FEDERAZIONE ITALIANA CANOA KAYAK

Anno XXV - n. 90

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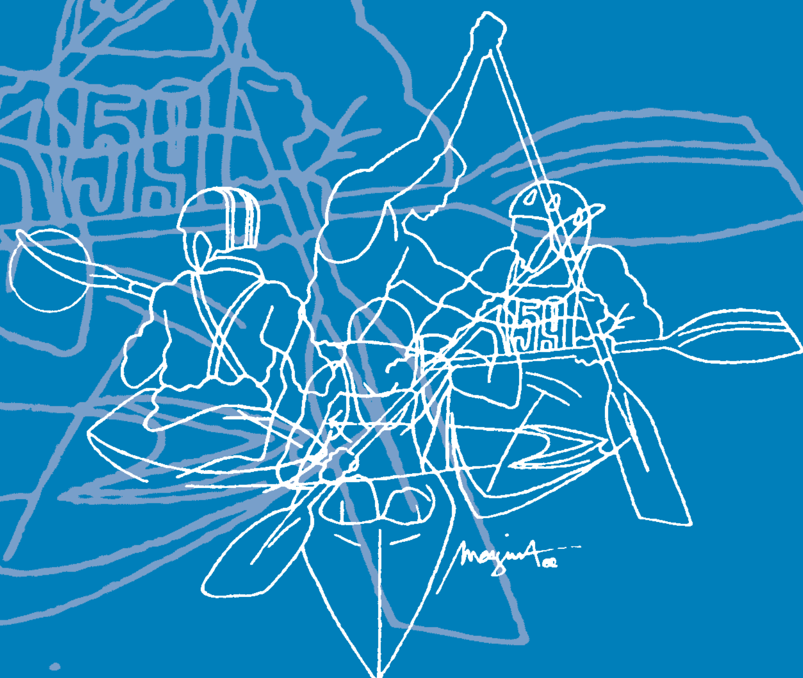

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SOMMARIO

INDICAZIONI PER GLI AUTORI

La rivista "Nuova Canoa Ricerca" è aperta a tutti i contributi (articoli, studi, ricerche, ecc…) che abbiano una certa rilevanza per la scienza e la cultura sportiva, con particolare riferimento alla sport della canoa.
Gli interessati possono inviare tramite e-mail, il materiale da pubblicare a: centrostudi@federcanoa.it, oppure in forma cartacea o digitale a: Nuova Canoa Ricerca, Federazione Italiana Canoa Kayak, Viale Tiziano 70, 00196 Roma.
Il testo deve essere composto da un massimo di 30.000 caratteri in formato "Word" e distribuito su pagine numerate. Eventuali figure, grafici e foto dovranno essere realizzati con la "risoluzione minima di stampa 300dpi" e numerati con numero corrispondente inserito nel testo. L'articolo dovrà riportare Cognome, Nome e breve curriculum dell'autore.
L'articolo deve essere strutturato nel seguente modo:
- **Abstract**, max 20 righe (circa 1500 caratteri), comprendente lo scopo della ricerca, il metodo usato, il sommario dei risultati principali. Non deve comprendere le citazioni bibliografiche.
- **Introduzione**, natura e scopi del problema, principali pubblicazioni sull'argomento, metodo usato e risultati attesi dalla ricerca.
- **Metodologia seguita**: ipotesi, analisi e interpretazione dati, grafici, tabelle, figure, risultati.
- **Conclusioni**. Principali aspetti conclusivi, applicazioni teoriche e pratiche del lavoro.
- **Bibliografia**, solo degli autori citati nel testo con in ordine: Cognome, Nome, anno di pubblicazione, titolo, rivista, numero della rivista, pagine o casa editrice, città (se libro).

La pubblicazione è subordinata al giudizio del Comitato di Redazione.

L'ANGOLO

di *Luciano Buonfiglio **

Eccoci di nuovo a parlare di Centro Studi, Ricerca e Formazione, tre fondamentali aspetti per puntare all'alto livello, ma anche alle più corrette modalità di insegnamento e avviamento a tutte le nostre discipline.

Non casualmente, l'inizio di questo quadriennio si è caratterizzato per significative variazioni agli staff tecnici federali, soprattutto nelle discipline olimpiche, mentre si è deciso di differire lievemente la riorganizzazione di questo settore. I risultati di Rio, incoraggianti ma senza medaglie, imponevano una profonda riflessione in tal senso, pertanto gli sforzi organizzativi iniziali sono andati nella direzione prevalente di dare una guida forte e sicura alle Squadre.

Definite le Direzioni Tecniche e l'impianto delle attività, eccoci pronti a sostenere come merita il Centro Studi e la sua rivista "Nuova Canoa Ricerca", che da sempre ha rappresentato la vetrina delle migliori attività in materia di formazione e divulgazione dei contenuti tecnici e scientifici connessi con gli sport della pagaia.

Ad esser precisi, la formazione, giustamente, non ha subito alcuno "stop and go", infatti tutte le attività, soprattutto quelle territoriali, hanno avuto seguito in piena continuità con il passato. Anzi alcune, come i corsi Maestro, programmati a cavallo tra i due cicli olimpici, sono terminate (Corso Nazionale di formazione Maestri da Mare) o stanno per concludersi (Corso Maestri Fluviali).

Questa breve pausa di riflessione, necessaria per ben impostare la parte Studio e Ricerca e la sua continuità rispetto alla definizione degli organigrammi tecnici e alla pianificazione delle attività, scaturisce appunto dall'esigenza di creare armonia tra parti, le quali necessariamente devono supportarsi vicendevolmente.

Nel riprogrammare questo settore, affidato al Consigliere federale Gabriele Moretti, rappresentante dei Tecnici che coordina anche le commissioni tecniche Slalom e Velocità, si è deciso di continuare e possibilmente migliorare lo stretto contatto tra l'area operante nella ricerca, fatta soprattutto dentro e a sostegno dell'alto livello, e la formazione, che invece abbraccia tutto il panorama delle attività federali. Non può esserci, infatti, uno sviluppo delle conoscenze senza sperimentazione e, nel contempo, non ci sarà crescita di competenze e professionalità se a quanto svolto sul campo, con le evidenze scientifiche che ne derivano, non viene data la giusta diffusione per favorire ampie ricadute sulla vasta platea degli "addetti ai lavori".

In questa prospettiva sono da intendere anche i due articoli pubblicati in questo numero: il primo, firmato Guazzini - Gatta - Guerrini (Commissione Scientifica Velocità), riguarda una analitica "Review" a livello mondiale di ricerche e pubblicazioni sulle specialità della Canoa e del Kayak. L'altro contribuito, estrapolato dalla tesi di laurea di Alessandro Barzon, tratta degli aspetti organizzativo-gestionali e sociologici di un importante evento canoistico, la Maratona Internazionale "Terra dei Forti".

Questa la strada segnata per far crescere gli allenatori e, più in generale, tutto l'articolato insieme dei tecnici FICK operante nelle attività agonistiche, ma anche in quelle non agonistiche, promozionali, giovanili e scolastiche.

Questa è la strada a suo tempo intrapresa grazie all'impegno del Prof. Andrea Argiolas che continuerà a collaborare in quest'importante settore federale perché dobbiamo proseguire ora, con ancor più convinzione..

* Presidente della Federazione Italiana Canoa Kayak.

Marco Guazzini[1,3], Giorgio Gatta[2,3], Guglielmo Guerrini[3]

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Il presente elenco comprende i principali autori e relativi articoli stranieri di canoa, in ordine alfabetico e lingua originale (Inglese, Francese, Spagnolo). Gli autori evidenziati in verde sono riportati negli elenchi successivi con *abstract* dell'articolo in lingua inglese, raggruppati per macroargomenti (biomeccanica; fisiologia; *flatwater*, *sprint*, *marathon*; *white waters*; *slalom*; *canoepolo*) e presentati in ordine cronologico di pubblicazione. Degli autori evidenziati in grigio, il Centro Studi FICK è in possesso degli articoli integrali.

This list includes the major authors and related foreign canoe articles, in alphabetical order and original language (English, French, Spanish). Authors highlighted in green are listed in the following abstract lists of articles in English, grouped by macro arguments (biomechanics, physiology, flatwater, sprint, marathon, white waters, slalom, canoepolo) and presented in chronological order of publication. Of the authors highlighted in gray, the FICK Study Center is in possession of integral items.

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ABSTRACT DELLE PRINCIPALI PUBBLICAZIONI STRANIERE PER ARGOMENTI PRESENTATE IN ORDINE CRONOLOGICO

BIOMECCANICA APPLICATA ALLA CANOA KAYAK
FLAT WATER CANOE, SPRINT, MARATHON

Mann RV, Kearney JT. (1980)
A biomechanical analysis of the Olympic-style flatwater kayak stroke.
Med Sci Sports Exerc. 1980; 12(3): 183-8.

To investigate the biomechanics of flatwater kayaking, the technique of nine Olympic caliber K-1 paddlers was analyzed using cinematographic and computer procedures. Results indicated that, during paddle-water contact, the horizontal arm action was one of push-then-pull with the push coming from the arm farthest from the water (thrust segments) followed by the pull coming from the arm closest to the water (draw segments). During this action, the center of paddle rotation shifted up the paddle shaft as the stroke progressed, which increased the time the paddle was in the power phase of the stroke. The horizontal movement patterns of the individual segments indicated that the push was accomplished by an integrated movement of the thrust wrist and elbow, with minimal shoulder involvement. Subsequently, the pull was accomplished by an integrated movement of the draw wrist, elbow, shoulder, as well as the thrust shoulder. During the latter stages of water contact, since the performers were unable to generate additional useful power, the paddle was rapidly withdrawn to avoid dragging. Subject stability in the frontal plane was maintained by shifting the body mass toward the water contact side at paddle entry and away from it at exit. This action opposed the vertical forces produced as a by-product of the stroke. The final outcome of this stroke technique was the maintenance of the body center of gravity velocity while the boat oscillated under the performer.

Liow DK[1], Hopkins WG. (2003)
Velocity specificity of weight training for kayak sprint performance.
Med Sci Sports Exerc. 2003 Jul;35(7): 1232-7.
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PURPOSE: Athletes often use weight training to prepare for sprint events, but the effectiveness of different types of weight training for sprinting is unclear. We have therefore investigated the effect of slow and explosive weight training on kayak sprint performance. METHODS: Twenty-seven male and 11 female experienced sprint kayakers were randomized to slow weight training, explosive weight training, or control (usual training) groups. Weight training consisted of two sessions per week for 6 wk; in each session the athletes performed 3-4 sets of two sport-specific exercises with a load of 80% 1-repetition-maximum. The two training programs differed only in the time taken to complete the concentric phase of the exercises: slow, 1.7 s; explosive, <0.85 s. To determine the effects of training on sprint acceleration and speed maintenance, the athletes performed 15-m kayaking sprints pre- and posttraining; an electronic timing system provided sprint times at 3.75-, 7.5-, and 15-m marks. RESULTS: Relative to control, both types of weight training substantially improved strength and sprint performance. The improvements in mean sprint time over 15 m in each group were: slow, 3.4%; explosive, 2.3%; control, -0.2% (90% confidence limits for pairwise differences, approximately +/-1.4%). Over the first 3.75 m, the improvements were: slow, 7.1%; explosive, 3.2%; control, 1.4% (approximately +/-2.6%). Over the last 7.5 m, the improvements were: slow, 2.1%; explosive, 3.0%; control, -0.8% (approximately +/-1.9%). CONCLUSIONS: Slow weight training is likely to be more effective than explosive training for improving the acceleration phase of sprinting, when force is high throughout the length of the stroke. Explosive weight training may be more effective in speed maintenance, when forces are developed rapidly over a short period at the start of the stroke.

van Someren KA, **Palmer GS**. **(2003)**

Prediction of 200-m sprint kayaking performance

Can J Appl Physiol. 2003 Aug; 28(4): 505-17

School of Life Sciences, Kingston University, Penrhyn Road, Kingston-upon-Thames KT1 2EE, UK.

The aim of this study was to determine the anthropometric and physiological profile of 200-m sprint kayakers and to examine relationships with 200-m race performance. Twenty-six male kayakers who were categorised in two ability groups, international (Int) and national (Nat) level, underwent a battery of anthropometric and physiological tests and a 200-m race. Race time was significantly lower in Int than Nat (39.9 +/- 0.8 s and 42.6 +/- 0.9 s, respectively). Int demonstrated significantly greater measures of mesomorphy, biepycondylar humeral breadth, circumferences of the upper arm, forearm and chest, peak power and total work in a modified Wingate test, total work in a 2-min ergometry test, peak isokinetic power, and peak isometric force. Significant relationships were found between 200-m time and a number of anthropometric variables and anaerobic and dynamometric parameters. Stepwise multiple regression revealed that total work in the modified Wingate alone predicted 200-m race time (R2 = 0.53, SEE = 1.11 s) for all 26 subjects, while biepycondylar humeral breadth alone predicted race time (R2 = 0.54, SEE = 0.52 s) in Int. These results demonstrate that superior upper body dimensions and anaerobic capacities distinguish international-level kayakers from national-level athletes and may be used to predict 200-m performance.

Grigorenko A[1], Bjerkefors A, Rosdahl H, Hultling C, Alm M, Thorstensson A. (2004)

Sitting balance and effects of kayak training in paraplegics.

J Rehabil Med. 2004 May;36(3): 110-6.

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OBJECTIVES: The objectives of this study were to evaluate biomechanical variables related to balance control in sitting, and the effects of kayak training, in individuals with spinal cord injury.
SUBJECTS: Twelve individuals with spinal cord injury were investigated before and after an 8-week training period in open sea kayaking, and 12 able-bodied subjects, who did not train, served as controls. METHODS: Standard deviation and mean velocity of centre of pressure displacement, and median frequency of centre of pressure acceleration were measured in quiet sitting in a special chair mounted on a force plate. RESULTS: All variables differed between the group with spinal cord injury, before training, and the controls; standard deviation being higher and mean velocity and median frequency lower in individuals with spinal cord injury. A significant training effect was seen only as a lowering of median frequency. CONCLUSION: The results indicate that individuals with spinal cord injury may have acquired and consolidated an alternative strategy for balance control in quiet sitting allowing for only limited further adaptation even with such a vigorous training stimulus as kayaking.

Hagemann G, **Rijke AM**, **Mars M**. **(2004)**
Shoulder pathoanatomy in marathon kayakers.
Br J Sports Med. 2004 Aug; 38(4): 413-7
University of Natal, Durban, South Africa.

OBJECTIVES: To determine the prevalence of soft and hard tissue abnormalities and their interrelations in the shoulders of marathon kayakers and to examine the pathoanatomical factors that predispose these athletes to injury. METHODS: Fifty two long distance kayakers completed a questionnaire. Their shoulders were examined for range of motion, pain, and stability using a standard set of 10 clinical tests. The shoulder was subsequently scanned by magnetic resonance imaging (MRI) in three planes and evaluated for evidence of injury or other abnormality. The relation of clinical symptoms and MRI findings was investigated with respect to kayaker's age, number of years kayaking, and number of marathon races completed. RESULTS: Thirty subjects were asymptomatic at the time of scanning, and twenty two showed symptoms of pain and/or instability. MRI showed acromioclavicular hypertrophy, acromial or clavicular spur, supraspinatus tendinitis, and partial tear of the supraspinatus as the most common abnormalities. Kayaker's age, number of years kayaking, and number of races completed did not relate significantly to symptoms or to the presence of an abnormality on MRI scan. Of all the pathoanatomical findings that are reported to predispose to rotator cuff injury, only acromial and clavicular spurs were found to correlate highly with supraspinatus muscle pathology. CONCLUSIONS: Rotator cuff injuries make up a large portion of the injuries seen in marathon kayakers, about twice the number reported for sprint kayakers. These injuries are the result of secondary impingement factors associated with overuse, possibly specific to kayakers, and not the result of bony restrictions around the shoulder joint. Acromioclavicular hypertrophy is a common finding in marathon kayakers, but is possibly the result of portaging or a previous injury.

Ong K, Elliott B, Ackland T, Lyttle A. (2006)

Performance tolerance and boat set-up in elite sprint kayaking.

Sports Biomech. 2006 Jan; 5(1): 77-94

School of Human Movement and Exercise Science, University of Western Australia, Crawley.

The aim of this study was to examine the inter-relationship between athlete morphology, equipment set-up and performance in elite sprint kayaking. Correlations applied to data from the 2000 Olympics were used to select the most important links between morphology and boat set-up--paddle grip width and foot-bar distance. Associations between body size and the above selected equipment set-ups were calculated using a Pearson correlation matrix, to facilitate the logical selection of independent variables as input for regression analyses. Significant ($p < 0.01$) regression equations were developed for the prediction of foot-bar distance (r2 = 0.589: standard error of estimate (SEE) = 4.48) and paddle grip width (r2 = 0.541: SEE = 3.08). Three national-standard sprint kayakers used their preferred set-up together with modifications of their predicted set-up, derived from Olympic data, to test performance tolerance in sprint kayaking. Mean coefficients of multiple determination over three trials for the three paddlers of 0.91, 0.91 and 0.92 for left paddle force, right paddle force, and paddle angle at water entry, respectively, were recorded when using their preferred set-up. These data showed that the paddlers produce consistent patterns of motion. The intervention of altering the boat set-up resulted in varying changes to boat speed. The mean preferred speed for the three paddlers of 4.47 m/s was reduced by 0.07 and 0.10 m/s when the above boat set-up was modified to a predicted and 'predicted plus one standard deviation'respectively. These changes in boat speed were the result of alterations in the mechanics of paddling technique.

Guilbaud M.[1] , Durand F.[2] (2006)

***Wind effect on the performances of canoes and kayaks in flatwater races*,**

Sport Biomechanics, Computer-Simulation in Sport. 4500 Mo-Tu, no. 27 (P61).

[1] Laboratoire d'estudes Aerodynamiques, Universitè de Poitiers, France,

[2] Research group of the Federation Francaise de Canoa-Kayak, CAIPS-CREPS, Poitiers, France

As wind affects performances of canoeists and kayakers, a correction tool enabling coaches to easily calculate equivalent zero-wind times during training sessions would be a precious help. Because it must be usable on site, limited computer resources, typically laptop computer, must be used. The following correction method is based on two different elements: a hydrodynamic solver based on a panel method using the wave resistance Green function for the prediction of the boat wave resistance while the friction drag is derived from a simple formula and a data base derived from tests performed in a large subsonic wind tunnel with a 2.4 2.6 m 2 test section for the wind resistance of the crew with paddles plus the top-side hulls of the boats. Forces and moments are measured for various boats, static positions of paddlers and paddles, wind velocities and directions and weather conditions (air and water temperature). Hydrodynamic and aerodynamic results were used to build up a hypersurface which was defined through

polynomial approximations. The propulsive force model is represented by a constant force (F =Fmean) during the underwater phase of the paddles 7-1 and F =0 otherwise. The longitudinal motion equation is solved by using a fourth order Runge-Kutta method. The input data are boat type (single or double canoe or kayak); race length (500 or 1000 m), sex of the competitor; air and water temperature (°C); wind velocity and direction; paddler stroke rate and duration of the underwater phase and the race time measured. The result of the calculation is the corrected time for zero-wind conditions. First, the duration time with the given wind conditions and an arbitrary value for the propulsion force is calculated. Then, the time obtained is compared with the actually measured time and the propulsion force is modified till the difference with the actual time is less than 1%. Time without wind is then computed.

Forbes SC, **Chilibeck PD**. **(2007)**

Comparison of a kayaking ergometer protocol with an arm crank protocol for evaluating peak oxygen consumption.

J Strength Cond Res. 2007 Nov; 21(4): 1282-5.

College of Kinesiology, University of Saskatchewan, Saskatoon, SK, Canada.

The purpose of this study was to compare a kayak ergometer protocol with an arm crank protocol for determining peak oxygen consumption (V(.-)O2). On separate days in random order, 10 men and 5 women (16-24 years old) with kayaking experience completed the kayak ergometer protocol and a standardized arm crank protocol. The kayak protocol began at 70 strokes per minute and increased by 10 strokes per minute every 2 minutes until volitional fatigue. The arm crank protocol consisted of a crank rate of 70 revolutions per minute, initial loading of 35 W and subsequent increases of 35 W every 2 minutes until volitional fatigue. The results showed a significant difference ($p < 0.01$) between the kayak ergometer and the arm crank protocols for relative peak V(.-)O2 (47.5 +/- 3.9 ml x kg(-1) x min(-1) vs. 44.2 +/- 6.2 ml x kg(-1) x min(-1)) and absolute peak V(.-)O2 (3.38 L x min(-1) +/- 0.53 vs. 3.14 +/- 0.64 L x min(-1)). The correlation between kayak and arm crank protocol was 0.79 and 0.90, for relative and absolute V(.-)O2 peak, respectively (both $p < 0.01$). The higher peak V(.-)O2 on the kayak ergometer may be due to the greater muscle mass involved compared to the arm crank ergometer. The kayak ergometer protocol may therefore be more specific to the sport of kayaking than an arm crank protocol.

Trevithick BA, **Ginn KA**, **Halaki M**, **Balnave R**. **(2007)**

Shoulder muscle recruitment patterns during a kayak stroke performed on a paddling ergometer.

J Electromyogr Kinesiol. 2007 Feb; 17(1): 74-79.

Faculty of Health Sciences, School of Biomedical Sciences, University of Sydney, P.O. Box 170, Lidcombe, NSW 1825, Australia.

Precise muscle co-ordination is required to maintain normal shoulder function and alterations in synchrony between shoulder muscles can result in loss of full range of

movement and pain. Although shoulder pain in kayakers is high with 53% of elite international paddlers reporting shoulder injuries, little information is available regarding the pattern of shoulder muscle recruitment during paddling. The aim of this study was to investigate the normal recruitment pattern of shoulder muscles during the kayak stroke. Nine recreational paddlers without shoulder pain were examined. EMG data from eight shoulder muscles of the dominant arm were collected simultaneously with video data during simulated paddling on an ergometer. EMG data was normalized to time and peak amplitude. Intersubject consistency was evaluated using Pearson correlation analysis. The results of this study indicated a fair to high correlation in at least one phase of the kayak stroke in five of the muscles examined: upper trapezius, supraspinatus, latissimus dorsi, serratus anterior and rhomboid major. This normative data will enable comparisons with the shoulder muscle recruitment patterns in kayakers with shoulder pain in order to determine the role of altered motor control in the painful kayaking shoulder.

Michael JS[1], Smith R, Rooney KB. (2009)

Determinants of kayak paddling performance.

Sports Biomech. 2009 Jun;8(2):167-79. doi: 10.1080/14763140902745019.

[1] School of Exercise and Sport Science, Faculty of Exercise, Health and Performance, Sydney University, Lidcombe, New South Wales, Australia. jmic3063@mail.usyd.edu.au

Successful kayak paddling requires a powerful and skilful paddler with an appropriately designed kayak and blade to effectively maximize power to provide forward propulsion and minimize negative drag forces. With a greater understanding of the biomechanical properties and design characteristics of kayaking, coaches and athletes can work towards successful paddling performances. Examination of what is occurring biomechanically under the stress of competition is an important step in improving race times. Since the introduction of kayaking as a sport, an increase in the understanding and research behind the biomechanics of flatwater kayaking has, in part, contributed to improved race times. This information may aid coaches in the development of more specific training programmes for their athletes. It is the purpose of this paper to review previous literature regarding the biomechanical principles of flatwater kayaking and certain design modifications in the context of its application to improving paddling performance.

Janssen I[1], Sachlikidis A. (2010)

Validity and reliability of intra-stroke kayak velocity and acceleration using a GPS-based accelerometer.

Sports Biomech. 2010 Mar;9(1): 47-56.

[1] Biomechanics and Performance Analysis, Australian Institute of Sport, Bruce, Australia. ina.janssen@ausport.gov.au

The aim of this study was to assess the validity and reliability of the velocity and acceleration measured by a kayak-mounted GPS-based accelerometer units compared to the video-derived measurements and the effect of satellite configuration on velocity.

Four GPS-based accelerometers units of varied accelerometer ranges (2 g or 6 g) were mounted on a kayak as the paddler performed 12 trials at three different stroke rates for each of three different testing sessions (two in the morning vs. one in the afternoon). The velocity and acceleration derived by the accelerometers was compared with the velocity and acceleration derived from high-speed video footage (100Hz). Validity was measured using Bland and Altman plots, R2, and the root of the mean of the squared difference (RMSe), while reliability was calculated using the coefficient of variation, R2, and repeated measures analysis of variance (ANOVA) tests. The GPS-based accelerometers under-reported kayak velocity by 0.14-0.19 m/s and acceleration by 1.67 m/s2 when compared to the video-derived measurements. The afternoon session reported the least difference, indicating a time of day effect on the velocity measured. This study highlights the need for sports utilising GPS-based accelerometers, such as minimaxX, for intra-stroke measurements to conduct sport-specific validity and reliability studies to ensure the accuracy of their data.

Ualí I[1], Herrero AJ, Garatachea N, Marín PJ, Alvear-Ordenes I, García-López D. (2012)

Maximal strength on different resistance training rowing exercises predicts start phase performance in elite kayakers.

J Strength Cond Res. 2012 Apr;26(4): 941-6.

[1] Laboratory of Physiology, European University Miguel de Cervantes, Valladolid, Spain.

This study aimed to examine the relationship existing between maximum strength values in 2 common resistance training row exercises (bilateral bench pull [BBP] and one-arm cable row [OACR]) and short sprint performance in elite kayakers. Ten junior kayakers (5 women and 5 men) were tested on different days for 1 repetition maximum (1RM) and maximal voluntary isometric contraction in both exercises. Moreover, a 12-m sprint kayak was performed in a dew pond to record split times (2, 5, and 10 m), peak velocity, distance completed considering the first 8 strokes, and mean acceleration induced by right blade and left blade strokes. No differences ($p > 0.05$) were observed when right and left arms were compared in sprint testing or strength testing variables. Maximal strength values in BBP and OACR were significantly correlated with short sprint performance variables, showing the bilateral exercise with slightly stronger correlation coefficients than the unilateral seated row. Moreover, the relationship between strength testing and sprint testing variables is stronger when maximal force is measured through a dynamic approach (1RM) in comparison with an isometric approach. In conclusion, maximal strength in BBP and OACR is a good predictor of the start phase performance in elite sprint kayakers, mainly the 1RM value in BBP.

Michael JS[1], Rooney KB, Smith RM. (2012)

The dynamics of elite paddling on a kayak simulator.

J Sports Sci. 2012;30(7): 661-8.

[1] School of Exercise and Sport Science, Faculty of Health Sciences, The University of Sydney, Lidcombe, NSW, Australia. jmic3063@uni.sydney.edu.au

During kayak paddling, athletes attempt to maximize kayak velocity with the generation of optimal paddle forces. The aim of the current study was to examine ten elite kayakers and identify a number of key biomechanical performance variables during maximal paddling on a custom kayak simulator. These included analysing the effect of side (left and right) and period (beginning, middle, and end of the kayak simulation) on paddle force, paddle angle, mechanical efficiency, and stroke timing data. Paddle kinetics and kinematics were measured with strain gauge force transducers attached to either end of the ergometer paddle and using a 3D motion analysis system respectively. Results indicated a significantly greater mechanical efficiency during the right paddle stroke compared with the left ($P < 0.025$). In addition, analysing the effect of period, peak paddle force demonstrated a significant reduction when comparing the beginning to the middle and end of the simulated race respectively ($P < 0.025$). Examination of individual force profiles revealed considerable individuality, with significant variation in the time course of force application. Analysis of the profiles presented may provide meaningful feedback for kayakers and their coaches.

Fleming N[1], Donne B, Fletcher D. (2012)

Effect of Kayak Ergometer Elastic Tension on Upper Limb EMG Activity and 3D Kinematics.

J Sports Sci Med. 2012 Sep 1;11(3): 430-7.

[1] Department of Kinesiology, Recreation and Sport, Indiana State University , Indiana, USA.

Despite the prevalence of shoulder injury in kayakers, limited published research examining associated upper limb kinematics and recruitment patterns exists. Altered muscle recruitment patterns on-ergometer vs. on-water kayaking were recently reported, however, mechanisms underlying changes remain to be elucidated. The current study assessed the effect of ergometer recoil tension on upper limb recruitment and kinematics during the kayak stroke. Male kayakers ($n = 10$) performed 4 by 1 min on-ergometer exercise bouts at 85%VO2max at varying elastic recoil tension; EMG, stroke force and three-dimensional 3D kinematic data were recorded. While stationary recoil forces significantly increased across investigated tensions (125% increase, $p < 0.001$), no significant differences were detected in assessed force variables during the stroke cycle. In contrast, increasing tension induced significantly higher Anterior Deltoid (AD) activity in the latter stages (70 to 90%) of the cycle ($p < 0.05$). No significant differences were observed across tension levels for Triceps Brachii or Latissimus Dorsi. Kinematic analysis revealed that overhead arm movements accounted for 39 ± 16% of the cycle. Elbow angle at stroke cycle onset was 144 ± 10°; maximal elbow angle (151 ± 7°) occurred at 78 ± 10% into the cycle. All kinematic markers moved to a more anterior position as tension increased. No significant change in wrist marker elevation was observed, while elbow and shoulder marker elevations significantly increased across tension levels ($p < 0.05$). In conclusion, data suggested that kayakers maintained normal upper limb kinematics via additional AD recruitment despite ergometer induced recoil forces. Key pointsKayak ergometer elastic tension significantly alters

Anterior Deltoid recruitment patterns.Kayakers maintain optimal arm kinematics despite changing external forces via altered shoulder muscle recruitment.Overhead arm movements account for a high proportion of the kayak stroke cycle. KEYWORDS: 3D joint kinematics; Kayaking; electromyography; ergometry; shoulder.

McDonnell LK[1], Hume PA, Nolte V. (2012)

An observational model for biomechanical assessment of sprint kayaking technique.

Sports Biomech. 2012 Nov;11(4): 507-23.

[1] School of Sport and Recreation, Sports Performance Research Institute New Zealand, Auckland University of Technology, Auckland, New Zealand. lisa.mcdonnell@aut.ac.nz

Sprint kayaking stroke phase descriptions for biomechanical analysis of technique vary among kayaking literature, with inconsistencies not conducive for the advancement of biomechanics applied service or research. We aimed to provide a consistent basis for the categorisation and analysis of sprint kayak technique by proposing a clear observational model. Electronic databases were searched using key words kayak, sprint, technique, and biomechanics, with 20 sources reviewed. Nine phase-defining positions were identified within the kayak literature and were divided into three distinct types based on how positions were defined: water-contact-defined positions, paddle-shaft-defined positions, and body-defined positions. Videos of elite paddlers from multiple camera views were reviewed to determine the visibility of positions used to define phases. The water-contact-defined positions of catch, immersion, extraction, and release were visible from multiple camera views, therefore were suitable for practical use by coaches and researchers. Using these positions, phases and subphases were created for a new observational model. We recommend that kayaking data should be reported using single strokes and described using two phases: water and aerial. For more detailed analysis without disrupting the basic two-phase model, a four-sub-phase model consisting of entry, pull, exit, and aerial sub-phases should be used.

