Free Communication Abstracts

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 # 3 Assessment of a sport socicalization intervention programme on social skill learning of children with intellectual disability in Kakamega , Kenya

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Background: Experts advocate for promotion of socialization of children with intellectual disability, into sports for social skills enhancements. Despite this, trend shows that large numbers of these children are still inactive and susceptible to social skill challenges. The purpose of this study was to determine if socialization in sports leads to social skill learning among these children.

Methodology: This Study used Single Subject Research Design (SSRD) replicated across 8 subjects. Purposive sampling was used to get the study sample of 8 children with ID (4 Boys and 4 Girls) and 24 typically developing (TD) peers from Kakamega County. Data was collected at 3point intervals: baseline of two weeks with non –intervention, treatment of six weeks, and post – intervention for four weeks. Instruments of data collection were, Peer Social Task Rating Scale (PSTRS) adapted from Social Skill Rating Scale (Gresham &Elliot 1990) and 3-5 minute video coding (Faith 2012). Data was subjected to SAT/ETS software. Chi-square, Pearson's Moment Correlation Coefficient (PMCC), Time series and Regression analysis, were used in data analysis. Level of significance was set at 0.05 alpha level and results presented in graphs, charts, histograms and percentages.

Results: Participants scored lower in use of social skill strategies: 35% at baseline compared to 65% after the program. The social skill functioning levels of the study participants improved from a mean of 3.35 and SD of .50 at baseline to 4.29 and SD of .94 after the program. There was a positive correlation between social competence and time taken in the intervention program at 0.88.

Conclusion: The intervention program was effective in enhancing social skill development of children with ID. The study recommends that policy frameworks should focus more on socialization programs in promoting social skill learning in the school curriculum and community level for overall development of children with ID.

Faith, A. Hodgins, J.K. and Reigh, J.M (2012). Audi-Visual Prediction of Child social Behaviour. Decoding children's social behavior; social Interactions; A first person Perspective. Centre for Behaviour Imaging. Emory University, U.S.A.,Gresham, F.M. & Elliot, S.N. (1990). Social Skill Rating System. Circle Pines MN: American Guidance Service.

 # 4 Quality Participation in Parasport: A Narrative Perspective

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BACKGROUND: Despite the many prospective benefits associated with parasport involvement, rates of parasport participation among individuals with physical disabilities are quite low. For those individuals who do participate in parasport,

notions of quality participation – that is, the subjective or experiential aspects that make participation satisfying or meaningful – are not well understood (Martin Ginis et al., 2016). As such, the purpose of this study was to explore and typify narratives of athletes' participation in parasport throughout the life course. Narratives represent common stories that people tell to communicate meaning and share experiences; thus, these narratives provide important insight into what quality participation means and how quality experiences be fostered for parasport athletes.

METHODS: Two-part retrospective life history interviews were conducted with 21 current or former athletes with a physical disability (congenital or acquired). This sample included men and women with experience participating in a range of individual and team parasports from recreational to elite levels. Interviews were transcribed verbatim and subjected to a dialogical narrative analysis (Smith, 2015). This analysis enabled an in-depth examination of the common stories told by athletes and the effects of these stories on their past, present, and future participation in parasport.

RESULTS: Six distinct narrative types were constructed from the data, representing differential developmental trajectories and conceptions of participation in parasport. These narrative types were framed by three common narratives in the sport literature (Douglas & Carless, 2006): performance (i.e., "I couldn't be successful without sport being the most important thing in my life"), discovery (i.e., "Sport was the conduit for me to be in different worlds"), and relational (i.e., "I played my heart out for someone else"). Narrative types were further distinguished by athletes' gender, disability type, and the specific meaning or value associated with participation in parasport (e.g., social acceptance; sense of purpose; independence and autonomy; confidence and success; (re-)discovering sense of self or identity; fun and enjoyment).

IMPLICATIONS: The results of this study will inform the future development of parasport programmes designed to enhance the quality of participation and improve participation rates among individuals with physical disabilities. Specifically, these narratives offer alternative perspectives on the developmental pathways of parasport athletes and what it means for these athletes to participate; such views may inform successful recruitment and retention efforts targeting (prospective) athletes in the parasport system.

Douglas, K., & Carless, D. (2006). Performance, discovery, and relational narratives among women professional tournament golfers. Women in Sport and Physical Activity Journal, 15, 14-27.

Martin Ginis, K. A., Evans, M. B., Mortenson, W. B., & Noreau, L. (2016). Broadening the conceptualization of participation for persons with physical disabilities: A configurative review and recommendations. Archives of Physical Medicine and Rehabilitation. Advance online publication.

Smith, B. (2015). Narrative analysis. In E. Lyons & A. Coyle (Eds.), Analyzing qualitative data in psychology (2nd ed., pp. 202-221). London, UK: Sage.

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5 Setting the classification standards for para-shooters with vision impairment

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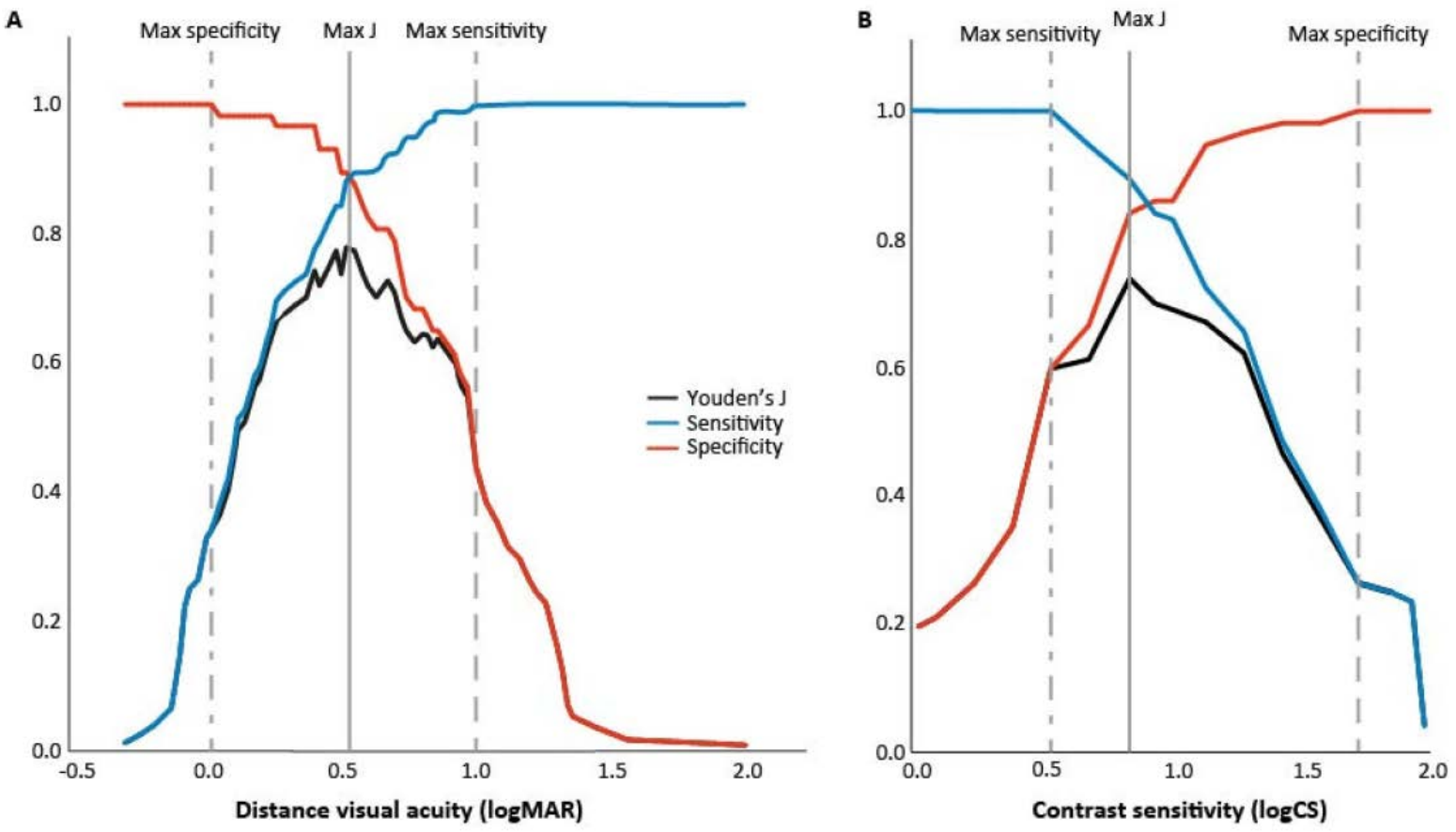
VI shooting is not currently included in the Paralympic games as a stand-alone sport. A potential barrier for inclusion is the need to develop, in accordance with the IPC Classification Code, an evidence-based system of classification specific to the sport. This means that the sport must provide evidence to demonstrate (1) the minimum level of impairment necessary for inclusion in competition (the minimum impairment criteria), and (2) whether the eligible athletes should compete together in one class or be separated into separate classes. Shooting is a sport of particular interest to athletes with vision impairment because, in the adapted form of the sport, competitors can rely on sound in addition to (or rather than) vision to guide the direction of the gun barrel towards the target. Two studies addressing the appropriate criteria for shooting are reported here. Study 1 aimed to establish the minimum level of vision impairment necessary to compete in visually impaired (VI) shooting by testing the level of simulated impairment that would reduce performance in athletes without impairment in the un-adapted form of the sport. The shooting performance of nineteen elite able-sighted shooters was assessed while wearing lenses that simulated a range of different levels of vision impairment. There was no change in shooting performance for initial decreases in visual acuity (VA) and contrast sensitivity (CS), and then quickly deteriorated with more severe loss. When treated individually, a VA cut-off of 0.53 logMAR (log of the minimum angle of resolution - approximately half the level of impairment currently required to compete) was deemed to be the most suitable cut-off for acuity, and 0.83 logCS (log of contrast sensitivity - not used for classification presently) for the cut-off for contrast sensitivity. However, the results show that a suitable minimum impairment criterion is most likely to require a combined consideration of both VA and CS. The aim of study 2 was to determine whether a significant relationship exists between vision and performance in those shooters currently competing with vision impairment in the adapted form of the sport (using auditory guidance of the rifle towards the target). Ten athletes with vision impairment currently competing internationally in VI shooting events participated. The relationships between VA, CS and shooting performance confirmed that individuals with residual vision had no advantage over those without vision (auditory guidance helps them overcome the loss of vision) suggesting that one class might be appropriate for VI shooting. The results help to work towards a sport-specific evidence-based system of classification for VI shooting.



Tweedy, S.M., and Vanlandewijck,Y.C. (2011) .International Paralympic Committee position stand: background and scientific principles of classification in Paralympic sport. Br. J. Sports Med. 45, 259–269.doi: 10.1136/bjsm.2009.065060,

Myint,J., Latham,K., Mann,D.L., Gomersall,P., Wilkins,A.J., and Allen, P. M.(2016).The relationship between visual function and performance in rifle shooting for athletes with vision impairment. BMJ Open Sports Exerc. Med. 2:e000080. doi:10.1136/bmjsem-2015-000080,

Allen P.M., Latham K., Mann D.L., Ravensbergen H.J.C. and Myint J. (2016) The level of vision necessary for competitive performance in rifle shooting: setting the standards for Paralympic shooting with vision impairment. Front. Psychol. 7:1731. doi: 10.3389/fpsyg.2016.01731

 # 8 Impact of trunk and arm impairment on performance of wheelchair and ball activities in wheelchair rugby during competition

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INTRODUCTION: Wheelchair rugby classification is developing toward evidence based classification. The classification system consists of an evaluation of neuromusculoskeletal impairments resulting in scores for trunk and arm impairment. The impact of trunk and arm impairment on wheelchair activities has been established in standardised activities. However, it is unknown if this impact is also present in ball activities and during a competition.

PURPOSE: To determine the impact of trunk and arm impairment on wheelchair and ball activities in elite wheelchair rugby players during competition.

