

Abstracts of XVIIth FINA World Sports Medicine Congress

Podium #1

Physiological Responses to Front Crawl Intermittent Incremental Protocols with Different Step Lengths

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Introduction: The use of the intermittent incremental protocol of 200 m step length (2-3min depending on the swimming intensity), conducted in ecological conditions, is not new for swimmers evaluation and training control. Studies that used it provided an important contribution regarding swimmers physiological characterization through the assessment of oxygen uptake (VO_2), blood lactate concentrations ($[\text{La}^-]$) and energy expenditure. However, steps higher than 4min duration have been suggested to be proper for VO_2 stabilization and to the $[\text{La}^-]$ better express its muscular production. We aimed to compare three variants of a front crawl intermittent incremental protocol with different step lengths to assess traditional and recently proposed relevant physiologic parameters.

Methods: Six trained swimmers (21.0 ± 2.06 years, $73.8 \pm 4.02\text{kg}$ and $1.82 \pm 0.05\text{m}$) performed three randomized repetitions of a front crawl intermittent incremental protocol until exhaustion. Each variant had different step lengths (200, 300 and 400m), increments of $0.05\text{m}\cdot\text{s}^{-1}$ and 30s intervals between steps (24h were respected between variants). VO_2 was collected breath-by-breath (averaged 10s) using a K4b2portable gas analyser connected to the new AquaTrainer respiratory snorkel (Cosmed, Italy). For the data analysis, it was selected, in each variant, the step where $\text{VO}_{2\text{max}}$ occurred, and compared the values of $\text{VO}_{2\text{max}}$, maximal ventilation (VEmax), maximal VO_2 efficiency (OUE, VO_2/VE), and $[\text{La}^-]_{\text{max}}$. Descriptive statistics and Friedman's test ($p = 0.05$) were calculated.

Results: Median and interquartil range for $\text{VO}_{2\text{max}}$, VEmax , OUE and $[\text{La}^-]$ for 7x200, 300 and 400m were, respectively: 56.05 (51.9-71.3), 54.3 (51.1-59.9) and 51.6 (51.6-55.3) $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ (with differences between variants, $p < 0.01$), 140.8 (120-149), 138.9 (100-167) and 132.5 (101-157) $\text{l}\cdot\text{min}^{-1}$, 29.8 (26.3-34.8), 29.9 (23.5-37.4) and 29.2 (24.8-34.7) $\text{ml}\cdot\text{l}^{-1}$, and 8.1 (7.9-10.9), 8.2 (8-8.8) and 8.5 (7.8-10.8) $\text{mmol}\cdot\text{l}^{-1}$.

Conclusions: The values of VEmax , OUE and $[\text{La}^-]$ were similar independently of the step lengths used. However, the variant of the incremental protocol using 400m step length seems to underestimate the $\text{VO}_{2\text{max}}$ values, suggesting that the 7x400m incremental protocol might not be the ideal one to use when the aim is to characterize the swimmers maximal aerobic power. So, coaches and researchers should use incremental protocols with short step

durations, particularly of 200 m, once the test will be simpler and faster, swimmers will be easier motivated to perform a maximal effort, and the final results will not be negatively affected by its shorter step length.

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Podium #2

Isokinetic Strength Profiles of Elite Swimmers

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Introduction: Isokinetic strength profiles can assist in determining if elite athletes have enough strength and endurance to complete their required tasks, or whether there are muscle imbalances which could predispose them to injury. There has been very limited research conducted in South Africa on the isokinetic profiles of elite swimmers. The aim of the study was to assess the isokinetic strength and endurance profiles of shoulder internal and external rotator muscles of elite swimmers.

Methods: Isokinetic testing was performed on 21 elite swimmers (5 female, 16 male) using a Biodex 3 dynamometer. Strength testing was done using concentrically and eccentrically at $60^\circ/\text{s}$, completing 5 maximal contractions. Endurance testing was done at $180^\circ/\text{s}$, completing 15 maximal contractions. Swimmers with acute injuries were excluded from the study. Muscular endurance was measured using the relative fatigue ratio, and muscular strength with various strength ratios as well as average power, and maximum repetition total work. The strength ratios measured included torque to body ratio, the reciprocal ratio, the functional ratio and bilateral ratio. Statistical analysis included mean and standard deviation for strength and endurance. An isokinetic strength profile was determined for elite swimmers in a South African context.

Results: The main findings for strength included a bilateral discrepancy between the arms of less than 10% for both the internal and external rotator muscles in both female and male swimmers, except in the ECC/ECC (eccentric/eccentric) test at $60^\circ/\text{s}$ where the external rotators had a discrepancy of 17.8% in the female swimmers. Both male and female swimmers showed a better than average peak torque to body weight ratio between the limbs as compared to non-elite athletes. With respect to endurance, the relative ration of the internal rotators of female swimmers ranged from 8.76 – 9.0% and the external rotators ranged from 18.1-25.9% and for the male swimmers the internal rotators ranged from 6.2 – 9.1% and the external rotators ranged from 16.4 - 17.6%.

Conclusions: Swimmer external rotator muscles fatigued

at a quicker rate than the internal rotators for both male and female swimmers tested. When compared to international data, strength and endurance profiles of elite South African swimmers were not comparable to those found internationally. Further research should focus on analysing the possible relationship between strength and endurance adaptations, and the development of specific injuries. This would contribute to determining the potential risk for injury due to muscle strength and endurance adaptations, and possible individual rehabilitation interventions for injury prevention.

Podium #3

Hydration Status of Swimmers Training at High Altitude in Warm Conditions

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Introduction: Dehydration is a serious detrimental factor for athletic performance. Training on daily bases in warm conditions at high altitude may cause dehydration problem. The aim of this study was to evaluate the hydration status of swimmers during a high altitude training camp period for 3 weeks.

Methods: 17 national team swimmers (11 male and 6 female) were joined to this 3 weeks training program which performed in Pretoria – South Africa at February 2012 (aged 19.4 ± 3.1 ; height 176.6 ± 10.0 cm, body mass 71.6 ± 10.7 kg [mean \pm SD]). Swimmers were trained for 6 days per week and 2 sessions per day; each session was divided to dry land and swimming trainings. Total swimming time for each training session was about 90 minutes. Ambient temperature under the sunshine and in shadow area was recorded as 36.5 ± 3.7 and $24.3 \pm 4.4^\circ\text{C}$, respectively. Water temperature was measured as 26°C at the middle of the day and recorded as 21°C at the very early morning. All swimmers had free access to drinking liquids from the individual bottles assigned to them. All drink bottles were weighed on an electric scale before and at the end of the training to determine the volume consumed by each swimmer. Body mass measurements were performed just before and immediately after the training session with an electronic scale to calculate sweat rate. Hydration statuses of the swimmers were analysed from the early morning and late night urine samples specific gravity measurements by a refractometry (ATAGO). All statistical analyses were performed using SPSSv13.0.

Results: Swimmers drunk 409 ± 294 ml of liquid per training (maximum – 1960; minimum – 0 ml). Their sweat rates were calculated as 675 ± 549 ml (maximum - 2740; minimum - + 640 ml). Early morning and late night urine specific gravity were measured as 1023 ± 6 and 1023 ± 8 respectively. Minimum and maximum urine

specific gravity values were recorded as 1002 and 1045.

Conclusions: The swimmers training at high altitude in warm environmental conditions are under the risk of dehydration. Daily measurement of urine specific gravity is an important step to protect these athletes from any possible deleterious effect of dehydration. The possibility of swallowing water during swimming may cause underestimation of sweat rate. It is important to keep in mind that, because of the individual variability, each swimmer deserves personal evaluation in terms of dehydration.

Podium #4

A Three-Week Sprint Swimming Training With Active or Passive Recovery Intervals : Effect on Performance and Endurance Indices

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Introduction: Active compared to passive recovery during the interval between short duration swimming sprints may impair the rate of phosphocreatine resynthesis. The decreased availability of phosphocreatine may be counterbalanced by an increased activation of glycolysis and aerobic metabolism for maintenance of performance. The altered energy contribution during a training period may have an impact on metabolic adaptations and performance outcome.

Methods: Sixteen swimmers with competitive experience (age: 20 ± 1 years, body mass: 77 ± 8 kg, height: 178 ± 5 cm) were assigned to two groups of equal performance ability. Both groups completed 12 maximum intensity repeated sprint training sessions within a 3-week period. The interval between sprint repetitions in all training sessions was active for one group (ACT) and passive for the other group (PAS). Before the start and after the completion of the training period the swimmers completed 50, 100, 200 and 400 m tests with maximum intensity for the critical velocity (CV) calculation, a 400 m test at intensity 85% of the maximum 400-m speed (400-85%) and a 30 s tethered swimming test (TF). Blood lactate was measured immediately after the 400-85%.

