performance time in the year of competition). Total number of athletes in each race was included as an offset, to account for the lower chance of winning with more competitors. Effects were estimated for top athletes with a reasonable chance (10-70%) of winning a medal. A difference between packs in chance of winning a medal was deemed clear if it had acceptable uncertainty (90% confidence interval) in relation to the smallest difference of 10% (one extra medal in 10 races).

In the first pack, percent chances of winning in solo through large packs were 56, 66, 62, 49 and 29. In the second pack the corresponding chances were 11, 18, 42, 31 and 20, while in the third they were 35, 40, 5, 13 and 17. Chance of winning dropped dramatically for 4th, 5th and 6th cycling packs. In general, percent differences of >15 between any two packs were clear, allowing the following recommendations… Ending the cycle phase in the first pack is the best strategy for a top triathlete, when the pack has up to five riders. The triathlete should initiate or join any group breaking away from a large or possibly moderate 1st pack. If a pack of this size is 2nd or 3rd, the triathlete should join a breakaway only totalling 4-5 riders. Breaking away from a small second pack is not advisable unless it is to join the first pack. Finally the triathlete should avoid ending the cycle phase in 4th or later packs.

This method of analysis has provided useful recommendations, but some outcomes were unclear in spite of a large amount of race data. An analysis of finishing position rather than medal winning should be investigated for possible improvement in the precision of the estimates.

SESSION 15: RUGBY

POD 15.1
A three dimensional analysis of swing motion during kicking in Rugby and Gaelic football players

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A wide range of skills form the foundation of performance in the sports of Rugby and Gaelic football. Although several detailed studies have been carried out on injury-risk prevention (Gabbett et.al, 2010; King et.al, 2006), minimal information is available about the kicking technique players use to score a 'penalty' in Rugby or a 'free' in Gaelic football. Previous studies have identified the importance of certain leg swing characteristics pre-post kick and rotational dynamics of lower body segments, as critical factors for effective kicking in soccer (Nunome 2002a, 2006b; Hong et al. 2011; Sakamoto et al. 2010). The purpose of this study is to perform an in-depth analysis of kicking technique used by Rugby and Gaelic football kicking experts to see if the kicking actions are guided by similar principals or whether successful kicking is more sport specific.

This study used an opto-electronic system (Qualisys, 1989) to record three dimensional marker positions, carefully placed on key anatomical landmarks to obtain full positional information that could be used for subsequent modelling of the leg swing profile (C-Motions, 1997). An outdoor motion capture set up was used to capture the movements of ten (5 experts, each for Rugby and Gaelic football) different expert players kicking 'accurately' towards the posts to score a 'penalty' or a 'free' from a fixed distance.

The data presented will show a detailed kinematic analysis of the kicking actions with a focus on the timing related kinematic variables in both sports. An analysis of kinematic differences and similarities in kicking technique in Rugby and Gaelic football will be highlighted and will allow us to identify parameters related to skill transfer from one sport to another.

Gabbett, T., Jenkins, D. & Abernethy, B. (2010) Physical collisions and injury during professional rugby league skills training. *Journal of Science and Medicine in Sport*, 13(6): 578-583.

King, D.A., Gabbett, T.J., Dreyer, C. & Gerrard, D.F. (2006) Incidence of injuries in New Zealand national rugby league sevens tournament. *Journal of Science and Medicine in Sport*, 9(1–2): 110-118.

Nunome H, Asai T, Ikegami Y, et al. (2002) Three-dimensional kinetic analysis of side-foot and instep soccer kicks. *Med Sci Sports Exerc*, 34: 2028–36.

Nunome H., Lake, M., Georgakis, A. & Stergioulas, L.K. (2006) Impact phase kinematics of the instep kick in soccer. *Journal of Sport Sciences*, 24: 11-22.

Hong S., Chung S., Sakamoto, K. & Asai, T. (2011) Analysis of the swing motion on knuckling shot in soccer. *Procedia Engineering*, 13: 176-181.

Sakamoto, K., et.al. (2010) Kinematics of foot joint in female soccer players during ball impact phase of kicking. *Procedia Engineering*, 2: 2549-2554.

Qualisys AB, Sweden (1989) *Qualisys Motion Capture Systems*. 'http://www.qualisys.com'. Last accessed 12 Jan 2012.

C-Motions, Baltimore, US (1997) *C-Motion Research Biomechanics*. 'http://www.c-motion.com/index.php'. Last accessed 12 Jan 2012.

POD 15.2

Experienced and novice rugby union players had the same physical exertion during small sided games…but different game performances

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Recent technological innovations have made global positioning system (GPS) a new and valid method to quantify movement patterns and physical demands in sport (Coutts, & Duffield, 2010, Gray, *et al*., 2010). GPS provide a detailed description of player movement demands and can assist teams and coaches from a tactical view point. The purpose of this study was to compare the physical exertion and game performance of experienced and novice rugby union players when playing small-sided games (SSGs).

Forty male rugby players participated in eight rugby SSGs over a 4-week period. Each rugby SSG involved 6 players per team, lasted 12-minutes and was performed continuity with no interval. The playing areas used were 60×40m. For quantifying physical and movement demands we used the GPS unit´s (SPI Elite*, GPSports Systems*, Australia) and a heart rate (HR) belt (Polar Electro, *Kempele*, Finland) to incorporate HR data. The GPS units captured data at 5Hz throughout the duration of each game (12-min), and recorded 6 varying zones velocity were compared against timing gates (km/h), estimated distance (m) mean %, heart rate, altitude, latitude and longitude.

Repeated measures ANOVA showed that the single effect of partial distances was statistical significant ($p< .001$), with pairwise differences in all, exception made in the pair Zone 2-Zone 3. There was no significant interaction with group ($p= .970$). Additionally, independent t-test showed no differences between groups regarding total distance covered ($p= .307$). The single effect of percentage of time was statistical significant ($p< .001$), with pairwise differences in all pairs. Again, there was no significant interaction with group ($p=.302$). The independent t-test showed no differences between groups regarding total impacts ($p= .772$). Results from game actions along with group comparison performed with Mann-Whitney-U test and non-parametric effect size (Cliff's delta) showed differences in all analyzed actions but balls out and free kicks. The differences in tackles, passes and trays were substantial.

Although the available literature is consistently suggesting the usage of rugby SSGs to simultaneously achieve appropriate conditioning, technical and tactical performances, the present study point out the fact the possibility of achieving specific physical conditioning without performing adequately (technically and tactically).

Coutts, A. J., & Duffield, R. (2010) Validity and reliability of GPS devices for measuring movement demands of team sports. *Journal of Science and Medicine in Sport,* 13, 133-135.

Gray, A., Jenkins, D., Andrews, M., Taaffe, D. & Glover, M. (2010) Validity and reliability of GPS for measuring distance travelled in field-based team sports. *Journal of Sports Sciences*, 28, 1319-1325.

POD 15.3
A network analysis of the contribution of turnovers to defensive performance in Rugby World Cup 2011

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The aim of the current study was to identify the rugby-union game-related statistics that discriminated the defense performance in close and balanced games in International Rugby Board (IRB) world Cup competition 2011. Despite 2009 rules amendment for advantage to the attacking side (severe limitations on the defensive side in the tackle), the numbers of try scores in Rugby World Cup has decreased (6.9 tries in 2003, 6.2 tries in 2007, and 5.5 tries in 2011). It suggested the defensive capabilities improvement. To raise the evidence to discuss defense, the current study was to focus the defensive turnover situations in the game and to apply the social network analysis on organizational strategy. The result suggested the turnover contributors by "double tackle" (tackled by two man) situation of positional characteristics.

Data were derived from 20 matches of closed and balanced scores by cluster analysis. The ration of the two men tackled turnovers was 31% (204 / 660) in all tackled turnover situations. For understanding the two positional relation structure, the frequencies of double tackled turnover were plotted in the adjacent matrix (15 * 15) and calculated the eigenvector centrality. The calculation and network mapping program was made in "R program" by authors.

Main double tackle contributors were "8", "6", "7" and "12". These four positions might be a crucial function in "double tackled turnover in Rugby Union World Cup 2011. Comparing the losing sides with wining sides characteristics, the formers were suggested some out of the balanced networking systems. The network analysis (graph theory) would present some strategic and tactic knowledge for planning in the game, practice, and the communication situations.

POD 15.4
Tackling in Super 15 Rugby 2011

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In Rugby matches players are frequently exposed to multiple physical contacts and tackles and as a result good defensive and tackling skills are required (Gabbett & Kelly 2007). Success in rugby has also been shown to be linked with tackle frequency and tackling proficiency (Ortega et al., 2009, van den Berg & Malan, 2010, van Rooyen et al., 2008 and Vaz et al., 2011).

Data for this comparative study were collected from statistics supplied by Verusco Sport's Advanced Rugby Analysis System during the 2011 Super 15 rugby competition. The data collected were the number of points conceded; points difference; number of tackles 'made' and 'missed'.

There were an average of 139 (± 34 SD) tackles 'made' and 18 'missed' tackles (± 7 SD) per team in a match. The data was combined into Forwards (n = 8) and Backs (n = 7) it was discovered that Forwards contributed 64.4 % ± 6.1 SD and the Backs only 35.6 % ± 6.1 SD (P < 0.05). There was a 1.2 times greater probability of a Forward successfully completing a tackle than would occur by chance and a 1.8 times greater probability a Forward would successfully execute a tackle than a Back. The 'missed' tackle data was more equally distributed (Forwards 53.2 % ± 13.2 SD vs. Backs 46.7 % ± 13.4 SD) (P > 0.05). The contribution of the Back Row Forwards to the final tackle count was significantly higher than that of the Scrumhalf and Fly half, Centre and Wings and Fullback groups (P < 0.05) for tackles 'made'. The Props & Hookers group contributed more than the Wings and Fullback for tackles 'made' (P < 0.05). There were no significant positional differences across the groups for tackles 'missed' (P > 0.05). Examination of the data by final log placing shows that 60 % of matches played by teams in the top 6 were won with fewer 'missed' compared with only 41 % by the remaining 9 teams. The percentage of 'missed' tackles when expressed by positional group did vary significantly between winning and losing teams. Forwards from winning teams 'missed' fewer tackles (52.6 % vs. 53.6 % for winning and losing respectively) and the Backs 'missed' more tackles (47.0 % winning vs. 46.3 % losing).

These data indicated that the percentage of 'missed' tackles a team made had an influence on the final result of the game and thus the final log position at the end of the conference stage of the tournament. In addition there were fluctuations in the percentage contribution that the Forwards and the Backs made towards the final team's percentage 'missed' tackles and this also affected the outcome of the match.

Ortega, E., Villarejo, D. & Palao, J. (2009) Differences in game statistics between winning and losing rugby teams in the six nations tournament. *Journal of Sports Science and Medicine*, 8: 523-527.

van den Berg, P. & Malan D. (2010) Match analysis of the 2006 super 14 rugby union tournament. *African Journal for Physical Health Education, Recreation and Dance,* 16: 580-593.

van Rooyen, M.K., Rock, K., Prim, S.K. & Lambert, M.I. (2008). The quantification of contacts with impact during professional rugby matches. *International Journal of Performance Analysis in Sport*, 8(1): 113 - 126.

Vaz, L., Mouchet, A., Carreras, D. & Morente, H. (2011) The importance of rugby game-related statistics to discriminate winners and losers at the elite level competitions in close and balanced games. *International Journal of Performance Analysis in Sport*, 11: 130-141.

POD 15.5

The effect of game location on positional profiles during a competitive season in professional rugby union: Implications for the coaching process

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Previous studies within rugby union have examined various aspects of performance including performance profiles (Reed & Hughes, 2006) and position-specific performance indicators (James et al., 2005). The investigations have provided an insight into the relative demands and effectiveness of each position, however, the impact of game location has not been considered. It is suggested that home teams play an attack dominated style (Thomas et al., 2008) and therefore the aims of the present study are to examine the impact of the game location on positional profiles of a professional rugby union over a competitive season and also gain an insight into the implications for the coaching process.

Match analysis: Twenty-eight competitive matches (14 Home; 14 Away) from the 2010 English Championship were analysed using the SportsCode elite system (Sportstec). All fifteen playing positions were fully coded utilising 31 performance indicators: Minutes played prior to substitution; Total tackles attempted; Effectively completed tackles; Ineffective completed tackle; Assisted tackle; Missed tackle; Jackal; Kick pressure; Ball-in-hand; Pass; Into contact; Ball out of tackle; Recycle; lost in contact; Tackled into touch; Hammer; Ruck clears; Try; Handling error; kick; Penalty conceded; Penalty won; Turnover conceded; Turnover won; Line-out throw; Line-out jump; Lift; Maul attack; Maul defence; Scrum engage; Set piece error (Inter operator reliability – % error score 0.85±0.26). Coach interview: A semi-structured interview was conducted with the team Head Coach to consider the game location positional profiles and their subsequent use within the coaching process.

Match Analysis: Mann Whitney U tests identified no significant (p<0.05) differences between the home and away location scenarios for all the performance indicators coded. Interesting findings included: All forwards (except the No.8) completed more tackle attempts at home (Home 65; Away 61) in contrast to the backs who achieved a greater number of tackle attempts (Home 33; Away 37) when away (except the right winger). Generally, there tended to be a higher number of ball-in-hand occurrences among all players (except the right second row and full-back) when playing away from home (Home 146; Away 169). Coach Interview: Thematic content analysis of the interview highlighted that the coach did not fully engage with the performance analysis support afforded and despite acknowledging the interesting nature of the information presented admitted that the results would not be used within the planning process.

The study has identified that game location has little impact on the positional profiles in rugby union over a competitive season however the elite Premiership rugby coach has emphasised the need for individual player-specific information to assist in player development as opposed to general positional profiles. However, the importance of the positional demand information for use by the multi-disciplinary support staff, as opposed to the coach, has been highlighted.

James, N., Mellalieu, S. & Jones, N. (2005) The development of position-specific performance indicators in professional rugby union. *Journal of Sports Sciences*, 23: 63–72.

Reed, D. & Hughes, M. (2006) An exploration of team sport as a dynamical system, *International Journal of Performance Analysis in Sport.* 6(**2**): 114-125.

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POD 15.6
An analysis of ruck-play during the RBS Six Nations 2010 rugby championship

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In the strive for success in rugby union, it is important for coaches, sport scientist and trainers to adapt their current training programs (conditioning, technical and tactical) and methods (training drills and time spend on each facet of play), especially when changes (law changes or admendants) occur in the action varaibles of the sport (Eaves & Hughes, 2003). To the researchers knowledge limited publiced studies in this regard could be found that specifically focus on the analysis of the number of players committed at ruck-play. The aim of this study was to compare the ruck-play during two halves of the 2010 Six Nations Rugby Championship matches.

Fifteen matches (N=15) in total were recorded on video and was analyzed by means of the tagging function of a Dartfish Team Pro video analysis software package (version 4.0.6.0, Rte de la Fonderie 6, CP 53 - 1705, Fribourg 5, Switzerland). A ruck was defined according to either (i) the IRBs definition which is that a ruck is a phase of play where one or more players from each team, who are on their feet, in physical contact close around the ball on the ground when open play has ended or (ii) when the referee indicated that a ruck has been formed. The frequencies of the rucks will be recorded per match and team (a ruck was assigned to a specific team when they had possession of the ruck ball when the ruck is formed). Successful (S) rucks will be recorded in terms of whether possession of the ball was maintained. Unsuccesful (US) rucks will be recorded in terms of whether possession of the ball was lost. The number of attacking and defending players at the ruck will be determined by how many players binding on each other while on their feet. The location on the field where the ruck was formed will be recorded zonally accoring to the classification by Van Rooyen *et al*. (2010). The data was analysed by an experienced performance analyst (Level 4 accrediated performance analyst). The frequency, outcome (successful or unsuccesful), location and the number of aattacking and defending players commited at the ruck. The same person analyzed all the games so as to prevent interpersonal variability in the different observations and interpretations of activities.

There were 736 and 742 rucks formed, 92 % and 91% were successful respectively during the 1st and 2nd half respectively. The zonal locations for successful retention at rucks were made up as follows: 1st half (A- S=23%); (B- S= 49%); (C- S= 25%) and (D- S=3%) and 2nd half (A- S=20%); (B- S= 48%); (C- S= 27%) and (D- S=5%). The attacking players committed at successful retention of rucks were made up as follows: 1st half (1- S=81%); (2- S= 94%); (3- S= 95%) and (4- S=93%) and 2nd half (1- S=88%); (2- S= 90%); (3- S= 93%); (4- S=100%) and (5- S=100%). The defending players committed for unsuccessful retention of the rucks were made up as follows: 1st half (1- US=36%); (2- US= 52%); (3- US= 5%) and (4- US=7%) and 2nd half (1- US=36%); (2- US= 20%); (3- US= 25%) and (4- US=3%).

The study revealed that 49% and 48% of the successful rucks were formed in zone B for the 1st and 2nd half of match-play respectively. Rucks were most successfully retained when 3 or 4 players were committed during the first and second half. Rucks were mostly unsuccessfully when 2 and 1 defenders were committed respectively during the 1st and 2nd half.

Eaves, S. & Hughes, M. (2003) Patterns of play of international rugby union teams before and after the introduction of professional status. *International Journal of Performance Analysis in Sport*, 3(2), 103-111.

SESSION 16: EQUESTRIAN

POD 16.1
Motivational orientation and support perception of young riders in the United Kingdom

Samantha Penrice, Charlotte Brigden, Stefanie Tinsley & Jaime Martin

Motivational behaviour in sporting achievement has been investigated for over six decades. Elite athlete development is now centred on the long term development of individuals from childhood, the focus of much research has turned to determining what motivates young athletes to participate and ultimately succeed in their sport. Motivational research in equestrianism has primarily been conducted on a small-scale through focus groups and interviews, focussing on elite and sub elite athletes. At present, no work has used large-scale data collected from young riders. Motivational orientation can be broadly categorised as intrinsic or extrinsic, where the latter can be detrimental to young athlete participation levels when they, in their view, fail to achieve their goal of winning (Curran *et al.,* 2011). Long term athlete development (LTAD) research has highlighted the importance of avoiding early investment in a single sport in favour of sampling a range of sports at a young age. This concept is reinforced in the equestrian industry through the publication of the British Equestrian Federation's LTAD framework. Early specialisation and extrinsic motivation has been identified as a causative factor in drop out (Curran *et al.,* 2011). Many factors can influence the motivational climate of young athletes including parents (Côté 1999; Malete 2006), coaches (Vazou *et al.*, 2005) and peers (Vazou *et al.*, 2005). As equestrian sport is both time and resource intensive, it is rarely the case that a child can participate without the help of an outside party and less time is available to participate in several other sports. For this reason, it is hypothesised that the motivational climate is a significant influencing factor in prolonged participation in equestrian sport. The aim of this investigation is to determine the motivational orientations of young equestrians in the UK, as well as their perception of support from coaches, parents and peers. In order to do this a large scale questionnaire has been launched and made available to riders under the age of 18 in the UK. Sport and activity participation, competition level and perceptions of support are explored. Motivational orientations are determined through blinded questions. Preliminary results indicate that perceived coach support is more important than parental and peer support to young equestrians and that intrinsic motivation is most prevalent in those who do not participate in any other sports. The findings of this research will show present involvement of young riders and assess whether current understanding of motivational orientation and LTAD are applicable to equestrian sport.

Côté, J. (1999) The influence of family in the development of talent in sport. *The Sport Psychologist,* 13.

Curran, T., Appleton, P., Hill P. and Hall, H. (2011) Passion and burnout in elite junior soccer players: The mediating role of self-determined motivation. *Psychology of Sport and Exercise,* 12.

Malete, L. (2006) Goal orientations, sport ability, perceived parental influences and youths' enjoyment of sport and physical activity in Botswana. *International Journal of Applied Sport Sciences*; 18(2).

Vazou, S., Ntoumanis, N. & Duda, J. (2005) Predicting young athletes' motivational indicted as a function of their perceptions of the coach- and peer- created climate. *Psychology of Sport and Exercise, 7.*

Anthropometric and fitness characteristics of female novice, intermediate and advanced level Event riders

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[2]*Coventry University, UK*
[3]*Faculty of Health & Sport Sciences, University of Agder, Norway*

Enhanced anthropometric and fitness characteristics are evident in higher levels of performance in many sports and knowledge of anthropometric and fitness characteristics can help with selection and competition preparation (Roetert et al., 1996; Keogh et al., 2009). There is however, limited research investigating such characteristics in equestrian athletes (Meyers & Stirling, 2000; Meyers, 2006) with none conducted with competitive riders. The aim of this study was to investigate the anthropometric and fitness characteristics of female Event riders competing at different Event levels.

Anthropometric measurements included height, mass, circumference (waist, hip, mid thigh and mid upper arm) sum of four skin-folds with fitness tests to assess lower body strength (isokinetic dynamometry, single leg isometric wall squat), upper body strength (1 minute modified press up test), core strength (plank to fatigue, front abdominal power test), reaction and co-ordination (Batak wall), grip strength (handheld dynamometry), balance (single leg stance, eyes closed), and maximal aerobic power and lactate threshold using cycle ergometry. A one way ANOVA was used to investigate differences between competitive levels.

In the current preliminary sample [16 riders: 6 Novice (age 30.83±9.5years, height 165.7±2.7cm, mass 64.6±4.4kg); 6 Intermediate (age 25±5.8years, height 167.8±4.8cm, mass 65.5±9.1kg); 4 Advanced (age 33.5±5years, height 170.4±6.9cm, mass 65.9±6.8kg)], there are no statistical differences between competitive level for any variable. There are however, trends for greater core stability and leg strength at higher competitive level. The final sample is expected to contain 20 riders per competition level, thus increasing the possibility of the current trends becoming statistically significant differences in sport relevant anthropometric and fitness measures.

Keough, J.W.L., Marnewick, M.C., Maulder, P.S., Nortie, J.P., Hume, P.A. & Bradshaw, E.J. (2009) Are anthropometric, flexibility, muscular strength, and endurance variables related to club-head velocity in high and low handicapped golfers? *JSCR,* 23(6): 1841-1850.

Meyers, M. & Sterling, J. (2000) Physical, haematological, and exercise response of collegiate female equestrian athletes. *JSMPF,* 40: 131-138.

Meyers, M. (2006) Effect of equitation training on health and physical fitness of college females. *EJAP,* 98(2): 177-184.

Roetert, P.E., Brown, S.W., Piorkwoski, P.A. & Woods, R.B. (1996) Fitness comparisons between three different levels of elite tennis players. *JSCR*, 10(3): 139-143.

Timing factors in equestrian performance

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Performance analysis research of show jumping is sparse, despite the use of such technology within British Equestrian since 2002 (British Eventing, 2007). Understanding the factors that contribute to success in show jumping is essential when preparing the horse and rider combination for performance. As competition levels progress, the complexity of the courses constructed increases, putting a greater significance towards the understanding of optimal approach strategies. The aim of the current study was to investigate whether optimal riding strategies can be identified via the use of performance analysis techniques during the show jumping course of a British Eventing event.

Seventy six (n=76) competitors were analysed with angle of approach to the fence, the number of strides within the direct route before the fence, and the ground times between each fence recorded. Results data were grouped between competitors of successful clearance rounds (n=27) and those that obtained faults (n=49). Nine of the 14 split times and 10 of the 14 cumulative round times were normally distributed according to Kolmogorov-Smirnov tests ($p > 0.05$). Therefore, nonparametric procedures were applied. A series of Mann-Whitney U tests compared the split times and cumulative round times to each fence between competitors with clear rounds and those who obtained faults. Further Mann-Whitney U tests were used to compare the split times and cumulative round times to each fence between the competitors who cleared individual fences and those who did not. Mann-Whitney U tests were also used to compare the steps taken after turning into a fence between competitors who faulted and those who cleared for the 7 fences that followed curves in the course. The 6.14±0.45s split time to the final fence by those with clear rounds was significantly shorter than the 6.46±0.58s for those with faults ($p = 0.015$). The fifth fence was the second fence of a double jump. The 0.56±0.01s split time to this fence by the 3 competitors who faulted at the fence was significantly longer than the 0.48±0.08s for the 73 who cleared it. There were no other significant differences found in the timings ($p > 0.05$). No significant differences were found between the number of steps taken to any of the fences following curves between competitors clearing and faulting at those fences ($p > 0.05$).

Timing data showed controversial evidence to the effectiveness on success in show jumping events. The current study has allowed an insight into the strategies that could be developed to help competitors establish specific training methods to improve their individual rate of success to move through the levels of British Eventing,

British Eventing (2007). *Using Performance Analysis as a Training Tool.*

POD 16.4
A preliminary investigation into the effects of jumping saddle design on rider posture

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Rider posture plays a significant role in the oneness of horse and rider (Kang *et al.*, 2010). The correct (balanced, free and supple) seat forms the basis for effective communication with the horse via the application of the aids (Belton, 1997). It is also important for rider safety (Peham *et al.*, 2004). Although posture is known to vary with skill (Schils *et al.*, 1993, Kang *et al.*, 2010), the shape of the saddle seat is thought to influence the position of the rider (Belton, 1997). Manufacturers of more recent close contact saddle designs claim to put the rider in closer contact with the horse, aiding balance via the reduction of bulk between the horse and rider (Devoucoux, 2010). What is not clear however, is whether the change in saddle design has an effect on rider posture.

Nine experienced riders took part in this cross over designed study, mean height 1.69m (± 0.08m), mean weight 59.42kg (± 7.42kg). All participants rode the Ride Master Pro 2006 (Racewood Equestrian Simulators, Cheshire, UK). Circular, self-adhesive markers of 3.5cm diameter were placed on each rider at selected anatomical landmarks, in accordance with Schils *et al.* (1993), Lovett *et al.* (2004) and Terada *et al.* (2006). Participants rode in 2 saddles with the same stirrup leathers and stirrups; a single flap modern 'close contact' jumping saddle (CC) and a traditional style jump saddle with two saddle flaps (TS). A standardised exercise routine was followed for each subject at halt, walk, sitting trot, seated and forward seat canter. For each saddle, once participants had completed the exercise, stirrup leather length was measured; from buckle to the top of the stirrup iron.

Data were captured (240 Hz) using a Casio EXILIM EX-FH100 and footage analysed using Dartfish ProSuite® version 5.0. Data analysis was performed using SPSS version 19. Statistical significance was set at $P = 0.05$.

Individual preferred stirrup length was analysed and it was found that participants rode with significantly longer stirrups ($t = -3.124$, $P = 0.035$) in the close contact saddle (mean = 50.66 cm ± 4.27 s.d) than the traditional saddle (mean = 46.10 cm ± 2.60).

Absolute angles for hip, knee and ankle were analysed for each gait and no significant differences were identified for ankle or hip in walk, trot and seated canter ($P > 0.05$) however significant differences were found for the knee in walk ($Z = -3.97$, $P < 0.001$), trot ($Z = -4.18$, $P < 0.001$) and seated canter ($Z = -2.65$, $P = 0.008$), with the CC saddle resulting in smaller knee flexion angles throughout. In forward canter, there was no significant difference in knee or ankle angle ($P > 0.05$) but a significant difference in hip angle was found ($Z = -2.50$, $P = 0.012$). The CC saddle was found to have a median absolute angle of 128.1° compared to the TS saddle (133.3°).

The results from this preliminary study are of interest as it would appear that saddle design significantly affects rider posture. Whether the resultant posture has any effect on rider performance is unknown at this stage but this has highlighted areas of research into rider posture and the effect of saddle design that warrant further investigation.

POD 16.5
The effects of rider specific Pilates on rider position from a lateral view: a six week study

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The equine industry and rider community is increasingly acknowledging that rider strength and fitness is vital in achieving the best results in competition. Other sporting disciplines are more aware of the potential of the utilisation of additional methods to improve performance such as Pilates. For example Pilates is commonly used to develop optimal strength and balance in modern dance and ballet. In the absence of published work on the benefits of Pilates on rider posture, the aim of this study was to investigate if Pilates improves rider posture whilst mounted.

Riders (n=10) undertook a British Dressage recognised, Pilates training regime for a total of 6 weeks. The measurements were taken on horseback before the Pilates training commenced, after the third session and a final filming session was carried out after the six weeks, in walk, rising trot, canter left and canter right. Each rider had 3D spherical markers attached at specific anatomical landmarks; top of hat, shoulder, hip and heel. Using Quintic Sports Biomechanics Video Analysis Software package a line was drawn through the hip marker and the deviation of each marker from this line was recorded. All data were normally distributed and Multivariate Analysis of Variance was used to determine the effects of individual (rider), time (week) and horse gait.

Engagement in a Pilates training regime had a significant effect on rider position (from a lateral view) ($F_{2,316}=35.81$; $p<0.001$). The mean deviation from the ear, shoulder, hip heel (ESHH) alignment prior to the Pilates was 50mm ± 70mm in comparison to the (30mm ± 41mm) after the 6 week course had been completed. Rider profiles and horse gait ($F_{9,316}=37.11$; $p<0.01$ and $F_{3,316}=31.49$; $p<0.001$ respectively) also had a significant influence on deviation from the ESHH alignment. Other factors such as rider profiles ($F_{9,316}=37.11$; $p<0.01$) had a significant effect as well as the effect of gait on the deviation from the ESHH alignment. The largest variation in deviation was found between walk (29mm±47mm) and rising trot (55mm ± 60mm) which is in line with other literature findings on the impact of the rider whilst travelling in walk and rising trot.

Even though the study was undertaken on a relatively small sample of British Dressage affiliated riders, this study suggested significant results that using Pilates as an additional exercise method over a six week period leads to a significant improvement in rider position.

Poster Presentations

POST 1.1: SOCCER
POST 1.1.1
Relative number of outfield players as a constraint on coordination dynamics in futsal

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In this communication we sought to improve the understanding of game dynamics in futsal by examining how the relative number of outfield players constrains coordination patterns in futsal. More precisely, we compared coordination in two conditions: (i) equal number of attackers and defenders (GK+4-v-4+GK) and (ii) numerical advantage of attackers (5-v-4+GK). For the GK+4-v-4+GK condition, 71 players (25.31±4.73 years) played 10 futsal games in the 2009 Lusophony Games held in Lisbon. For the 5-v-4+GK condition, data were obtained from a 10 practice tasks of the National Futsal University Team of Portugal in which participate 15 players (23.25±1.96 years). Ten sequences of play ending in a shot at goal (without transition in ball possession) were analyzed for both conditions. Player and ball coordination were captured from all trials using single video camera and digitized using TACTO software (Fernandes et al., 2010) (coefficient of reliability $R = .999$). The angles of each player and the ball to the goal were computed, and relative phase obtained using Hilbert transform (Rosenblum et al. 2010) for: (i) attacker-attacker dyads, (ii) defender-defender dyads, (iii) attacker-defender dyads, (iv) attacker-ball pairs and (v) defender-ball pairs.

Results of the attacker-attacker dyadic coordination revealed no preferred phase attraction for each condition. The defender-defender dyadic coordination for GK+4-v-4+GK showed no preferred mode of coordination, whereas in 5-v-4+GK it was observed a strong attraction (25%) to in-phase coordination. The attacker-defender dyadic coordination showed weak attractions to -30º phase (14.83%) and in-phase (14.34%) forGK+4-v-4+GK and 5-v-4+GK game conditions, respectively. The coordination of the attacker-ball pairings revealed a flat distribution for both conditions, in which no obvious phase attractions were observed. Finally, strong -30º phase attractions were also showed for defender-ball pairings in conditions 5-v-4+GK (24.96%) and GK+4-v-4+GK (19.77%).

These results demonstrated that increasing the teams' relative number of outfield players (plus one attacker than defenders) constrained defenders to become more coupled in space and time with themselves and the ball. Conversely, attackers' relations with themselves and the ball were equally variable for both game contexts. Finally, numerical advantage of attackers forced defenders to coordinate their displacements symmetrically with the attackers (-30º to in-phase) to protect the paths to the goal.

Fernandes, O., Folgado, H., Duarte, R., & Malta, P. (2010) Validation of the tool for applied and contextual time-series observation. *International Journal of Sport Psychology, 41*(Sup. 4), 63-64.

Rosenblum, M., Pikovsky, A., & Kurths, J. (2004) Synchronization approach to analysis of biological systems. *Fluctuation and Noise Lett, 4*, L53-L62.

POST 1.1.2
Small sided games in football with university female players

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Recent technological innovations have made global positioning system (GPS) a new and valid method to quantify movement patterns and physical demands in sport (Coutts, & Duffield, 2010, Gray, *et al.*, 2010). GPS provide a detailed description of player movement demands and can assist teams and coaches from a tactical view point. The purpose of this study was to analyse the effects of a football teaching program (FTP), the number of players (NP) and coach encouragement (CE) on physiological demands, perceptive exertion, kinematic performance and technical/tactic components.