McDonnell LK[1], Hume PA, Nolte V. (2013)

A deterministic model based on evidence for the associations between kinematic variables and sprint kayak performance.

Sports Biomech. 2013 Sep;12(3): 205-20.

[1] School of Sport and Recreation, Sports Performance Research Institute New Zealand, Auckland University of Technology, Auckland, New Zealand. lisa.mcdonnell@aut.ac.nz

The aim of this narrative review was to propose a deterministic model based on a review of previous research documenting the evidence for the associations between average kayak velocity and kinematic variables in sprint kayaking. Literature was reviewed after searching electronic databases using key words ‘kayak,’ ‘biomechanics,’ ‘velocity,’ ‘kinematics,’ and ‘performance.’ Our kinematic deterministic model for sprint kayaking performance shows that the average kayak velocity is determined by kayak stroke displacement and stroke time. Stroke time had the strongest correlation with 200-m race time ($r = 0.86$, $p < 0.001$), and stroke rate (inversely proportional to

stroke time) was strongly correlated with average horizontal velocity over two consecutive strokes at race pace (r = -0.83, p < 0.05). Increased stroke rate via decreased absolute water phase time and increased relative water phase time were indicative of more elite performance. There was no significant relationship between stroke displacement and velocity; however, a large decrease in stroke displacement may be detrimental to performance. Individual characteristics may be responsible for a paddlers' ability to achieve and sustain a given stroke rate. Coaches should theoretically focus interventions on increasing stroke rate while maintaining stroke displacement; however this hypothesis should be confirmed with prospective studies.

Vaquero-Cristóbal R[1], Alacid F, López-Plaza D, Muyor JM, López-Miñarro PA. (2013)

Kinematic Variables Evolution During a 200-m Maximum Test in Young Paddlers.

J Hum Kinet. 2013 Oct 8;38: 15-22.

[1] Chair of Sport Traumatology. Catholic University of San Antonio of Murcia. Spain.

The objective of this research was to determine the kinematic variables evolution in a sprint canoeing maximal test over 200 m, comparing women and men kayak paddlers and men canoeists. Speed evolution, cycle frequency, cycle length and cycle index were analysed each 50 m section in fifty-two young paddlers (20 male kayakers, 17 female kayakers and 15 male canoeists; 13-14 years-old). Recordings were taken from a boat which followed each paddler trial in order to measure the variables cited above. Kinematic evolution was similar in the three categories, the speed and cycle index decreased through the test after the first 50 m. Significant differences were observed among most of the sections in speed and the cycle index (p<0.05 and <0.01, respectively). Cycle length remained stable showing the lowest values in the first section when compared with the others (p<0.01). Cycle frequency progressively decreased along the distance. Significant differences were identified in the majority of the sections (p<0.01). Men kayakers attained higher values in all the variables than women kayakers and men canoeists, but only such variables as speed, cycle length and cycle index were observed to be significantly higher (p<0.01). Moreover, lower kinematic values were obtained from men canoeists. The study of the evolution of kinematic variables can provide valuable information for athletes and coaches while planning training sessions and competitions. KEYWORDS: Speed evolution; canoeists; cycle frequency; cycle index; cycle length; kayakers.

Laurent A[1], Rouard A, Mantha VR, Marinho DA, Silva AJ, Rouboa AI. (2013)

The computational fluid dynamics study of orientation effects of oar-blade.

J Appl Biomech. 2013 Feb;29(1): 23-32.

[1] Sport Science Department, University of Savoie, Chambery, France.

The distribution of pressure coefficient formed when the fluid contacts with the kayak oar blade is not been studied extensively. The CFD technique was employed to calculate pressure coefficient distribution on the front and rear faces of oar blade resulting

from the numerical resolution equations of the flow around the oar blade in the steady flow conditions (4 m/s) for three angular orientations of the oar (45°, 90°, 135°) with main flow. A three-dimensional (3D) geometric model of oar blade was modeled and the k-ε turbulent model was applied to compute the flow around the oar. The main results reported that, under steady state flow conditions, the drag coefficient (Cd = 2.01 for 4 m/s) at 90° orientation has the similar evolution for the different oar blade orientation to the direction of the flow. This is valid when the orientation of the blade is perpendicular to the direction of the flow. Results indicated that the angle of oar strongly influenced the Cd with maximum values for 90° angle of the oar. Moreover, the distribution of the pressure is different for the internal and external edges depending upon oar angle. Finally, the difference of negative pressure coefficient Cp in the rear side and the positive Cp in the front side, contributes toward propulsive force. The results indicate that CFD can be considered an interesting new approach for pressure coefficient calculation on kayak oar blade. The CFD approach could be a useful tool to evaluate the effects of different blade designs on the oar forces and consequently on the boat propulsion contributing toward the design improvement in future oar models. The dependence of variation of pressure coefficient on the angular position of oar with respect to flow direction gives valuable dynamic information, which can be used during training for kayak competition.

Nilsson JE[1], Rosdahl HG. (2014)

New devices for measuring forces on the kayak foot bar and on the seat during flatwater kayak paddling: a technical report.

Int J Sports Physiol Perform. 2014 Mar;9(2): 365-70.

[1] Swedish School of Sport and Health Sciences, Stockholm, Sweden.

The purpose was to develop and validate portable force-measurement devices for recording push and pull forces applied by each foot to the foot bar of a kayak and the horizontal force at the seat. A foot plate on a single-point force transducer mounted on the kayak foot bar underneath each foot allowed the push and pull forces to be recorded. Two metal frames interconnected with 4 linear ball bearings, and a force transducer allowed recording of horizontal seat force. The foot-bar-force device was calibrated by loading each foot plate with weights in the push-pull direction perpendicular to the foot plate surface, while the seat-force device was calibrated to horizontal forces with and without weights on the seat. A strong linearity ($r2$ = .99-1.0) was found between transducer output signal and load force in the push and pull directions for both foot-bar transducers perpendicular to the foot plate and the seat-force-measuring device. Reliability of both devices was tested by means of a test-retest design. The coefficient of variation (CV) for foot-bar push and pull forces ranged from 0.1% to 1.1%, and the CV for the seat forces varied from 0.6% to 2.2%. The current study opens up a field for new investigations of the forces generated in the kayak and ways to optimize kayak-paddling performance.

Messias LH, Ferrari HG, Sousa FA, Dos Reis IG, Serra CC, Gobatto CA, Manchado-Gobatto FB. (2015)

All-out Test in Tethered Canoe System can Determine Anaerobic Parameters of Elite Kayakers.

Int J Sports Med. 2015 Oct;36(10): 803-808.

School of Applied Sciences, University of Campinas, Limeira, Brazil.

The aims of this study were to use a specific all-out 30-sec tethered test to determine the anaerobic parameters in elite kayakers and verify the relationship between these results and sports performance. Twelve elite slalom kayakers were evaluated. The tethered canoe system was created and used for the all-out 30-sec test application. Measurements of peak force, mean force, minimum force, fatigue index and impulse were performed. Performance evaluation was determined by measuring the time of race in a simulated race containing 24 gates on a white-water course. Blood was collected (25-µl) for analysis of lactate concentration at rest and at 2, 4, 6, 8 and 10-min intervals after both the all-out test and the simulated race. The Pearson product moment correlation shows a inverse and significant relationship of peak force, mean force and impulse with time of race. Blood lactate concentrations after the all-out test and the simulated race peak at same time (4min). Additionally, no interaction was visualized between time and all-out test/simulated race for blood lactate concentrations (P <0.365). These results suggest a relationship between the parameters of the all-out test and performance. Thus, the tethered canoe system is a useful tool for determining parameters that could be used in training control of slalom kayakers.

Gomes BB[1], Conceição FA[1], Pendergast DR[2], Sanders RH[3], Vaz MA[4], Vilas-Boas JP[1]. (2015)

Is passive drag dependent on the interaction of kayak design and paddler weight in flat-water kayaking?

Sports Biomech. 2015;14(4): 394-403.

[1]a Faculty of Sports , Centre of Research, Education, Innovation and Intervention in Sport (CIFI2D), Porto Biomechanics Laboratory (LABIOMEP), University of Porto, Porto, Portugal.

[2]b School of Medicine and Biomedical Sciences, Center for Research and Education in Special Environments, Department of Physiology, University at Buffalo, Buffalo, NY, USA.

[3]c Faculty of Health Sciences, Exercise and Sport Science, The University of Sydney, Lidcombe, NSW, Australia.

[4]d Faculty of Engineering, Institute of Science and Innovation in Mechanical and Industrial Engineering (INEGI), Porto Biomechanics Laboratory (LABIOMEP), University of Porto, Porto, Portugal.

Drag is one of the major factors that influences kayaking performance. To focus on the drag of the kayak's hull shape and the paddlers' weight per se, the passive drag (Dp) was measured on a flat-water sprint course for one paddler with added weights. Dp was measured by an electromechanical towing device using a load cell, at incremental and constant velocities from 2.78 to 5.56 m/s. Three kayaks of different sizes and shapes (Nelo® K1 Quattro-M, ML, and L) were used and the paddlers' body weight was adjusted with weights so the total paddler weight in the kayak was 65, 75, and 85 kg. The mean Dp increased by the power function of D = kv(n) (mean R(2) = .990; SD .006). The Dp went from 21.37±1.29 N at 2.78 m/s to 89.32±6.43 N at 5.56 m/s.

For the two lighter weighted kayaks (65 and 75 kg), the lowest Dp was observed with different kayak sizes (M, ML, or L) depending on the target velocity. The manufacturers suggest that paddlers should select a kayak size according to their body weight to minimise drag; however, the results of this study suggest that target velocities, and thus competition distance should also be factored into kayak selection. KEYWORDS: Hydrodynamics; hull; single-seat kayak.

Gomes BB[1], Ramos NV, Conceição F AV, Sanders RH, Vaz MA, Vilas-Boas JP. (2015)

Paddling Force Profiles at Different Stroke Rates in Elite Sprint Kayaking.

J Appl Biomech. 2015 Aug;31(4): 258-63.

[1] Faculty of Sports, CIFI2D, LABIOMEP, University of Porto, Porto, Portugal.

In sprint kayaking the role that paddling technique plays in optimizing paddle forces and resultant kayak kinematics is still unclear. The aim of this study was to analyze the magnitude and shape of the paddle force-time curve at different stroke rates, and their implications for kayak performance. Ten elite kayak paddlers (5 males and 5 females) were analyzed while performing 2000-m on-water trials, at 4 different paces (60, 80, and 100 strokes per minute, and race pace). The paddle and kayak were instrumented with strain gauges and accelerometers, respectively. For both sexes, the force-time curves were characterized at training pace by having a bell shape and at race pace by a first small peak, followed by a small decrease in force and then followed by a main plateau. The force profile, represented by the mean force/peak force ratio, became more rectangular with increasing stroke rate ($F[3,40] = 7.87$, $P < .01$). To obtain a rectangular shape to maximize performance, kayak paddlers should seek a stronger water phase with a rapid increase in force immediately after blade entry, and a quick exit before the force dropping far below the maximum force. This pattern should be sought when training at race pace and in competition.

Borne R[1], Hausswirth C, Costello JT, Bieuzen F. (2015)

Low-frequency electrical stimulation combined with a cooling vest improves recovery of elite kayakers following a simulated 1000-m race in a hot environment.

Scand J Med Sci Sports. 2015 Jun;25 Suppl 1: 219-28. doi: 10.1111/sms.12392.

[1] Research Department, Laboratory of Sport, Expertise and Performance, French National Institute of Sport (INSEP), Paris, France.

This study compared the effects of a low-frequency electrical stimulation (LFES; Veinoplus(®) Sport, Ad Rem Technology, Paris, France), a low-frequency electrical stimulation combined with a cooling vest (LFESCR) and an active recovery combined with a cooling vest (ACTCR) as recovery strategies on performance (racing time and pacing strategies), physiologic and perceptual responses between two sprint kayak simulated races, in a hot environment (~32 wet-bulb-globe temperature). Eight elite male kayakers performed two successive 1000-m kayak time trials (TT1 and TT2), separated by a short-term recovery period, including a 30-min of the respective recovery intervention protocol, in a randomized crossover design. Racing time, power output, and stroke rate were recorded for each time trial. Blood lactate concentration, pH, core, skin and body

temperatures were measured before and after both TT1 and TT2 and at mid- and post-recovery intervention. Perceptual ratings of thermal sensation were also collected. LFESCR was associated with a very likely effect in performance restoration compared with ACTCR (99/0/1%) and LFES conditions (98/0/2%). LFESCR induced a significant decrease in body temperature and thermal sensation at post-recovery intervention, which is not observed in ACTCR condition. In conclusion, the combination of LFES and wearing a cooling vest (LFESCR) improves performance restoration between two 1000-m kayak time trials achieved by elite athletes, in the heat. © 2015 John Wiley & Sons A/S. Published by John Wiley & Sons Ltd. KEYWORDS: Post-race recovery strategy; cooling strategy; exercise-induced heat stress; high-intensity exercise; low-intensity exercise.

Nilsson JE. and Rosdahl HG. (2016)

Contribution of Leg-Muscle Forces to Paddle Force and Kayak Speed During Maximal-Effort Flat-Water Paddling.

International Journal of Sports Physiology and Performance, 2016, 11: 22 -27.

The purpose was to investigate the contribution of leg-muscle-generated forces to paddle force and kayak speed during maximaleffort flat-water paddling. Five elite male kayakers at national and international level participated. The participants warmed up at progressively increasing speeds and then performed a maximal-effort, nonrestricted paddling sequence. This was follone after 5 min rest by a maximal-effort paddling sequence with the leg action restricted– the knee joints "locked." Left- and right-side foot-bar and paddle forces were recorded with specially designed force devices. In addition, knee angular displacement of the right and left knees was recorded with electrogoniometric technique, and the kayak speed was calculated from GPS signals sampled at 5 Hz. The results showed that reduction in both push and pull foot-bar forces resulted in a reduction of 21% and 16% in mean paddle-stroke force and mean kayak speed, respectively. Thus, the contribution of foot-bar force from lower-limb action significantly contributes to kayakers' paddling performance. KEYWORDS: foot-bar force, movement restriction, elite kayakers, knee extension.

Park J[1], Yim J. (2016)

A New Approach to Improve Cognition, Muscle Strength, and Postural Balance in Community-Dwelling Elderly with a 3-D Virtual Reality Kayak Program.

Tohoku J Exp Med. 2016;238(1): 1-8. doi: 10.1620/tjem.238.1.

[1] Department of Physical Therapy, The Graduate School of Sahmyook University.

Aging is usually accompanied with deterioration of physical abilities, such as muscular strength, sensory sensitivity, and functional capacity. Recently, intervention methods with virtual reality have been introduced, providing an enjoyable therapy for elderly. The aim of this study was to investigate whether a 3-D virtual reality kayak program could improve the cognitive function, muscle strength, and balance of community-dwelling elderly. Importantly, kayaking involves most of the upper body musculature and needs the balance control. Seventy-two participants were randomly allocated into the kayak program group (n = 36) and the control group (n = 36). The two groups were well matched with respect to general characteristics at baseline. The participants in both groups performed a conventional exercise program for 30 min, and then the 3-D virtual reality kayak program was performed in the kayak program group for 20 min, two times a week for 6 weeks. Cognitive function was measured using the Montreal Cognitive Assessment. Muscle strength was measured using the arm curl and handgrip strength tests. Standing and sitting balance was measured using the Good Balance system. The post-test was performed in the same manner as the pre-test; the overall outcomes such as cognitive function ($p < 0.05$), muscle strength ($p < 0.05$), and balance (standing and sitting balance, $p < 0.05$) were significantly improved in kayak program group compared to the control group. We propose that the 3-D virtual reality kayak program is a promising intervention method for improving the cognitive function, muscle strength, and balance of elderly.

López-Plaza D[1], Alacid F[1], Muyor JM[2], López-Miñarro PÁ[3] (2017)

Sprint kayaking and canoeing performance prediction based on the relationship between maturity status, anthropometry and physical fitness in young elite paddlers.

J Sports Sci. 2017 Jun;35(11):1083-1090. doi: 10.1080/02640414.2016.1210817. Epub 2016 Jul 19.

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This study aimed to identify the maturity-related differences and its influence on the physical fitness, morphological and performance characteristics of young elite paddlers. In total, 89 kayakers and 82 canoeists, aged 13.69 ± 0.57 years (mean ± s), were allocated in three groups depending on their age relative to the age at peak height velocity (pre-APHV, circum-APHV and post-APHV) and discipline (kayak and canoe). Nine anthropometric variables, a battery of four physical fitness tests (overhead medicine ball throw, countermovement jump, sit-and-reach test and 20 m multistage shuttle run test) and three specific performance tests (1000, 500 and 200 m) were assessed. Both disciplines presented significant maturity-based differences in all anthropometric parameters (except for fat and muscle mass percentage), overhead medicine ball throw and all performance times (pre > circum > post; $P < 0.05$). Negative and significant correlations ($P < 0.01$) were detected between performance times, chronological age and anthropometry (body mass, height, sitting height and maturity status), overhead medicine ball throw and sit and reach for all distances. These findings confirm the importance of maturity status in sprint kayaking and canoeing since the more mature paddlers were also those who revealed largest body size, physical fitness level and best paddling performance. Additionally, the most important variables predicting performance times in kayaking and canoeing were maturity status and chronological age, respectively. KEYWORDS: Maturity; canoeing; fitness level; kayaking; morphology.

BIOMECCANICA APPLICATA ALLA CANOA KAYAK
CANOE SLALOM, WHITE WATER

Janura M., Kratochvil J., Lehnert M., Frantisek V. (2005)
***An analysis of the forward stroke as used in a wild water kayak on flat waters*,**
Acta Univ.Palacki Olomuc, Gymn. 2005, vol.35, n.2: 113-117.
Faculty of Physical Culture, Palacki University, Olomuc, Czech Republic.

The forward stroke is one of the basic motion activities that are typically used for canoeing in white water. Kinematics analysis (4 women, 5 men; junior representatives and talented competitors) of records from three cameras was used. The movement of the kayak was carried out with maximal velocity. General parameters of the stroke on the left and right side of the kayak were determinate utilizing the APAS system. Lower velocity losses in the catch and pull phase of the paddle, a shorter time of the pull phase, higher frequency of the strokes are typical for kayakers with better levels of efficiency. The movement of the right and left wrist of these competitors in the frontal plane is more symmetrical. The deviation of the trunk is less in the sagittal plane as well as the sideways movement of the kayak. KEYWORDS: Kinematic analysis, forward stroke, wild water.

Guilbaud M., Huberson S., Voisine M. (2006)
Numerical optimisation of slalom canoe and kayak hulls performances.
Sport Biomechanics, Computer-Simulation in Sport. 4500 Mo-Tu, n. 27 (P61).
Laboratoire d’etudes Aerodynamiques, Universitè de Poitiers, France

Recent developments in hydrodynamic wave resistance calculations and in optimization by means of genetic algorithm are applied to the improvement of hull shapes of slalom canoes and kayaks. This improvement consists in minimizing the drag during straight path between gates, whereas additional constraints are accounted for in order to preserve the manoeuvring and seakeeping qualities of the boats. The drag is calculated using a wave resistance code based on a linear panel method together with the wave resistance Green function, the friction drag being calculated by the ITTC75 formula. For the optimisation, the hull is defined by 6 design parameters: 3 homothetic deformations along the 3 directions and 2 displacements of the locations of maximum width and depth (positive downwards and negative upwards) from an initial hull provided in this study by a canoe hull named “Adfor”. The sixth design parameter is linked to the position of the centre of gravity. In order to avoid hull shapes limited to flatwater races, 6 additional constraints are used to model the manoeuvring and seakeeping qualities. Beside this, the manoeuvring and seakeeping qualities are essentially compared to qualities of the initial hull, assumed to be satisfactory, through a set of geometric criteria which are reduced to two main measures of merit, one describing the manoeuvring quality and the other, the seakeeping quality. A better understanding

of the hull form variations is sought by presenting the results in the form of a pseudo "Pareto front" of the total resistance versus manoeuvrability and seakeeping measures of merit. Most of the calculations are performed with 18 9 panels on half a hull at a velocity of 2.5 m/s. The code is run on a 2.8 Ghz PC cluster; using 4 nodes of 2 processors each, the CPU time is about 4 days. The parameters used are the reference boat geometry, an initial population of 600 and a current population of 60 hull forms. The convergence is reached after about 3501 hulls analysed.

Hunter A[1], Cochrane J, Sachlikidis A. (2007)
Canoe slalom--competition analysis reliability.
Sports Biomech. 2007 May;6(2): 155-70.
[1] Biomechanics Department, Australian Institute of Sport, Belconnen, ACT, Australia. adam.hunter@ausport.gov.au

The aim of this study was to assess intra-observer and inter-observer reliability of data gathered from a lapsed-time time-motion analysis of canoe slalom competition. The data were collected using a definition set developed in conjunction with elite canoe slalom coaches. Competition runs from four national-standard paddlers in a national selection race were analysed in random order three times by three observers. For each run, observers identified various events specific to canoe slalom, including time taken between gates, touched and missed gates, turn times, major and minor avoidance, rolls, paddle in and out of water times, and stroke classification. The error of measurement was determined for each of these variables. For time taken between gates and turn times, the error was < or = 0.21 and < or = 0.39 s for intra-observer and inter-observer analysis, respectively. The error for stroke in and out of water times was < or = 0.08 and < or = 0.13 s for intra-observer and inter-observer analysis, respectively. Analysis of stroke classification identification for intra-observer comparisons revealed that 91% of the time identical stroke identification occurred. Inter-observer analysis revealed identical stroke identification was achieved 81% of the time. These reliability data compare favourably with previous time-motion analysis in other sports using fewer variables.

Hunter A[1], Cochrane J, Sachlikidis A. (2008)
Canoe slalom competition analysis.
Sports Biomech. 2008 Jan;7(1): 24-37.
[1] Department of Biomechanics, Australian Institute of Sport, Belconnen, Australia. adam.hunter@ausport.gov.au

The aim of this study was to quantify the differences between groups of elite canoe slalom athletes based on the class they paddle in and the strategies they use in competition. Canoe and kayak footage was recorded using three cameras and analysed using lapsed-time time motion analysis. Analysis was undertaken on the ten fastest competition runs for men's kayak and canoes and women's kayak for the 22-gate semi-final/final course at the 2005 canoe slalom world championships. Comparison between the categories of paddlers revealed that despite canoe paddlers taking significantly (P <

or = 0.05) fewer strokes than kayak paddlers, they were not significantly slower than men's single kayak paddlers with respect to their run times and only significantly slower between 4 of 22 gates. Results revealed also that paddlers using different turn strategies (spin vs. pivot) had significantly (P < or = 0.05) different split times for the gates before and after the execution of the manoeuvre. For a paddler this means that their individual strategy could be analysed and compared with those of others to determine if alternate strategies would be beneficial to their performance.

Hunter A[1]. (2009)

Canoe slalom boat trajectory while negotiating an upstream gate.

Sports Biomech. 2009 Jun;8(2): 105-113.

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adam.hunter@ausport.gov.au

The aim of this study was to determine how the path chosen by elite slalom paddlers influences the time taken to negotiate an upstream gate. Six trials for international men's single kayak (MK1) (n = 11) and single canoe (C1) (n = 6) paddlers were digitized for a left-hand upstream gate. Results revealed that the absolute variability of paddlers increased as their total time increased (r = 0.594), but the coefficient of variation remained constant. There was a strong correlation (r = 0.89, each individual trial; r = 0.93, mean total time for each participant) between boat trajectory and the total time. The MK1 and C1 paddlers used similar strategies to negotiate an upstream gate. There were significant differences (P < 0.05) between the boat trajectory of the fastest and slowest paddlers (average distance between paddler's head and the inside pole). These results suggest that to achieve a faster upstream gate performance, paddlers should concentrate on the distance between their head and the inside pole. However, there would be an optimal distance beyond which any further reduction in the distance would impede technique and performance. KEYWORDS: Biomechanics, kayak, paddler, performance, three-dimensional, whitewater.

Bílý M[1], Baláš J, Martin AJ[2], Cochrane D[2], Coufalová K, Süss V. (2013)

Effect of paddle grip on segmental fluid distribution in elite slalom paddlers.

Eur J Sport Sci. 2013;13(4): 372-7.

[1] Faculty of Physical Education and Sport, Charles University, Praha, Czech Republic.
[2] School of Sport & Exercise, Massey University, Palmerston North, New Zealand.

Issues of high levels of muscular asymmetry have been associated with injury risk, and therefore have potential implications for decremental performance at the elite sport level. The aim of this current study was to assess the relationship between the segmental fluid distribution and the paddle grip in elite male and female slalom kayakers and canoeists. Eighty-four world-cup competitors (61 males and 23 females) took part in the study. Impedance analysis was used to assess segmental fluid asymmetry. The effect of paddle grip (loose/fixed hand in kayakers, lower/upper hand in canoeists), morphological dominance (dominant/non-dominant) and discipline (ca-

noe/kayak) were evaluated by repeated measures ANOVA. The findings indicated a significant effect of paddle grip in canoeists on morphological asymmetry in upper limbs (arm of lower paddle hand mean fluid distribution 3.28, s=0.43 litres; arm of upper paddle hand mean fluid distribution 3.19, s=0.41 litres; P=0.000, [Formula: see text]=0.33). The sternmen demonstrated higher asymmetry between the arms of upper and lower paddle hand (mean 0.11, s=0.04 litres, P=0.000, [Formula: see text]=0.80) than the bowmen (mean 0.04, s=0.06 litres, P=0.015, [Formula: see text]=0.44) in double-canoes. Significant morphological asymmetry was found also in kayakers but the effect of paddle grip was not substantial. The use of segmental impedance analysis may be a suitable diagnostic tool for assessing morphological changes, which can be related to paddling training. Likewise muscular asymmetry is associated with injury risk; the evaluation of morphological changes during the training process may be considered by sport trainers and physical therapists. KEYWORDS: Canoeing, kayaking, impedance analysis, asymmetry.

Baláš J[1], Bílý M, Coufalová K, Martin AJ, Cochrane DJ. (2015)

Effect of paddle grip on segmental fluid distribution and injuries occurrence in elite slalom paddlers.

J Sports Med Phys Fitness. 2015 Mar;55(3): 185-190.

[1] Faculty of Physical Education and Sport Charles University, Praha, Czech Republic - balas@ftvs.cuni.cz.

AIM: The aim of this current study was to assess the segmental fluid distribution, grip strength and injury occurrence in elite slalom kayakers and canoeists. METHODS: Ninety three world-cup competitors (72 males; 21 females) took part in the study. Impedance analysis assessed segmental fluid asymmetry and a questionnaire evaluated injury occurrence during the three previous years. The effect of paddle grip (loose/fixed hand in kayakers, lower/upper hand in canoeists), morphological dominance (dominant/non-dominant) and discipline (canoe/kayak) was evaluated by repeated measures Anova. RESULTS: The findings indicated a significant effect of paddle grip in male canoeists on morphological asymmetry in the upper limbs (arm of lower paddle hand, mean fluid distribution 3.17, s=0.47 litres; arm of upper paddle hand mean fluid distribution 3.08, s=0.45 litres; P<0.001, ωp2=0.32). Significant morphological asymmetry was found also in kayakers but the effect of paddle grip was not substantial. Grip strength was not related to paddle grip. Paddlers with arm morphological asymmetry reported upper limb injury occurrence in 60% of cases, which was 3 times more than in paddlers without arm morphological asymmetry. CONCLUSION: As upper-limb asymmetry was directly associated with paddle grip in male canoeists, canoe paddling may lead to higher bilateral morphological asymmetry and therefore, injury occurrence.

FISIOLOGIA APPLICATA ALLA CANOA KAYAK
FLAT WATER CANOE SPRINT, MARATHON

Tesch P, Piehl K, Wilson G, Karlsson J. (1976)
Physiological investigations of Swedish elite canoe competitors.
Med Sci Sports. 1976 Winter; 8(4): 214-8.

Maximal as well as submaximal heart rate and oxygen uptake were measured during paddling and other types of arm and leg exercise in Swedish elite canoeists. Muscle fiber composition was determined in the canoeists: 4 seniors (22-28 year old) as well as 2 juniors (18 years). Vo2max during treadmill running averaged in the seniors 5.4 1 x min -1 and during arm exercise. Corresponding values for the juniors were 4.7 1 x min -1 and 4.21 x min -1 or 88%. Paddling 500 m resulted in relatively low oxygen uptake, but the highest blood lactate concentrations, whereas 1,000 m gave the highest oxygen uptake but also high blood lactate concentrations. During a 10,000 m race the heart rate was approximately 97% (range 96-98%) of the maximum measured. In nine present and former winners of World Championships or Olympic medals, fiber types were determined in the deltoid muscle. These data indicated that canoeists, who were successful in 500 m races, had a higher percentage of fast twitch (FT) muscle fibers (range 50-59%) than medalists, who competed in 10,000 m races (26-52% FT).

Ridge BR, Pyke FS, Roberts AD. (1976)
Responses to kayak ergometer performance after kayak and bicycle ergometer training.
Med Sci Sports. 1976 Spring;8(1): 18-22.

Ten moderately active male volunteers, age 19-30 years, completed one month of training on either a kayak or a bicycle ergometer (five men in each group). The men completed sixteen 30 minute sessions of continuous work at an intensity which maintained their HR within 85-90% of its maximum, as previously determined on the kayak ergometer. After this training period the kayak group demonstrated significant decreases in VO2, VE, HR and blood lactate in submaximal kayak ergometer work and a significant increase in VO2 during maximal kayak ergometer work. These changes contributed to a significantly higher maximal kayaking work output. The bicycle-trained group did not make any of these improvements on the kayak ergometer. However in their last training session on the bicycle ergometer they were able to work at a higher submaximal load while maintaining the same heart rate as in the first training session. It was concluded that the circulatory and metabolic adjustments to kayak work are greater with kayak training than with bicycle training.

Pendergast D., Cerretelli P., Rennie D.W. (1979)
Aerobic and glycolytic metabolism in arm exercise.
J Appl Physiol, 1979 Oct; 47(4): 754-60.

Eight kayakers (K) and 3 sedentary subjects (S) performed arm cranking and pedaling while erect or supine at each of several work loads from submaximal to the highest they could sustain for 2 min and for intervals varying from 10 s to 5 min. From measurements of VO2 and blood lactate concentration, the aerobic and glycolytic energy release in arm work was assessed. For steady-state aerobic work all subjects had a mechanical efficiency averaging 0.24 independent of posture or exercise mode. Per unit fat-free limb volume, arm VO2max of group K was 1.5-fold that of group S, whereas leg VO2max was the same in each group. Compared to group S, glycolytic arm work in group K was characterized by: 1) higher thresholds for release of lactate at the onset of submaximal work, 2) lower blood lactate concentrations during comparable absolute or relative submaximal work, 3) higher conventional anaerobic thresholds for absolute, but not relative work loads, 4) higher maximal rates of lactate release, and 5) the same maximal blood lactate concentrations. Measurement of the early lactate threshold, which occurred at considerably lower arm work loads than did anaerobic threshold, but which was greatly increased by specific muscle training, may provide a simple, sensitive, and nontraumatic evaluation of muscle training.