METHODS: 31 players from three world top 10 ranked teams participated, 18 had trunk score 0 (No Trunk, NT), 13 had trunk scores 0.5-1.5 (some Trunk, T). The arm scores were as follows 12, 0.5-1.5 (Poor Arm Function, PAF), 13, 2.0 (Moderate Arm Function, MAF) and 6, 2.5-3.5 (Good Arm Function, GAF). Teams competed in a total of 5 matches at an international competition. Physical data about each player's wheelchair activities were monitored during matches, using an indoor tracking system. Technical data about wheelchair and ball handling activities were monitored via video analysis. Outcome measures for wheelchair activities were: relative distance covered, peak speed and the relative time spend in six arbitrary speed zones (lowest speed Z1 – highest speed Z6). Outcome measures for ball activities included: goals scored, passes (including type, inbounds, assists, and success rate), possession duration and turnovers. Statistical analysis was performed using the Kruskall-Wallis test and multiple regression analysis. If a difference between categories of trunk and arm impairment was significant and the

performance measures were successfully entered into the regression model, effect sizes and 90% confidence intervals were calculated. Only if the confidence interval did not include a trivial effect size (< 0.2) the impact of the impairment of performance was considered relevant.

RESULTS: Trunk and/or arm impairment contributed to the explained variance observed in all measures of performance except catch success rate and the number of blocks performed, which were removed from further analysis. There was an impact of T versus NT on the chair activities relative distance and time spent in Z1, and on goals scored, passes and pick-ups.

There was an impact of GAF and MAF versus PAF for all chair activities except for time spent in Z2, and for goals scored, passes and possession duration. There were no differences between GAF and MAF except for passes received, one handed passes and defensive blocks.

CONCLUSIONS: Both trunk and arm impairment impact on wheelchair and ball activities in elite wheelchair rugby competition. Arm impairment had an impact on more activities than trunk impairment. However, this difference was mainly found between GAF and MAF versus PAF. Opposed to standardised testing, the impact of trunk and arm impairment on activities in a competition may also depend on team tactics and line up, the role on court and rules on equipment. A study limitation was that not all scores of trunk and arm impairment could be assessed separately, because of the limited number of participants.

Altmann VC, Groen BE, Hart AL, Vanlandewijck YC, van Limbeek J, Keijsers NL. The impact of trunk impairment on performance-determining activities in wheelchair rugby. Scand J Med Sci Sports. 2016 Oct 2. doi: 10.1111/sms.12720. [Epub ahead of print]

 # 16 VALIDITY, RELIABILITY AND SENSITIVITY TO CHANGE OF THE BASKETBALL WHEELCHAIR MOBILITY PERFORMANCE TEST

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INTRODUCTION: To examine in a standardized manner the maximal ability of wheelchair athletes to accelerate, sprint, brake or rotate in wheelchair basketball, i.e. the wheelchair mobility performance, a Wheelchair Mobility Performance Test (WMP test) was designed, based on observational data and measurements of wheelchair basketball matches and expert opinions (de Witte et al., 2017). The aim of the present study was to assess the construct validity and reliability of the WMP test and its sensitivity to change by manipulating the wheelchair configuration.

METHODS: Forty-six wheelchair basketball athletes, dived into three categories (classification, playing standard and sex), performed the test to determine its validity. Twenty-three athletes performed the test twice for reliability. In order to measure sensitivity to change, 8 athletes performed the test in three wheelchair conditions: 1) 10kg extra mass, 2) 50% reduced tire pressure (both conditions are assumed to increase external work required) and 3) control (no added mass and normal tire pressure). Construct validity was assessed by independent-samples t-tests and Cohen's d Effect Sizes [ES] on the differences in

the times needed to complete the test between classifications, playing standards and sex. The reliability of the WMP test was determined through Intraclass Correlation Coefficients (ICC) and the sensitivity to change of the WMP test was examined with paired t-tests, the standardized response mean and ES.

RESULTS: With respect to construct validity, males performed the WMP test faster than females ($p<0.001$, ES= 1.26) and international males outperformed national male players ($p<0.001$, ES= 1.62). Performance time of low (≤2.5 points) and high (≥3.0 points) classification players was borderline not significant with a moderate ES ($p=0.06$, ES=0.58). The reliability of the WMP test was excellent for overall performance time (ICC=0.95). Sensitivity to change was shown with significantly more time needed to complete the WMP test for both manipulated conditions compared to the control condition ($p<0.05$). The effect size values ranged from 0.33 to 0.61, which showed an acceptable to good sensitivity to change for these wheelchair configuration manipulations.

DISCUSSION: These results show that the WMP test can be used as a standardized mobility performance test among wheelchair athletes to validly and reliably assess the overground wheelchair mobility performance. The WMP test seems to have the ability to detect changes in mobility performance when external work- related wheelchair configuration characteristics are manipulated. Further research needs to be done to see to what extent the WMP test can detect changes in mobility performance when different wheelchair-user interface characteristics are manipulated.

de Witte AMH, Hoozemans MJM, Berger MAM, et al. Development, construct validity, and test-retest reliability of a field-based wheelchair mobility performance test for wheelchair basketball. J. Sports Sci. 2017. DOI: 10.1080/02640414.2016.1276613.

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18 A classification model for Paralympic clay target shooting

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INTRODUCTION: Olympic trap clay target shooting (CTS), a sport aimed at hitting clay targets thrown in a randomized order at varying speeds, angles and elevations, is currently also performed by motor impaired shooters (MI-CTSh). For CTS to receive the endorsement of the International Paralympic Committee (IPC) and to be included in shooting sport events, a selective classification model that would allow for an equitable competition (Tweedy and Vanlandewijck, 2011) must be developed.

PURPOSE: To provide an evidence-based classification model in which MI-CTSh are grouped according to their motor impairment kinds and levels, so that their activity limitations would impact on sport performance in a similar way.

METHODS: A group of 86 MI-CTSh were tested in accordance with the IPC standards for classification procedures. Thirty-four motor functions were evaluated for each side of the body with a score from 0 to 5, assessing either strength or active\passive range of movement (depending on the impairment). Only 75 MI-CTSh met the inclusion criteria of at least 1 international

competition and at least 2 years of shooting experience and had the following selected impairments: hypertonia (4), limb deficiency (7), impaired muscle strength (41) and reduced passive range of movement (13). They were clustered using a K-Means Cluster Analysis on both impairment and motor characteristics. To investigate for cluster differences, the MI-CTSh were compared in terms of their median performance score (% of 125 targets) over a 6 year period of competitions (PSmedian) using box-plot representation and a non parametric one-way ANOVA, with post hoc Mann-Whitney test.

RESULTS: Athletes were clustered in three groups. Cluster 1 included 22 MI-CTSh competing in a sitting posture on a regular wheelchair (21 with a spinal cord injury, 1 with multiple sclerosis). Cluster 2 included 29 MI-CTSh able to shoot in a standing posture despite their lower limb impairment (out of 29), 6 standing MI- CTSh with a mild impairment in the upper limb which sustains the barrel of the gun (out of 9) and 7 MI-CTSh (out of 29) who compete in a sitting posture using a regular wheelchair (one with Charcot-Marie-Tooth and 6 with an incomplete paraplegia). Cluster 3 included 10 MI-CTSh able to shoot in a standing posture: 7 (out of 7) using one upper limb to shoot because of their severe impairment in the upper limb which sustains the barrel of the gun and the remaining 3 (out of 9) MI- CTSh with a mild impairment in the upper limb which sustains the barrel of the gun. Performance was statistically different (p-value < 0.001) only between Cluster 1 and 2 (Figure 1). In Cluster 3, performance was higher for those shooting with two arms.

CONCLUSION: Cluster analysis, percentage distribution within the clusters and activity limitation support a classification model with three classes: Class 1 for sitting MI-CTSh, Class 2 for standing MI-CTSh with a lower limb impairment, and Class 3 for standing MI-CTSh with an impairment on the barrel-side upper limb. Given the different activity limitation and performance in Class 3, we propose the use of a correction factor based on performance score, to allow an equitable competition between those who use one or two upper limbs.

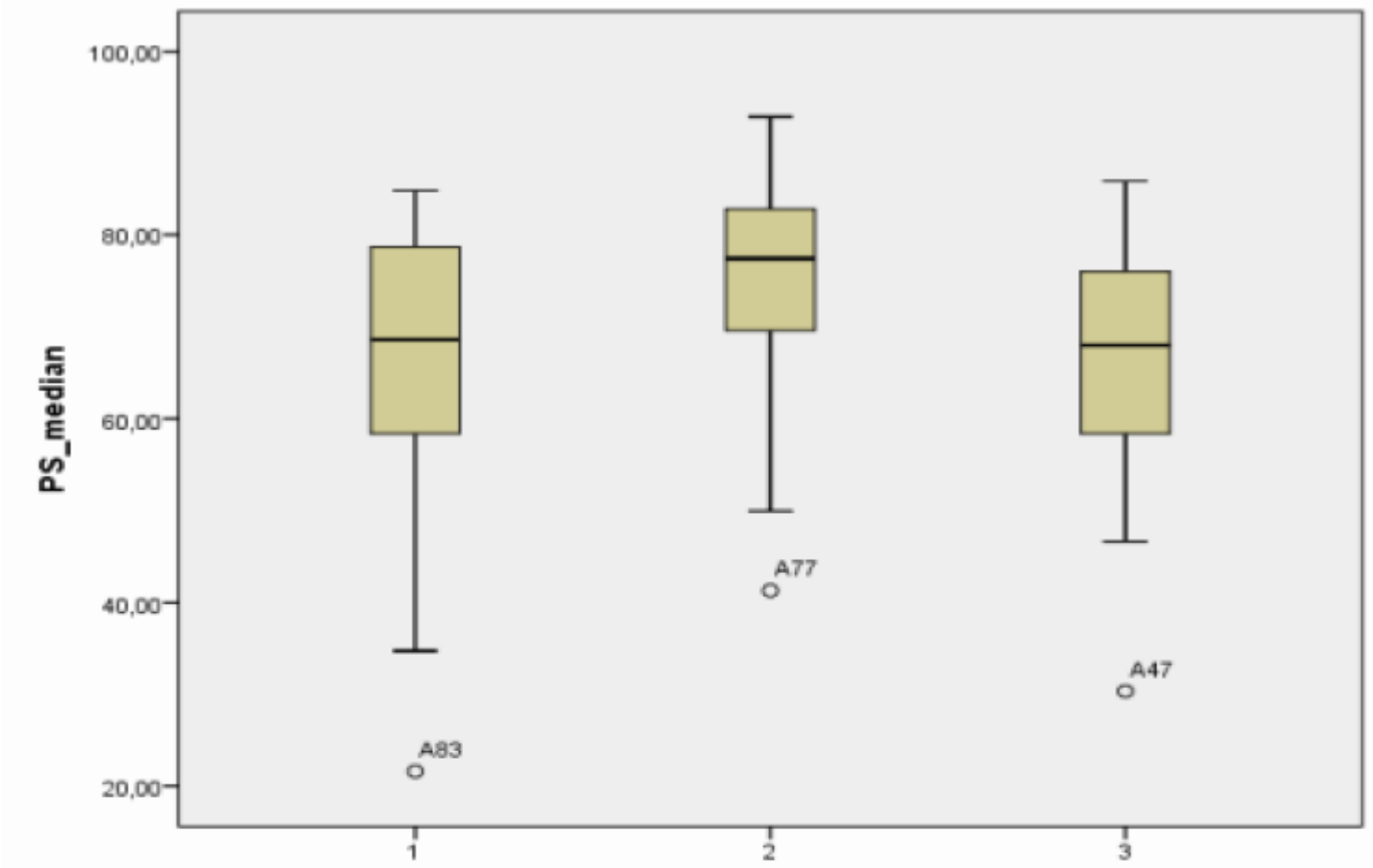

Figure 1. Boxbox-plot representation (median, interquartile and outliers) of the performance score obtained as percentage of the clay targets hit out of the total 125 targets of the eliminatory phase. The percentage is the median score obtained over a 6 year period of competitions (PS_median) in the 3 groups formed with the Cluster Analysis. The outliers are: A83 is a shoother with tetraplegia, A77 is a shooter with incomplete paraplegia, A 47 is a shooter with hemiplegia who shoots with one upper limb (no use of the barrel-side upper limb).

Tweedy SM, Vanlandewijck YC (2011) International Paralympic Committee position stand—background and scientific principles of classification in Paralympic sport. Br J Sports Med 45:259–269.