Twelve university students participated in this study (age 18.3 ± 0.7 years, weight 58.5 ± 6.4 kg, height 1.6 ± 0.1m, BMI 22.8 ± 1.7; mean ± standard deviation). Four small-sided games (SSGs) were applied: 6x6 at the beginning of FTP; 4x4; 6x6 at the end of FTP (without CE) and 6x6 (with CE). A constant pitch area of $225m^2$ per player was kept. During all SSGs the heart rate (HR), distance, speed and rating perceived exertion were recorded. The SSGs were recorded to further technical/tactical analysis. For data analysis we used the descriptive statistics and inferential analysis, using the *student t-test* and the *Wilcoxon* nonparametric test.

Significant differences ($p < 0.05$) were noticed in all components except for the HR. Results have shown that this FTP brings benefits to the technical/tactical and kinematic levels. The number of players is the variable which most influences the components analyzed. The reduction of the NP promoted the increased intensity and distance covered at a slow speed, as well as increased technical/tactical indicators. The use of CE increased the intensity and distance covered at higher speed (> 17,9 km/h) as well as the number of goals. Reduce the distance covered at lower intensity (0 at 6 km/h) and total distance covered.

Coutts, A. J., & Duffield, R. (2010) Validity and reliability of GPS devices for measuring movement demands of team sports. *Journal of Science and Medicine in Sport.* 13, 133-135.

Gray, A., Jenkins, D., Andrews, M., Taaffe, D. & Glover, M (2010) Validity and reliability of GPS for measuring distance travelled in field-based team sports. *Journal of Sports Sciences*, 28, 1319-1325

POST 1.1.3
Do action variables represent success in English Championship Football?

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Empirical research within association football has often used counts of action variables; frequently labelled performance indicators (PIs), in an attempt to describe differences between teams that are deemed as successful and unsuccessful (e.g. Lago-Ballesteros and Lago-Penas 2010; Lago-Penas et al., 2010). The premise being that coaches can design practices to control such variables in future competition (Lago-Penas et al., 2010). This current investigation attempts to identify which action variables could legitimately be called PIs, as they actually relate to success in the English Championship.

22 action variables were collected from 277 matches (2010-11 season) using Amisco Pro analysis system (Amisco Pro, Sport-Universal, Nice, France). Chi-square analysis revealed that scoring the first goal had a significant effect on the outcome of matches (Chi-square= 119.86, df = 2, $p<0.05$, Phi= 0.68) with home teams winning 70.6% and away teams 67.8% of such matches. Other variables had much less success in predicting match outcomes.

When teams were categorised as successful (finished top six in the league), unsuccessful (bottom 6) and mid-table (all other teams) Kruskal-Wallis analyses showed that successful teams scored more goals, had more ball possession in both the first and second halves of matches, with more possession within the opposition territory, had more total shots, with more shots on target, played more total and forward passes with higher success rates than unsuccessful teams, irrespective of playing at home or away (all tests $p<0.05$ or lower). However, when teams were ranked by these PI scores, top teams did not always finish in the top 6 in the table e.g. QPR who were the top ranked team were ranked 8th for shots of target.

It appears that the action variables used in this study did not reflect match outcomes particularly well and hence at this stage cannot be deemed performance indicators. However this could be due to a lack of sophistication in the analysis techniques i.e. some success was found for their predictive validity, or because football is so multi-faceted that successful performance on one action variable may be counteracted by performance on another action variable. It is therefore suggested that more complex analysis procedures e.g. logistic regression should be used to determine the extent to which these action variables counteract each other. In practical terms at this time it is pragmatic to suggest that coaches use action variable data to provide feedback on individual performances rather than to guide future performance.

Lago-Ballesteros, J. and Lago-Penas, C. (2010) Performance in team sports: identifying the keys to success in soccer. *Journal of Human Kinetics,* 25: 85-91.

Lago-Penas, C., Lago-Ballesteros, J., Dellal, A. and Gomez, M. (2010) Game-related statistics that discriminated winning, drawing and losing teams from the Spanish soccer league. *Journal of Sports Science and Medicine,* 9: 288-293.

POST 1.1.4
Effect of small-sided games on the physical performance of young football players of different ages and levels of practice

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This study aimed to examine the impact of two small-sided games formats, 3 vs. 3 + GKs (SSG1) and 5 vs. 5 + GKs (SSG2), on the physical performance and heart rate responses of young football players according to their ages and levels of practice.

Thirty male young football players of three different age groups participated in the study (U16 - age: 15,2 ± SD 0,4 years; playing experience: 6 ± 1,76 years; height: 1,74 ± 0,03 m; weight: 62,6 ± 4,2 kg; U17 - age: 16,3 ± 0,5 years; playing experience: 7 ± 1,4 years; height:1,78 ± 0,04 m; 67 ± 4,05 kg; U19 - age: 17,4 ± 0,5 years; 8,7 ± 2,8 years; height: 1,80 ± 0,07 m; weight: 69 ± 5,8 kg). Data were recorded in three training sessions that included two SSGs formats (8 min duration of each game interspersed by 5 min of passive recovery). The pitch size was set according to the following references: 23m x40m for SSG1 and 33m x 60m for SSG2. *GPSports systems SPI PRO* was used in data collections. Physical performance of players was characterized by following variables: 1) distance covered (D); 2) average speed (Sp_{avg}); 3) maximum speed (Sp_{max}). Heart rate minimum (HR_{min}), heat rate maximum (HR_{max}) and heart rate average (HR_{avg}) have also been recorded. One-way and two-way mixed-model ANOVA analysis were used to analyze the effect of SSG format as well as chronological age and level of practice on the physical performance and heart rate responses of young football players.

Results of performance of three groups of players in SSG1 and SSG2 are presented in the table 1. The significant differences between players' performances in SSG1 e SSG2 were observed for D - U17($p \leq 0,05$) and U19 ($p \leq 0,001$); Sp_{avg} - U16 ($p \leq 0,05$), U17 ($p \leq 0,05$) and U19 ($p \leq 0,001$); HR_{min} - U16 ($p \leq 0,05$). It was noted that older and higher experienced players demonstrated less intensive performance in both game formats. Although no significant differences were observed between performances of U17 and U19 groups, the change of SSG format had diverse impact on the physical performance and HR responses of young football players from different ages and practice levels.

Results pointed out that age and playing experience have a decisive influence on how the players manage the functional space and their playing actions during the SSG. This represents a more evolved tactical behavior with obvious effects on the physical performance of players.

Table 1. Performance profile of three groups of players in SSG1 and SSG2

	SSG 1			SSG 2		
	U16	U17	U19	U16	U17	U19
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
D	956,5 ± 91,6**[##]	881,4 ± 63,9**	853,3 ± 62,5[##]	988 ± 114,1**[##]	981,1 ± 74,2**	956,3 ± 68,8[##]
Sp_{max}	24,1 ± 1,7[#]	22,9 ± 2,3	22,3 ± 1,9[#]	23,63 ± 2,04[#]	23,4 ± 2,02	24,1 ± 2,1[#]
Sp_{avg}	6,96 ± 0,6**[##]	6,4 ± 0,47**	6,3 ± 0,4[##]	7,12 ± 0,81**[##]	7,02 ± 0,52**	6,94 ± 0,53[##]
HR_{max}	185,6 ± 15,13	186,3 ± 7,2	178,6 ± 14,3	184,8 ± 11,12	181,6 ± 9,6	178,1 ± 7,99
HR_{avg}	168,9 ± 20,2[#]	167,9 ± 9,6	156,9 ± 10,9[#]	160,1 ± 14,5[#]	161,4 ± 13,07	154,3 ± 9,3[#]
HR_{min}	120,4 ± 14,5[#]	111,1 ± 1,05	107,4 ± 14,3[#]	105,9 ± 18,4[#]	104,6 ± 14,9	101,7 ± 13,9[#]

* significant difference between U16 and U17($p \leq 0.05$); ** significant difference between U16 and U17($p \leq 0.01$);
[#] significant difference between U16 and U19($p \leq 0.05$); [##] significant difference between U16 and U19($p \leq 0.01$).

The influence of manipulating the defensive playing method on team synchrony in association football

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Successfull performance in Association Football is typically viewed as an expression of a collective synergy between the individual behaviours of each player. However, certain performance constraints, such as the defensive playing method, can influence the way team players synchronise their behaviour. The aim of this study was to analyse how the manipulation of the defensive playing method influences the collective synchrony of football players during performance.

Twelve under-17 elite footballers were divided in two teams, with a GK+1+3+1 diamond shape formation, with players assigned to their common positions. Teams performed two small-sided games in a 40 x 42m of pitch size, in which the defensive playing method was manipulated. In the first game both teams used zone defence. In the second game players were paired and teams used man-to-man defence. Positional data from the 10 outfield players were gathered using a Global Positioning System (GPSports, Australia) with a sample rate of 15 Hz. Based on players' movement displacement trajectories, the cluster phase method (Frank & Richardson, 2010) was used to calculate time-series data of team synchrony, as well as the individual synchronisation of each player with the team (employing relative phase analysis).

Time-series data of team synchrony is presented in left panel of Figure 1. Mean data showed considerable higher values for zone defence (0.63± 0.24) than for man-to-man defence (0.47±0.21), indicating that zone defence constrained players to enhance the team synchrony of their on-field movement trajectories in space and time. Frequency histogram analyses (right panel of Figure 1) also revealed differences in individual players' synchronisation with the whole team behaviour. Adopting a man-to-man defence implied less attraction for any specific mode of relation and more spread for the entire spectrum of coordination possibilities. Conversely, adopting zone defence promoted higher attraction for relative phase values near in-phase mode of coordination (49.8% between -30 and 30 degrees), suggesting that zone defence seems to result in more aggregated team behaviours with increasing stability in the individual-to-team coordination.
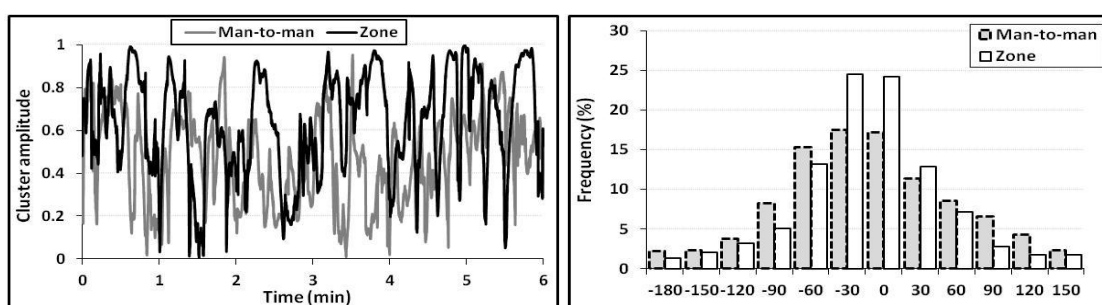

Figure 1. Variations in team synchrony (left panel); relative phase histograms with analyses between each individual player and team movement synchronisation (right panel).

Frank, T. D., & Richardson, M. J. (2010). On a test statistic for the Kuramoto order parameter of synchronization: An illustration for group synchronization during rocking chairs. *Physica D*, 239, 2084-2092.

POST 1.2: TEAM SPORTS

POST 1.2.1
Match analysis and a comparison between winning and losing teams in men's elite level goalball

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Goalball is a Paralympic sport for persons with visual impairment in which only few studies has been published and no comparison between the winning and losing teams has been made. Thus, the purpose of this study was to analyze the key technical aspects of the game and to determine which skills have the biggest effect on winning in men's elite level goalball.

15 men's matches from Goalball European Championships 2011 and IBSA World Games 2011 were recorded and analyzed with Data Volley -software. The analyzed variables were: throws (all/normal/penalty), type of throws (flat/bounce/curve), errors (high ball/long ball), goals (all/from normal throws/from penalties) and blocks (hands/torso/legs). The means and SDs of the analyzed variables were calculated and either t-test for paired samples or Wilcoxon signed-rank test was used to compare the winning and losing teams.

On average, 96.4 throws were thrown during a match. From these, 6.2 goals were scored and 3.0 errors thrown. From the normal throws during live game, 51.5 % were flat throws, 35.7% bounces and 12.9% curves. From all the goals, 74.6% were scored from normal throws and 25.4% from penalties. From the goals scored with normal throws, 57.3% were from flat throws, 30.3% from bounces and 13.5% from curves. Curve was the most effective type of throw as 6.7% of the curves led to a goal. However, the curves also had the highest error percentage (3.6 %). 47.0% of the goals were conceded from legs, 41.0% from hands and 12.0% from torso. The error percentage of blocks was highest from hands (12.8%).

The teams that won the matches had a significantly higher success percentage (more goals) (8.3% vs. 4.5%, $p<.001$) and smaller error percentage in all throws (1.5% vs. 4.7%, $p<.01$). The winners also excelled in normal throws during live game as their success percentage (5.9% vs. 4.0%, $p<.01$) was higher and error percentage smaller (1.5% vs. 4.7%, $p<.01$). The winners had significantly more penalty throws during the matches (4.7 vs. 1.4). They also succeeded better in their penalty throws (success% 52.0% vs. 45.8%), but this difference did not reach statistical significance. In the winning teams, the success percentage in all type of live game situation throws (flat/bounce/curve) was also better than in the losers, but the differences did not reach statistical significance. Furthermore, the winners' error percentage in flat throws (1.5% vs. 5.2 %, $p<.01$) and bounces was significantly smaller (0.6% vs. 3.9%, $p<.05$). The winning teams also varied their type of throw more, as less of their normal throws were flats (47.5% vs. 55.8%, $p<.05$). The error percentage in all blocks was significantly smaller in winners (5.3% vs. 9.4%, $p<.01$). The winners succeeded better in blocks with all body parts but especially with hands as the difference in error percentage in hands reached a statistical significance (7.9 vs. 19.9%, $p<.001$).

Based on the results it can be concluded that the ability to vary the type of throws and to score especially with flat throws is vital in men's elite level goalball. Furthermore, the ability to play without errors in throwing is important. Also the blocking skills especially with hands proved to be a separating factor between winners and losers.

POST 1.2.2
Determinants related to the attack tempo in high level male volleyball

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Volleyball game presents a cyclical and sequential pattern which implies that previous actions influence the next ones (Palao et al., 2004). In high level male Volleyball the attack action presents a positive correlation with the game victory (Marcelino et al., 2008). Additionally, attack tempo is a strong indicator of the offensive organization since influence the opponent's block organization. This study intents to analyse possible determinants that could influence attack tempo in high level male Volleyball.

The sample of this study was withdrawn of 1486 serve-reception actions, 1368 set actions and 1344 attack actions, corresponding to 19 games of the 10 best ranked teams of the 2006 FIVB Men's World Championships. *Attack tempo* (Castro & Mesquita, 2010) was the dependent variable of this study. In addition, 3 independent variables were considered: *serve-reception efficacy*; *setting zone* (Afonso et al. 2012); *type of set* (Papadimitriou, et al. 2004). A multinomial logistic regression was applied with a significant level established in 5%.

Results showed a significant relationship between *attack tempo* and all considered variables ($x^2_{(18)}$ = 694.484, p<0.001). *Serve-reception* influenced significantly the attack tempo. Excellent serve-reception action (allow all attack options) promoted faster attacks. On the other hand, serve-receptions that not allow a good attack organization promoted slower attacks. *Setting zone* determines the attack tempo as setting actions performed through reasonable and poor zone induced slower attacks. On the contrary, suspension setting promoted quicker attacks.

Although game evolution denote quicker attacks even when conditions are not excellent, serve-reception and setting action showed to have influence on the velocity of the offensive organization. In this way, these results showed that quicker attacks resulted from offensive constraints, more specifically from serve-reception, setting zone and type of set. These results can have implications for practice, namely the necessity of improve some variables that could promote faster attackers, for instance reception efficacy.

Afonso, J., Esteves, F., Araújo, R., Thomas, L. & Mesquita, I. (2012) Tactical determinants of setting zone in elite men's volleyball. *Journal of Sports Science and Medicine, 11*: 64-70.

Castro, J., & Mesquita, I. (2010) Analysis of the attack tempo determinants in volleyball's complex II – a Study on elite male teams. *International Journal of Performance Analysis in Sport, 10*(3): 197-206.

Marcelino, R., Mesquita, I., & Afonso, J. (2008) The weight of terminal actions in volleyball. Contributions of the spike, serve and block for the teams' rankings in the World League 2005. *International Journal of Performance Analysis in Sport, 8*(2): 1-7.

Palao, J. M., Santos, J. A., & Ureña, A. (2004) Effect of team level on skill performance in volleyball. *International Journal of Performance Analysis in Sport, 4*(2): 50-60.

Papadimitriou, K., Pashali, E., Sermaki, I., Mellas, S., & Papas, M. (2004) The effect of the opponents' serve on the offensive actions of Greek setters in volleyball games. *International Journal of Performance Analysis in Sport, 4*(1): 23-33.

POST 1.2.3
Proportion and efficiency of different serve techniques in relation to winning in elite female volleyball

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Serve is an important skill in volleyball in relation to winning matches especially in men's top-level volleyball. The goals of serving are either to score a direct point or to reduce the attack options of the opponent. The purpose of this study was to analyse the serve techniques and the serve efficiency in relation to winning a rally at two levels in elite female volleyball.

The serves were analyzed from World Championships 2010 (WC) and Junior European Championships 2010 (JEC). The number of analyzed serves was 656 for WC and 678 for JEC. The final result of each rally was also recorded. Serve techniques were divided into three categories: jump serves (JS), jump float serves (JF) and float serves (FL). The efficiency of a serve (SE) was analyzed using a 5-point scale (5=ace, 4=reception goes over the net/the receiving team has no chance to attack, 3=opponent has limited attack options, 2=opponent has all attack options and 1=serve error). Chi-Square -test was used for statistical analysis.

The use of different serve techniques differed significantly ($p<.001$) between the two levels. JF was used most in both levels (WC 71 %, JEC 89 %) and JS least used (WC 10 %, JEC 4 %). The efficiency of the JFs was higher in JEC ($p<.01$). In WC JS and in JEC JF was the most efficient technique (WC $p<.01$, JEC $p<.001$). (Table 1.) On average 42 % of the rallies were won with own serve. No significant differences were found in winning a rally on different serve techniques either between the two levels or in either levels. Significant differences ($p<.001$) in winning a rally were found between serve efficiencies in each serve technique in both levels. (Table 2.)

The proportion of jump float serves has increased considerably and the proportion of aces and errors was quite similar compared to the previous studies. (Palao et al. 2009; Quiroga et al. 2010.) To conclude there were no differences between serve techniques in relation to winning rallies. The winning percentage of a rally was higher with higher serve efficiency

Table 1. The proportion of the serves with different efficiencies and techniques.

	WC			JEC		
SE	JS	JF	FL	JS	JF	FL
5	7%	6%	4%	8%	10%	4%
4	6%	7%	5%	12%	5%	9%
3	40%	26%	25%	27%	34%	28%
2	28%	53%	58%	15%	42%	40%
1	18%	8%	8%	38%	9%	19%

Table 2. The winning percentage of a rally with different serve efficiencies.

	WC			JEC		
SE	JS	JF	FL	JS	JF	FL
5	100%	100%	100%	100%	100%	100%
4	100%	71%	50%	67%	48%	100%
3	41%	47%	41%	86%	44%	54%
2	37%	35%	37%	25%	38%	44%
1	0%	0%	0%	0%	0%	0%

Palao, J., Manzanares, P. & Ortega, E. (2009) Techniques used and efficacy of volleyball skills in relation to gender. *Int J Perf Anal Sport*, 9: 281-293.

Quiroga, M., Garcia-Manso, J., Rodriguez-Ruiz, D., Sarmiento, S., De Saa, Y. & Moreno, M. (2010) Relation between in-game role and service characteristics in elite women´s volleyball. *J Strength Cond Res*, 24: 2316-2321.
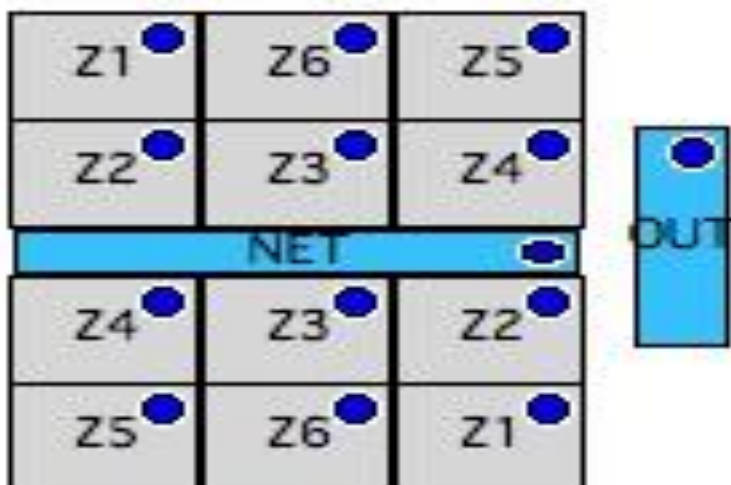
POST 1.2.4
The influence of the area of attack on point success in men's professional beach volleyball

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University of Alicante

This study was developed during the First International Training Tournament Sixto Jimenez, played in Tenerife (Spain) in 2010. The analysis of video recordings was performed with the software SportCode Pro. Therefore, the aim of this study is to identify areas (picture 1) of the field where win, lose or continue the attacks, determining in this way, what are the areas where higher scores are achieved. Quantitative analysis with a sample of 10 teams played 12 games with a total of 1027 attacks analyzed. The data analysis was performed with SPSS v.18 software, the Mann-Whitney test showed significant differences in certain areas. Of the attacks wins, 27% ($p \leq .05$) are achieved by leaving the ball out of bounds after being touched by an opposing team member, as well as a Zone 1 and Zone 2 21% to 11% . As for the continuation of points, significant differences were found both in zone 1, 2, the most consistent area 5 ($p \leq 0.05$). The points lost due to the blocking action of the opposing team as well as attacks where the ball strikes the net or falls outside the field ($p \leq 0.05$).

Picture 1: Court's areas

POST 1.2.4
The influence of the area of attack on point success in men's professional beach volleyball

POST 1.2.5
Sporting activities of volleyball players throughout the developmental stages according to competitive level and gender

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The acquisition and manifestation of high levels of performance is often linked to the long-term athlete development in which practice activities performed has been included as one of the most important elements for becoming an elite level athlete (Baker et al., 2003; Baker et al., 2005). The purpose of this study was to characterise sporting activities of Volleyball players throughout different developmental stages, according to their gender and competitive level.

The study involved 229 Portuguese adult Volleyball players that filled in a validate retrospective questionnaire that was design and applied to gather detailed data of the past practice activities of the players. Considering the *Developmental Model of Sport Participation* (Côté, 1999; Côté et al., 2003), three developmental stages were taken into account (stage 1: 6-12 year olds; stage 2: 13-14 year olds; stage 3: 15-16 year olds). The dependent variables considered were (i) average hours of training per week, (ii) average number of competition per week; (iii) number of team sports and individual sports practiced. This last variable was not considered at stage 3 (15-16 years) because players are solely involved with Volleyball training. These variables were analysed according to athletes' gender and competitive level. Two-way ANOVA was applied, using Tukey's post hoc multiple comparisons.

The results showed that high-level players trained more hours per week than middle-level ones throughout the three stages considered (stage 1: $p=0.027$; stage 2: $p=0,002$; stage 3: $p\leq0,000$) and males had a larger number of competitions than females throughout the second ($p=0,050$) and third ($p=0,010$) stages. Males practiced more team sports than females during the first ($p\leq0,001$) and second ($p=0,010$) stages. The interaction between gender and competitive level showed that high-level females practiced more individual sports than the other groups during the first stage ($p=0,034$). Moreover, high-level females and middle-level males practiced more individual sports than high-level males and middle-level females on the second stage ($p=0,023$).

The study suggested that the quantity and type of practice distinguished the players in terms of high level practice achievement, suggesting that involvement in a diversified practice during early phases of development (early diversification) might contribute to subsequent attainment of expertise. These findings should be considered when planning and designing youth sport programs in order to promote a harmonious growth and development of Volleyball players according to their features.

Baker, J., Côté, J., & Abernethy, B. (2003). Sport-specific practice and the development of expert decision-making in team ball sports. *Journal of Applied Sport Psychology*, 15: 12-25.

Baker, J., Côté, J., & Deakin, J. (2005). Expertise in ultra-endurance triathletes early sport involvement, training structure, and the theory of deliberate practice. *Journal of Applied Sport Psychology*, 17: 64-78.

Côté, J. (1999). The influence of the family in the development of talent in sport. *The Sport Psychologist*, 13: 395-417.

Côté, J., Baker, J., & Abernethy, B. (2003). From play to practice: A developmental framework for the acquisition of expertise in team sport. In J. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 89-113). Champaign, IL: Humam Kinetics.

POST 1.2.6
Determinants of success in Twenty20 cricket

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Since its inception in June 2003, Twenty20 (T20) cricket has quickly become extremely popular with players, supporters, administrators, coaches and owners (Douglas & Tam, 2010). However, there is currently a paucity of research that has examined T20 cricket from the scientific sub-discipline of notational analysis (Lemmer, 2008; Petersen *et al.*, 2008; Douglas & Tam, 2010). In addition, these studies have principally focused on generic batting and bowling indicators, emphasising the importance of a higher run rate, more runs in the middle 8 overs, taking more wickets and bowling more dot balls. Consequently, this information would be insufficient to adequately guide and facilitate the coaching process. As such, a more detailed analysis of T20 cricket is warranted. Therefore, the purpose of this study was to identify the key determinants of success in English domestic T20 cricket.

29 matches for winning teams and 30 matches for losing teams were analysed from the 2010 English domestic T20 competition. All matches were coded using Crickstat version 3.0.0.12 (CSIR, South Africa). A total of 60 performance indicators were analysed including batting indicators, such as partnerships, run-rate, run type (1's, 4's, 6's) and scoring areas, and bowling indicators, such as dot balls, wickets and bowling length. Magnitude-based inferences, reported as effect sizes (ES), were used to characterise differences in performance indicators between winning and losing teams. The criteria for interpreting the magnitude of effect size were: < 0.2 trivial, 0.2 − 0.6 small, 0.6 − 1.2 moderate, 1.2 − 2.0 large (Hopkins, 2004).

The top 5 indicators of success were losing less wickets in the powerplay overs (ES = -1), losing less wickets between overs 7-10 (ES = -1), 50+ run partnerships (ES = 1), individual batsmen contributing 75+ runs (ES = 1) and 50-74 runs (ES = 1). In addition, winning teams scored a higher percentage of total runs to long-off (ES =0.4) and the off-side (ES = 0.2), and bowled a higher percentage of deliveries at a yorker (ES = 0.4) and short length (ES = 0.6) than losing teams. Collectively, these findings highlight that teams should retain wickets in the first 10 overs of an innings, without necessarily maximising the number of runs scored. In the final 10 overs, teams should outscore the opposition by hitting boundary 4's and avoid scoring a high percentage of runs from 1's. Moreover, although bowlers should continue to vary delivery length to remain unpredictable, the findings suggest an emphasis towards short and yorker length deliveries is advantageous.

Douglas, J.M. and Tam, N. (2010) Analysis of team performances at the ICC World Twenty20 Cup 2009. *International Journal of Performance Analysis in Sport,* 10 (1), 47-53.

Hopkins, W.G. (2004) How to interpret changes in an athletic performance test. *Sportscience*, 8, 1-7.

Lemmer, H.H. (2008) An analysis of players' performances in the first cricket Twenty20 World Cup Series. *South African Journal for Research in Sport, Physical Education and Recreation*, 30 (2), 71-77.

Petersen, C., Pyne, D.B., Portus, M.J. & Dawson, B. (2008) Analysis of Twenty/20 cricket performance during the 2008 Indian Premier League. *International Journal of Performance Analysis in Sport*, 8 (3), 63-69.

POST 1.2.7
Performance analysis of decision making in team sports

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One specific skill that has, to date, been largely ignored in notational analysis, is decision making, a key indicator of expert performance (Baker et al., 2003). Those studies that have analysed decision making in game situations (Bruce et al., 2009) neglected to measure decision accuracy, unless it was linked to the outcome of the skill execution. This research involves a notational analysis system specifically designed to measure in game decision making accuracy in team sports, in particular Australian Football (AF).

Thirteen elite AF players matches were analysed in rounds one, two, 10 and 11, using broadcast footage. Decision making performance indicators include was decision accuracy, number of options available and level of defensive pressure. Decision accuracy was based on a three point system as allocated by elite AF coaches. Three points was allocated to the best option, two and one points to the second and third options. The number of options was based on how many options could be seen in camera view. The level of defensive pressure was measured by the distance away the opponent was.

Decision accuracy increased from round one and two to rounds ten and eleven. By quantifying decision accuracy (best, 2nd, 3rd) we were able to further break down what was happening with decisions. Defensive pressure and number of options available for each decision did not differ between games.

A one way ANOVA revealed a significant interaction effect between total accuracy and season time, $F(3,22) = 8.76$, $p = .001$, Wilks Lambda = .456, $\eta p^2 = .544$. No significant effects were found between pressure and season time, $F(4,21) = 1.45$, $p < .05$, Wilks Lambda = .821, $\eta p^2 = .179$ or season time and number of options available $F(2,23) = 1.15$, $p < .05$, Wilks Lambda = .90, $\eta p^2 = .091$. Inter-rater reliability of the notational analysis system showed high inter-rater reliability for accuracy (k = .84) and defensive pressure (k = .90). Intra-rater reliability was also very high with an almost perfect agreement for coder one for accuracy (k = .91) and defensive pressure (k = .94) and for coder two for accuracy (k = .92) and defensive pressure (k = .93). Each kappa statistic result also showed a significant *p* value of less than .001.

This research creates an exciting new platform for future research to build upon in order to further develop our ability to measure cognitive skills such as decision making in live match situations.

Baker, J., Côté, J., & Abernethy, B. (2003) Sport specific practice and the development of expert decision making in team ball sports, *Journal of Applied Sport Psychology*,15, 12-25.

Bruce, L., Farrow, D., Raynor, A., & May, E. (2009) Notational analysis of skill expertise differences in netball. *International Journal of Performance Analysis in Sport*, 9, 245-254.

POST 1.2.8
The structure of intensity of play in ice hockey

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Ice hockey game is characterized by high speed and dynamics connected with short-term intensive efforts of players. Ice hockey is a high-speed and dynamic game characterized by short, intense bursts of energy. A hockey player stays on the ice during 25-30s. A hockey player is actively involved in the game for 25-30s. During one "change" the competitor plays with maximum intensity during 3-4s, alternating with the work of low intensity during 5-6s. Competitors of attack formations: the middle and the front, are burdened with an effort of similar intensity. By contrast, the work of defenders is about 1/3 less than maximum intensity. The effort of hockey player throughout the whole game is characterized by submaximal and maximal intensity, which is interrupted by the period of waiting for change. The aim of the research was the assessment of the intensity of effort of 18-year-old Polish hockey team participating in the World Championships in ice hockey.

The study involved a group of 15 hockey players 17-18 years old of Polish national team during the World Championship U-18. During ramp test performed on an ergometric bicycle Monark 814 E the degree of load corresponded to 1 $Wxkg^{-1}$ of body weight. In the ramp test using an ergonometric bicycle Monark 814 E the load was set at 1 $Wxkg^{-1}$ of body weight. Each following level was higher by 0.5 $Wxkg^{-1}$ of body weight. During the effort on the analyzer K4b2 (Cosmed, Italy) the volume of oxygen consumption (VO_2) was recorded, and using a heart rate monitor Polar Team (Polar OY, Finland), the contractions of the heart were registered. Basing on the work of, where Energetic classification of effort intensity during a game were estimated [Flanagen & Merrick 2002]. Classification is based on the values of oxygen consumption and the corresponding heart contractions. Five areas of effort intensity was obtained: VHI - area of very high effort intensity - 86-100% VO_2max, HI (76-85%), MI (51-75%), LI (31-50%), AR (15-30%), SR (≤ 14%). For each tested player the above mentioned areas were set on the base of VO_2 values, recorded during the progressive effort. The next step was to assign the corresponding values of heart contractions (HR) to the individual VO_2. Thus the individual ranges of heart contraction values were obtained for each player in each area of intensity. During three games of the World Championship the frequency of heart contractions during a game was recorded by heart rate monitor Polar Team. During three games at the World Championship the frequency of heart contractions was recorded with a Polar Team heart rate monitor. Based on the intensity of the individually determined areas of intensity, the time of staying in each determined sphere of intensity was assigned to each tested player. This time is expressed as a percentage of the total time of period.

Position of hockey player in the game determines the structure of the effort intensity during a match. The players of the attack, besides performing the majority of their work in MI area (25,40-38,11%) and VHI area (20,79-37,21%), works in large extent in HI area (17,70-25,08%). The work of LI intensity is performed by attack formation players very rarely (11,93-23,31%). But for the competitors playing in defense, MI (25,62-36,50%) dominated, rarely - LI (17,76-29,92%) and HI (18,46-29,22%). Very rare the effort of the defenders has VHI character (9,02-18,88%).

Flanagan T. & Merrick E. (2002) Quantifying the work-load of soccer players. (in) *Science and Football IV* (red.) Spinks W., Reilly T., Murphy A., Routledge, London: 341-349.