Cerretelli P, Pendergast D, Paganelli WC, Rennie DW. (1979)
Effects of specific muscle training on VO2 on-response and early blood lactate.
J Appl Physiol. 1979 Oct; 47(4): 761-69.

The relationship between half time of the O2 uptake on-response (t1/2 VO2on, seconds) and early blood lactate accumulation (delta Lab, mmol.1(-1) at the onset of submaximal arm and/or leg exercise was the object of a cross-sectional study of sedentary subjects (S,n = 3), and kayakers (K, n = 8), and of a longitudinal study on 11 untrained subjects of specific arm vs. leg training. In supine arm cranking (W = 125 watts) S had an average t1/2 VO2on of 82 s and a delta Aab of 9.2 mmol.1(-1) compared to 47 +/- 7 s and 4 +/- 1.4 mmol.1(-1), respectively, for K. In longitudinal trainees shorter t1/2 VO2on was accompanied by lower Lab for the trained limbs. Specific limb conditioning in swimmers and runners resulted in shorter t1/2 VO2on. A linear relationship was observed between delta Lab and t1/2 VO2on having an intercept on the time axis at congruent to 20 s and a slope proportional to muscle mass. Trained muscles were grouped closest to the intercept indicating local acceleration of the rate of O2 transfer approaching the t1/2 VO2on for isolated perfused muscle at the onset of work. Since t1/2 VO2on, we conclude that factors distal to the capillary are specifically involved in the local training response.

Clarkson PM, Kroll W, Melchionda AM. (1982)
Isokinetic strength, endurance, and fiber type composition in elite American paddlers.
Eur J Appl Physiol Occup Physiol. 1982;48(1):67-76.

Muscle fiber type and isokinetic strength and fatigue were examined in nine highly trained canoe and kayak paddlers. Needle biopsies were taken from the right vastus lateralis and biceps brachii muscles and the samples stained for myofibrillar ATPase. Baseline elbow flexion and knee extension isometric (0 degrees . s-1) and isokinetic (60 degrees . s-1 or 1.05 rad . s-1 and 180 degrees . s-1 or 3.14 rad . s-1) peak torques were determined. Each subject then performed two series of 50 isokinetic contractions at an angular velocity of 180 degrees . s-1: elbow flexion and knee extension series, separated by 3 h. The percentage of slow twitch fibers was similar in the biceps brachii (43.9%) and the vastus lateralis (43.3%). The fast twitch/slow twitch fiber area ratio was significantly higher in the more highly trained biceps brachii due to larger FT fibers. No relationship was found between fiber type composition and baseline peak torques or decline in peak torque due to the fatigue regimens. Baseline peak torque correlated with initial strength level, body weight, and limb girth. The results suggested that for these paddlers muscle strength and the decline in strength induced by repetitive isokinetic contractions were more dependent on characteristics of body size than on fiber type composition.

Tesch PA. (1983)
Physiological characteristics of elite kayak paddlers.
Can J Appl Sport Sci. 1983 Jun;8(2): 87-91.

Elite flat-water kayak paddlers were characterized with regard to body composition, muscle strength and endurance for upper-body exercise. Furthermore, maximal oxygen uptake was measured during three types of exercise: treadmill running, arm cranking and outdoor paddling. Blood samples for subsequent lactate analysis were collected not only after maximal exercises but also during training sessions and post 1000 m racing. In comparison with other groups of athletes known to exhibit great upper-body muscle strength, kayakers were found to possess high values for shoulder strength, endurance and anaerobic capacity. Total body maximaloxygen uptake averaged (+/- SD) 5.36 +/- 0.25 l X min-1. The values for arm cranking and paddling were 4.30 +/- 0.29 l X min-1 and 4.67 +/- 0.16 l X min-1. High blood lactate levels were noticed under training conditions and post competition (11.0-17.5 mmol X l-1). Taken together, the present study suggests success in flat-water kayak racing to require great upper-body muscle strength, anaerobic capacity and endurance in addition to high aerobic power.

Fleck SJ. (1983)
***Body composition of elite American athletes*.**
Am J Sports Med 1983 Nov; 11(6): 398-403.

Five hundred twenty-eight male athletes participating in 26 Olympic events and 298 female athletes participating in 15 Olympic events underwent determinationof body fat percentage (% fat) and lean body mass (LBM) via hydrostatic weighing and/or anthropometric methods. All groups of athletes were below the average values for % fat of college age men and women of 15% and 25%,respectively. In general, athletes involved in a sport where their body weight is supported, such as canoe and kayak (males, 13.0 +/- 2.5%; females, 22.2 +/-4.6%) and swimming (males, 12.4 +/- 3.7%; females 19.5 +/- 2.8%), tended to have higher % fat values. Athletes involved in sports where a weight class has to be made to compete, such as boxing (males, 6.9 +/- 1.6%) and wrestling(male, Junior World Freestyle 7.9 +/- 2.7%), events such as the 100, 200, and400 meters in athletes (male 100 and 200 meters, 6.5 +/- 1.2%; female 100, 200and 400 meters, 13.7 +/- 3.6%) that are very anaerobic in nature and extremely aerobic events such as the marathon (males, 6.4 +/- 1.3%) demonstrated lower %fat values. Athletes involved in sports where body size is a definite advantage, such as basketball (males, 84.1 +/- 6.2 kg; females, 55.3 +/- 4.9kg) and volleyball (males, 75.0 +/- 6.6 kg; females, 58.4 +/- 4.5 kg) tended tohave a larger LBM.

Csanady M, Gruber N. (1984)
***Comparative echocardiographic studies in leading canoe-kayak and handball sportsmen*.**
Cor Vasa 1984; 26(1): 32-37

Echocardiographic data on 21 top-grade kayak-canoeists and 16 top-grade handball players are compared. While the end-diastolic and end-systolic diameters as well as end-diastolic and end-systolic volumes did not appreciably differ, the posterior wall and particularly the interventricular septum both in diastole and systole were significantly thicker in kayak- canoeists than in handball players. Also the left ventricular mass was considerably greater in the former group. The differences were even more striking when the parameters in question were calculated in relation to 1 kg body weight, 1 m-2 height and 1 m2 body surface area. Since the members of both groups were competitors at international level, it can be assumed that the differences are due to the different degree of strain placed on the heart in these sports.

Csanady M, Forster T, Hogye M, Gruber N, Moczo I (1986)
Three-year echocardiographic follow-up study on canoeist boys.
Acta Cardiol 1986; 41(6): 413-425

The echocardiographic parameters were followed for 3 years in 15 boys aged 13 years on average, who were beginning competitive canoe race training, and were compared with the corresponding data on 17 boys of the same age who did not take part in sports. As compared to non-sporting boys the 13-year-old canoeist boys had a larger left ventricular end-diastolic diameter (46.13 +/- 4.64 mm vs 44.35 +/- 3.06 mm), a thicker left ventricular posterior wall (7.47 +/- 0.74 mm vs 6.47 +/- 1.18 mm) and particularly a thicker interventricular septum (8.33 +/- 1.18 mm vs 7.59 +/- 1.6 mm) just after they began sport, in spite of the fact there were no significant differences between the two groups in age, height, weight and body surface area. The preexisting difference in left ventricular hypertrophy between the two groups increased significantly during the 3-year follow-up period. The thickness of the left ventricular posterior wall in diastole increased to 9.20 +/- 1.01 mm vs 8.24 +/- 0.83 mm (p = 0.006), and that of the interventricular septum to 10.73 +/- 1.58 mm vs 9.59 +/- 1.18 (p = 0.025). The hypertrophic index and the left ventricular mass corresponded to the data given above (9.97 +/- 1.25 mm vs 8.91 +/- 0.94 mm, p = 0.01; and 261 +/- 50.7 g vs 202.83 +/- 45.8, p = 0.002, respectively). The canoeist boys had a slightly larger aortic root diameter at the beginning, and this difference increased and became more significant during the 3 years (29.4 +/- 2.39 mm vs 27.18 +/- 1.88 mm, p = 0.006). There were no significant differences between the two groups in the size of the left atrium, the fractional shortening of the left ventricle and the calculated ejection fraction and stroke volume.

Shephard RJ. (1987)
***Science and medicine of canoeing and kayaking*.**
Sports Med. 1987 Jan-Feb; 4(1): 19-33

Canoeing and kayaking are upper-body sports that make varying demands on the body, depending on the type of contest and the distance covered. The shorter events (500 m) are primarily anaerobic (2 minutes of exercise), calling for powerful shoulder muscles with a high proportion of fast-twitch fibres. In contrast, 10,000 m events call for aerobic work to be performed by the arms. Such contestants need a high proportion of slow-twitch fibres, and an ability to develop close to 100% of their leg maximum oxygen intake when paddling. In slalom and whitewater contests, the value of physiological testing is somewhat limited, since performance is strongly influenced by experience and the ability to make precisely judged rapid paddling efforts under considerable emotional stress. Paddlers face dangers from their hostile cold water environment; causes of fatalities (drowning, cardiac arrest, ventricular fibrillation and hypothermia) are briefly reviewed. Medical problems include provision of adequate nutrition and a clean water supply, effects of repeated immersion (softening of the skin, blistering, paronychial infections, sinusitis, otitis), varicose veins (secondary to thoracic fixation) and hazards

of exposure to fibreglass and polystyrene in the home workshop. Surgical problems include muscle sprains and mechanical injuries (haemotomas, lacerations, contusions, concussion, and fractures).

Fry RW; Morton AR (1991)

Physiological and kinanthropometric attributes of elite flatwater kayakists.

Med Sci Sports Exerc (US) Nov 1991; 23(11): 1297-1301.

Department of Human Movement and Recreation Studies, University of Western Australia, Nedlands.

Physical and physiological factors accounting for the variability of performance in 500, 1000, 10,000, and 42,000 m flatwater kayaking were reinvestigated using linear regression. Times achieved for each distance we used as the dependent variable for analysis while the independent variables were the parameters derived from the test battery. The 38 kayakists who participated were categorized as either state team members or nonselected paddlers, based on an objective selection policy. Several of the participant subjects were Australian international representatives. All selected paddlers were grouped together and Student's t-tests performed to determine which variables could distinguish between selected and nonselected paddlers. Simple regression was used to determine the strength of association of each parameter with performance time over each race distance, and multiple regression was used to generate equations for the prediction of performance times. Aerobic power and variables related to the aerobic-anaerobic transition were examined using gas analysis during an incremental workload test on a kayak ergometer. A 1-min all-out test also on a kayak ergometer was used to obtain an indication of anaerobic capacity and power. Muscular strength and fatigue were assessed using a simulated kayak stroke on a Cybex isokinetic dynamometer. Physical characteristics were determined using kinanthropometric tests. Aerobic power, anaerobic power and capacity, muscular strength, resistance to muscular fatigue, and measures of body size were significantly greater in more successful kayakists. All of the parameters measured correlated significantly with performance time over at least one of the four race distances.

Fry RW, Morton AR, Keast D (1992)

Acute intensive interval training and T-lymphocyte function.

Med Sci Sports Exerc 1992 Mar; 24(3): 339-345.

University of Western Australia, Nedlands.

Immune suppression has been suggested to occur as a result of acute exercise although results of previous studies are variable, possibly due to the failure of some researchers to control exercise intensity and duration. Most of the studies so far have investigated immediate effects after bouts of exercise mainly in subjects undertaking lower body exercise (running or cycling), andthe time course of recovery has rarely been determined. We chose two groups of athletes for our studies. One group represented subjects of a range of fitness levels from recreational runners to high-performance runners. The

second groupre presented kayakists with a similar range of fitness levels. Following interval training designed to stress either the lower or upper body anaerobically, we have now shown that upper body exercise (kayaking) induces similar in vitro responses to those described for lower body exercise. There were no differences between the responses of low-fitness versus high-fitness subjects. In addition we have studied the in vitro responses of leukocytes following acute anaerobic exercise over a 24-h recovery period. The resultsshowed that the reduced lymphocyte proliferative response, in vitro, to theT-cell mitogen CONA experienced immediately after exercise returned to normal levels within 2 h of recovery time. This suggests that the reduction in lymphocyte proliferative response is a short transient one.

Gray GL, **Matheson GO**, **McKenzie DC. (1995)**

The metabolic cost of two kayaking techniques.

Int J Sports Med. 1995 May; 16(4): 250-254

Allan McGavin Sports Medicine Centre, University of British Columbia, Vancouver, Canada.

A common technique employed in flatwater kayak and canoe races is "wash riding", in which a paddler positions his/her boat on the wake of a leading boat and, at a strategic moment, drops off the wake to sprint ahead. It was hypothesized that this manoeuver was energy efficient, analogous to drafting in cycling. To study this hypothesis, minute ventilation (VE), heart rate (HR) and oxygen consumption (VO2) were measured in 10 elite male kayak paddlers (age = 25 +/- 6.5 yrs, height = 183.6 +/- 4.4 cm, mass = 83.9 +/- 6.1 kg) during steady-state exercise at a standardized velocity in conditions of "wash riding" (WR) and "non-wash riding" (NWR). The data were collected in field conditions using a portable telemetric metabolic system (Cosmed K2). Statistical analysis of the mean values for VE, VO2 and HR was performed using the Hotelling's T2 statistic and revealed significant ($p < 0.05$) differences between the WR and NWR trials for all three dependent variables. Mean values for VE (l/min) were WR = 113 +/- 16.5, NWR = 126.3 +/- 15.7; for VO2 (l/min) were WR = 3.22 +/- 0.32, NWR = 3.63 +/- 0.3; and for HR (bpm) were WR = 167 +/- 9.9, NWR = 174 +/- 8.0. It was concluded that wash riding during kayak paddling confers substantial metabolic savings at the speeds tested. This has implications for the design of training programs and competitive strategies for flatwater distance kayak racing.

Fernandez, B., Perez-Landaluce, J., Rodriguez, M., & Terrados, N. (1995)

Metabolic contribution in Olympic kayaking events.

Medicine and Science in Sports and Exercise, 1995; 27(5), Supplement abstract 143.

Nine world-championship finalists were tested on water over 250, 500, and 1000 m distances and physiological parameters noted. The duration of each performance was then replicated on a kayaking ergometer and the metabolic costs analyzed (demand, uptake, oxygen deficit, and maximal accumulated oxygen deficit). The results indicated that energy requirements were similar to those for swimming and running events of similar duration.

Distance	Duration	%Anaerobic	%Aerobic
250 m	56.8 sec	56.5	43.5
500 m	2:04 min	37.1	62.9
1000 m	4:15 min	20.3	79.7

Implication: For most Olympic kayak events, aerobic functioning will provide a greater proportion of energy than will anaerobic functioning. However, it must be remembered that both systems must be trained but with an understanding of the very different roles that each plays in an athlete's development and competitive performance.

Billat V[1], Faina M, Sardella F, Marini C, Fanton F, Lupo S, Faccini P, de Angelis M, Koralsztein JP, Dalmonte A. (1996)

A comparison of time to exhaustion at VO2 max in élite cyclists, kayak paddlers, swimmers and runners.

Ergonomics. 1996 Feb;39(2): 267-77.

[1] Laboratoire STAPS, Université Paris XII, Créteil, France.

A recent study has shown the reproducibility of time to exhaustion (time limit: tlim) at the lowest velocity that elicits the maximal oxygen consumption (vVO2 max). The same study found an inverse relationship between this time to exhaustion at vVO2 max and vVO2 max among 38 élite long-distance runners (Billat et al. 1994b). The purpose of the present study was to compare the time to exhaustion at the power output (or velocity) at VO2 max for different values of VO2 max, depending on the type of exercise and not only on the aerobic capacity. The time of exhaustion at vVO2 max (tlim) has been measured among 41 élite (national level) sportsmen: 9 cyclists, 9 kayak paddlers, 9 swimmers and 14 runners using specific ergometers. Velocity or power at VO2 max (vVO2 max) was determined by continuous incremental testing. This protocol had steps of 2 min and increments of 50 W, 30 W, 0.05 m s-1 and 2 km-1 for cyclists, kayak paddlers, swimmers and runners, respectively. One week later, tlim was determined under the same conditions. After a warm-up of 10 min at 60% of their vVO2 max, subjects were concluded (in less than 45 s) to their vVO2 max and then had to sustain it as long as possible until exhaustion. Mean values of vVO2 max and tlim were respectively equal to 419 +/- 49 W (tlim = 222 +/- 91 s), 239 +/- 56 W (tlim = 376 +/- 134 s), 1.46 +/- 0.09 m s-1 (tlim = 287 +/- 160 s) and 22.4 +/- 0.8 km h-1 (tlim = 321 +/- 84 s), for cyclists, kayak paddlers, swimmers and runners. Time to exhaustion at vVO2 max was only significantly different between cycling and kayaking (ANOVA test, p < 0.05). Otherwise, VO2 max (expressed in ml min-1 kg-1) was significantly different between all sports except between cycling and running (p < 0.05). In this study, time to exhaustion at vVO2 max was also inversely related to VO2 max for the entire group of élite sportsmen (r = -0.320, p < 0.05, n = 41). The inverse relationship between VO2 max and tlim at vVO2 max has to be explained, it seems that tlim depends on VO2 max regardless of the type of exercise undertaken.

Byrnes, W. C., & Kearney, J. T. (1997)
Aerobic and anaerobic contributions during simulated canoe/kayak sprint events.
Medicine and Science in Sports and Exercise, 1997; 29(5), Supplement abstract 1256.

US kayakers (M = 6; F = 4) and canoeists (N = 2) completed submaximal/maximal tests and simulated 200 m, 500 m, and 1000 m race efforts. Data were pooled revealing the average percentage contribution of aerobic energy to each distance being 36.5%, 63.5%, and 84.5% respectively. Females recorded higher contributions of aerobic energy (40, 69, 86%) than males to each task (37, 62, 82%) supporting the recognized fact that females use more aerobic energy when compared to males in extended-effort tasks. Implication. The contribution of aerobic energy to canoe/kayak races is extensive. It is dominant in 500 and 1000-m races and higher in females than males.

McNaughton LR[1], Dalton B, Tarr J. (1998)
The effects of creatine supplementation on high-intensity exercise performance in elite performers.
Eur J Appl Physiol Occup Physiol. 1998 Aug;78(3): 236-40.
[1] Kingston University, Kingston upon Thames, Survey, UK.

The aim of this research was to determine whether creatine supplementation at a dose of 20 g x day(-1), given in 4 x 6-g doses (5 g creatine monohydrate and 1 g glucose) for 5 days, was effective in improving kayak ergometer performances of different durations. Sixteen male subjects with the following characteristics [mean (SEM)]: age 21 (1.2) years, height 170.2 (1.7) cm, weight 75.3 (2.3) kg, sigma8 skinfolds 59.3 (2.6) mm, and maximal oxygen consumption 67.1 +/- (4.3) ml x kg x min(-1), undertook three maximal kayak ergometer tests of 90, 150 and 300 s duration on a wind-braked kayak ergometer (CON). Two groups were then randomly formed, with one group taking the supplement (SUP) while the other took a placebo (PLAC). No pre-test differences existed between the SUP and the PLAC groups in any of the variables measured. After supplementation each group then repeated the same kayak ergometer tests as performed previously and after a 4-week "washout period" the groups took either the PLAC or SUP for another 5 days and then completed the final tests. The SUP group completed significantly more work than either the CON or PLAC groups in all of the tests (90 s, $P < 0.01$; 150 s, $P < 0.001$; 300 s, $P < 0.05$). Body mass remained stable throughout the test period in both the CON and PLAC groups, but both were significantly less than the SUP body mass of 77.3 (1.0) kg ($P < 0.01$). The results of this work indicate that creatine supplementation can significantly increase the amount of work accomplished during kayak ergometer performance at durations ranging from 90 to 300 s.

Pérez-Landaluce J, Rodríguez-Alonso M, Fernandez-Garcia B, Bustillo-Fernandez E, Terrados N. (1998)
***Importance of wash riding in kayaking training and competition*.**
Med Sci Sports Exerc. 1998 Dec; 30(12): 1721-1724.
Fundación Deportiva Municipal de Avilés, Spain.

PURPOSE: The use of different wash-riding techniques is common during kayak training and competition. Changes in wash-riding positions could imply a different exercise intensity. The aim of this study, therefore, was to quantify the energy savings made when a kayaker is "wash riding." METHODS: Eight male international flat water kayakers, who performed a field test of 2000 m in each of the four wash-riding positions, head (H), right wave (RW), left wave (LW), and end position (V), were studied. The data investigated were: time, stroke rate, blood lactate (BL), heart rate (HR), and rate of perceived exertion (RPE). Under laboratory conditions kayakers performed the same intensity of exercise in a kayak ergometer, and HR, oxygen uptake (VO2), BL, mean power output (W), and RPE were measured. RESULTS: The results show significant differences ($P < 0.05$) among H, RW/LW, and V. The mean values for BL ($P < 0.05$) were 4.2, 2.0, 2.2, and 1.5 mmol.L-1, for H, RW, LW, and V, respectively. RPE also revealed differences, with values of 15, 12.6, 12.6, and 9.7 for H, RW, LW, and V, respectively. Mean power output gave values of 190.3 (H), 155.6 (RW and LW), and 129.5 (V) W. HR was different between H and V (172 and 151), while stroke rate was different among the parameters H, RW, and V (93.7, 88.8, and 87.6, respectively). The VO2 in the kayak ergometer test showed a difference between H and V (3.78 and 2.23 L.min-1). CONCLUSIONS: We conclude that "wash riding" involves a saving in energy cost of between 18% and 31.9%, depending on the position. This conclusion is of importance for the quantification and calibration of kayak training and competition.

Aitken DA, Jenkins DG (1998)

Anthropometric-based selection and sprint kayak training in children.

J Sports Sci 1998 Aug; 16(6): 539-543.

Performance Enhancement Centre, Queensland Academy of Sport, Woolloongabba, Australia.

A 12 week kayak training programme was evaluated in children who either had or did not have the anthropometric characteristics identified as being unique to senior elite sprint kayakers. Altogether, 234 male and female school children were screened to select 10 children with and 10 children without the identified key anthropometric characteristics. Before and after training, the children completed an all-out 2 min kayak ergometer simulation test; measures of oxygen consumption, plasma lactate and total work accomplished were recorded. In addition, a 500 m time trial was performed at weeks 3 and 12. The coaches were unaware which 20 children possessed those anthropometric characteristics deemed to favour development of kayak ability. All children improved in both the 2 min ergometer simulation test and 500 m time trial. However, boys who were selected according to favourable anthropometric characteristics showed greater improvement than those without such characteristics in the 2 min ergometer test only. In summary, in a small group of children selected according to anthropometric data unique to elite adult kayakers, 12 weeks of intensive kayak training did not influence the rate of improvement of on-water sprint kayak performance.

Zamparo P., Capelli C., Guerrini G. (1999)
Energetics of kayaking at submaximal and maximal speeds.
European Journal of Applied Physiology and Occupational Physiology, 1999 October; 80(6): 542-548.

The energy cost of kayaking per unit distance (C_k, kJ · m^{m1}) was assessed in eight middle- to high-class athletes (three males and five females; 45-76 kg body mass; 1.50-1.88 m height; 15-32 years of age) at submaximal and maximal speeds. At submaximal speeds, C_k was measured by dividing the steady-state oxygen consumption (VO_2, l · s^{m1}) by the speed (v, m · s^{m1}), assuming an energy equivalent of 20.9 kJ · 1 $O^{m1}{}_2$. At maximal speeds, C_k was calculated from the ratio of the total metabolic energy expenditure (E, kJ) to the distance (d, m). E was assumed to be the sum of three terms, as originally proposed by Wilkie (1980): $Ev=vAnSv+vVO_{2max} \cdot tmVO_{2max} \cdot F(1me^{mt \cdot Fm1})$, were is the energy equivalent of O_2 (20.9 kJ · 1 $O_2{}^{m1}$), F is the time constant with which VO_{2max} is attained at the onset of exercise at the muscular level, AnS is the amount of energy derived from anaerobic energy utilization, t is the performance time, and VO_{2max} is the net maximal VO_2. Individual VO_{2max} was obtained from the VO_2 measured during the last minute of the 1000-m or 2000-m maximal run. The average metabolic power output (E, kW) amounted to 141% and 102% of the individual maximal aerobic power (VO_{2max}) from the shortest (250 m) to the longest (2000 m) distance, respectively. The average (SD) power provided by oxidative processes increased with the distance covered [from 0.64 (0.14) kW at 250 m to 1.02 (0.31) kW at 2000 m], whereas that provided by anaerobic sources showed the opposite trend. The net C_k was a continuous power function of the speed over the entire range of velocities from 2.88 to 4.45 m · s^{m1}: $C_k = 0.02 \cdot v^{2.26}$ (r = 0.937, n = 32).

Iglesias Cubero G, Batalla A, Rodriguez Reguero JJ, Barriales R, Gonzalez V, de la Iglesia JL, Terrados N. (2000)
Left ventricular mass index and sports: the influence of different sports activities and arterial blood pressure.
Int J Cardiol 2000 Sep 15; 75(2-3): 261-265.
Cardiology Department, Hospital Central de Asturias, c/Julian Claveria s/n, 33006, Oviedo, Spain.

The mechanisms by which endurance training produces physiological hypertrophy have been thoroughly investigated but not with young athletes. The aim of our study was to investigate arterial blood pressure exercise responses in young athletes who started heavy training by the age of 11, participating in metabolically different sports (cycling, kayaking, and soccer) and to analyse the influence that arterial blood pressure at maximum exercise and VO(2) max could have on the development of cardiac mass in these subjects. SUBJECTS AND METHODS: We studied a group of well trained normotensive male subjects, comprising 37 cyclists, 15 soccer players and 12 canoeists (mean age, 16+/-1 years). Evaluation included a clinical history and physical examination, M-mode and two-dimensional echocardiography, 12-lead resting electrocardiogram and a graded exercise test with direct determination of VO(2) max.

Systolic and diastolic blood pressure were measured at rest and maximum exercise. Determination of the left ventricular mass index (LVMI) was performed using Devereux's formula with correction for the body surface area. RESULTS: Cyclists showed values of LVMI in g m(-2) significantly higher than those of other subjects (123 vs. 92 and 113). Canoeists showed the maximal arterial blood pressure at maximum exercise in mmHg (190 vs. 172 and 170) and cyclists showed the maximal VO(2) ml kg(-1) min(-1) uptake (57.6 vs. 48.5 and 53.3). A linear correlation was found between LVMI and VO(2) max (r=0.4727, P<0.001) and this correlation was also significant with systolic blood pressure at maximum exercise (r=0.2909, P<0.01). No differences in LVMI were found when comparing those subjects who presented systolic blood pressure at maximum exercise equal or greater than 195 mmHg with those who presented less than this value. CONCLUSIONS: It can be concluded that VO(2) max is the variable that better correlates with the LVMI. Athletes who reach greater systolic blood pressures at peak exercise have a tendency to develop greater LVMI. In comparison with soccer players and canoeists, cyclists are the sportsmen who develop a greater LVMI and VO(2) max.

Bishop D. (2000)

Physiological predictors of flat-water kayak performance in women.

Eur J Appl Physiol. 2000 May; 82(1-2): 91-97

Western Australian Institute of Sport, Claremont, Australia. dbishop@wais.org.au

This study was conducted to investigate the relationship between selected physiological variables and 500-m flat-water kayak (K500) performance. Nine female, high-performance kayak paddlers, mean (SD) age 23 (5) years, participated in this investigation. Testing was conducted over 6 days and included anthropometric measurements (height, body mass and skinfolds), an incremental test to determine both peak VO2 and the "anaerobic threshold" (Th(an)), and a 2-min, all-out test to calculate accumulated oxygen deficit (AOD). Blood lactate concentrations were measured during the incremental test and at the completion of both tests. Subjects also completed a K500 race under competition conditions. K500 time was significantly correlated with both peak VO2 (r = -0.82, P < 0.05) and the power output achieved at the end of the incremental test (r = -0.75, P < 0.05). However, the variable most strongly correlated with K500 time was Th(an) (r = -0.89, P < 0.05). A stepwise multiple regression, for which r = 0.95 and the standard error of estimate = 1.6 s, yielded the following equation: K500time(s) = 160.6-0.154 x AOD x kg(-1) - 0.250 x Th(an). In conclusion, the results of this study have demonstrated that although K500 performance is a predominantly aerobic activity, it does require a large anaerobic contribution. The importance of both the aerobic and anaerobic energy systems is reflected by the K500 time being best predicted by a linear combination of Th(an) and AOD x kg(-1). This suggests the need to develop and implement training programmes that develop optimally both of these physiological attributes. Further research is required to elucidate the most effective means by which to develop both the aerobic and anaerobic energy systems.

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van Someren KA[1], Phillips GR, Palmer GS. (2000)

Comparison of physiological responses to open water kayaking and kayak ergometry.

Int J Sports Med. 2000 Apr;21(3): 200-4.

[1] Department of Sport, Health and Exercise Science, St. Mary's, England.

This study compared the physiological responses of simulated kayaking on a K1 ERGO kayak ergometer with open water paddling. Nine well-trained male kayakers (VO2peak 4.27 +/- 0.58 L x min(-1), age 24 +/- 4 yr, mass 77.3 +/- 6.4 kg, height 179.5 +/- 5.3 cm; [mean +/- SD]) performed two 4 min exercise bouts on open water (OW) and on an air braked kayak ergometer (Erg). During exercise, expired air and heart rate (HR) were continuously measured. The distance covered during OW (992 +/- 47.1 m) was highly correlated (r2 = 0.86) with the total work performed in Erg (47.64 +/- 7.67 kJ). There were no differences between trials for oxygen uptake, carbon dioxide production or estimated carbohydrate oxidation. However, during OW, minute ventilation was significantly higher at 60 and 90 s (104.2 +/- 16.4 vs. 92.6 +/- 20.4 L x min(-1) and 120.5 +/- 15.8 vs. 111.7 +/- 17.6 L x min(-1) for 60 and 90 s, respectively, p < 0.05), and HR was higher in OW during the first minute (120 +/- 20 vs. 104 +/- 19 beats x min(-1), 164 +/- 8 vs. 147 +/- 18 beats x min(-1) and 178 +/- 6 vs. 170 +/- 7 beats x min(-1) for 0, 30, and 60 s, respectively, p < 0.05). There were no differences in peak VO2 between OW and Erg (4.10 +/- 0.49 vs. 4.09 +/- 0.53 L x min(-1), respectively) nor in post-exercise blood (lactate) (6.43 +/- 1.47 vs. 6.59 +/- 0.99 mmol x L(-1), respectively). We conclude that the K1 ERGO accurately simulates the physiological demands of short-term, high-intensity kayaking.

Millard M, Mahoney C, Wardrop J. (2001)

A preliminary study of mental and physical practice on the kayak wet exit skill.

Percept Mot Skills. 2001 Jun; 92(3 Pt 2): 977-984

School of Sport, Performing Arts and Leisure University of Wolverhampton, Walsall, UK.