Results :Swimming speed of distances 50, 100, 200, 400 m was improved post-training compared to pre-training values but no difference was observed between groups [%change, mean \pm SD ($\pm 90\%$ confidence limit); ACT: $2.4 \pm 2.2\%$ (+0.9, +3.9%), $2.6 \pm 2.3\%$ (+1.1, +4.1%), $1.6 \pm 1.2\%$ (+0.8, +2.4%), $2.4 \pm 1.1\%$ (+1.7, +3.1%); PAS: $1.9 \pm 1.4\%$ (+0.9, +2.8%), $1.4 \pm 1.1\%$ (+0.6, +2.1%), $1.1 \pm 1.4\%$ (+0.2, +2.1%), $1.6 \pm 1.2\%$ (+0.8, +2.4%) for 50, 100, 200, 400 m respectively]. Blood lactate concentration after the 400-85% was decreased and CV was increased following the training period but no difference was observed between groups ($p > 0.05$). TF showed no changes after training and between groups ($p > 0.05$). Performance data were also assessed for practical signifi-

cance using magnitude-based inferences. Using this approach the improvement was possibly trivial and likely trivial in the ACT group and very likely trivial in the PAS group for distances of 50 and 100 m. The improvement was very likely trivial in the ACT group and likely trivial in the PAS group for distances of 200 and 400 m. Both groups showed a likely trivial improvement in CV.

Conclusions: Improvement of 50 and 100 m speed was more likely trivial with passive recovery while improvement of 200 and 400 m was more likely trivial following active recovery intervals. The application of active compared to passive recovery between repeated sprints during a short duration sprint training period may not alter competitive performance.

Podium #5

Energy Characterization of 100m Maximal Front Crawl

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Introduction: The majority of studies that assess the oxygen consumption (VO_2) kinetics in swimming are conducted at the moderate and heavy intensity domains; at faster paces, VO_2 dynamics assessment is still scarce and a challenging task. Despite it has been suggested that aerobic energy contribution is greater than 50% even at short duration efforts, little is known about the relative contribution of the different energy systems at short swimming distances. In addition, the contribution of the legs action on swimming propulsion is often depreciated due to the additional energy expenditure, without evident benefits for propulsion; however, over short duration swimming, exercise economy is usually assumed to be of secondary importance. The purpose of the present study was to characterize the VO_2 kinetics, determine the relative contribution of the three energy sources, and to analyse the effect of legs action on energy cost (C) and performance, on 100m maximal front crawl.

Methods: Ten trained swimmers (19 ± 1.38 yrs, 181.42 ± 3.45 cm, 72 ± 2.56 kg) performed 2x100m front crawl all-out with 24h in-between, the 1st swimming freely and then performing with “arms only” (legs supported by a pull-buoy). VO_2 was measured by a K4b² portable gas analyser connected to the new AquaTrainer respiratory snorkel (Cosmed, Italy), and capillary blood lactate was taken at rest and during the recovery period (Lactate Pro, Arkay Inc., Japan). C was calculated as the ratio between energy expenditure (aerobic + anaerobic lactic + anaerobic alactic pathways) and corresponding velocity. VO_2 data was fitted using the following mono-exponential model: $\text{VO}_2 = \text{VO}_2\text{Basal} + \text{VO}_2\text{Amplitude} \cdot (1 - e^{-(\text{time}/\text{time constant})})$.

Results: An instantaneous and sudden increase in the VO_2 occurred from the beginning of the effort, with mean \pm SD for VO_2peak , $\text{VO}_2\text{Amplitude}$, and time constant being 54.27 ± 3.80 and 41.14 ± 5.59 ml \cdot min \cdot kg⁻¹, and 11.32 ± 3.02 s, respectively. The relative energy sources contributions were 41.61, 34.78 and 23.61% for the aerobic, anaerobic lactic and anaerobic alactic pathways. Task complexity constraints and lower maximal velocity may account for some hypothetical overestimation of the aerobic contribution in a 100m competitive event. C for whole body swimming was higher than swimming with arms only (0.85 vs 0.65 kJ \cdot m⁻¹), and the magnitude of the legs contribution for performance was 14.1%.

Conclusions: Despite the short duration of the 100m front crawl event, swimmers were able to attain high values of VO_2peak and $\text{VO}_2\text{Amplitude}$, and the aerobic energy system was found to be predominant. Notwithstanding the higher C, legs action revealed to have an important propulsive contribution.

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Podium #6

Exhaled Nitric Oxide is a Good, Non-Invasive Test for Steroid Responsive Airways Disease in Elite Swimmers

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Introduction: Asthma is common in elite level swimmers. With the change in WADA testing rules there is no longer a requirement for elite level athletes to have objective airways testing. There is marked heterogeneity in athletes and knowing which athletes are likely to respond to inhaled corticosteroids allows for targeted therapy. As part of a larger study looking at airways disease in symptomatic elite level athletes, we compared the effectiveness of the cheap, quick, non-invasive measurement of exhaled nitric oxide against induced sputum eosinophil percentage counts and response to standard eucapnic voluntary hyperventilation (EVH) testing.

Methods: Athletes were inhaled corticosteroid naïve or stopped steroids for 4 weeks prior to testing. All of the athletes had symptoms suggestive of exercise asthma. They had baseline exhaled nitric oxide, spirometry, EVH and then induced sputum carried out using our standard research protocols.

Results: A total of 80 elite level swimmers took part in the study. Of these 27 had a sputum eosinophil count of >3% (34%) and of these 26 (96%) had a drop in FEV1 after EVH of >10%. Of the 53 (66%) of swimmers with a sputum eosinophil count of <3% only 24 had a positive EVH test (45%). When comparing the levels of measured FENO to sputum eosinophilia an FENO of >43 had the best predictive value. (ROC: AUC = 0.93, $p < 0.0001$, sens: 88.46%, spec: 96.23%).

Conclusions: A sputum eosinophil count of >3% is the most robust marker of steroid responsiveness in asthma. Swimmers with this level of disease have positive EVH tests and an elevated FENO. FENO is an excellent non-invasive, cheap, pool side test that can be used to screen symptomatic elite level swimmers for steroid responsive airways inflammation.

Podium #7

The Therapeutic Use of Pseudoephedrine and Its Impact on The Performance of South African Masters Swimmers

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Introduction: Pseudoephedrine, a sympathomimetic substance which is on the World Anti-Doping Agency list of prohibited substances, is easily available in over-the-counter medications. The adverse effects of long term use far outweigh the benefits, but its accessibility still and apparent favourable qualities still allow it to be commonly used in sport. Previous research has shown ergogenic effects in athletes using above threshold amounts (urine concentration >150 µg·mL⁻¹) in doping trials; however, literature on the effects of the therapeutic use of pseudoephedrine in swimming is limited. Hence, the purpose of the study was to determine the effect of the therapeutic dose of pseudoephedrine on the performance of masters' level competitive swimmers.

Methods: The study used a double-blind randomised control trial design in which participants were randomly assigned into experimental and control groups initially. The experimental group received pseudoephedrine and the control group received a placebo at the outset of the study. Anthropometric data were collected and anaerobic (50m sprint) and endurance (2000m timed swim) swim tests were performed during the trials. Both groups underwent a wash out period before being switched into alternate groups, and the swim tests repeated. Ethical clearance was obtained (M110445) and confidentiality was ensured.

Results: All of the participants (n = 8) were familiar with the swim tests, and had fairly high BMIs (28.06 ± 3.5) which is customary in long distance swimmers. The fifty metre swim sprint test exhibited no significant differences between the swim tests at baseline, using the placebo and the pseudoephedrine (Friedman ANOVA, $\chi^2 = 0.92$, *d.f.* = 2, *p* = 0.63). Moreover, we did not find any evidence of ergogenic effect in the long distance two kilometre swim test (Friedman ANOVA, $\chi^2 = 1.14$, *d.f.* = 2, *p* = 0.57). Neither did heart rate, blood pressure or the rate of perceived exertion vary significantly from baseline.

Conclusions: The therapeutic use of pseudoephedrine in sprint and endurance swimming does not seem to enhance performance. Higher doses of the substance may be needed to confirm ergogenic effects in swimmers.

Podium #8

Immunometabolic and Nutrigenomic Interventions in Elite Swimmers and Water-Polo Players

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Elite athleticism high demanding and extensive literature, aiming to delineate the interplay between metabolic, genetic and immune responses is missing in detail. Our laboratory has been working on the molecular mechanisms that govern adaptations in exercise for more than 10 years. We have published more than 35 papers on this subject and we have gained extensive experience studying elite athletes of various sports. We have developed a program of following up the athlete all the year, consisting from five groups of biomarkers. These biomarkers are a) the classical biochemical parameters, b) hormones like glucagon, insulin, C-peptide, adiponectin, somatomedin-C that regulate energy stores, c) oxidative stress markers like ratio of GSH/GSSG, lipid peroxidation, protein oxidation, catalase and antioxidant capacity, which affected by either ischemia/reperfusion phenomenon or aerobic load and could be detrimental in metabolic equilibrium, d) immune related cytokines like IL-6 and IL-10, that are associated with susceptibility to infections in elite athletes that spend hours in hard training every day and e) genotyping in FTO, MC4R, TMEM 18, CTNBL1, SH2B1 / ATP2A1, NEGR1, MAF, MTCH2 and KCTD15 genes that regulate metabolic adaptations in elite athletes. Studying these markers in various time points during the year we can effectively regulate bodily function and diminish metabolic factors that are detrimental in athletic performance. Application in elite athletes and how the nutrigenomic intervention can regulate athletic performance to the maximum in swimmers and water polo players will be presented.

Podium #9

Use of Anabolic Androgenic Steroids in Swedish Former Elite Male Athletes in Power Sports

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Aim: There is an increasing knowledge about the negative effects of Anabolic Androgenic Steroid (AAS)-use, but few studies have investigated possible long-term effects. The aim of the present study was to investigate the long-term effects of AAS-use concerning substance abuse and occurrence of mental health problems in male elite power sport athletes in Sweden.