POST 1.2.9

Notational analysis of three matches from the 'Women's Team Handball European 2010 Qualification Round'

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The aim of this research was to compare the performance of the winning teams against the losing teams from three competitive matches played during the 'Women's Team Handball European 2010 Qualification'.

Despite the widespread use of notational analysis and the advantages it provides in other sports, including men's handball (Hughes & Franks, 2004; Gruić et al., 2006; Lopes et al., 2008; Rogulj et al., 2004); there is a definite lack of academic research using notational analysis, in women's handball. I have only found one recent study of this type that analyses the performance of women's handball teams (Yamada *et al.,* 2011). This seems to be an area of research still in its infancy. Hopefully this study can be one of the first in providing invaluable information and statistics and therefore encourage a greater use of notational analysis specific to women's handball.

The research was based on the attacking situational efficiency factors in women's handball. Three women's handball games were analysed using notational analysis (participants n=69). Inferential (regression) and descriptive statistics were used to analyse the data. The predictor variables, 'shots on' (B = 0.597, $p < 0.001$), 'shots on converted (%)' (B = 0.014, $p < 0.001$) and 'counter attack goals' (B = 0.472, $p < 0.001$) were significant in deciding the result of a match. This research goes someway to explaining situational efficiency in women's handball. Further research is required to validate these findings and complete a better overall picture for strategies, tactics and the training needs in women's handball.

Gruić, I., Vuleta, D. & Milanović, D. (2006) Performance indicators of teams at the 2003 men's world handball championship in Portugal. *Kinesiology,* 38(2): 164-175.

Hughes, M. & Franks, I.M. (2004) *Notational Analysis of Sport: Systems for Better Coaching and Performance in Sport.* Routledge: 2nd Edition.

Lopes, A., Camerino, O., Anguera, T. & Jonsson, G.K. (2008) Ball recovery in the handball tournament of the 2008 Beijing Olympic Games: Sequential analysis of positional play as used by the Spanish team's defence. *Proceedings of Measuring Behavior 2010* (Eindhoven, The Netherlands, August 24-27, 2010) Eds. A.J. Spink, F. Grieco, O.E. Krips, L.W.S. Loijens, L.P.J.J. Noldus, and P.H. Zimmerman.

Rogulj, N., Srhoj, V. & Srhoj, L. (2004) The contribution of collective attack tactics in differentiating handball score efficiency. *Collegium Antropologicum, 2*8(2): 739–746.

Yamada, E., Aida, H. & Nakagawa, A. (2011) Notational analysis of shooting play in the middle area by world-class players and Japanese elite players in women's handball. *International Journal of Sport and Health Science,* 9: 15-25.

POST 1.2.10
A scoring system for pertinent actions in rugby union

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Numerous studies have assessed performance using action variables but have largely failed to consistently identify a statistically significant link between individual performance indicators and match outcome e.g. in rugby (Vaz et al., 2011). Invasion games, such as rugby union, consist of a complex interaction of physical actions, which, within the framework of the Laws of the game, results in a complex, possibly even random, sequence of events. In an attempt to better understand the relationship between these actions some researchers have considered whether complex sports display properties akin to a self-organising dynamic system (McGarry et al., 2002). Two groups of matches were analysed using a purpose built computerised data collection system. Group 1 was (n=26) home and away matches played by a single RFU National League 3 South West team in the 2011/12 season. Group 2 was (n=12) randomly selected matches from the 2011/12 Six Nations. Intra-operator reliability was tested on one match from each group with each action variable having less than 5% error. A selection of actions was chosen predominately from previous research findings although a few were added on the basis of significance from a coaching perspective. Each of these individual actions e.g. ball won at the ruck, were awarded a score on the basis of relative importance (in match outcome terms), location, gaining ground and game state. The method for determining each score was based on a bespoke formula, derived for this study using the relationship between variables with reference to preceding and proceeding actions. For example, losing a lineout when throwing the ball in was given a negative score on the basis of previous research identifying this as a key performance indicator. When determining the magnitude of the score weightings were given for the impact of an action e.g. a line break was awarded more points than simply gaining ground because the defence had been broken in addition to the gaining of territory. Once a system for awarding scores for each of the relevant actions was in place, these scores could be added for sequences of play i.e. a number of actions were combined for an individual possession. This method allowed the creation of scores for each individual action, phase and possession. Since each match is the competition between two teams with possession changing from one team to another this approach allowed the match to be viewed as a series of scores for each team, which retained the sequence of the data but could also be combined to create overall team performance scores. Preliminary results suggested that team performance scores showed a very strong correlation with match outcome (>0.8). The system was also able to automatically identify and present the main positive and negative phases of play for each team. A sequential analysis of team action, phase and possession scores was also able to suggest the existence of perturbations in rugby union, thereby suggesting that further research in this area may be worthwhile as an aide to coaching in the future.

McGarry, T., Anderson, D.I., Wallace, S.A., Hughes, M.D. & Franks, I.M. (2002) Sport competition as a dynamical self-organizing system. *Journal of Sports Sciences*, 20: 771-781.

Vaz, L., Mouchet, A., Carreras, D. & Morente, H. (2011) The importance of rugby game-related statistics to discriminate winners and losers at the elite level competitions in close and balanced games. *International Journal of Performance Analysis in Sport*, 11(3): 130-141.

POST 1.2.11
An investigation into clean and un-clean scrums in the 2011 Rugby World Cup

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Scrummaging in rugby union is a set piece movement that occurs after a minor infringement or a stoppage in play. The main purpose of the scrum is to restart play safely, quickly and fairly (International Rugby Board [IRB] 2011a). The scrum is a fundamental part of the modern game and can provide a platform to attack or defend (Winder, 1990). In 2007, the IRB introduced the "crouch, touch, pause and engage" process, on the advice of the IRB Medical Advisory Committee, in order to reduce the risk of injury. However, evidence has suggested that the scrum has become a problem area in rugby union since the rule change, having negative impact on the game (IRB, 2011b). The purpose of this study is to analyse scrummaging during the 2011 Rugby World Cup and examine the relationship between clean and un-clean scrums in the tournament and according to Northern versus Southern hemisphere and top ranking versus bottom ranking teams.

Forty-six matches were analysed post-event from commercially available footage, comprising 901 scrums. All scrums were analysed using a video-statistical analysis package (GameBreaker Plus, SportsTec, New Zealand). A code window was developed relating to each predetermined key performance indicator (KPI), outlined by the IRB as infringements at the scrum. All scrums were viewed to observe whether a clean or un-clean engagement was demonstrated, a clean scrum was determined by play being allowed to continue whereas an un-clean scrum was an infringement at contact causing a stopping in play or the awarding of a penalty or free kick.

In the tournament a total of 520 scrums were deemed clean and 381 un-clean. A Mann-Whitney U test demonstrated significantly more clean scrums then un-clean during the tournament ($P < 0.05$). The top 10 ranked teams had a difference between clean and un-clean scrums of 10.6 ± 7.82 per team, and the bottom 10 a difference of 12.5 ± 5.08 per team. There was no significant difference between the rankings in relation to clean and un-clean scrums. Teams from the Northern hemisphere (n=12) had a difference of 11.25 ± 6.84 per team between clean and un-clean scrums, and Southern hemisphere teams (n=8) had a difference of 12 ± 6.37 per team, again no significant difference was observed between the two groups.

To conclude, in relation to the "crouch, touch, pause and engage" sequence, although regarded as having a negative impact on the game, there are still significantly more clean scrums being observed. These results, in conjunction with reduced neck and back injuries being observed (Gianotti *et al.*, 2008) suggest that the current engage sequence should remain in place.

Gianotti, S., Hume, P. A., Hopkins, W. G., Harawira, J., & Truman, R. (2008) Interim evaluation of the effect of a new scrum law on neck and back injuries in rugby union. *British Journal of Sports Medicine*, 42, 427-430.

International Rugby Board. (2011a) *Laws of the game incorporating the player charter: Rugby Union 2011*. Dublin, Ireland: International Rugby Board.

International Rugby Board. (2011b) *Statistical Review and Match Analysis: 2011 RBS 6 Nations. Rugby Union*. Dublin, Ireland: International Rugby Board.

Winder, P. (1990) *Rugby Training*. London, UK: A & C Black

POST 1.2.12
Scoring profiles in the 2009 RBS Six Nations rugby union championship

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Rugby research has focused on a range of performance indicators related to game structures and tactical aspects, including lineout tactics, differences between winning and losing teams, which side of the field try scoring predominates, and the number of passes per try (Vaz et al., 2009). Research has included analysis of the world's top teams to assess the effect of law changes on the game and rates of foul play across different competitions. Despite the range of detailed analysis in the literature, there is a need for a structured account of all logical units of play, defined and quantified in accordance with coaching language and concepts. The purpose of this study was to quantify the scoring profiles of Six Nations Rugby Championship 2009.

All Six Nations Rugby Championship 2009 games (N=15) were video-analysed and game related-statistics use descriptive statistics. The obtained results allowed identifying significant differences in the game-related statistics for all teams ($p < 0.05$).The rate of try scoring shows the number of tries scored by each country. A team may obtain little possession but still manage to score a significant number of tries. We consider this and attempt to show how successful each team was in converting possession into tries. This was done by adding together the time each team was in possession of the ball in each of the matches played and then dividing it by the number of tries scored. The result then gave a rate of try scoring – or a measure of how effective each country was in converting possession into tries. The rate of try conceding shows how effective was each team in restricting tries in relation to the possession that their opponents obtained. The tries to measure show successful each team was in preventing their opposition from converting possession into tries. This was done by adding together the total time the team's opponents were in possession of the ball - and then dividing it by the number of tries conceded. The result then gave a rate of try scoring by the opposition.

There were 597 points scored in the 15 matches played, giving an average of 40 points per game. They were made up as follows: converted tries 34 points; unconverted tries 22 points; penalty goals 74 points and 9 drop goals 27 points. Of the total points scored: 47% came from tries; 37% came from penalty goals; 11% came from conversions; 5% came from drop goals. There were 74 penalty goals kicked in 2009 – this is 9 fewer than 2008. A further breakdown shows that the top two teams: Ireland and England – scored 28 tries and kicked 16 penalties goals. The bottom two teams, on the other hand, scored just 6 tries but kicked 29 penalties goals.

It still remains true that it is tries that win matches. In Six Nations 2009, just as in 2008, the winning team scored the most tries in 12 of the 15 matches (80% winning ratio). It has always been at around this percentage. Only one team scored fewer tries than their opponents and won the game (Wales win against England in 2009).

Vaz, L., Van Rooyen, M. & Sampaio, J. (2009) Rugby game-related statistics that discriminate between winning and losing teams in IRB and Super Twelve close games. *Journal of Sport Science & Medicine*, 9, 51-55.

POST 1.2.13
Game analysis comparing the final top nations with the others in the 2011 Rugby World Cup

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In the 2011 Rugby World Cup, the unions of Tier 1 advanced to the final tournament like all RWCs. This result doesn't change a lot with RWCs, and the remarkable progress of the Tier 2 unions, including Japan, is expected to spread as the union continues to develop. Therefore, the research aimed to analyse the top final unions, as well as other unions, to clarify the difference of game structures and to search for the causes of winning or losing.

The result of the play classified game statistics of IRB into the analysis item and the category of the score, the tackle, and the clean line break. The game performance analysis was conducted on each game. Significant differences of the results were verified by the Fischer's test.

Overall statistical features of games are shown in Table 1 and Figure 1.2

Table1 Scoring		
Types of score	The top final unions	The other unions
Tries	61.7%	52.1%
Conversions	18.3%	12.4%
Penalty goals	18.2%	31.3%
Drop goals	1.8%	4.2%
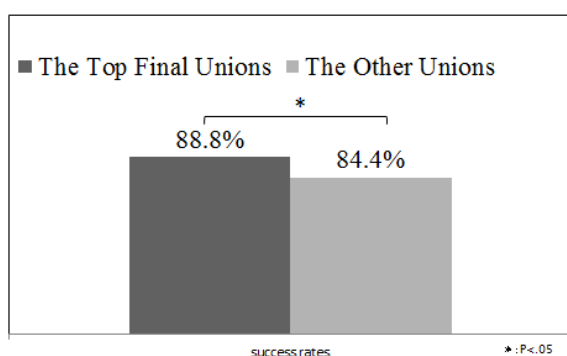
Fig.1 Tackle
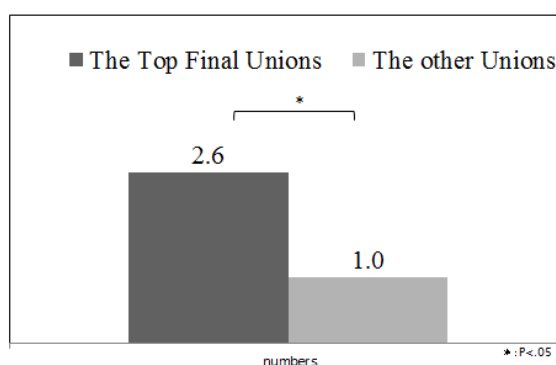
Fig.2 Clean line break

POST 1.3: PERFORMANCE ANALYSIS AND COACHING

POST 1.3.1
Temporal aspects of coach behaviour

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The Arizona State University Observation Instrument (ASUOI) has been used in research into coach bevaviour for over 25 years (Lacy and Darst, 1984). The ASUOI allows the frequency, duration and intensity of 14 named coaching behaviours to be determined. However, these descriptive results do not include important details of temporal patterns in coach behaviour. Therefore, the purpose of the current investigation was to analyse data gathered using a computerized implementation of the ASUOI with respect to temporal patterns. The computerized system was implemented in Focus X2 (Elite Sports Analysis, Delgaty Bay, Fife, Scotland, UK) and applied to a netball coach who was observed during 4 coaching sessions for a total of 3 hours 30 minutes. The system had a good level of inter-observer reliability (κ = 0.651). A chi square test of independence was used to determine whether coaching bevaviour was independent of the previous coach behavior performed. It was necessary to use a subset of behaviours from the ASUOI in order to satisfy the assumptions of the chi square test as shown in Table 1. There was a significant influence of previous behavior on the behavior of the coach (χ^2_{25} = 184.7, p < 0.001) with four behaviours followed by further instances of those behaviours more than expected (concurrent instruction, praise, pre-instruction and questioning). Other temporal patterns were that pre-instruction was followed by management, concurrent instruction was followed by praise and management was followed by pre-instruction more than expected. In addition to this quantitative analysis of coaching behaviours at the event level, qualitative analysis of video sequences revealed that there was a broad temporal structure to the training sessions. This type of analysis for coaching data in other sports may reveal chains of pairs of behaviours as well as cycles of behaviours. This additional information is an enhancement to the ASUOI which to date has been limited to a static analysis of behavior.

Table 1. Frequency of coaching behaviours.

Previous behavior	Behaviour						
	Concurrent instruction	Management	Post-instruction	Praise	Pre-instruction	Questionning	Total
Concurrent instr	80 (39.0%)	15 (7.3%)	7 (3.4%)	73 (35.6%)	14 (6.8%)	16 (7.8%)	205
Management	11 (14.7%)	10 (13.3%)	7 (9.3%)	13 (17.3%)	18 (24.0%)	16 (21.3%)	75
Post instr	10 (27.0%)	3 (8.1%)	2 (5.4%)	6 (16.2%)	8 (21.6%)	8 (21.6%)	37
Praise	59 (33.3%)	14 (7.9%)	11 (6.2%)	64 (36.2%)	9 (5.1%)	20 (11.3%)	177
Pre-instruction	25 (29.8%)	17 (20.2%)	1 (1.2%)	8 (9.5%)	26 (31.0%)	7 (8.3%)	84
Questionning	20 (17.4%)	17 (14.8%)	9 (7.8%)	13 (11.3%)	9 (7.8%)	47 (40.9%)	115
Total	205 (29.6%)	76 (11.0%)	37 (5.3%)	177 (25.5%)	84 (12.1%)	114 (16.5%)	693

Lacy, A.C. & Darst, P.W. (1984) Evolution of a systematic observation system: The ASU coaching observation instrument. *Journal of Teaching in Physical Education,* 3: 59-66.

POST 1.3.2

Pedagogical supervision in swimming: The influence of retrospective reflection in technical behaviours of coaches' performances

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The purpose of this investigation was to verify the existence of behaviour changes on the coaches, in swimming trainings, after the retrospective reflection that takes place after the first and after the second lessons, of swimming practice.

Our sample was constituted by 6 (six) individuals, 4 (four) from the male gender and other 2 (two) from the female gender. Of these 6 (six) individuals, 3 (three) are graduated teachers, and the other 3 (three) are academical students of Swimming High Performance Training. It was used the S.O.P (professor observation system from Pieron M., 1988).

The variables that we studied became separated in two groups: (Independents) the variables that characterize the teaching agents: Gender, Age, Academical Graduating, Service Experience (in years) and Training Graduating and the variables (dependents) of the behaviours exhibit: Instruction, Feed-back, Organization, Positive Affection, Negative Affection, Students Verbal Interventions, Observation and Other Behaviours.

For the statistical comparison among the defined subgroups, we used two non-parametric tests: the Wilcoxon test that allows us to compare the same behaviours between the first and second trainings of each subgroup; and the evidence "U" of Mann Withney that allows us to compare the same behaviours between the first trainings of each subgroup, and also allows us to compare the same behaviours between the second trainings of each subgroup.

We didn't find any significant differences in any behaviour from de analysis and comparison of the subgroups; however, we verify significant differences in the Instruction and Organization behaviours between the first and second trainings comparatively to the global sample.

Pieron, Maurice (1988) *Para una Enseñanza Eficaz de las Actividades Fisico-Desportivas*. INDE Publicaciones: Barcelona, Espana.

POST 1.3.3
Behaviour of academy soccer coaches during training sessions

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The Arizona State University Observation Instrument (ASUOI) was implemented in Focus X2 (Elite sports analysis, Delgaty Bay, Fife, Scotland) and a reliability study revealed a good strength of inter-operator agreement (k = 0.712). A set of 7 coaches were observed during 3-4 training sessions each which lasted 40-93 minutes using the ASUOI with the results being shown in Table 1. The sessions performed by each coach were compared using chi square tests of independence with the 15 behavioural categories condensed to 6 broader categories in order for the data to satisfy the assumption of at least 5% of observation time being accounted for by at least 80% of the cells of each cross-tabulation. The most common behaviour for all coaches was silent monitoring. There were different distributions of session time shown by the 7 coaches which may be explained by the differences in coach qualification, the age of players being coached and the purpose of the sessions being conducted. There was a general tendency for the A Licence coaches to have a greater variability in behaviour between sessions than the C License coaches. This may reflect higher qualified coaches being able to adapt behaviour to different situation encountered in coaching with lower qualified coaches tending to use a more "by the book" approach. This agrees with a similar finding found for netball coaches of different levels (Donnelly & O'Donoghue, 2008).

Reference: Donnelly, C. & O'Donoghue, P.G. (2008) Behaviour of netball coaches of different levels. In *Performance Analysis of Sport VIII* (Edited by Hokelmann, A. and Brummond, M.), 743-749.

Table 1. Percentage of time spent performing each behaviour (mean+SD).

Coach / player detail	Coach						
	A1	A2	B1	B2	B3	C1	C2
Licence level	A	A	B	B	B	C	C
Age of players	U15	U16	U9	U11	U14	U16	U13
Behaviour							
Concurrent	8.1±2.1	7.3±0.8	7.3±1.2	6.2±1.3	7.1±3.9	12.4±2.0	5.5±0.9
Humour	0.4±0.2	0.8±0.3	0.1±0.1	1.3±0.7	0.0±0.0	0.5±0.4	0.2±0.1
Hustle	1.5±0.9	0.8±0.2	4.8±0.8	2.5±0.3	2.7±2.0	3.1±1.2	1.9±1.3
Management	16.2±2.2	1.7±0.9	23±5.3	18.3±3.9	1.3±0.8	1.6±1.7	24.0±2.3
Negative Modelling	0.1±0.2	0.1±0.1	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.3±0.2
Physical Assistance	0.0±0.0	0.3±0.3	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0	0.0±0.0
Positive Modelling	1.5±1.0	1.0±0.3	1.1±0.5	3.9±0.6	0.2±0.2	0.3±0.3	1.8±1.3
Post Instruction	7.8±4.8	3.5±2.1	6.1±1.9	3.0±1.0	3.7±5.0	2.6±1.8	4.2±3.5
Praise	8.5±2.1	5.6±0.8	9.5±0.9	8.4±1.3	3.8±1.6	7.5±1.2	5.6±0.2
Pre Instruction	6.6±2.3	9.6±4.0	14.7±0.9	11.8±4.6	11.0±9.5	5.0±2.4	10.2±0.8
Questioning	2.1±1.2	3.2±2.1	1.5±0.6	7.6±2.0	3.2±2.4	0.3±0.3	1.1±0.5
Scold	0.0±0.1	0.6±0.3	0.4±0.4	0.1±0.1	0.8±0.7	0.6±0.5	0.3±0.2
Silence	44±5.3	51.3±14.4	29.3±2.8	29.3±3.7	63.2±10.2	62.2±3.1	41.1±5.2
Talk to coach	1.5±1.2	0.0±0.0	1.1±1.2	4.7±1.9	0.0±0.0	0.0±0.0	0.2±0.1
Uncodable	1.5±1.3	14.2±17.3	1.0±0.3	3.0±1.4	2.9±3.1	3.8±2.3	3.5±2.1
Total	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0
Inter-session statistics							
χ^2	16.5	103.8	6.3	15.9	64.7	10.9	15.7
DF	10	10	15	15	10	10	15
P	0.086	<.001	0.974	0.390	<.001	0.364	0.402

POST 1.3.4

The art of sports officiating: Learning how to referee rugby union

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There has been an abundance of coach education programs developed in many countries around the world with a core purpose of assisting the beginning coach to carry out his or her duties as effectively as possible. Previous research has detailed how coaches' experiences at education courses, previous playing experience and watching other coaches all inform how they develop as coaches themselves (Bloom et al., 1998; Cushion, Armour, & Jones, 2003; Gilbert & Trudel, 2001; Lyle, 2002; Salmela, 1995). To date little research has focused on refereeing experiences and how match officials learn to officiate.

This research sought to explore the different learning situations with which semi-elite rugby union referees in Australia learn to officiate. Twenty-five semi-elite rugby union referees from 5 associations across the states of New South Wales, Queensland and Victoria in Australia participated in this study.

Referees were interviewed individually using a semi-structured approach. Questions asked of the rugby union referees included their experiences of the formal face to face education courses they attended; how their learning has now continued outside of the classroom and how their learning may have started prior to the course, such as when they themselves were young athletes playing rugby union.

Data analysis of the first part of the interview consisted of statistical questions including years refereed, number of years as a player, level of accreditation, when attained, when it was last updated. These were entered into a spreadsheet for descriptive statistical tests. The next part of the analysis involved more in-depth questioning surrounding the referees learning opportunities and how these have assisted their overall development as a rugby union referee. These responses were transcribed verbatim for analysis using Nvivo 9.

The results revealed that for these semi-elite rugby union referees there were many ways with which they developed and learned their refereeing art. Education programs, monthly and annual seminars, mentoring by senior referees and their own personal experiences are all just a few ways which these referees have learnt to be rugby union referees. Results suggest further analysis and the broadening of officiating programs need be considered.

Bloom, G. A., Durand-Bush, N., Schinke, R. J., & Salmela, J. H. (1998). The importance of mentoring in the development of coaches and athletes. *International Journal of Sport Psychology, 29*, 267-281.

Cushion, C. J., Armour, K. M., & Jones, R. L. (2003). Coach education and continuing professional development: experience and learning to coach. *Quest, 55*, 215-230.

Gilbert, W., & Trudel, P. (2001). Learning to coach through experience: reflection in model youth sport coaches. *Journal of Teaching in Physical Education, 21*, 16-34.

Lyle, J. (2002). *Sports coaching concepts: a framework for coaches' behaviour*. London: Routledge.

Salmela, J. H. (1995). Learning from the development of expert coaches. *Coaching and Sport Science Journal, 2*(2), 3-13.

POST 1.3.5
Path to excellence: A case study with an elite basketball player

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The aim of this study is to characterize the path and determine the elements, (training, psychological, and socio-cultural factors) moments and stages that are decisive in the development of elite athletes. The object of the study was the basketball player "Ticha" Penicheiro. Born in Figueira da Foz – Portugal, a country with modest basketball status, Ticha was still able to become a unique basketball player at worldwide level.

The case study was built upon an in-depth interview with the player, complemented with interviews with meaningful persons in different stages of her process. A comprehensive search of available data in the media was also conducted. Data were analyzed by means of deductive and inductive procedures of qualitative content analysis techniques.

The main conclusions point to the decisive importance of the social environment during her childhood, parental education and safety of the neighborhood. Psychological factors were identified: intrinsic motivation, willingness to sacrifice, adaptive perfectionism, calm and self-reliance. These are the basis of a strong competitive attitude, with great control over stress and anxiety. Humility, sports intelligence, professionalism, leadership skills and respect for the game are other features that stand out.

The volume of deliberate play and the specific way in which occurred constitute a decisive training factor that carved the athlete way of play. The distinct stages and characteristics of the deliberate practice were also decisive for the development of the skills aroused in her childhood. Constant individual success is considered crucial in the development of increased perceptions of competence and motivation.

POST 1.3.6
Functional advantages of informatization for realization of Olympic education

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The important constituent transition of Ukraine to the new level of functioning society is a necessity of effective introduction informative component in different spheres of activity (Aristova, 2000; Briskin & Pityn, 2011; Ermakov, 2006).

Informatization of physical culture and sport has the proper normative-lawful maintenance of different tendency (Aristova, 2000; Ermakov, 2006). At the same time a level of informatization in realization of Olympic education is insufficient; an introduction new methods of studies with application of modern informative-communicative technologies is slow; a level of informative representation of Ukraine in the Internet is subzero (Ermakov, 2006). In opinion a number of experts (Aristova, 2000; Briskin and Pityn, 2011; Ermakov, 2006) the stage of development informative society in Ukraine in comparison to world tendencies does not conform its potential and possibilities. The purpose of this study was to define peculiarities and advantages of informatization for Olympic education.

Informatization, that inherent on the modern stage evolution of society found the reflection in the scientific works of experts in different spheres. One of the promising directions introduction of modern technologies is informatization a sphere of physical culture and sport and in particular Olympic education (Aristova, 2000; Ermakov, 2006). It must be taken into account considerable educational potential of informative means. A wide discussion the pressing questions of using modern technologies acquired in pedagogy at consideration pressing aspects of education in various directions. At the same time the specialists in physical education and sport considerably rarer pay attention to potential of informatization in relation to Olympic education (Briskin & Pityn, 2011). Generalization of expert's opinions, structural-meaningful supplement allows to assert that functional advantages in relation to using informative means for the appropriate approach in development, introduction, directed use of informative-communicative technologies and informatization altogether, should be considered in such constituents: economic, advertisement organizational, productive, technological, informative, communicative, gnoseological, diagnostic, analytical, correction, world-view, orientation, developing, prognostic, pedagogic, hedonistic. Informatization has potential of constructive influence on reformation and improvement Olympic education and sphere of physical culture and sport in whole. In full range the unrealized are remained the wide spectrum of media technologies means, social communications, visualization and video products, WEB-technology and other.

Functional advantages of informatizational means before traditional in sphere of physical culture and sport will be realized in next constituents: economic, advertisement organizational, productive, technological, communicative, gnoseological, prognostic and other. Informatization as complete process has potential of structural influence on reformation and improvement the system of athletic education and sphere of physical culture and sport altogether.

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Briskin Y.A., Pityn M.P. (2011) Problems of Olympic education in general education. *Physical Culture, Sport and Health of the Nation*, 1(12): 13-17.

Ermakov S.S. (2006) Scientific information aspects of physical education. *Current Physical Education*, Kharkov: 3-6.

POST 1.4: SYSTEMS

POST 1.4.1
Use of barcode scanning for notational analysis

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Bias and subjectivity are barriers to sound development of training and competitive performance. Conversely, notational analysis represents a powerful means for sport development. Given the variety in sporting situations, viewpoints of coaches and trainers and club budgets, a range of notational techniques is required.

We have been developing use of barcode readers as an inexpensive and effective means of notation. Small barcode readers (32 x 62 x 16 mm, Opticon 2001) have been found from extensive testing to be a highly reliable means of recording barcoded information. Time (to the nearest second) and date are also recorded along with the barcode, allowing monitoring of both events and their temporal sequence. The barcode reader's flash ROM of 512kbyte can store over 15000 barcodes, including time stamps. Barcode fonts are available as free downloads from the Internet. Barcodes for events are laid out on customised sheets that enable spatially congruent scanning of events. Data files are subsequently downloaded from scanner to computer via a USB interface and the data processed using spreadsheet software. After quite modest practice, we have reliably used barcode scanning to record, in real-time, up to 1000 match events in 38 categories over the course of a football match. Under normal conditions the scanner failed to read 0.86% of barcodes. Use of scanning in combination with video recording has enabled both the checking of more difficult judgments and iterative notation of martial arts for which real-time scanning is not feasible. In this respect characteristics of game-play can be profiled, providing a timeline of the dynamic interactions that outline strategic implementation in relation to tactics, shot selection and subsequent scoring potential. The details of data collection and processing will be presented.

POST 1.4.2
An analysis of navigation patterns in rowing

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The effect of weather and environmental conditions on sports has been extensively studied over the last few years (Pezzoli et al., 2010). Based upon the studies of Lobozewicz (1981) and of Kay and Vamplew (2002), Pezzoli and Cristofori (2008) have studied the impact of some specific environmental parameters over different sports using a particular impact index divided into five classes. This analysis clearly shows that most of the outdoor sport activities are strongly influenced by the variation of meteorological parameters. However the impact of meteorological conditions on outdoor sport activities has not yet been extensively studied.

The aim of this research is to show that an accurate assessment of wind and wave parameters enables decisive improvements in both training and race strategy planning. Furthermore this analysis provide a very innovative working method for the applied sport research.

The work has been based on in-situ measurements of both environmental and performance parameters (wind direction, wind velocity, boat speed and stroke rate) made over different classes and in different race conditions during the 2009 FISA World Championship (Poznan, Poland). In particular a detailed environmental analysis was performed by measuring the wind direction, the wind speed and by evaluating the significant wave height and the wave peak period for each class during the semi-final phase and the final phase. It should be noted that, since wind is a key parameter affecting not only the boat speed but also the race strategy, the assessment of the wind velocity and of the wind direction has been made in connection with the boat movement.

The comparison between coupled wind-wave data, boat speed and stroke rate evidently demonstrates that only crews that managed the adaption to changing in the environmental conditions from semi-final to final phase of the race, were able to get better results.

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Pezzoli, A,, Moncalero, M., Boscolo, A., Cristofori, E., Giacometto, F., Gastaldi, S., & Vercelli, G. (2010) The meteo-hydrological analysis and the sport performance: which are the connections? The case of the XXI Winter Olympic Games, Vancouver 2010. *Journal of Sports Medicine and Physical Fitness*, 50: 19-20.

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POST 1.4.3
Predicting sports results using regression and neural models

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The investigation was aimed at comparing regression and neural models with respect to their accuracy of predicting sports results (Murakami et al., 2005). The presented study involved a group of 146 javelin throwers, aged 18⊡0.5 years. The statistical analysis was initially done by the Shapiro-Wilk normality test and by the homogeneity test (Leaven criterion). All variables presented normal distribution and homogeneity. Correlation matrix and analysis of regression revealed four predictors (cross step, specific power of the arms and the trunk, specific power of the abdominal muscles and the grip power).Then, non-linear regression models as well as neural models were built (Maier et al., 2000). Thus, to verify models, the sports results were predicted for the group of 20 javelin throwers from the Polish National Team (age 18-19 years old) in May 2010 and tested in May 2011 by comparing the models-generated predictions (May 2010) with the actual results achieved by the same javelin throwers (average of three throws after 30 min. warm up).

The non-linear regression models (*R2=0.871*) and perceptron networks structured as 4-3-1 (*NRMSE-learning:0.224, validation:0.233* and *test series:0.218*), demonstrated their capacity for making generalization and predicting sports results. What's more the difference in the absolute errors values was 10.54m (between true and estimated performances in verification group of 20 Polish javelin throwers), favoring the neural models.

The neural model had better goodness of fit for athletes achieving medium or weak results. The negative total error of the network indicates that the model makes larger errors in athletes who throw the javelin further. The analysis of the above data clearly shows that the neural model better predicts sports results than the regression model, confirming also the Bartlett et al. findings (1996), whose neural models provided predictions of better quality than the multiple regression models. Murakami et al. (2005) indirectly proved that neural models are capable of better predictions than nonlinear or linear regression models. Therefore, the investigation demonstrated a significantly greater accuracy of prediction for the perceptron models.

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Maier, K., Wank, V., Bartonietz, K. & Blickham, R. (2000) Neural network based models of javelin flight. Prediction of flight distances and optimal release parameters. *Sports Engineering*, 3: 57-63.