Outdoor activities and high-risk water sports often create anxiety in participants who feel concern about danger. Relaxation and imagery, often used to enhance training, can improve performance of skills in a variety of sports. The aim of this study was to establish whether Mental Practice, Physical Practice, Combined Mental and Physical Practice, or No Practice would affect the acquisition of skill for a kayak wet exit. 60 postprimary girls aged 11-16 yr., competent swimmers but without previous experience in kayaking, gave their informed consent to be in the study. Each participant was randomly assigned to one of the four experimental groups. Following their practice periods, each group performed three kayak wet exit attempts (unseen by others); these were videotaped for later analysis by an observer. The participant and an independent observer, who was blind to the allocation of practice group, then used a 6-point rating scale to assess each performance. Participants' and the observer's ratings were analysed by separate Kruskal-Wallis one-way analysis of variance which indicated a significant practice effect. Subsequent chi-squared tests indicated significantly dif-

ferent distributions of groups, showing Physical Practice superior to No Practice and Mental Practice. While physical practice remained effective in improving technique, combinations of mental and physical practice were better than no practice.

Bishop D[1], Bonetti D, Dawson B. (2001)

The effect of three different warm-up intensities on kayak ergometer performance.

Med Sci Sports Exerc. 2001 Jun;33(6): 1026-32.

[1] Department of Human Movement and Exercise Science, University of Western Australia, Nedlands, WA 6907, Australia. dbishop@cyllene.uwa.edu.au

PURPOSE: The purpose of this study was to investigate the influence of warm-up (WU) intensity on supramaximal kayak ergometer performance. METHODS: In the initial testing session, eight institute of sport kayak squad members performed a graded exercise test for determination of VO2max and lactate (La) parameters. In a random, counterbalanced order, subjects subsequently performed WU for 15-min at either their aerobic threshold (W1), their anaerobic threshold (W3), or mid-way between their aerobic threshold and anaerobic threshold (W2). A 5-min passive rest period and then a 2-min, all-out kayak ergometer test followed the WU. RESULTS: For the three different WU conditions, no significant differences were observed for average power, peak VO2, total VO2, total VCO2, or accumulated oxygen deficit (AOD) during the 2-min test. However, when compared with W3, differences in average power approached significance after both W1 ($P = 0.09$) and W2 ($P = 0.10$). Furthermore, when compared with W3, average power during the first half of the 2-min test was significantly greater after W2 ($P < 0.05$) and approached significance after W1 ($P = 0.06$). After each WU period, there was a significant difference in blood pH ($W1>W2>W3$; $P < 0.05$) and blood [La] ($W1<W2<W3$; $P < 0.05$). Despite the significantly different metabolic acidemia after each WU condition, there were no significant differences in the VO2 responses to the 2-min test. However, the greater metabolic acidemia after W3 was associated with impaired 2-min kayak ergometer performance. CONCLUSIONS: It was concluded, that although a degree of metabolic acidemia may be necessary to speed O2 kinetics, if the WU is too intense, the associated metabolic acidemia may impair supramaximal performance by reducing the anaerobic energy contribution and/or interfering with muscle contractile processes.

van Someren KA, Oliver JE. (2002)

The efficacy of ergometry determined heart rates for flatwater kayak training.

Int J Sports Med. 2002 Jan; 23(1): 28-32

School of Life Sciences, Kingston University, England. k.vansom@kingston.ac.uk

The aim of this study was to investigate the use of incremental ergometry determined heart rate training intensities for the control of kayak ergometer and open water kayak training. Eight well-trained male kayakers completed a maximal incremental exercise test on an air-braked kayak ergometer for the determination of LT(1) (the power

output at which blood lactate concentration increased by > or = 1 mmol x L(-1)), the associated heart rate (HR-LT(1)), VO(2)peak, maximal heart rate and maximal aerobic power. Subjects then performed 20 min trials of kayak ergometry (E), open water kayaking in a single kayak (K1) and open water kayaking in a four-seat kayak (K4) at HR-LT(1). During the three trials, heart rate was continuously measured, and blood lactate concentration, rating of perceived exertion (RPE) and stroke rate were determined every 5 min. In all trials, exercise at HR-LT(1) resulted in stable blood lactate concentrations and a stable RPE. Comparison of the three trials demonstrated that the only difference was for RPE, which was lower in (K4) than in (E), ($p < 0.05$). The results demonstrate that the prescription of HR-LT(1) elicits similar blood lactate concentrations during kayak ergometer and open water kayak training in both single and team boats.

Bishop D, Bonetti D, Dawson B. (2002)

The influence of pacing strategy on VO2 and supramaximal kayak performance.

Med Sci Sports Exerc. 2002 Jun; 34(6): 1041-47.

Department of Human Movement and Exercise Science, University of Western Australia, Crawley, Australia. dbishop@cyllene.uwa.edu.au

PURPOSE: The purpose of this study was to investigate the effects of manipulating pacing strategy on VO2 and kayak ergometer performance in well-trained paddlers. METHODS: Eight well-trained kayak paddlers (500-m time = 115-125 s) first performed a graded exercise test for determination of VO2max and lactate (La-) parameters. On subsequent days and in a random, counterbalanced order, subjects performed a 2-min, kayak ergometer test using either an all-out start or even pacing strategy. RESULTS: There was a significantly greater peak power (747.6 +/- 152.0 vs 558.3 +/- 110.1 W) and average power (348.5 +/- 47.6 vs 335.5 +/- 44.8 W) using the all-out start strategy, when compared with the even-paced strategy. There was however, no significant difference between the two pacing strategies for peak VO2, accumulated oxygen deficit (AOD), peak [La-], or posttest pH. Using the all-out start, total VO2 was significantly greater (7.3 +/- 0.8 vs 6.9 +/- 0.8 L). CONCLUSION: The results of this study indicate that 2-min kayak ergometer performance is significantly greater following an all-out start strategy when compared with an even-paced strategy. The improved performance appears to be attributable to faster VO2 kinetics, without a significant change in the total AOD (although the AOD distribution was altered).

Bonetti DL[1], Hopkins WG, Kilding AE. (2006)

High-intensity kayak performance after adaptation to intermittent hypoxia.

Int J Sports Physiol Perform. 2006 Sep;1(3): 246-60.

[1] Sport and Recreation Dept, AUT University, Private Bag 92006, Auckland, Auckland 1020 New Zealand.

CONTEXT: Live-high train-low altitude training produces worthwhile gains in performance for endurance athletes, but the benefits of adaptation to various forms of

artificial altitude are less clear. PURPOSE: To quantify the effects of intermittent hypoxic exposure on kayak performance. METHODS: In a crossover design with a 6-week washout, we randomized 10 subelite male sprint kayak paddlers to hypoxia or control groups for 3 weeks (5 days/week) of intermittent hypoxic exposure using a nitrogen-filtration device. Each day's exposure consisted of alternately breathing hypoxic and ambient air for 5 minutes each over 1 hour. Performance tests were an incremental step test to estimate peak power, maximal oxygen uptake, exercise economy, and lactate threshold; a 500-m time trial; and 5 x 100-m sprints. All tests were performed on a wind-braked kayak ergometer 7 and 3 days pretreatment and 3 and 10 days posttreatment. Hemoglobin concentration was measured at 1 day pretreatment, 5 and 10 days during treatment, and 3 days after treatment. RESULTS: Relative to control, at 3 days posttreatment the hypoxia group showed the following increases: peak power 6.8% (90% confidence limits, + or - 5.2%), mean repeat sprint power 8.3% (+ or - 6.7%), and hemoglobin concentration 3.6% (+ or - 3.2%). Changes in lactate threshold, mean 500-m power, maximal oxygen uptake, and exercise economy were unclear. Large effects for peak power and mean sprint speed were still present 10 days posthypoxia. CONCLUSION: These effects of intermittent hypoxic exposure should enhance performance in kayak racing. The effects might be mediated via changes in oxygen transport.

Michael JS[1], Rooney KB, Smith R. (2008)

The metabolic demands of kayaking: a review.

J Sports Sci Med. 2008 Mar 1;7(1): 1-7.

[1] School of Exercise and Sport Science, Faculty of Health Sciences, Sydney University, Australia.

Flat-water kayaking is one of the best-known competitive canoeing disciplines in Australia and across the European countries. From a stationary start, paddlers are required to paddle their kayaks with maximal effort along the length of the competing distance. The ultimate criterion of kayak performance is the time taken to paddle a designated competition distance. In flat-water racing, events are contested over 500 and 1000 metres. To approximate the ultimate criterion over these distances, the velocity of the kayak should be measured. Furthermore, other factors that affect performance, such as force, power, technique and aerobic fitness, would all provide a valuable insight to the success of the kayak paddler. Specific research performed examining the physiological demands on kayak paddlers demonstrate high levels of both aerobic power and anaerobic capacity. It is the purpose if this review to present the published physiological data relating to men's and women's kayaking. With a number of recent publications, a need for an updated review is necessary. The present review summarises recent data on anthropometrics, physiological characteristics of successful and unsuccessful kayak athletes and methods of physiological testing. Due to the fact that more data have been reported for male competitors than for their female counterparts, the demands of kayaking on male athletes will be the main focus for this review. The review also suggests areas for future research into flatwater kayaking performance.

Understanding the physiological requirements of kayaking can assist coaches and athletes in a number of ways. During competition or training, such information is helpful in the selection of appropriate protocols and metabolic indices to monitor an athlete's performance improvements and assess an athlete's suitability for a particular race distance. Furthermore, it may aid the coach in the development of more specific training programs for their athletes. Key pointsFlat water kayaking is characterised by exceptional demands on upper body performance.When examining the oxygen consumption, it is notable that although a high value is attainable, they are not quite as high as other sporting events such as road cycling, rowing or running where lower body is dominant. Elite kayakers demonstrate superior aerobic and anaerobic quantities and have reported maximal oxygen consumptions of around 58 ml·kg(-1)·min(-1) (4.7 L·min(-1)) and lactate values of around 12 mM during laboratory and on water testing. KEYWORDS: Kayak; aerobic power; anthropometry; ergometer; lactate; oxygen demand.

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van Someren KA, **Howatson G. (2008)**

Prediction of flatwater kayaking performance.

Int J Sports Physiol Perform. 2008 Jun; 3(2): 207-218.

English Institute of Sport, St Marys High Performance Centre, Twickenham, UK.

PURPOSE: To determine the relative importance of anthropometric and physiological attributes for performance in the 1000-m, 500-m, and 200-m flatwater kayaking events. METHODS: Eighteen competitive male kayakers completed performance trials over the 3 distances and a battery of anthropometric and physiological tests. RESULTS: Performance times (mean +/- SD) for 1000 m, 500 m, and 200 m were 262.56 +/- 36.44 s, 122.10 +/- 5.74 s, and 41.59 +/- 2.12 s, respectively. Performance in all 3 events was correlated with a number of physiological parameters; in addition, 500-m and 200-m performance was correlated with upper body dimensions. 1000-m time was predicted by power output at lactate turnpoint expressed as a percentage of maximal aerobic power, work done in a 30-s ergometry test and work done in a 2-min ergometry test (adjusted R2 = 0.71, SEE = 5.72 s); 500-m time was predicted by work done and the fatigue index in a 30-s ergometry test, work done in a 2-min ergometry test, peak isometric and isokinetic function (adjusted R2 = 0.79, SEE = 2.49 s); 200-m time was predicted by chest circumference, humeral breadth, peak power, work done, and the fatigue index in a 30-s ergometry test (adjusted R2 = 0.71, SEE = 0.71 s). CONCLUSIONS: A number of physiological variables are correlated with performance in all events. 1000-m, 500-m, and 200-m times were predicted with a standard error of only 2.2%, 2.0%, and 1.7%, respectively.

García-Pallarés J[1], Sánchez-Medina L, Carrasco L, Díaz A, Izquierdo M. (2009)

Endurance and neuromuscular changes in world-class level kayakers during a periodized training cycle.

Eur J Appl Physiol. 2009 Jul;106(4): 629-38.

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This study was undertaken to analyze changes in selected cardiovascular and neuromuscular variables in a group of elite kayakers across a 12-week periodized cycle of combined strength and endurance training. Eleven world-class level paddlers underwent a battery of tests and were assessed four times during the training cycle (T0, T1, T2, and T3). On each occasion subjects completed an incremental test to exhaustion on the kayak-ergometer to determine maximal oxygen uptake (VO(2max)), second ventilatory threshold (VT2), peak blood lactate, paddling speed at VO(2max) (PS(max)) and at VT2 (PS(VT2)), stroke rate at VO(2max) and at VT2, heart rate at VO(2max) and at VT2. One-repetition maximum (1RM) and mean velocity with 45% 1RM load (V (45%)) were assessed in the bench press (BP) and prone bench pull (PBP) exercises. Anthropometric measurements (skinfold thicknesses and muscle girths) were also obtained. Training volume and exercise intensity were quantified for each of three training phases (P1, P2, and P3). Significant improvements in VO(2max) (9.5%), VO(2) at VT2 (9.4%), PS(max) (6.2%), PS(VT2) (4.4%), 1RM in BP (4.2%) and PBP (5.3%), V (45%) in BP (14.4%) and PBP (10.0%) were observed from T0 to T3. A 12-week periodized strength and endurance program with special emphasis on prioritizing the sequential development of specific physical fitness components in each training phase (i.e. muscle hypertrophy and VT2 in P1, and maximal strength and aerobic power in P2) seems effective for improving both cardiovascular and neuromuscular markers of highly trained top-level athletes.

García-Pallarés J[1], Carrasco L[2], Díaz A[1] and Sánchez-Medina L[3] (2009)

Post-season detraining effects on physiological and performance parameters in top-level kayakers: comparison of two recovery strategies.

Journal of Sports Science and Medicine 2009; 8: 622-628

[1] Faculty of Sport Sciences, University of Murcia, Spain,
[2] Department of Physical Education and Sport, University of Seville, Spain,
[3] Faculty of Sport, Pablo de Olavide University, Seville, Spain.

This study analyzed changes in physiological parameters, hormonal markers and kayaking performance following 5-wk of reduced training (RT) or complete training cessation (TC). Fourteen top-level male kayakers were randomly assigned to either a TC (n = 7) or RT group (n = 7) at the end of their competitive season (T1). Subjects undertook blood sampling and an incremental test to exhaustion on a kayak ergometer at T1 and again following 5 weeks of RT or TC (T2). Maximal oxygen uptake (VO2max) and oxygen uptake at second ventilatory threshold (VT2) significantly decreased following TC (-10.1% and -8.8%, respectively). Significant decreases were also observed in RT group but to a lesser extent (-4.8% and - 5.7% respectively). Heart rate at VT2 showed

significant increases following TC (3.5%). However, no changes, were detected in heart rate at VO2max in any group. Peak blood lactate remained unchanged in both groups at T2. Paddling speed at VO2max declined significantly at T2 in the TC group (-3.3%), while paddling speed at VT2 declined significantly in both groups (-5.0% and -4.2% for TC and RT, respectively). Stroke rate at VO2max and at VT2 increased significantly only following TC by 5.2% and 4.9%, respectively. Paddling power at VO2max and at VT2 decreased significantly in both groups although the values observed following RT were higher than those observed following TC. A significant decline in cortisol levels (-30%) was observed in both groups, while a higher increase in testosterone to cortisol ratio was detected in the RT group. These results indicate that a RT strategy may be more effective than complete TC in order to avoid excessive declines in cardiovascular function and kayaking performance in top-level paddlers. Key words: Detraining; aerobic power; kayaking; paddling parameters; hormonal profile.

García-Pallarés J[1], Sánchez-Medina L, Pérez CE, Izquierdo-Gabarren M, Izquierdo M. (2010)

Physiological effects of tapering and detraining in world-class kayakers.

Med Sci Sports Exerc. 2010 Jun;42(6): 1209-14.

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PURPOSE: This study analyzed changes in neuromuscular, body composition, and endurance markers during 4 wk of tapering and subsequent 5 wk of reduced training (RT) or training cessation (TC). METHODS: Fourteen world-class kayakers were randomly assigned to either a TC (n = 7) or an RT group (n = 7). One-repetition maximum (1RM) strength, mean concentric velocity with 45% 1RM (V45%) in the bench press (BP) and prone bench pull (PBP) exercises, and body composition assessments were conducted at the start (T0) and end (T1) of a 43-wk training program, after tapering for the world championships (T2) and after TC or RT (T3). A graded exercise test on a kayak ergometer for determination of maximal oxygen uptake at T0, T1, and T3 was also performed. RESULTS: After tapering, no significant changes were observed in 1RM or V45%. TC resulted in significantly greater declines in 1RM strength (-8.9% and -7.8%, $P < 0.05$, respectively, for BP and PBP) than those observed for RT (-3.9% and -3.4%). Decreases in V45% in BP and PBP were larger for TC (-12.6% and -10.0%) than for RT (-9.0% and -6.7%). Increases in sum of eight skinfolds were observed after both TC and RT, whereas declines in maximal aerobic power were lower for RT (-5.6%) than for TC (-11.3%). CONCLUSIONS: Short-term TC results in large decreases in maximal strength and especially V45% in highly trained athletes. These results suggest the need of performing a minimal maintenance program to avoid excessive declines in neuromuscular function in cases where a prolonged break from training is required.

Laursen PB[1]. (2010)

Training for intense exercise performance: high-intensity or high-volume training?

Scand J Med Sci Sports. 2010 Oct;20 Suppl 2: 1-10.

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Performance in intense exercise events, such as Olympic rowing, swimming, kayak, track running and track cycling events, involves energy contribution from aerobic and anaerobic sources. As aerobic energy supply dominates the total energy requirements after ~75s of near maximal effort, and has the greatest potential for improvement with training, the majority of training for these events is generally aimed at increasing aerobic metabolic capacity. A short-term period (six to eight sessions over 2-4 weeks) of high-intensity interval training (consisting of repeated exercise bouts performed close to or well above the maximal oxygen uptake intensity, interspersed with low-intensity exercise or complete rest) can elicit increases in intense exercise performance of 2-4% in well-trained athletes. The influence of high-volume training is less discussed, but its importance should not be downplayed, as high-volume training also induces important metabolic adaptations. While the metabolic adaptations that occur with high-volume training and high-intensity training show considerable overlap, the molecular events that signal for these adaptations may be different. A polarized approach to training, whereby ~75% of total training volume is performed at low intensities, and 10-15% is performed at very high intensities, has been suggested as an optimal training intensity distribution for elite athletes who perform intense exercise events.

Michael JS[1], Smith R, Rooney K. (2010)

Physiological responses to kayaking with a swivel seat.

Int J Sports Med. 2010 Aug;31(8): 555-60.

[1] University of Sydney, Exercise Health and Performance Research Group, Lidcombe, Australia. jmic3063@uni.sydney.edu.au

The present study compared the physiological characteristics of flat-water kayaking utilising two seat conditions, the traditional fixed seat and novel swivel seat on an air-braked kayak simulator. The testing protocol included a submaximal warm up and one maximal ergometer paddling test. Ten elite kayakers (age 25+/-6 years, body mass 84.9+/-5.8 kg) were randomised to perform the testing protocol twice, once on each seat. During the testing protocol, expired air, heart rate (HR) and power output (PO) were continuously measured and gross efficiency (GE (kayak)) was calculated. Lactate (La) was recorded at the conclusion of each test. Repeated measures ANOVA indicated that paddling with the swivel seat generated significantly greater mean PO over the two-minute race duration compared to the fixed seat (299.1+/-24.9W and 279.8+/-19.2W respectively; $p<0.05$). This equated to a 6.5% increase in PO. A similar (6.9%) but non-significant difference in efficiency was generated as there was no significant difference recorded in the metabolic load over the two-minute ergometer test. No significant differences were present in any other variable measured. This greater PO generated with a swivel seat may be a significant advantage during on-water competition if the results from present ergometer test transfer.

Buglione A[1], Lazzer S, Colli R, Introini E, Di Prampero PE. (2011)

Energetics of best performances in elite kayakers and canoeists.

Med Sci Sports Exerc. 2011 May;43(5): 877-84.

[1] Human Performance and Training Lab Carmelo Bosco, University Tor Vergata, Rome, Italy. antonio.buglione@uniroma2.it

PURPOSE: The objectives of this study were 1) to validate a new test to determine maximal
oxygen uptake (V˙O2max) in kayakers, 2) to calculate the energy cost (Ck) of high-level kayakers and canoeists at submaximal and race speeds, and 3) to correlate individual best performances achieved in practice with those theoretically calculated. These were obtained from the individual relationships Ėr=f(t) and Ėmax=f(t), where Ėr is the metabolic power required to cover the distance in question and Ėmax is the maximal metabolic power. The time yielding Ėr=Ėmax was assumed to yield the best performance time. METHODS: Seventy-four male and female athletes from the Italian national canoe kayak teams participated in this study. A portable metabolic unit was used to determine V˙O2max during an incremental exercise test on the boat. Peak oxygen uptake (V˙O2peak) was also measured in a 2-min test at 100% race speed over 1000 m. Individual Ck values were evaluated in tests of 6, 5, and 2 min at average speeds of 84%, 90%, and 100% of the 1000-m race speed. RESULTS: The V˙O2max values determined during the incremental or the 2-min test were not significantly different (4613 ± 619 vs 4582 ± 598 mL·min). The Ck (J·kg·m) of male kayakers increased from approximately 4 (at 3.23 m·s) to approximately 6 (at 4.63 m·s) and was approximately 30.7% smaller than that of male canoeists (P<0.001). Over the same speed range, male kayakers were approximately 14.2% more economical than female kayakers (P=0.044). CONCLUSIONS: Individual theoretical best times and speeds were essentially equal to those measured during actual competitions.

Peeling P[1], Andersson R. (2011)

Effect of hyperoxia during the rest periods of interval training on perceptual recovery and oxygen re-saturation time.

J Sports Sci. 2011 Jan;29(2): 147-50.

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The effect of hyperoxic gas supplementation on the recovery time of oxygen saturation levels (S(a)O(2)), and its effect on perceptual recovery were assessed. Seven national-level kayak athletes completed two laboratory-based ergometer sessions of 6 × 3-min maximal aerobic intervals, with 2 min recovery between repetitions. During each recovery period, athletes either inhaled a hyperoxic gas (99.5 ± 0.2 % F(I)O(2)) or were given no external supplementation (control). Mean power output, stroke rate, heart rate, and ratings of perceived exertion were collected during each interval repetition, and the intensity was matched between trials. During each 2-min recovery period, post-exercise haemoglobin saturation levels were measured via pulse oximetry (S(p)

O(2)), and the time taken for the S(p)O(2) to return to pre-exercise values was recorded. Subsequently, a rating of perceived recovery quality was collected. There were no differences in the levels of post-exercise de-saturation between the hyperoxic and control trials ($P < 0.05$), although the recovery time of S(p)O(2) was significantly faster in the hyperoxic trial ($P < 0.05$). There was no influence of oxygen supplementation on the athletes' perception of recovery quality. Hyperoxic gas supplementation during the recovery periods between high-intensity intervals substantially improves the recovery time of S(p)O(2) with no likely influence on recovery perception.

Peeling P[1], Cox GR, Bullock N, Burke LM. (2015)

Beetroot Juice Improves On-Water 500 M Time-Trial Performance, and Laboratory-Based Paddling Economy in National and International-Level Kayak Athletes.

***Int J Sport Nutr Exerc Metab.* 2015 Jun;25(3):278-84. doi: 10.1123/ijsnem.2014-0110. Epub 2014 Sep 8.**

[1]School of Sports Science, Exercise and Health. University of Western Australia. Crawley, Western Australia.

We assessed the ingestion of a beetroot juice supplement (BR) on 4-min laboratory-based kayak performance in national level male (n = 6) athletes (Study A), and on 500 m on-water kayak time-trial (TT) performance in international level female (n = 5) athletes (Study B). In Study A, participants completed three laboratory-based sessions on a kayak ergometer, including a 7 × 4 min step test, and two 4 min maximal effort performance trials. Two and a half hours before the warm-up of each 4 min performance trial, athletes received either a 70 ml BR shot containing ~4.8 mmol of nitrate, or a placebo equivalent (BRPLA). The distance covered over the 4 min TT was not different between conditions; however, the average VO2 over the 4 min period was significantly lower in BR ($p = .04$), resulting in an improved exercise economy ($p = .05$). In Study B, participants completed two field-based 500 m TTs, separated by 4 days. Two hours before each trial, athletes received either two 70 ml BR shots containing ~9.6 mmol of nitrate, or a placebo equivalent (BRPLA). BR supplementation significantly enhanced TT performance by 1.7% ($p = .01$). Our results show that in national-level malekayak athletes, commercially available BR shots (70 ml) containing ~4.8 mmol of nitrate improved exercise economy during laboratory-based tasks predominantly reliant on the aerobic energy system. Furthermore, greater volumes of BR (140 ml; ~9.6 mmol nitrate) provided to international-level female kayak athletes resulted in enhancements to TT performance in the field.

Farley O[1], Harris NK, Kilding AE. (2012)

Anaerobic and aerobic fitness profiling of competitive surfers.

J Strength Cond Res. 2012 Aug;26(8): 2243-8.

[1]Sports Performance Research Institute New Zealand, AUT University, Auckland, New Zealand. ollyfarley@hotmail.com

Despite widespread popularity of competitive surfing internationally, very little research has investigated the physiological profile of surf athletes and attempted to identify the relationships between physiological measures and surfing performance. This

study determined the peak oxygen uptake (V(O2)peak) from an incremental ramp test and anaerobic power (watts) during a 10-second maximal-paddling burst using a surf paddle-specific modified kayak ergometer, customized with a surfboard and hand paddles. Twenty nationally ranked surf athletes volunteered to participate in the VV(O2)peak test, and 8 also participated in the anaerobic power test. The interrelationships between these components of athletic performance and surfing performance, as assessed by season rank, were determined using Pearsons correlations. We found a significant relationship between anaerobic power and season rank ($r = 0.55$, $p = 0.05$). No significant relationship between VV(O2)peak and season rank was found ($r = -0.02$, $p = 0.97$). Although correlations do not imply cause and effect, such a finding provides theoretical support for the importance of including anaerobic paddling power in assessment batteries and conditioning practice for surf athletes.

Gomes BB[1], Mourão L, Massart A, Figueiredo P, Vilas-Boas JP, Santos AM, Fernandes RJ. (2012)

Gross efficiency and energy expenditure in kayak ergometer exercise.

Int J Sports Med. 2012 Aug;33(8): 654-60.

[1] University of Coimbra, Faculty of Sport Sciences and Physical Education, CIDAF, Coimbra, Portugal.

We purposed to study energy expenditure, power output and gross efficiency during kayak ergometer exercise in 12 elite sprint kayakers. 6 males (age 24.2±4.8 years, height 180.4±4.8 cm, body mass 79.7±8.5 kg) and 6 females (age 24.3±4.5 years, height 164.5±3.9 cm, body mass 65.4±3.5 kg), performed an incremental intermittent protocol on kayak ergometer with VO2 and blood lactate concentration assessment, a non-linear increase between power output and energy expenditure being observed. Paddling power output, energy expenditure and gross efficiency corresponding to VO2max averaged 199.92±50.41 W, 75.27±6.30 ml.kg - 1.min - 1, and 10.10±1.08%. Male kayakers presented higher VO2max, power output and gross efficiency at the VO2max, and lower heart rate and maximal lactate concentration than females, but no differences were found between genders regarding energy expenditure at VO2max. Aerobic and anaerobic components of energy expenditure evidenced a significant contribution of anaerobic energy sources in sprint kayak performance. Results also suggested the dependence of the gross efficiency on the changes in the amount of the aerobic and anaerobic contributions, at heavy and severe intensities. The inter-individual variance of the relationship between energy expenditure and the corresponding paddling power output revealed a relevant tracking for females ($FD\gamma=0.73\pm0.06$), conversely to the male group ($FD\gamma=0.27\pm0.08$), supporting that some male kayakers are more skilled in some paddling intensities than others.

Zouhal H[1], Le Douairon Lahaye S, Ben Abderrahaman A, Minter G, Herbez R, Castagna C. (2012)

Energy system contribution to Olympic distances in flat water kayaking (500 and 1,000 m) in highly trained subjects.

J Strength Cond Res. 2012 Mar;26(3): 825-31.

[1] Movement, Sport, and Health Sciences Laboratory, UFR APS, University of Rennes, Rennes Cedex, France. hassane.zouhal@univ-rennes2.fr

Olympic flat water kayaking races take place over a distance of 500 and 1,000 m. This study was designed to determine the aerobic and anaerobic contributions to 500- and 1,000-m races during flat water paddling in open water, using the accumulated oxygen deficit (AOD) method. Seven internationally ranked athletes, specialized in 500-m races and familiar with 1,000-m races, participated in this study (age: 21.86 ± 1.68 years, body mass: 78.54 ± 3.41 kg, height: 1.84 ± 0.03 m, body fat%: 10.14 ± 0.69%). All the participants performed 3 track-kayaking sessions. During the first session, the maximal oxygen uptake and maximal aerobic speed were determined using a portable gas analyzer and a global positioning system. During the successive testing sessions, paddlers performed in a randomized counterbalanced order a 500- and a 1,000-m race under field conditions (open water track kayaking). The 500-m AOD was significantly higher than the 1,000-m AOD (18.16 ± 4.88 vs. 9.34 ± 1.38 ml·kg(-1), $p < 0.05$). The aerobic contribution resulted in being higher during the 1,000 m compared with that in the 500-m condition (86.61 ± 1.86% vs. 78.30 ± 1.85%, respectively, $p < 0.05$). The results of this study showed that the 500- and 1,000-m races are 2 physiologically different kayaking events with a higher aerobic contribution in the 1,000 m. The training prescription for elite athletes should emphasize aerobic high-intensity training for the 1,000 m and anaerobic short-term training for the 500-m race.

Abraham D[1], Stepkovitch N. (2012)

The Hawkesbury Canoe Classic: musculoskeletal injury surveillance and risk factors associated with marathon paddling.

Wilderness Environ Med. 2012 Jun;23(2): 133-9.

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OBJECTIVE: The aim of this study was to assess the incidence and risk factors for musculoskeletal injury associated with marathon paddling. METHODS: A prospective observational cohort study was conducted during the 2006 Hawkesbury Canoe Classic (HCC), an annual 111-km paddling race in Sydney, Australia. Before the race, a written questionnaire was distributed to competitors to gather information regarding their age, gender, type of craft they were competing in, paddling experience, HCC experience, training distances, and preceding injuries. The paddler's average race speed was also used for analysis. Injuries were recorded throughout the race. Logistic regression analysis was used to identify if any of the variables were associated with injuries observed during the race. RESULTS: Six hundred and twelve paddlers competed in the race, with 298 respondents participating in the study. Eighty-eight paddlers with a

total of 135 injuries presented for medical assessment. More than one third of injuries involved the shoulder (35.6%), followed by the thoracic spine (23%), and lumbar spine (17%). Men were 3.6 times (CI: 1.39 to 9.32, P = .01) more likely to present with an injury compared with the women. A faster average speed (ie, faster finishing time) was correlated with a decrease in injury presentation (odds ratio 0.77, CI: 0.63 to 0.93, P = .01). Modifiable risk factors such as age, type of craft, paddling experience, HCC experience, training distances, and preceding injuries were not shown to increase the chance of injury presentation. CONCLUSIONS: Further data gathered over a series of this race may point to modifiable risk factors that may help reduce the incidence of injury.