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20 Development of two evidence-based classification systems for Paracanoe

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Introduction: One of the conditions for a new sport to be included in the Paralympic Games is to comply with the International Paralympic Committees (IPC) Athlete Classification Code by developing a sport-specific classification system through evidence-based research focusing on the relationship between impairment and key performance determinants (IPC 2015). This has been conducted for para-kayak (PK), one of two disciplines in the relatively new sport Paracanoe, which made its debut in the 2016 Paralympic Games. A new system for the other discipline, para-va'a (PV), has recently been developed and the proposal will be submitted to the IPC in 2017 for inclusion in the next Paralympic Games.

Purpose: The purpose of this presentation is to describe the development process of creating evidence-based classification systems for the two disciplines PK and PV.

Methods and results: The first step in creating the classification systems for both disciplines was to examine the three-dimensional (3D) kinematics and kinetics during high intensity level kayak or va'a ergometer paddling to define the performance determining joints and in which ranges of movement (ROMs) the athletes move for power production. In the PK study, ten elite able-bodied sprint kayak athletes (4 females, F) and 41 elite PK athletes (13 F) participated. Ten elite able-bodied sprint va'a athletes (5 F) and 44 elite PV athletes (13 F) participated in the PV study. With this information new physical assessment tests for trunk and leg function was developed in sport- specific ROMs for PK and PV, respectively. The kinematic and kinetic data was also used to develop technical assessment tests for on-water paddling for each discipline. A scoring system from 0-2 was used for all tests and a definition of what each score implied was established. The second step was to analyse if the results from the kinematic and kinetic data correlated with the scoring from the new tests in order to validate each test. The results showed that the tests were significantly positive correlated with the kinematic and kinetic data. The third step was to conduct a cluster analysis to identify clusters within the para-athlete group for each test, to set the boundaries in the scoring of the tests between the clusters and to identify differences between the para-athlete group and the able-bodied group to define minimal eligibility for each discipline. The fourth step was to identify the number of existing cluster combinations for trunk, leg and on-water tests in order to further divide the para-athletes into classes, i.e. three classes for PK and PV, respectively.

Conclusion

The results from the PK and PV studies demonstrated that the new tests were valid and sport-specific since they well reflected how the athletes were performing during paddling. The stepwise process of the development of the classification system was also successfully performed since the PK classification system has already been approved by IPC and the PV will be submitted shortly after helpful feedback from the IPC. The information about the process might be helpful for other Paralympic sports when creating new evidence-based systems.

IPC Athlete Classification Code
http://www.paralympics.org.nz/Portals/17/Documents/Pathway/Classification/Classifier%20Resources/IPC%20Athlete%20Classification%20Code%20and%20International.pdf

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 # 21 An Analysis of Female Athlete Triad Risk Factors in Elite Para Athletes

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INTRODUCTION: The female athlete triad (triad) is a syndrome defined as the interaction of three interrelated conditions: low energy availability with or without disordered eating, menstrual dysfunction, and low bone mineral density (BMD). The triad may also impact males, and may have long term health consequences if unaddressed. Although participation in elite para sport is rapidly growing, no studies have assessed the prevalence of triad risk factors in this population. The purpose of the present study is to evaluate the prevalence of triad risk factors in an elite para athlete population and association to sex and para sport type.

METHODS: Subjects were United States elite para athletes who were training to qualify for the 2016 summer or the 2018 winter Paralympic games. Participants completed an online questionnaire characterizing nutrition, menstrual status (if female), bone health, and awareness of the triad. Responses were analyzed to determine the prevalence of risk factors for triad components, and significant differences based on sex and sport type (leanness vs. non-leanness).

RESULTS: A total of 248 (144 male, 104 female) athletes completed the survey. Of these, 137 athletes competed in leanness sports and 109 athletes in non- leanness sports. Of the cohort, 40% (53 male, 45 female) of athletes indicated that they were currently trying to lose weight, and 61% (n = 151; 90 male, 61 female) indicated they were attempting to change their body composition to improve sport performance. Only 3% (1 male, 6 female) of athletes indicated that they had been previously diagnosed with an eating disorder. For pre-menopausal women, 32% (n = 29) reported less than 9 menstrual cycles in the past year. A total of 21% (27 male, 25 female) of athletes reported a history of a bone stress injury, yet 9% (8 male, 13 female) reported a diagnosis of low BMD based on DXA scan. There were no differences in risk factor prevalence between sexes or those competing in leanness versus non-leanness sports. Only 9% of athletes were aware of the triad.

CONCLUSIONS: Elite para athletes are at significant risk for triad components, regardless of sex or sport type. Awareness of the triad in athletes is low. While consequences of the triad in a para athlete population are poorly understood, screening tools and education to increase awareness are required to optimize overall health of this population.

De Souza MJ, Nattiv A, Joy E, et al. 2014 Female Athlete Triad Coalition Consensus Statement on Treatment and Return to Play of the Female Athlete Triad: 1st International Conference held in San Francisco, California, May 2012 and 2nd International Conference held in Indianapolis, Indiana, May 2013. Br J Sports Med. 2014;48(4):289.

Tenforde AS, Barrack MT, Nattiv A, et al. Parallels with the female athlete triad in male athletes. Sports Med. 2016;46 (2):171-82.

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Runciman P, Tucker R, Ferreira S, et al. Site-specific bone mineral density is unaltered despite differences in fat-free soft tissue mass between affected and nonaffected sides in hemiplegic paralympic athletes with cerebral palsy: preliminary findings. Am J Phys Med Rehabil. 2016;95(10):771-8.

 # 22 The impact of continental association affiliation and inequality-adjusted human development index level on NPC team size, gender split and medal success at the summer and winter Paralympic Games.

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In order to claim to be a truly worldwide sporting movement it is essential that the International Paralympic Committee ensure that the Paralympic Games encompasses as diverse a range of the worldwide population of people with disabilities as is possible. This presentation will examine the diversity of participation at the Paralympic Games in terms of athlete origins and social and economic development in order to investigate how these factors might impact both on the opportunity to participate at the summer and winter Paralympic Games as well as the potential for medal success. These issues will be investigated from the perspective of Continental Association affiliation (athlete origin) and the ranking of each NPC's country using the Inequality-adjusted Human Development Index (social and economic development) in order to assess the impact of each on issues such as team size, gender make-up of teams and medal success at the summer and winter Paralympic Games.

As an example table 1 (see attached) clearly shows that the number of NPCs attending the summer Paralympic Games has risen significantly across all continents, but that the average team size has dropped (most likely due to the athlete cap on numbers). It can be seen in Africa in particular despite the huge increase in NPCs participating the average team size since 2004 hasn't risen above 8 and actually dropped to 7 in 2016. Analysis of the team sizes from Rio shows that 43.1% of all athletes (and 42.8% of all female athletes) competing in Rio came from Europe, whereas only 7.3% (and 7.4% of women) came from Africa. This is reflected in the medal tables where Europe won 49.3% of all medals in London and 43.6 of medals in Rio (most likely due to the absence of Russia). The Continental Association figures for the winter Games are even more stark with Europe making up 62.1% of all athletes and winning 80.1% of all medals.

However, the really interesting outcomes appear when the data is analysed in terms of the Inequality-adjusted Human Development Index (IHDI) indicating a clear link between IHDI ranking between team size, number of women in a team (See Table 2 (attached) as an example) and medal success. The results of this analysis show that the higher the IHDI ranking of the participating NPCs the team size will be greater, the number of women in the team will be greater (only 8% of NPCs in the highest IHDI rank had no women in Rio compared to 50% in the lowest rank), the NPC is more likely to win medals and that the majority of all medals go to NPCs in countries from the top two IHDI ranks with 92.9% of all medals in Rio going to NPCs from these countries. The same pattern is found for the winter Games where 100% of all medals in Sochi went to NPCs in countries from the top two IHDI ranks.

The aim of this presentation is not to try and explain all of these issues (although suggestions will be made for some of them), but rather to highlight them as important issues worthy of deeper investigation in order to assist IPC become a truly worldwide sporting movement based upon equality of opportunity.

Brittain & Mashkovskiy

Table 1. NPC and Number of Athletes Participation by Continental Association

Location	Europe	Americas	Africa	Asia	Oceania
Seoul	(27) 1479 (55)	(11) 706 (64)	(4) 73 (18)	(16) 610 (38)	(2) 189 (95)
Barcelona	(33) 1798 (54)	(16) 630 (39)	(11) 94 (9)	(20) 316 (16)	(2) 147 (74)
Atlanta	(41) 1939 (47)	(18) 654 (36)	(16) 130 (8)	(25) 339 (14)	(3) 197 (66)
Sydney	(41) 2076 (53)	(20) 668 (33)	(20) 213 (11)	(33) 583 (18)	(7) 339 (48)
Athens	(42) 1927 (46)	(24) 695 (29)	(28) 216 (8)	(36) 778 (22)	(5) 192 (38)
Beijing	(45) 1954 (43)	(24) 751 (31)	(30) 251 (8)	(40) 858 (21)	(7) 197 (28)
London	(47) 2085 (44)	(28) 803 (29)	(39) 307 (8)	(42) 854 (20)	(8) 188 (23)
Rio	(44) 1859 (42)	(26) 1010 (39)	(42) 314 (7)	(39) 925 (24)	(6) 207 (35)
Average	(40) 1890 (47)	(21) 740 (35)	(24) 200 (8)	(31) 658 (21)	(5) 207 (41)

Red= No. of NPCs; **Blue** = No. of Athletes; **Green** = Average Team Size

Table 2. NPC Team Size Average in Rio by IHDI

IHDI	NPCs	Men	Average	Women	Average	Total	Average
Very High	50	1530	30.60	1002	20.04	2532	50.64
High	44	883	20.07	554	12.59	1437	32.66
Medium	29	179	6.17	68	2.34	247	8.52
Low	34	54	1.59	45	1.32	99	2.91
	157*	2646	16.85	1669	10.63	4315	27.48

* Does not include the two male Independent Paralympic Athletes

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 # 24 Determinants of Participation in Paralympic sports among athletes with disabilities in developing nations. The case of Kenya, Uganda and Tanzania.

Bukhala, P, .D.[1]; Legg, D.[2]; Higgs, C.[2]

1. Masinde Muliro University of Science & Technology, Kenya; 2. Mount Royal University, Canada; Memorial University, Canada

Background: Understanding the socio-economic determinants of Paralympic participation and success is important for the Paralympic movement's growth and evolution. Many of the existing research in this realm have focused on western and or developed nations. Unfortunately, for those in developing and non western nations many persons with disability do not participate in sports. To address this lack of participation a global model of the determinants of participation was developed by Legg, Panikowiak and Higgs (2016) to better plan for and address participation in all nations. The current study builds upon this theoretical model by attempting to validate it by focusing on the the determinants of participation in sports for persons with disabilities in Kenya, Uganda and Tanzania.

Methods: Approximately 300 athletes in different Paralympic sports in rural and urban settings from Kenya, Tanzania and Uganda were assessed by survey to determine their determinants for sport participation. One example where data was collected was the national sitting volleyball competition in Kakamega, Kenya. Specific examples of issues addressed in the surveys included funding, availability of inclusive sports programmes and competitions. Government and nongovernmental agency representatives were also interviewed to complement the survey results.

Results: Analysis of data are on going but early results suggest that a number of factors impact participation including the role of non-governmental organizations to support disability programmes. Funding from governments for disability sport are also significant factors as too are the urban rural divide resulting in varying access to facilities. Access to classification for participation and competition in various parasports also appears to be a significant factor impacting participation.

Legg, D., Panikowiak, A., & Higgs, C. (2016). Understanding the Para Sport Athlete Pathway: Focus on Participation, Presentation at the International Convention on Science, Education and Medicine in Sport Conference, Sao Paulo.

 # 28 Validation of a class allocation method for wheelchair track athletes with impaired strength – a proof of concept study

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BACKGROUND: Methods for allocating athletes with impaired strength to one of the four wheelchair track racing classes – T51 to T54 – are relatively straightforward if the athlete has an impairment profile that is consistent with a single class (e.g., motor-complete spinal cord injury or lower limb amputation). However many athletes have impairment profiles which include features from two or more class profiles and under these circumstances reliable decision-making is difficult to achieve and the validity of the decision is difficult to demonstrate. We recently demonstrated that cluster analysis of six novel isometric strength measures produced a valid, evidence-based, four-class structure for a sample of wheelchair track racing athletes. In order to implement such a system in the sport of Para athletics automated, statistically-based decision-making procedures are required. Such procedures would greatly increase the reliability, objectivity and validity of decision-making in classification.