Murakami, M., Tanabe, S., Ishikawa, M., Isolehto, J., Komi, V. & Ito, A. (2005) Biomechanical analysis of the javelin throwing at 11th World Championships in Athletics in Helsinki. *New Studies in Athletics*, 4: 11-21.

POST 1.4.4

Comparing results of biomechanical analyses of raw data determined using AutoCAD software with those determined by AutoMatlab software for a number of athletic performances

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Biomechanics is concerned with the multiple and complicated gymnastic moves .The development in performing these moves stemmed from the development of analysis, clarification, correction, and study of the subtle movements while recognizing the degree of relation between the biomechanical variables to perform any of the moves and their relation to balance either in the beginning , end , or during the move. The study aimed at determining the relation between dynamic and static balance with a number of biomechanical variables for gymnastic performers at the age category of (5-8) years old .The descriptive method was used in the study using objective analysis based on video streaming in order to determine some biomechanical values during when the player is positioned on his arms upside down on the matt . The researchers also tested the static and dynamic balance for boys of this age by dividing the upside down position on arms into: the first position   (backwards while slightly lifting the hip of the floor), and the second which is the upper position (the hip is lifted from the ground) as the hip is the center of gravity in these positions. The two positions were further divided into two stages in which the first stage starts with complete extension of the body to the flex in the hip joint while the second stage starts from the flex of the hip joint to the extension of the hip joint .The researchers concluded a significant correlation between the static and dynamic balance with open eyes while the correlation was non-significant between the two types of balance with the angles of body joints (ankle , knee , and hip joints) .

POST 1.4.5
The use of taxonomic tools to analyse national team ice hockey game play

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The term situation occurs in sports games in various forms, including match situations, game situations, power play situations, short-handed situations and situations with the same number of players, potentially advantageous or disadvantageous game situations [1]. Nowadays there is a necessity to apply the multidimensional analyses in sport sciences.

The material for the investigation was a group of 16 elite national ice hockey teams from the World Championship in Canada 2010. Conducted research were of an empiric and exploration character. Multidimensional scaling methods and cluster analysis are applicable to the analysis of the game national ice hockey teams, because distance measures can be obtained in any number of ways.

The analysis confirmed striking similarity in both defensive and offensive game of particular teams in the lead. The analysis showed big similarities in play of European teams, who play hard, dynamic and tactical hockey. Very big similarities were also observed in the case of Russia and Czech Republic. In the past, European team based their play on focusing on good, strong form, whereas their play today is much like Canadian teams', who play dynamic, technical and hard combination hockey, where shooting the puck is attempted from any possible situation. *Conclusions.* On the basis of the conducted measurements and calculations it can be concluded that multi dimensional exploration techniques can be helpful in the process of the analysis of the game of National Teams in ice hockey.

POST 1.4.6
Feedback technology in performance analysis

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The use of feedback within sport has been discussed by many and is widely accepted that for athletes, especially those at the elite level, to continually perform at the highest level, appropriate and accurate feedback must be provided (Bartlett, 2001; Hughes & Franks, 2004). Coaches understand their limits in recalling accurate information about performances, and strive for the most efficient and valuable sources of information regarding performance to assist (Jenkins *et al.*, 2007). Technology available has greatly influenced the provision of performance analysis and the opportunities for coaches to provide feedback within their coaching process. Admittedly there are some sports where the use of such assistive technology is prohibited, as it is deemed to impinge the rules that govern the sport; however many have embraced technology and are now at the cutting edge with research, design and workflow integration. We have already seen such integration into officiating of some sports, where officials can access visual replays to assist with their decisions, i.e Hawkeye in Cricket and Tennis.

Technologies available for feedback within sport have been explored by many researchers (Liebermann et al., 2002). With the use of technology within sport science more prevalent than ever before, it has influenced the type, timing and manner in which feedback is available to coaches and athletes today (Baca, 2006). With the most significant impact affecting the provision of 'real-time' feedback, where valuable coach driven information collated on performance can be output during a game, so feedback can be optimized. It is now possible to give real-time/immediate feedback via a number of different mediums using wireless networks and handheld peripheral devices. This paper will explore the technologies, peripherals and applications available to the modern day performance analyst and coach in their task in the provision of feedback to their athletes.

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Bartlett, R.M. (2001) Performance analysis: can bringing together biomechanics and notational analysis benefit coaches? *International Journal of Performance Analysis in Sport*, 1, 122-126.

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POST 1.4.7
Analysis of the factors of yield in professional basketball applied to an ACB equipment

Marcelo Alejandro Jove Tossi, Maria del Mar Silvestre García, Alfonso Penichet Tomás, Jose Manuel Jimenez Olmedo, Eliseo Cabrera Andreu, Concepción Suarez Llorca, Federico Carreres Ponsoda, Carbonell Martínez & Antonio Jose

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The recent research was conducted in a professional basketball team in the league ACB. Data were collected during the 2009-2010 season. The objective is to understand the relationship between anthropometric parameters and performance in a specific test of fitness for post game.We analyzed 12 professional basketball players, separate bases, Eaves and Pivots to check your progress on anthropometric parameters and specific fitness test.The average muscle mass percentage was 41.1 ± 2.1, the initial step, and 40.9 ± 1.8 in the final measurement. The percentage of fat mass media was 11.5 ± 3.5, in taking off, and the percentage of fat mass media, in the final shot, was 15.9 ± 5.4. Looking for post game, we see that The foundations were 43.6 ± 1.9% of muscle mass, the eaves, 41.7 ± 0.8% and 39.6 ± 1.0% pivots 12.39 ± 0.3% body fat, the eaves, 15.39 ± 4.2% and pivots 17.97 ± 6.7%. The specific test of fitness, the average maximum heart rate of the bases in the pretest and post test was 198 ± 1 pulses, the average was 191.6 ± 5 forwards in the pretest and 192.6 ± 6 in the post test and 196.2 ± 195.6 ± 2 and 3 respectively in the pivots.The results obtained in this research allows us to state that lost percentage of muscle mass and that the final values for the percentage of fat mass, are significantly higher in the posttest than in the pretest. As for heart rate differences were not significant.Therefore, the intervention plan carried out, can not be correct. Also, this could indicate that the end of the season players are in their best athleticism in their muscle definition. However, this does not mean it's the best state, in general, to achieve victory in a sport as complex as basketball where evidently involved a number of factors including technical, tactical, psychological, physical, and chance).

POST 1.4.8
Using kinematic measures to predict post flight time in the women's artistic gymnastics straight twisting Yurchenko vault

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The aim of this study was to investigate kinematic parameters of the Yurchenko vault in elite level competition. The Yurchenko vault is made of a run up, round off entry onto the spring board, back flick onto the vaulting table and at least one and a half somersault rotations before landing on the feet (FIG Code of Points, 2009-2012). Sands and McNeal (1995) stated that gymnasts may profit from further real-time analyses of kinematic parameters of the Yurchenko vault for implementation in training. The aim of this study was to predict optimal performance of the Yurchenko vault based upon data from the 2011 Women's Artistic Gymnastics World Championships.

Eighteen of the best scoring Yurchenko vaults from the 2011 Women's Artistic Gymnastics World Championships were digitised using Quintic Biomechanics software (9.03v.17) to compute temporal and kinematic components of performance using the hip as Centre of Mass estimate and video captured at 25fps. Data analysis was completed in SPSS version 17, IBM. This competition included Yurchenko variations of one and a half twists, two twists and two and a half twists in the straight layout somersault position.

Correlations between post flight duration and horizontal velocity at board take off and vertical velocity at horse takeoff were positive, significant and strong (horizontal $r=0.79$ $p<0.01$, vertical $r=0.89$ $p<0.01$). There were no significant correlations between post-flight time and body angles during vaulting table contact, contrary to previous findings by (Koh & Jennings, 2007; Uzunov, 2010). However, this may be due to the variance of characteristics of the gymnasts analysed. Checks for multicollinearity of the data found no issues and so stepwise multiple regression models were developed to predict post flight time using horizontal velocity at spring board take off and vertical velocity at vaulting table take off. The first model used only vertical velocity at vaulting table take off and accounted for 79.9% of the variance in post flight time (adjusted $r^2 = 0.799$). The inclusion of horizontal velocity at board take off resulted in an additional 9.4% of the variance explained ($\Delta r^2 = 0.94$). The final model consequently significantly improves the ability to predict post flight time in this sample and explains 87.9% of the variance (adjusted $r^2 = 0.879$, $F_{2,15} = 62.647$, $p = <.001$).

The findings of this study in relation to vertical velocity at vaulting table take off concurs with those of Koh et al., (2003) and thus extends the conclusion of existing literature to recent elite level competition.

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Non-linear methods to analyze variability of indoor pedaling kinematics
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Recent empirical studies of cyclical human motion, which were focused on walking and running, have revealed fluctuations with interesting structures during a stable motion, even under constant environmental conditions. These fluctuations, also known as variability, which is defined by the amount of variation and its structure, contain important information useful to characterize mature motor skills and healthy states. Such fluctuations have been used to determine disease severity, medication utility, and fall risk (Barlett et al, 2007). Lack or excess of variability are understood as a deficiency in motor skills. Analysis of kinematic variability using non-linear tools has not been reported for pedaling. Leg motion data was recorded in two different devices: (1) during pedaling using a bike simulator and (2) during walking using a motorized treadmill. For the bike simulator, four tests were done with different cadences (80 and 100 rpm) and pedal break forces (120 and 140 Newton, configurable on the simulator). The power average is indicated in Watts. For the treadmill device, four tests were done with three different speeds forces (3, 4 and 5 km/h, configurable on the treadmill). The x-coordinate of the sagital plane of the knee motion and the angle formed by knee joint were used as variables for all tests. Variability has been associated with invariant characteristics of dynamical systems such as the maximal Lyapunov exponent and the correlation dimension. Surrogate data is used to test that the hypothesis that irregularity of the data is most likely due to non-linear determinism rather than random inputs.

Table 1: Maximal Lyapunov exponent Λ and correlation dimension D_2 of pedaling data

Variable\ Test	140N 100 rpm (218 W)		120N 100 rpm (187 W)		140N 80 rpm (176 W)		120N 80 rpm (150 W)	
	Λ	D_2	Λ	D_2	Λ	D_2	Λ	D_2
knee angle	0.0022 ± 0.0003	1.0929 ± 0.0167	0.0021 ± 0.0001	1.1171 ± 0.0207	0.0023 ± 0.0000	1.1365 ± 0.0074	0.0025 ± 0.0002	1.0935 ± 0.0179
knee x-coordinate	0.0021 ± 0.0002	1.0965 ± 0.0275	0.0021 ±0.0002	1.1443 ± 0.0309	0.0020 ± 0.0001	1.0762 ± 0.0103	0.0025 ± 0.0001	1.0822 ± 0.0124
knee angle (surrogate)	0.0016 ± 0.0002	1.9941 ± 0.0548	0.0016 ± 0.0001	1.7736 ± 0.0709	0.0013 ± 0.0003	2.1593 ± 0.0898	0.0017 ± 0.0001	1.6964 ± 0.0844
knee x-coordinate (surrogate)	0.0015 ± 0.0004	2.1372 ± 0.1020	0.0019 ± 0.0010	2.0407 ± 0.1102	0.0021 ± 0.0008	2.2384 ± 0.1272	0.0014 ± 0.0004	1.9323 ± 0.1006

Table 2: Maximal Lyapunov exponent Λ and correlation dimension D_2 of gait data

Variable\ Test	140N 100 rpm (218 W)		120N 100 rpm (187 W)		140N 80 rpm (176 W)		120N 80 rpm (150 W)	
	Λ	D_2	Λ	D_2	Λ	D_2	Λ	D_2
knee angle	0.0022 ± 0.0003	1.0929 ± 0.0167	0.0021 ± 0.0001	1.1171 ± 0.0207	0.0023 ± 0.0000	1.1365 ± 0.0074	0.0025 ± 0.0002	1.0935 ± 0.0179
knee x-coordinate	0.0021 ± 0.0002	1.0965 ± 0.0275	0.0021 ±0.0002	1.1443 ± 0.0309	0.0020 ± 0.0001	1.0762 ± 0.0103	0.0025 ± 0.0001	1.0822 ± 0.0124
knee angle (surrogate)	0.0016 ± 0.0002	1.9941 ± 0.0548	0.0016 ± 0.0001	1.7736 ± 0.0709	0.0013 ± 0.0003	2.1593 ± 0.0898	0.0017 ± 0.0001	1.6964 ± 0.0844
knee x-coordinate (surrogate)	0.0015 ± 0.0004	2.1372 ± 0.1020	0.0019 ± 0.0010	2.0407 ± 0.1102	0.0021 ± 0.0008	2.2384 ± 0.1272	0.0014 ± 0.0004	1.9323 ± 0.1006

Positive Lyapunov exponents Λ validated against surrogate data confirmed the evidence of deterministic chaos in pedaling- and gait- motion. In table 1, it can be observed that Λ was even positive and it was significantly lower for phase randomized surrogate data. Furthermore, the correlation dimensions D_2 of surrogate data were larger than D_2 of original variables. On the other hand, there is no significant difference of Λ between tests made for pedaling motion. Additionally, for this motion D_2 was similar between knee variables for all tests. Comparisons between Tables 1 and 2 demonstrate that for gait motion Λ is lower, and D_2 is larger than the corresponding values of pedaling motion. Other invariants like the approximate entropy, Rényi entropies, and test for multifractality were calculated to illustrated further differences between test and type of motions.

POST 1.4.10
The accuracy of judging compared with objective computerised analysis in trampolining

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Five execution judges are used in competitive trampolining to score performance. Athletes perform two routines of ten skills with each skill being judged by the five execution judges (Kunze *et al.*, 2009). With judging being performed in real time subjectivity can falsely deduct marks or miss an imperfect performance due to human error, perspective error or bias. Therefore, using an objective computer analysis system, a true reflection of performance can be measured (Hughes & Franks, 2004; Coalter *et al.,* 1998).

Thirteen competitors at a national competition were recorded, sagittal and frontal planes, to allow for routines to be evaluated. All participants were over the age of 18 and gave full informed consent. Judges' also gave consent to participate, however, the true purpose of the study was initially withheld. Judges' scores for each skill and routine were collected post event as to not influence or cause bias. Performance indicators were established via coaching manuals from British Gymnastics and the Code of Practice by the Federation Internationale de Gymnastique (FIG) (British Gymnastics, 2009a, b, c, d; Kunze *et al.*, 2009). Post event analysis was performed by a qualified judge using a statistical video analysis package (GameBreaker Plus, Sports Tec, New Zealand).

Results showed no significance difference (p=0.925) between judges' scoring and the post performance computer analysis of the final routine scores. However, the overall competition rankings differed between the judges and post event scores, with a discrepancy between 2nd and 3rd places. Kappa and percentage error scores demonstrated sound reliability of the analyest, 0.99 and 0.1% respectively (Hughes & Franks, 2004; McGinn *et al*., 2004)

To conclude, the current judging system is an accurate method of scoring competitions. However, post analysis of the judges' marks revealed many arithmetic errors showing limitations to the method from human error when analysing in real time. Therefore, aiding judgeing with the addition of computerised methods could increase accuracy. Further research is needed to investigate the reliability of judging panels at competitions to check it is within the limits set by the FIG.

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POST 1.5: SPORT SCIENCE AND MEDICINE

POST 1.5.1
A comparison of lower limb strength and static balance in elite gymnasts and wrestlers with non-athletes

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The purpose of this study was to compare centre of gravity deviance to difference surface in adolescent male elite gymnasts and wrestlers with non-athletes. Subjects were asked to maintain balance in four standing postures: standing with open eyes, standing with close eyes; standing with right leg and standing with left leg. Quadriceps muscle and posterior muscle legs strength collected with dynamometer.

The results shows; there is significant difference static balance in standing one leg (left) in end tasks (P<0.01).There are no significant difference the static balance in other tasks. Posterior muscle legs strength in elite athletes was significant difference with non- athlete. There is no significant difference in quadriceps muscle strength (P > 0.05). Gymnasts can decrease anterior- posterior (A / P) and medial – lateral (M / L) Deviance on one leg to use vision feedback and proprioceptor. We concluded that gymnasts are able to use the remaining sensory modalities to compensate for in unstable postures.

POST 1.5.2
The relationships between physical readiness and cardiovascular risk factors

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Recent studies have shown that muscular and aerobic fitness are independently associated with cardiovascular risk. Whether the protective effect of physical fitness could be ascribed dominantly to its impact on overweight and obesity remained to be investigated. The aim of this study was to investigate the relations between muscular and cardio-respiratory fitness tests and cardiovascular risks in younger and middle age adults. The subject sample consisted of 279 members of the Croatian Armed Forces, aged between 19 and 42 years (29 ± 5,6 years). Physical readiness was assessed through Army Physical Fitness Test (APFT) and 2 additional tests covering muscular and aerobic endurance. Maximal aerobic test was performed on a treadmill (Cosmed, Italy) and relative oxygen uptake and maximum speed obtained on the treadmill, were used to estimate the aerobic endurance. Height, weight and three skin folds were measured following standardized procedures. The body mass index (BMI) was calculated and fat percentage (%BF) was assessed by the anthropometric method (Jackson and Pollock, 1988). Blood pressure, fasting plasma glucose (BGL), total cholesterol (TC), low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides (TG), fibrinogen (FBG) and uric acid (UA) were measured. Factor analysis was used for determining the structure of the physical readiness and testing the factor validity of the tests used in the research. The Pearson correlations were used, to analyze the relations between physical readiness tests and risk indicators. Significant negative correlations with the general physical readiness factor were found for age, BMI, %BF, BP, TC, LDL, TC/HDL, triglycerides, UA, and fibrinogen. After adjustment for age, BMI and %BF, significant correlations with the general physical readiness factor persisted for TC, TC/HDL and TG were found.

Biological markers in the pre-competition and competition phases of triathlon

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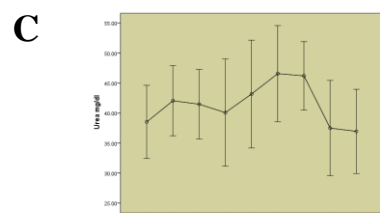
[1]*Faculty of Sport Organization, UANL, Nuevo León, México;* [2]*Faculty of Medicine, UANL, Nuevo León, México*

A

B

C
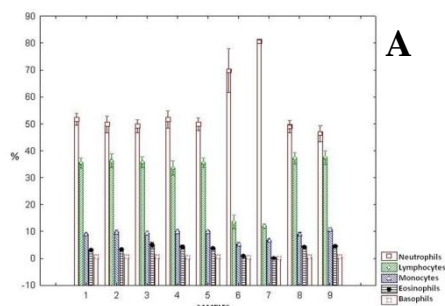
The physiological effects induced by the training process can be assessed by biological markers, which can be used for monitoring workloads in training to power up sport performance. In the present study the creatine kinase, urea and immune response behavior was analyzed, during the precompetitive and competitive phases of a master category triathlon team in Monterrey, Mexico, with the main objective of establishing the biological standards for our Mexican athletes and with this to develop personalized training programs in order to accomplish better results in this particular sport.
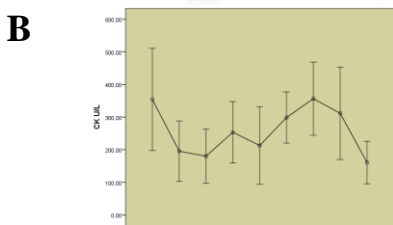
The sample was composed of twelve male athletes (age M=36.41, SD=5.51; height M=179.33 cm, SD=8.02; weight M=81.84 Kg, SD=10.97; Body mass index M=25.25 Kg/m^2, SD=1.11), the athletes participation was voluntary with a consent letter. Total blood and serum samples were taken, for the quantification of neutrophils, eosinophils, basophils, lymphocytes and monocytes and also for creatine kinase and urea. The samples were taken weekly in the first hour before the athlete started the physical activity during five weeks in the precompetitive training (samples 1-5), during the competition the samples were taken in the next order: immediately after de competition (sample 6), two hours after the competition (sample 7), 48 hours after competition (sample 8) and one week after the competition when the triathletes performed soft physical activity, for recovery (sample 9).

During the training period a constant concentration of urea and the analyzed cells (neutrophils, eosinophils, basophils, lymphocytes and monocytes) (fig. A and D); and for creatine kinase a concentration increase was observed in the samples 1 and 4 because the athletes had an important physical wear due to the increase of the training intensity in their preparation process for competition. All the variables analyzed in the study presented a high significance difference (P<0.1) among the samples; the creatine kinase, urea and neutrophils during the post competition phase (samples 6 and 7) showed a high significant value followed by a return to normal level values in sample 8 and 9 (fig. A, B, and C). The lymphocytes, eosinophils, monocytes and basophils showed a contrary behavior to what mentioned before, when the triathlon competition was over, the concentration of the analyzed cells diminished on a high significance way, and it recovered in the week after competition (fig. A). The creatine kinase, urea and immune response values reflected changes after performing an exhausting physical activity followed by a recovery to basal values after a week period, which represents an elevation or diminishment towards the physiological boundaries of training. It is important to point that the results presented in this study were an average; however it is also important to mention that in individual way each athlete showed a different response to training, concluding that an integral and personal physical preparation is strictly necessary in this discipline to avoid any overtraining risk, muscle skeletal injuries and myocardial damage.

POST 1.5.4

Effect of aging on lung function induced by regular physical activity

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Background: The maximum lung function for human being reached around the age of 20-25 years. Studies on lung function indicated a progressive age-related functional change of the respiratory physiology. Regular physical activity throughout the life may delay this deterioration of lung function.

Objective of the study: The present study was designed to observe the effect of aging on lung function in relation to regular physical activity.

Methods: Respiratory function was tested by digital spirometry. 500 persons (Male: 250 and Female: 250) ages between 20-70 yrs were examined at the departmental laboratory, Jadavpur University, Kolkata. 20 persons were excluded from the study due to acute or chronic respiratory disorders. All the subject were allotted in the five age category (20-29 yrs; 30-39 yrs; 40-49 yrs; 50-59 yrs and 60-70 yrs) to observe the age related changes between the trained (Male: 120 and Female:120) and untrained persons. Mean, Standard deviation and 't' test were done to calculate the statistical significance and made a valid conclusion.

Result: A slow progressive age related decline were observed in trained group compared to untrained in all the age category for both male and female.

Conclusion: From the above study it can be concluded that regular physical activity may delay the age related decline of lung function for all the age groups and promote healthy aging.

POST 1.5.5

Oral contraceptive cycle phase has no effect on fuel oxidation during prolonged exercise in female recreational endurance-trained rowers

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It is apparent that oral contraceptive (OC) use is becoming more prevalent in athletes (Rechichi et al., 2009). During the active pill (AP) phase of the OC cycle endogenous female hormones are suppressed and general hormonal milieu is stable. However, exogenous hormone concentrations decrease and endogenous hormone levels may vary after AP phase of the OC use (Rechichi et al., 2008). Therefore, endogeneous sex hormones may have secondary effects on substrate metabolism (Rechichi, et al., 2009). Oestrogen has been linked to increased lipid and reduced carbohydrate oxidation during prolonged exercise, while progesterone may oppose the lipolytic effects of estrogen (D'Eon et al., 2002*)*. The aim of the present study was to examine the effects of AP and not active pill (NAP) phases of the OC cycle on substrate utilization and lactate level over 1-h submaximal rowing exercise in recreationally trained female rowers.

Eight female rowers (21.0±2.8 yrs; 173.4±4.3 cm; 69.6±13.6 kg; body fat: 26.6±2.3%; VO_2max: 45.9±5.7 ml/min/kg) using a monophasic oral contraceptive (OC) pills participated in this study.

Female rowers performed 1-h rowing ergometer test at the intensity of 70% VO_2max during the AP and NAP phases of the OC cycle.

No significant differences (p>0.05) were found in mean energy expenditure (EE), oxygen consumption, respiratory exchange ratio and heart rate during the endurance test at AP and NAP phases of the OC cycle. Mean EE rate, carbohydrate EE, lipid EE and blood lactate during the test were not different (p>0.05) among OC cycle phases.

The results of current study found no significant effect of OC cycle phase on substrate oxidation and blood lactate level during rowing exercise at slightly lower than 70% of VO_2max in recreationally endurance-trained rowers.

D'Eon, T.M., Sharoff, C., Chipkin, S.R., Grow, D., Ruby, B.C., & Braun, B. (2002) Regulation of exercise carbohydrate metabolism by estrogen and progesterone in women. *American Journal of Physiology*, 283: E1046-E1055.

Rechichi, C., Dawson, B., & Goodman, C. (2008) Oral contraceptive phase has no effect on endurance test. *International Journal of Sports Medicine*, 29: 277-281.

Rechichi, C., Dawson, B., & Goodman, C. (2009) athletic performance and the oral contraceptive. *International Journal of Sports Physiology and Performance*, 4: 151-162.

POST 1.5.6

The effect of corrective training on control and correction of tend to head to front in Islamic azad university Dezful branch personnel

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This study examine the effect of corrective training on control and correct of tend to head to front in Islamic azad university dezfoul branch man personnel. This study was semi-experimental and statistical society was 170 male from Islamic azad university dezfoul branch man personnel. Statistical sample included 30 ma personnel with tend to head to front that identified by New York test. Sample divided into two control and test groups (n=15). This study done per- post test. Training protocol done as 8 weeks and 3 session per week and 75 min per session. Test group divided into two groups. First group included those that scales of distance between auricle and plummet line was less than 2.5 cm and they nominated weak abnormality .second group included those that scales distance between auricle and plummet line was more than 2.5 cm and they nominated high abnormality. To information analysis was used the descriptive statistics and independent T and significant level was p=0/05%.the result with comparison between test and control groups showed that selected training head significant effect on tend to front abnormality. Also results showed that neural, vision and cardio respiratory systems and society manner being effective.

POST 1.5.7
A retrospective study of injuries in elite women windsurfers

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University of Alicante

This study was designed to identify the injuries of professional women windsurfers, from their anatomical location, type of sport, context when they occurred, type of injury, the time of inactivity as a result of the same, the type of health care received ant the relationship between the number of injuries and the position in the final classification of professional windsurfing competitions. We gave a retrospective questionnaire to 18 women elite windsurfers who took part in the Word Cup competition held in Fuenteventura (2008). Women are injured more frequently during training than competition (77.8%; $p<0.05$). Women suffer leg injuries more than men (83.3%; $p<0.05$) in freestyle. Serious injuries were more frequent for women (66.7%; $p<0.05$) and the time of inactivity due to the injury was shorter for women (50%; $p<0.05$). These results indicate that female windsurfers are more liable to suffer injuries, generally serious, during training sessions. Freestyle involves a greater risk of leg injuries for women. The knee is the area where most injuries occur, both for men and women, followed by the leg.

POST 1.5.8
Training based on testing results: Implications for performance and injury prevention

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Rugby game involves a wide range of physical qualities and for this reason is very important that training be based on relevant functional tests for this sport so that players can be prepared for the high physical demands of the game.

The study is aiming to demonstrate the importance of proper testing and adaptation of training in order to improve physical performance and decrease the risk of injury.

We conducted a 2 months study on a grup of 22 professional rugby players (age between 18 to 32 years). Before the start of a training camp and after two months of training, we avaluate explosive power of the lower limbs by performing the Counter movement jump test (using Myotest system, Switzerland) and Complex acoustic reaction test (using Optojump Next system, Italy). In order to identify any possible muscle imbalances between legs, we also tested one leg explosive power (using Optojump system).

Training comprised: strength training (once on 48 hours, 3-6 sets of 4-6 repetitions at 80-95% 1RM), aerobic training, field training, coordination and plyometric exercises.
Strength training considered the power differences between legs and aim balancing the power of the lower limbs, in order to increase the leg stability and performance, but also to decrease the sports injuries.

At the end of training, we noticed a significant improvement of the parameters presented in Table 1.

Differences of explosive power between right and left leg were reduced after only 2 months, from a mean difference of 0.48 W/kg to 0.28 W/kg.

Our results show that two months of proper exercise training, can significantly increase explosive power and force of the lower limbs. By emphasizing the strength training of the weaker leg, we can adjust the muscles imbalance and decrease the risk of sport injuries.

Table 1. The results obtained at baseline and after 2 months of exercise training.

Parameters	Baseline	After 2 months	P value
Complex reaction time (sec.)	1.345±0.06910	1.410±0.06404	<0.001
Explosive Power(W/Kg)	39.41 ± 6.998	46.36±8.399	0.009
Right leg Power(W/kg)	9.08±0.86	8.60±0.98	0.014
Left leg Power(W/kg)	10.05±1.17	9.77±1.15	0.235

Values are presented as mean ± standard deviation.

Analysis of the peak performance age in track and field

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The aim of this paper is to process and evaluate the peak performance age in athletics. The knowledge in this field of study plays an important role by long term planning in sport training theory. The object of this paper is analyzing the top world's championships (World Championship, European Championship and the Olympic Games) between years 1970 – 2007. Our study is based on status description using all three advisable methods (normative investigation, developmental survey and case study). During the data collecting procedure we have used both, the cross-sectional and longitudinal survey. Within our investigation we tried to answer questions concerned with significant features of the peak performance age, possibility to state the age accurately, and to monitor its progress. The needed information has been gathered from the official internet sites from each sport federation (national and international). The missing personal information was gathered from the championships, the International Olympic Committee, and personal site of each athlete. To trace back the older information we used the traditional resources. Our data set includes 6314 athletes in total (3474 men, 2840 women). Some of the events have binomial distribution which enables the accurate peak performance age identification. The peak performance age has slowly increased in sprint events, and slowly decreased in long distance runs. At present, the age for both sexes moves around 25 and 26 years (except the marathon race). In addition, in long distance races is found a big disproportion between European and World Championships. In 10 km long race is the difference of 4 years in average age! We believe that our results may be of benefit to the individual sport federations, trainers and athletes themselves in their long-term planning of their sport preparation.

POST 1.5.10
Physical ability tests for pregnant women participating in adapted gymnastics

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Gymnastics classes provide the most opportunity to work variable on different muscle groups in women with normal pregnancies (Kisselkova, 2006). The aim is to study some physical abilities by specific tests in women with normal pregnancy, practitioners adapted gymnastics.

10 normal pregnancy women (2nd & 3rd trimesters; informed consent; age 28.7±4.0 yrs; pre-pregnancy weight (PPW) 61.6±9.47 kg; study pregnancy weight (SPW) 68.5±9.35 kg, height 165.5±8.49 cm, BMI 25.0±3.05, length torso 57,7±2,75 cm) performed 2 groups tests consists of: flexibility test[in cm]-posterior thigh musculature (PTM), tilt right in chair sitting position (TRCSP), tilt left in chair sitting position (TLCSP); balance stability test [in s] - one arm one knee support (AKS), upright raised right leg (URRL), upright raised right leg (URLL).

Statistics data are presented in Table 1. Age, weight and BMI are in normal limits for such contingent. PPW and SPW differ significantly (p<0.01). It was found the following significant correlations: age with BMI; weight with length torso, TRCSP with TLCSP; AKS with URRL.

Age, weight and BMI are in normal limits for such contingent. When comparing these results with published our results (Nesheva et al., 2011) of another group of pregnant women are also practicing gymnastics were more pronounced difference in balance stability tests. The physical changes of pregnancy cause significant changes in balance, posture and locomotion. The validation of such tests is an important part of monitoring these changes during pregnancy.

Table 1 Descriptive statistics of test variables (Mean±SD)

Variables	PTM [cm]	TRCSP [cm]	TLCSP [cm]	AKS [s]	URRL [s]	URLL [s]
Mean	10,4	49,3	49,4	53,5	60,1	68,6
SD	4,90	3,53	3,87	35,48	27,51	24,86

Kisselkova, E. (2006) Physiological characteristics of sports sessions with women (in Human Physiology with Physiology of Sport). *Publ. House New Knowledge*, Sofia: 147-155.

Nesheva I., E. Pavlova, D. Fenerova, M. Georgiev (2011) Gymnastics program model and some physical ability tests in normal pregnancy females. V I Congress "People, Sport and Health", Saint-Petersburg, Russia. *Proc. Part 3, Section 6. Sport and Reproductive Health*: 367.

POST 1.5.11
The height of female Brazilian beach volleyball players in relation to specialization and court dimensions

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[4]Integrated Faculty of Ceara, Brazil

Rules changes made by the FIVB (Fédération Internationale de Volleyball) in 2001 (reduction of the court and new score system) have increased the duration of point rallies (Giatisis et al., 2003, 2005) and of game actions such as the attack (Giatsis et al., 2003). Analyzing FIVB World Tour players, Giatsis et al. found that after the changes the blockers and the defenders were significantly larger. The purpose of this paper was to analyze the effect of these rules changes in the height of Brazilian women beach volleyball players in relation to specialization.

The sample included the winners of Brazilian CBV (Brazilian Volleyball Confederation) in seasons 1991 to 2011; Tournaments in 9x9m court, n=20 players; Tournaments in 8x8m court, n=21 players). The winners were categorized in relation to court dimensions (9x9m court and 8x8m court) and to their specialization: defenders (DE), blockers (BL) and without any specialization (NS). Data was collected in 2011 from the official site of the Brazilian Volleyball Confederation (www.cbv.com.br). One-way Anova and Post-hoc Dunnett C tests were performed to find differences in the winners' height in relation to their specialization and the court dimensions.