Methods: All male elite power sport athletes in Sweden, defined as being in the top 10 ranking lists during the years 1960-1979 in wrestling, Olympic lifting, power lifting and the throwing events in track and field, were identified (n = 1199). Out of these athletes 996 were traceable and alive. 683 athletes completed a structured questionnaire concerning socio-demographic data, sport issues, mental health problems and substance use (including AAS use).

Results: The lifetime prevalence of AAS-use was 20.9% (n = 143). AAS-users, compared to non AAS-users, had significantly more often been offered AAS, were older when they started training and trained more hours during their active years. AAS-use was associated with higher lifetime prevalence of other substance use, especially illicit drugs and with a higher lifetime occurrence of mental health problems, especially depression and anxiety.

Conclusions: The results show that Swedish male elite power sport athletes, who used AAS during their active sport career in the 1960s and 1970s, differed significantly concerning sport patterns, substance use and occurrence of mental health problems in this retrospective follow-up study. These results indicate that AAS-use may have several negative long-term effects on mental health.

Podium #10

Heterogeneity of Airways Disease in Elite Level Swimmers with Symptoms of Asthma

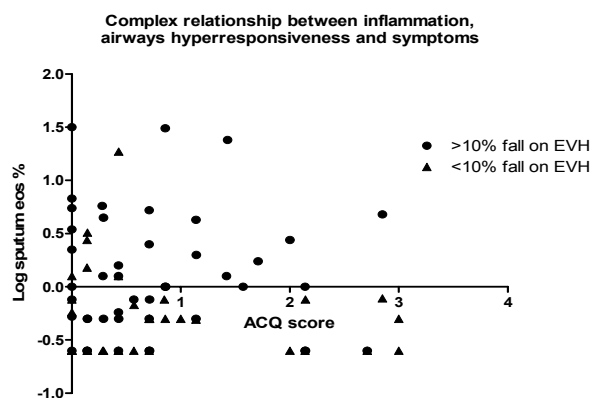
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Introduction: Respiratory symptoms are common in elite level swimmers, as is a diagnosis of asthma. Previous studies have suggested higher levels of eosinophilic disease in swimmers compared to other endurance sports. How the degree of symptoms relates to airways inflammation and airways hyperresponsiveness remains unclear, especially whether there is a particular phenotype for 'swimmers asthma'.

Methods: Athletes were inhaled corticosteroid naïve or stopped steroids for 4 weeks prior to testing. All had symptoms suggestive of exercise asthma. They had baseline exhaled nitric oxide, spirometry, EVH and an induced sputum inflammatory cell percentage carried out using our standard research protocols. Symptoms were scored using the Juniper Asthma Control Questionnaire

Results: A total of 60 athletes took part in the study. The complex relationship between symptoms (ACQ score), airways inflammation (log sputum eosinophil %) and airways hyperresponsiveness (>10% fall in FEV1 post EVH) is shown in the graph below.



Conclusions: There is marked heterogeneity within the swimming population for athletes with the same or similar levels of symptoms on exertion. This would suggest that the return to clinical diagnosis in this group as suggested by the revised WADA guidelines is unhelpful and detailed objective assessment is needed to appropriately guide treatment and management.

Podium #11

The Physiological and Subjective Responses to Repeated Cold Water Immersion in a Group of 10-12 Year Olds

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Introduction: Swimming is the most popular participation sport in the UK. However, swimming in cold water is not without risk. Drowning represents the third leading cause of accidental death worldwide and children are considered particularly susceptible to drowning, cold-related illness and hypothermia. The 'cold shock' response on initial immersion, the insidious onset of hypothermia and swim failure that accompanies prolonged exposure, have been well documented in adults, and can be fatal. Adults show an habituation of their 'cold shock' response and change in cooling rates following repeated exposures to cold water, but there is little quantitative data regarding similar processes in children. Consequently, current understanding, management, and safety guidelines associated with juvenile immersion and swimming remains largely theoretical or extrapolated from adult studies.

Methods: Following ethical approval, 17 volunteers recruited from applicants to the Bristol Channel English Swim Team (BEST), aged 10-11 years, and considered 'unacclimatised', were immersed in 15°C water for an initial 5-minute static period, after which 10 participants then swam for up to 40-minutes. Anthropometric profiles were taken and deep body temperature (gastrointestinal radio pill), heart rate, respiration and oxygen uptake were

monitored throughout; thermal comfort and sensation were also recorded. Following a year of regular cold water swim-training, eight children repeated the 5-minute static immersion and five of the original ten swimmers completed a swim of up to 40 minutes.

Results: An increase in heart rate, respiratory frequency and inspiratory volume was seen in all participants in the first few minutes of immersion. However, after a year of regular exposure to cold water, whilst children felt warmer ($p < 0.01$) and more comfortable ($p < 0.05$) following five minutes of immersion, no significant attenuation was seen in their initial physiological responses. The original mean (SD) cooling rate of the children whilst swimming was $2.5(3.06)^{\circ}\text{C}\cdot\text{h}^{-1}$ and no significant difference was found in the cooling rates following a year of cold water swim-training, although there was a trend towards a slower rate of cooling following acclimatisation, as seen previously in adult studies.

Conclusions: This study provides evidence of a 'cold shock' response in children and gives cooling rates whilst swimming. The data support an habituation of children's subjective thermal responses and suggest that children aged 11-12 years old exhibit an insulative acclimatisation on swimming, following a year of regular cold water swim-training.

Podium #12 Injuries in High Diving

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Introduction: High Diving was initially popularised in the 1960's by the cliff divers from Acapulco in Mexico. More recently the sport of high diving has been formalised by the likes of the World High Diving Federation [WHDF] (established 1996) and the *Red Bull*TM Cliff Diving World Series. Typically dives are made into natural bodies of water from heights of 18-27m. At the 2013 FINA World Championships, a 27m high diving event will be introduced. Anecdotally, little is known regarding incidence of injuries sustained by high divers although the potential for significant and catastrophic injury clearly exists.

Methods and Results: A literature search of a conventional scientific database (PubMed) was performed utilising the MeSH terms 'high diving', 'cliff diving' and 'injury.' The results revealed no relevant studies to the organised, competitive sport of high diving. Occasional case reports of injuries in unsupervised and recreational high diving or jumping were found confirming the potential for significant injury involving the spine, head and neck and abdominal viscera². Searches in the popular media (GoogleTM and YoutubeTM) suggest that not all injuries are reported and that these do occur in organised high diving events resulting in fractures and fatalities.

Conclusions: Competitive diving from a 10m platform is a well established and popular aquatic discipline. Injuries are common but injury rates are still not well defined^{3,4}.

Serious and catastrophic injuries are rare but include death, spinal cord injury and significant visceral injury⁵. Diving from extreme heights provides additional excitement and spectacle but also risk of injury. Le Viet¹ demonstrated that divers from a height of 10m will hit the water at $14\text{ m}\cdot\text{s}^{-1}$ ($50\text{ km}\cdot\text{h}^{-1}$). Diving from a height of 27m increases the impact speed to $23\text{ m}\cdot\text{s}^{-1}$ ($83\text{ km}\cdot\text{h}^{-1}$). The WHDF insist on two rescue scuba divers in the water and a minimum water depth of 5m. There is a natural tendency to perform more complex dives to score higher points. The experience, fitness and skills of the high diver are paramount and yet injuries both acute and chronic will occur. Greater understanding of the injuries and injury rates in high diving is needed. Caution should be exercised until the dangers are better understood. Safety standards for high diving need to be clearly defined to include skills of attendant personnel, equipment provision, emergency evacuation procedures and site risk assessments. Further research is required and FINA could have a future role in this.

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Podium #13 Epidemiology of Platform and Springboard Diving: A Prospective Cohort Study Abstract Objective

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Introduction: Platform and springboard diving is a widely-established sport both in the UK and internationally. Literature searches have revealed a lack of studies assessing injury rates and type of injury reported in the sport. The majority of athletes participating in club diving is children and therefore at theoretical risk of injury to growth plates as well as other structures. This study seeks to assess the injury rates within diving as a whole, within the individual training modalities involved and seeks to ascertain if risk of injury increases according to the level of difficulty squad. Training modalities include pool work, trampolining, gymnastics and weight-training.

Methods: 46 divers at Plymouth Dive Centre were followed prospectively over a six month period from March 1st to August 31st 2009. Injuries were reported on injury reporting forms and collected anonymously in the dive office. The number of injuries per 1000 training hours was calculated. For the purpose of this study, an injury was defined as "any event that causes physical injury

sustained during either diving, dive-training or competition and that lasts for more than 48 hours". Many of the divers involved in the study are aged less than eighteen years. As a result, parental consent was required for inclusion into the study.

Results: 65 eligible divers were invited. 46 responded with five divers dropping out from the study. Therefore the total sample size was 41. Of these 19 were male and 22 were female. The total number of years of experience in diving was 189 with a mean of 4.6 years of diving. This study reveals a relatively low injury rate in diving of 1.34 injuries per 1000 training hours. There was no significant difference in rates between level of squads or training modalities.