PURPOSE: The purpose of this study was to evaluate 6 statistical methods that could be used for allocating athletes with impaired muscle strength to a wheelchair track class based on isometric muscle strength scores.

METHODS: Fifty simulated datasets were generated each comprising 1000 samples of six muscle strength outcomes. Each generated dataset was based on strength data collected in 32 international wheelchair track racers (ranging from T54 to T51 athletes) who had impaired muscle strength. The six strength measures comprised: the weakest and strongest arm pronators; the weakest and strongest left and right arm extension; an isolated trunk strength measure; and an arm extension+trunk strength measure. Cluster analysis with a four class structure was used on each dataset to determine the true class for each generated sample. The accuracy and error rate of six classification methods - artificial neural networks, k-nearest neighbour, decision tree, discriminant analysis, naïve bayes and ensemble classification - was estimated for each of the 50 datasets using 10-fold cross validation. These analyses were carried out in Matlab version R2015b (Mathworks, USA).

RESULTS: Preliminary results indicate that the statistical classification methods show acceptable accuracy with low error rates consistently less than 5%.

DISCUSSION: This is the first study to demonstrate that statistical classification techniques which automate the class allocation process can accurately allocate athletes to a class with low error rates. The differences between the methods will be discussed. These methods have the potential to provide classifiers with non- biased classification recommendations based on isometric strength outcomes alone. In future studies, these procedures need to be replicated in a large, representative sample from the true wheelchair track racing athlete population to determine the optimal parameters of the best performing model.

 # 30 Visual function of Para Alpine and Para Nordic skiers with visual impairment

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Paralympic skiers with visual impairment (VI) are classified into groups for competition based on their level of impairment with the intent to minimise the impact of the impairment on competition.[1] The current classification system only considers visual acuity (VA) and visual field size in the better eye.[2] No other measures of visual function are considered. The purpose of this study was to examine a wide range of visual functions in elite skiers with VI, to determine 1) the range of visual impairment in this population, 2) how the measures of visual function are related in individuals with visual impairment, and 3) how visual function is related to skiing performance.

Sixty-one skiers (29 Alpine, 32 Nordic) from the 2015-16 season participated in this research; additional Alpine and Nordic skiers are being recruited during the 2016-17 season. Skiers were 12 - 69 years old; 38 were male, 23 were female. During 2015-16, static VA (ETDRS, Berkeley Rudimentary Vision Test [BRVT]), contrast sensitivity (CS; Pelli-Robson), dynamic VA and low contrast VA (in-house software [moV&, V&mp Vision Suite]), colour vision (large D-15) and glare sensitivity and glare recovery (glare source + MARS charts) were measured. All tests were done binocularly except for glare sensitivity and recovery, which were done monocularly. During 2016-17, static VA (ETDRS, BRVT) and CS (Adaptive Sensory Technology, Berkeley Contrast Squares) are being measured binocularly. Results of the visual function tests were compared with each other and with skiing performance. IPCAS and IPCNS points from 2015-16 were used to measure performance. Additionally, a normalised point system based on raw race times was used as a second measure of performance. Data were not normally distributed, therefore correlations between visual function parameters were examined using Spearman's rho. P-values were adjusted using Holm's method to control for multiple comparisons. Similar analysis will be done for 2016-17 when data collection is completed.

Static VA was quantifiable in 55 athletes tested during 2015-16 (mean logMAR 1.54±0.72, range 0.14 logMAR to no light perception). Mean CS (n=50) was 0.64 logCS ± 0.50 (range 0.00-1.55 logCS). Significant correlations ($p<0.01$) were found between a number of visual functions, including static and low contrast VA ($r_s=0.863$), static and dynamic VA ($r_s=0.773$), static VA and CS ($r_s=-0.749$), low contrast and dynamic VA ($r_s=0.899$), CS and low contrast VA ($r_s=-0.641$),

CS and dynamic VA (rs=-0.565), and glare sensitivity and glare recovery (rs=0.477). No single measure of visual function was found to independently predict performance, however in male Alpine skiers there was a trend that suggested skiers with greater visual function had a better overall ranking.

A wide range of visual functions can be measured in skiers with VI. Different measures of visual acuity (static, dynamic and low contrast) were highly correlated. Contrast sensitivity also correlated with measures of acuity. No individual visual function was predictive of performance in Alpine or Nordic skiing; therefore, it is likely that revised classification systems will need to include multiple measures of visual function.

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International Paralympic Committee. Athlete Classification Code.; 2015. https://www.paralympic.org/sites/default/files/document/151218123255973_2015_12_17%2BClassification%2BCode_FINAL_0.pdf

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 # 32 Comparison of rolling athletes' leg times to runners' in a running relay – a multivariate approach

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Today some running races also have a wheelchair class with a separate result list for that class. However, in running relay races it is difficult to form a full team of wheelchair athletes and thereby also to arrange a competitive wheelchair class with many teams. In this work a running relay race organiser wanted to include athletes manually propelling on different kind of rolling equipment in the same class as leisure runners and the objective of the research study was to facilitate this by developing a multivariate prediction model that adjusted the rolling athletes' leg times to be comparable with runners' times.

The race had 51 legs over 337 km and 15 athletes (12 male, 3 female) with and without disabilities rolled through all the legs. There was also a mix of physical performance ability in the group. 37 of the legs were rolled by athletes with a physical disability; such as uni-lateral leg amputation (wheelchair or double-poling on a skate-board), bi-lateral leg amputation (hand bike), spinal cord injury (hand bike or wheelchair) and uni-lateral partial paralysis on both leg and arm (three wheel bicycle). Legs rolled by able-bodied were carried out on a hand bike.

A Polar RS800CX watch with a G3 GPS sensor was used to acquire all positioning data during the race. Based on information of for example time, distance, altitude, estimated physical ability, equipment weight, person weight, type of equipment and ground material; 31 variables were created. One single response variable was used for calibration of the prediction model. This response variable stated an adjusted leg time that was originating from a 1-10 grading by the authors of the athlete's physical ability and a corresponding estimated running speed, ranging from 3,5 min/km to 6,5 min/km. Partial least squares prediction modelling in SIMCA P-11 by Umetrics AB was used for the multivariate analysis. During the modelling work 13 weak variables

were excluded as they were not considered to contribute with additional information to the model. Also, 6 out of 51 observations were excluded due to measurement uncertainties.

The results showed that it was possible to calibrate a valid prediction model of adjusted leg times with an explained variance (R2) of 0.97 and a predicted variance (Q2) of 0.92. These are high values, however, it should be remembered that the model's response variable used for calibration was estimated and no model is better than the information it is based upon. Also, a validation using new data has not been done.

Based on the adjusted leg times o f the prediction model, the total rank of the rolling team would be approximately 140th position out of nearly 200 teams and the best ranking on an individual leg was 17th. The total rank without timing adjustment was approximately 90th and the results on an individual leg could vary between first position (predominantly downhill in the leg) and last position (predominantly uphill in the leg). When looking at the total ranking, it could be discussed if this type of adjusting of times is needed in the leisure class of a long relay race.

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33 Relationships between internal and external training load in handcyclists

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Background: Monitoring of training is important to prevent overuse injuries or overtraining in handcyclists and to give handcyclists insight in their (perceived) training load. Two methods that are often used to monitor the internal training load are based on heart rate (HR) and rating of perceived exertion. Although these measures have been validated and are very promising in exercises such as kayaking and cycling, the validity of these measures in Paralympic sports is only investigated in wheelchair rugby. Better relationships might be expected in handcycling since, in contrast to court sports, it is an endurance activity and in addition, the power output can be measured continuously during handcycling to get a very good indicator of the external training load.

Purpose: To establish the relationship between internal training load (i.e. TRaining IMPuls (TRIMP) methods, based on session Rating of Perceived Exertion (sRPE) and HR and external training load (i.e. Training Stress Score (TSS) based on power output (PO)) during handcycling training sessions.

Methods: 13 Recreational handcyclists participated in this study. All handcyclists were training four months for a mountain time trial in Austria. Participants performed a graded peak exercise test in their handcycle attached to an ergometer before the start of the training. During the training session PO and HR were measured. After each training session, the participants filled out their sRPE. The TSS was calculated from the PO data and the TRIMP based on HR, HRzones and sRPE were also calculated. Partial and Pearson correlations were performed to determine the relationship between TSS, TRIMP_HR, TRIMP_HRzones and TRIMP_sRPE for the whole group and each participant, respectively.

Results: The participants achieved on average a POpeak of 156±26 W, HRpeak of 181±12 bpm, and a median Borg score of 9 (interquartile range of 9-10). In total, there were 334 training sessions of which the mean cycling distance was 36.6±18.2 km, with a mean velocity of 21.6±5.1 km/h, a mean power output of 82.7±21.9 W and a mean HR of 132±23 bpm.

The within-subject correlations between the internal and external load measures were very large (r=0.80-0.83) as well as the correlations between the TRIMP_sRPE and the TRIMP scores based on HR (r=0.76-0.79). However, on an individual level the correlations varied from large to nearly perfect, e.g., r=0.56 -0.99 between TRIMP_sRPE and TSS.

Conclusions: Since the correlations varied considerably among individuals, it is recommended to use different training load measures in handcycling. However, when it is not possible to monitor the training with PO due to lack of the necessary equipment, the cheap TRIMP_sRPE or TRIMP_HR seems to work well in most athletes.

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34 Issues Pertaining to Development of Athletes with a Disability

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In recent decades, the Paralympics movement has gone through tremendous development (Radtke & Doll-Tepper, 2014). Compared to the first Paralympics held in Rome in 1960, which attracted 400 athletes from 23 nations, the most recent summer Games, in Rio, Brazil (2016), attracted 4,342 competitors from 159 countries. However, the literature examining the development and training histories of athletes with a disability has not kept pace with the growth of the Games (Bednarczuk, Rutkowska, & Skowronski, 2013; Dehghansai, Lemez, Wattie, & Baker, in press). While there may be similarities between mainstream and parasport athletes pertaining to elements such as the influence of various forms of practice on performance, the introduction of disability-related variables further complicates the complexity of athlete development. This presentation describes our multi-phase exploration of the development of athletes with a disability.

The first phase of our study involved a systematic literature review to synthesize the existing literature, which resulted in 21 studies categorized into three categories; training and practice (n=9), short-term interventions (n=8), and long-term changes due to training (n=4). Results demonstrated that very little is known of training characteristics and developmental trajectories of athletes with a disability. The second phase of this project examined developmental trajectories and training histories of fifty-two junior and senior, female and male athletes training with the National Canadian Wheelchair Basketball Academy. There were no between-group differences in regards to development and training when athletes' disability severity was controlled for. While the majority of athletes demonstrated a similar pattern of development, athletes with congenital disabilities reached milestones at earlier ages than athletes with acquired disabilities. However, this significance was reduced when only key milestones (i.e., international debuts) were considered.

The general findings of this study generated a range of issues that form the basis for future studies. For example, do athletes with acquired disabilities transfer their skills learned from mainstream sports to reach key milestones at a similar ages to those with congenital disabilities. In addition, does the nature of disability (i.e., neuromuscular or skeletal) influence the process of skill acquisition and does this differ across sports (complexity and skill demands vary such as between open vs. closed-skill sports). Furthermore, considering the limited evidence provided to date, the significance of athletes' direct (i.e., family members,

coaches) and indirect (i.e., policies, program offerings) environments is unknown. In conclusion, there is clear need for research on the development of athletes with a disability across a variety of sports in order to understand the nuances pertaining to disability and development among this population.

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35 Investigating the Clinical Effects of Performance-focussed Swimming Training for People with Cerebral Palsy: a Pilot Study

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Background : Participation in sports training typically involves accumulating large volumes of vigorous intensity physical exercise throughout organised training cycles which are designed to optimise performance for competition. Anecdotal evidence from Paralympic athletes with Cerebral Palsy (CP) who have participated in ‘performance-focused’ training over a number of years suggests that this type of exercise confers meaningful clinical benefits, which may exceed those associated with low-moderate volume therapeutic programs. However, this premise is yet to be investigated scientifically. The aim of this pilot study is to evaluate the impact of participation in a performance-focused swimming training program on clinical outcomes and impairments to strength, range of movement and co-ordination. This paper presents outcomes related to health, fitness and function.