Borges TO[1], Bullock N, Duff C, Coutts AJ. (2014)

Methods for quantifying training in sprint kayak.

J Strength Cond Res. 2014 Feb;28(2): 474-82.

[1] 1 Faculty of Health, University of Technology Sydney, Sydney, Australia; 2 Physiology, Australian Institute of Sport, Gold Coast, Australia; 3 Australian Canoeing, Sydney, Australia; and 4 Sydney Northern Beaches Kayak Club, Sydney, Australia.

The aims of this study were to determine the validity of the session rating of perceived exertion (session-RPE) method by comparing 3 different scales of perceived exertion with common measures of training load (TL). A secondary aim was to verify the relationship between TLs, fitness, and performance in Sprint Kayak athletes. After laboratory assessment of maximal oxygen uptake (V[Combining Dot Above]O2peak) and lactate threshold, the athletes performed on water time trials over 200 and 1,000 m. Training load was quantified for external (distance and speed) and internal (session-RPE: 6-20, category ratio [CR]-10 and CR-100 scales, training impulse [TRIMP], and individual TRIMP). Ten (6 male, 4 female) well-trained junior Sprint Kayak athletes (age 17.1 ± 1.2 years; V[Combining Dot Above]O2peak 4.2 ± 0.7 L·min) were monitored over a 7-week period. There were large-to-very large within-individual correlations between the session distance and the various heart rate (HR) and RPE-based methods for quantifying TL (0.58-0.91). Correlations between the mean session speed and various HR- and RPE-based methods for quantifying TL were small to large (0.12-0.50). The within-individual relationships between the various objective and subjective methods of internal TL were large to very large (0.62-0.94). Moderate-to-large inverse relationships were found between mean session-RPE TL and various aerobic fitness variables (-0.58 to -0.37). Large-to-very large relationships were found between mean session-RPE TL and on water performance (0.57-0.75). In conclusion, session-RPE is a valid method for monitoring TL for junior Sprint Kayak athletes, regardless of the RPE scale used. The session-RPE TL relates to fitness and performance, supporting the use of session-RPE in Sprint Kayak training.

Jones MJ[1], Peeling P. (2014)

A comparison of laboratory-based kayak testing protocols.

Int J Sports Physiol Perform. 2014 Mar;9(2): 346-51.

[1] School of Sport Science, Exercise and Health, University of Western Australia, Crawley, WA, Australia.

PURPOSE: To compare the differences in peak oxygen uptake (VO2peak) and lactate threshold (LT2) between the 7 × 4-min incremental step test (7-ST) and the maximal accumulated oxygen deficit (MAOD) test protocols in sprint kayak athletes. METHODS: Nine highly trained kayak athletes performed the 2 laboratory test protocols. The 7-ST involved six 4-min submaximal incremental stages, each separated by a 1-min recovery, before a 4-min all-out effort. The MAOD test involved four 4-min submaximal incremental stages (also with each stage separated by a 1-min recovery), followed by 20-min recovery and a 4-min all-out effort.
RESULTS: No statistically significant differences in VO2peak were recorded between the 2 protocols ($P > .05$). However, distance covered, power output, stroke rate, and speed were almost certainly greater in the MAOD test (magnitude-based inference: 99-100% positive), while blood lactate (BLa), heart rate (HR), and rating of perceived exertion (RPE) were likely lower (magnitude-based inference: 78-92% negative). The derived measures of LT2 (excluding HR) were not different between the 2 protocols. CONCLUSION: The results of this study suggest that both the 7-ST and MAOD test protocols are comparable with regard to the measurement of VO2peak and LT2 in highly trained sprint kayak athletes. However, since differences in the measures of distance traveled, power, stroke rate, HR, BLa, and RPE were reported in the maximal stage of the these 2 test protocols, their interchangeable use in a laboratory setting is not ideal if the data output is to be compared and contrasted over time.

Li Y.[1], Niessen M.[1], Chen X.[2], Hartmann U.[1] (2014)

Maximal Lactate Steady State in Kayaking,

Int J Sports Med 2014; 35: 939–942.

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[2] Department of Physical Education, Ningbo University, Ningbo, China

A fixed blood lactate value of 4 mM was commonly used to calculate workload at maximal lactate steady state (MLSS) in kayaking. Our purpose was to measure the actual blood lactate value at MLSS and workload at MLSS in kayaking and assess the validity of using a fi xed blood lactate value to calculate the workload at MLSS. 8 junior kayakers (15.1 ± 1.2 years; 179.9 ± 7.3 cm;
72.3 ± 4.9 kg) participated in an incremental workload test and 4–6 sub-maximal constant workload tests (duration of 30 min) on a kayaking ergometer. Blood lactate was measured to calculate the blood lactate value and workload at MLSS. The blood lactate value at MLSS in kayaking was 5.4 ± 0.7 mM. The measured workload at MLSS (112 ± 22 watts) was signifi cantly greater than the calculated workload using a lactate value of 4 mM (104 ± 18 watts, $p = 0.016$). The measured MLSS workload was not signifi cantly different from the calculated workload using a fixed lactate value of 5.4 mM (115 ± 19 watts, $p = 0.16$) or 5.0 mM (113 ± 19 watts, $p = 0.78$) in the incremental tests. A fi xed blood lactate value of 5 mM instead of 4 mM might be a better estimate in kayaking given the incremental workload test used in this study. Key words: anaerobic threshold; ergometer; incremental test; lactate; workload.

Lundgren KM[1], Karlsen T, Sandbakk Ø, James PE, Tjønna AE. (2015)

Sport-Specific Physiological Adaptations in Highly Trained Endurance Athletes.

Med Sci Sports Exerc. 2015 Oct;47(10): 2150-7

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[2] Department of Cardiology, St. Olavs University Hospital, Trondheim, NORWAY;
[3] Center for Elite Sports Research, Department of Neuroscience, Norwegian University of Science and Technology, Trondheim, NORWAY;
[4] Wales Heart Research Institute, Department of Cardiology, Cardiff University, Cardiff, UNITED KINGDOM.

PURPOSE:This study aims to compare maximal oxygen uptake (V˙O2max), blood volume (BV), hemoglobin mass (Hbmass), and brachial endothelial function, measured as flow-mediated dilatation (FMD), in international-level endurance athletes primarily exercising with the whole body (cross-country skiing), lower body (orienteering), or upper body (flatwater kayak).
METHODS:Seventeen cross-country skiers, 15 orienteers, and 11 flatwater kayakers were tested for V˙O2max, BV, Hbmass, and FMD. Additionally, body composition and annual training (type, volume, and intensity of training) were analyzed. RESULTS:Absolute and body-mass-normalized V˙O2max values were 11.3% and 9.9% higher, respectively, in skiers (5.83 ± 0.60 L·min and 77.9 ± 4.2 mL·min·kg) compared to orienteers (5.24 ± 0.45 L·min and 70.9 ± 3.5 mL·min·kg) ($P < 0.01$), whereas kayakers (5.78 ± 0.56 L·min and 73.7 ± 6.3 mL·min·kg) did not differ from skiers. BV was 9.9%-11.8% higher in skiers and orienteers compared to kayakers when normalized for total body mass and fat-free mass, and skiers had 9.2% and 9.9% higher Hbmass normalized for total body mass and fat-free mass compared to kayakers (all $P < 0.05$). Arterial diameter was 11.8%-15.0% larger in kayakers (4.38 ± 0.63 mm) and skiers (4.22 ± 0.36 mm) compared to orienteers (3.81 ± 0.32 mm) ($P < 0.05$), whereas FMD did not differ between groups.
CONCLUSIONS: This study indicates that higher V˙O2max in cross-country skiers and greater arterial diameters in the arms of skiers and kayakers are sport-specific physiological adaptations to chronic endurance training in whole-body and upper-body exercise modes. However, variations in these variables are not associated with BV or Hbmass.

Borges TO[1], Dascombe B, Bullock N, Coutts AJ. (2015)

Physiological characteristics of well-trained junior sprint kayak athletes.

Int J Sports Physiol Perform. 2015 Jul;10(5):593-9.

[1] UTS: Health, University of Technology, Sydney, Australia.

This study aimed to profile the physiological characteristics of junior sprint kayak athletes (n=21, VO2max 4.1±0.7 L/min, training experience 2.7±1.2 y) and to establish the relationship between physiological variables (VO2max, VO2 kinetics, muscle-oxygen kinetics, paddling efficiency) and sprint kayak performance. VO2max, power at VO2max, power:weight ratio, paddling efficiency, VO2 at lactate threshold,

and whole-body and muscle oxygen kinetics were determined on a kayak ergometer in the laboratory. Separately, on-water time trials (TT) were completed over 200 m and 1000 m. Large to nearly perfect (-.5 to -.9) inverse relationships were found between the physiological variables and on-water TT performance across both distances. Paddling efficiency and lactate threshold shared moderate to very large correlations (-.4 to -.7) with 200- and 1000-m performance. In addition, trivial to large correlations (-.11 to -.5) were observed between muscle-oxygenation parameters, muscle and whole-body oxygen kinetics, and performance. Multiple regression showed that 88% of the unadjusted variance for the 200-m TT performance was explained by VO2max, peripheral muscle deoxygenation, and maximal aerobic power (P<.001), whereas 85% of the unadjusted variance in 1000-m TT performance was explained by VO2max and deoxyhemoglobin (P<.001). The current findings show that well-trained junior sprint kayak athletes possess a high level of relative aerobic fitness and highlight the importance of the peripheral muscle metabolism for sprint kayak performance, particularly in 200-m races, where finalists and nonfinalists are separated by very small margins. Such data highlight the relative aerobic-fitness variables that can be used as benchmarks for talent-identification programs or monitoring longitudinal athlete development. However, such approaches need further investigation.

Orysiak J[1], Sitkowski D, Zmijewski P, Malczewska-Lenczowska J, Cieszczyk P, Zembron-Lacny A, Pokrywka A. (2015)

Overrepresentation of the ACTN3 XX genotype in elite canoe and kayak paddlers.

J Strength Cond Res. 2015 Apr;29(4):1107-12. doi: 10.1519/JSC.0000000000000717.

[1] Departments of 1Nutrition Physiology; and[2]Physiology, Institute of Sport, Warsaw, Poland; and [3]Department of Biological Bases of Physical Culture, Faculty of Physical Education and Health Promotion, University of Szczecin, Szczecin, Poland; and [4]Department of Biology Basis of Physical Education and Sport, University of Zielona Góra, Zielona Góra, Poland; and [5]Department of Anti-Doping Research, Institute of Sport, Warsaw, Poland.

The aim of the study was to examine the association between the ACTN3 R577X polymorphism in canoe sprint athletes (canoe andkayak paddlers) and their results at 200- or 1000-m distance. Eighty-six European white male athletes divided into 2 groups-successful, who were outstanding at national championships, and nonsuccessful in these competitions-and 354 nonathletic controls were included in this study. The R577X polymorphism of ACTN3 was typed using PCR-RFLP. ACTN3 genotype distribution among all tested athletes and controls was in Hardy-Weinberg equilibrium. The odds ratio (OR) for successful 1000-m athletes harboring the XX genotype compared with sedentary controls was 2.95 (95% confidence interval [CI]: 1.37-6.35), but the OR for nonsuccessful 200-m athletes having the XX genotype compared with controls was 2.64 (95% CI: 1.30-5.36). These results suggest that factors associated with the ACTN3 XX genotype in canoe and kayak paddlers might provide some competitive advantage in performance at 1000 m, but it seems to limit at 200 m. Further studies aimed at development of training strategies based on genetic factors are needed.

FISIOLOGIA APPLICATA ALLA CANOA KAYAK
CANOE SLALOM, WHITE WATER

Baker S. J. (1982)
Post competition lactate levels in canoe slalomists
Br J Sports Med 1982, 16: 112-113.
Outdoor Education Dept, Normal College, Bangor

During the "Pre-World" international canoe slalom championships held at Bala, in North Wales in 1980, post competition blood samples were drawn from 19 competitors in four events. The events were: 1. Mens Kayak singles in which the competitor uses a double blade paddle. 2. Mens Canadian singles in which a kneeling competitor uses a single blade paddle. 3. Mens Canadian doubles in which two canoeists each with a single paddle propel one canoe. 4. Womens Kayak singles - as mens K1. Venous blood samples, from an antecubital vein, were drawn between 4 and 5 minutes after each competitor had finished his/her event and subsequently assayed for lactate content. It can be seen from the results shown in Table 1 that the highest lactate level 17.2 mMl/I was recorded in the mens K1 event. TABLE I: The lactate content of blood plasma taken from members of the British canoe slalom teams in four events. BALA INTERNATIONAL 1980.

Event	Ints.	Resting lactate mmol/l.	Post competition lactate mmol/l.	Post event time to sampling.	Unif fold lactate gain
	RF	1.8	15.3	4	14
	JS	1.3	14.5	5	13
K1 Men	RM	1.3	17.1	5	16
	AS	2.0	17.2	5	15
	PG	1.8	16.8	4	15
	LW	1.6	15.3	5	14
C1 Men	PK	2.1	14.3	4	12
	SC	1.9	11.9	5	10
	WB	1.2	10.8	5	10
	RW	2.0	9.6	5	8
	PH	1.8	9.6	4	8
C2 Men	RJ	1.?	8.8	5	7
	DS	1.9	13.8	5	11
	RN	2.1	12.6	4	11
	EJ	1.3	11.1	4	10
	JH	2.0	9.6	4	8
K1 Women	SC	1.3	12.8	5	12
	JR	1.5	12.8	5	11
	SG	1.9	13.6	4	12

The highest mean lactate value 16.18 mMI/I (Table 2) is calculated also from the mens K1 event. TABLE II-Means and standard deviations of lactate levels from 19 competitors in four slalom events.

Event	Mean lactate mmol/l	Range mmol/l	SD	Sample size
K1 men	16.18	2.7	1.20	5
C1 men	13.10	4.5	1.75	4
C2 men	10.83	4.5	1.68	6
K1 women	12.20	4.0	1.77	4

There was a significant difference (.01 level) between events when the lactate values were treated by ANOVA (Table 3). ANOVA revealed a no-difference effect (.01 level of significance) between event-resting lactate values.
TABLE III-Summary table for results of ANOVA on lactate levels from four events.

Variation	SS	df	MS	F
Between events				
Between events	81.31	3	27.10	9.09*
Within events	44.77	15	2.98	
TOTAL	126.08	18		

*F (3, 15) at .01 level = 5.42 is significant.

Carré F, Dassonville J, Beillot J, Prigent JY, Rochcongar P. (1994)
Use of oxygen uptake recovery curve to predict peak oxygen uptake in upper body exercise.
Eur J Appl Physiol Occup Physiol. 1994; 69(3): 258-61.

A group of 18 well-trained white-water kayakers performed maximal upper body exercise in the laboratory and during a field test. Laboratory direct peak oxygen uptake (VO2) values were compared, firstly by a VO2 backward extrapolation estimation and secondly by an estimation calculated from VO2 measured during the first 20 s of exercise recovery. Direct peak VO2 correlated with VO2 backward extrapolation (r = 0.89), but the results of this study showed that the backward extrapolation method tended to overestimate significantly peak VO2 by [0.57 (SD 0.31) l.min-1 in the laboratory, and 0.66 (SD 0.33) l.min-1 in the field, P < 0.001]. The VO2 measured during the first 20 s of recovery, whether the exercise was performed in the laboratory or in the field, correlated well with the laboratory direct peak VO2 (r = 0.92 and r = 0.91, respectively). The use of the regression equation obtained from field data (VO2F20s), that is peak VO2 = 0.23 + 1.08 VO2F20s, gave an estimated peak VO2, the mean difference of which compared with direct peak VO2 was 0.22 (SD 0.13) l.min-1. In conclusion, we propose the use of a regression equation to estimate peak VO2 from a single sample of the gas expired during the first 20 s of recovery after maximal exercise involving the upper part of the body.

Males J.R.[1], Kerr J.H.[2], Gerkovitch M.M.[3] (1998)

Metamotivational states during canoe slalom competition: a qualitative analysis using reversal theory,

Journal of Applied Sport Psychology, 10: 185-200.

[1] Centre for Organisational Health and Development, Department of Psychology, University of Nottingham, Nottingham, England.
[2] Institute for Health and Sport Sciences, The University of Tsukuba, Tsukuba, Japan.
[3] Midwest Research Institute, Kansas City, Missouri.

Fifty post-event interview with 9 elite male slalom canoeists were analysed using a modified version of the Matamotivational State coding schedule (Potocky, Cook & O'Connell, 1993). Participants reported 7 of the 8 metamotivational categories posited by reversal theory (Apter, 1982). All partecipants consistently experienced autic mastery (self focused control) although they varied in their tendency to exhibit a telic (serious and future oriented) or paratelic (spontaneous and present focused) orientation. Most were willing to conform to competitive norms although there were several instances of negativism. Partecipants' experience changed (or reversed) at different stages of the competition in response to errors or external events. Above average performances occurred more frequently when partecipants'experience was consistent with paratelic autic mastery. Implications for coaches and practitioners are discussed.

Kameyama O[1], Shibano K, Kawakita H, Ogawa R, Kumamoto M. (1999)

Medical check of competitive canoeists. **J Orthop Sci. 1999;4(4): 243-9.**

[1] Department of Orthopaedic Surgery, Kansai Medical University, Osaka 570-8507, Japan.

We gave a sports injury questionnaire survey to 821 active canoeists, members of the Japan Canoe Association (JCA), and performed a medical check of 63 top competitive JCA canoeists, including physical and laboratory tests and radiographic examinations of the chest, spine, shoulder, elbow, and wrist joints. Completed questionnaires were returned by 417 canoeists, whose reported racing styles were: kayak, 324; Canadian canoe, 71; slalom, 13; and not specified, 9. Of the 417 respondents, 94 canoeists (22. 5%) reported that they experienced lumbago; 20.9% experienced shoulder pain; 3.8%, elbow pain; and 10.8%, wrist pain. On medical examinations, lumbago was found to be mainly of myofascial origin or due to spondylolysis. Impingement syndrome was also observed in 4 canoeists with shoulder problems. The competitive canoeists had low blood pressure, and some had bradycardia. On laboratory examinations, serum hemoglobulin, hematocrit, high-density lipoprotein cholesterol (HDL-CHO), creatine phosphokinase (CK), and creatine (CRTN) in the top competitive canoeists showed high values in comparison with those of an age-matched control group. However, low serum total cholesterol (TP) values were observed in the top competitive canoeists.

Leveque JM, Brisswalter J, Bernard O, Goubault C. (2002)
Effect of paddling cadence on time to exhaustion and VO2 kinetics at the intensity associated with VO2max in elite white-water kayakers.
Can J Appl Physiol. 2002 Dec; 27(6): 602-611.

The influence of paddling cadence on the time to exhaustion (t.lim) and VO2 kinetics at the intensity associated with VO2max (IVO2max) was examined in seven highly-trained white water kayakers. All subjects were engaged in national or international competitions. Subjects took part in three constant-load tests at IVO2max, each test performed at a different paddling cadence (50, 60 or 70 cycles min(-1). The VO2 kinetics recorded during these constant-load tests at IVO2max were fitted with a mono-exponential equation. A significant increase in t.lim (P <.05) was observed as the paddling cadence increased from 50 to 70 cycles min(-1). No effect was found either on values of VO2peak, post-exercise blood lactate concentration, or on the time at which VO2peak was attained (TAVO2peak). Our results suggest that experienced kayakers may choose a high paddling cadence during physiological assessments at IVO2max. Further experiments are needed in order to identify the physiological significance of t.lim at IVO2max. Key words: performance, exercise test, pulmonary gas exchange, locomotory pattern, kayaking.

MacIntyre T[1], Moran A, Jennings DJ. (2002)
Is controllability of imagery related to canoe-slalom performance?
Percept Mot Skills. 2002 Jun;94(3 Pt 2): 1245-50.
[1] Department of Psychology, University College Dublin, Belfield, Ireland. tadhg.macintyre@ucd.ie

This study investigated the relationship of controllability of mental imagery with canoe-slalom performance. Controllability of mental imagery was assessed by an objective test of mental rotation, the Mental Rotations Test. This test was administered to both elite (n = 19) and intermediate (n = 12) athletes. Predictive validity of the controllability test was supported by a significant correlation between test scores and race rank-order for the elite canoeing group (rs = 0.42, p<.05); however, it did not distinguish elite from intermediate groups (t29 = 0.98, p>.05). Researchers should attempt to evaluate vividness of imagery, controllability of imagery, and accuracy of reference to understand more fully the nature of athletes' imagery.

Zamparo P[1,2], Tomadini S[2], Didonè F[2], Grazzina F[3], Rejc E[3], Capelli C.[1] (2006)
Bioenergetics of a slalom kayak (K1) competition.
Int J Sports Med. 2006 Jul;27(7): 546-52.
[1] Dipartimento di Scienze e Tecnologie Biomediche, Facoltà di Medicina e Chirurgia, Università degli Studi di Udine, Udine, Italy. PZamparo@mail.dstb.uniud.it
[2] Canoa Club Udine, Federazione Italiana Canoa-Kayak, Udine, Italy
[3] Corso di Laurea in Scienze Motorie, Universita degli Studi di Udine, Gemona del Friuli (Udine), Italy.

The aim of this study was: 1) to compute an energy balance of a slalom kayak competition by measuring the percentage contributions of the aerobic and anaerobic energy

sources to total metabolic power (E(tot)); and 2) to compare these data with those obtained, on the same subjects, over a flat-water course covered at maximal speed in a comparable time. Experiments were performed on eight middle- to high-class slalom kayakers (24.8 +/- 8.1 years of age, 1.75 +/- 0.04 m of stature, and 69.8 +/- 4.7 kg of body mass) who completed the slalom race in 85.8 +/- 5.3 s and covered the flat water course in 88.1 +/- 7.7 s. E(tot) was calculated from measures of oxygen consumption and of blood lactate concentration: it was about 30 % larger during the flat water all-out test (1.72 +/- 0.18 kW) than during the slalom race (1.35 +/- 0.12 kW). However, in both cases, about 50 % of E(tot) derives from aerobic and about 50 % from anaerobic energy sources. These data suggest that, besides training for skill acquisition and for improving anaerobic power, some high intensity, cardiovascular conditioning should be inserted in the training programs of the athletes specialised in this sport. Key words: Kayaking, canoeing, metabolic power, lactate.

Pinkert S. (2006)

Whitewater Slalom, Long-Term Paddler Development Model.

High Performance Director Slalom, CKC.

The concept of LTAD has grown out of a recognition of the many gaps in athlete talent identification and development in the current Canadian sport system, a system that has been built in haphazard layers over time, that has a strong reliance on volunteer initiative and intuition combined with elements of sport science and coaching education, and that, by design, has had to focus more on short-term needs rather than on the longterm health of sport and lifestyle programming. However, with the agreement by the major sport funding partners in Canada to better align and integrate their financial and human resources into a comprehensive Canadian Sport Policy, the opportunity to create clear building blocks for sport development has arrived, with LTAD being one of the key structural elements in a new Canadian sport system. LTAD is the product of many years of research and analysis into athlete development models throughout the world. The Canadian version uses the core concept of "a training, competition, and recovery program based upon developmental age (the maturation of an individual) rather than chronological age" but takes into consideration the unique nature of the Canadian sport system and culture. Many national sport organizations are now involved in the further customization of this model to meet their athlete development needs and are taking this opportunity to re-examine the myriad of support services provided to support such development.

Ridge B.R.[1], Broad E.[2], Kerr D.A.[3], & Ackland T.R.[4] (2007)

***Morphological characteristics of Olympic slalom canoe and kayak paddlers*,**

European Journal of Sport Science, June 2007; 7(2): 107-113.

[1] University of Western Sydney, Penrith South, Australia.
[2] Australian Canoeing Inc.
[3] Curtin University of Technology, Perth, Australia.
[4] University of Western Australia, Perth, Australia.

Sydney and Shephard (1973) were the first to report on the morphology of slalom paddlers and characterized therm as having “a substantial standing height and lean body mass, good general muscle development with particular emphasis on the leg muscles”. The purpose of this study was to analyze the morphological characteristics of Olympic slalom kayak and canoe paddlers to determine whether they possess unique physique or structural characteristic that provide an advantage for their sport. Thirty-one male and 12 female slalom paddlers were measured using a battery of 36 anthropometric dimensions in the 15-day period before competition at the Olympic Games. Male slalom paddlers were older, lighter, shorter, and less fat than those reported previously. They were taller and lighter than the reference population of non-athetes and of similar age and height but lighter and leaner than the Olympic sprint paddlers. While a high brachial index was reported for both male and female slalom paddlers, the Best male paddlers (those ranked in the top 10 placings) were more compact, had smaller proportional hip girth, and showed a tendency for smaller proportional hip breadth but a larger proportional waist girth than the Rest (those not ranked in the top 10 placings). Charges to the technical aspect of the events and to competition rules and the nature and approach to training were explored as possible reasons for some of these differences. We outline the contribution this research makes to talent identification and highlight the need for further research. KEYWORDS: Olympic, slalom, paddler, morphology, proportionality.

Davranche K.,[1,2] Paleresompoulle D.,[1] Pernaud R.,[1] Labarelle J.,[1,3] and Hasbroucq T.,[1] (2009)
Decision Making in Elite White-Water Athletes Paddling on a Kayak Ergometer.
Journal of Sport and Exercise Psychology, 2009, 31: 554-565.
[1] Université de Provence & CNRS;
[2] University of Chichester;
[3] Pôle Espoir de Canoë-Kayak de Marseille and Fédération Française de Canoë-Kayak.

The present study investigated the effects of acute paddling on performance in a typical decision-making task. It was aimed at assessing whether the effects of moderate exercise can be replicated using the feet as response effectors when physical exercise essentially solicits upper-body muscles. Twelve national-level paddling athletes performed a Simon task while paddling at a moderate (75% of maximal heart rate, HRmax) and at very light (40% of HRmax) intensities. The results showed that the effects of moderate exercise can be generalized to exercises involving different response effectors and upper-body muscle groups. They suggest (1) that the activation-suppression hypothesis (Ridderinkhof, 2002) holds when the task is performed with the feet, and (2) that moderate exercise speeds up reaction time and impairs the suppression of direct response activation. KEYWORDS: reaction time distribution, moderate exercise, activation-suppression hypothesis, response effectors, upper-body muscles.

Wassinger C.[1], Myers J.[2], Oyama S.[2], Sell T.[3], Lephart S.[3] (2010)

***Kayak stroke technique and musculoskeletal traits in shoulder injured whitewater kayakers*,**

Journal of Science and Medicine in Sport 12 (2010) e1–e232 32.

[1] University of Otago
[2] University of North Carolina at Chapel Hill
[3] University of Pittsburgh.

Introduction: Whitewater kayaking has been shown to be a highly injurious sport with a large proportion of injuries focused on the shoulder. Both kayak stroke technique and musculoskeletal traits of the kayaker have been implicated as having a role in shoulder injuries, suggesting the need for exploration of whitewater kayaking kinematics and range of motion. The aim of this study was to compare kayak stroke symmetry and shoulder range of motion between injured and uninjured limbs in kayakers with unilateral shoulder injury and compared to healthy kayakers. Subjects: Sixteen whitewater kayakers (mean age: 33.1years, range 19–43; mean height: 178.6 cm, range 151–191; mean mass: 83.4 kg, range 51–98) with unilateral shoulder injury and sixteen healthy, matched whitewater kayakers participated in the study (mean age: 31.9 years, range 23–44; mean height: 177.7 cm, range 163–196; mean mass: 81.2 kg, range 57–102). Methods: Bilateral scapular internal/external rotation, upward/downward rotation, anterior/posterior tipping, elevation/ depression, protraction/retraction, and humeral elevation and plane of elevation were assessed using an electromagnetic tracking device while the subjects paddled on a kayak ergometer. Kinematics at six time points during the forward kayak stroke were used for comparison. Bilateral shoulder range of motion was also measured. Data were analyzed using two-way ANOVA (group×limb), with significance set at $\alpha = 0.05$ a priori. Results: Scapular and humeral kinematics did not differ between injured and uninjured limbs or between groups ($p = 0.18–0.90$). Shoulder range of motion in kayakers with unilateral shoulder injury was decreased on the injured limb compared to the matched limb of the healthy kayakers for flexion ($p < 0.01$), abduction ($p < 0.01$), internal rotation ($p < 0.01$), and horizontal adduction ($p < 0.01$). Internal rotation was also significantly limited in injured compared to uninjured shoulders within the injured group ($p < 0.01$). Range of motion was similar for external rotation ($p = 0.08$) and extension ($p = 0.17$). Conclusions: Unilateral shoulder injury did not appear to play a role in the kayak stroke technique used among this set of whitewater kayakers, despite the shoulder injury and range of motion discrepancy. Regardless of injury, the kinematic patterns required to effectively kayak on whitewater rivers may necessitate use of a standard technique. Clinicians should focus rehabilitation efforts on restoring range of motion and pain management, versus forward kayak stroke technique, given the lack of difference in kayak stroke kinematics found in the current study.

Nibali M.[1,3], Hopkins W.G.[2], & Drinkwater E.[3] (2011)

Variability and predictability of elite competitive slalom canoe-kayak performance.

European Journal of Sport Science, March 2011; 11(2): 125-130.

[1] Physiology, Australian Institute of Sport, Canberra, ACT, Australia,
[2] Department of Sport and Recreation, Auckland University of Technology, Auckland, New Zealand.
[3] School of Human Movement Studies, Charles Sturt University, Bathurst, NSW, Australia.

Little is known about the race performance characteristics of elite-level slalom canoeists or the magnitude of improvement necessary to enhance medal-winning prospects. Final placing in this sport is determined by the aggregate of semi-final and final run times inclusive of penalty times. We therefore used mixed linear modelling to analyse these times for finalists ranked in the top and bottom half in the men's canoe, men's kayak, and women's kayak boat classes at World Cups, World Championships, and Olympic Games from 2000 to 2007. The run-to-run variability for top-ranked athletes at different courses ranged from 0.8% to 3.2% (90% confidence limits x/÷1.11-1.31), reflecting differences in how challenging these courses were. The race-to-race variability of aggregate run time was 1.2-2.1% (x/÷ ~1.09); 0.3 of this variability yields the smallest worthwhile enhancement of 0.4-0.6%. The variabilities of bottom-ranked finalists were approximately double those of top-ranked finalists. The home advantage was small (0.3-0.8%), and incurring a penalty had a marginal effect on reducing actual run time (0.2-0.7%). Correlation coefficients for performance predictability within competitions (0.06-0.35), within years (0.12-0.47), and between years (0.12-0.43) were poor. In conclusion, the variability of performance and smallest worthwhile enhancements in slalom canoe-kayaking are larger than those of comparable sports, and race outcomes are largely unpredictable. KEYWORDS: Athlete, home advantage, intraclass correlation, penalty, reliability.

Engebretsen L[1], Soligard T, Steffen K, Alonso JM, Aubry M, Budgett R, Dvorak J, Jegathesan M, Meeuwisse WH, Mountjoy M, Palmer-Green D, Vanhegan I, Renström PA. (2013)

Sports injuries and illnesses during the London Summer Olympic Games 2012.