The Post Hoc tests indicated significant differences ($F_{(5.48)}$ = 118. 43, p<0.001) between the DE_{9x9}, DE_{8x8}, BL_{9x9}, BL_{8x8}, NS_{9x9} and NS_{8x8} (see Table 1). These results show that, after reduction of the court dimensions (9x9 m to 8x8 m), the height of the defenders (M=1.68; M=1.71) and blockers (M=1.77; M=1.78) has increased significantly, while players without any specialization (M=1.77; M=1.73) significantly decreased. The results found support those found by Giatsis *et al*., (2011).

Table 1. Descriptive Statistics of the height in Defenders, Blockers and No specialization players in the 9x9 m and 8x8 m.

Specialization	Court (m)	N	Height (m)			
			M	SD	Minimum	Maximum
Defenders	9x9	7	1.68*	4.0	1.65	1.78
Blockers	9x9	7	1.77*	3.1	1.72	1.83
No Specialization	9x9	6	1.77*	2.3	1.72	1.80
Defenders	8x8	10	1.71*	4.5	1.65	1.80
Blockers	8x8	9	1.78*	2.7	1.68	1.91
No Specialization	8x8	2	1.73*	2.1	1.72	1.75

* Significant differences, p<0.001.

The present study found an increase of the height of the Brazilian women players after the rule changes; the height of the defenders increased an average of 0.03m and the height of the blockers increased an average of 0.01m.

Giatsis G. (2003) The effect of changing the rules on score fluctuation and match duration in the FIVB womens beach volleyball. *International Journal of Performance Analysis in Sport,*3: 57-64.

Giatsis G., Zetou E. & Tzetzis G. (2005) The effect of rule changes for the scoring system on the duration of the beach volleyball game. *Journal of Human Movement Studies*, 48(1): 15-23.

George G, Tili M, Zetou E. (2011) The height of the women's winners FIVB Beach Volleyball in relation to specialization and court dimensions. *J Hum Sport Exerc*. 6(3): 497-503.

POST 2.1: SOCCER

POST 2.1.1
Home and away: An analysis of team positioning in the FA Premier League

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Courneya & Carron (1992) presented a systematic review that established the strength of home field advantage upon match result in team sports. Pollard (1986) reported that home teams accounted for 64% of all points gained in the English Football League. This was compounded by Bray et al. (2003) who found that football teams won 22% more games at home than away. Further research by Tucker et al. (2005) reported that home advatage came in terms of both winning and scoring more in home games. Therefore, the aim of the study was to examine the relationship between the points earned at home and away and final position on the English Premier League table. It is expected that final league table position will be the 1) teams finishing in a higher position will have achieved more home and away points compared to middle or bottom table teams, 2) teams in the middle position will have a high number of home points and low number of away points and 3) teams at the bottom of the table will have a lower number of home points scored. Using data from the English FA Premiership league table from 1998 to 2010 a multivariate regression analysis will be used to determine the relationships between points scored at home and away games and league table position.

Bray, S.R., Law, J., & Foyle, J. (2003) Team quality and game location effects in English professional soccer. *Journal of Sport Behavior,* 26: 319-334.

Courneya, K.S. & Carron, A.V. (1992) The home advantage in sport competitions: A literature review. *Journal of Sport & Exercise Psychology,* 14: 13-27.

Pollard, R. (1986) Home adavatage in soccer: A retrospective analysis. *Journal of Sport Sciences,* 3: 237-248.

Tucker, W., Mellalieu, S.D., James, N., & Joseph, B. (2005) Game Location Effects in Professional Soccer: A Case Study. *International Journal of Performance Analysis in Sport,* 5(2): 23-35.

POST 2.1.2
Normative performance profiling for the analysis of corner kicks

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Set plays including corner kicks, free-kicks, penalties and throw-ins are a vital method of scoring; contributing approximately 40% of goals (Armatas *et al*., 2007). Moreover, one in three corner kicks produce an attempt on target, of which 8% result in a goal (Taylor et al., 2004). With the importance of corner kicks for goal scoring clearly evident, it is important that the strengths and weaknesses associated to this set play are identified. One approach that could provide such information is the normative performance profiling technique (O'Donoghue, 2005). Therefore, the purpose of this study was to demonstrate how normative profiling can be used for the objective assessment of corner kicks.

Dartfish Classroom Plus (Dartfish, Switzerland) was used to analyse 12 matches from a League One professional football team's 2010/11 season. This yielded a total of 136 corner kicks, of which 52 were opposition corner kicks used to develop the opposition normative data. Key performance indicators essential to performing successful corner kicks were selected and given clear, unambiguous operational definitions (see Taylor et al., 2004). Finally, a normative performance profile was developed using the technique proposed by O'Donoghue (2005).

The results of the current study (Figure 1) demonstrate the utility of normative performance corner kicks. These strengths and e percentile plot, offering valuable istency in performance. Moreover, performance insight that can be
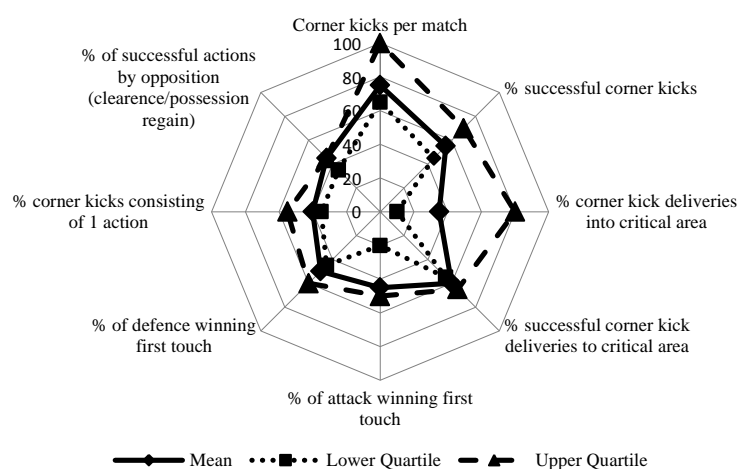
Figure 1. Corner kick normative performance profile.

Armatas, V., Yiannakos, A., Papadopoulou, S. & Galazoulas, C. (2007) Analysis of the set-plays in the 18th World Cup in Germany. *Physical Training*, October.
O'Donoghue, P. (2005) Normative profiles of sports performance. *International Journal of Performance Analysis of Sport*, 5(1): 104-119.
Taylor, J.B., James, N., & Mellalieu, S.D. (2004) Notational analysis of corner kicks in the English Premier League. *Journal of Sports Sciences*, 22(6): 518-519.

POST 2.1.3

The influence of the type of goalkeeper action on the offensive patterns of play in association football

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[3]*Manchester City Football Club*
[4]*Faculty of Human Kinetics, Lisbon, Portugal*

In performance analysis, the identification of collective patterns of play is highly topical for improving performance. One of such methods that allow identifying the structure and dynamics of the interpersonal interactions developed by players is social networks analysis (Duch et al., 2010). In previous studies the "flow network" of successful passing actions were measured for the entire game to identify the most relevant players within a team (Passos et al., 2011). In this investigation we developed a preliminary analysis of the influence of different goalkeepers' actions such as goal kick, passing with foot and reposition by hand on the "flow network" of an association football competition.

Three competitive matches from the English Premier League were analyzed. A total of 61 goalkeeper passing sequences started by the goalkeeper were identified, which consisted in 19 goal kicks, 33 passing actions with foot and 9 repositions by hand. Network analysis and graph network were performed using SocNetV 0.81 software. Betweeness centrality (%BC) was computed as a measure of player's influence in the flow network, i.e. the player that performed and received more passes (Duch et al., 2010).

Data showed that the offensive sequences started by the goalkeeper followed a different flow as a function of the type of goalkeeper's action. In the goal kick sub-phase of play, the players number 3 (centre back) and 10 (centre forward) received each 31.6% of the balls played from goalkeeper and the player number 3 (centre back) had the highest value of BC (29%). In the passing actions with the foot, the player number 10 (centre forward) received 42% of the played balls and the player number 9 (attacking midfielder) revealed the highest value of BC (20%). Finally, in the reposition by hand actions, the player number 5 (right back) received 45% of the played balls and the player number 8 (left wing) revealed the highest value of BC (43%).

Results suggested that the type of actions performed by the goalkeeper influenced his possibilities of interaction with teammates, probably due to the specificities of the environmental conditions featuring each performance context such as the available passing lines and the goalkeeper's action capabilities. These preliminary findings suggest the need of further investigation in specific game sub-phases for which social network analysis could be a valuable methodology.

Duch, J., Waitzman, J. S., & Amaral, L. A. N. (2010) Quantifying the performance of individual players in a team activity. *PloS one, 5*(6): e10937.

Passos, P., Davids, K., Araújo, D., Paz, N., Minguéns, J., & Mendes, J. (2011) Networks as a Novel Tool for Studying Team Ball Sports as Complex Social Systems. *Journal of Science and Medicine in Sport, 14*(2): 170-176.

POST 2.1.4

Analysis of goal scoring opportunities in semi elite female soccer

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Analysis of attacking play and goal scoring in elite level male soccer has highlighted trends in goals scored during match play (Yiannakos and Armatas, 2006). However, limited research has focused on female soccer in regards to attacking play and goal scoring (Bergier et al., 2009), with no literature available focusing specifically upon semi elite female soccer. Therefore the purpose of the study was to investigate goal scoring opportunities in semi elite female soccer match play. After gaining institutional ethical clearance sixteen competitive semi elite female soccer games were recorded and analysed via computerised video playback software (SportsCode Pro v 8.0, Sportstec, Australia). The total number of goal attempts (*n*=388) and goals scored (*n*=51) were analysed according to the time during the game the attempt occurred, the origin of the attack in relation to pitch location, the number of passes leading up to the goal attempt and the pitch location of the goal attempt. Data were analysed in regards to the half of match play in which it occurred and the 90 minutes of match play was divided into six 15 minute segments. Results revealed that significantly more goal attempts occurred in the second half of match play (57%) than the first half (43%) ($P < 0.01$). A significantly lower number of goal attempts were recorded during the 30 − 45 minute time period of match play (12%) than all other 15 minute time periods throughout the match ($P < 0.05$). Goal scoring analysis revealed a significant difference ($P < 0.01$) between the number of goals scored in the first half (35%) and second half of match play (65%), however no significant differences were found between goals scored in each 15 minute time period during the match ($P > 0.05$). Significant differences ($P < 0.05$) were observed in regards to the origin of build up play preceding an attempt at goal with 11% of attempts originating from the defensive third of the pitch, 35% from central areas and 54% from the offensive third. A significantly greater number of goal attempts were created through phases of play including zero (26%) and one (30%) passes than all other passing sequences ($P < 0.01$). A greater amount of shots were attempted from outside the penalty area (57%) than within the penalty area (43%) ($P < 0.01$), however a greater amount of goals were scored from within the penalty area (71%) than from outside the penalty area (29%) ($P < 0.01$). The results suggest that goal attempts and goal scoring in semi elite female soccer are time dependent with a greater number of goal attempts and goals scored observed during the second half of match play. Greater numbers of goal attempts are created when the sequence originates in the offensive third of the pitch and goal attempts have a higher success rate (goal scored) if the attempt occurs within the penalty area. The identified trends in goal attempts and goals scored may assist in the development of specific attacking tactical strategies for female soccer at a semi elite level. The findings may also be useful in enhancing the understanding of semi elite female soccer match play for coaches and players alike.

Bergier, J., Soroka, A. & Buraczewski, T. (2009) Analysis of actions ending with shots at goal in the Women's European Football Championship (England 2005). In *Science and Football VI: The Proceedings of the Sixth World Congress on Science and Football* (Eds. T. Reilly and F. Korkusuz): 197-201. Routledge: London.

Yiannakos, A. & Armatas, V. (2006) Evaluation of goal scoring patterns in the European Championships in Portugal 2004. *International Journal of Performance Analysis of Sport,* 6(1): 178-188.

POST 2.1.5

The effect of manipulating the number of touches on the ball in small-sided games of Association football on players' spatial interaction

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Understanding the effects of manipulating task constraints in small-sided games (SSGs) is a hot topic in sport science research for improving practice sessions (Hill-Haas et al., 2011). Hence, the aim of this study was to examine how limiting the number of ball touches in 6 vs. 6 + GK in Association football small sided games (SSGs) influence the spatial interaction behavior between attacker players.

Eighteen U-17 elite footballers (M = 15.6 ± 1.6 years) performed two 6 vs. 6 + GK SSGs in which the number of ball touches was manipulated. In the first (SSGs1) game players were limited to a maximum of three touches on the ball and in the second game (SSGs2) there was no limit number of touches. A total of 40 sequences of pass between the attacker players were considered, 20 from SSGs1 and other 20 from SSGs2. Each sequence has evaluated in three different moments: M1 - when attacker 1 receives the ball, M2 - when attacker 1 passes to attacker 2 and M3 - when attacker 2 receives the ball. The coordinates of the attacker players at each moment were extracted using Digitizexy and the minimum interpersonal distance was calculated.

Results indicate that limiting the number of ball touches influence the spatial interaction behavior between attacker players; the interpersonal distance was significantly higher in the exercise SSGs1 (maximum of three touches allowed) in all moments in comparison with the observed distances for sequences with unlimited number of touches (M1: 29.08±4.01 vs. 22.32±3.89, $p<0.001$; M2: 29.92±4.51 vs. 22.23±3.52, $p <0.001$; M3: 32.67±8.25 vs. 22.77±4.05, $p <0.001$).

The present study suggests that limitation in the number of ball touches increases the interpersonal distance between attacker players, which may emerge due to a need of defining greater areas in which one has more opportunities of action.

Hill-Haas, S., Dawson, B., Impellizzeri, M., & Coutts, J. (2011) Physiology of small-sided games training in football: A systematic review. *Sports Medicine, 41*(3): 199-220.

POST 2.1.6
Small sided games in football with University players

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Research Center for Sport Sciences, Health and Human Development (CIDESD)*, Portugal*

Recent technological innovations have made global positioning system (GPS) a new and valid method to quantify movement patterns and physical demands in sport (Coutts, & Duffield, 2010, Gray, *et al.*, 2010). GPS provide a detailed description of player movement demands and can assist teams and coaches from a tactical view point. The purpose of this study was to analyse the effects of a football teaching program (FTP) and the number of players (NP) on physiological demands, perceptive exertion, kinematic performance and technical/tactic components.

Fourteen male university students participated in this study (age 19.07 ± 0.62 years, weight 66.2 ± 7.4 kg, height 1.78 ± 0.05m, mean $\pm$ standard deviation). Four small-sided games (SSGs) were applied: 6x6 at the beginning of FTP; 4x4; 6x6 at the end of FTP. A constant pitch area of $225m^2$ per player was kept. During all SSGs the heart rate (HR), distance, speed and rating perceived exertion were recorded. The SSGs were recorded to further technical/tactical analysis. For data analysis we used the descriptive statistics and inferential analysis, using the *student t-test* and the *Wilcoxon* nonparametric test.

Significant differences ($p < 0.05$) were noticed in intensity and distance covered at higher speed (> 17,9 km/h). All others components (HR, Technical indicators and perception exertion) don't show differences after applied the FTP.

The number of players is the variable which most influences the components technical analyzed. The reduction of the NP promoted the increased of total distance covered and at a slow speed (0-6 km/h; 10-12,9 km/h), as well as increased technical/tactical indicators (touch ball contacts; game interventions, time ball possession; shoot at the goal and goals.

Coutts, A. J., & Duffield, R. (2010) Validity and reliability of GPS devices for measuring movement demands of team sports. *Journal of Science and Medicine in Sport,* 13: 133-135.

Gray, A., Jenkins, D., Andrews, M., Taaffe, D. & Glover, M (2010) Validity and reliability of GPS for measuring distance travelled in field-based team sports. *Journal of Sports Sciences*, 28, 1319-1325.

POST 2.1.7
Spatial analysis of soccer games for effective coaching

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[2]*University Systems Dept., University of Victoria, Victoria, Canada*

In this paper we discuss few approaches to analyze the spatial behaviour of soccer games. The analysis is based on modeling ball movements using a weighted graph in which the zones are vertices and the weight of an edge represents the frequency of ball transition from one zone to an other. This representation allows the coach to see the dominate zones and links, and, therefore, make well-informed and quantified decisions using tools such as spatial outlier analysis (Goodchild et al., 1992). Instead of focusing on the performance of each player as done in (Kim, 2006), the attention is shifted to the zones and the links between them. The movement of the ball is then modeled as a Markov Chain Process (Hughes & Franks, 2004) that we use to estimate several parameters including the stationary probability distribution of the ball across the zones. To prioritize the content of coaching intervention and improve team performance, a spatial multi-resolution Markov Chain based on binary trees is proposed to study the game.

Our analysis is taking into the prediction stage by learning the patterns of the soccer game using a neural network. This neural network is trained during the first half of the game and then used to predict the movement of the ball in the second half. Training based on previous games is also used to improve the predictions and learn long-term patterns.

The data used was collected alive using a smart phone with the Darfish EasyTag application during 8 games from the 2011 Canadian University National Men's soccer championship (CIS). The data was gathered over a period of 90 minutes in addition to overtime and injury extra time. The penalty shootouts were omitted. The data collected include the ball possession times and the durations of the ball in each zone as time series.

The knowledge gained during the analysis of the 8 games was transferred qualitatively to a focus group of the CIS winning team. The participant group, which had no previous experience in performance analysis, indicated a significant increase in the players' ability to select information and implement a successful strategy during competition. This supports the accuracy of our chosen analysis.

Goodchild, M., Haining, R., & Stephen, W. (1992) Integrating gis and spatial data analysis: problems and possibilities. *International Journal of Geographical Information Systems*, 6(5): 407–423.

Hughes, M. and Franks, I. (2004) *Notational analysis of sport: Systems for better coaching and performance in sport*. Psychology Press.

Kim, S. (2004) Voronoi analysis of a soccer game. *Nonlinear Analysis: Modelling and Control*, 9: 233–240.

Kim, S. (2006) Who plays the dominant role in a soccer game? *Journal of the Korean Physical Society*, 48(2): 188–191.

POST 2.1.8
Characterising the attacking patterns of football teams using social networks: players and field zones as network nodes

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Recently, social networks analysis has been suggested as a useful tool to capture the complex patterns emerging from the nonlinear interactions between team players (Passos et al., 2011). The aims of this study were: 1) to analyse the strength of interaction between the players within two competing teams 2) to test the field zones as nodes of the networks linked by the ball trajectory dynamics to characterise the attacking playing patterns. Data from pass distribution of two competing teams from the English Premier League, associated to the players and zones of the field, were collected by OPTA. Twelve field zones resultant from four longitudinal and three lateral pitch sections were obtained using a computerised notation system. The origin and end zone of the successful passes formed the links of the network. Data were analysed using Microsoft Excel and SocNetV 0.81 software. Our preliminary analyses showed that the individuals from team A with the highest frequency of connection were the players' number 7, 8, and 10 (Figure 1). Zone 5,7,8 and 9 were the zones that provide larger connectivity with the others (Figure 3). Data allowed identifying the great importance of the central area of the playing field and the midfielders in the development of the attacking patterns in this specific team. In team B, it can be seen that the more frequently connected players were numbers 7 and 11 (Figure 2) and the zone with highest connectivity to the other areas was zone 9, specially with the zones 6 and 12 (Figure 4). Data allowed identifying different trends in the development of the attacking patterns for the two analysed teams. The complementarity between players and field zones as nodes of the networks analyses may be of interest for further investigations in this field.

Figure 1: Visualization of players' interactions within Team A.
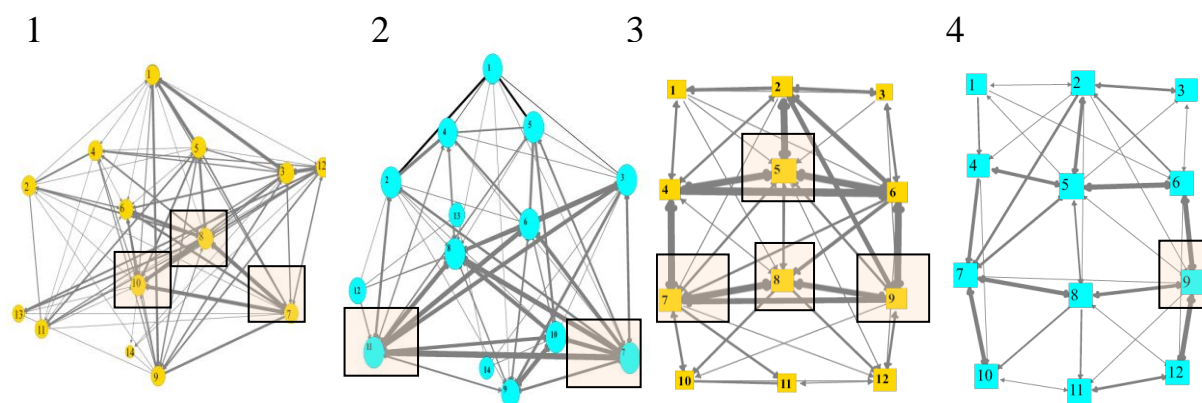Figure 2: Visualization of players' interactions within Team B.
Figure 3: Visualization of field zones interactions for Team A.
Figure 4: Visualization of field zones interactions for Team B.

Passos, P., Davids, K., Araújo, D., Paz, N., Minguéns, J. & Mendes, J. (2011) Networks as a novel tool for studying team ball sports as complex social systems. *Journal of Science and Medicine in Sport, 14, 170-176.*

POST 2.1.9
The impact of game status on the performance of a Premier League football reserve team: Implications for coaches.

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Game status has been defined as winning, drawing or losing during a match (Lago 2009) and demonstrated to have had a significant impact on the playing patterns, match variables and strategies of football teams at a variety of different levels (Lago & Martin 2007). Previous studies have predominately focused on match outcome (Jones & James, 2004), however factors such as game status have been highlighted as areas for further research in order to provide coaches with a more comprehensive and functional analysis of performance (Barreira et al. 2010; Lago & Martin 2007). The aim of the present study is to analyse the impact of game status on the performance of a premier league reserve football team and consider implications for coaches.

Fourteen Premier League reserve football games during a competitive season were analysed investigating eleven key performance indicators using the Match Insight Software (ProZone) including: Total passes; Direction of pass; Passing success rate; Length of pass; Time in possession; Zonal possession; Total attacking entries; Total crosses; Total number of shots; Shooting accuracy and goals scored.

Kruskal Wallis with further Mann Whitney U tests identified the following: When winning the team kept more possession than both drawing and losing scenarios ($p < 0.05$) and displayed more successful passes in a backward direction ($p < 0.05$). When drawing, there was a significantly higher shot success ($p < 0.05$) and subsequently more goals were scored ($p < 0.05$). In the losing situation the team demonstrated more accurate passing ($p < 0.05$), a higher success rate of sideways passing ($p < 0.05$), a greater number of long passes ($p < 0.05$) and also more medium range passes, although not statistically significant. It was also discovered when losing, the team played more forward passes and entered the final third on more occasions ($p < 0.05$), leading to more crossing and shooting opportunities than in the drawing scenario ($p < 0.05$). Within all three situations (winning, drawing and losing) it was discovered that short passes were the most successful indicator and also more possession was kept in the middle third of the pitch ($p < 0.05$).

The results suggest that a more attacking style of football occurred when the team found itself in a losing situation as opposed to in the drawing or winning situations. Coaches could be more positive when winning and drawing instead of playing defensively or indeed protecting a lead where in the winning scenario teams could be more creative and exercise more penetration and depth in attack. Playing patterns and strategies in relation to game status require careful consideration by coaches.

Barreira, D., Garganta, J. & Anguera, T. (2010) In search of nexus between attacking game-patterns, match status and type of ball recovery in European Soccer Championship 2008. *Research Methods & Performance,* 3, 226-237.

Jones, N.M.P. & James, N. (2004) Possession as a performance indicator in soccer. *The International Journal of Performance Analysts of Sport,* 4 (1), 98-102.

Lago, C. (2009) The influence of match location, quality of opposition, and match status on possession strategies in professional association football. *Journal of Sports Sciences,* 27 (13), 1463-1469.

Lago, C. & Martin, R. (2007) Determinants of possession of the ball in soccer. *Journal of Sports Sciences,* 25 (9), 969-974.

POST 2.1.10
A corner kick analysis of a League One professional football team

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Set plays are a vital method of scoring, contributing to approximately 40% of goals (Armatas *et al.*, 2007). Approximately 11 corner kicks occur per game with one in three producing attempts on target, of which 8% result in a goal (Taylor et al., 2004). However, there is currently very limited research that conducts a detailed analysis of, and offers an analysis template for, corner kicks. Therefore, the aim of the current study was to develop an analysis template for corner kicks.

Dartfish Classroom Plus (Dartfish, Switzerland) was used to analyse 136 corner kicks from a League One professional football team's 2010/11 season (12 matches). The coding process involved eleven key performance indicators essential to performing corner kicks, and entered in the following sequence; team, corner taker player, corner side, corner strategy, corner type, target zone, first contact team, first contact player, number of touches, defining actions and outcome. Each performance indicator was given a clear, unambiguous operational definition and subjected to a chi-squared test to determine statistical significance ($p < 0.05$). Pitch location was divided into five key areas with 21 sub-zones (Figure 1).
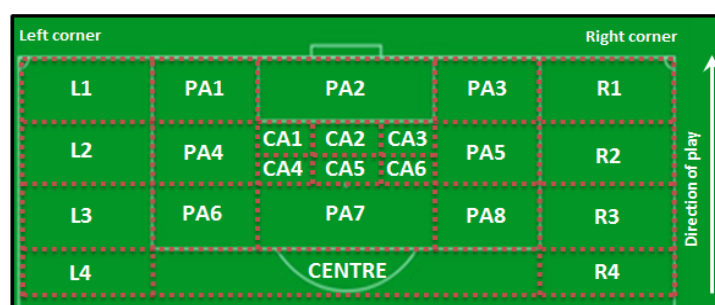

Figure 1. Target zone pitch divisions (adapted from James *et al.*, 2002)

Results indicate that corners occur frequently (7 per game) providing a one in three chance of achieving a shot on or off target. Further analysis highlighted that inswing/outswing corner kicks were used significantly more than other techniques, presenting a 35% chance of a shot on goal when delivered into the critical area (CA) ($p < 0.001$). Successful corner kicks resulting in a shot on goal were also characterised by a low number of attacking actions. With regards to team weaknesses, significantly more defensive clearances and occasions where the attacking team failed to make contact with the ball (zero actions) occurred ($p < .001$), in addition to opposition defenders and goalkeepers winning significantly more first contacts of the ball ($p < 0.05$). Based on the current findings it is evident that the analysis template created can provide a detailed analysis of corner kicks and can be used to inform and facilitate the coaching process for this specific set play.

Armatas, V., Yiannakos, A., Papadopoulou, S. & Galazoulas, C. (2007) Analysis of the set-plays in the 18th World Cup in Germany. *Physical Training*, October.
James, N., Mellalieu, S.D. & Hollely, C. (2002) Analysis of strategies in soccer as a function of European and domestic competition. *International Journal of Performance Analysis of Sport*, 2(1): 85-103.
Taylor, J.B., James, N., and Mellalieu, S.D. (2004) Notational analysis of corner kicks in the English Premier League. *Journal of Sports Sciences*, 22(6): 518-519.

POST 2.1.11
Career analysis of youth talent Brazilian soccer players

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The aim of this study was to analyze the future career of young talents in Brazilian soccer to assess the variation in performance between the transitions from youth to adult teams. The sample consisted of 154 players who competed in the under 17 FIFA World Cup for Brazil between 1995 and 2009. We used six rating categories for assessing payers career success : 1 - Participation in the World Cup, 2 – Play in Brazilian National Team, 3 - Long career in the big leagues, 4 - Short career in the big leagues, 5 - Only play in the minor leagues, 6 - Did not play professional soccer. It was determined a minimum of 150 games to rank this success as long as 30 short. For younger players the number of matches was reduced in 2005 (75, 30), 2007 (50, 20) and 2009 (30, 10). The results showed that most of the players could not play major leagues (71, 46.1%) or had short career (40, 25.97%). Only four players (2.6%) played the World Cup, 16 (10.39%) played for the Brazilian team and 23 (14.94%) had long-standing success. All players have turned professional. With these results we conclude that the most talented players failed to maintain the success achieved in football adult.

POST 2.1.12

Relationship between high risk situations and the characteristics of injuries in elite youth football players

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10,000 hours of directed and organized coaching over a period of 10 years are needed for reaching the highest level in sport (Durand-Bush & Salmela, 2002). An audit of injury show that a significant proportion of development time can be missed through injury (Price et al., 2004). While various studies examined the mechanism of injuries among elite adult football players, information about elite youth is scarce. Therefore, the aim of the study is to describe the characteristics of injuries and high-risk situations (incidents) among elite youth football players while developing a modified version of Football Incidents Analysis (m-FIA), a hand based notation analysis system.

Injuries and incidents had been analyzed from all home and away matches between August-March during the 2010 competitive season of a Spanish top football academy. Events when the match was interrupt due to an injury or incident had been analyzed using m-FIA, in order to detect the characteristics of the playing situation leading to them. Inter and intra observed reliability was calculated with the Kappa statistic. Mean inter and intra-observer reliability were 0.81 and 0.84 respectively.

Of the 160 matches analyzed, 243 incidents were recorded and 158 acute injuries were reported. Of those 158 injuries, 97 (61%) were identified on video including all head injuries, 81% of knee injuries, 93% of ankle injuries and 80% of lower leg injuries. Defenders and midfielders were more susceptible to injury compare to other positions; no single classic injury situation typical for youth football injuries or incidents could be recognized. However, two main high risk mechanisms had been observed (1) Offensive set-play while the tackling player initiated a one foot tackle, approached from the side or back. (2) Defensive tackles in the central defending area, in all situations the attention of the exposed player was focused on the ball and/or having a low ball control.

Most incidents and injuries occurred during set-play and breakdown attacks, and in tackling duel situations. The exposed player seems to move in high intensity, while his attention is focused mainly on the ball, not on the opponent player approaching in order to gain ball possession. Coaches needs to increase player attention distribution that ultimately will allow better decision making and reduce possibility for getting into high-risk situation.

Durand-Bush, N., & Salmela, J. H. (2002) The Development and Maintenance of Expert Athltic Performance: Perceptions of World and Olympic Champions. *Journal of Applied Sport Psychology,* 14: 154-171. doi: 10.1080/10413200290103473

Price, R. J., Hawkins, R. D., Hulse, M. A., & Hondson, A. (2004) The Football Association medical research programme: an audit of injuries in academy youth football. *British Journal of Sports Medicine,* 38: 466-471. doi: 10.1136/bjsm.2003.005165

POST 2.2: TEAM SPORTS

POST 2.2.1

Differences between winning and losing teams in top-level female beach volleyball

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Top-level beach volleyball matches are often very even and the purpose of this study was to analyse technical skills as possible determinants on winning in international top-level female beach volleyball. In total 31 normal (to 21 points) beach volleyball sets played in World Tour 2010 and 2011 and European Championships 2011, were analysed using Data Volley -match analysis software. The teams that played on these matches were placed 3-38 on the World Tour ranking. Serve was analysed using a 6-level scale, reception and attack using a 5-level scale, dig using 3-level scale. Attacks were also divided to attacks after reception and attacks after dig. Also the number of successful blocks and the number of opponent's errors were analysed. The success and error percentages were calculated for each team in each skill in each set. The normality of every variable was tested using Shapiro-Wilk test and then either t-test for paired samples or Wilcoxon signed-rank test was used to compare the winning and losing teams.

The teams that won sets were found to be significantly better in overall attacking (success% 59.8 % vs. 46.2 %, $p<.001$, error% 11.6 % vs. 18.5 %, $p<0.01$), attacking after reception (success% 60.7 % vs. 46.5 %, $p<.001$, error% 11.6 % vs. 18.6 %, $p<0.01$), transition attacking (success% 53.5 % vs. 45.4 %, $p<.01$) and blocking (1.5 blocks/set vs. 0.6 blocks/set, $p<.001$). The set winners had a smaller error percentage in reception (6.7 % vs. 11.3 %, $p<.05$). On the contrary the success or error percentages for serves (success% 29.0 % vs. 23.6 %, ns., error% 11.0 % vs. 12.5 %, ns.) and digs (success% 65.0 % vs. 64.8 %, ns., error% 23.1 % vs. 24.8 %, ns.) did not differ significantly. The error percentages for transition attacks (10.1 % vs. 17.4 %, ns.) did not differ significantly. Also no significant difference was found in the number of points received from the opponent's errors (4.7 vs. 4.4 points/set). (Figure 1.)