Conclusions: There was no difference in injury rate found with respect to squad level. This may be due to closer monitoring and supervision in higher level squads balancing the increased training demands. Also no difference was found in injury rate between training modalities. Diving remains a relatively safe sport in comparison to many other sports. Further research is needed including the use of injury surveillance systems within the sport to reduce risk of injury. Further studies with larger sample sizes would allow further development of evidence base relating to safety in the sport.

Podium #14

The Effects of 5000m Open Water Swimming on Blood Physiological and Oxidative Stress Levels in Swimmers

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Aim: We aimed to investigate the effects of 5000m open water swimming on blood physiological and oxidative stress levels in swimmers.

Methods: 14 trained, healthy and on average 13.8 (± 1.12) years old (male and female) swimmers joined to a 5000m open water swimming like competition in may which was realized in sea after breakfast. Physical (height, body mass, mass index) and physiological (4mM lactate threshold, ANT and critical speed, CS) measurements were performed. HR, blood lactate, leukocyte, urea, uric acid levels, creatine kinase (CK), aspartate aminotransferase (AST), alanin aminotransferase (ALT), gamma glutamil aminotransferase (GGT) enzyme activities as indicators of physiological stress; and also blood total oxidant status (TOS) and oxidative stress index (OSI = TOS / TAS) as indicators of oxidant stress; total antioxidant status (TAS), ferritine, albumine and uric acid levels as markers of antioxidant defence system were determined from venous bloods before and after 5000m swimming. The values were corrected for plasma volume changes. The statistical analyses were performed by SPSS 15.0 program and ($p < 0.05$) value was accepted for significance level.

Results: The HR and blood lactate levels were respectively 166 bpm and 3.0 mM after swimming activity. The HR and, blood lactate, leukocyte, ferritine levels and CK, AST and ALT enzyme activities increased significantly compared with the first measurement values. Blood TOS and OSI values were decreased significantly and TAS value was not different when compared with the baseline measurements. No significant changes were observed for blood urea, uric acid, albumin, glucose and GGT parameters and these parameters were in normal borders. Positive relationships between OSI with urea and ALT, and between CK and AST and, negative relationships between uric acid and leukocyte after both measurements were observed. The significant relationships were found between 5000m time with ANT ($r = 0.843$, $p = 0.001$) and CS ($r = 0.971$, $p = 0.001$) parameters.

Conclusions: This results show that 5000m swimming; 1) created a mid-level physiological stress, 2) decreased oxidative stress level under basal levels just oppositely as expected, 3) performance was related with ANT and CS 4) not caused to Hypoglicemia.

Podium #15

Effects of Continuous Versus Intermittent Swimming Training on Lipid Profile in Young Obese Patients

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Introduction: Obesity is a chronic disease affecting young adult population with several complications. The gravity of this growing phenomenon resides in the fact that obesity and excess weight represent a major risk factor for many of the chronic diseases, like type 2 diabetes, cardiovascular diseases or cancer. Several research results suggest that the physical exercise, intermittent or continuous, may be effective to prevent weight gain and improve some metabolic parameters in obese subjects. Our study purpose is to compare the effects of continuous with intermittent swimming training on anthropometrics and lipid parameters in young obese patients.

Methods: The study has been developed during 24 weeks on 30 young male obese patients (aged 22.2 ± 2.6 years, with body mass index $\geq 30 \text{ kg}\cdot\text{m}^{-2}$) which have been separated into 2 groups: group I who has undertaken 40 minutes of continuous swimming training, at 70-75% of the maximal rate heart (MHR) intensity, 5 dally sessions/week, and groups II who has undertaken 20 minutes of intermittent swimming training (5 sets of 60s at 90-100% MHR intensity, with 3 minutes at 40-50% MHR). Weight, waist circumference, total serum cholesterol, serum triglyceride and serum high density lipoprotein were measured at 0 week and after 24 weeks of physical exercise protocol.

Results: At the end of study, the anthropometric and lipid parameters has registered significant changes for the group II versus group I regarding: weight (kg): -9.1 ± 3.4

vs - 6.7 ± 2.8 ; waist circumference (cm): - 12 ± 3.5 vs - 9.2 ± 2.4 ; total serum cholesterol ($\text{mg}\cdot\text{dL}^{-1}$): $185.5 \pm 15.7/165 \pm 16.8$ vs $185.3 \pm 14.32/176 \pm 15.64$; serum triglycerides ($\text{mg}\cdot\text{dL}^{-1}$): $190 \pm 25.6/156 \pm 19.7$ vs $192 \pm 7.6/169 \pm 8.5$; high density lipoprotein ($\text{mg}\cdot\text{dL}^{-1}$): $40 \pm 5.4/51 \pm 4.6$ vs $38 \pm 3.5/45 \pm 4.2$.

Conclusions: Physical exercise is one of the best treatments of obesity in young patients. Our study confirms the positive effects of the swimming training on anthropometric and lipid parameters. In this context, the results of our research show that the intermittent swimming training has better results comparative with the continuous swimming training.

Podium #16

The Study of The Effects of Physical Activity and Swimming on The Levels of Depression and The Amount of Using Drugs

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Introduction: The present study has been done with the purpose of necessary attention to mental health and with the overall objective to describe and compare the effect of effect of physical activity on the level of depression and the amount of using drugs in men.

Methods: This study is half-experimental and the results are studied based on the comparison between the samples of pretest and post-test. The method used in this paper is a causal comparative research. The samples were selected in number of 75 people randomly. The age of the samples have been between 30 & 45 years old. They were divided in to three groups: 1-swimming exercise (N = 25). 2-swimming exercise with light music and mind concentration (N = 25) 3-The group without exercise or control group (N = 25) Beck Depression Inventory (B.D.I) depression questionnaire was selected as the measurement instrument. This measures 21 depression aspects. The subject of experimental group practiced 45 – 60 minutes during 12 weeks 3 sessions in a week. In this research descriptive and inferential statistics included T, one-way ANOVA and Tukey test were used.

Results: The results manifests that there is a significant difference in reducing of drug use in pre-test and post-test of both experimental groups(one and two) and in post-test of two experimental groups in comparison to post-test of control group. But there is no significant difference in reducing drug use between the two experimental groups and pre-test, post –test of control group.

Podium #17

Swimming to Combat Obesity: Does Swimming Twice a Week Help?

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Introduction: Obesity, especially childhood obesity is a major health concern in Turkey like in many other countries. Strategies including physical activity enhancement, interventions to eating behavior, are the mostly debated and studied ones. Yet, a certain final formula is not established. Research on target groups are of value for strategy development.

Methods: The study consisted of swimming (N = 370, girls: 198, boys: 172; Age: 9.11 ± 1.3) and control (N = 2518, girls: 1245, boys: 1273; Age: 8.99 ± 1.11) groups. The Swimming group was training twice a week in a public swimming pool. The control group consisted of children not reporting any regular activity. Body Mass Index (BMI) and body composition of the subjects were measured with body-impedance method (Tanita BC-418). The classification underweight-obese was done using age specific BMI percentile curves for Turkish children. The classification was made as; $\leq 5^{\text{th}}$ percentile “underweight”; $5^{\text{th}} - 85^{\text{th}}$ percentiles “normal”; $\geq 85^{\text{th}} - < 95^{\text{th}}$ percentiles “overweight”; $\geq 95^{\text{th}}$ percentile “obese”. Student’s t-test and chi-square testing was used to compare and to detect significant differences in the distribution of weight categories among and within the two groups. Data analysis was performed using SPSS version 17.0. Level of significance was determined as 0.05.

Results: The groups were statistically not different in aspect to age ($p = 0.105$), weight ($p = 0.694$), length ($p = 0.059$), BMI ($p = 0.439$), fat % ($p = 0.510$) and fat mass ($p = 0.276$). The underweight, normal, overweight and obese children in the swimming group were 8 (2.2%), 221 (59.7%), 69 (18.6%), 72 (19.5%); and 41 (1.6%), 1481 (58.8%), 511 (20.3%), 485 (19.3%) in the control group, respectively. The groups did not differ statistically (χ^2 ; df: 3, $p = 0.794$).

Conclusions: Although swimming is a very demanding sport with considerably high caloric expenditure, children training twice a week for one hour do not differ from non-exercising children in BMI, body composition and underweight-obesity classification. In order to achieve health benefits of swimming the training frequency in public services should be enhanced.

Podium #18**Impact of Cool and Warm Water Immersion on 50-M Sprint Performance in Trained Swimmers**

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Introduction: During competition, swimmers are many times required to swim repetitive events with limited rest in between. They often chose to rest either in or out of the water, in normal or warmer water temperature pools. The aim of this study was to elucidate the effect of cool water (CWI), warm water (WWI) and no water immersion (NWI), on sprint swimming and performance variables in simulated competition conditions which demand high performance with short rest intervals.

Methods: Eight well-trained swimmers (21± 2.4 years), after an initial warm up and a 15 min rest period performed two 50-m swimming sprints (S1 and S2) interspersed with a 15-min passive water immersion (head out) period in either cool water (26.7°C) or warm water (30.0°C). Both conditions took place within a 48 period and swimmers were randomly assigned to each condition using a cross-over design. Prior to S1 and S2, blood lactate concentration ($[La]^0$), heart rate, strength (handgrip test) and flexibility (sit and reach test) were recorded. During S1 and S2, time, velocity, stroke rate and stroke length were either recorded or calculated. After S1 & S2, blood lactate concentration at 1 min ($[La]^1$) and 3min ($[La]^3$) were measured.