Br J Sports Med. 2013 May;47(7): 407-14.

[1] Medical & Scientific Department, International Olympic Committee, Lausanne, Switzerland.

BACKGROUND: The Olympic Movement Medical Code encourages all stakeholders to ensure that sport is practised without danger to the health of the athletes. Systematic surveillance of injuries and illnesses is the foundation for developing preventive measures in sport. AIM: To analyse the injuries and illnesses that occurred during the Games of the XXX Olympiad, held in London in 2012. METHODS: We recorded the daily occurrence (or non-occurrence) of injuries and illnesses (1) through the reporting of all National Olympic Committee (NOC) medical teams and (2) in the polyclinic and medical venues by the London Organising Committee of the Olympic and Paralympic Games' (LOCOG) medical staff. RESULTS: In total, 10 568 athletes (4676 women and 5892 men) from 204 NOCs participated in the study. NOC and

LOCOG medical staff reported 1361 injuries and 758 illnesses, equalling incidences of 128.8 injuries and 71.7 illnesses per 1000 athletes. Altogether, 11% and 7% of the athletes incurred at least one injury or illness, respectively. The risk of an athlete being injured was the highest in taekwondo, football, BMX, handball, mountain bike, athletics, weightlifting, hockey and badminton, and the lowest in archery, canoe slalom and sprint, track cycling, rowing, shooting and equestrian. 35% of the injuries were expected to prevent the athlete from participating during competition or training. Women suffered 60% more illnesses than men (86.0 vs 53.3 illnesses per 1000 athletes). The rate of illness was the highest in athletics, beach volleyball, football, sailing, synchronised swimming and taekwondo. A total of 310 illnesses (41%) affected the respiratory system and the most common cause of illness was infection (n=347, 46%). CONCLUSIONS: At least 11% of the athletes incurred an injury during the games and 7% of the athletes' an illness. The incidence of injuries and illnesses varied substantially among sports. Future initiatives should include the development of preventive measures tailored for each specific sport and the continued focus among sport bodies to institute and further develop scientific injury and illness surveillance systems.

Da Silva C.C.[1 2], Wolff M.[2], Dechechi C.J.[3], Gomes de Almeida A.[4 5], Nakamura F.Y.[2] (2013)

Análise da cinética de remoção de lactato em atletas de Canoagem slalom,

Rev.Bras.Ciênc.Esporte, Florianópolis, v.35, n.2: 425-439, abr./jun.2013.

[1] Universidade Estadual do Norte do Paraná
[2] Universidade Estadual de Londrina (Londrina – Paraná – Brasil)
[3] Laboratório de Bioquímica do Exercício (LABEX), Instituto de Biologia - IB - Universidade Estadual de Campinas
[4] Universidade Estadual Paulista (UNESP-Rio Claro)
[5] Pontifícia Universidade Católica de Campinas (São Paulo – Brasil)

O objetivo do presente estudo foi verificar a cinetica de producao e remocao de lactato em atletas de canoagem slalom da categoria K1, durante competicao oficial. Participaram do estudo oito atletas do sexo masculino (22,6 ± 4,3 anos). Foram realizadas coletas de 25μL de sangue capilar para analise do lactato. A cinetica de remocao do lactato foi realizada antes do aquecimento (Pre), logo apos a saida dos competidores do rio (Pos 0'), 5 (Pos 5') e 20 (Pos 20') minutos. Os resultados demonstraram um aumento significativo nas concentracoes de lactato (9,8 mmol/l, 9,4 mmol/l e 6,6 mmol/l) nos tempos 0', 5' e 20' minutos pos respectivamente, com valores de P<0,01. Os achados indicam que apos 20 minutos, os valores de lactato se reduziram de forma importante (P<0,05) em relacao aos valores pre exercicio (2,0 mmol/l), sugerindo que os atletas indicariam boas condicoes metabolicas para a segunda descida da prova. Palavras-chave: Lactato sanguineo; exercicios de alta intensidade; competicao; atletas.

Manchado-Gobatto F.B.[1], Vieira N.A.[2], Messias L.H.D.[1], Ferrari H.G.[2], Borin J.P.[2], De Carvalho Andrade V.[3], Terezani D.R.[3] (2014)

Anaerobic threshold and critical velocity parameters determined by specific tests of canoe slalom: Effects of monitored training.

http://dx.doi.org/10.1016/j.scispo.2014.04.006 0765-1597.

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[3] Faculty of health sciences, Methodist university of Piracicaba, UNIMEP, Piracicaba, SP.

Objectives: The aims of study were to determine the anaerobic threshold (AT) and critical velocity (CV) parameters using specific test for canoe slalom and verify the effects of 7-weeks of monitored training on these parameters. Methods: Well-trained kayakers were submitted to specific tests on a lake before and after training. The AT was determined by a progressive kayak ‘‘shuttle’’ exercise (50- m course, 3 min/stage, 5.0—9.5 km.h–1). The blood lactate (BLC) was determined after each stage and AT was obtained using visual inspection and the intersection of the bi-segmental linear regressions. The CV protocol consisted of four maximal paddling exercises (150—600 m). The slope and y-intercept of the ‘distance vs. time’ model were CV and anaer-obic paddling capacity (APC). The training intensity sessions were obtained by the rating of perceived exertion (RPE) and the product of daily volume and RPE was the load training. KEYWORDS: Invasive and non-invasive aerobic evaluation; Progressive test; Blood lactate; Canoe slalom; Training.

Messias LHD[1], Ferrari HG[1], Reis IG[1], Scariot PP[1], Manchado-Gobatto FB[1]. (2015)

Critical velocity and anaerobic paddling capacity determined by different mathematical models and number of predictive trials in canoe slalom.

J Sports Sci Med. 2015 Mar 1;14(1): 188-93.

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The purpose of this study was to analyze if different combinations of trials as well as mathematical models can modify the aerobic and anaerobic estimates from critical velocity protocol applied in canoe slalom. Fourteen male elite slalom kayakers from Brazilian canoeslalom team (K1) were evaluated. Athletes were submitted to four predictive trials of 150, 300, 450 and 600 meters in a lake and the time to complete each trial was recorded. Critical velocity (CV-aerobic parameter) and anaerobic paddling capacity (APC-anaerobic parameter) were obtained by three mathematical models (Linear1=distance-time; Linear 2=velocity-1/time and Non-Linear = time-velocity). Linear 1 was chosen for comparison of predictive trials combinations. Standard combination (SC) was considered as the four trials (150, 300, 450 and 600 m). High fits of regression were obtained from all mathematical models (range - $R^2 = 0.96$-1.00). Repeated measures ANOVA pointed out differences of all mathematical models for CV ($p = 0.006$) and APC ($p = 0.016$) as well as R^2 ($p = 0.033$). Estimates obtained from the first (1) and the fourth (4) predictive trials (150 m = lowest; and 600 m =

highest, respectively) were similar and highly correlated (r=0.98 for CV and r = 0.96 for APC) with the SC. In summary, methodological aspects must be considered in critical velocity application in canoe slalom, since different combinations of trials as well as mathematical models resulted in different aerobic and anaerobic estimates. KEYWORDS: Canoe slalom; aerobic parameter; anaerobic parameter; critical velocity; elite athletes; sports performance.

Vieira N.A.[1] , Messias L.H.D., Cardoso M.V., Ferrari H.G., Cunha S.A., Terezani D.R., Manchado-Gobatto F.B. (2015)

Characterization and reproducibility of canoe slalom simulated races: physiological, technical and performance analysis.

J. Hum. Sport Exerc., 10(4): 835-846.

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The aims of this study were to characterise and test the reproducibility of canoe slalom race simulations performed on two different days, analysing the physiological, technical and performance responses characteristic of the sport. Six high-performance male canoe slalom K1 athletes (age 17±2yrs) underwent two race simulations with an interval of 72 hours. The artificial course consisted of twelve gates. Each simulation was analysed the runtime, distance travelled, mean velocity; images were captured by the digital camera (JVC) and determined quantitative variables. Heart monitors (Polar, RS800x model) were used to record heart rate during race simulations and recovery; data were stored every 5 s, to determine the blood lactate concentration ([Lac]), blood samples were collected from the earlobe at rest and after 1, 3, 5, 7 and 9 min of race simulation (recovery). Tests of normality (Shapiro Wilk) and variance (Levene) were applied. The variables were compared using paired t-tests. Intraclass coefficient correlation (ICC) and Pearson product moment were used for relationship. In all cases, the level of significance was pre-fixed at 5%. Differences between the first and second simulations could not be noticed. Another important indicator was the high correlation found between the runtime (ICC=0.71), distance travelled (ICC=0.77), mean velocity (ICC=0.80) and total number of paddles (ICC=0.79). The lactate levels on minutes 3, 5, 7 and 9 also pointed towards strong correlations (ICC=0.88, ICC=0.90, ICC=0.95 and ICC=0.90 respectively), which may indicate that the adopted simulation model seems to be practicable and of great value to canoe slalom evaluations. KEYWORDS: simulated race characterization, performance, reproducibility, canoe slalom.

Ferrari HG[1, 2], Messias LH[1], Reis IG[1, 2], Gobatto CA[1], Sousa FA[1], Serra CC[1], Manchado-Gobatto FB[1, 2]. (2016)

Aerobic Evaluation in Elite Slalom Kayakers Using Tethered Canoe System: A New Proposal.

Int J Sports Physiol Perform. 2016 Dec 5: 1-25.

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BACKGROUND: Among other aspects, aerobic fitness is indispensable for performance in slalom canoe. PURPOSE: The aims of the study were to propose the maximal lactate steady state (MLSS) and critical force (CF) tests using a tethered canoe system as new strategies for aerobic evaluation in elite slalom kayakers. Also, we studied the relationship between the aerobic parameters from these tests and the kayakers' performances. METHODS: Twelve male elite slalom kayakers from the Brazilian National Team participated in this study. All tests were conducted using a tethered canoe system to obtain the force records. The CF was applied on four days and analyzed by hyperbolic (CF_{hyper}) and linear (CF_{lin}) mathematical models. The maximal lactate steady state intensity ($MLSS_{int}$) was obtained by three 30-minute continuous tests. The time of a simulated race was considered as the performance index. RESULTS: No difference ($P < 0.05$) between CF_{hyper} (65.9 ± 1.6 N) and $MLSS_{int}$ (60.3 ± 2.5 N) was observed; however, CF_{lin} (71.1 ± 1.7 N) was higher than $MLSS_{int}$. An inverse and significant correlation was obtained between $MLSS_{int}$ and performance ($r= -0.67$, $P<0.05$). CONCLUSIONS: In summary, MLSS and CF tests on a tethered canoe system may be used for the aerobic assessment of elite slalom kayakers. In addition, CF_{hiper} may be used as an alternative low-cost and non-invasive method to estimate $MLSS_{int}$, which is related with the slalom kayaker's performance. KEYWORDS: Canoe slalom; aerobic evaluation; critical power; maximal lactate steady state; performance.

Drory A.[1], Zhu G.[1] , Li H.[1 2], Hartley R.,[1 2 3] (2016)

***Automated detection and tracking of slalom paddlers from broadcast image sequences using cascade classifiers and discriminative correlation filters, Computer Vision and Image Understanding*.**

http://dx.doi.org/10.1016/j.cviu.2016.12.002

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This paper addresses the problem of automatic detection and tracking of slalom paddlers through a long sequence of sports broadcast images comprised of persistent view changes. In this context, the task of visual object tracking is particularly challenging due to frequent shot transitions (i.e. camera switches), which violate the fundamental spatial continuity assumption used by most of the state-of-the-art object tracking algorithms. The problem is further compounded by significant variations in object location, shape and appearance in typical sports scenarios where the athletes often move rapidly. To overcome these challenges, we propose a Periodically Prior Regularised Discriminative Correlation Filters (PPRDCF) frame-work, which exploits recent successful Discriminative Correlation Filters (DCF) with a periodic regulari- sation by a prior that constitutes a rich discriminative cascade classifier. The PPRDCF framework reduces the corruption of positive samples during online learning of the correlation filters by negative training samples. Our framework detects rapid shot transitions to reinitialise the tracker. It successfully recovers the tracker when the location, view

or scale of the object changes or the tracker drifts from the object. The PPRDCF also provides the race context by detection of the ordered course obstacles and their spatial relations to the paddler. Our framework robustly outputs the evidence base pre-requisite to derived race kinematics for analysis of performance. Experiments are performed on task-specific dataset containing Canoe/Kayak Slalom race image sequences with successful results obtained.
KEYWORDS: Detection Tracking. Cascade classification. Discriminative correlation filter. Multi-class SVM Canoe Kayak Slalom. Shot transition. Sports biomechanics. Performance analysis.

Murtagh M.[1], Brooks D.[1], Sinclair J.[1], & Atkins S.[2] (2016)

The lower body muscle activation of intermediate to experienced kayakers when navigating white water.

European Journal of Sport Science, 2016 Vol. 16, No. 8: 1130–1136.

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In white-water kayaking, the legs play a vital part in turning, stabilising and bracing actions. To date, there has been no reported information on neuromuscular activation of the legs in an authentic white-water environment. The aim of the current study was to identify lower body muscle activation, using ‘in-boat’ electromyography (EMG), whilst navigating a white-water run. Ten experienced male kayakers (age 31.5 ± 12.5 yr, intermediate to advanced experience) completed three successful runs of an international standard white-water course (grade 3 rapids), targeting right and left sides of the course, in a zigzag formation. Surface emg (sEMG) outputs were generated, bilaterally, for the rectus femoris (RF), vastus lateralis, biceps femoris and gastrocnemius, expressed as a percentage of a dynamic maximal voluntary contraction (dMVC). Only RF showed significantly higher activation than any muscle on the left side of the body, and only on the left side of the course ($p = .004$; eta2 = 0.56). Other results showed no significant difference between muscle activation in the right and left legs during each run, nor when assessed at either the right or left side of the course ($p > .05$). These findings indicate that contralateral symmetry in lower limb muscle activation is evident during white-water kayaking. This symmetry may provide a stable base to allow more asymmetrical upper body and trunk movements to be fully optimised. Lower body symmetry development should be considered useful in targeted training programmes for white-water kayakers. KEYWORDS: kayaking; electromyography; white water; bilateral; lower body; bracing.

FISIOLOGIA APPLICATA ALLA CANOA KAYAK
CANOE POLO

Hill A[1], Hall H.[1], Appleton P.[2], Murray J.[2], (2010)

***Perfectionism and Burnout in Canoe Polo and Kayak Slalom Athletes: The Mediating Influence of Validation and Growth-Seeking*,**

The Sport Psychologist, 2010, 24: 16-34.

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Recent research suggests that validation-seeking and dimensions of perfectionism may be antecedents of athlete burnout.The present investigation examined whether validation and growth-seeking mediate the relationship between selforiented and socially prescribed perfectionism and burnout. One-hundred and ifty canoe polo and kayak slalom athletes recruited from the top two divisions in the UK completed measures of validation and growth-seeking (GOI), perfectionism
(HMPS), and athlete burnout (ABQ). Analyses supported the mediating role of validation-seeking in the relationship between socially prescribed perfectionism and burnout. However, while bivariate correlations indicated that self-oriented perfectionism was positively related to both validation and growth-seeking, neither mediated the self-oriented perfectionism-burnout relationship.The indings
suggest that validation-seeking may be an important psychological factor in the development of burnout for athletes exhibiting high levels of socially prescribed perfectionism. The relationship between self-oriented perfectionism and athlete burnout remains unclear because of its association with multiple motives and with socially prescribed perfectionism.

Alves CR[1], Pasqua L, Artioli GG, Roschel H, Solis M, Tobias G, Klansener C, Bertuzzi R, Franchini E, Lancha Junior AH, Gualano B. (2012)

Anthropometric, physiological, performance, and nutritional profile of the Brazil National Canoe Polo Team.

J Sports Sci. 2012;30(3): 305-11.

[1] Laboratory of Applied Nutrition, School of Physical Education and Sport, University of São Paulo, São Paulo, Brazil.

The purpose of this study was to determine the physiological, anthropometric, performance, and nutritional characteristics of the Brazil Canoe Polo National Team. Ten male canoe polo athletes (age 26.7 ± 4.1 years) performed a battery of tests including assessments of anthropometric parameters, upper-body anaerobic power (Wingate), muscular strength, aerobic power, and nutritional profile. In addition, we characterized heart rate and plasma lactate responses and the temporal pattern of the effort/recovery during a simulated canoe polo match. The main results are as follows: body fat, 12.3 ± 4.0%; upper-body peak and mean power, 6.8 ± 0.5 and 4.7 ± 0.4 W · kg(-1), respectively; 1-RM bench press, 99.1 ± 11.7 kg; peak oxygen uptake, 44.3 ± 5.8 mL · kg(-1)

· min(-1); total energy intake, 42.8 ± 8.6 kcal · kg(-1); protein, carbohydrate, and fat intakes, 1.9 ± 0.1, 5.0 ± 1.5, and 1.7 ± 0.4 g · kg(-1), respectively; mean heart rate, 146 ± 11 beats · min(-1); plasma lactate, 5.7 ± 3.8 mmol · L(-1) at half-time and 4.6 ± 2.2 mmol · L(-1) at the end of the match; effort time (relative to total match time), 93.1 ± 3.0%; number of sprints, 9.6 ± 4.4. The results of this study will assist coaches, trainers, and nutritionists in developing more adequate training programmes and dietary interventions for canoe polo athletes.

Vastola R.[1], Sgambelluri R.[1], Di Tore S.[1], Buglione A.[2], Prosperi R.[3], Cecoro G.[1], Carlomagno N.[4], Sibilio M.[1] (2012)

The value of didactic-pedagogical skills of canoe-polo tecnica.

J. Hum. Sport Exerc. Vol. 7, N.2: 489-494.

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Canoe-polo is a team sport. It is played in over 50 countries around the world. The role of coach concerns not only the technical – tactics skills but also the managerial, organizational and logistical skills of the players. From the point of view of teaching methodology, the canoe polo coach must be aware of the fact that his role always involves the role of teacher, and to excel in the performance of this function, must possess a number of characteristics that define the area of his specifically pedagogical jurisdiction The aim of the research is to define the elements characterizing the performance model in canoe polo that are the most important in developing a technique, tactics and conditional plan in order to provide the coach the most appropriate knowledge to organize a didactically coherent process to the requires of the group – team. The experimental research was carried out on two subjects of the 2010 Italian champions (CN Posillipo in Naples), during eight matches of the Italian Canoe Polo Championship. The research project provided for the monitoring of the heart rate (HR) during the races by teams polar heart rate monitors system, with a sampling rate of 5s per subject. The acquisitions were subsequently analyzed with a dedicated software Polar Pro Trainer 5.2. The results in this pilot study show, canoe-polo like many other team games where you use a ball, it is an intermittent sport with a high metabolic intensity (4.8). Key words: canoe polo, technical, pedagogical skills, didactic methodology.

Forbes SC[1], Kennedy MD, Bell GJ. (2013)

Time-motion analysis, heart rate, and physiological characteristics of international canoe polo athletes.

J Strength Cond Res. 2013 Oct;27(10): 2816-22.

[1] Faculty of Physical Education and Recreation, University of Alberta, Edmonton, Canada.

To evaluate the time international canoe polo players spend performing various game activities, measure heart rate (HR) responses during games, and describe the physiological profile of elite players. Eight national canoe polo players were videotaped and wore HR monitors during 3 games at a World Championship and underwent fitness testing. The mean age, height, and weight were 25 ± 1 years, 1.82 ± 0.04 m, and 81.9 ± 10.9 kg, respectively. Time-motion analysis of 3 games indicated that the players spent 29 ± 3% of the game slow and moderate forward paddling, 28 ± 5% contesting, 27 ± 5% resting and gliding, 7 ± 1% turning, 5 ± 1% backward paddling, 2 ± 1% sprinting, and 2 ± 1% dribbling. Sixty-nine (±20)% of the game time was played at an HR intensity above the HR that corresponded to the ventilatory threshold (VT) that was determined during the peak V[Combining Dot Above]O2 test. Peak oxygen uptake and VT were 3.3 ± 0.3 and 2.2 ± 0.3 L·min, respectively, on a modified Monark arm crank ergometer. Arm crank peak 5-second anaerobic power was 379 W. The majority of the time spent during international canoe polo games involved slow-to-moderate forward paddling, contesting for the ball, and resting and gliding. Canoe polo games are played at a high intensity indicated by the HR responses, and the physiological characteristics suggest that these athletes had high levels of upper body aerobic and anaerobic fitness levels.

McKean MR[1], Burkett BJ.[2] (2014)

The influence of upper-body strength on flat-water sprint kayak performance in elite athletes.

Int J Sports Physiol Perform. 2014 Jul;9(4):707-14. Epub 2013 Nov 14.

[1, 2] School of Health and Sport Science, University of Sunshine Coast, Queensland, Australia.

Dry-land strength training is a fundamental component for elite kayak performance. The aims of this research were 3-fold: 1st, to determine the relationship between performance time and strength scores for elite kayakers; 2nd, to identify how strength changes (gains or losses) over 3 training y relate with changes in performance time for elite kayakers; and 3rd, to compare the progression in performance times for elite athletes with the top 3 performers from the national championships. The performance data for 15 elite male and 10 elite female kayakers were collected over 2 y. This group was reduced to 9 men and 8 women in the 3rd and final year. There were direct and significant correlations between strength scores and performance times across the 3 y. Bench-press 1RM increased by 34.8% for men and 42.3% for women. Over the 3 seasons, mean 1000-m time decreased by approximately 4.8%, 500-m times decreased by 7.3% (women), and 200-m times decreased by 9.1%. The women's 500-m changed from 11.9% difference from medalists to within 1.1% during the 3 y. During the 3 y of this study a change in 1-repetitionmaximum (1RM) bench press of 13% for men and 6.5% in women coincided with a change in performance times of 1%. For 1RM pull-up a change of 10% in men and 2.3% in women coincided with a change in performance times of 1%.
KEYWORDS: 1RM, bench press; pull-up; strength ratio.

Sheykhlouvand M.[1], Gharaat M.[2], Bishop P.[3], Khalili E.[4], Karami E.[4], Fereshtian S.[5] (2015)

Anthropometric, Physiological, and Performance Characteristics of Elite Canoe Polo Players,

Psychology & Neuroscience © 2015 American Psychological Association, Vol. 8, N. 2: 257–266.

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[5] Islamic Azad University, Central Tehran Branch

The purpose of this study was to determine the physiological, anthropometric, and performance characteristics of elite canoe polo players. Fifteen elite male canoe polo players (age: 24.8 $\pm$ 2.1 years, height: 178.5 $\pm$4.4 cm, body mass: 83.9 $\pm$ 5.2 kg) underwent body composition assessment by bioelectrical impedance analysis. They were also evaluated on upper-body anaerobic power (Wingate 30-sec), aerobic power, flexibility, muscular strength, muscular endurance, and maximum speed. Body fat was 13.2 $\pm$ 3%, basal metabolic rate was 1,905.3 $\pm$ 100 $kcal \cdot day^{-1}$, and body mass index was 26.2 $\pm$ 1.8 $kg \cdot m^{-2}$. Peak oxygen uptake (VO2peak) was 41.8 $\pm$ 4.2 $ml \cdot kg^{-1} \cdot min^{-1}$, peak oxygen pulse was 19.7 $\pm$2.4 $ml \cdot b \cdot m^{-1}$, %VO2peak at lactate threshold was 80.2 $\pm$ 2.4, VO2 at lactate threshold was 2.7 $\pm$ 0.4 $L \cdot min^{-1}$, and heart rate at lactate threshold was 155.8 $\pm$ 10.3 $b \cdot min^{-1}$. Upper-body minimum and peak power were 1.76 $\pm$0.52 and 5.32 $\pm$0.36 $W \cdot kg^{-1}$, respectively, and the 1-repetition maximum of bench press was 107.8 $\pm$ 16.2 kg. Ball-throwing velocity was 22.1 $\pm$ 0.45 $m \cdot sec^{-1}$. The results of this study suggest that success in the high level of canoe polo matches in male canoe polo players appears to require a high explosive power, throwing velocity, speed, and muscular strength. KEYWORDS: body composition, aerobic power, anaerobic power, canoe polo, anaerobic.

Sheykhlouvand M[1], Khalili E, Agha-Alinejad H, Gharaat M. (2016)

Hormonal and Physiological Adaptations to High-Intensity Interval Training in Professional Male CanoePolo Athletes.

J Strength Cond Res. 2016 Mar;30(3): 859-66.

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[4] Department of Exercise Physiology, Faculty of Physical Education and Sport Sciences, Shahid Rajaee Teacher Training University, Tehran, Iran.

This study compared the effects of 2 different high-intensity interval training (HIIT) programs in professional male canoe polo athletes. Responses of peak oxygen uptake (VO2peak), ventilatory threshold (VT), peak and mean anaerobic power output (PPO and MPO), blood volume, and hormonal adaptations to HIIT were examined. Male athletes (n = 21, age: 24 ± 3 years; height: 181 ± 4 cm; mass: 85 ± 6 kg; and body fat:

12.9 ± 2.7%) were randomly assigned to one of 3 groups (N = 7): (a) (G1) interval paddling with variable volume (6, 7, 8, 9, 9, 9, 8, 7, 6 repetitions per session from first to ninth session, respectively) × 60 second at lowest velocity that elicited VO2peak (vVO2peak), 1:3 work to recovery ratio; (b) (G2) interval paddling with variable intensity (6 × 60 second at 100, 110, 120, 130, 130, 130, 120, 110, 100% vVO2peak from first to ninth session, respectively, 1:3 work to recovery); and (c) (GCON) the control group performed three 60 minutes paddling sessions (75% vVO2peak) per week for 3 weeks. High-intensity interval training resulted in significant (except as shown) increases compared with pretest, in VO2peak (G1 = +8.8% and G2 = +8.5%), heart rate at VT (b·min) (G1 = +9.7% and G2 = +5.9%) and (%maximum) (G1 = +6.9%; p = 0.29 and G2 = +6.5%), PPO (G1 = +9.7% and G2 = +12.2%), MPO (G1 = +11.1%; p = 0.29 and G2 = +16.2%), total testosterone (G1 = +29.4% and G2 = +16.7%), total testosterone/cortisol ratio (G1 = +40.9% and G2 = +28.1%), and mean corpuscular hemoglobin (G1 = +1.7% and G2 = +1.3%). No significant changes were found in GCON. High-intensity interval paddling may improve both aerobic and anaerobic performances in professional male canoe polo athletes under the conditions of this study.

Sheykhlouvand M.[1], Gharaat M.[2], Khalili E.[3], Agha-Alinejad H.[4] (2016)

The effect of high-intensity interval training on ventilatory threshold and aerobic power in well-trained canoe polo athletes. (Effets d'un interval training à haute intensité sur le seuil ventilatoire et la capacité aérobie de canoéistes de kayak polo bien entraînés).

Science & Sports (2016) 31: 283-289.

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[4] Department of physical education and sports sciences, faculty of humanities, Tarbiat Modares university, Tehran, Iran.

Objective: The aim of this study was to evaluate and compare the effects of two different high-intensity interval training (HIIT) protocols on peak oxygen uptake (˙VO-2peak) and ventilatory threshold (VT) in male well-trained canoe polo athletes. Methods: Several aspects of ˙VO2peak and VT were measured after two different training programs performed for 3 weeks. Following the pre-test, 21 well-trained male canoe polo athletes (˙VO2peak for arms = 38.1 ± 4.7 mL/kg/min) were randomly divided into two training groups (group 1 [G1], n = 7; 6,7,8,9,9,9,8,7,6 (repetitions/session from 1st to 9th session respec-tively) × 60 seconds (s) at the paddling speed associated with ˙VO2peak (v ˙VO2peak), 1:3 work to recovery ratio; group 2 (G2), n = 7; 6 × 60 s at (100,110,120,130,130, 130,120,110,100)% v ˙VO2peak from 1st to 9th session respectively, 1:3 work to recovery; group 3 (GCON), n = 7, the control group performed three sessions 60 minutes (min) paddling (75% v ˙VO2peak) per week. KEYWORDS: ˙VO2peak; Paddling; Conditioning; Interval training; Training technique.

Alessandro Barzon

PUBBLICO E ORGANIZZAZIONE DEI GRANDI EVENTI SPORTIVI

Analisi sociologica della Maratona Internazionale di Canoa "Terra dei Forti"

Il presente articolo è la sintesi della Tesi di Laurea Specialistica in Scienze delle Attività Motorie Preventive ed Adattate, Università degli Studi di Verona, sostenuta dall'autore il 15 Marzo 2010 (relatore prof. Bruno Sanguanini).

ABSTRACT

L'obiettivo di questo lavoro è l'analisi sociologica della competizione sportiva denominata "Maratona Internazionale Terra dei Forti di Canoa Kayak" che ha visto la sua prima edizione il 24 ottobre 2004. Nell'edizione 2008 è stata esaminata l'intera storia sociale e l'organizzazione della manifestazione.
Lo studio sociologico è stato centrato sia sull'analisi dell'apparato organizzativo e gestionale, con una serie di interviste a dirigenti, tecnici e volontari, che del pubblico sul campo di gara, con una ricerca empirica sugli spettatori durante la giornata di gara e l'utilizzo di un questionario di tipo quantitativo e qualitativo.

The goal of this work is the sociological analysis of sports competition called "Land of the Strong International Marathon Canoe Kayak" which saw its first edition on October 24, 2004. In the 2008's the whole social history was examined and the organization of the event.
The sociological study was centered on the analysis apparatus both organizational and management, with a series of interviews with executives, technicians and volunteers, and the public on the competition, with an empirical research on the spectators during the race day and the using a quantitative and qualitative questionnaire.

INTRODUZIONE

La "Maratona Internazionale" è una manifestazione sportiva che vede gli atleti navigare sul fiume Adige, nel tratto compreso tra Borghetto di Avio (Trento) e Pescantina (Verona). É un territorio di grande fascino naturale con particolari caratteristiche storiche e artistiche. In occasione della "Maratona" diventa teatro di una vera e propria "festa" dello sport della canoa. La gara coinvolge un elevato numero di partecipanti e spettatori, desiderosi di vivere oltre a un bel momento agonistico, un'esperienza ricca dal punto di vista ambientale, turistico e ricreativo.