Methods: A 20-year old female with ataxic CP classified as level II on the Gross Motor Function Classification System is completing a four-phase N-of-1 trial which lasts 65 weeks. The trial comprises a baseline phase (A1), introductory training phase (B), performance-focused training phase (C) and a withdrawal phase (A2). There is no formal training in the baseline phase (A1). Training load in the introductory training phase (B) is low-moderate and progresses to the dose recommended as physical activity guidelines. Training load in the performance-focused phase (C) is moderate-high, consistently exceeds physical activity guidelines and is individually tailored to optimise swimming performance. In the withdrawal phase (A2) there is no formal training, and physical activity behaviour mirrors the baseline phase. Measurement of outcomes related to health (SF-36), fitness (V02 peak) and function (Gross Motor Function Measure) are performed five times in each of the four phases, with a total of twenty data collection points during the trial.

Results: Data will be aggregated, and comparison of trends between phases will illustrate the true effect of the intervention. Complete results in the outcome areas of health (SF-26), fitness (V02 peak) and function (Gross Motor Function Measure) will be presented at the conference.

Conclusion: This is the first study to evaluate the relationship between performance-focused swimming training and the clinical outcomes of health, fitness and function in people with CP. Outcomes from this study will provide an insight into the therapeutic value of participation in swimming for performance, and may provide a framework for increasing participation in competitive sport for people with CP.

Tweedy, S.M. et al., Performance-Focussed Sport – An Avenue to Gold-Medal Clinical Outcomes for People with Neurological Impairments? Brain impairment, 2016. 17(01): p. 99-110.

Verschuren, O., et al., Exercise and physical activity recommendations for people with cerebral palsy. Developmental Medicine & Child Neurology, 2016

 # 36 Usability and feasibility of a novel eHealth application for self-reports of Sports-Related Injuries and Illnesses in Paralympic Sport

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Background: Knowledge of sports-related injuries and illnesses in Paralympic sport (SRIIPS) is limited and few studies have longitudinally assessed SRIIPS. An established method to monitor athletes' health over a longer period is to use self-reports. When combined with modern eHealth applications, large scale epidemiological studies can be pursued. However, surveillance of self-reported health outcomes using eHealth is an unexplored area within Paralympic sport. To establish a user-friendly surveillance system, adjustment of current eHealth applications to the needs of the target population is a key factor, and the usability of such an application needs to be tested with regard to users' task and needs. To allow full-scale research, a feasibility study is also needed to ascertain the validity of such a new approach.

Objective: The aim of this study was to evaluate the usability and feasibility of a novel eHealth application for self-reports of SRIIPS.

Design: A four-week pilot study with an integrated usability and feasibility evaluation.

Participants: Twenty-eight elite Swedish Paralympic athletes with vision (n=11), physical (n=15) and intellectual impairments (n=2) active in 11 sports.

Methods: The athletes were asked to every week self-report electronically SRIIPS, pain, anxiety, training load and exposure. To evaluate its usability and feasibility, the athletes were asked to retrospectively assess the method in an electronic and modified version of the Post-Study System Usability Questionnaire. Quantitative data were analysed through descriptive statistics and qualitative data were analysed using a thematic analysis method.

Results: The average weekly response rate was 95%. In total 1643 self-reports were registered; there were only 37 instances of missing data (2%), mostly from visually impaired athletes that had problems to respond to multiple-choice questions. The athletes sometimes found it difficult to understand the definition of a new injury and if they should report it, especially when the impairment was involved. The athletes found it important to have the opportunity to also report new events related to their impairment. The eHealth application design issues were related to the reporting of multiple incidents. The athletes were generally of the opinion that the eHealth application could be extended to longer periods of time. Fifteen new injuries and fourteen new illnesses were reported, giving a cumulative incidence of 1.8 injuries/100 hours and 1.7 illnesses/100 hours of athlete exposure. The typical injury severity was 1-3 days time loss of training. In 20% of the injuries and 21% of the illnesses the impairment contributed to the injury and illness.

Conclusions: This is the first study of self-reported SRIIPS using an eHealth application. Generally, the eHealth application was usable, but should be adjusted to visually impaired athletes and injury definitions need to be explained in greater detail and better adapted to Paralympic sport. Overall, the proposed variables and method are feasible. Based on this, we prepare a long-term prospective longitudinal study with the aim to estimate the annual incidence of SRIIPS.

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38 Modelling shooting performance across major international tournaments in elite men's wheelchair basketball

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The ability to score baskets is the key technical skill that separates winning and losing teams in men's wheelchair basketball (Gómez, Pérez, Molik, Szyman, & Sampaio, 2014). Previous studies have focused specifically on the technical aspects of free-throw shooting (Goosey-Tolfrey, Butterworth, & Morriss, 2002; Malone, Gervais, & Steadward, 2002) with limited research exploring the technical and tactical components of field-goal shooting (Francis, Owen, Molnar, & Peters, 2016). Francis et al.'s (2016) work explored the technical and tactical factors affecting two-point and three-point shooting in the 2015 men's European Wheelchair Basketball Championships, identifying shot movement and shot positioning as being significantly related to shot outcome (successful versus unsuccessful; $p < 0.001$). This study explores the key determinants of two-point and three-point shooting across two major tournaments and develops a valid prediction model. Following ethical approval, footage of each two-point and three-point shot taken by the top five teams (30 games; 2432 shots) at the 2016 Paralympic Games was

analysed in SportsCode (version 10, SportsTec Ltd) using the same performance analysis template and combined with the shooting data from the 2015 European Wheelchair Basketball Championships (nine games; 1144 shots; Francis et al, 2016) to provide data for 3576 shots. Chi-square tests highlighted eleven categorical variables that were significantly associated with shot outcome ($p<0.001$). The most significant categorical variable was the 'zone' in which the shot was taken. A binary logistic regression model was developed to assess the impact of these categorical variables as predictors of the probability of shooting success, using the forward selection method with 70% of the sample (2,499 shots). The final model included thirteen statistically significant predictors and when tested against the remaining 30% of the data an area under the curve (AUC) value of 0.667 was achieved. The model demonstrated that the odds of a shot with similar characteristics being successful were approximately 1.2 times higher in the Paralympics compared to the European Championships ($p < 0.05$; Odds Ratio: 1.23) as teams at the Paralympics used different defensive systems to apply pressure. These findings support the previous model (Francis et al. 2016) and re-emphasize the importance of shot movement and shot positioning ($p < 0.001$) as key predictors of shot success. In addition, the new model highlights the odds of achieving a successful shot are increased when the shot is either taken early or late in the shot clock (Odds Ratios of seconds remaining in the shot clock: 0-6 seconds: 2.06; 7-12 seconds: 1.25; 13-17 seconds: 1.45; 18-24 seconds: 1.84). The information gained from this model could be used by coaches and support staff to provide technical and tactical feedback to enhance performance. During training sessions coaches can attempt to ensure players are taking shots in a square to basket position (Odds Ratio: 2.06) or can use the information to recreate shooting situations in order to work on areas of weakness to increase the players odds of success over time.

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 # 41 Cardiovascular responses to heat acclimatization in athletes with spinal cord injury

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Purpose: To determine the effect of heat acclimatisation (HA) training on blood profile and resting cardiac function in athletes with spinal cord injury (SCI). Methods: Eleven athletes (10m, 1f) completed a five-day isothermic HA protocol whereby core body temperature (Tc) was elevated to and maintained at ~38.5 degrees Celsius (°C) for sixty minutes via intermittent exercise.

Blood samples were collected pre- and post-HA to determine changes in plasma volume (PV). Doppler ultrasound of the left-ventricular outflow tract and 2-d speckle tracking echocardiography were performed in a subset of athletes (n=5) to determine indices of resting left-ventricular function and mechanics, respectively. Differences in all indices were assessed using dependent samples t-tests. Significance was set at $p<0.05$.

Results: Ten athletes were successfully able to raise Tc to 38.5 °C. PV showed a trend to increase with HA training (ΔPV%: 3.0±5.4%, p=0.086). Following HA, resting HR decreased (64±4 vs. 57±5 bpm, p=0.002), velocity time integral (21.4±2.7 vs. 23.7±3.0 cm, p=0.045) and stroke volume increased, (64.8±7.6 vs. 70.2 ±10.5 mL, p=0.055) and twist (6.1±3.1 vs. 13.4±0.8 degrees (p=0.030)) and twist velocity (81.5±9.8 vs. 121.9±22.1 (p=0.049)) were higher.

Conclusion: This is the first study to examine HA in elite athletes with SCI. Our findings suggest a short-term HA protocol in athletes with SCI can induce beneficial changes in plasma volume and indices of resting cardiac function and mechanics. Future studies on HA in athletes with SCI should focus on determining mechanisms of adaptation and performance outcomes.

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43 Head impact of slalom gates on Paralympic Alpine Sit-Skiers - a pilot study

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Introduction: Unlike standing skiers, sit-skiers do not cross-block slalom gates by using their arms. Consequently, multiple impacts to their upper body and head can occur. Due to FIS rules and regulations a slalom event has to feature a certain number of gates, which is roughly 55 gates per run which equals the amount of possible repetitive head impacts. Additionally, athletes have to cope with training volumes of up to 15 runs (á appr. 40 gates) per day.

Despite using excessive protective gear (full face helmets), some sit-skiers reported discomfort, e.g. headache and neck pain after slalom training sessions and races according to information presented by the athletes representative working group.

The subject of mild traumatic brain injury (mTBI) and sub-concussive trauma due to repetitive lower intensity impacts recently has come into the spotlight of research due to an increasing number of athletes affected by late damage to their brains in the sports of e.g. football, rugby, boxing (Galgano et al. 2016).

The aim of the study is to quantify gate impact of slalom gates to the Sit-skiers' heads.

As impact and load are influenced by the properties of gate material, especially mass, different pole diameters were tested and evaluated against each other.

Methods: Four elite (World cup level) Paralympic Sit-skiers performed one run in three parallel set slalom courses comprising 25 gates with diameters of 25, 27 and 30 mm. The test device fixed to helmet recorded linear and rotatory acceleration in three axes (2D Datarecording, Karlsruhe, Germany), and velocity (GPS). All data was processed and analyzed using Matlab R2016a (Mathworks, Natick, USA). Resulting linear and rotatory acceleration was calculated. Point of gate contact was identified by separating turns based on gyroscope (located in the seat) signals after signal synchronization. Additionally, head-gate-contact was confirmed using video footage.

Results: No clear difference between the different pole diameters could be confirmed for linear or rotational acceleration (see Tab.1 and Fig.1). However, mean linear acceleration of 25mm gates resulted in the lowest head impacts on the athletes (see Fig.1).

Mean (±SD) velocity for 25 mm gate diameter was 29.1 km/h (±1.3), 30.3 km/h (±1.6) for 27 mm, and 29.5 km/h (±1.6) for 30 mm.

Discussion

All results remained below reported values measured during attested concussive events presented in a recent review of Williams et al. (2016). However, a threshold or number of impacts for sub-concussive events is still lacking (Tong et al. 2015). Thus, as there in no benchmark in number and intensity of impact which can clearly predict any potential late damage, any possibility for a reduction in impact should be investigated, e.g. protective gear that could prevent gate impact to the head in the first place.

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Tong, D. C.; Winter, T. J.; Jin, J.; Bennett, A. C.; Waddell, J. N. (2015): Quantification of subconcussive impact forces to the head using a forensic model. In: Journal of clinical neuroscience : official journal of the Neurosurgical Society of Australasia 22 (4), S. 747–751. DOI: 10.1016/j.jocn.2014.11.018.