Results: The statistical analysis revealed, a) no significant differences within and between any of the conditions between CWI, WWI and NWI in time, velocity, stroke rate and stroke length, and flexibility, b) a significant reduction of strength after only WWI ($p=0.029$), c) significantly higher lactate levels prior to sprinting ($[La]^0$) after both WWI and CWI ($p<0.001$) when compared to NWI and d) most interestingly, a complete dissociation of swim performance times (sec) to starting blood lactate levels ($R^2=0.047$; slope NS from zero).

Conclusion: In conclusion, it appears that neither cool nor warm water immersion have any significant impact on performance and swimmers can exert maximally, despite physiological shifts associated to fatigue.

Poster #1**The Study of Sports Injuries over a Period of Two Years in Iranian Swimmers**

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Introduction: Establishing the range of the sport injury is the first step of prevention. Injury prevention is an important part of health care in sport. According to Van Mech-

elen injury prevention model in 1992, first the magnitude of the problem should be recognized with the epidemiological studies in order to be able to plan a preventive measure. Swimming as one of the Olympic sports had the lowest injury risk in Beijing 2008 Summer Olympic Games. While there is a few researches studying the injury profile in swimming and due to the importance of injury identification in prevention studies, this article aimed to study the profile of injuries in Iranian athletes presented to the sport medicine federation injury surveillance system.

Methods: A retrospective analysis was conducted on the data of swimmers in the sport medicine federation injury surveillance system of Iran in 2009-2010. The injury definition was any reported event to the sport medicine federation injury surveillance system as a result of participating in competition or practice, required medical attention by physician and resulted in restriction of the athlete's participation for at least one day beyond the injury. Descriptive statistic and Chi-Square test ($p < 0.05$) was used by the statistic package of SPSS (version 14).

Results: Among 119460 registered athletes, 187 athletes (male = 133 & female = 54 with mean age of 25.76 ± 12.84), presented 223 injuries. The incidence rate of 1.86 per 1000 athletes registered was calculated. Most of injuries happened in males (65%). Chi-Square test showed a significant difference of injuries in dissimilar body regions in 5-14 ($\chi^2 = 24.345$, $df = 3$, $p < 0.001$) and 25-34 ($\chi^2 = 15.538$, $df = 3$, $p < 0.001$) years old groups.

Conclusions: As observed the injury rate was 1.86 per 1000 registered athletes. Boys (5-14 years) and junior or young boys (15-24 years) incurred significantly more injuries than girls and junior girls respectively ($P = 0.001$) however, no significant difference was observed between men and women ($P > 0.005$). The Chi-Square test showed a significant difference in distribution of injuries in different body regions among the children and adults ($P = 0.001$) with the Head & Neck (51.7%) and lower extremity (44.2%) as the most common ones in them respectively. Likewise, youth incurred more injuries in upper extremity (36.7%), Head & neck (29%) and knee (19.2%) in males, furthermore, head & neck (19.2%), knee and low back (both= 15.4%) in females were the most frequently injured body parts. In conclusion, it seems that injury prevention programs should be provided for children and more focused on head & neck in both gender.

Poster #2**Using The Force Time Curve to Determine Centre of Mass Horizontal Velocity at Take-Off The During Grab Start In Swimming**

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Introduction: The centre of mass horizontal velocity when the swimmer's feet leave the starting block (take-off velocity) is a determinant factor for optimal start performances, and is dependent on preceding actions during the block phase. The use of a force-plate can be less-time consuming to provide concomitantly an accurate feedback on the centre of mass horizontal take-off velocity and immediate movement sequences description on starting block. This study aimed to validate concurrently the digital videography and dynamometric methods to assess the centre of mass horizontal take-off velocity.

Methods: Six experienced competitive swimmers (age: 24.16 ± 3.18 years, body mass: 71.27 ± 10.61 kg, height: 1.76 ± 0.06 m), performed three maximal repetitions of the grab starting technique over a 15 m distance with 5 min rest intervals. Four above water video cameras (Sony, Sony® DCE-HC42E, Japan) and a tri-axial force plate (Bertec FP 4060-15, Bertec Corp., USA) collected synchronized 3D kinematic and dynamometric data, respectively. Twenty-four anatomical landmarks were manually digitized for each field using the APASystem (APAS, Ariel Dynamics Inc., USA) and the centre of mass horizontal take-off velocity was assessed. A MatLab routine (Mathworks Inc., USA) was written and run to process ground reaction force-time curves to calculate horizontal velocity component outcomes. The repeatability coefficient and 95% limits of agreement described by Bland and Altman (1986) were calculated.

Results: The centre of mass horizontal take-off velocity values obtained between the two methods showed a repeatability coefficient of 0.43 m.s-1 and [-0.17 to 0.68 m.s-1] agreement limits. A large range of limits of agreement might be explained by two major influences: (i) small bias values present in force measurement can affect integration, giving rise to relevant final velocity measurement deviations; and (ii) filters used in kinematic image processing system might increase the overall uncertainty of measurements, especially in low rate of data acquisition systems.

Conclusions: Findings showed a poor agreement between kinematical and dynamometrical assessment of centre of mass horizontal take-off velocity, with large limits of agreement range. We suggested further studies with higher videometric sampling rate, and with a larger sample.

Poster #3

Linear Kinematics of The Underwater Undulatory Swimming of Two Backstroke Starting Techniques

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Introduction: To maximize speed while minimizing drag during the underwater phase of starts and turns, swimmers perform dolphin-like undulatory swimming. Despite the relevance to performance of the undulatory underwater swimming is extensively recognized, little is known about possible technical modifications during the undulatory cycles with specific fatigue and when performing different backstroke starts like the one with feet parallel and entirely immersed (BSFI), and the one with feet parallel and entirely above water surface (BSFE). The present study aimed to analyze the effects of the backstroke start used (BSFI and BSFE) on the kinematics of the undulated underwater swimming cycles. Simultaneously, the effect of specific fatigue due to repetition of this particular action will also be evaluated in both techniques.

Methods: Four high level backstrokers (age: 22.75 ± 1.70 years, body mass: 75.95 ± 8.85 kg, height: 1.78 ± 0.06 m) performed two randomized sets of three maximal bouts of 15 m backstroke start, each set using BSFI or BSFE. A cable velocimeter (50 Hz) connected at the distal end to a harness belt attached to the swimmer's waist was used to assess linear kinematic parameters of successive undulated underwater cycles (upward and downward kick). The kinematical analysis of the four initial and the last four undulated underwater cycles of each underwater phase was performed using a MatLab routine with a correction for the effect of cable angulation. The mean horizontal velocity and horizontal amplitude were determined in each individual velocity-time curve and presented as a mean value of each of the two groups of four undulated underwater cycles. Descriptive statistics, paired sample t-test ($p < 0.05$) and effect size (d) were calculated.

Results: The kinematic variables were not different between BSFI and BSFE for the four initial and the last four undulated underwater cycles. The four initial undulated underwater cycles showed higher mean horizontal velocity than the last four ones ($p < 0.05$) for BSFI (1.47 ± 0.11 vs. 1.28 ± 0.07 m.s-1) and BSFE (and 1.44 ± 0.04 vs. 1.30 ± 0.04 m.s-1), with large effect sizes ($d = 0.87$ and 0.83 , respectively). The horizontal amplitude for the four initial undulated underwater cycles was greater than the last four in BSFI (0.61 ± 0.07 vs. 0.55 ± 0.05 m) and BSFE (0.60 ± 0.06 vs. 0.55 ± 0.07 m) with large effect sizes ($d = 1.37$ and 0.79 , respectively).

Conclusions: In terms of backstroke technique development, coaches should instruct swimmers to maintain higher horizontal velocity and amplitude of undulated underwater cycles especially at the end of this particular phase, when swimming closer to the water surface, to achieve top results.

Poster #4**Backstroke Technical Characterization of 11 – 13 Years Old Pubertal Female Swimmers**

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Introduction: In swimming, technical ability has traditionally been evaluated through changes in the stroking parameters, i.e., by assessing velocity, stroke rate, and stroke length; complementarily, stroke index was also used to estimate swimming technical skill. More recently, special attention has been given to the temporal coordinative structure, using the Index of Coordination (IdC), which measures the lag time between inter-arm propulsive phases; notwithstanding that many studies were conducted to assess IdC in adult recreational, trained and elite swimmers, the understanding of the motor organization in young swimmers, whatever the swimming technique, is scarce. The aim of the current study was to characterize, both technical and coordinative, the backstroke technique of young female swimmers performing at very high intensity.

Methods: Twenty four pubertal young (11-13 years old) female swimmers of regional level, performed 25-m backstroke at 50-m pace. Tanner stages scale was used to identify the maturation status of the swimmers. Two underwater cameras were used to assess the stroking parameters (velocity, stroke rate, stroke length, and stroke index), as well as two Indexes of Coordination (being identified each stroke phase): (i) IdC 1 that characterizes the continuity between propulsive phases of each arm and (ii) IdC 2 that evaluates the simultaneity between the beginning of the pull of one arm and the recovery phase of the other arm.