Il tratto di fiume Adige che va dal Basso Trentino all'Alto Veronese è l'area denominata "Terra dei forti". Si tratta di un territorio pedemontano con particolari cime dei monti, dove sono presenti 8 forti militari risalenti a fine Ottocento nella zona a sud e il Castello di Avio nella zona nord. Quindi la zona risente sia della tradizione austriaca che di quella italiana.
La prima parte presenta l'analisi sociologica del contenuto delle interviste da me effettuate ai "decisori" della manifestazione. Con il termine "decisori" intendo tutti coloro che rappresentano gli organismi decisionali e gli apparati organizzativi. L'analisi consiste in una spiegazione comparativa del contenuto delle risposte. Dai risultati emerge quali sono i trend di gestione ed organizzazione.
La seconda parte riguarda la comunicazione della "Maratona". Per prima cosa considero la realtà sociale del volontariato, risorsa indispensabile sia dall'organizzazione sia dalla popolazione locale. Dalle interviste effettuate a un campione di volontari risulta, per esempio, quali sono i significati socio-sportivo e socio-turistico che la conoscenza ordinaria attribuisce all'Evento. Poi evidenzio quali sono i canali mediatici con i quali i "decisori" pubblicizzano l'Evento.
La terza parte riguarda la spiegazione sociologica della ricerca effettuata tramite il questionario che, sul campo di gara, ho somministrato al pubblico. Tale questionario, già testato dal relatore di tesi, con cui condivido l'utilizzo libero dei dati, si avvale di n. 50 e più variabili. I questionari sono prodotti grazie al supporto di alcuni collaboratori volontari. I validi sono 257, un numero adeguato per costituire un campione rappresentativo del pubblico. I questionari presentano i dati sia demografici che i "valori" circa gli atteggiamenti, il comportamento, la cultura sportiva.
In definitiva, per questo lavoro ho predisposto quattro ipotesi. L'ipotesi di base (**ipotesi 1**) è verificare la *dimensione internazionale* della manifestazione veneto-trentina. L'ipotesi elementare (**ipotesi 2)** comporta l'accertamento delle *qualità gestionali-organizzative* dell'apparato decisionale locale. L'ipotesi avanzata (**ipotesi 3**) consiste nel comprendere qual è il *punto di vista del pubblico* circa i caratteri di "Evento" e la "Valorizzatore del territorio" della Manifestazione. L'ipotesi ultima (**ipotesi 4)** è comprendere quali sono le *qualità del marchio TerradeiForti"* che, secondo i decisori e il pubblico, risultano dalla continuità e dall'innovazione che accompagnano la Competizione sportiva.
Per il lavoro di ricerca sulla "Maratona di canoa Terra dei forti" ho utilizzato il questionario già predisposto e testato dal prof. Sanguanini, che, peraltro, ha inviato sul campo alcuni studenti di un suo corso didattico. Il dott. Marco Corradore, assegnista di ricerca presso il Dipartimento di Scienze dell'Educazione dell'Ateneo, ha effettuato l'elaborazione tecnica dei questionari con la tecnica SPSS. I costi di elaborazione sono stati coperti dalla ricerca scientifica del Relatore.
Le pagine che seguono sono il frutto della mia "spiegazione" e "interpretazione" dei dati che mi sono stati assegnati dal Relatore. Per tutto questo, ringrazio i docenti che hanno atteso a questo lavoro di tesi.

ANALISI DEGLI ATTEGGIAMENTI DEI DECISORI

Il Comitato organizzatore: l'organigramma

Il comitato organizzatore della *Maratona TerradeiForti* cura ogni aspetto della manifestazione con la massima professionalità e, per soddisfare le esigenze di tutti gli attori coinvolti (partecipanti, spettatori, simpatizzanti, residenti, sponsor, autorità locali), ha deciso di suddividere la struttura organizzativa in varie aree, nominando per ciascuna di esse un responsabile.

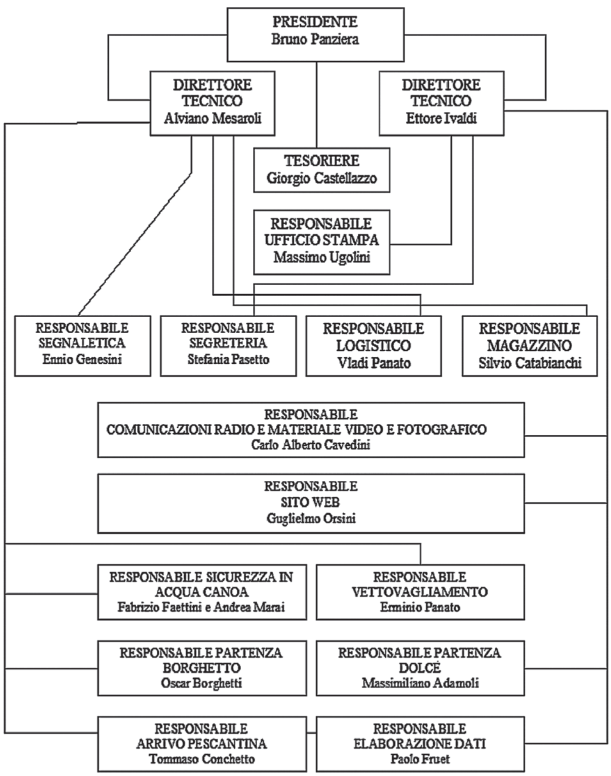

Figura 1 – Organigramma del Comitato Organizzatore.

Il settore dirigenziale e i responsabili di settore agiscono in maniera indipendente e si confrontano periodicamente, relazionando il lavoro svolto.
La Figura 1 descrive schematicamente la composizione dell'organico. Ogni responsabile si avvale di propri collaboratori in modo da formare una squadra base fissa, allargata poi ad altri volontari fino a raggiungere il numero ritenuto sufficiente per quel determinato tipo di servizio, che in più riunioni dibatte i singoli problemi e propone soluzioni che vanno poi concordate con il responsabile di area. In pratica l'organigramma ha una struttura piramidale a base allargata. Ogni volontario ha un responsabile di riferimento che a sua volta fa capo ad un responsabile di area e cosi via fino ad arrivare ai due direttori tecnici che coordinano i vari settori.

Il comitato si occupa della Manifestazione per tutto l'arco dell'anno, intensificando la propria organizzazione nei periodi che precedono gli eventi collaterali, primo in ordine d'importanza, l'evento fieristico internazionale "Vinitaly". Vengono indette tre riunioni per singolo settore precedute da altrettanti incontri da parte del comitato esecutivo, dove oltre i membri del comitato sono molte le persone che partecipano. Le tematiche trattate durante le riunioni vanno dalla sicurezza in acqua alla rassegna stampa, dalla partecipazione degli sponsor ai problemi logistici durante la gara. In tale occasione il presidente del comitato organizzatore ufficializza la data della *Maratona TerradeiForti* e annuncia la partecipazione degli sponsor e dei testimonial.

L’organizzazione secondo i dirigenti: *interviste*

Con questo paragrafo raccolgo i dati oltre che impressioni, idee e aspettative riguardo l’Evento, intervistando i componenti dello staff dirigente. Da tutti è emersa la piena soddisfazione per la riuscita della Manifestazione, per l’incremento di anno in anno del numero dei partecipanti e dell’affluenza del pubblico. È emerso inoltre ottimismo riguardo alle prossime edizioni e a tutti quei progetti collaterali come gemellaggi con altre manifestazioni canoistiche e non. Alcuni dubbi sono emersi riguardo agli aspetti logistici che a detta dello staff possono essere migliorati e potenziati in maniera adeguata ad una Manifestazione sempre più in crescita come numero di partecipanti, eventi collaterali, spettacolarità e visibilità.
La prima questione formulata ci da un’idea su come e grazie a chi sia nato questo Evento che, nell’ambito sportivo, non ha precedenti sul territorio in quanto alla spettacolarità e al numero di partecipanti. La seconda questione fa emergere dalle parole dei dirigenti e tecnici quale è stata l’evoluzione interna all’organizzazione e come la stessa sia stata in grado di utilizzare le risorse del territorio. La terza questione invece va un po’ più in dettaglio nell’organigramma dell’organizzazione cogliendo la quantità di risorse umane che la preparazione dell’Evento richiede come numero di adepti. La quarta domanda è quella che mette più in crisi gli interlocutori di questa intervista. Per quanto l’organizzazione si sia prodigata per la riuscita dell’evento, lo staff ammette che c’è molto da migliorare soprattutto sul piano logistico in quanto a problematiche tipiche di manifestazioni sportive molto numerose: i trasporti, il cronometraggio, i servizi e la fruibilità dell’evento da parte del pubblico, la spettacolarità e la visibilità sul territorio.
Infine con la quinta domanda ho voluto indagare quali fossero le aspettative dello staff riguardo la prossima edizione e quali gli obbiettivi prefissati per l’edizione 2009. E’ emersa l’idea di portare avanti in maniera sinergica obiettivi comuni con altre realtà sportive oltre alla convinzione di poter confermare il numero di partecipanti della scorsa edizione.
Il campione degli intervistati è così composto:

a) *Presidente*: Bruno Panziera, 58 anni, residente a Pescantina, laureato in giurisprudenza, attualmente giornalista, capo redattore del quotidiano L’Arena.
b) *Dir. Tecnico*: Ettore Ivaldi, 46 anni, residente a Verona, ex atleta nazionale di canoa slalom del Corpo Forestale dello Stato, attualmente allenatore federale della Squadra Nazionale Spagnola di canoa e presidente del canoa club Verona.
c) *Dir. Tecnico*: Mesaroli Alviano, residente a Pescantina, 54 anni, diplomato ISEF, ex docente all’Istituto Superiore di educazione fisica, attualmente insegnante di scienze motorie all’istituto comprensivo di Pescantina, presidente del Canoa Club Pescantina.

1) Com'è nata l'idea di creare una maratona di livello internazionale sull'Adige?

a) L'idea di creare una maratona sul fiume Adige è nata in un giorno di luglio del 2004. Io e mio figlio Luca eravamo affacciati sul muraglione che Protegge l'Adige in piazza a Pescantina e guardavamo l'acqua scorrere veloce a valle pensando alle tante opportunità che poteva offrire il fiume.
Tra queste una gara che avrebbe potuto coinvolgere decine di persone per rendere onore alla bellezza del territorio e all'importanza dell'Adige lungo tanti secoli di storia. Così, con presunzione, abbiamo pensato a una gara che non avrebbe dovuto avere rivali in Italia e ci siamo proposti di imitare quello che la Francia, grande nazione canoistica, faceva con la Maratona internazionale dell'Ardèche che ha oltre vent'anni e raduna quasi duemila pagaiatori sulle acqua dell'omonimo fiume. Ovviamente l'idea, prima di realizzarla, doveva avere il supporto tecnico di persone qualificate e ci siamo rivolti a Ettore Ivaldi ed Alviano Mesaroli, allora allenatori della squadra nazionale italiana di discesa. Entrambi hanno espresso il loro parere altamente positivo e così è stata perfezionata un'alleanza per organizzare la manifestazione con l'apporto dei Canoa club di Verona e di Pescantina che, attraverso i loro presidenti, hanno accolto con entusiasmo l'iniziativa e messo a disposizione le loro competenze. Inoltre la maratona, all'insegna dello slogan "non solo canoa" offre varie iniziative collaterali che negli anni si sono tradotte in concerti di musica classica e jazz, proiezioni di filmati e dvd di canoa nelle varie specialità, mostra di speleologia, mostra di geologia sulla zona interessata alla maratona, incontri e dibattiti su scuola, sport e turismo all'aria aperta, mostra filatelica, iniziative promozionali collegate ad altre manifestazioni quali Festival del Garda, Baldofestival, Montefortiana e Lake Garda Marathon di podismo, riunioni sulla protezione civile e altro. Ogni maratona ha come madrina una medaglia d'oro olimpica, tra cui Sara Simeoni, Livio Berruti, Klaus Dibiasi.

b) L'idea iniziale e' stata quella di riprendere una manifestazione che il canoa club Verona in collaborazione con il Touring Club d'Italia organizzava fino al 1980. Noi dell'organizzazione sentivamo la necessità di offrire alla canoa un'opportunità che raggruppasse, magari proprio a fine stagione, tutte le varie realtà che operano sul fiume: canoa discesa, canoa da velocità, rafting, dragon boat, e canoe polinesiane. L'intento è stato quello di far capire che si possono organizzare grandi manifestazioni anche in questo settore.

c) Il tutto è nato dall'idea di poche persone di sfruttare le caratteristiche del fiume Adige per una manifestazione internazionale che avesse una grande risonanza nel territorio bagnato dalle sue acque. Il "nostro" fiume ha le caratteristiche ideali per una maratona di canoa: più di 35 chilometri di navigazione su acque di difficoltà non superiori al secondo grado e senza sbarramenti di alcun tipo. Sono state organizzate in passato molte manifestazioni di canoa agonistiche e amatoriali dal canoa club Verona e dal canoa club Pescantina sia a livello regionale che nazionale ma mai a livello internazionale. Era arrivato il momento di concretizzare un'idea che ben si adattava alle caratteristiche del nostro fiume e dei comuni che esso attraversa.

2) Nelle varie edizioni cos'è cambiato all'interno dell'organizzazione?

a) Già il primo anno abbiamo pensato di dare un'impronta il più professionale possibile all'organizzazione suddividendola in vari settori affidati ciascuno a singoli referenti: dalla logistica all'ospitalità, dal servizio di sicurezza in acqua al cronometraggio, dall'organizzazione di eventi collaterali alla maratona ai servizi di trasporto. L'organizzazione si è affinata negli anni al punto che oggi possiamo contare su un gruppo ben affiatato di persone che conoscono esattamente i loro compiti da effettuare prima, durante e dopo la manifestazione. Non solo sono stati resi omogenei i campi di intervento ma è stato anche deciso di riunire i referenti una volta al mese per perfezionare gli interventi.
b) Più che veri e propri cambiamenti la manifestazione, prendendo sempre più piede, ha dovuto adeguarsi alle sempre più crescenti necessità. Quindi la struttura organizzativa ha definito chiaramente i vari ruoli evitando così sovrapposizioni nell'ottica di ottimizzare il tempo e le risorse.
c) Molte cose. Si è partiti con un piccolo gruppo che credeva profondamente in questo progetto fino ad arrivare ad un vero comitato organizzatore formato da professionisti provenienti da vari settori diversi in grado ognuno di dare un specifico contributo per la riuscita di questa manifestazione.

3) Quanta gente lavora a tempo pieno per questo evento?

a) Nessuno lavora a tempo pieno per la Maratona. L'organizzazione è fondata esclusivamente sulla partecipazione volontaria e le persone coinvolte sono ormai quasi quattrocento suddivise in varie associazioni: canoa club, protezione civile, gruppi locali, subacquei e altro. Tutte queste persone hanno un loro compito ben definito da svolgere durante la Manifestazione.
b) Per il momento non possiamo parlare di personale a tempo pieno, possiamo parlare di un gruppo di tre persone che periodicamente (settimanalmente) si confrontano. Inoltre c'è una sorte di burocrazia di ordinaria amministrazione che viene portata avanti costantemente durante l'anno: domande per contributi, bilanci, pagamenti, organizzazione di eventi collaterali, preparazione gadget, manifesti, conferenze stampa.
c) Si va da sei sette persone che lavorano tutto l'anno per l'evento anche se non si può parlare di persone a tempo pieno fino a circa trecento nella settimana che anticipa l'Evento.

4) In che cosa potrebbe essere migliorata?

a) I margini di miglioramento sono notevoli e ogni anno la Maratona cerca non solo di dare risposta a possibili problemi che si sono evidenziati nell'edizione precedente, ma anche di dare nuove opportunità agli sportivi che vi partecipano. La Manifestazione, ad esempio, può essere migliorata nella logistica, nel servizio di trasporto, nel servizio cronometraggio, nella predisposizione di fotografie personalizzate da consegnare agli interessati subito dopo l'arrivo e nel servizio internet.

b) Possiamo ulteriormente aumentare i servizi ai partecipanti e allargare la partecipazione a tutte le persone che praticamente non conoscono il mondo della canoa e del rafting, cosa comunque che già stiamo facendo ma che verrà sempre più potenziata. Inoltre stiamo studiando pacchetti turistici da offrire direttamente alle agenzie di viaggio in collaborazione con le realtà locali.
c) In quest'ultima edizione tutto è andato secondo il previsto anche se possiamo migliorare alcuni servizi soprattutto quelli relativi ai competitori che alla fine sono i principali attori di questo Evento.

5) Qual è l'obbiettivo della prossima edizione?

a) Gli obiettivi dell'edizione 2009 sono la conferma del numero di 1400 pagaiatori in fiume, l'incremento del numero dei gommoni turistici che partecipano alla maratona, il gemellaggio con le più piccole maratone dei fiumi Nera, Ticino e Mincio, il consolidamento dei rapporti con le maratone di Cesky Krumlov in Repubblica Ceca e dell'Ardèche in Francia.
b) Il nostro obiettivo è creare una sorta di "consorzio delle manifestazioni sportive" che raggruppi varie realtà organizzative comprese nel bacino: lago di Garda - fiume Adige. Ovvero riunire vari comitati organizzatori per rafforzare rapporti con sponsor e offrire agli stessi più opportunità.
c) Sicuramente ripetere i numeri di partecipanti e incrementare il pubblico. Più di 1400 pagaiatori in partenza sono un'emozione fortissima ma anche un elevato numero di persone da gestire per questo non aspiro a incrementarlo. Il pubblico "esterno" ha meno esigenze dei competitori, sicuramente lavoreremo per una maggiore visibilità.

Relativamente alla prima domanda sia il presidente sia il secondo tecnico intervistato dichiarano che l'idea di creare un evento di canoa a livello internazionale è nato dalla consapevolezza delle potenzialità del fiume e dalla passione dimostrata dagli appartenenti ai canoa club promotori. Solo il primo tecnico intervistato ammette che l'idea è stata quella di riprendere un meeting, di qualche decennio fa, patrocinato dal Touring Club Italiano che si svolgeva sulle stesse acque.
Tutti e tre i dirigenti si sono dimostrati coerenti nel rispondere alla seconda domanda affermando che il comitato organizzatore ha lavorato con professionalità fin dalla prima edizione ma nel tempo ha dovuto adattare alle crescenti esigenze della Manifestazione. Alla terza domanda gli interlocutori rispondono in maniera differente interpretando personalmente il termine "a tempo pieno". Il presidente sostiene che nessuno lavora a tempo pieno per questo Evento ma centinaia di volontari appartenenti a diverse associazioni danno il loro contributo svolgendo un compito specifico. Anche per il primo tecnico intervistato nessuno è assunto dal comitato per lavorare tutto l'anno a tempo pieno, ma un ristretto gruppo di persone periodicamente si incontra per affrontare le problematiche attinenti alla manifestazione. Il secondo tecnico afferma invece che sono sei o sette la persone che lavorano a tempo pieno per la "Maratona" in quanto, nonostante l'organizzare l'evento non sia la loro occupazione principale, esse devono

continuamente occuparsi anche agli aspetti collaterali.
Il presidente e il secondo tecnico intervistato nel rispondere al terzo quesito sono d’accordo nel sostenere che vanno migliorati alcuni servizi logistici per gli atleti mentre il primo tecnico sposta l’attenzione più sulla partecipazione del pubblico.
I tre interlocutori attraverso l’ultimo quesito fanno emergere diversi obbiettivi: il presidente aspira ad una crescita della Manifestazione sul profilo internazionale, un tecnico si concentra sulle opportunità di ingaggiare nuovi sponsor, l’altro invece su una maggior visibilità e un incremento del pubblico.
Dall’analisi sintetica sugli atteggiamenti dei decisori possiamo affermare che i dirigenti hanno realizzato e consolidato, nel susseguirsi delle varie edizioni, un evento sportivo di alto livello, seppur legato ad un sport di “nicchia” come quello della canoa. Dai decisori emergono alcuni elementi-chiave che rendono la Competizione unica nel suo genere. Primo tra tutti, il territorio di grande fascino naturale dalle particolari caratteristiche storiche e artistiche che, in occasione della “Maratona”, diventa teatro di una vera e propria festa dello sport della canoa, capace di ospitare un elevato numero di partecipanti e spettatori, desiderosi di vivere oltre a un bel momento agonistico, un’esperienza ricca dal punto di vista ambientale, turistico e ricreativo.
Il secondo elemento chiave è il perfezionarsi negli anni del lavoro svolto dal del comitato organizzatore, suddiviso, secondo un organigramma ben preciso, in aree gestite dai vari responsabili, che coordinano le attività dei propri collaboratori.
Il terzo elemento evidenziato è la sinergia creatasi negli anni tra il comitato organizzatore e gli enti locali come Comuni e associazioni appartenenti al territorio “Terra dei Forti”. Queste collaborazioni, indispensabili per la riuscita della Manifestazione, ha dato un impronta sempre più professionale all’organizzazione.
Il quarto elemento significativo è la forte e massiccia presenza di volontari, che si adoperano costantemente durante la Competizione, per garantire i servizi per atleti e pubblico.
Il quinto e ultimo elemento emerso dalle interviste ai decisori è tutto ciò che riguarda la sicurezza in acqua durante la gara: la presenza di professionisti subacquei specializzati in soccorso fluviale e di molti canoisti di supporto, sono fondamentali nel salvataggio di atleti in difficoltà e nel recupero delle loro attrezzature.

LA MARATONA NELLA COMUNICAZIONE

L’organizzazione secondo i volontari: interviste

Questa seconda serie di interviste riguarda gli addetti ai lavori nel settore amministrativo e logistico, persone con un ruolo operativo importante, a stretto contatto con decine di volontari. Essi si adoperano sul campo prima durante e dopo la gara perché tutto funzioni alla perfezione.
Ho effettuato due questioni per individuare il ruolo dell’interlocutore nell’organigramma e le eventuali esperienza nelle varie edizioni passate. Con la terza domanda ho indagato sulla motivazione che li ha spinti a prendere parte ad un gruppo lavorando insieme

per un unico obbiettivo: il successo della *Maratona TerradeiForti*. Dalle risposte si evince che la passione per lo sport e in particolare la canoa fluviale cosi indissolubilmente legata al territorio, sia il comune denominatore degli interlocutori.

a. *Intervista al responsabile ufficio stampa*: Massimo Ugolini, 39 anni, residente a Pescantina, diplomato, ragioniere al comune di Dolcè, appassionato del settore informatico.
b. *Segretaria del consorzio Terra dei Forti*: Natascia Piccoli, 29 anni, residente a Verona, laureata in lingue straniere, segretaria.
c. *Atleta del Canoa Club Pescantina:* Luca Panziera, residente a Pescantina, 28 anni, laureato in scienze naturali, atleta d'interesse nazionale.
d. *Standista:* Leonardo Dal Maso, 37 anni residente a Quinto di Treviso, diplomato, dipendente della ditta Ozone, canoista per passione.
e. *Volontario*: Fabrizio Sterzi, 56 anni, residente a Pescantina, diplomato, libero professionista.
f. *Tesoriere*: Giorgio Castellazzo, 60 anni, residente a Verona, laureato in lettere antiche, attualmente in pensione.
g. *Responsabile comunicazioni radio e materiale video e fotografico:* Carlo Alberto Cavedini, 48 anni, residente a Negrar, diplomato, bancario.

1) A quante edizioni della *Maratona TerradeiForti* hai partecipato?

a. Tutte e cinque
b. Questa è la seconda edizione a cui partecipo.
c. A tutte.
d. A quattro edizioni nelle quali ho preso parte alla gara oltre ad aver allestito lo stand in zona arrivo
e. Alla prima ho partecipato come atleta, tutte le altre invece ho lavorato.
f. A tutte tranne la prima.
g. A tutte le edizioni sempre nello stesso ruolo.

2) Che cosa ti ha impressionato di più dell'organizzazione?

a. Originariamente seguivo più fasi, oggi prevalentemente l'ufficio stampa. Proprio perchè, di anno in anno, la Manifestazione ha subito mutamenti positivi che hanno implicato necessariamente una specializzazione delle funzioni in settori predefiniti. Pensavo a questo mentre organizzavamo l'edizione 2008: una macchina organizzata in cui ognuno ha un proprio compito che svolge come meglio può: questo è forse il segreto della *Maratona TerradeiForti*
b. Efficienza e la capacità di dividerci in gruppi per portare avanti diversi compiti per uno stesso obiettivo.
c. Tutti i servizi per gli atleti: in modo particolare all'arrivo dove trovi una piatto caldo, le docce, recupero bagagli etc.

d. L’entusiasmo che hanno i volontari e gli organizzatori, sembra che non facciano fatica a lavorare perché lavorano sempre con il sorriso sulla bocca.
e. La capillarità dei soccorsi, la disposizione di tutti i volontari sul percorso, la soddisfazione degli atleti all’arrivo.
f. Il lato tecnico e il lato partecipativo. Mi spiego meglio: il lato tecnico grazie a due signori tecnici che non lasciano nulla al caso. Il lato partecipativo grazie a tutta l’organizzazione che ha saputo coinvolgere i maggiori club italiani ed europei.
g. La spettacolarità soprattutto con una partenza della gara agonistica molto coreografica oltre che un’organizzazione ottima.

3) Cos’è che ti ha motivato a lavorare e/o partecipare?

a. Lavoro da dieci anni in Comune di Dolcè. Cinque anni or sono, a seguito di un accordo tra il comitato organizzatore nella persona del Bruno Panziera ed il Comune di Dolcè nella persona dell’allora sindaco Filiberto Semenzin, ho partecipato in primis perchè hanno istituito la segreteria organizzativa della maratona presso il Comune di Dolcè, uno dei maggiori sponsor della Manifestazione. Mi chiesero se me ne volessi occupare, ho accettato e da allora seguo direttamente alcune fasi della “Maratona”. Per i primi due anni ufficio stampa, segreteria organizzativa, iscrizioni, ospitalità, coordinamento associazioni in collaborazione con Sindaco Dolcè, Filiberto Semenzin per i primi mesi, Luca Manzelli dal gugno 2004. Da un paio di edizioni ufficio stampa, segreteria organizzativa mentre per le iscrizioni se ne occupa Stefania Pasetto, moglie di Alviano.
b. Dovere e piacere. Dovere perché lavoro per lo sponsor principale dell’evento e quindi seguo alcune pratiche che sono parte del mio lavoro e piacere perché sono ho incontrato e conosciuto alcuni personaggi noti del mondo sportivo.

L’ambizione al podio e il fatto di gareggiare in casa, perché è il fiume in cui mi alleno abitualmente e sento di avere delle chances in più rispetto agli altri, non ultimo il fatto di poter pagaiare insieme a migliaia di canoisti.

c. Oltre al motivo economico, l’occasione di incontrare un elevatissimo numero di canoisti amici che normalmente non riesco ad incontrare
d. Cercare i miei limiti in quanto atleta ed appartenere ad un gruppo che opera per una riuscita ottimale della Manifestazione e vedere la soddisfazione degli atleti partecipanti.
e. La motivazione è molto semplice: un giorno un caro amico mi incontrò per strada e mi disse che aveva bisogno di me per un progetto ambizioso coinvolgendomi nell’amministrazione di questo Evento. Accettai in quanto questo amico, nonché il presidente della Manifestazione, mi appassionò a tal punto da non poter dire di no. In realtà non ho mai avuto passione per lo sport della canoa ma mi sento molto preso dal lato organizzativo.
f. Principalmente la passione per questo sport e per l’ambiente del mondo della canoa.

4) Pensi di lavorare e/o partecipare alla prossima edizione?

a. Ci stiamo già lavorando. Prime tappe: serata di Avio dello scorso febbraio, presentazione Manifestazione al Vinitaly 2009.
b. Si, dando la mia disponibilità non solo all'evento della maratona ma anche agli altri eventi che fanno da corollario a questa Manifestazione.
c. Certamente sì.
d. Si, in tutte e due le vesti.
e. Si, ma nell'ambito organizzativo.
f. Si, credo proprio di si visto che da tempo abbiamo iniziato ad organizzare l'edizione 2009.
g. Me lo auguro, probabilmente dovrò prendere ferie dal mio lavoro ma non posso rinunciare a questo evento. Io assieme agli altri dell'organizzazione contribuiamo con tutta la nostra esperienza alla buona riuscita della Manifestazione. Se si vuole mantenere il successo ottenuto nelle scorse edizione ritengo che tutti noi siamo indispensabili e difficilmente sostituibili.

5) In che cosa l'organizzazione può essere ancora migliorata?

a. In tantissime cose com'è ovvio che sia perché se pensassimo di avere conseguito la perfezione, probabilmente dovremmo impiegare il nostro tempo in altre cose. Non c'è nulla di meglio, nelle riunioni post "Maratona", che evidenziare le lacune per migliorare l'anno successivo. Miglioramenti sono necessari a livello di comunicazione per cercare di diffondere la manifestazione in più direzioni possibili: tv, radio, internet, carta stampata. Nei rapporti tra le associazioni laddove si affronta il tema della sicurezza in acqua, base imprescindibile su cui appoggia la maratona. Se succede qualcosa in acqua, te lo ritrovi ad aprendo i telegiornali della sera ed il giorno dopo sui titoli dei giornali senza la necessità di avere chiamato i giornalisti. E questo significherebbe vanificare un anno di lavoro e dedizione.
b. La base c'è ma potrebbe essere migliorata la spettacolarità e la visibilità dell'evento nel territorio.
c. Più di così, non mi viene in mente niente. L'Evento è organizzato alla perfezione.
d. Per prima cosa organizzare meglio i recuperi dei propri mezzi di trasporto lasciati alla partenza, in quanto i tempi di attesa delle navette è abbastanza lungo, e poi farei una premiazione un po' meno caotica e dove gli atleti hanno più tempo per rilassarsi e godere di questo momento.
e. Non saprei dire, perché la manifestazione è riuscita bene, si potrebbe potenziare a livello numerico gli operatori che lavorano in tutti i settori, specialmente per quanto riguarda la sicurezza in acqua per coprire tutto il percorso.
f. Come evento sportivo io credo che abbiamo toccato l'apice. I partecipanti saranno sempre di più per la risonanza che questa Manifestazione sta avendo a livello europeo. In quest'ultima edizione c'è stata molta meno confusione rispetto alle altre. Questo aspetto è da un lato positivo perché è il risultato di un organizzazione

perfetta nei servizi e nei tempi, dall'altra ha tolto un po' di colore e spontaneità all'Evento. Negli anni tutto è diventato più razionale, dalla partenza all'arrivo, dalle premiazioni alla ristorazione, nulla è più lasciato al caso. Se c'è una cosa che vorrei migliorasse nella prossima edizione è valorizzare le categorie femminili che per il numero esiguo non hanno per regolamento potuto fruire dei premi in palio. Vorrei invece sottolineare il gran lavoro fatto dai cronometristi in quanto nonostante le difficoltà hanno dimostrato grande professionalità.

g. Per quanto la "Maratona" sia migliorata negli anni, c'è sempre qualche cosa da sistemare o modificare. Per esempio in alcune edizioni il livello del fiume Adige era cosi basso che in alcuni punti le imbarcazioni subivano danni al timone di poppa compromettendo il risultato finale degli atleti. Dalle ultime riunioni fatte abbiamo pensato di segnalare con delle boe lungo tutto il percorso i punti di scarsa profondità garantendo ai partecipanti una navigazione sicura anche da questo punto di vista.

Sulla base delle risposte emerge che tutti gli interlocutori hanno già partecipato ad almeno una delle cinque edizioni della "Maratona", ma ognuno di loro ha un'opinione diversa riguardo a ciò che rende la "macchina" organizzativa così efficiente: due sostengono che il segreto di questo successo risiede nella capacità dei collaboratori di suddividersi i compiti lavorando per uno stesso obiettivo. Altri due dicono che è la disponibilità dei moltissimi volontari ha rendere l'evento speciale. Un altro dichiara che la spettacolarità, grazie ad un progetto coreografico studiato nei particolari, rende la Competizione un evento di successo.
Riguardo la motivazione che li ha spinti a prender parte a più di una edizione, due di loro dicono di esser spinti da motivo economico mentre per gli altri dalla passione per questo sport e dal senso di appartenenza ad un gruppo. Spinti dalle stesse motivazioni tutti e cinque pensano di partecipare alla prossima edizione.