The results suggest that attacking and blocking were the most decisive skills concerning winning in top-level female beach volleyball. Especially the attack after reception considered to be a very important skill. Also the quality of receiving had an effect to winning.
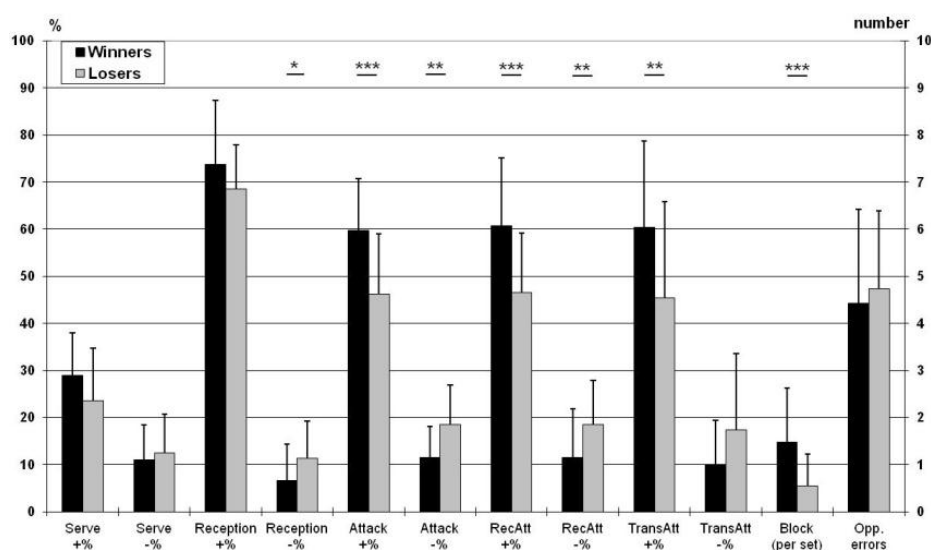

Fig. 1. The success and error percentages of analysed variables and the number of successful blocks and points received from opponent's errors (*=p<.05, **=p<.01, ***=p<.001).

POST 2.2.2
Determinants of serve action in high level male volleyball

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[2]*Federal University of Rio Grande do Sul, School of Physical Education, Brazil*

Throughout the evolution of Volleyball as a game, serve has been one of the most important game actions that contribute for game result (Marcelino et al., 2008; Yiannis & Panagiotis, 2005). In this way, the purpose of the present study was to examine probabilistic relationship within the dynamics of serve action in high-level men's volleyball.

The sample of this study comprises 1698 serve actions, corresponding to 19 games of the 10 best teams that participated in the 2006 FIVB Men's World Championships. Two independent variables were considered: (i) *server player*: setter, opposite, left-side attackers and middle-attackers; and (ii) *type of serve* (Lirola, 2006): jump serve, jump floating serve and jump tennis serve. *Serve effect* was also considered as dependent variable: error, easy serve (allow all attack options), moderate serve (without all attack options), hard serve (do not allow attack organization) and serve point. A multinomial logistic regression was applied with a significant level established in 5%.

Results showed that both *server player* and *type of serve* were predictive determinants of *serve effect* ($x^2_{(20)}$ = 121.500, p<0.001). Middle-attackers are the less effective servers, creating more facilities to opponent's attack organization. Despite the setters and left-side attackers presented more errors and less effective serves, those players also presented more serves resulting in point than opposite player. Although opposite player didn't showed more points and errors, it was this server that caused more difficulties to opponent's attack. According to the *type of serve* jump serve not only caused more points but also more errors. Jump tennis serve didn't show influence in the *serve effect*. As conclusion, the present study suggests server player and type of serve as determinants for the serve effect and therefore to the opponent's attack organization. From these results some implications can be withdrawn for practice and competition, namely a better used of power jump serve and more opportunities to other players practice their serves.

Lirola, D. (2006) Research and analysis of the serve in the current high performance Men's Volleyball. *International Journal of Sport Science,* II(5): 12-28.

Marcelino, R., Mesquita, I., & Afonso, J. (2008) The weight of terminal actions in volleyball. Contributions of the spike, serve and block for the teams' rankings in the World League 2005. *International Journal of Performance Analysis in Sport,* 8(2): 1-7.

Yiannis, L., & Panagiotis, K. (2005) Evolution in men's volleyball skills and tactics as evidenced in the Athens 2004 Olympic Games. *International Journal of Performance Analysis in Sport, 5*(2): 1-8.

POST 2.2.3
The use of serve of men's teams in top beach volleyball competition

Maria del Mar Silvestre García, Alfonso Penichet Tomás, Jose Manuel Jimenez Olmedo, Juan José Chinchilla Mira, Eliseo Cabrera Andreu, Concepción Suarez Llorca, Federico Carreres Ponsoda, Jose Antonio Martínez Carbonell, Jove Tossi & Marcelo Alejandro

University of Alicante

This study was designed to develop a method to analyse serve types so as to quantify the movement types and their relationship to real and made competition during the European volleyball Championships celebrated in Valencia (Spain) in 2006, using the SportsCode analysis software. The objective of the study was to compare types serve in men's professional beach volleyball. The quantitative analysis of the game of beach volleyball was carried out in 18 players participate in the Volleyball Championship mentioned above, through video recordings of 227 service were registered in four games played. The recordings were analysed using SPSS version 13.0. Chi square test showed significant differences between the types of serve. The first results of the analysis showed men players use the jump serve (22%)and the overhead floater serve (15%) and the overhead spin serve (63%).

Identify and understand the types of serve in male top-level players are vital for the defining of specific and effective beach volleyball training strategies.

POST 2.2.4
The sport developmental pathway of volleyball players: The nature and type of sport practice

Patrícia Coutinho, Rui Araújo & Isabel Mesquita

Center of Research, Formation, Innovation and Intervention in Sport (CIFI[2]*D), University of Porto, Faculty of Sport, Porto, Portugal*

The acquisition and development of sport expertise research has been considering training factors as an important factor in this process (Côté et al., 2003). This study aimed to analyse the sport developmental pathway of Volleyball players considering the nature and type of sport practiced throughout the developmental stages considered according to gender and competitive level.

The study involved 60 Volleyball players (30 female and 30 male) of different competitive level (30 experts and 30 non-experts). A retrospective semi-structured interview was applied in order to gather detailed information about: (i) the number of sporting activities practiced; (ii) the nature of sporting activities practiced (individual sport or team sport); (iii) the type of sporting activities practiced (organized activities or non-organized activities). These variables were analyzed according to players' gender and competitive level. Considering the *Developmental Model of Sport Participation* (Côté, 1999; Côté et al., 2003), three developmental stages were taken into account (stage 1: 8-12 year olds; stage 2: 13-16 year olds; stage 3: 17-20 year olds). Repeated Measures ANOVA was applied, using post hoc test (Tukey and Bonferoni) for multiple comparisons.

The results revealed that nature, type and quantity of practice distinguished sport developmental pathway of Volleyball players. Considering the nature of practice, significant differences were found in the quantity of individual sports practiced merely according to the developmental stages ($p<0,000$) and gender ($p=0,001$). Volleyball players practiced more individual sports in stage 1 than in stage 2 ($p<0,000$) and stage 3 ($p<0,000$). Female players practiced more individual sports than male players in stage 1 ($p=0,010$). According to team sports practiced, Volleyball players practiced more team sports in stage 1 than in stage 2 ($p<0,000$) and stage 3 ($p=0,004$). Moreover, related to the type of practice Volleyball players practiced more organized activities in stage 2 than in stage 3 ($p=0,045$). The competitive level also distinguished players since expert male players practiced more organized activities during all developmental stages than non-expert male players ($p=0,025$). Curiously, expert female players had a greater organized activities practice only in stage 3, while non-expert female players practiced more organized activities in stage 1 and stage 2 than expert female players. According to non-organized activities practice, no significant differences were found, which seems this type of practice does not distinguished the Volleyball players' sport development.

The study suggested that the nature and the type of practice determined and influenced the Volleyball player development, proposing that a diversified practice during early stages of development might contribute to expertise achievement. Moreover, the gender differentiated the early sport practice. Indeed, although female players practiced less organized activities in the early stages of development, they practiced more individual sports than male players, which might had contributed to their expertise accomplishment.

Côté, J. (1999) The influence of the family in the development of talent in sport. *The Sport Psychologist*, 13: 395-417.

Côté, J., Baker, J., & Abernethy, B. (2003) From play to practice: A developmental framework for the acquisition of expertise in team sport. In J. Starkes & K. A. Ericsson (Eds.), *Expert Performance in Sports: Advances in Research on Sport Expertise* (pp. 89-113). Champaign, IL: Humam Kinetics.

POST 2.2.5

The use of patterns of movement and displacement and types of shots in handball in the Valencian community

Martínez Carbonell & Jose Antonio

The Valencian ball, is a traditional sport of handball in the Valencian Community (Spain), is composed of a set of forms among which we highlight the modality of Stand and rope (Escala i Corda), professional modality in which we have based the study. The objective of the same was analyse and quantify the types of shots and displacement motor patterns, and compare them between the positions of first game line and second game line. Analysis of 6 games of the 19th Professional League of Stand and rope 2009-2010 was carried out so i, and specifically of 12 players, using Sports Code and Game Breaker analysis software.

Once quantified patterns of movement in displacement and shots rates used, the data were treated with SPSS software v.15, calculating descriptive statistics and frequency distributions, to perform the Kolmogorov-Smirnov test and Levene and non-parametric Mann-Whitney test.

The results indicate significant differences (P < 0.05) between the shots carried out by first game line player and second game line in the rebound of right hand (p=0.037), rebound of left hand (p=0.037), rebound-shot of right hand (p=0.046), rebound-shot of caiguda d' scale (p=0.046) right hand and left hand (p=0.037); being almost realitzados only by players from the rest position.

At the same time we find data which demonstrate us by another band used mainly by second game line players beatings, these have been volley shot of right hand (p0.050), volley shot after bounce right hand (p=0.046), volley shot under the line of the shoulders of right hand (p0.046), palm shot of right hand (p=0.046), and horizontal shot of right hand (p=0.046).

How the patterns of movement in displacement, we find significant differences in front displacement (p=0.05) and backward displacement (p=0.05).

POST 2.2.6
Temporary structure of ice hockey game

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[3]4SportLab Laboratory of Physical Preparation, Warsaw, Poland

Ice hockey is very fast, dynamic and full contact sport where two contesting teams fight to defeat the opponent (Kostka et al., 2000). A game can be essentially divided into two phases: attack and defence. The aim is to score as many goals as possible, while conceding very few. The two phases make a whole and each team has to bear in mind that effective attack and correct defence are prerequisites to success (Bukac, 2005). Ice hockey is a full contact game and the players are allowed to fight with each other. An accidental and frequently painful contact with the opponent can be avoided, but the players must watch the game throughout. The most important players' actions during a game are puck handling, shots and strikes, bodychecks, skating (intensive skating, stops and starts), passes, receptions, stops and takeaways (Bukac, 2005; Gabrys, Rutkowski, 2002).

The presented investigation was designed to identify the structures of actions of the Poland's national ice hockey team under 18 years executed during three ice hockey matches played under the Ice Hockey World Championship. The research aimed at measuring the players' elementary actions: shots, passes, receptions, starts, stops, bodychecks, intensive skating, puck handling, takeaways, and shifts. The list of actions can be broken down into two groups according to the relevant type of measurement, i.e. the number of repetitions or time in seconds (s). The actions that can be described by means of repetitions are shots, passes, receptions, starts, stops, bodychecks, takeaways, and substitutions, while the time-measured ones are starts, bodychecks, intensive skating, puck handling and shifts.

Passes and receptions were the most frequent actions (5 and 9 on average in one period). Besides, players frequently stopped (7 times on average in a period) and started (around 5 times on average in a period). Bodychecks were less frequent (around 3 confrontations on average). Shots and takeaways were the rarest, 1 and 3 in a period, respectively. The presented order of actions results from levels of difficulty inherent in the actions. Players have more problems with accomplishing actions that require perfect technique, fast reaction and high concentration. Analysing the typically offensive and defensive elements, i.e. shots, takeaways and bodychecks, we can see that their numbers differ depending on the opponent. Polish players sent 30 shots while playing against the Danes, 63 in the match against the Norwegians and 67 in the match against the Ukraine. As far as giveaways are concerned, the Danes lost the puck to the Polish national team 45 times, the Norwegians 72 times, and the Ukrainians 54 times. In the match against Denmark Polish players bodychecked their opponents 150 times, while in the matches against the Norwegians and the Ukrainians the numbers were 122 and 79, respectively. The differences between particular games should be attributed to the different skills and playing styles of the opposing teams.

Bukac, L. (2005) *Intellect, learning, skills, coaching ice hockey*. Olimpia: Praha.

Gabryś, T., Rutkowski, T. (2002) *Ice hockey*. Warszawa: COS.

Kostka, V. et al. (2000) *Book for couche IIHF*. Warszawa: PZHL.

POST 2.2.7
Tackling effectiveness in professional rugby league

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On average 300 tackles are made in a professional rugby league match with tackling proficiency suggested to be related to success (Gabbett et al., 2011). This study assessed tackling proficiency in terms of number of players committed, type of tackle, area of the pitch, tackle count and the outcome of the tackle. Ten London Broncos RLFC games (known as Harlequins Rugby League at the time) were randomly selected from the 2011 Engage Super League season with a balanced win loss record. Performance measures were defined specifically for this study and coded using the Focus X2 software (Elite Sports Analysis, 2002). Intra-observer reliability tests demonstrated <5% error for each of the variables examined. Data was analysed using the chi-square test for independence in the IBM SPSS Statistics package (v19, SPSS Inc, 2010).

Results showed that the analysed team committed similar numbers of players into the tackle in both winning and losing matches but the success rate for tackling when just one man was committed was significantly lower (chi-square = 12.55, df = 1, $p < 0.001$, phi = 0.16) in losing matches (26.70%) compared to winning matches (42.20%). Similar success rates were shown between winning and losing matches when two (≈87%; chi-square = 0.35, df = 1, $p = 0.55$, phi = 0.02) or three or more players (≈96%; chi-square = 0.97, df = 1, $p = 0.33$, phi = 0.04) were committed. Further analysis revealed that it was when the opposition ran a C play (ball passed across the width of the pitch) that tackling success rate decreased from a success rate of 80.00% in winning matches to 53.40% in losing matches (chi-square = 21.99, df = 1, $p < 0.001$, phi = 0.28). This tackling success rate was also different between winning and losing matches when the opposition ran the A/B play (81.40% and 76.90% respectively; chi-square = 4.19, df = 1, $p < 0.05$, phi = 0.05) but there was no difference for the scoot play (≈73% success rate; chi-square = 0.01, df = 1, $p = 0.93$, phi = 0.01).

This analysis has showed where this particular team performed at a lower level during losing matches. This was shown to be a lower success rate of tackling when only one man was committed to the tackle and this seemed to be more prevalent when the opposition ran a C play. It is suggested that the use of the effect size (phi) in this study gives better practical information for coaches than the significance level. For example tackling success rate for the A/B plays was significantly different ($p < 0.05$) but the effect size (0.05) was very small suggesting that there was no general difference in performance although just one missed tackle at a crucial point in time could be the difference between winning and losing! Future studies could further this research by adding more performance variables and compare between different levels of playing standard.

Gabbett, T.J., Jenkins, D.G. & Abernethy, B. (2011) Correlates of tackling ability in high performance rugby league players. *Journal of Strength and Conditioning Research*, 25(1): 72-79.

POST 2.2.8
A statistical profile of twelve-a-side rugby union game in Japan

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[6]*University of Otago, Dunedin, New Zealand*

Japan national team has intended to perform open play in international matches to compensate its own body size. In 1989, Japan Rugby Union adopted twelve a side game for junior high school boys aged 13 to 15. This game is regarded as lead-up to fifteen a side game based on the stages of physical development and Japanese own play style. Thus, the aims of this modified game are not only to promote safety in scrum, but also to increase ball in-play time, to facilitate more running and handling skills and to reduce contact plays in a match (Yokoi, 1989; Kawashima, 1991). The purpose of this study was to provide statistical features of twelve a side game.

 A manual notation system was used to collect data from digital video recording of junior high school games in 2010 and 2011. Fifteen games were analyzed. The scoring points, modes of scoring, sources of try, frequency of pass, kick, ruck/maul, lineout and scrum were observed. Chi-Square test was used to identify significant differences among phases and sources that preceded each of the tries.

Overall statistical features of games are shown in Table 1,2 and 3.

Table 1. Scoring

Average points per game	33.8
Types of scores	
Tries	80.8%
Conversions	14.4%
Penalties	1.8%

Table 2. Source of tried

Pen / free kick	25.0%
Turnover/handling	14.0%
Scrum own	11.0%
Opponent kicks	11.0%
Line outs own	8.0%
Restarts	4.0%

Table 3. Type of ball activity / cycle.

Average ball in play time	17 minutes 37s	
Activity cycle		
Average passes per game	115.7	6.5 / minute
Average Rucks / Mauls per game	60.8	3.4 / per minute
Average kicks per game	15.8	0.8 per minute

Kawashima, A. et al. (1991) Play in junior rugby. *Annual Issue of Rugby Science*, 3: 89-94.

Yokoi, H. (1989) A study on junior rugby. *Annual Issue of Rugby Science*, 1: 1-4.

POST 2.2.9
Analysis of playing time of elite male water polo players at the 2011 World Championships

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At the FINA Water Polo World Championships, the preliminary round of a match lasts 3 days, followed by the final round held over 4 days. Men's and women's matches are held on alternate days. Changing the player is permitted anytime during the official match of 32 minutes. The physical fitness of each player, and the tactical ability of the team determine the playing time for each player. Therefore, the analysis of playing time of opponents may help in planning scouting tactics. The official match scoresheet, including the playing time of each player, of the international water polo tournament can be acquired from the official web site. The purpose of the current study is to analyze the significance of the playing time of elite male water polo players in the World Championships 2011, by conducting a statistical analysis of the official scoresheet.

The official score sheets of 48 men's water polo matches held at FINA World Championships 2011 (Shanghai, China) were obtained from the web site: http://www.omegatiming.com/index_home.htm#waterpolo/racearchives/2011/WP_Shanghai/res.html. The playing time of 177 male field players from 16 countries were selected. The average (SD) age and participation rate were 26.7(4.3) years and 6.0(0.7) matches, respectively. Each player participated in 5 to 7 matches during tournament. The average playing time, the coefficient variance (CV) of playing time for each player, and Pearson's correlation coefficient between the average playing time and CV for each player were computed. PASW Statistics 18.0 was used for the statistical analysis.

Average (SD) playing time of every player was 17.5(3.8) minutes per match. Average (SD) CV of every player was 0.27(0.24). The correlation coefficient between the average playing time and CV for every player was -0.64 ($p < 0.01$). Average (SD) age and playing time of centerback (CB; n = 43), driver (DR; n = 99), and centerforward (CF; n = 35) were respectively 27.5(4.4) years and 17.8(5.6) minutes, 26.0(4.1) years and 17.6(6.6) minutes, and 27.5(4.8) years and 16.8(4.6) minutes. Average (SD) CV of CB, DR, and CF were 0.25(0.15), 0.30(0.29), and 0.19(0.11), respectively. The correlation coefficient between the average playing time and CV for CB, DR, and CF were -0.73, -0.69, and -0.44, respectively ($p < 0.01$).

The playing time for the leading 4 countries in this tournament were analyzed. Average (SD) age and playing time of ITALIA (ITA, 1st place, n = 11), SERBIA (SRB, 2nd place, n = 11), CROATIA (CRO, 3rd place, n = 12), and HUNGARY (HUN, 4th place, n = 11) were respectively 28.4(3.6) years and 18.0(4.7) minutes, 25.7(2.7) years and 18.5(7.3) minutes, 27.2(4.8) years and 16.0(3.8) minutes, and 29.7(3.7) years and 18.0(8.0) minutes. Every country participated in 6 matches during this tournament. The number of field players from CRO was higher than that from other countries. This might be the reason that the average playing time of CRO was lower than that of other countries. Average (SD; country code) CV of the playing time for each player was as follows: 0.22 (0.12; ITA), 0.29 (0.16; SER), 0.32 (0.18; CRO), and 0.26 (0.29; HUN). The correlation coefficient between the average playing time and CV for ITA, SRB, CRO, and HUN was -0.66 ($p = 0.029$), -0.70 ($p = 0.017$), -0.38 ($p = 0.22$), and -0.69 ($p = 0.018$), respectively.

POST 2.2.10
Independence of shots in netball

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There is a perception of momentum among athletes and commentators of sport, but most scientific studies of actual sports behaviour have failed to provide evidence to support a greater chance of success when previous events are successful than when they are not (Bar Eli et al., 2006). To date, momentum has not been investigated in netball shooting and, therefore, this study aimed to analyse the concept in netball. Shooting performances in 20 British National Super League matches were analysed. This included 40 team performances and 112 player performances. As well as recording the outcomes of shots, locations and defence variables were also recorded. A series of chi square tests of independence were applied to the data to see if shot outcome was related to previous shot outcome.

There was one team performance with a significantly association between shot outcome and previous shot outcome (p = 0.010). However, the 8 / 30 shots scored when the previous shot had been scored was a lower proportion than the 21 / 36 when the previous shot had been missed. There were only three individual player performances out of 112 that were significant, but two of these showed the opposite to momentum (5 / 15 scored when previous shot scored and 10 / 13 when previous shot missed, p = 0.021; 6 / 16 scored when previous shot scored and 10 / 13 when previous shot missed, p = 0.034). The one performance where a greater proportion of shots were scored when the previous shot had been scored (30 / 33) than when the previous shot had been missed (4 / 7) failed to satisfy the assumption of an expected frequency of at least 5 in each of the cells.

Other factors such as marking conditions and location of shot had a significant influence on shot outcome. The 79.2$\pm$31.5% of shots scored when two defenders were marking was significantly higher than the 65.7$\pm$12.7% and 66.3$\pm$18.7% of shots scored when 1 and 0 defenders were marking respectively (p = 0.046). Shot location had a significant influence on the percentage of shots scored with a greater percentage of shots being scored close to the net (p < 0.001); more than 70% of shots were scored in the 3 areas closest to the net, less than 60% were scored from the at edge of the shooting circle and between 60% and 70% were scored when shooting from the middle band. The 64.5$\pm$13.1% of shots scored when defender was in front of the player was significantly lower than the 81.1$\pm$30.2% and 81.7$\pm$24.6% of shots scored when the defender was to the back and side of the player respectively (p < 0.001). An interesting observation that might explain the discrepancy between perception of momentum and actual performance is where shots were taken from. When the previous shot had been missed, 29.6% of shots were played close to the net compared with 22.4% when the previous shot was scored. Thus the perception of momentum may have lead players to take on more difficult shots when a shot was scored.

Considering the 66 players who took 20 or more shots, the location of the next shot was examined. When the previous shot was scored, players shot from close range on 22.6$\pm$16.1% of shots, mid-range 62.2$\pm$16.1% and long range on 15.2$\pm$14.3% of shots. Wilcoxon Signed ranks tests tests revealed no significant difference to the percentage of shots taken from close (26.1$\pm$24.3%, p=0.257), medium (61.4$\pm$24.9, p=0.820) and long range (12.5$\pm$14.1%, p=0.087) when the previous shot was missed.

Bar-Eli, M., Avugos, S., & Raab, M. (2006) Twenty years of "hot hand" research: Review and critique. *Psychology of Sport and Exercise*, 7(6): 525-553. doi: Doi 10.1016/J.Psychsport.2006.03.001

POST 2.2.11
How a basketball game works: the time

Juan Manuel Martín González[2], Yves de Saá Guerra[1] & Juan Manuel García-Manso[1].

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The reality shows us that the score of a basketball game is a direct reflection of the dynamic and non-linear interactions of the teams and its components (Kubatko et al. 2007; George et al. 2009; Yarrow et al. 2009; Ziv et al. 2010). However, the evolution of the score in time seems to have certain patterns or properties that confer identifiable characteristics of each league. We tried to identify them in order to know in detail the internal logic of competition. We studied a total of 5 seasons (1230 games per season, with a total of 6150 games) of the NBA regular season. In every game we analyzed the game transcription published by the NBA in which are described in detail, all incidents that occur play by play (NBA). In basketball, the time between points is a random process, which a part follows an exponential distribution defined by ⍺. It is the relationship between the number of events and the time. The distribution has a peak around 20´´, and a possible long tail beyond 100´´, with a maximum value of 310´´. The most likely time between goals is around 20´´. Below and above these values the probability drops rapidly, although the effect is much greater for short baskets times. For higher values of this peak, the probability decreases until attained a certain value, begin to be considered rare phenomena (low probability). For values above 100´´ is possible that it begins to exhibit similar behavior to a *power law*. The ⍺ value does not remain stable throughout the game. In the first quarter, it presents the lower values than the rest of the quarters. And the last one stands out for its end so marked. Moreover, the Coefficient of Variation tells us that the data behave uniformly (Poisson process) to a certain value, from which this tendency is weakened and becomes much more heterogeneous.
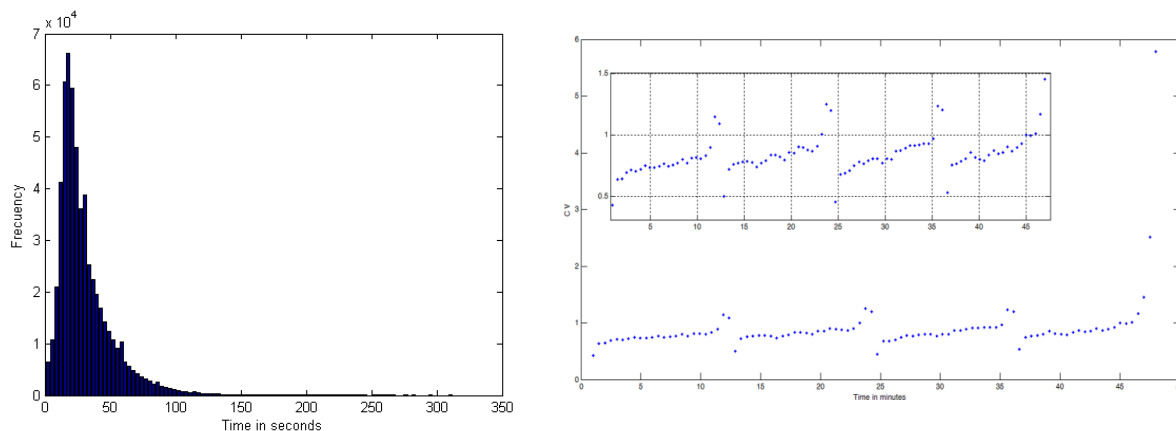
Figure. Frequencies histogram of the time between points in the sample analyzed (Right). We can observe that the distribution is not homogeneous. Exists a peak around 20´´ time value, and also presents a possible long tail behavior. The coefficient of variation of the seasons analyzed quarter by quarter (Left) does not remain in the same values throughout the game. The tendency is always to increase from the beginning to the end of each quarter. And especially, it increase significantly in the final minutes of the last quarter. In the upper left box is represented a zoom of the coefficient of variation, where the values greater than 1.5.have been rejected.

POST 2.2.12
Tendencies of youth basketball defense to offense transition

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The aim of this study is to describe the tendencies of youth basketball defensive to offensive transition. In that regard, games (n=9) of an under-14 basketball Portuguese regional final competition, were first videotaped and later analyzed, using the software of analysis – Utilius. The final sample was composed of 1022 transitions, in which were determined the following variables: 1) Area where the ball was recovered; 2) form of recovery; 3) Area of outlet pass; 4) Area of transition development; 5) duration; 6) number of passes; 7) number of dribble actions; 8) Shooting area; 9) End of transition; 10) Shot outcome.

The main results show that in average the duration of the transitions was 5,05 sec. with 1,4 passes being executed and 1,16 dribbling actions being taken. Transitions were mainly developed through the central corridor (62,4%), the preferred shooting areas were the ones closest to the basket (86,4%) and the layup (72,9%) was the most used shot with 49,5% of success. The conversion to 5 on 5 half court offense (70,6%) was the main outcome of the transitions, with turnovers being the second (13,0%).

POST 2.2.13
Analysis of the influence of the Líbero in different phases of the game in KI and KII volleyball

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The aim of the study was to analyze the participation and the influence of the líbero player in the assault phase and in the defense phase in male high-level volleyball.

The sample of study was composed by 1101 actions of game of receipt and defense, of four equipments better classified under the Olympic Games of Pekin 2008. The variables of study were: player reception/defense, zone of reception/defense, efficiency of the receipt/defense, and efficiency of the placement, zone of assault/counterattack, time of assault/counterattack and efficiency of the assault/counterattack. Data were treated in an initial phase through descriptive statistical techniques and, subsequently, was used inferential statistical techniques, based on the latter, in contingency tables, Chi-square and Cramer's V values.

The results showed that in the phase of assault significant associations did not exist between the different studied variables and the player who receives (Mesquita et al. 2007). On the contrary, in the phase of defense there were significant associations between: the player who defends and the zone of defense, predominating over the defense of the líbero in defensive zone (left side); the player who defends and the efficiency of the defense, being major that waited by the random the defense of efficiency 4 on the part of the player líbero, opposite to the predominance of the efficiency 0 when another player defends; the player who defends and the zone of counterattack and the assaults being increased by zone 6 when it defends the líbero.

The participation of libero player on defense is significantly higher than the rest of their peers in defensive zone (left side), fundamental importance in defense field. Quality of his performance defensive (libero), as well as frequent intervention zone (5 zone), allowing both aspects the use of fast attack combinations that generate more uncertainty and defensive difficulty for the opponent.

Mesquita, I., Manso, F. & Palao, F. (2007) Defensive participation and efficacy of the libero in volleyball, *Journal of Human Movement Studies*, 52: 95-107.

POST 2.2.14

Behavior trends of competitive amateur athletes and professional college of futsal teams: a study of the prevalence of variables between them; set goals, compete and win

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The present study aimed to investigate and compare the prevalence of variables between them set goals, compete and win in the behavioral tendencies of competence competitive athletes female futsal teams associated with the practice time and age. Identify the possible differences between the perceptions of these tendencies in competitive athletes belonging to two groups: athletes, professionals and university federated-Amateur. The method used in this study was exploratory and descriptive. The survey instrument used was the "ACS-2" - Metric System Diagnostics and Trends of Competitive Behavior (Simões, 2011) consists of a set of twenty descriptive phrases and objective information on behavioral tendencies of athletes. Were diagnosed and measured 69-federated professional athletes between 16 and 37 (mean age 21.85 +4.38 years), components of seven teams that compete in national competitions, 35-college amateur athletes between 18 and 29 years (22 42 +2.43 years) belonging to five teams vying for championships college-level state of Sao Paulo. Among the survey results were not statistically significant differences for age, length of practice and competitive behavioral variables between the groups getting the homogeneity between groups. In assessing the sum of trends, statistical difference was observed to set goals (TQ3 College = 79.76% + 9.12% Federated TQ1 X = 89.89 + 8.64), Trends in Winning (TQ2 College = 84%, 10 + 10.06% Federated TQ2 X = 90.53 + 8.33) and Racing (TQ1 College = 88.65% + 7.38% Federated TQ1 X = 90.35 + 7.36). The categories below were shown less ability to overcome psychosocial internal and external challenges (winning and setting goals) and confront them (compete). It is concluded that the Brazilian women's soccer stands carrying the responsibility of being the "poor cousin" of a nation, social groups, the amalgam of cultures and miscegenation, a sport of Brazilian soul who suffers for the lack of interest from organizations, but resists difficulties with pride and determination.

POST 2.3: INDIVIDUAL AND RACKET SPORTS

POST 2.3.1
Strategy in national championship 2000m indoor rowing

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Tactics in middle distance running events can be represented by split times during races (Brown, 2005). The purpose of the current research was to apply this approach to 2000m indoor rowing. The 500m spit times for athletes who competed in the 2010 British Indoor Rowing Championships are available on the championship web site (http://concept2.co.uk/birc/results?year=2010). These split times were converted into percentages of each athlete's finishing time so that strategy could be considered in a way that accounted for differing ability levels. Data for the 125 finishers in the men's and women's open lightweight and heavyweight categories were entered into SPSS version 18 (SPSS: An IBM Company, Armonk, NY). Kolmogorov-Smirnov tests revealed the split times for the first three 500m sections were not normally distributed ($p \leq 0.012$). Therefore, nonparametric statistical tests were used to compare the four groups. A series of Kruskal-Wallis H tests revealed no significant differences between the 4 groups for any of the four 500m splits ($p \geq 0.056$). A cluster analysis revealed two dominant clusters of performance and two other clusters as shown in Table 1. The males were distributed 52 in Cluster 1, 33 in Cluster 2, 8 in Cluster 3 and 2 in Cluster 4. The females were distributed 14 in Cluster 1, 12 in Cluster 2, 3 in Cluster 3 and 0 in Cluster 4. There was no significant association between gender and strategy ($\chi^2_2 = 0.521$, $p = 0.771$). The data show that different strategies are adopted by rowers but that there are no gender differences in strategy adopted. A limitation of the study is that observed split times may result from factors such as fatigue or loss of motivation in some cases rather than strategic decisions made by rowers.