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44 Relationship between physiological parameters and paratriathlon performance in well-trained athletes

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Paratriathlon consists of a 750m swim, 20km bike, 5km run; the equivalent of an able-bodied sprint distance triathlon race (ITU, 2014). It is a relatively young Paralympic sport making its Paralympic games debut in Rio 2016. Consequently there is little research in paratriathlon and therefore, many coaches are drawing from studies pertaining specifically to able-bodied triathlon. A month prior to completing a competitive triathlon, fourteen male well-trained GB paratriathletes underwent comprehensive physiological testing in an attempt to determine which physiological variables were associated with performance. The athletes (classified pre-2017) from ITU classification groups (PT1-PT5) were required to attend the lab for testing on two separate occasions. Day one consisted of cycle ergometry with athletes performing a 30s Wingate test in addition to sub-maximal and maximal test, to determine V̇O2max/peak, maximal aerobic power (MAP), aerobic lactate threshold (AeT) and anaerobic lactate threshold (AnT). Day two involved a run-cycle-run protocol, comprising of sub-maximal run either side of a 20km cycle to assess economy and efficiency. The competitive triathlon was completed in conditions of a mean dry temperature of 16-18ºC (64% relative humidity). Mean race time was 1:11:33 (hr:min:sec), with swimming (17.8 ±2.3%), cycling (47.5 ±3.4%), running (26.0 ±3.7%) and transitions (8.7 ±2.0%) representing different amounts of the total race time. Since there were notable

differences found for anaerobic capacity measured by the 30s Wingate test (398 ±41 vs. 663 ±109 W), VO2max/peak and MAP (3.07 ±0.27 vs. 4.01 ±0.51 L.min-1; 210 ±17 vs. 326 ±41W respectively) between PT1 (wheelchair athletes, n=4) and PT2-5 (ambulant athletes, n=10) the PT1 group were excluded from the correlations with triathlon performance. Thus, for this sub-group of ambulant athletes (n=10) the mean race time was 1:12:56 (hr:min:sec), with swimming (17.2 ±2.1%), cycling (46.4 ±2.6%), running (28.1 ±1.2%) and transitions (8.3 ±1.3%) representing different amounts of the total race time. The six most significant (P<0.05) predictors of overall triathlon performance were MAP (r = 0.67), peak and mean power output (PPO (r =0.68), MPO (r = 0.67)) achieved during the 30s Wingate test, peak cadence achieved during the 30s Wingate test (r = 0.71), power output (PO) (r = 0.66) and VO2max (r = 0.64) achieved during the 20km time trial. Strong associations were found between bike time performance and cycling gross efficiency (%) (r = 0.81; P<0.01), mean and peak cadence (r = 0.70 and 0.72 respectively; P<0.01), which is a dominate part of overall race time. The results of this study are not in total agreement with the able-bodied literature which suggests high VO2max, AnT and running economy are attributed to successful triathlon performance. Whilst our data spanned a good range of performance times (1:02:09 to 1:23:11 hr:min:sec) there was a wide range of impairments across PT2-5. Therefore more data is warranted within each individual classification group to fully understand the physiological training requirements. However, the results do help guide the physiologist to prioritise the laboratory test battery.

ITU (2014). International Triathlon Union Competition Rules. Approved by the ITU Executive Board.

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50 Impact of Limb Deficiency Impairment on Paralympic Swimming Performance: A Step Towards Evidence-Based Classification

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Background: World Para Swimming has recently mandated research be conducted to guide the formulation of a new evidence-based classification system. Objectives: (i) To establish the strength of association between novel measures of limb deficiency impairment and Para-swimming performance and (ii) determine the influence that swimming stroke and event distance has on predicted performance of para-swimmers with limb deficiency.

Methods: A cross-sectional study design was employed. Impairment data and best race times of 273 male and female para-swimmers with limb deficiency were obtained from the IPC Sports Data Management System. Pearson's correlation coefficients were calculated to determine the strength of association between novel measures of limb length and symmetry and race performances. Limb length and symmetry measures were included in full-model multiple linear regression analyses to collectively describe para-swimmers' limb deficiencies and predict swimming performances. Differences between limb deficiency groups were examined.

Results: Limb length measures had trivial to very large correlations with race performance times ($r=-0.10$ to 0.73). Multiple linear regression models that described the relative contribution of limb segment lengths to swimming performance were the best predictors of race performance for all swimming events ($R2=0.26$ to 0.66, $p<0.01$). There were significant differences between limb deficiency groups for the disparity in predicted swimming performances between the different swimming strokes (range=-14.9±1.7% to 3.1±4.8%, $p<0.01$) and Freestyle event distances (range=-4.7±1.6% to 7.5±2.1%, $p<0.01$).

Conclusions: This study provides an improved understanding of the impact that limb deficiency has on Para-swimming performance and can be used to help guide the development of a new evidence-based classification system.

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51 Improving mobility performance in wheelchair basketball.

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Introduction : De Witte et al. [1] recently developed and validated a wheelchair mobility performance test (WMPtest) for the assessment of mobility performance, i.e. the maximal ability to accelerate, sprint, brake or rotate, in wheelchair basketball players. Athlete, wheelchair and athlete-wheelchair interaction characteristics are likely to determine performance on the WMPtest. Knowledge of the best predictors of test performance may aid coaches and mechanics in improving mobility performance in wheelchair basketball [2,3].

Objective: This study aimed to investigate which athlete, wheelchair and athlete-wheelchair interaction characteristics are the best predictors of wheelchair basketball mobility performance.

Methods: Sixty experienced wheelchair basketball players performed the WMPtest to assess their mobility performance. Additional measurements provided 33 characteristics, including 10 athlete (e.g. trunk length), 19 wheelchair (e.g. wheel diameter and wheel axis height) and 4 athlete-wheelchair interaction characteristics (e.g. elbow angle with the hand at the top dead center of the hand rim). To determine which characteristics were the best predictors of mobility performance, forward step-wise linear regression analyses were performed.

Results: On average, the athletes needed 79 (SD 7) seconds to complete the WMPtest. Seven of the characteristics turned out to be significant predictors of the end time on the WMPtest, i.e. mobility performance (see table). Maximal isometric force, trunk length, wheel diameter and camber angle – which both were interchangeable with each other and wheel axis height and hand rim diameter – and the vertical distance between shoulder and rear wheel axis – which was interchangeable with seat height – were positively associated with mobility performance. The horizontal distance between the footrest and the rear axis and the vertical distance between the front seat height and the footrest were negatively associated with mobility performance.

Concluding remarks: With the results of the present study, coaches and mechanics are provided with tools to decide on which characteristics they could focus on best to improve mobility performance. Six out of the seven predictors – the interchangeable predictor options not taken into account – are modifiable and can be optimized to improve mobility performance. These adjustments could be carried out both in training (maximal isometric force) as in wheelchair configurations (e.g. camber angle).

Table: Results of four stepwise regression analyses (for athlete, wheelchair and athlete-wheelchair characteristics separately as well as all characteristics together) to determine the best predictors of performance (end time) at the WMPtest.

	Predictors	Regression coefficients	*p*-values	R^2
Athlete characteristics	(Constant)	107.29	<0.001	
	Maximal isometric force	-0.02	0.022	
	Trunk length	-0.39	0.049	0.33
Wheelchair characteristics	(Constant)	162.94	<0.001	
	Wheel diameter	-1.46	<0.001	
	Horizontal distance footrest and rear axis	0.28	0.018	0.40
Interaction athlete-wheelchair	(Constant)	111.61	<0.001	
	Vertical distance shoulder and rear wheel axis	-0.44	<0.001	0.26
All together	(Constant)	116.22	<0.001	
	Vertical distance shoulder and rear wheel axis	-0.55	<0.001	
	Vertical distance front seat height and footrest	1.00	<0.001	
	Maximal isometric force	-0.02	0.006	
	Camber angle	-1.67	0.026	0.60

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de Witte AMH, Hoozemans MJM, Berger MAM, et al. Do field position and playing standard influence athlete performance in wheelchair basketball? J. Sports Sci. 2016;34:811–820

van der Slikke RMA, Berger MAM, Bregman DJJ, et al. From big data to rich data: The key features of athlete wheelchair mobility performance. J. Biomech. 2016;49:3340–3346.

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52 Doing a Brazilian: lessons on culture and community from Rio 2016

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At the closing ceremony of the Rio 2016 Paralympic Games IPC president Sir Philip Craven stated ‘These Games importantly signal a very bright future for this youthful and wonderful nation’. This is different from the usual rhetoric that celebrates

each Games as 'The Best Ever' but we believe the Paralympic movement has a great deal to thank the Cariocas for. The potential the Paralympic Games would not go ahead it Rio - after problems during the Olympics, made headlines worldwide. Hosting a major sporting event is a fiddle for all local organising committees as that they gain the pleasure and burden of hosting the Olympic and Paralympic Games seven years ahead of time. This allows for detailed planning and preparations but even with the best forward planning world's leading economist are never certain when economies will slow down and Rio 2016 took place in difficult economic times. This paper highlights how the community of Rio and Brazilian culture more generally celebrated the Paralympic Games in an unashamedly passionate manner and this should be a positive lesson for the Paralympic movement. Drawing upon an ethnography of the Paralympic media representations and first hand participant observation in Rio during the games this paper uses Bourdieuian practice theory to illuminate how and Cariocas made the Paralympic games as success in spite of the poor economic climate. Ultimately, we want the Paralympics Movement to have the confidence and maturity to dare to be different.

 # 55 A maximal perceptually-regulated exercise test is reliable and valid for measuring peak oxygen uptake during arm crank ergometry in manual wheelchair user

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Though ramp-incremented workload (RAMP) protocols are widely used to measure exercise responses, the recent introduction and validation of maximal perceptually- regulated exercise testing ($PRET_{max}$) may provide an alternative for use in manual wheelchair users. The $PRET_{max}$ involves 5 x 2-min stages clamped at overall RPE 11, 13, 15, 17 and 20. The $PRET_{max}$ has been validated in able-bodied populations during upper and lower body exercise, but has not been evaluated in people with disabilities. Therefore, the aim of this study was to investigate the reliability and validity of the $PRET_{max}$ for measuring peak oxygen uptake ($\dot{V}O_{2peak}$) during arm crank ergometry in manual wheelchair users. Following institutional ethics approval, nine participants (8 male, 1 female, 56 ± 10 years, 1.76 ± 0.15 m, 91.0 ± 22.4 kg) completed four trials across a two-week period. Using a randomised, counterbalanced design, participants completed two $PRET_{max}$ in week 1 followed by two RAMP, with verification phase (VER) in week 2, or vice versa. Throughout all trials, participants maintained their preferred cadence and during the $PRET_{max}$ changed the power output (PO) as often as required to maintain the desired RPE. RAMP trials began at 0-40 W and increased by 5-10 $W \cdot min^{-1}$ until volitional exhaustion. Following 10 min recovery, VER was performed at PO 5 W greater than the end of the RAMP, until volitional exhaustion. Expired air, heart rate and power output were collected throughout all trials. Feeling Scale (FS) and differentiated measures of peripheral (RPE_P), central (RPE_C) and overall (RPE_O) RPE were collected at the end of each stage during both protocols. The greater response for RAMP and VER were used for each trial in subsequent analyses. Test- retest reliability analysis for $\dot{V}O_{2peak}$ resulted in coefficients of variation equal to 5.2% and 7.1% and intraclass correlation coefficients of 0.91 and 0.76 for $PRET_{max}$ and RAMP, respectively. Measurement error was found to be 2.3 and 2.4 $ml \cdot kg \cdot min^{-1}$ for $PRET_{max}$ and RAMP, respectively. RAMP (16.8 ± 0.3 $ml \cdot kg^{-1} \cdot min^{-1}$) resulted in significantly greater $\dot{V}O_{2peak}$ compared to $PRET_{max}$ (14.8 ± 0.3 $ml \cdot kg \cdot min$, $t_{(8)} = 3.534$, $P = 0.008$), although the mean difference between protocols (2.0, 95% confidence interval 0.7 to 3.3 $ml \cdot kg^{-1} \cdot min^{-1}$) was smaller than the measurement error of both RAMP and $PRET_{max}$. Validity analysis was conducted using the maximum value obtained across the two trials for $PRET_{max}$ andRAMP/VER.