Results: Young female pubertal swimmers showed lower values of velocity ($1.06 \pm 0.03 \text{ m}\cdot\text{s}^{-1}$), stroke rate ($39.50 \pm 1.20 \text{ cycle}/\text{min}$), stroke length ($1.64 \pm 0.05 \text{ m}\cdot\text{cycle}^{-1}$) and, consequently, stroke index ($1.76 \pm 0.09 \text{ m}^2\cdot\text{s}^{-1}\cdot\text{cycle}^{-1}$) comparing to data available in the literature for adult swimmers performing at similar relative swimming intensity. This could be justified by their lower anthropometric characteristics once they have not completed the growth and maturation processes. In addition, these young adolescent swimmers, in accordance to data reported in adults, adopted a catch-up ($-9.9 \pm 0.64\%$), and superposition ($2.25 \pm 0.52\%$) coordination mode for the IdC 1 and IdC 2, respectively; the recovery phase had the highest duration, whereas the pull phase had the shortest (no hand lag time was noticed).

Conclusions: Young female swimmers are able to apply a similar coordination mode as adults do. However, their growth and maturation process are yet incomplete, which have consequences on the general stroke parameters.

These characteristics should be taken in account to model the technical and coordinative training done by the swimmers of these ages.

Poster # 5**Benefits of Aquatic Therapy for Children with Cerebral Palsy or Related Disorders**

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Introduction: Water-based therapy is often recommended for persons with disabilities, but little is known about the expected treatment effects. For many children with cerebral palsy, aquatic therapy is appealing due to the reduced joint impact and the positive effects on balance and posture that water provides. The objective of this study was to describe the experiences and outcomes of a structured aquatic therapy program for children with physical impairment due to cerebral palsy or a related disorder.

Methods: Retrospective case series of three children with disabilities who received aquatic therapy through a pediatric hospital-affiliated physical therapy program. An Aquatic Therapy and Rehab Institute-certified physical therapist administered treatment. Children were evaluated before and after the treatment interval with the Water Orientation Test Alyn (WOTA) and parents provided comments. The WOTA1 is a valid and reliable assessment designed for aquatic evaluation of swimmers with limited functional and cognitive abilities and the WOTA2 targets swimmers who can follow instructions. Both are based upon the Halliwick Concept of aquatic rehabilitation which includes initial skills related to orientation in the water and breathing while subsequent skills address static positioning in the water and, later, dynamic control.

Results: All children demonstrated improved aquatic skills. The children were 4, 4, and 10 years of age with motor impairments ranging from mild to severe. They received between 8 and 30 treatment sessions over 2-12 months. WOTA2 scores increased from 14 to 23 (out of 81) for Case 1 and WOTA1 scores increased from 22 to 27 and 28 to 30 (out of 52) for Cases 2 and 3. Case 1 improved in kicking and jogging, single limb stance, and independent exiting in the pool and also showed improved gait pattern and advanced gross motor skills on land. His parents reported improved stair climbing and dynamic balance at home and in the community. Case 2 demonstrated improved active arm movements, kicking, transitions, and weight-bearing in the water. Her parents reported improved posture and upright positioning as well as better body awareness. Case 3 attained better standing, sit-to-stand transitions, and kicking in the water and better weight acceptance for transfers on land. Her family reported greater ease with transfers and transitions, greater strength, and greater confidence.

Conclusions: Aquatic therapy demonstrated positive effects as reflected by the WOTA. The three profiled children gained aquatic skills and also showed improved motor skills on land by parent report.

Poster # 6

Long Term Effects of Different Amplitudes of Whole- Body Vibration Training on Fibrinolytic and Coagulative Factors

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Use of whole body vibration (WBV) as an exercise method has rapidly increased over the last decade. The aim of this study was to evaluate long term effects of different amplitude whole- body vibration training with progressive frequencies on fibrinolytic and coagulative factors. Twenty six healthy male students were divided randomly in three groups: high amplitude vibration group (n=10), low amplitude vibration group (n=11), and control group (n=5). The vibration training consisted of 5 week whole-body vibration 3 times a week with amplitudes 4 and 2mm and progressive frequencies from 25Hz with increments of 5Hz weekly. Concentrations of fibrinogen, plasminogen, tPA, and PAI-1 before and after 5 weeks of training were measured in plasma samples. Statistical analysis was done using one way analysis of variance. $P < 0.05$ was considered statistically significant. The 5 week low or high amplitude vibration training programs with progressive frequencies did not show any significant change in the measured factors, however increase in fibrinolytic and decrease in coagulative activity were shown in the normal range which were not significant statistically. Designing long term whole body vibration training with different amplitudes will cause variable responses in fibrinolytic and coagulative activities.

Poster # 7

Anthropometrical Changes of Talented Turkish Children Swimmers in One Year Period

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Introduction: It is well known that building up an elite swimmer requires a dedicated hard training for years. Choosing the talented swimmer and adjusting the training program up to physiological changes during childhood is extremely important to start performance training. With this in mind we aimed to follow a group of talented swimmers from Turkey for one year period to determine some of the anthropometric changes appear in this time period.

Methods: 23 talented children swimmers (13 girls and 10

boys) aged 11 - 12 were followed for 1 year. Children were swimming regularly in their clubs and invited to national training camp to evaluate their swimming technique and anthropometric characteristics 1 year apart. Body weight, height, fat percentage, arm span, and foot length were measured by the same investigator. Body fat percentage was determined as defined by Yuhasz formula. All statistical analyses were performed using SPSSv13.0.

Results: Stature height increased significantly in both boys (8.3 ± 2.7 cm [mean \pm SD]) and girls (7.5 ± 4.5). Final stature height was measured for boys and girls as 160.3 ± 6.0 and 155.8 ± 4.8 cm, respectively. During one year period, boys gained 6.0 ± 2.73 kg and their body weight was measured as 48.7 ± 6.4 kg ($p < 0.001$). Girls gained 5.8 ± 3.1 kg in one year ($p < 0.001$) and their final weight was measured as 45.2 ± 5.0 kg. Body fat was calculated as 10.7 ± 4.8 % for girls and 9.1 ± 2.4 % for boys ($p < 0.01$). Parallel with the changes in stature height, arm span measurements and foot length was increased significantly for the both sexes. Final arm span was measured for girls 161.4 ± 5.8 cm (increased 8.4 ± 2.8 cm). Boys' final arm span was 164.4 ± 8.8 cm (increased 8.6 ± 5.3 cm). Foot length of girls and boys were measured as 24.4 ± 1.0 and 25.9 ± 1.4 cm, respectively.

Conclusions: The changes in stature height rate indicate that children swimmers from both sexes may be in the peak height velocity age group. Pre-pubertal and presumably beginning of adolescence age group training is extremely important. Coaches have to adjust loading strategy properly for these children. High arm span - stature height ratio may be interpreted as an anthropometric advantage swimmers. Regular evaluation of children is important for futures' champions.

Poster # 8

Anthropometrical Characteristics of Talented Turkish Children Swimmers

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Introduction: Federations have to begin working with age groups to create a good national competitive team in world swimming. Finding the talented swimmer is obviously a challenge for a nation and requires a long time programmed dedicated effort. Turkish swimming Federation is collecting nationwide children swimmers annually and evaluates their swimming and anthropometric characteristics. The aim of this study is to share the findings of last 3 years nationwide data.

Methods: 283 children swimmers (143 girls - 140 boys) aged 11 - 12 were followed with this program. Children were swimming regularly in their clubs and invited to training camp to evaluate their body weight, stature height, fat percentage, arm span, lower extremity, foot

and hand length were measured. Body fat percentage was determined by Yuhasz formula. All statistical analyses were performed using SPSSv13.0.

Results: Boys' stature height measured as 153.0 ± 8.7 cm [mean \pm SD] and was not significantly different from girls (154.5 ± 6.6). Body weight difference between girls and boys were not significant as well (45.3 ± 8.2 vs 44.0 ± 7.0 ; respectively). Boys' body fat percentage was 9.6 ± 4.3 %, and found to be significantly lower than girls (10.9 ± 4.9 %). Arm span was not significantly different for boys and girls (158.9 ± 10.0 vs 158.2 ± 7.2 ; respectively). Comparison of arm span to stature height ratio had shown that boys and girls have similar characteristics (1.02 ± 0.02 vs 1.02 ± 0.03 , respectively). However, boys' shoulder – wrist length (58.2 ± 3.2) was significantly longer than girls (57.0 ± 3.6). Hand length difference for boys (17.7 ± 1.5) and girls (17.44 ± 1.9) was not significant. The difference of lower extremity length for boys (81.0 ± 11.5) and girls (80.0 ± 10.4) was not significant. Boys had significantly longer foot compare to the same age grouped girls ($p < 0.001$) (boys: 24.7 ± 1.7 , girls: 23.9 ± 1.1). Foot to stature length ratio was higher than girls (0.16 ± 0.01 vs 0.15 ± 0.01 ; respectively) ($p < 0.001$)

Conclusions: Genetic is one of the main determinants of anthropometric characteristic of an individual. Finding the most extremes in terms of body composition that available for competitive swimming may be important to determine top level athlete. It is a challenging issue to predict changes during adolescence in age groups. Delicate evaluation of the children in their lifespan is necessary to make conclusion for anthropometric characteristics.