Table 1. Percentage of 2000m finishing time taken for different 500m sections of the race.

Group	1st 500m	2nd 500m	3rd 500m	4th 500m
Open Male Heavyweight (n=75)	24.4±0.7	25.1±0.3	25.4±0.4	25.1±0.5
Open Male Lightweight (n=21)	24.6±0.5	25.0±0.3	25.2±0.3	25.3±0.5
Open Female Heavyweight (n=21)	24.2±0.7	25.2±0.2	25.4±0.3	25.2±0.5
Open Female Lightweight (n=8)	24.2±0.4	25.0±0.2	25.5±0.2	25.3±0.4
Cluster 1 "Fast last 500m" (n = 67)	24.8±0.3	25.2±0.2	25.2±0.2	24.8±0.3
Cluster 2 "Fast first 500m" (n = 45)	23.9±0.6	25.0±0.3	25.5±0.3	25.7±0.4
Cluster 3 "Fast first and last 500m" (n = 11)	23.6±0.4	25.6±0.2	25.9±0.3	25.0±0.3
Cluster 4 "Slow first and last 500m" (n = 2)	24.8±0.2	24.7±0.2	24.7±0.3	25.8±0.5

POST 2.3.2
Performance analysis in individual competitions in rhythmic gymnastics

Tina Breitkreutz & Anita Hökelmann

Rhythmic Gymnastics belongs to the technical-compositional sports and combines high level sport performance with difficult body movement elements (jumps and leaps, balances, flexibilities and waves, pivots) and apparatus techniques of ball, hoop, ribbon, rope or clubs with an aesthetic and artistic aspect. Thus, performances in Rhythmic Gymnastics are influenced by quantitative and qualitative factors. Qualitative factors are difficult to analyse as they are highly dependent of subjective perceptions. Quantitative factors are more objective and as a consequence, more suitable for performance analysis. Pivots are thought to be an important body movement group in terms of the required constant performance improvements as they provide a high variability in movement execution and therefore, increase the creativity and originality of the whole routine. The finals of the Berlin Masters competitions 2011 (Berlin, Germany) were analysed with a special interest in *Pivots*. The aim was to define the current performance level in individual competitions in Rhythmic Gymnastics, to detect tendencies in performance development and thus, derive recommendations for the specific coaching process.

The analysis was done post-event, based on video footage of the 32 final routines (each 8 routines with the apparatus ball, hoop, ribbon, and clubs). The videos were recorded at 25Hz and showed the entire gymnastics mat from the perspective of the jury desk. The analysis was performed utilising the notational software Utilius vs. (CCC-Software, Germany). Finally, the Cohen's Kappa test was employed to check the results for reliability.

Table 1. Intra- Inter reliability in the Berlin Masters 2011.

Apparatus	Intra-reliability	Inter-reliability
Ball	91%	98%
Ribbon	79%	69%
Hoop	96%	91%
Clubs	100%	77%

115 pivots were carried out within the examined final routines. Most pivots were performed with the apparatus ribbon and clubs. It also became apparent, that the highest number of pivot revolutions (more than 4 full revolutions) was demonstrated in the routines with clubs (6) and the fewest with the ball (3). With regards to the behaviour of the free leg during the pivots with the most revolutions it was found, that the most frequent position was 'At Horizontal' or 'In Split'. Also Fouetté-Pivots were demonstrated very often. Almost every pivot (84-93%) was started using the Relevé technique and was then performed in the direction of the supporting leg (equilateral [85-89%]). Spirals with the ribbon and Handling of the clubs tend to be combined with pivots most frequently. The test for reliability showed good to very good results for intra- and inter-reliability in all apparatus final groups (Table 1).

Concluding, it must be stated that the choreography analysis of the Berlin Masters 2011 contributes to the description of the performance structure in rhythmic gymnastics. Most findings conform to the statements in the Code of Points (official competition regulations) or can be explained by biomechanical aspects. For example, it was found that the most pivots were performed with clubs and ribbon and the fewest with ball. Clubs and the ribbon may be utilised as an elongation of the free mass and thus have a positive effect on the generation of the angular momentum. The Relevé can be stated as beneficial for the routines due to the powerful extension of the previously bent supporting leg in terms of load relieving in upward movements. To gain more knowledge about the performance structure in rhythmic gymnastics more analysis of high level individual competitions need to be done.

POST 2.3.3
A needs analysis of canoe and kayak slalom to identify a coherent performance analysis strategy

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Unlike many individual sports (e.g. running and jumping events in athletics) canoe slalom does not have world records to aim for or to be measured against. This brings challenges to training sessions when determining what was a good performance and how this could be compared with competition performance. Canoe and kayak slalom analysis typically involves identifying time losses / gains by an athlete in comparison to their competitors to identify moves that are quicker and to provide objective feedback to their athlete on how good their performance was.

O'Donoghue & Longville (2004) documented a step-by-step procedure of how they developed their notation system for netball. This needs analysis; evolutionary approach was adapted for the current study with the outcome an analysis template that could be used real-time (limited data input) and lapsed-time (additional data input for more complex analysis). As O'Donoghue (2008) stated, it was necessary to have an optimal set of performance indicators to provide sufficient information but small enough to be collected reliably in real-time.

Interviews with the coaches and athletes identified the benefits that performance analysis could provide and the performance indicators thought to be beneficial (Table 1). These measures were not simple in many cases, for example split times can be used at different parts of the course and be determined by upstream and downstream gates. Ultimately the utility of these times lay in the ability of the analyst to identify performance standards (peer-related) and quantify differences in times (course specific) with identifiable reasons for the time differentials.

The next stage of development hopes to identify season trends e.g. an athlete may lose the majority of time in the upstream gates, with a view to incorporating this information in a coherent performance enhancement strategy.

Table 1: Performance indicators used in the analysis of canoe / kayak slalom

Performance Classification	Technical	Tactical
Run time (inc. pens)	Penalties	Penalties
Run time (exc. pens)	Moves	Moves
Penalties	Type of gates	Type of gates
Split times	Time loss / gains	Time loss / gains
	Technique	Techniques used
	Water features	Water features
	Stroke count	Strokes used

O'Donoghue, P.G. & Longville, J. (2004) Reliability testing and the use of Statistics in performance analysis support: a case study from an international netball tournament. *Performance Analysis of Sport 6* (Editors: O'Donoghue, P.G. and Hughes, M.D.), Cardiff: CPA Press, UWIC: 1-7.

O'Donoghue, P.G. (2008) Principal components analysis in the selection of key performance indicators in sport. *International Journal of Performance Analysis in Sport*, 8(3): 145-155.

POST 2.3.4
The evaluation method for effects of shots in ground strokes of tennis

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The purpose of this study was to clarify the evaluation methods for effects of shots in ground strokes. We hypothesized that effects of shots were evaluated the receiver's condition of posture in ground strokes. In general players could not shot effectively for opponent on the poor posture. We made an original scale to evaluate the receiver's condition of posture in ground strokes (Table 1). This scale consists of 14 checkpoints. We evaluated each ground strokes by using this checkpoints (each checkpoints : 1 point, total score : 14 points). We analyzed 2470 ground strokes of 4 matches held in 2004 Masters Cup (men's singles tournament). We calculated average score of each analysis points as following :"result of shots", "situation of play", "feature of ball", "hitting position (forward) of opponent (fig.1)", "hitting position (forward) (fig.1)", "hitting position (lateral) (fig.1)", "situation of play" (tab.2). Those analysis points were picked up from tactical point of view. To investigate construct validity of the scale, those scale score were compared within each analysis points. An ANOVA test was used to compare and Tukey's HSD test was used to pairwise comparisons (tab.2). There were significantly different in all analysis points. Those results suggested that we could evaluate effects of shots by the score for the condition of posture in ground strokes and this scale was made good of use.

Table 1. The scale for evaluated the condition of posture between ground strokes

Phases of stroke	checkpoint	Juddgement (Yes or No)
Preperration and Backswing	Trunk and Upper Body	a. The steady of trunk and upper body is kept at the end of a racquet preperation
	Head	b. The head position is between both feet at the end of a racquet preperation
	Racquet preparation	c. The racquet preparation is finished when the ball is bound.
	Legs	d. Either leg is made placement as hitting stance when the ball is bound.
		e. Both legs are made placement as hitting stance when the ball is bound.hen the ball is bound
Forward swing and Contact	Trunk and Upper Body	f. The steady of trunk and upper body is kept during swing
	Head	g. The head is between both feet during swing
	Impact	h. The impact positon is a comfortable distance from the body
	Movement	i. The moving speed and range is effective during swing
	Swing	j. The racquet speed is appropriate to control the ball
Follow through	Trunk and Upper Body	k. The steady of trunk and upper body is kept during swing
	Head	l. The head is between both feet during swing
	Follow through	m. The Racquet finsh is appropriate to keep balance
	Recovery	n. The body work of recovery is appropriate for ready to move to the next stroke.
Follow through	Follow through	m. The Racquet finsh is appropriate to keep balance
	Recovery	n. The body work of recovery is appropriate for ready to move to the next stroke.

Table 2 The score compared by each factors

Result of shots			Situation of play			Feature of Opponet's balls		
Aces	12.26		Base-lined play	11.18		Slow	11.62	
Continued	11.59	*	Return	9.39	*	Normal	11.45	*
Errors	9.14	*				Fast	8.87	*
						Slice	11.28	*
						Lob	12.67	

Hitting position of Oppornet(forward)			Hitting position (forward)			Hitting position (lateral)	
Net	8.12		Net	8.8		Eternal-D	10.05
Front	9.23		Front	11.38	*	Internal-D	10.83
Middle	10.71	*	Middle	11.76		Center	12.04
Baseline	10.54		Baseline	11.53		Internal-AD	11.38
Back	10.7		Back	9.93		External-AD	10.90 *: all except "ED×IAD"

* P < 0.05

Figure 1 Division of tennis court
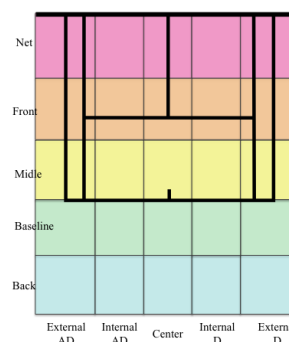
POST 2.3.5

Momentum in tennis matches at Grand Slam tournaments

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Previous investigations have provided evidence for and against the existence of momentum in sports performance (Bar Eli et al., 2006). Previous notational analysis research in tennis has failed to reveal more sequences of points of various lengths than would be expected by chance (O'Donoghue and Brown, 2009). However, the work of O'Donoghue and Brown was applied at the point level rather than at broader game and set levels. Analysing momentum in terms of games in tennis is problematic due to the dominance of the serve. Therefore, the purpose of the current investigation is analyse momentum at the set level in tennis. All completed matches of the 2009 to 2011 Grand Slam singles tournaments were included in the investigation. Winning players always win the last set of a match and if the preceding set outcomes are independent then a chi square goodness of fit test would not find a significant difference between the distribution of matches of different set orderings and an expected uniform distribution. Table 1 reveals that there is evidence momentum at the set level in men's singles with eventual winning players having lost the first set of 4 set matches more than expected and eventual winning players having lost the first set or first 2 sets of 5 set matches more than expected. In women's singles, the eventual winning player lost the first set more than significantly than expected at the French Open.

Table 1. Number of completed matches of different numbers of sets in 2009, 2010 and 2011 Grand Slam singles tournaments.

Gender	Sets	Aus Open	Fr Open	Wimbledon	US Open	All Matches
Women 3 sets	LWW	55	61	70	61	247
	WLW	69	51	46	44	210
	χ^2_1	1.6	0.9	5.0 *	2.8	3.0
Men 4 sets	LWWW	41	40	42	36	159
	WLWW	26	47	37	35	145
	WWLW	32	17	41	28	118
	χ^2_2	3.5	14.2 ***	0.4	1.2	6.2 *
Men 5 sets	LLWWW	17	13	21	14	65
	LWLWW	12	9	10	12	43
	LWWLW	9	11	14	9	43
	WLLWW	10	11	6	12	39
	WLWLW	6	8	6	6	26
	WWLLW	12	8	17	9	46
	χ^2_5	6.2	2.0	15.0 *	4.0	18.2 **

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Bar-Eli, M., Avugos, S., & Raab, M. (2006) Twenty years of "hot hand" research: Review and critique. *Psychology of Sport and Exercise*, 7(6): 525-553.

O'Donoghue, P.G. & Brown, E.J. (2009) Sequences of service points and the misperception of momentum in elite tennis. *International Journal of Performance Analysis in Sport*, 9(1): 113-127.

POST 2.3.6
Analysis of distance covered and speed of movement in a Valencia Open 500 elite tennis match

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This study analyzed the distance covered and speed of movement in high level tennis using the SAGIT software, an automatic tracking system that allows automatic player motion data from digitized video recordings of matches (e.g. Filipcic & Filipcic, 2009; Vučkovićet al., 2002). The aim was to provide information about the demands of high-level tennis, of which there is little in the extant literature. One match, played on an indoor hard court in the Valencia Open 500, was recorded with two video cameras; each placed above one half of the court. The match score was 6-3, 6-1 and had a duration of 1h 6min. The players covered an average distance of 3,375m, with the winner covering 3,705m (an average of 231.56 m per game) and the loser 3,045m (190.31m per game). The players' average speed in the match was 0.70m/s with the winner's average speed 0.77m/s and his maximum speed 7.4m/s. In contrast the loser's average speed was 0.63m/s and his maximum 6.6m/s. Trajectories and velocities for the winner (a) and loser (b) are showed in Figure 1. The distance covered was similar to that found for squash players (Vučković et al., 2002) and higher than for wheelchair tennis players (Filipcic & Filipcic, 2009) with the speed of movements also higher than for wheelchair players. It was interesting that the winner covered a greater distance than the loser, contrary to expectations. This may have been due to his apparent tactic of playing a defensive game and waiting for his opponent to make errors. Further analyses of more elite tennis matches played on different surfaces are needed to establish the specific requirements of elite level tennis.

(a)　　(b)
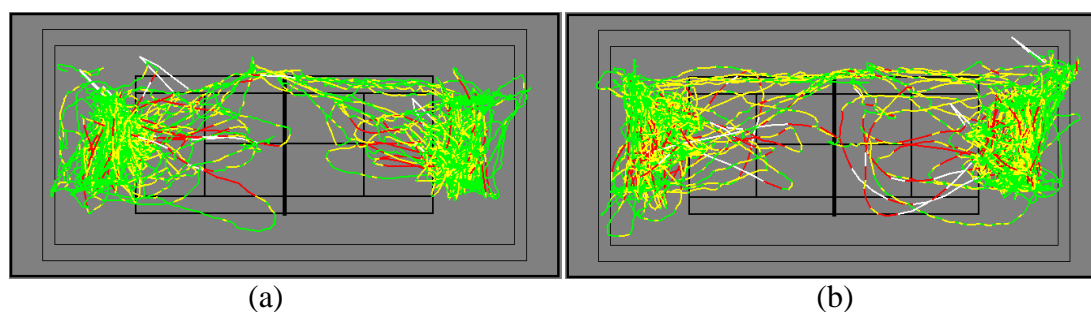
Figure 1: Trajectories and velocities for winner and loser in a straight sets match at the Valencia Open 500.
Key: Green, yellow, red and white lines indicate movement categories of walking, jogging, running and sprinting respectively

Filipcic, T., & Filipcic, A. (2009) Analysis of movement velocity and distance covered in wheelchair tennis. *Kinesiologia Slovenica, 15*(2): 25–32.

Vučković, G., Dezman, B., Erculj, F., Kovacic, S. & Pers, J. (2002) Computer tracking of players at squash matches. *Acta Kinesiologia*, 7: 216-220.

POST 2.3.7
Investigation of serve and serve return strategies in different elite tennis populations

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A match analysis of singles tournament at the 2008 Australian Open Grand Slam tournament and the 2008 Australian National Junior Tennis Singles Championship was investigated to examine tennis serve and return of serve performance of different age-groups. It was found that male professionals served significantly more aces than the Under-16 and Under-12 male players, while female professionals served more aces than the Under-12 female players. Irrespective of gender, professional players served significantly fewer double faults and won a higher percentage of first serve points, as well as a higher percentage of second-serve return points. The male professionals experienced significantly more difficulty in winning points when receiving their opponents" first serves than all the other groups. The findings highlight age-group differences of serve and return of serve performance on single event on hard court and suggest coaches to try to recognise specific serve and serve return drills suitable for different age-group.

POST 2.3.8
Designing a complex analysis system for real tennis

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The complexity of a notation system is determined by data entry considerations (essentially time required to input if live coding) and the analysis requirements (depth of data processing, sequential dependency). Most racket sports notation systems use a basic information structure: Player, Position, Action and Outcome although this has been modified in many ways to generate specific information of interest e.g. the simple winner error analysis in squash (Murray & Hughes, 2001). This study is the first to provide a method for the comprehensive analysis of real tennis, a game which is complex in comparison to other racket sports mainly due to the fact that some rallies are not completed at the end of the rally but held in abeyance and the outcome of the rally used as an outcome constraint in a future rally. The reason for this rather confusing scenario is fact that the court is not symmetrical and serving takes place on only one side of the court. The mechanism for changing ends is the system of holding a rally in abeyance, known as the "chase" and is determined by where the ball finishes if the opponent does not make contact with the shot (either the ball bounces twice or enters one of the galleries at the side of the court). In order to assess real tennis in terms of shots (location, accuracy, efficiency and selection) and player movements (Vučković et al., under review) rallies had to be categorised according to whether a chase was in force or not, and if there was, what the chase was. Hence 6 categories were entered for each shot: rally type (chase (n = 33) or not), player (match winner or loser), area of the court (n = 22 cells), shot type (drive, boast, volley, service), shot trajectory (floor, main wall, grille wall, dedans wall, galleries wall, side wall, high grille wall, high dedans wall, penthouse, tambour) and outcome (rally continues, chase, winner, error, target hit, non-determined shot). Data entry was undertaken using Dartfish TeamPro v6.0 in conjunction with SAGIT (Perš *et al.*, 2001) for player movement and ball location analysis. Reliability tests were used to determine that the errors associated with data entry were acceptable for analysis purposes. Where this was not the case the data entry was modified to provide acceptable error (<5%).

Murray, S. and Hughes, M. (2001) Tactical performance profiling in elite level senior squash. In (eds. M. Hughes and I.M. Franks) *pass.com*, Cardiff: CPA, UWIC, pp. 185-194.

Perš, J., Vučković, G., Kovačič, S. & Dežman, B. (2001) A low-cost real-time tracker of live sport events. In *Proceedings of the 2nd international symposium on image and signal processing and analysis in conjunction with 23rd International conference on information technology interfaces* (edited by S. Lončarić and H. Babić), pp. 362-365. Zagreb: Faculty of Elektrical Engineering and Computing.

Vučković, G., James, N. Murray, S. and Hughes, M & Perš, J. (under review) The effect of court location, preceding shot type and available time on the tactical shot selection of elite squash players. *Journal of Sports Sciences*.

POST 2.3.9
The effect of changing the scoring system on game related activity in squash

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Previous research has assessed game related activity in squash played under the old scoring system to 9 points, with scoring on serve only (Vučković et al., 2009). The World Squash Federation has subsequently adopted an alternative scoring system to 11 points, point a rally scoring system (PARS). The original PARS format was to play up to 15 points but this was reduced to 11 points in 2004. During the same period the Professional Squash Association (PSA) introduced a reduction of 2 inches to the tin height (for professional men's squash only) in an attempt to shorten the rallies and the match duration. This paper will assess the extent to which these objectives have been met.

Matches at the 2003 World Team Championships (n = 11) and the 2010 Rowe British Gran Prix (n = 10) were recorded and processed by the SAGIT/SQUASH tracking system (Vučković et al., 2009). Game time, ball in play time, distance covered and number of rallies were calculated for each game and each player. All data were examined for normality (Shapiro-Wilk) and with some departures from normality and large differences in variance noted between groups Mann-Whitney U tests were used.

The average game time for the new scoring system (590.9s, sd = 245.7) was significantly shorter (p<.001) than for the old scoring system (1004.9s, sd = 403.2). This also resulted in a significantly shorter ball in play time (330.6s, sd = 119.9) than previously found (547.1s, sd = 215.7) but ball in play as a proportion of total game time did not change significantly for the new scoring (57.2%) in comparison to the old (55.0%). In a similar pattern the distance covered by each player during a game was significantly less (p<.001) for matches played under the new scoring system (635.9m, sd = 247.0) in comparison to the old (1118.9m, sd = 425.7) as was distance covered during ball in play time less for the new scoring (451.0m, sd = 168.0) compared to the old (795.2m, sd = 305.5). The new scoring system has resulted in significantly (p<.001) fewer rallies (21.1 sd = 5.7) than previously found (34.0 sd = 10.8).

The Professional Squash Association's (PSA) attempt to shorten the rallies and the match duration by changing the scoring system appears to have worked. This analysis has shown that game times have been reduced by nearly one half with a reduction in the number of rallies by about one third. This means that rally durations have been shortened, a key objective thought to make the game of squash more exiting to watch. Future analyses need to assess how the game has changed in terms of the types of shot played by elite players. One might suggest that with shorter rallies and thus less distance covered, players are now able to be more attacking in their strategies as higher intensity rallies are now more achievable.

Vučković, G., Perš, J., James, N. & Hughes, M. (2009) Tactical use of the T area in squash by players of differing standard, *Journal of Sports Sciences,* 27(8): 863-871.

POST 2.4 SPORT PERFORMANCE PSYCHOLOGY

POST 2.4.1
Management of psychological preparation in sport
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The important task of the sport psychology appears in the creation of psychological programs system for the different kinds of sport, securing decision of the tasks, constantly arising before coaches and sportsmen the time of the preparation and taking part in competitions. There are the following tasks: formation of psychological stability, formation of mental sportsman's reliability at the most responsible moments of performance in the competition, leading the sportsman (team) to the peak of psychological readiness in the responsible competitions, management of a mental condition of the sportsman by preparation and performance in competition.

The system of psychological securing, consisting of 6 programs, for use in the preparation of separate the sportsmen and the teams was worked out. The first program: «The leading of sportsman (team) on an optimum level of psychological stability». The main psychological principle of realization of this program is the principle "Limitation" of number of attempts at performance of the technical and tactical tasks with taking into account per cent individual effectiveness. It secured formation of a condition of "Confidence" by carrying out act games during competition. The second program: «Management psychological stability of sportsmen during competition season». The main psychological principle of this program is the principle «Permission to mistake» by definite limitation in games act. The third program: «Leading team to Pick of the psychological и sport form». The main psychological principle is the principle of «Planning mental strain in the training by preparation of the sportsman (team) to important competitions». Such work is planned 2-3 weeks prior to responsible competition. The fourth program: «Mental reliability forming of the sportsman in extremely situation of the competition». The main psychological principle of the program is the principle «One attempt» in the time of the training. The realization of this principle in training promotes formation at the sportsman of psychological readiness to effective performance of action at the most responsible moment of competition. The fifth program: «Management of the mental state of the sportsman during the preparation in more responsible competitions (games)». The main psychological principle is «Set to struggle». Constant use of this principle by preparation for competition and estimation of efficiency of actions of the sportsman in competition on the basis of this principle allows to form at the sportsman reliance and removes fear of a mistake. The sixth program: «Formation psychological readiness of the coach to the management of the sportsman (team) in extremely condition of the competition (game). The main psychological principle is «Till the competition is not finished the competition is not lost» by psychological readiness to defeat. The realization of these programs in teams of High and Super league allowed with more effectiveness to inclusion of psychological methods in training and competition process preparation teams and had a positive estimation of coaches. So, stability of service in volleyball and tennis the in responsible competitions has raised on from 15 % to 40 %, at the football players in hit in frame of a gate in competition was improved on 17 % the average. The using date given technology allowed to improve of psychic reliability with 20 % till 42 % on training and competition reliability with 12 % till 35 %. The usage of technology on the basis of principle of regulation of a mental pressure by preparation for final games allowed to lead 70 % of the sportsmen on peak of mental readiness by final tournament. The team (mini-football) won the goblet of Russia and European Cup of Goblet. At the same time the use of these programs demand essential change of ordinary organization of training and competition process. The main principle of this changing consist in that, the effectiveness of the training work of sportsman and team will be defined not quantitative criterions of carry out number of the technical-tactic acts but psychological criterion-per estimation sent of effectiveness carry out acts on the principals of «Limitation»,«Permission to mistake», «One attempt», «Rule to risk».

POST 2.4.2
Mental toughness and social loafing in male elite ice hockey players in Norway

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Social loafing (SL) refers to an individuals' tendency to exert less effort when working with others than when working alone, which may result in team performance that is not optimal. The presence of SL at elite level have been documented (Høigaard 2010) and several situational factors e.g. identifiability of individual effort, team cohesion, motivational climate, appear to moderate the magnitude SL with research recommending the investigation of personal factors in relation to SL (Høigaard et al. 2010). One such personal factor is Mental Toughness (MT) which is considered to be a crucial attribute in competitive sport and is defined by Loehr (1994, p.5) as 'the ability to consistently perform toward the upper range of your talent and skills regardless of competitive circumstances'. Theoretically therefore it is reasonable to investigate if MT is negatively related to SL among high performance athletes.

One hundred and fifty five players from 11 teams in the Norwegian premier league (mean age 22.7± 4.0 years; mean time playing at elite level 4.3±3.8 years) completed the Self-Reported Social Loafing Questionnaire (SRSLQ, Høigaard et al. 2010) and the Sport Mental Toughness Questionnaire (SMTQ; Sheard et al. 2009). The higher the SRSLQ score the higher the degree of SL and the higher the score on three SMTQ MT components; Confidence, Constancy and Control the higher the level of MT.

As can be seen in Table 1, SL was low; perceived level of MT was relatively high & that MT is negatively related to SL (Table 1). The results confirm that MT is invaluable aspect of elite athletes. Furthermore it also indicates that MT in addition to influence athletes' mental attitude also is related to motivation and effort. Taken together, this is all important factors in on order to improve team effectiveness and team performance. Investigate antecedents to MT is therefore of vital importance, and specifically what and how athletes and coaches can develop MT.

Table 1. SMTQ subscales and SRSLQ Cronbach α, means (±SD), correlation coefficients with SRSLQ (r) and multiple regression standardised beta

Scale	α	Mean±SD	R	beta
MT Confidence	.72	3.01±.48	-.22**	.03
MT Control	.53	2.75±.57	-.36**	-.19*
MT **Constancy**	.66	3.18±.56	-.48**	-.41**
SRSL	.77	1.70±.76		.

*p <0.5, **p<0.01 Regression model significant (F=(3, 135) 15.89, p<0.001, adj. R^2=.26)

Høigaard, R. (2010) *Social loafing in sport. From theory to practice*. VDM Verlag Dr. Müller Aktiengesellschaft & Co. KG.

Høigaard, R., Fuglestad, S., Peters, D.M., De Cuyper, B., De Backer, M., & Boen, F. (2010) Role satisfaction mediates the relation between role ambiguity and social loafing among elite women handball players. *Journal of Applied Sport Psychology*, 22(4): 408 - 419.

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POST 2.4.3

Analysis of psychological effects of the presence of peers and space perception during the performance of the twelve minutes run test (12-MRT) in estimating maximal oxygen consumption

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[3]Higher Teacher Training College, Yaounde, Cameroon

Field tests used to estimate maximum oxygen uptake (VO_2max) were developed to overcome the expensiveness of direct determination. Some authors found that the presence of peers enhances the spirit of challenge, motivation and self-determination resulting in the improvement of performance (Scalan et al., 1993; Vazou et al., 2005). The aim of this study was to assess the psychological effects of the presence of peers, and the perception of a reduced space in estimating VO_2max during the twelve minutes run test (12-MRT).

Thirty one athletes participated in three tests: achieving alone the 12-MRT of Cooper (Alone) on a 400 m track; achieving in groups of three the 12-MRT (Group); completing in groups of three the 12-MRT on a 200 m tract (Half). At the end of each test, the rate of perceived exertion (RPE), Heart rate (HR) and blood lactate [La] were determined.

Oxygen uptake output ($mLO_2.min^{-1}.kg^{-1}.km^{-1}$) was significantly higher during (Group) compared to (Half) (p = 0.0001), and compared to (Alone) (p = 0.002) (Table 1). VO_2max was significantly reduced by 4% in (Alone) and 9.3% in (Half) compared to (Group); whereas (HR) and [La] did not show any significant difference.

These results suggest that the improvement of VO_2max was due to psychological implication. Consequently, real VO_2max taking into account the psychological effect of group should be given as follows: ***VO_2max = VO_2max estimated + (4 VO_2max estimated /100)*** when the test is completed by one individual. Performing the 12 -MRT in a 200 m closed circuit impairs significantly VO_2max.

Table 1: Performance during the three testing protocols

Test	Distance (m)	VO_2 max ($mL.min^{-1}.kg^{-1}$)	Average speed ($m.min^{-1}$)	HR (bpm)	[La] ($mmol.L^{-1}$)
Alone	2880.2 ± 345.6^a	53.1 ± 7.7^a	240.0 ± 28.8^a	182 ± 10	7.5 ± 2.7
Group	2975.6 ± 355.1^{bc}	55.2 ± 7.9^{bc}	248.0 ± 29.6^{bc}	185 ± 8	8.3 ± 2.6
Half	2765.3 ± 325.4	50.5 ± 7.3	230.4 ± 27.1	184 ± 10	8.1 ± 2.6

[a]: significant difference from (Half) (p<0.001) [b]: significant difference from (Half) (p<0.0001)
[c]: significant difference from (Alone) (p<0.001)

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POST 2.4.4
Passion motives among top-class referees in football

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Vallerand and his colleagues (2003) have defined passion in sport as a strong inclination or desire toward an activity that one likes (or even loves), that one finds important (high valuation), and in which one invests time and energy. Johansen & Bjørnestad (2011) found in their study of motives for officiating football among part-time referees in lower leagues passion as one of three main categories; *fitness motives* (31 %), *passion motives* (25 %), and *social motives* (25 %). One may then ask: Do top-class football referees have the same motives for officiating, and do they see refereeing as a passionate activity? The aim of this study is to investigate the role of passion for officiating football among Norwegian top-class referees.

This cross-sectional study was conducted as a part of the "Norwegian Elite Referees in football"-study. A total of 83 (participating rate: 84.7 %) top-ranked referees (73 males and 10 females) from age 20 to 46 (mean age 33.3 years) completed a web based questionnaire (SurveyXact). The referees were asked to report randomly three main reasons or motives for officiating football. The data was analyzed using a well specified phenomenological procedure for qualitative research (Marton, 1995). Results were obtained by bracketing, intuiting, and describing the different motives reported and organized into categories of description. The different categories of description that emerged were studied and regrouped by two colleagues.

236 different motives for being a referee reported were bracket and grouped, and three main categories emerged; *passion motives*, 61 % (e.g., simply love football, enjoyment, mental fulfillment, coping of stress), *social motives*, 26 % (e.g., meeting with people, staying in football, football family, member of the officiating team), *fitness motives*, 13 % (e.g., physical activity, being in good shape, body appearance). A second analysis of the category *passion motives* revealed two main categories of passion; *activity related passion* (e.g., enjoyable, excitement, incredible fun), and *performance related passion* (e.g., handling stressful situations, feeling of success, leadership fulfillment).

It may seem that Norwegian top-class referees are in some extent more passionate in their refereeing than referees in lower leagues, and they don't report the fitness motives as frequent as referees at a lower level. One could say that Norwegian top-class referees´ officiating is based on the enjoyment in refereeing in itself, and their desire for an errorless performance. Their handling of the implementation of the laws throughout a football games gives them great satisfaction and fulfillment, and they are passionate about it.

Vallerand R.J. et al. (2003) Les passions de l´ãme: On obsessive and harmonious passion. *Journal of Personality and Social Psychology*, *85*: 756-767.

Johansen, B.T. & Bjørnestad, J.O. (2011) Motives for being a referee in football (soccer). *Proceedings for the 16th Annual Congress of the ECSS*, 6th – 9th July, Liverpool-UK: 97-98.

Marton F. (1995) Cognosco ergo sum. *Nordisk Pedagogik* [*Nordic Pedagogy*], *15*: 165-180.

POST 2.4.5
Influence of self-concept among adolescents in respect of sex, loyalty and regional culture

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The purpose of the study was to find out the influence of Self-concept among adolescents in respect of Sex, Locality and Regional culture. Four hundred eighty students age ranging from 16 to 18 years were selected following stratified random sampling method, from sixteen rural schools and fourteen urban Schools situated at four typically distinct geographical regions in west Bengal namely, Central Gangetic Valley, Western Table Land, Southern Sea-Coast and Northern Hill area. Even after selection of samples from the four distinct regions, the samples were further classified into rural and urban localities under which the subjects were categorized into boys and girls gender groups. 60 boys and 60 girls from each region were proportionately distributed. Each region consisted of 60 boys and 60 girls of which 30 boys and 30 girls were from urban schools and 30 boys and 30 girls belonged to rural schools. Schools affiliated under the west Bengal Council of Higher secondary education and situated within the jurisdiction of the four stated regions, were selected for the purpose of the study. The data have been collected during the year 2007-08, when the subjects were admitted in grade XI. Self-concept questionnaire consisting of 48 questions as standardized by Raj Kumar Saraswat to determine Self-concept. To assess the Influence of Self-concept among Adolescents in Respect of Sex, Locality and Regional Culture of four typically distinct geographical regions in west Bengal namely, Central Gangetic Valley, Western Table Land, Southern Sea-Coast and Northern Hill area, Three way Analysis of Variance statistics was applied at 0.05 level of significance. Significant differences were observed by the influence of Self-concept among adolescents in respect of Sex and Regional culture but insignificant difference was observed by the influence of Self-concept among adolescents in respect of locality.