The 95% limits of agreement were 2.0 ± 1.7 (-1.3 to 5.4) ml·kg·min^{-1} for V̇O2peak. The FS rating was significantly more positive at RPE 11 (Z = -2.395, *P* = 0.017), 13 (Z= -2.201, *P* = 0.028), 15 (Z = -2.379, *P* = 0.017) and 17 (Z = -2.371, *P* = 0.018) during $PRET_{max}$ than RAMP, and was tending toward significance at the end of each test (Z = -1.904,*P* = 0.057). There was no difference in peak RPE_C or RPE_O between protocols, however peak RPE_P was significantly greater in RAMP compared to $PRET_{max}$ (Z = -2.264, *P* =0.024). In conclusion, the $PRET_{max}$ can be used as a reliable and valid test by which to measure $\dot{V}O_{2peak}$. Furthermore as it promotes more positive feelings at submaximal intensities, the $PRET_{max}$ offers a realistic alternative when testing wheelchair athletes for maximal exercise responses

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 # 57 Predictive models and reference values for peak power output during handcycling in people with a chronic spinal cord injury

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Background: Handcycling has become a popular sport for wheelchair users. To get insight in the physical capacity and to prescribe an individualized training regime, it is important to perform a graded exercise test (GXT). To set adequate resistance levels during the GXT a realistic estimated peak power output (POpeak) is needed. Estimated POpeak is often based on expert opinion and is hard to determine in individuals with spinal cord injury (SCI) due its many determinants, e.g. lesion level and motor completeness, apart from age, sex and training status. Since reference values for POpeak during handcycling are scarce in literature, the current study focused on development of a predictive model and reference values for POpeak during handcycling in SCI.

Purpose: This study had two aims:

1) To develop and validate a predictive theoretical and statistical model for POpeak (in W and W/kg) in a handcycling GXT for people with SCI.

2) To define reference values for POpeak during handcycling based on lesion level and sex.

Methods: 98 Recreational handcyclists (39.5±11.7 years old, 79 men) with SCI or spina bifida performed a GXT in a handcycle attached to an ergometer or on an arm crank ergometer. PO (W) was measured and other characteristics were obtained during physical examination and from questionnaires.

The group was split into two samples: (1) one to develop the predictive models (80% of the data) and (2) one to cross-validate the reliability of the models (20% of the data). Thereafter, a multi-level regression analysis was performed. Four linear regression models were developed, i.e., a theoretical model and a statistical backward regression model with both POpeak and POpeak/kg as dependent variable. The independent variables were: age (years), sex, body mass index (BMI, in kg/m2), time since injury (TSI, years), lesion level (two categories: (1) > Th6 and (2) ≤ Th6), handcycling classification (two categories: (1) H1-H3 and (2) H4-H5) and ASIA Impairment Scale (AIS, motor complete/incomplete). Intraclass correlation coefficient (ICC) and Bland Altmann plots were used to compare the estimated POpeak with the true POpeak. Reference values for POpeak and POpeak/kg were calculated based on percentiles of the whole group and were made for lesion level and sex.

Results: The theoretical models were based on age, sex, BMI, TSI, lesion level, and AIS. The explained variance was 29% for POpeak and 27% for POpeak/kg. The ICC between predicted and true POpeak was 0.47 for POpeak and 0.72 for POpeak/kg.

In the statistical models, significant determinants for POpeak (R2=30%) and POpeak/kg (R2=18%) were BMI and lesion level. Sex was a third determinant for POpeak. The ICC between predicted and true POpeak was 0.46 for POpeak and 0.48 for POpeak/kg. All Bland-Altman plots showed a large variability. Table 1 and 2 show the reference values based on sex and lesion level.

Conclusions: POpeak reference values were defined. Statistical models for POpeak and POpeak/kg were based on BMI, lesion level and sex and showed a low explained variance and moderate validity. On average, the theoretical models showed similar values. In the future, these models might be improved by adding relevant determinants such as training status.

Table 1.

Reference values for POpeak and POpeak/kg, for participants with (1) lesion level above Th6 and (2) equal to or below Th6. Poor (<20%), Fair (20-40%), Average (40-60%), Good (60-80%) and Excellent (>80%).

Variable	Level	n	Poor	Fair	Average	Good	Excellent
POpeak (W)	1	28	< 65	65-101	101-116	116-144	>144
	2	69	<100	100-115	115-132	132-155	>155
POpeak/kg (W/kg)	1	27	<0.78	0.78-1.18	1.18-1.54	1.54-1.84	>1.84
	2	64	<1.31	1.31-1.50	1.50-1.64	1.64-1.86	>1.86

Table 2.

Reference values for POpeak and POpeak/kg, for male (M) and female (F) participants. Poor (<20%), Fair (20-40%), Average (40-60%), Good (60-80%) and Excellent (>80%).

Variable	Sex	n	Poor	Fair	Average	Good	Excellent
POpeak (W)	M	79	<107	107-120	120-135	135-155	>155
	F	19	<70	70-85	85-98	98-115	>115
POpeak/kg (W/kg)	M	74	<1.22	1.22-1.47	1.47-1.64	1.64-1.88	>1.88
	F	18	<1.10	1.10-1.31	1.31-1.55	1.55-1.63	>1.63

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60 Effects of trunk muscle activation on trunk stability, arm power, and performance in wheelchair rugby players with a spinal cord injury

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Background: Important aspects in wheelchair rugby (WR) are quick wheelchair turning, braking, acceleration from standstill, and ball handling. However, as these aspects largely depend on trunk stability and upper extremity power, they are impaired in most players with high spinal cord injury (SCI), due to the (partial) loss of innervation of upper extremity and trunk muscles. In addition, performance may be hampered by the generally low blood pressure in these individuals as a result of a disturbed sympathetic innervation. Abdominal strapping, commonly used to counteract these problems, may only solve some problems and can even have detrimental effects (e.g., lower reaching). Another solution may be by electrical stimulation (ES) induced co-contraction of paralyzed trunk muscles. The aim of this study was, therefore, to assess the effects of increased ES-induced co-

contraction of trunk muscles on trunk stability, arm force/power, blood pressure, and wheelchair rugby performance in players with high SCI.

Methods: Ten wheelchair rugby athletes with a cervical SCI participated. ES was simultaneously applied to the rectus abdominus, obliquus externus abdominus and erector spinae muscles. Stability was assessed with reaching tasks in different directions, arm force and power with an isokinetic test on a dynamometer, blood pressure during an ES protocol and wheelchair rugby skills with the USA Wheelchair Rugby Skill Assessment. For every test, the ES condition was compared to the non-ES condition.

Results: Overall reaching distance (FES 14.54±9.26 cm, noFES 13.61±9.75 cm), arm force (FES 154.29±102.62 Nm, noFES 147.96±97.39Nm), and arm power (FES 37.14±25.34 W, noFES 35.66±23.99 W) were significantly improved with ES. Both systolic and diastolic blood pressure showed a significant increase after FES application. Wheelchair rugby skills were not significantly improved with the use of FES.

Discussion/Conclusion: ES-induced trunk muscle activation positively affects trunk stability, blood pressure, and arm force/power. No effects were found in wheelchair rugby skills, probably due to abdominal strapping. More research is needed to assess different FES (training) protocols, and to compare the effects of abdominal strapping with FES application.

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61 Para swimming start performance: is the current classification system fit for purpose?

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Introduction: The few studies that have measured start performance in Para Swimming have grouped classes, omitted lower classes and/or failed to acknowledge different start techniques (Dingley et al 2014, Burkett et al 2010, Daly et al 2001). No study has comprehensively analysed swim start performance across all Para swimming classes or evaluated whether the current classification system provides a valid assessment of starting ability. This study aims to: i) determine the relationship between start performance parameters and race time in Para swimmers, ii) provide a descriptive analysis and comparison of these parameters across para-swimming classes, and iii) establish the effect of impairment and/or start technique on start performance and examine whether the current system used to classify starts is fit for purpose.

Method: Data were captured from 172 males from classes S2 to S10 during the finals at the London 2012 Paralympics. Impairments included limb deficiency (n=80), cerebral palsy (n=30), spinal cord injury (n=34), polio (n=10), athrogyrophosis or muscle dystrophy (n=9), neurological condition (n=7), and short stature (n=3). Specific temporal and distance start parameters were extracted from video recordings obtained using three fixed, synchronised cameras (Almena et al., 2015).

Results

For 50m and 100m freestyle, breaststroke and butterfly events, all swimmers classed S7 to S10 used a standing dive, S5-S6 swimmers used either a standing or a seated dive, while the majority of S2 to S4 swimmers used a seated dive or a water start. Race time was strongly correlated to 5m and 15m time (r_S = >0.903 (p=<0.001)), and 5m and 15m times were correlated to breakout time, underwater time, start distance, dive distance and underwater distance (s = >-0.657 to -0.717 (p=<0.001)), but not block time (r_S = >0.046 (p = 0.720)) for almost all strokes and distances. This presentation will detail temporal and distance parameters for each stroke and distance. In brief, there was considerable within-class variation across all start parameters, but breakout time, underwater time, start distance and underwater distance were all significantly shorter for classes S2 and S4 than for each class from S5 to S10. There were no significant differences between classes S5 to S10 for these parameters.

Discussion: The start is one of the key determinants of race outcome in swimming. It would appear most likely that the large variation in start performance within all classes has caused an overlapping of performances, and thus no significant inter-class

differences in start performance parameters. One of the potential reasons for this may be because different impairments are included within the same class and therefore perform better or worse at some start performance parameters. Further analysis is ongoing to determine the effect impairment has on start performance. Examining the interaction between impairment, race distance and start technique will help to determine whether the current system used to classify starts is fit for purpose.

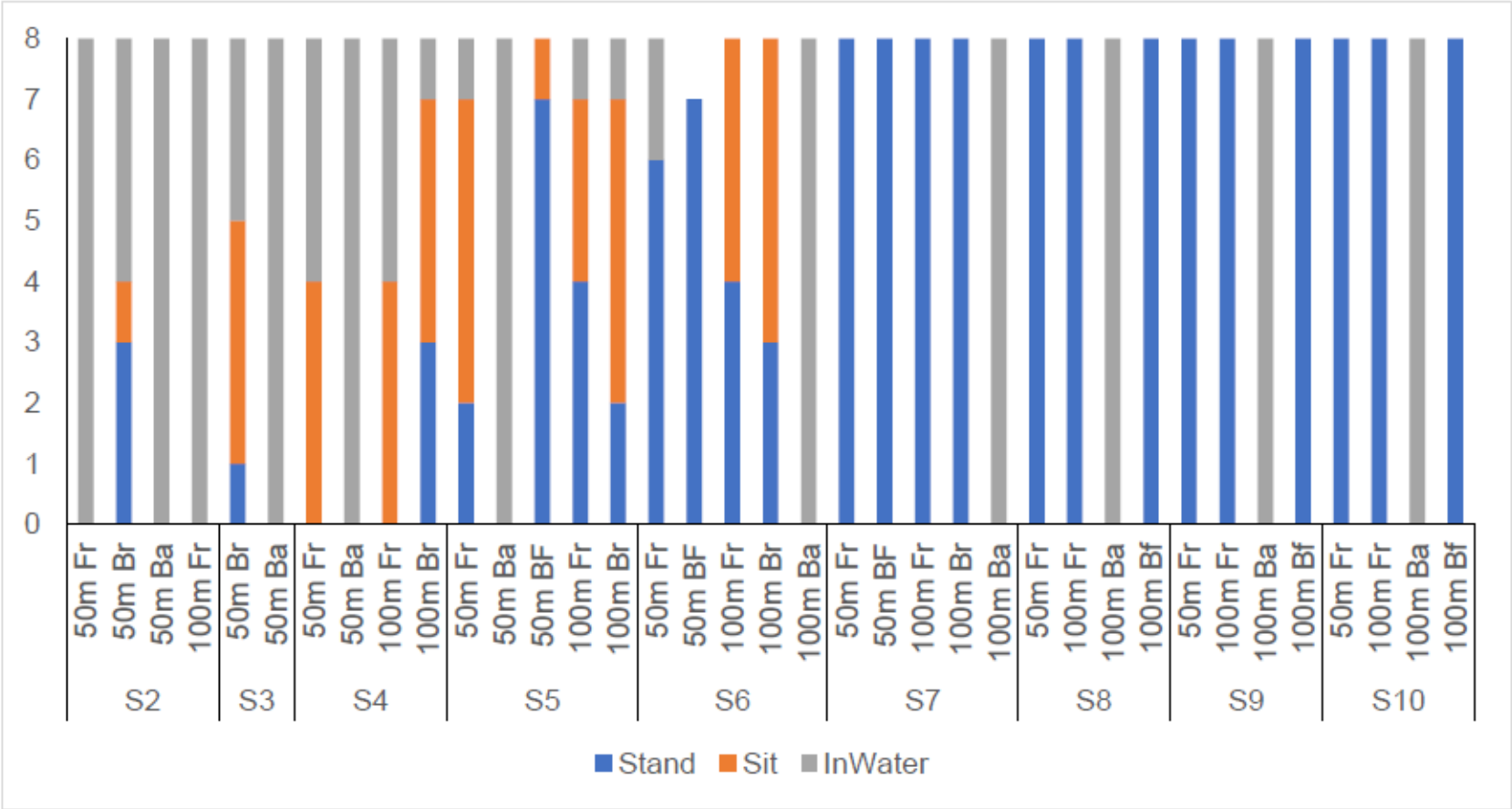

Figure 1: The start technique chosen per stroke and distance for each class at London 2012 Paralympics swimming.