La Comunicazione nei media

La comunicazione ha un ruolo strategico per la promozione e la diffusione di questo Evento. Ogni edizione ha trovato spazio su alcune testate giornalistiche nazionali e locali. In particolare l'edizione 2008 ha goduto di una notevole risonanza grazie agli articoli dedicati all'evento *Maratona "TerradiForti"*. Alcuni di questi con inserti pre-gara hanno svolto una funzione pubblicistica sia della manifestazione sia degli sponsor in essa coinvolti. Cinque di queste testate giornalistiche sono dei quotidiani locali, tra questi *L'Arena* è il giornale più venduto nella provincia di Verona. Due sono testate giornalistiche nazionali tra cui uno, *La gazzetta dello Sport,* è il primo quotidiano sportivo nazionale. Due invece sono riviste specializzate, una nel settore della canoa amatoriale e l'altro nel settore enogastronomico.
Tre delle cinque reti, *Telearena*, *Telenuovo* e *Rai regionale* sono di appannaggio locale, mentre le altre due, *Rai due* e *La Sette* sono diffuse sul territorio nazionale.

Molti sono i siti internet che hanno dedicato largo spazio all'evento sia tra quelli più specialistici, che tra quelli che parlano di sport in generale. I siti legati alla Manifestazione con il maggior numero di visualizzazioni sono stati *www.terradeiforti.it* seguito dal sito ufficiale della federazione *www.federcanoa.it*.

Bilancio e criticità

Dopo la prima edizione, gli organizzatori hanno pensato di organizzare una seconda edizione e nel 2005 si sono rispettate le aspettative, con un incremento di partecipanti pari al 60% il secondo anno e del 70% per la terza edizione.
L'organizzazione si avvale di oltre cento volontari non solo dei canoa club coinvolti ma anche numerosi gruppi appartenenti alla protezione civile, impegnati soprattutto nella sicurezza in acqua e fuori e nella vigilanza.
I "numeri" della "Maratona" sono in costante crescita: quasi 400 partecipanti il primo anno, 719 iscritti il secondo, oltre mille persone in acqua nel 2006, milletrecento nel 2007 fino a superare i milleseicento nel 2008. Sono due i fattori di criticità che si avvertono maggiormente nell'organizzazione di questo Evento: uno di carattere economico, il reperimento dei fondi, e l'altro di ordine naturale, ossia avere un livello d'acqua sufficiente per poter pagaiare con qualsiasi imbarcazione nei 35 chilometri di gara. Per quanto riguarda il primo aspetto, il costo dell'organizzazione della prima edizione è stato di 64.900 euro, una somma ripartita tra:

- sponsor per il 70%;
- enti pubblici per il 15%;
- tassa di partecipazione 15%.

Per gli sponsor a sua volta è stato coperto per il 35% dallo sponsor di riferimento, il Consorzio Tutela Vini TerradeiForti. Nell'ultima edizione il costo della Manifestazione è aumentato del 50% con una ripartizione in percentuale uguale alla prima. Gli Enti locali, oltre a dare il loro patrocinio, hanno, in alcuni casi, anche stanziato delle risorse economiche.
Il secondo problema è una costante per tutte le manifestazioni che si svolgono sull'acqua: si è scelto di gareggiare in ottobre perché con la fine di settembre si esaurisce il prelievo di acqua dall'Adige per l'agricoltura, le condizioni meteorologiche che normalmente caratterizzano questo mese garantiscono il riempimento del bacino idrografico e le possibili piogge innalzano il livello d'acqua del fiume.
Per ridurre al minimo il problema è in atto un accordo con l'Enel che garantisce la modulazione dell'acqua in funzione della portata dell'Adige e ai bisogni della manifestazione.
In maniera sintetica possiamo affermare che le prospettive della Maratona TerradeiForti sono legate non solo al mondo sportivo, ma anche alla valorizzazione e promozione del territorio considerato che il percorso si sviluppa in una zona di particolare interesse ambientale e naturalistico. Il primo obiettivo per l'edizione 2009 è il consolidamento delle mille e oltre presenze e l'incremento del numero dei partecipanti alla

Manifestazione che va interpretato sia come fidelizzazione della "clientela" che come apprezzamento per l'organizzazione e la qualità dei servizi che vengono offerti prima, durante e dopo la "Maratona": più atleti vi partecipano maggiore è l'eco che la Manifestazione può avere e quindi maggiore può essere l'interesse di eventuali sponsor a supportare l'iniziativa.
Inoltre quanto più è elevato l'indice di gradimento, tanto più il "passaparola" contribuisce a reclamizzare la manifestazione nell'ambiente canoistico, che è il vero e unico serbatoio nel quale si può attingere per incrementare la partecipazione a una manifestazione il cui obiettivo è anche quello di rappresentare una grande festa di fine stagione per tanti appassionati che hanno così l'opportunità di vedere da vicino i loro beniamini.
Anche per questo l'organizzazione punta ad avere sempre più campioni in gara che possono essere di stimolo soprattutto per i giovani che già praticano questo sport e per quanti intendono avvicinarsi alla canoa. Una costante crescita, quindi, può portare a una maggiore diffusione della canoa soprattutto tra gli abitanti dei paesi che sono lungo il percorso della manifestazione. A tale proposito in tre anni il Canoa Club Pescantina è passato da 40 a oltre 150 soci grazie al cambiamento della sede, ora situata in una posiziona ideale proprio sulle rive dell'Adige, ma anche alla promozione dovuta alla Maratona di canoa.
Dalle interviste effettuate emerge che da un lato la prospettiva è quella di allargare sempre più la partecipazione alla Manifestazione, dall'altra è naturale che a trarne beneficio sai tutto il territorio interessato dalla Competizione, che ha l'opportunità di farsi conoscere da un pubblico particolarmente attento all'ambiente e al territorio e in grado quindi di apprezzarne le caratteristiche. In quest'ottica gli organizzatori intendono proporre soggiorni di due, tre giorni che non si limiteranno all'allenamento e alla partecipazione alla "Maratona", ma proporranno visite alla città di Verona e del Lago di Garda e di altre zone di particolare interesse. Per il futuro c'è anche l'intenzione, sempre avvalendosi di esperti o proposte già collaudate, di inserire nell'offerta "Maratona" anche visite guidate ad aree dalle particolari caratteristiche (vino, riso, pesche, asparagi) con degustazioni di prodotti tipici.
Un'attenzione particolare infine viene riservata all'incremento delle presenze straniere e per questo l'organizzazione punta su specifiche proposte:

1. gemellaggio con altre realtà fuori dall'Italia per dare vita ad un "Europa Marathon Canoa Kayak Tour"
2. apertura completa a partecipare alla discesa con mezzi messi a disposizione dall'organizzazione e in modo particolare raft (gommoni)
3. pacchetti specifici sport-turismo-natura per mercati quali Germania, Repubblica Ceca e Ungheria – nazioni queste con tradizioni canoistiche e con importanti numeri di praticanti.
4. rendere l'evento valevole come una delle tappe del campionato mondiale di maratona fluviale.

ANALISI QUANTITATIVA DEL PUBBLICO

La ricerca sociologica sul campo 2008

Con questo capitolo presento i risultati della ricerca empirica scaturiti da un attenta analisi del questionario proposto e compilato da atleti, decisori, giornalisti, amministratori e pubblico generico.
I questionari, rigorosamente anonimi, elaborati con la software SPSS, presentano i dati socio-demografici e interessanti valori circa gli atteggiamenti, il comportamento e la cultura sportiva del pubblico. Dei 29 quesiti, 20 sono chiusi a risposta multipla e 9 sono quesiti aperti cosi come 20 sono quesiti riguardanti la Manifestazione e 9 invece relativi ai dati personali.
Analizzando la prima serie di quesiti (Tab. 1-5), ho voluto delineare le caratteristiche del pubblico della ”Maratona”: il sesso, l’età, la provenienza, il titolo di studio. Ne risulta un soggetto omogeneo per quanto riguarda il sesso, giovane, proveniente dalla regione Veneto e una discreta cultura.
Con la seconda serie di quesiti, ho preso in considerazione l’atteggiamento del pubblico: il grado di fidelizzazione all’evento, l’“indice” di gradimento e la fruibilità dei servizi durante la gara. Dai risultati si evince che il pubblico è molto attento al livello di sicurezza durante la Competizione, ma anche alla valorizzazione del territorio e alla socializzazione.
Gli stessi quesiti sono stati sottoposti ad un’analisi bivariata, ossia vengono evidenziate eventuali correlazioni od una qualche relazione tra due o più variabili aleatorie: il titolo di studio, l’indice di gradimento della Manifestazione e la spesa prevista vengono suddivise per sesso dell’intervistato.
Se la partecipazione è risultata omogenea per quanto riguarda maschi e donne non possiamo dire altrettanto sul comportamento e gli atteggiamenti durante l’Evento: la maggior parte del sesso femminile non si “sbilancia” nel valutare l’organizzazione della “Maratona” mentre i soggetti intervistati di sesso maschile affermano che il comitato organizzatore ha fatto un ottimo lavoro.
Diverso è il comportamento tra maschi e donne riguardo la spesa prevista nel prendere parte all’Evento: la maggior parte dei donne sono più parsimoniose e stimano una spesa che non superi i 50 euro mentre la maggior parte dei maschi intervistati dichiara di investire per questa occasione più di 50 euro.

Descrizione del campione dei soggetti intervistati

Attraverso i dati elaborati in questo paragrafo ho individuato le caratteristiche di colui che si avvicina, partecipa o semplicemente osserva la *Maratona TerradeiForti*. La prima tabella riguarda la percentuale di partecipanti divisi per sesso, la seconda riguarda l’età divisa in step di 10 anni, la terza il titolo di studio, mentre la quarta e ultima la provenienza.

Tab. 1 – Sesso.

Sesso	**Numero**	**%**
Maschio	143	55,6
Donne	114	44,4
Totale	257	100

Tab. 2 - Età in classi.

Età	**Numero**	**%**
Meno di 25 anni	59	23,1
26-35 anni	51	20,0
36-45 anni	64	25,1
46-55 anni	49	19,6
Oltre 56 anni	32	12,9
Totale	255	100

Entrando nello specifico dell'età si può dire che il campione di intervistati con meno di 25 anni si suddivide nel seguente modo: il 10,2% ha meno di 17 anni mentre il 12,9 ha dai 18 ai 25 anni compresi. Questi dati mostrano una buona partecipazione dei minorenni, mentre coloro che hanno dai 18 ai 25 anni sono circa il 13%. La fascia di partecipanti più numerosa tra gli intervistati è quella rappresentata da persone di mezz'età: una maratona di kayak di 35 chilometri con una durata media di tre ore richiede una buona resistenza aerobica unita a una certa esperienza di conduzione del mezzo sul fiume e sono le persone con età compresa tra i 30 e 40 anni ad avere queste caratteristiche.
Esaminando la fascia d'età più elevata risulta che le persone con età compresa tra i 56 e i 65 anni sono il 7,1% mentre tra gli intervistati il 5,1% è rappresentato da amatori di età compresa tra i 66 e 76 anni: tenendo in considerazione che questa Manifestazione è un evento sportivo outdoor di una durata superiore alle due ore il valore più rilevante è quello relativo ai soggetti di età superiore ai 56 anni: il dato (quasi il 13% dei partecipanti) dimostra che la "Maratona" di canoa è un evento sicuramente accessibile a soggetti della terza età. È proprio questa fascia di età quella maggiormente interessata agli aspetti ricreativi e di socializzazione che si vengono a creare durante questo evento (ristorazione, premiazioni e lotteria).

Tab. 3 – Titolo di studio.

Titolo di studio	Numero	%
Licenza elementare	7	2.7
Media inferiore	45	17.5
Scuola professionale	30	11.7
Istituto tecnico	80	27.6
Liceo	40	15.6
Laurea	60	23.3
Post-laurea	4	1.6
Totale	266	100

Tab. 4 – Zona geografica di residenza.

Residenza	Numero	%
Nel comune dove si tiene la manifestazione	49	19,3
Nella regione in cui si tiene la manifestazione	107	42,1
In altra regione	80	31,5
In altra nazione	18	7,1
Totale	254	100

Comportamento e atteggiamenti del pubblico

L'analisi delle "opinioni" relative la Manifestazione denota che per più del 60% non è la prima volta che partecipa all'evento, ciò vuol dire che ha partecipato alle precedenti edizioni, mentre circa il 38% è la prima volta che assiste o partecipa a questo Evento: questo dimostra il buon lavoro dell'organizzazione per fidelizzare i partecipanti delle precedenti edizioni.

Tab. 5 – È la prima volta che partecipi a questa manifestazione?

Frequenza di partecipazione	Numero	%
Sì	100	38,1
No	162	61,1
Totale	262	100

Questo risultato incrociato con l'aumento dei partecipanti nelle varie edizioni (più del 50% ad ogni anno) dimostra il trend positivo e fa presagire un altro successo nella prossima edizione.

Tab. 6 – Quante altre volte hai partecipato in passato?

Numero di partecipazioni	**Numero**	**%**
Una	23	14,6
Due o tre	79	50.6
Quattro o cinque	43	26.5
Tutte	14	8.9
Totale	*159*	100

Prendendo in esame i soggetti che hanno aderito anche alle precedenti edizioni (Tab.6), si osserva che il campione di intervistati è così composto: il 14,6% ha aderito ad una sola manifestazione negli anni passati, mentre quasi il 50,6% a due o tre edizioni. Il 26.5% ha partecipato a quattro o cinque edizioni. Gli intervistati che hanno seguito tutte le edizioni sono quasi il 9%.
Questa Tabella mostra il lavoro svolto dall'organizzazione: un'ulteriore conferma che concorrente ed osservatore, soddisfatti della alta qualità della Manifestazione e dei servizi disponibili sul territorio, hanno voluto partecipare più volte all'evento confermando ulteriormente il suo successo.

Tab. 7 – Da quanti giorni segui questa manifestazione?

Numero di giorni	**Numero**	**%**
Mai/zero	10	6,3
Uno	68	42,9
Due o tre	56	35.7
Quattro o più	24	15,1
Totale	158	100

La domanda "da quanti giorni segui questa Manifestazione?" può essere intesa come un indicatore di "intensità" dell'attrazione per questa Competizione. Chi non segue mai l'Evento è il 6,3% mentre le persone che la seguono a distanza di un giorno sono quasi il 43%. Coloro che la seguono per due o tre giorni sono il 35.7%. Il 15,1% segue la Manifestazione per quattro o più giorni.
La *Maratona Terradeiforti* è un evento candidato a far parte del circuito della Coppa del Mondo Marathon, secondo le direttive dell'I.C.F. (International Canoe Federation). Fin tanto che la Commissione Internazionale non convalida questo evento a far parte del circuito internazionale, la sua risonanza rimane limitata nel tempo.

Anche la rassegna stampa relativa all'Evento ci dimostra che l'organizzazione si è concentrata soprattutto sui tre giorni precedenti alla gara probabilmente perché i quotidiani e le tv locali hanno in ugual modo risonanza limitata nel tempo. Le persone che seguono tutto l'anno la manifestazione e che hanno aderito alla ricerca sono il 2,1%.

Tab.8 – Da quanti giorni segui questa manifestazione?

Numero di giorni	Numero	%
0	15,0	6,3
1	102,0	42,9
2	64,0	26,9
3	21,0	8,8
4	5,0	2,1
5	1,0	0,4
6	1,0	0,4
7	7,0	2,9
8	1,0	0,4
10	4,0	1,7
14	1,0	0,4
15	3,0	1,3
30	4,0	1,7
60	2,0	0,8
90	2,0	0,8
365	5,0	2,1
Totale	238,0	100,0

La Tabella 8 dimostra che la manifestazione "Terra dei Forti" ha un margine di crescita come notorietà sul territorio nazionale, mentre ha già una notevole risonanza sul territorio locale.
La Tabella 9 invece dimostra chiaramente che la maggior parte dei partecipanti alla Manifestazione appartengono ad un gruppo. Spesso è il club di appartenenza che accompagna gli atleti o amatori (30,2%). Ma sono molti anche i partner o familiari a sostenere i canoisti durante l'Evento. Infatti accorpando insieme questi ultimi due dati si raggiunge il 42,4%.

I solitari che si avvicinano alla maratona di kayak sono solamente l'11,4%. Il motivo risiede nel supporto logistico che si ha bisogno quando si scende un fiume: molto spesso mentre l'atleta prova alcuni tratti di gara, l'amico o compagno lo segue e lo raggiunge all'arrivo con il mezzo di trasporto e gli indumenti asciutti.

Tab. 9 – Con chi sei qui ora?

Sono qui con…	**Numero**	**%**
Da solo	29	11,4
Solo con il mio partner	53	20,8
Con un solo amico/amica	29	11,4
Con familiare/i	55	21,6
Con gruppo	77	30,2
Con Ditta o Ente di lavoro	12	4,7
Totale	255	100

Quello che dovrebbe risultare un aspetto problematico per la pratica di questo sport si rivela per la Manifestazione un incremento del numero di osservatori.

Tab. 10 – Come valuti questa Manifestazione?

Valutazione	**Numero**	**%**
Sufficiente	7	2.7
Discreta	41	16,0
Ottima	208	81,3
Totale	*256*	*100*

Ho voluto analizzare i giudizi riguardo l'Evento e come mi aspettavo sono stati tutti positivi: solo il 2,7% ha affermato che la Manifestazione è sufficiente, mentre il 16% ha dichiarato che è discreta. Più dell'80% dichiara che la Manifestazione è ottima. Appare evidente da un dato cosi significativo che l'organizzazione ha lavorato per rendere l'Evento soddisfacente da tutti i punti di vista per chi partecipa e fruibile nei servizi per chi assiste.

Tab. 11 – Cosa ti attrae di più della Manifestazione?

Attrazione	Numero	%
Gara, strumenti degli atleti, soccorso	74	31.0
Fruizione del luogo, valorizzazione del territorio	35	14,6
Pubblico/Socializzare, incontrare e sostenere atleti	44	18,4
Atmosfera, aspetti artistici, tutti gli aspetti	51	21,3
Incontrare e sostenere alcuni atleti/amatori	20	8,4
Lo spirito sportivo, nuova esperienza/curiosità	24	10.0
Promozione libri, cibo, stando	10	4,2
Nulla	2	0,4
Totale	239	100

La maggior parte dei soggetti intervistati è attratta dalla gara (22,2%), segue poi la fruizione del luogo (14,2%) vale a dire poter accedere al fiume, poter provare ad andare in canoa sul fiume, e poi la socializzazione 10%, quindi la manifestazione consente al pubblico momenti di incontro con altre persone.

Analisi bivariata dei dati demografici

Esaminando il pubblico in riferimento al titolo di studio e al sesso, si nota che, relativamente al titolo di studio elevato, non si ha una sostanziale differenza tra i maschi e le donne: a possedere una laurea sono il 24,1% dei maschi rispetto al 25,7% delle donne. Il pubblico maschile presenta un titolo di studio medio molto più elevato rispetto quello femminile: sono il 60,3% dei maschi rispetto al 48,7% di femmine ad aver conseguito un diploma di scuola media superiore o professionale. Circa il titolo di studio più basso si nota che le donne presentano tale livello di istruzione più ricorrente: il 25,7% delle donne possiede il titolo di scuola media inferiore contro il 15,7 % dei maschi.
Questi dati, riportati nella Tabella 12, evidenziano quindi un pubblico della “Maratona” mediamente bene istruito.

Tab. 12 – Titolo di studio per sesso dell'intervistato (%).

Istruzione	**Sesso**	
	Maschi	**Donne**
Elementari, media inferiore	15,6	25,7
Scuola prof., liceo, ist.tecnico	60,3	48,7
Laurea, post laurea	24,1	25,7
Totale	100	100
N	*141*	*113*

La tabella 13 descrive la partecipazione all'evento per fasce d'età in maniera dettagliata mentre la tabella 14 raggruppa i risultati in due grandi gruppi, giovani e adulti. La partecipazione all'Evento è maggiore da parte delle femmine se si considera l'età fino ai 25 anni, mediamente uguale in percentuale dai 25 ai 45 anni, superiore da parte dei maschi dai 46 anni in poi.

Tab. 13 – Età dei partecipanti per sesso (%).

Classi di età	**Sesso**	
	Maschi	**Donne**
Fino 17 anni	5,7	16,1
Da 18 a 25 anni	12,8	13,4
Da 26 a 35 anni	23,1	18,8
Da 36 a 45 anni	22,7	27,7
Da 46 a 55 anni	24,8	13,4
56 anni e oltre	12,8	10,7
Totale	100	100
N	*141*	*112*

Si evince che, nell'approcciare uno sport a contatto con la natura come la canoa fluviale, gli uomini di età superiore ai 45 anni si dimostrano molto più intraprendenti rispetto alle donne della stessa età: le donne dopo una certa età, forse perché il loro ruolo di madre le induce ad essere più prudenti, difficilmente si cimentano in sport dove le avversità naturali possono avere il sopravvento.
Durante una maratona fluviale le condizioni metereologiche avverse e le incognite del fiume talvolta mettono a dura prova anche i soggetti maschi più allenati.

Tab. 14 – Età dei partecipanti per sesso (%).

Valutazione	Sesso	
	Maschi	**Donne**
Giovani	39,7	48,2
Adulti	60,3	51,8
Totale	100	100
N	*141*	*112*

La tabella 14 dimostra la partecipazione di giovani (fino a 35 anni) e adulti (oltre 35 anni) divisi per sesso. Fino all'età di 35 anni sono più le donne (48,2%) a partecipare rispetto ai maschi (39.7%). Dopo i 35 anni avviene l'inverso (Tabella 15): i maschi adulti superano le donne in una percentuale di circa 10%. In pratica questa tabella riassume quello che nella tabella precedente ho analizzato nel dettaglio.

Tab. 15 – Partecipazione per sesso (%).

Valutazione	Sesso	
	Maschi	**Donne**
È la prima volta che partecipo: sì	41,3	37,7
È la prima volta che partecipo: no	58,7	62,3
Totale	100	100
N	*143*	*114*

A partecipare maggiormente per la prima volta sono i maschi mentre le femmine dimostrano di aver seguito altre edizioni: questo risultato sottolinea che la donna da una certa età in poi partecipa ad una manifestazione con queste caratteristiche solo se lo ha già fatto in passato.

Analisi bivariata: *la valutazione della gara*

Le sette tabelle che seguono rilevano l'opinioni del pubblico e dei partecipanti all'Evento divisi par sesso. La tabella 16 indica che il 40% circa sia dei maschi che delle femmine ha seguito questa Manifestazione da tempo.
Questo dato ci descrive un pubblico che ha sentito parlare della "Maratona" attraverso i media, preparato quindi all'Evento e che, con buona probabilità, ha preso parte ad edizioni passate, in grado in questo caso di esprimere con più oggettività un giudizio.

Tab. 16 – Seguire tramite i media per sesso (%).

Valutazione	Sesso	
	Maschi	**Donne**
Ha già seguito questa manifestazione: sì	40,8	40,2
Ha già seguito questa manifestazione: no	59,2	59,8
Totale	100	100
N	*142*	*112*

Non c'è differenza tra maschi e femmine per chi ha seguito la manifestazione tramite i media e chi no, l'informazione tramite i media arriva a colpire l'interesse di entrambe i sessi in ugual misura.

Tab. 17 – Valutazione della manifestazione per sesso dell'intervistato (%).

Valutazione	Sesso	
	Maschi	**Donne**
Sufficiente	2,1	3,6
Discreta	9,9	24,3
Ottima	88,0	72,1
Totale	100	100
N	*142*	*111*

Prendendo come riferimento la categoria "ottima" si osserva che sono i maschi (88%) che dichiarano più positiva la Manifestazione rispetto le femmine che sono il 72,1%: Il risultato va visto come una particolare attenzione delle femmine verso alcuni servizi di utenza prettamente femminile, probabilmente non soddisfacenti, come il numero di bagni pubblici lungo il percorso o il servizio recupero attrezzatura pesante.

Tab. 18 – Valutazione della Manifestazione per titolo di studio dell'intervistato (%).

Valutazione	Titolo di studio		
	Basso	**Medio**	**Alto**
Sufficiente	7,7	0.7	3.1
Discreta	9,6	21,2	10,9
Ottima	82,7	78,1	85,9
Totale	100	100	100
N	*52*	*137*	*64*

Prendendo in considerazione chi esprime un giudizio positivo si nota che, sono essenzialmente chi ha un titolo di studio alto a valutare positivamente la Manifestazione (85,9%), tuttavia un buon apprezzamento è espresso anche dalle persone con un livello di istruzione basso (82,3%).

Tab. 19 – Spesa prevista (%).

Spesa prevista in Euro	Numero	%
0 Euro	53	21,2
Da 1 a 50 Euro	135	56,0
Da 51 a 100 Euro	29	12,4
Oltre 100 Euro	25	10,4
Totale	241	100

Se consideriamo che il 31.5% proviene da altre regioni e il 7,1% da altre nazioni, possiamo affermare che l'indotto economico di questo Evento è notevole. Basti pensare che un atleta proveniente dalla regione Lazio, giunge sul territorio della gara almeno due giorni prima dell'Evento soggiornando in alberghi consigliati dall'organizzazione. Dopo aver concluso la Competizione comprerà probabilmente dell'attrezzatura specifica negli stand posti all'arrivo.
Considerando la spesa del viaggio e che molto probabilmente l'atleta è accompagnato almeno da una persona, giustifichiamo il motivo per cui il 22,8% spende più di 50 euro.

Tab. 20 – Provenienza per sesso dell'intervistato (%).

Provenienza	Sesso	
	Maschi	Donne
Regione	58,9	64,5
Altra Regione	29,8	33,6
Altra Nazione	11,3	1,8
Totale	100	100
N	*141*	*110*

Pur essendo la Manifestazione un evento internazionale, la maggior affluenza risulta essere della stessa regione con una prevalenza femminile. Le proporzioni sia di affluenza che distinte per sesso rimangono costanti anche se numericamente inferiori per partecipanti provenienti da altre regioni.
Anche se il dato relativo alla presenza di partecipanti di altre nazioni risulta essere inferiore rispetto agli altri, dimostra l'interesse dell'Evento a livello internazionale.

In questo ultimo dato prevale la presenza maschile con un 11,3% dei maschi contro solamente l'1,8% delle donne.

Tab. 21 – Spesa prevista per sesso dell'intervistato (%).

Spesa prevista in euro	**Sesso**	
	Maschi	**Donne**
Da 0 € a 50 €	72,2	82,9
Oltre 51 €	27,8	17,1
Totale	100	100
N	*108*	*82*

La Tabella 21 evidenzia la tendenza delle donne ad essere maggiormente oculate nelle spese rispetto ai maschi quando queste non superano i 50 euro; mentre sono i maschi ad affrontare spese più consistenti: il 27,8% di persone appartenenti al sesso maschile spende più di 50 euro. Solamente il 17,1%.

Tab. 22 – Spesa prevista per zona di provenienza dell'intervistato (%).

Valutazione	**Zona di provenienza**		
	Stessa regione	**Altra regione**	**Altra Nazione**
Da 0 € a 50 €	96,4	59,0	12,5
Oltre 51 €	3,6	41,0	87,5
Totale	100	100	100
N	*112*	*61*	*16*

Come analizzato nella Tabella precedente gli intervistati che spendono di più sono quelli che vengono da fuori regione ma soprattutto da altra nazione, persone che con tutta probabilità sono accompagnate da parenti, amici, sostenitori e devono provvedere alle spese di viaggio, di alloggio in albergo per più giorni.
Anche in questo caso l'organizzazione per convenzione, propone ai partecipanti alla manifestazione una serie di pacchetti vantaggiosi sia per il vitto che per l'alloggio. Analizzando nel dettaglio la tabella 22 vediamo infatti che delle persone provenienti dalla stessa regione il 96.4% vanno incontro ad una spesa non superiore ai 50 euro; il rimanente 3,6% supera questa cifra.
Riguardo i partecipanti alla Manifestazione provenienti da altre regioni il 59.0% è rappresentato dai più parsimoniosi mentre il restante 41.0% si azzardano a spendere un po' di più. L'87.5% di coloro che provengono da altre nazioni sono "costretti" per le ragioni già dette superare abbondantemente i 50 euro di spesa.

CONCLUSIONI

Dai risultati della ricerca empirica fatta attraverso il questionario siamo in grado di costituire un campione rappresentativo del pubblico.
Possiamo definire il pubblico della Maratona Terra dei Forti come una popolazione giovane e con una certa omogeneità tra maschi e donne. È un pubblico con grado di istruzione medio-alta, proveniente prevalentemente dal territorio bagnato dal fiume Adige. Emerge che questa popolazione non è alla sua prima esperienza, ma ha già partecipato a precedenti edizioni.
Tuttavia possiamo affermare con una certa tranquillità che la Manifestazione ha una *dimensione internazionale* in quanto dai risultati ottenuti si stima la partecipazione all'*evento* di circa un centinaio di competitori provenienti da altre nazioni europee.
Dall'analisi delle risposte date si evince che il pubblico non vive la Competizione come evento fine a se stesso, ma è attratto da una serie di iniziative collaterali della Manifestazione, come gli stand, la gastronomia, i gadget, gli strumenti degli atleti e gli atleti stessi. Inoltre pubblico, decisori e osservatori esterni si avvicinano a questo tipo di evento con il fine ultimo di socializzare, condividendo un'esperienza unica insieme a un gruppo, amici o accompagnatori. L'indice di gradimento riguardo gli aspetti organizzativi e i servizi messi a disposizione dal comitato di gara è in percentuale molto alto.
L'analisi bivariata evidenzia eventuali correlazioni o una qualche relazione tra due o più variabili come il titolo di studio, l'indice di gradimento della manifestazione e la spesa prevista, suddivise per sesso dell'intervistato, riguardo la valutazione complessiva dell'evento.
Per quanto riguarda la valutazione della Manifestazione, i grafici ci mostrano una certa uniformità tra il sesso maschile e quello femminile, mentre l'analisi fatta per titolo di studio evidenzia alcune differenze: i più critici in senso positivo e in senso negativo, risultano essere le persone con un grado di istruzione basso.
Come già detto, la popolazione della "Maratona" proviene dalla regione Veneto per circa il 60% con una leggera prevalenza delle donne rispetto ai maschi, mentre i competitori provenienti da altre nazioni sono prevalentemente di sesso maschile.
Dai dati acquisiti, riguardo la spesa prevista, si evince che la maggior parte dei pubblico e competitori devono affrontare spese di viaggio e alloggio, superando perciò la soglia dei 50 euro. Il rapporto tra spesa prevista e zona di provenienza risulta essere direttamente proporzionale: il 96.4% proveniente dalla stessa regione prevede una spesa non superiore ai 50 euro, al contrario l'87,5% proveniente da altra nazione è costretto a superare abbondantemente questa cifra.

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