POST 2.4.6
Effect of worship level in student athletes' mood

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People have learned in all situation take refuge from God and ask Him to help them and sharing with him their needs, desires and interests to get calm .The aim of this study was to examine Effect of worship level in student athletes' mood. The statistical society of this study was all students' athletes, Islamic Azad University of Dezful. The study sample included 80 male students' athletes that participate in training of university teams and selected randomly in different sports(badminton,Volleyball, football, wrestling, ping pong and Taekwondo).Descriptive and inferential statistical frameworks were applied to analyze and interpret the data. Tools for this research contain three researcher-designed questionnaires (assessment worship questionnaire) including 36 items with Likert 5 and MMPI questionnaire (questionnaire measuring psychological characteristics) included 71 questions and SPQ (sport personality questionnaire). The research method was descriptive-field, and with questionnaire examining research factors. The study variables were the amount of worship (independent) and mood (dependent). After selecting research participants randomly, subjects satisfactory completion of the questionnaires. There was Significant and negative relationship between sport anxiety and worship. There was significant relationship between sport motivation and worship. There was significant relationship between self-concept and worship. There was no significant relationship between average education and worship. The results of this study clarify that worship can influence on athletes mood.

Individualization psychoforming training in sport

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The formation of stabilizing personality of a sportsman is a very important component to the achievement of high level sport results in responsible competitions. Different methods are used for decision of this task. Methods of psychic self-regulation (autogen training, psychoregulation, psycho-muskle, mental trainings and etc.) are used also. The lack of these methods of psychic self-regulation consists that they include in process regulation in the more degree mechanisms of a physiological level ensuring regulation of physiological processes organism. Psycho-forming training is directed on include process regulation mechanisms of a psychological level: system motivational, emotional, purpose sets, what regulate mind of the sportsman, worked out at the center of sports psychology Ural University.

For realization this task it was used special psychotechnology. The first stage was directed on formation "govern set" for realization necessary programs. The psychological background are concentration-calm-confidence in myself. For formation this set used motivational set and directive myself suggest. The second stage was directed on formation system of sets. For it was used show performance, self-belief, self-order, self-analysis. The psychological background: that J want, that J can; that J must to do, that J want become, J can means. The third stage formation the personal purpose program of sportsman.

The rise of the effectiveness psycho-forming training must be individualized for each sportsman. The specificity of kind of the sport, personal features of24 the sportsman and situational moment of the competition activity it was taken into account while working out of individual programs. So, the five setting models for preparation to competition were used for sportsman runner of sprint.

1. **Calm model** - set to calm state before the start. It is used by inexperienced sportsmen, with high level of the anxious and s.o.
2. **Technique model** - it is used by sportsmen with unstable run and start technique; a bad relaxation in competition conditions and   s.o.
3. **Concentration model** - it is used by sportsmen with easy distracted and bad concentration; sportsmen with bad start and technique of run.
4. **Mobilization model -** set to maximum mobilization. It is used by sportsmen having a good sport form at main starts.
5. **5.Explosing model -** set to explosion. It is used by sportsmen for going out from habitual technique and psychological stereotype and development more high physical and mental level of the strain during run; for setting record.

The practice of individualization showed it help to achieve optimum and stable results of sportsmen with different sport form, run technique, psychological feature. Besides it was noticed   positive change psychodynamics tendency of a personality of the sportsmen: strengthening motive achievement of the success by sportsmen with high level of the motive to avoid of the failure from 4,5 to 3,1, P<0.01, optimization of general level of the motivation (lowering when there was a high level motivation with 16,5 to 13,3, P<0,01, increase less level motivation with 9,4 to 12,2, P<0,01), lowering level anxiety of highanxious sportsmen with 41,9 to 37,5, P,0,05.

These gate allow to consider that psychoforming training appears to be not only means psychoprophyfilactic for activity in stress – competitional conditions but a mean to   form psychological stable personality of the sportsman.

POST 2.4.8
Examination of three methods of goal setting in sport motivation in students athletes

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Athletic psychologists intend to keep athletes in desirable level of motivation or extend them to this level, control well strengthening or weakening factors influencing this matter and expand efficiency amount of individual and group in doing athletics. The aim of this study was Examination of three methods of goal setting in sport motivation in students' athletes. Statistical society of this study included all boy students that participate in training of university teams (football, Volleyball, Basketball).Statistical sample involved 4 groups(one group control and three groups test), each 15 people selected randomly (n=15). This study has been performed as field-descriptive method in 12 weeks and investigates factors of personality characteristics using questionnaire. This study performed as pretest-posttest. Study variables included motivation (dependent variable) and goal setting (independent variable). Measurement tool of this study is questionnaire of athletic personality designed by Brook Smith in 2003. One of measurement factors in this questionnaire was motivation. The reliability of this questionnaire based on criterion reliability and examined by questionnaire that obtained value was equal and significant in p<0.05 level. Its stability obtained 0.800 by alpha Cronbach and was significant in p<0.05 level. After selecting sample people randomly, the questionnaires were given to subjects as pretest and gathered after completing. First group every week two times was tested and comparison to goals. Second group once every two weeks was tested and comparison to goals. Third group once every six weeks tested and comparison to goals. The subjects recompleted questionnaires after 12 weeks that were considered as posttest. Finally all subjects were appreciated. .the results of the study showed that after 12 weeks goal setting, there is significant difference between anxiety of control and test groups. The results of study showed that 12 weeks goal setting has significant different on anxiety in three groups. According to the results, one every two weeks goal setting have more effect on motivation. So, one two weeks goal setting is suggested to increase motivation. The results suggest every activity has optimum time to offering goals to increasing motivation.

Mental toughness and sport competition anxiety among young swimmers in Norway

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Research has documented that competitive anxiety (e.g. specific negative emotional response to competitive stressors) in sport is a double edged sword. For some athletes competitive anxiety hampers performance, but for others it facilitates it (Mellalieu et al., 2006) so it is imperative to performance to optimize the athlete's pre-competition anxiety level. It is therefore important to investigate personal factors in relation to competitive anxiety. Mental Toughness (MT) defined by Loehr (1994, p.5) as 'the ability to consistently perform toward the upper range of your talent and skills regardless of competitive circumstances' is one such personal factor that is considered to be a crucial attribute in competitive sport. The purpose of this this study was to investigate the relationship between MT and competitive anxiety among young swimmers.

23 junior (6 male and 17 female) swimmers from 2 teams in Norway (mean age 16.9±2.2 years; mean swimming career 8±2.8 years ; mean number of practice sessions per week 10.7±3.9) completed the Sport Competitive Anxiety Test (SCAT, Martens et al., 1990) and the Sport Mental Toughness Questionnaire (SMTQ; Sheard et al., 2009). The higher the SCAT score is the higher the degree of competitive anxiety and the higher the score on three SMTQ MT components; Confidence, Constancy and Control the higher the level of MT.

As can be seen in Table 1, both SCAT and MT scores were relatively high, and MT was negatively related to SCAT. The results indicate that MT influences an athlete's competitive anxiety level. This relationship between MT and competitive anxiety is an important and innovative finding, but this is a preliminary study and more research is needed to confirm this relationship in larger samples of athletes and in different sports. There is also a need for research to develop a more in-depth understanding on how MT influences the competitive anxiety level, and how it is related to subsequent performance.

Table 1. SMTQ subscales and SCAT Cronbach α, means (±SD), correlation coefficients with SCAT (r) and multiple regression standardised beta (N =23)

Scale	α	Mean±SD	R	beta
MT Confidence	.90	2.89±.66	-.64*	-.52*
MT Control	.58	2.63±.67	-.65*	-.53*
MT Constancy	.66	3.11±.49	-.43*	-.03
SCAT	.89	2.29±.50		.

*$p < 0.01$ Regression model significant ($F_{(3, 19)}$ 13.77, $p < 0.001$, adj. $R^2 = .64$)

Loehr J.E. (1994) *The New Toughness Training for Sports: Mental, Emotional, and Physical Conditioning from one of the World's Premier Sports Psychologists.* NY: Penguin Putnam.

Martens, R., Vealey, R.S. & Burton, D. (1990) *Competitive anxiety in sport*. Champaign: Human Kinetics Books.

Mellalieu, S.D., Hanton, S. & Fletcher, D. (2006) A competitive anxiety review: recent direction in sport psychology research. In: S. Hanton & S.D. Mellalieu (Eds.). *Literature reviews in sport Psychology*, pp. 1-45. New York: Nova Science Publishers, Inc.

Sheard, M., Golby, J. & van Wersch, A. (2009) Progress toward construct validation of the sport mental toughness questionnaire. *European Journal of Psychological Assessment, 25*(3): 186-93.

POST 2.4.10

The influence of self-management and self-confidence on performance in Chinese table tennis athletes

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The purpose of this research was to uncover the influence of self-management and self-confidence on Chinese collegiate table tennis athlete's performance, and in the process develop information that would also prove beneficial for table tennis internationally. 290 research participants were gathered by the purposive sampling method at the Chinese National Table Tennis from 8 Universities in the Beijing and Shanghai areas. Of the surveys collected from the 290 participants, 280 were analyzed using Windows SPSS Version 17.0 with 10 being discarded due to either missing data or unclearly marked answers. Through SPSS, an exploratory factor analysis and a Cronbach's α test was used to verify the appropriateness and dependability of the data. Following this, relational analysis and multiple regression analysis were used to determine the role self-management and self-confidence played on athlete performance. Through this research two things were discovered. First, the factors pertaining to self-management including mental management, training management and body management, all exerted an influence on athlete performance. Second, the factors pertaining to self-confidence including social support, coach leadership and self-confirmation of athletic ability also had an influence on athlete performance.

POST 2.4.11

Ideology of leadership of a technical process and football social relations and job performance: a study of the structure of relationships

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The main objective of this study was to investigate and characterize the process of social and execution of tasks between the participants of a football team emerges from the structuring of relationships, considering the strong influence of ideology and leadership adopts the "Ideal Self" by the Technical , by the way the "Real Team" of athletes perceive the exercise of command actions and associating the group dynamics involved with the participants to collaborate more and less for the sake of efficiency and effectiveness of the team. The method employed is that of non-experimental design, type a descriptive-exploratory. Study participants were 15 athletes and 01 coach's soccer field, with mean age 24.7 years, participants of a football team from São Paulo. The research instruments called "CHA-4" - System diagnostics and metrics on the Leadership Behavior of the Leader (composed of 30 questions descriptive and objective information on the behavior of the leader) - and the "ACS-2" - Diagnostic System Measurement and evaluation of the Degree of Cohesion Group, composed of 40 questions concerned with the behavior of athletes who more or less collaborate to support the efficacy of group behavior. It was concluded that the group behavior of a football team, analyzing the ideology of leadership described by the coach as "Ideal Self" and the perceived and described by the "Real Team" of athletes, depends on the quality of relationships between individuals and the participants that more and collaborate unless they can generate strong mutual links and greater capacity to produce results in the course of competitive football field.

POST 2.5: SPORTS SCIENCE AND MEDICINE

POST 2.5.1
Anaerobic capacity in detraining periods in 11 year old male swimmers

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Detraining period may cause a decrease in physical fitness and work capacity. Although there are quite a few research works on adult athletes, reliable research on children and youths seems to be insufficient (Ingle et al., 2006). The main objective of this work was to evaluate changes in anaerobic power and capacity during a 6- week detraining period in 11 year old female swimmers.

Methods
The research was conducted on a group of 25 male swimmers with a 3-year training experience, at average age of $11,65 \pm 0,31$ yr, body height of $152,23 \pm 6,25$ cm and body mass of $39,12 \pm 3,21$ kg. In order to evaluate the level of anaerobic power and capacity, the 30s Wingate test was applied. The following variables were considered: maximal power [W and W/kg], time of reaching peak power [s], time of sustaining peak power [s], and total work output.

Results
The obtained results were analyzed statistically with ANOVA as the main method to determine the significance of differences in considered variables. During the detraining period the most significant changes occurred in total work output and it was $9,21 \% \pm 2,1$. Peak power and time of reaching and sustaining P_{max} were affected to a much smaller degree than total work output and amounted to $3,16\% \pm 0,32$; $4,21 \pm 1,7\%$ relatively

Discussion
Higher level of physical fitness in athletes was due to systematic training stimulation (Liu et al., 2009). Long period of little training or no training usually affects all performance indicators (Mujika, Padilla, 2000). Performed research showed that anaerobic capacity, evaluated by total work output during the Wingate test declined significantly already after 3 weeks of detraining and reached even lower values after 6 weeks without training stimuli. Peak power reached within 4-6s during the test dropped insignificantly during the first 3 weeks of detraining. Nevertheless, peak power after 6 weeks was significantly lower. It may be concluded that anaerobic capacity is more susceptible to detraining than anaerobic power in 11- year old male swimmers. The conclusion to be drawn is that trainers should be aware of the transient nature of the response when developing long-term exercise programs.

Ingle L., Sleap M. & Tolfrey K. (2006) The effect of a complex training and detraining programme on selected strength and power variables in early pubertal boys. *Journal of Sports Sciences*, 24 (9): 987-997.

Liu Y; Cao Z.D., Fu S.J., Peng J.L. & Wang Y.X. (2009) The effect of exhaustive chasing training and detraining on swimming performance in juvenile darkbarbel catfish (Peltebagrus vachelli). *J Comp Physiol B: Biochem Syst Environ Physiol,* 179 (7): 847-55.

Mujika, I. & Padilla, S. (2000) Detraining: loss of training-induced physiological and performance adaptations. Part II: long term insufficient training stimulus. *Sports Medicine*, 30 (3): 145-154.

Frequency of injuries in young swimmers

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Because of the emphasis upon excellence, which is now a widely held, that in order to achieve either national or international success, training and competition should begin earlier. But we should bear in mind that the risk of injury may be bigger. The increasing frequency of injury in young athletes over the last two decades reflects the increase in sports participation at a young age (Capranica & Millard-Stafford, 2011). Therefore, the objective of this study was to determine the type and frequency of injuries occurring in young swimmers.

In the present study, injuries were investigated using a standard semi-structured retrospective interview questionnaire (Maffulli et al. 1994). The research was conducted in a group of youth swimmers from sports classes with a swimming profile, coming from the Silesian region (n=67) with a 3- year training experience at an average age of 11.75 ± 0.43 yr, body height of 151 ± 7.43 cm and body mass of 38.89 ± 3.05 kg. Training at that stage was aimed at stimulating comprehensive physical development, teaching and improving all four styles of swimming techniques, starts and turns, aerobic capacity and revealing specific abilities to cope with swimming.

The results showed just over half the children suffering one or more injuries per year ($52.4\% \pm 4.2$), and the majority of those injured sustaining one injury only ($69.1\% \pm 7.02$). The most frequent ones were shoulders injuries ($37.3\% \pm 8.12$).

Most injuries in these young athletes were minor and relatively infrequent; and in the short to medium term did not constitute a significant health problem. However, we do not know the implications in long-term training (Capranica & Millard-Stafford, 2011). Sports medicine specialists should find out what coaches are already doing to prevent injuries. Coach injury prevention programs should be evaluated for safety reasons in order to select such exercises that prove to be safe and effective so that later they could be incorporated into the practitioner`s /trainer`s / a general prevention program.

Capranica L. & Millard-Stafford M.L. (2011) Youth Sport Specialization: How to Manage Competition and Training? *International Journal of Sports Physiology and Performance*, 6, 572-579.

Maffulli N., King J.B. & Helms P. (1994) Training in elite young athletes (The Training of Young Athletes [TOYA] Study): Injuries, flexibility and isometric strength. *Br J. Sports Med.* 28:123-136.

POST 2.5.3
Power, speed and anthropometric measures of Portuguese elite junior volleyball players

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The purpose of this study was to describe the main power performance and anthropometric characteristics in different components in professional male volleyball players in order to determine if differences exist in these characteristics according to playing position.

Fourteen subjects were assessed on anthropometric factors and conditional components of Explosive Strength of the Lower Limbs, as countermovement jumps without ball [CMJ; CMJ in spike (CMJ_S) and block (CMJ_B)] and simulation of real action during the volleyball game (CMJ_{Sb} and CMJ_{Bb}) using Ergojump. Speed was evaluated in 20m sprint, using photocells. The difference between performance levels and the specific positions has been analyzed through independent measures of ANOVA analysis, followed by Tukey Post Hoc of multiple comparisons.

14 athletes were divided in 5 groups [middle blocker (n=3; 17.6±1,1 yrs.; 194±0.06 cm; 83.6±5.5 kg and 2.02±0.02 arm span); Libero (n=2; 17.5±0.7 yrs.; 178±0.02 cm; 68±4.2 kg and 1.83±0 arm span); Setter (n=3; 18.3±1.15yrs.; 184±0.04 cm; 75.3±7.57 kg and 1.86±0.03 arm span); opposite player (n=3; 16±1 yrs.; 189±0.01 cm; 71.6±8.62 kg and 1.93±0.08 arm span) and Z4 (n=3; 17.3±1.52yrs.; 190±0.05 cm; 78.6±13.5 kg and 1.99±0.03 arm span).
The results indicated that anthropometric measure showed significant differences in height value (p=0.036). No other significant differences (p<0.05) were found between among groups for power. However, libero players were the most explosive in CMJ. Setter players were explosive in almost jump tests (CMJ_B, CMJ_R, CMJ_{Rb} and CMJ_{Bb}) and sprint time than the others. The Z4, middle blocker, and opposite player positional groups had considerably poorer explosive performance and speed than the libero and setter.

Anthropometric and explosive differences exist among playing positions in elite male volleyball players (Marques, et al., 2009; João, et al., 2010). These findings provide some data for elite male volleyball players competing in specific individual playing positions. Explosive tasks should be performed without ball but also it may be developed by a simulation of real actions during volleyball game.

João, P.V., Leite, N., Mesquita, I. & Sampaio, J. (2010) Sex differences in discriminative power of volleyball game-related statistics. *Perceptual and Motor Skills,* 111(3): 893-900.

Marques, M., Tillaar, R.; Gabbett, T.; Reis, V.; González-Badillo, J. (2009) Physical fitness qualities of professional volleyball players: Determination of positional differences. *Journal of Strength & Conditioning Research* 23(4): 1106-1111.

POST 2.5.4
The relationship between speed, change of direction speed and reactive agility in soccer players

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Quality and efficient movement is said to be a fundamental aspect of performance in most field sports, and soccer is no exception. The purpose of this study was to evaluate the ability of a Reactive Agility Test (RAT) to distinguish a group of upper level soccer players from a group of lower level soccer players when comparisons were drawn using standard speed and change of direction tests.

Thirty (30) soccer players took part in the study, and were categorized into either, an upper level group (ULG) (n = 15), or a lower level group (LLG) (n = 15) based on their playing level in the current season (2011/2012). All participants completed a testing session comprising of a 10 and 20 metre straight sprint, an 8 – 9 metre change of direction (COD) test (Sheppard et al., 2006), 5-0-5 agility test and the RAT. Independent T-tests were applied to the mean scores for the 3 tests in order to determine which of the tests, if any, were able to distinguish between the two groups of players.

No statistically significant differences between the two testing groups were observed in the comparisons of straight line speed ($p>0.05$), the change of direction test ($p=0.18$), as well as when comparisons were drawn between the two groups on the modified 5-0-5 agility run ($p>0.05$) and the RAT test ($p=0.22$).

Although the straight line speed and change of direction tests between the two groups did not yield statistically significant differences, the LLG did produce scores that were, on average, faster than their counterparts for these two tests. When the mean times were compared for the change of direction tests, the lower level groups were slighter faster on average 1.73 ± 0.11s, than the upper level group 1.76 ± 0.08s. In contrast when comparisons were made for the 5-0-5 agility test and the RAT, the upper level players performed better in both tests. The results obtained were in accordance with results in other studies for straight line speed and agility when comparing upper and lower level soccer players.

The study has revealed that upper level players produce better agility scores than lower level scores which is in keeping with current research literature on agility. Furthermore and more crucially, it was concluded that the improved agility scores of the ULG, enabled this group to execute reactionary movements on the RAT faster than lower level players.

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POST 2.5.5
Training models and path selection in the training of Chinese elite athletes

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This research looks at the development patterns of Chinese elite athletes and the difference in path selection by analysing the present situation of the elite athletes training system in China. The purpose of the research is to identify the factors that affect the development of elite athletes and provide countermeasures and suggestions for the path selection in training.

The methods of literature review, comparative analysis, expert interview and investigation were adopted. The data were analyzed from the perspectives of sociology, economics, management and sports marketing. There are mainly three training models of Chinese elite athletes: the executive-led, half-executive-led and market-oriented. At present, the training of elite athletes is run in the market with the administrative intervention from the government in the form of administrative means and allocation of sports resources. With the executive force to promote the construction of athlete training system, a market-oriented development model with the government intervention is formed. This model is the result of a top-down reform in the government, showing the pattern of interest diversification. In the development of athlete training models and in selection of training paths, China is pursuing a win-win result.

Results of the research indicate that there are a variety of factors that affect the development of athletes: personnel factors, institutional factors, training factors, contest institutional factors and resources factors. The training model of athletes decides the development path of the athletes and their future career development plans. The training system and the training path selection of Chinese elite athletes are in the process of improvement, adjustment and balance. It is suggested that the training of elite athletes be incorporated with athlete career development plans.

POST 2.5.6
The effect of water treatment on performance of ACL and PCL in male athletes

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To day with progress and increase in variety of sport training, professional athletes and non professional have portion of sport injuries. Sport injuries in the first accrue by bad warm up and some injuries accrue end of training by much tried. In this study sample was 25 male professional athletes with 20-24 old in dezful city university that suffering to strain and sprain in ACL and PCL. The research methods were post test examination. The research was done in 12 session's hydrotherapy in 4 weeks, 3 sessions per week and 75 min per session. The results of training showed after this period power of quadriceps depleted muscles and twin muscles had 78% increase in atrophy. Endurance of quadriceps muscles return to the initially state.

POST 2.5.7

The examination causes of osteoporosis in 45-65 old females in Dezful city

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This study examine amount of decrease in osteoporosis in 45-65 old females in dezfoul city. Research was done in experimental method. Statistical society was 205 females with 45-65 old in dezfoul city. Method of sampling was as census through demographic information questionnaire and factors related osteoporosis as interview and DEXA method.informaton exanimate according T scale descriptive and analytical statistics. The mean of old in females postmenopausal were 55 that minimum of old was 40 and maximum of old was 65 with 60 kg weight. Osteoporosis prevalence in femoral neck zone was 34.4%and lumbar vertebrate was 14.8% and was natural density. Osteoporosis was significant and prevalence in postmenopausal female with weight less than 60 kg. Less use in calcium food had significant relationship with patient prevalence. Physical activity had significant relationship with bone density only in spine vertebrae.

POST 2.5.8

The relationship between muscle bioelectric activity during performance of the acrobatic back handspring and maximal isometric and isotonic muscle contraction

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The quality of performance of gymnastic exercises including acrobatic exercises directly depends on gymnasts' strength level. The strengths developed by skeletal muscles performing acrobatic exercises can be estimated by electromyogram (EMG) amplitude. Therefore the purpose of our research was to compare the muscle bioelectric activity when performing acrobatic back handspring with maximum isometric and isotonic contractions of the main working muscles.

5 gymnasts of different qualification took part in the research. The 16-channel telemetric "ME6000" system was used to record surface EMG. The "Biodex Multi-Joint System Pro-3" (USA, 2006) was used for registration of isometric and isotonic maximum contraction.

The gymnasts did plantar flexion in an ankle joint, and also a straitening in knee and elbow joints. The video shooting of acrobatic back handspring performance with the subsequent computer data processing was parally done for determination of angular parameters and duration of the maximum isometric and isotonic contraction (MVC).

The received amplitudes of the maximum muscle bioelectric activity during performance of the two main phases of acrobatic back handspring (leg and hand push off) were compared with the amplitudes of the maximum isometric and isotonic contraction of gastronemius muscle, quadriceps femoris muscle and triceps brachia muscle.

All gymnasts had the highest bioelectric activity of gastronemius muscle performing acrobatic back handspring. 4 gymnasts showed the maximum amplitudes of EMG at the isotonic MVC of the quadriceps femoris muscle. The gymnasts of higher qualification performing hand push off in acrobatic back handspring showed lower amplitudes of triceps brachia muscle EMG in comparison with the maximum isotonic contraction amplitudes.

The received results allowed to choose means of gymnasts' strength preparation with emphasis on various modes of main muscle groups contractions.

POST 2.5.9
Designing ergometer tests for the calibration of physiological endurance models

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Physiological endurance models are widely used to characterize the capabilities, limitations, and dynamics of human performance (Morton, 2006). Their calibration is a classical curve fitting task, where the parameters are chosen to minimize the deviation of model estimations from measurements of performance indicators such as power, heart rate, oxygen consumption, and lactate level for a particular ergometer test. The design of an appropriate ergometer test setup is often based on heuristics and experience of sports scientists. However, the sensitivity of the model parameters with respect to variations of the measurements depends on that design. Here, we focus on the 3-parameter critical power model and present an alternative ergometer test setup, which improves the parameter calibration for the modeling of short intense workload and choose interval lengths to maximize the sensitivity of the parameters.

The 3-parameter critical power model (Morton, 2006) assumes, that there is an (aerobic) critical power P_c, which is the maximum power a human can perform for a long (infinite) time. In addition, an anaerobic resource E_a, which is initially filled with and limited by an anaerobic capacity E_0, is at the athlete's disposal. Upon exercise with power P, the anaerobic resource is tapped: $\dot{E}_a = P_c - P$. The maximum available power P_m decreases linearly with the relative consumed anaerobic resource from the fixed total maximum power P_{max} to the critical power: $P_m = (P_{max} - P_c) E_a/E_0 + P_c$.

The estimation of the model parameters $\boldsymbol{k} = (P_c, P_{max}, E_0)^T$ is typically done with ergometers based on series of tests using constant power, ramp or interval setups, (Morton, 1997, 2004), where the time until exhaustion indicates the anaerobic capacity. In contrast, we exploit that P_m depends on E_0 and design a test protocol of *fixed* duration T that consists of N maximum power intervals $P = P_m$ interrupted by $N-1$ recovery intervals $P = r\tilde{P}_c$, where $r < 1$ is a recovery factor and $(\tilde{\cdot})$ stands for an a-priori guess. Modern ergometers provide an isokinetic modus for the P_m-intervals so that the athlete can perform the maximum power at his preferred cadence. During the recovery intervals, the ergometer ensures constant power $r\tilde{P}_c$. For the cost function J the least squares method is used to fit $\boldsymbol{k}$ to measurement data. Due to the P_m-intervals, J is sensitive to variations of each parameter in $\boldsymbol{k}$. The quality of the minimum depends on its curvature $\mathbf{d}^2 J/\mathbf{d}\boldsymbol{k}^2|_{\tilde{\boldsymbol{k}}}$. The curvature, however, is a function of the switching times $t_1, \cdots, t_{2N-2}$ between the intervals. Therefore, varying the switching times to ensure a sufficient curve in *any* direction on the surface $\boldsymbol{dk}/\tilde{\boldsymbol{k}} = $ const is used to maximize the sensitivity.

The approach is extensible to optimize the test protocols for any curve fitting based calibration of constrained dynamical systems.

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POST 2.5.10
Body segmental weights of Indian college age males

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The purpose of the study was to analyze the body segmental weight of college age males. 41 male students of Bachelor of Physical Education course were selected randomly, from the total population of 150 males. Their mean age weight and height were 24.05 years, 164.36 c.m. and 54.40 kgs respectively. The total body was divided into eight segments viz. Feet, Lower leg, Thigh, Hands, Fore arm, Upper arm, Trunk, and Head & Neck. At first the body density was calculated by anthropometric method by using regression equation with values of skin folds of Chest, Abdomen and Thigh. The segmental volume was calculated by immersion technique used by Stadler.

Finally the segmental weights were found out using mean of density of the body and segmental volume. From the result the mean value of body density were found to be 1.09 gm/cc. Percentage of different body segmental weights were Foot - 1.38%, Lower leg - 4.39%, Thigh - 12.10%, Hands - 0.56%, Fore arm - 1.74%, Upper arm - 2.64%, Trunk - 46.29%, Head & Neck - 8.09%.

POST 2.5.11
Morphofunctional survey in adapted gymnastics training for normal pregnancy

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Physical activity improves physiological, metabolic parameters and maintain functional reserve of pregnant women (Michael et al., 2008; Meltzer et al., 2010). The aim is to study the main morphofunctional parameters before and after gymnastics training in normal pregnancy.

10 normal pregnancy women (3rd trimester; informed consent; age 29.6±4.17yrs; weight 67,9±10,60 kg, height 166,9±7.32 cm, BMI 24.4±3.83) were studied in gymnastics session. Protocol: 45 min moderate training session; chest circumferences at baseline, RR, HR, vital capacity (VC) monitoring pre- and post training session. Statistical analysis has been made.

Chest circumferences (Mean ±SD) are 83,450±6,7225 cm; 86,600 ±6,5693 cm; 1,450±6,6976 cm; significant differences b/n them (p>0.05). RRs (systolic) RRd (diastolic), HR and VC variables are given in Table 1. Correlations indicate strong relationships between studied parameters at baseline, but relations with those ones measured after training are limited.

Morphofunctional control before the training session demonstrates that parameters are in referent limits. Cardiorespiratory changes show good adaptation of pregnant women to the training load and fast recovery. It can be concluded that the pattern of gymnastic training no risk and is suitable for maintaining the functional capacity of pregnant women.

Table 1 Descriptive statistics of variables pre- and post gymnastics sesssion

Variables	RRspre	RRspost	RRdpre	RRdpost	HRpre	HRpost	VCpre	VCpost
Mean	102,7	104,6	66,0	61,6	89,5	87,9	2995	3081
SD	10,47	11,95	6,36	10,37	15,78	11,55	470,5	548,7

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POST 2.5.12
The height of male Brazilian beach volleyball players in relation to specialization and court dimensions

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Rules changes made by the FIVB (Fédération Internationale de Volleyball) in 2001 (reduction of the court and new score system) has increased the importance of game actions such as the attack and the block (FIVB,2001; Ronglan and Grydeland, 2006). Analyzing FIVB World Tour players, Tili & Giatsis (2011) found that after the changes blockers were significantly larger, while the defenders did not show significant increases. The purpose of this paper was to verify the effect of these rules changes in the height of Brazilian men beach volleyball players in relation to specialization.

The sample included the winners of Brazilian CBV (Brazilian Volleyball Confederation) in seasons 1991 to 2011 (Tournaments in 9x9m court, n=32 players; Tournaments in 8x8m court, n=28 players). The winners were categorized in relation to court dimensions (9x9m court and 8x8m court) and their specialization: defenders (DE), blockers (BL) and without any specialization (NS). Data was collect in 2011 from the official site of the Brazilian Volleyball Confederation (www.cbv.com.br). One-way Anova and Post-hoc Dunnett C tests were performed to find differences in the winners' height in relation to their specialization and the court dimensions.

The Post Hoc tests indicated significant differences ($F_{(5.53)}$ = 112. 48, $p<0.001$) between the DE_{9x9}, DE_{8x8}, BL_{9x9}, BL_{8x8}, NS_{9x9} and NS_{8x8} (see Table 1). In sum, these results show that, after reduction of the court dimensions (9x9 m to 8x8 m), the height of the defenders (M=1.88; M=1.91), blockers (M=1.93; M=1.98), and players without any specialization (M=1.94; M=1.93) has increased significantly. Therefore, our results support those found by Tili and Giatsis (2011).

Table 1. Descriptive Statistics of the height in Defenders, Blockers and No specialization players in the 9x9 m and 8x8 m.

Specialization	Court (m)	N	Height (m)			
			M	SD	Minimum	Maximum
Defenders	9x9	14	1.88*	3.6	1.83	1.98
Blockers	9x9	14	1.93*	2.6	1.89	2.00
No Specialization	9x9	4	1.94*	5.3	1.89	2.00
Defenders	8x8	12	1.91*	3.0	1.84	1.98
Blockers	8x8	12	1.98*	4.3	1.90	2.10
No Specialization	8x8	4	1.93*	5.3	1.89	2.00

* Significant differences, $p<0.001$.

The present study found an increase of the height of the Brazilian mean players after the rule changes; the height of the defenders increased an average of 0.02m and the height of the blockers increased an average of 0.05m.

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