Poster # 9

Evidence of Increased Epithelial Stress and Damage in Swimmers with Airways Hyper-responsiveness

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Introduction: Asthma is common in elite level swimmers. There is concern that this may be due to exposure to the chlorinated pool environment and that the development of AHR is related to repetitive stress and damage to the epithelium. Prostaglandin E2 (PGE2) has previously been proposed as a bronchoprotective molecule in the human airway and is secreted from epithelial cells.

Methods: In a cohort of swimmers undergoing investigation for exercise asthma we collected induced sputum inflammatory cell counts and analysed the sputum supernatant for a number of chemokines including PGE2.

Results: In this cohort of 90 swimmers there were higher levels of PGE2 in the sputum of those with a positive EVH test (mean log PGE2 1.41 ± 0.06 ng·ml⁻¹, n = 40) than those with a negative EVH test (mean log PGE2 1.23 ± 0.04 ng·ml⁻¹, n=50). There were also greater numbers of

epithelial cells in the sputum of those with a positive EVH test (sputum epithelial cell % 18.74 ± 3.4 %, n = 40) than those with a negative test (sputum epithelial cell % 9.42 ± 2.24 %, n = 50).

Conclusions: The induced sputa from elite level swimmers with AHR shows increased levels of epithelial cell shedding and significantly greater levels of the protective chemokine PGE2 than those with no evidence of AHR. This suggests a strong role for epithelial cell damage in the development of AHR in elite level swimmers.

Poster # 10

The Effects of Different Resistance Exercises in Water on Blood Lactate Kinetics in Swimming

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Aim: The aim of this study is; to examine the effects of additional resistance using on lactate kinetics in competitive swimming.

Methods: For this aim, 14 male elite swimmers are selected from 14-16 age group who are located in first 5 rank in national wide swimming competitions. Swimmers are separated in two groups according to the results of body mass index measurements. The swimming test protocol is applied to the groups on different days with 1 day intervals in 50m indoor swimming pool. The swimming test protocol is applied in order with; “without additional resistance equipment (H)”, “with fins (F)”, “with pedal (P)”, “pedal and fins together (P+F)”. Second test is applied 5 weeks after the first test and, third and last test is applied after 5 more weeks following the second test with same swimming test protocol. Beside blood lactate test, number of total swimming strokes and pulse rates are recorded. In swimming protocol, 2x300m and 2x200m Freestyle (crawl) swims are applied. Swimmers swum first 300m at aerobic threshold level, second 300m at anaerobic threshold level, following 200m at maxVO₂ level and last 200m at maximum pace. After first 300m 1 minute, after second 300m 3 minute, after following 200m 15 minute rest is given. Blood samples are taken from the fingers before and after the test swims. “Kruskal-Wallis” test is applied at the data's statically analysis and discussion phase of every test according to the methods to find any significant result and after “Dunn multiple comparison” test is also applied to these statistically significant results. “Repetitious measurements” and “Variance analysis” is also applied to the test results to determine the differences between the trainings and the groups each other. The statically analysis of the data's are done with SPSS 15.0 version.

Results: As a result, blood lactic acid values are found significantly higher while using additional resistance equipment in maximum speed swims at the beginning of season. Besides that, no significant differences are found between additional water resistance equipments using

training group and non-using group in terms of speed development. By using additional water resistance swimming equipment, swimming speed increase against reduction on stroke frequency is also determined.

Poster # 11

Thoracic Outlet Syndrome in a Male Swimmer- A Case Report

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Introduction: Thoracic outlet syndrome is the result of compression on the superior thoracic outlet. In this region, various structures might put pressure onto the neurovascular bundle. Differential diagnosis is essential for proper treatment.

A Case Report: A 17 year old male swimmer had pain and swelling in his both forearms and hands. During swimming he had pain in the first 30 minutes and could not complete training sessions. X-ray results didn't show cervical rib. EMG and cervical MRI findings were normal. He was diagnosed to suffer from lateral epicondylitis by two different orthopedic surgeons and received steroid injection to his right lateral epicondyle. The treatment did not relieve his complaints and he came to our clinic. After the examinations, he was diagnosed as Thoracic outlet syndrome. He tended to use especially shoulder elevator muscles in any relevant and some irrelevant arm movements. After one week of rest, his complaints were decreased. Three weeks of specific exercise protocol for postural stabilisation around scapular region and upper back muscles started to relieve his symptoms, his participation to low intensity swimming training became more comfortable, and also duration of painfree swimming increased.

Conclusions: In thoracic outlet syndrome, the involvement of physiologic structures needs to be considered. Correcting postural deficits and building scapular muscle strength and stability could be very important for overhead athletes and swimmers. These stability and strength may also help prevention of other possible overhead related injuries and may help for the performance of athletes.

Poster # 12

Parent's Awareness of Obesity Increase Attendance to Swimming

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Introduction: Childhood obesity is a major health concern in Turkey. Enhancing physical activity is one of the prevention strategies. In childhood, mostly the parents are decision makers. Swimming is a very suitable mode of exercise for obese children. We studied parents' awareness of obesity in two different groups, one swimming regularly and the other not.

Methods: The study consisted of swimming (N= 296, girls: 167, boys: 129; age: 9.59 ± 1.64) and control (N= 986, girls: 492, boys: 494; age: 8.31 ± 1.44) groups. The swimming group was participating in swimming activities twice a week in a public facility, where the controls were not exercising regularly. The parents were asked to define their children in one of the four categories; underweight, normal, overweight and obese. Body Mass Index (BMI) and body composition of the subjects were measured (body-impedance; Tanita BC-418). The classification underweight-obese was done using age specific BMI percentile curves. The determinations were; $\leq 5^{\text{th}}$ percentile "underweight"; $5^{\text{th}} - 85^{\text{th}}$ percentiles "normal"; $\geq 85^{\text{th}} - < 95^{\text{th}}$ percentiles "overweight"; $\geq 95^{\text{th}}$ percentile "obese". Student's t-test and chi-square testing was used to compare the groups and to detect differences in the distribution of weight categories among and within the two groups; and parent's awareness/recognition of obesity. Data analysis was performed using SPSS version 17.0. Level of significance was determined as 0.05.

Results: The groups were found to be statistically different in their age, weight, length, BMI, fat% and fatmass ($p < 0.001$ for all). These findings were irrelevant to the main aspect of the study. The rates of underweight, normal, overweight and obese children did not statistically differ between the groups (χ^2 ; df:3, $p = 0.668$). Both parent groups did tend to estimate their children in a lesser weight category. The parents of the swimming group (SP) especially the parents of overweight and obese children have categorized their children more realistic/correct than the parents of the control group (CP). The ratios of underweight, normal, overweight and obese children in swimming (S) and control (C) groups were found to be S: 2.7%, 61.8%, 18.6%, 16.9%, C: 3.7%, 58.2%, 19.6%, 18.6% respectively, where the estimation of parents were SP: 20.9%, 49.7%, 26.0%, 3.4%; CP: 14.6%, 65.7%, 18.3%, 1.4%.

Conclusion: Attendance to physical activities of children is the decision and with the consent of parents. The parents of the swimming group have been found to be better in recognition of the problem; hence they are thought to direct their children to regular swimming activity.

Poster # 13

Correlations Between Physiological and Kinematic Variables in Assessment of Swimmers' Exertion

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Introduction: The factors assessing athletes' commitment in performed physiological tests are not commonly discussed in literature. Proper interpretation of test results depends on conscientious workout performed by athlete. Permanent analysis of physiological variables together with measurement of kinematics parameters is essential in planning long-term athlete development. The aim of the study was to present correlations between physiological and kinematic variables as the factors determining swimmers' involvement in performance of 5x200m step test. We wanted to discover individual relationships between lactate concentration (LA) and stroke length (SL), stroke rate (SR), stroke index (SI), turns velocity and swimming velocity.

Methods: Four junior swimmers (3 male and 1 female) aged 16 ± 0.4 years, participated voluntarily in the study. They all presented high level of sport competence, placing in finals of national junior championships. The study was conducted using a 5x200 m backstroke step test which consists of five 200-metre bouts that must be covered with increasing pace every subsequent repeat. The first bout was completed with 75-80% of the maximal velocity for the distance, the second with 81-85%, the third with 86-90%, the fourth with 91-95%, and the last one with maximal velocity. Breaks between the repeats lasted 3, 5, 7 and 20 minutes respectively. Capillary blood samples were drawn from the ear lobe 1 minute after each repeat. Time measurement was done with the use of 25 Hz Sony camera and a professional computer software (Adobe Premiere Pro v7.0). The software calculated turns and swimming velocity as well as stroke length, stroke rate and stroke index. Pearson's coefficient was used in assessment of correlations between kinematic variables and lactate values. The level of statistical significance was set at $P < 0.05$.

Results: Mean values of Pearson's coefficient showed significant correlations between lactate and most analysed kinematics variables. Mean LA concentration during maximal effort was $12.12 \text{ mmol} \cdot \text{l}^{-1}$. The highest relations were observed between lactate and stroke rate ($r = 0.98$, $p < 0.05$). The lowest and non-significant liaisons were found between lactate and stroke index ($r = 0.62$, $p > 0.05$). Lactate concentration was correlated insignificantly with stroke length and turns velocity in one participant.

Conclusions: The analysis of lactate concentration and kinematics variables revealed individual diversity. It is suggested that correlation value may be an indicator determining swimmers' involvement in exertion tests.

Poster # 14

Recovery of Performance Following Repeated 10 S Sprints in Cycling, Free Swimming and Leg-Kick with Flippers Swimming Exercise Modes

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Introduction: Recovery of performance during repeated sprint swimming seems to be faster compared to similar duration sprint cycling protocols. However, these protocols have been applied to different groups of participants and there is no such a comparison on the same group of subjects. It is likely that the mode of exercise, the muscle mass involved or the body position affects the rate of performance recovery.

Methods: Five male and five female swimmers with previous competitive swimming experience participated in the study (mean \pm SD, $n = 10$, age: 21.1 ± 0.4 , Body mass: 76 ± 3 kg). Maximum oxygen uptake (VO_2max) during cycling and during tethered swimming was measured before the commencement of the main trials (Oxycon Jaeger). The participants completed two 10 s sprints interspersed with 15, 30, 60, 120 and 300 s passive rest with cycling (MONARK 894E), tethered crawl swimming and tethered leg-kick with flippers swimming exercise modes (piezoelectric force transducer connected with analog to digital converter - MuscleLab). Each testing session was completed on a different day with a counter-balanced order. The percentage change of performance during the second compared to the first sprint were calculated and compared between exercise modes (power output during cycling and force during swimming and leg-kick with flippers swimming). A two-way analysis of variance (exercise types x interval duration) was used for the statistical analysis.

Results: Cycling VO_2max was lower than tethered swimming VO_2max (43 ± 4 vs. $46 \pm 3 \text{ ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, $p < 0.05$). The percentage recovery of power output, tethered swimming and tethered leg-kick with flippers swimming force were similar between exercise modes at 15, 30, 60, 120, 300 s intervals (cycling: 85 ± 6 , 88 ± 6 , 95 ± 4 , 97 ± 3 , $99 \pm 2\%$; tethered swimming: 83 ± 7 , 87 ± 7 , 92 ± 5 , 98 ± 6 , $98 \pm 5\%$, tethered leg-kick with flippers swimming: 84 ± 7 , 89 ± 7 , 93 ± 8 , 99 ± 6 , $100 \pm 5\%$ $p > 0.05$). The rate of recovery was not related to maximum oxygen uptake in cycling or swimming ($p > 0.05$). Heart rate was lower during leg-kick with flippers swimming compared to cycling and swimming (Cycling: 138 ± 9 , Swimming: 137 ± 11 , leg-kick with flippers swimming: $128 \pm 9 \text{ b} \cdot \text{min}^{-1}$, $p < 0.05$).

Conclusion: Despite different exercise modes and body position or exercise environment, the recovery of performance is comparable following 10 s maximum intensity bouts.

Poster # 15

Strength and Endurance Training in Elite Water Polo Players

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Introduction: Concurrent strength and endurance training is usually applied together with water polo training

planned for improvements of technique or game tactics (game specific training). However, no data exist describing the effect of such training on performance parameters in elite water polo players. The purpose of the present study was to investigate the effect of maximal strength training and high intensity endurance training concurrent to game specific water polo training on maximal strength and swimming performance indices.

Methods: Seven elite male water polo players (age: 29.6 ± 5.2 years, body mass: 91.5 ± 10.3 kg) participated in the study and completed 8 weeks of maximal strength and high-intensity endurance training concurrent with game specific water polo training during the pre-season period. Maximal strength and specific performance indices such as swimming speed corresponding to blood lactate concentration of 4.0, 5.0, 10.0 $\text{mmol} \cdot \text{l}^{-1}$ (V4, V5, V10) and lactate tolerance ability defined as the differential velocity between blood lactate concentrations of 5.0 and 10.0 $\text{mmol} \cdot \text{l}^{-1}$ (V10-V5) were examined using a one-group pre-post-test design. The maximal strength was measured by bench press 3 repetition maximum (3RM). On a separate day, each player performed an incremental swimming test (5 X 200-m) at intensities corresponded to 60, 70, 80, 90 and 100% of maximum 200-m speed, with a 5-minute passive recovery between each effort. A blood sample was obtained at the end of each repetition for the determination of lactate concentration. The swimming velocity corresponding to V4, V5 and V10, was calculated from the speed-lactate curve by interpolation of a second order polynomial function. The intervention program consisted of endurance training (2 series of 8 X 100-m) at intensity ~5% above the V4 and maximal strength training (90% 3RM, 5 repetitions, 4 sets) which targeted on specific muscles that mainly used in water polo. Both training modes were conducted twice per week on separate days and followed by game specific water polo training.

Results: Significant improvements in maximal strength (~20%, $p < 0.05$), in swimming speed corresponding to V4 ($4 \pm 4\%$, $p < 0.05$), V5 ($3 \pm 3\%$, $p < 0.05$) and the lactate tolerance ability (V10-V5, $30 \pm 31\%$, $p < 0.05$) were observed after the training period compared to pre-training values.

Conclusion: it appears that the pre-season strength and endurance training concurrent to game specific water polo training improves both swimming performance indices and muscle strength of elite water polo players.

Poster # 16

Kinematical Parameters Around The Maximal Lactate Steady State Test in Swimming

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Introduction: Nowadays, performance tests are used as part of elite training programs to access important variables to achieve the best performance of each subject, as the understanding of the fatigue at the maximal aerobic intensity (aerobic capacity) and biomechanical adjustments needed to the maintenance of that swimming intensity. Thereby, the purpose of this study was to compare the kinematical parameters obtained at and above maximal lactate steady state (MLSS) in front crawl.

Methods: Thirteen long distance swimmers (28.9 ± 10.8 yrs, 1.75 ± 0.51 m, and 67.1 ± 5.7 kg) performed, in different days, two to four 30-min constant speed tests to determine the velocity at MLSS (100%MLSS) and above (102.5%MLSS) (Pelarigo et al., 2011). The video analysis were digitalized manually and frame by frame (APAS, Ariel Dynamics, USA) allowing the determination of kinematical relevant parameters at five different instants of each test (0, 25, 50, 75 and 100%).

Results: There were significant differences in intensity and blood [La-] at the 10th and 30th min between 100%MLSS (1.10 ± 0.15 $\text{m} \cdot \text{s}^{-1}$, 3.25 ± 1.08 and 3.38 ± 1.18 mM) and 102.5%MLSS (1.13 ± 0.16 $\text{m} \cdot \text{s}^{-1}$, 3.80 ± 1.99 and 5.26 ± 2.21 mM), respectively. In relation to the exercise intensity, there was no difference. Regarding the effect of time, at 100%MLSS, there were a significant increase in stroke rate (SR) (0.46 ± 0.06 - 0.50 ± 0.07 Hz) and propulsive phase C (push) along the test (19.5 ± 3.7 and $22.1 \pm 4.3\%$) and a decrease in stroke length (SL) (2.21 ± 0.30 - 2.13 ± 0.31 $\text{m} \cdot \text{cycle}^{-1}$). At 102.5%MLSS, there were a significant increase in SR (0.47 ± 0.07 - 0.53 ± 0.10 Hz) and a decrease in SL (2.19 ± 0.32 - 2.06 ± 0.35) and propulsive efficiency (0.37 ± 0.06 - 0.34 ± 0.05).

Conclusions: Since differences between intensities were not found at the same time instants of the test, our results suggests that the major differences between kinematical parameters occurred along the time within each test, which might explain the specificity of the long distance swimmers training, requiring biomechanical adjustments to maintenance of the intensity.

Poster # 17

Anthropometrical Evaluation of Turkish National Team Before and After Altitude Training Camp

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Introduction: It is well known that elite, successful swimmers have a specific anthropometric characteristic which is important to determine the athletic performance. The aim of this study was to evaluate the effect of high altitude heavy training program on the anthropometric characteristics of the Turkish national team swimmers.

Methods: 17 national team swimmers (11 male and 6 female) aged 19.4 ± 3.1 (mean \pm SD) were joined to this 3 weeks training program which performed in Pretoria – South Africa at February 2012. Swimmers were trained for 2 sessions per day and each session was divided to dry land and swimming trainings. Somatotype evaluation was measured before and after the training period by utilizing Heath-Carter methodology and body fat percentage was determined as defined by Siri Formula. Pre- and post training statistical evaluation was performed with paired samples *t* test by the use of SPSSv13.0.

Results: Swimmers' pre-training height, body mass and fat percentage was measured as 176.6 ± 10.0 cm, 71.6 ± 10.7 kg and 13.6 ± 5.1 respectively. After 3 weeks of extensive training, body mass and fat percentage was reduced to 71.0 ± 10.8 kg and 10.5 ± 3.9 % respectively ($p < 0.05$). Training session also affected the somatotype profile of the swimmers. Pre-training ectomorphy (2.6 ± 0.8), endomorphy (2.8 ± 0.8) and mesomorphy (3.8 ± 1.1) was changed significantly after the training camp. Swimmers' post-training ectomorphy, endomorphy and mesomorphy was calculated as 2.7 ± 0.8 , 2.5 ± 0.7 and 4.3 ± 1.0 respectively. Swimmers' body muscle mass percentage was increased nearly 1.2 % through out the training period (pre- training 46.6 ± 1.8 to post- training 47.8 ± 2.0).

Conclusions: Three weeks intensive training was enough to make a significant change in body composition which presumably may affect their performance. Efficiency of training period may be determined with anthropologic evaluation. Regular calculations of somatotype profile are important to keep elite athletes ready for heavy training and top level competition.