Burkett et al 2010 Journal of Applied Biomechanics

Dingley et al (2014) Journal of Applied Biomechanics

Daly et al (2001) Adapted Physical Activity.

 # 65 A framework for implementing Adapted Athletics programs in Australian Universities

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Background: In the United States, the Wheelchair Basketball collegiate division has been a pathway to the Paralympic games for many emerging para- athletes. Aligning with NCAA guidelines, the collegiate division requires student-athletes to undertake academic programs in an Adapted Athletics program to compete in the division (American Collegiate Society for Adapted Athletics, 2017). Adapted Athletic programs support the sporting and academic development of student-athletes and provide an opportunity for other nations to identify, develop and implement strategies that may provide support for emerging para-athletes through adapted university programs.

The purpose of this project was to develop a framework that could guide Australian universities in planning and implementing high performance university sport programs, aiming to guide the development of optimal training environments for para-athletes to train and study whilst preparing for Tokyo 2020 and beyond.

Method: A multiple case study method was used (Yin, 2013). Two programs were studied in-depth: Australian wheelchair basketball and an internationally recognized adapted athletics wheelchair basketball program based in the United States. Interviews were conducted with coaches, athletes and administrators to gain multiple perspectives on the factors that could influence the success of the programs.

Findings: The multiple case study identified environmental barriers and facilitators athletes experience in training for wheelchair basketball, offering insight into the socio-economic determinants of Paralympic participation and success. The United States Adapted Athletics case revealed how the program supported the athletic and educational development of student-athletes. Data collected informed the development of a framework for implementing adapted athletics programs in universities. The framework incorporates socio-economic determinants of Paralympic participation and success, and supports the generation of recommendations for resourcing such programs in the Australian context. Areas highlighted include facilities, social support and policies. From a practical perspective, this framework informed the planning of the University of the Sunshine Coast SEEDS pilot project, a high performance para-sport program in a regional Australian university using an action research approach. In the future, the framework could be expanded and adapted to academies, clubs and programs that aim to provide optimal training environments for para-athletes.

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 # 67 Expert consensus for the evidence based classification of vision impairment in judo

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Background: Judo is one of the most popular Paralympic sports for athletes with vision impairment (VI), yet it remains controversial because partially sighted judokas compete in the same class against others who are completely blind. A recent expert consultation across all VI sports showed there is strong support for the development of classification systems that cater for the specific visual demands of a sport (Ravensbergen, Mann & Kamper, 2016). A key barrier to evidence-based classification in judo is a lack of knowledge about the specific needs of VI athletes in this sport, in particular the needs of those who are blind. Therefore, the aim of this study was to reach expert consensus on the specific needs of an evidence-based classification system for VI judo.

Method: A group of eighteen VI judo athletes (current or former), coaches, and administrators accepted an invitation to be part of an expert panel. They participated in a three-round Delphi review using online questionnaires that sought to reach consensus (minimum 75% agreement) on issues related to classification in VI judo.

Results: The expert panel agreed that the present system of classification for VI judo fails to adequately minimise the impact of impairment on sport performance (83% agreement). The panel members recommended that (i) creating a separate sport class for blind judokas would increase the fairness of competition; (ii) further research is required to establish new minimum impairment criteria which represent the minimum level of impairment that has an impact upon judo performance; and (iii) new visual functions need to be considered for classification in addition to visual acuity and visual field. On the classification methods, the panel agreed that (i) classification should be based on the test results obtained from both eyes together and with the best

possible optical correction; (ii) intentional misrepresentation of visual abilities is a big threat to fair competition in VI judo, and additional measures should be taken against it; and (iii) the establishment of classification centres, where athletes need to travel outside of competition, would be favoured wherever possible over the current method of classification at competition venues. The panel also ranked the visual functions they believed were most important to include for classification in VI judo, and which aspects of judo performance are most likely to be impacted by vision impairment. The panel could not agree on whether the use of blindfolds is suitable in VI judo.

Conclusion: Strong consensus was found amongst the VI judo community to change the way that judokas with vision impairment are classified for competition. The findings offer guidelines for how to best address key issues specific to classification in VI judo.

Ravensbergen, H.J.C., Mann, D.L. & Kamper, S.J. (2016). Expert consensus statement to guide the evidence-based classification of Paralympic athletes with vision impairment: a Delphi study. British Journal of Sports Medicine, 50, 386-391. doi: 10.1136/bjsports-2015-095434

 # 72 Lessons from DoD Warrior Games: Challenges adopting Paralympic Classification to Military Adaptive Sports

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United States Department of Defense Warrior Games

Despite the intertwined histories of rehabilitating wounded military with the origins of Paralympic sport, inclusion of tactical athletes into the Paralympic model remains challenging. Due to advances in technology survival rates from armed conflicts continue to improve, but survivors have more severe injuries. Recent conflicts in Afghanistan and Iraq have resulted in more than 1,643 US Service Members and Veterans with major limb amputation, 5,928 with spinal cord injury,(1) and more than 320,000 with traumatic brain injury(TBI)(2). Classification of these athletes is challenging due to the high incidence of comorbid chronic pain (81.5%), post-traumatic stress disorder (PTSD) (68.2%), and post-concussive syndrome (66.8%).(3) The high rates of comorbid TBI, chronic pain, and PTSD have reaching impact on venue management, coaching, and classification. The vast majority of tactile athletes have acquired injuries, limiting eligibility based on meeting the IPC eligibility criteria for physical impairments of hypertonia, limb deficiency, impaired muscle power, and impaired range of movement.

This presentation will outline how adaptive sports have become an integral part of reintegration and rehabilitation of injured military and the challenges to integrating these tactical athletes to the Paralympic model. At the 2016 United States Depart of Defense Warrior Games a civilian team of national Paralympic classifiers and coaches was brought on board to improve alignment of Paralympic and military models. This annual event was started in 2010, offering an opportunity for some 250 athletes from the US and UK to compete in seven adaptive sports: archery, shooting, wheelchair basketball, sitting volleyball, cycling, swimming, track & field. Almost half (n=121, 49%) of participating athletes would be eligible for Paralympic classification in at least one sport. Rule changes and modification of the established Paralympic classification code will be discussed. There is great potential for military adaptive sports programs such as the DoD Warrior Games and Invictus Games to be feeder programs for the Paralympics.

Table 1. Percentage of 2016 DoD Warrior Games participants who are eligible for Paralympic classification in at least one sport.

	Athletes n	**Paralympic Eligible** n (%)
US Air Force	45	20 (44%)
US Army	48	26 (54%)
US Marines	41	16 (34%)
US Navy	40	17 (43%)
US SOCOM*	35	24 (69%)
UK	39	18 (46%)
TOTAL	**248**	**121 (49%)**

*SOCOM = Special Operations Command

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73 Kinematic responses of a novice swimmer with moderate cerebral palsy to a performance-focused swimming program – a pilot study

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Background - Competitive swimmers aim to achieve and maintain high velocities in order to reduce the time to cover a certain distance and succeed against opponents. This result depends on: (1) the ability to produce high propulsive forces using an individual combination of strokes and kicks cycles; and (2) the ability to overcome resistance forces through postural control and leg movements. Emerging advances in video technology have facilitated the analysis of stroke mechanics and swimming performance of professional non-disable athletes. Data provide a technique model that novice swimmers can use to identify weakness areas and make it focus of practice (Mooney, Corley et al. 2015). Cerebral Palsy (CP) is a static neurological condition that affects motor control but also musculoskeletal functions such as muscle tone, strength, range of movement, postural control and proprioception (Rosenbaum, Paneth et al. 2007). Swimmers with moderate to severe CP show low propulsion generation caused by muscle contracture, hypertonia and restricted range of motion, additionally poor postural control enhance resistance forces and poor motor control affects the coordination of breaths actions with stroke cycles that increase the risk of water ingestion and aspiration. In this scenario, the application of conventional stroke mechanics of non-disable swimmers is inappropriate and scientific literature does not describe the front crawl mechanics of people with moderate to severe CP neither inform how this change over time. Therefore the objective of this study is to present a framework that describes the front crawl kinematics of a swimmer with moderate CP and apply this structure to track changes over 15 weeks of training.

Methods - The 25m front crawl time trial of a 20-year old female with ataxic CP (GMFCS level II) was filmed using the first 15-weeks training session. Prior to this point, the participant reached physical activity guidelines swimming 3 sessions per week for recreational purposes. The cameraman walked in parallel with the swimmer along the pool deck handling an iPad. The footage

was imported in Kinovea to measure the number of stops, left and right arm recoveries, frontal and lateral breaths, left and right foot breaking the surface, time spent using dog paddle movements. Swimming performance was assessed using a stopwatch.
Results - The swimmer covered 25m in 1:14s without stops (18s front crawl, 56s dog paddling motion). The front crawl segment was characterised of 6 consecutive stroke cycles (3 left, 3 right - arm outside the water) and 16 kick cycles (12 left, 4 right - feet breaking the surface) performed without breathing. The swimmer is currently training and further results will be presented at the conference.
Conclusion - The study presented a framework used to describe the stroke mechanics of a novice swimmer with moderate to severe CP. The first data collection point evidenced that poor motor control limited the ability to alternate inhale and exhale actions with stroke and kick cycles. Consequently, the front crawl technique is inconsistent and propulsion phases are interposed by dog paddle movements and deep kick actions which enhance resistance and decrease swimming velocity.

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 # 74 A position stand guiding the sport-specific classification of athletes with vision impairment: What you need to know

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Background: The IPC Classification Code requires sports to develop an evidence-based classification system that is based on the impact of impairment on performance in that particular sport. However, sports for athletes with vision impairment (VI) classify athletes using a system based on the legal definition of low vision or blindness, employing essentially the same classification system across all VI sports. One key barrier to the development of evidence-based classification in VI sport is the absence of an agreed approach for how to perform research which addresses classification issues unique to athletes with VI.
Purpose: The aim of this position stand is to provide guidance for how sport-specific classification should be achieved in sports for athletes with VI.
Method: A four-round Delphi review of 25 experts in VI sport (athletes, coaches, classifiers, & administrators; Ravensbergen, Mann & Kamper, 2016) uncovered the issues to be addressed in the Position Stand. In response, the stand was developed by the IPC Research and Development Centre for the Classification of Athletes with Vision Impairment, in coordination with the International Paralympic Committee and the International Blind Sports Federation.
Results: On the basis of the expert consultation performed during the Depth review process, we provide guidance on how classification research can be performed to take into account (1) the minimum level of VI necessary to take part in competition; (2) the potential inclusion of new vision tests during classification (e.g., contrast sensitivity, motion and depth perception) to better account for the sport-specific impact of VI on performance; (3) the need to test vision during classification when using both eyes together (i.e., habitual vision) rather than with the best eye only (as is presently done); (4) the need during classification to account for the different types of lighting experienced during competition; (5) the potential impact on sport performance of the age at which an athlete acquired their VI; and

(6) whether blindfolds should be used to minimise the impact of VI on the outcome of competition. Three specific research models are presented that can be used to develop sport-specific classification: (1) a correlational model that directly examines the relationship between impairment and sport performance; (2) a simulation model that simulates vision impairment to examine changes in performance in able-sighted athletes; and (3) a component-analysis model that establishes the visual information relied on by skilled able-sighted athletes, and examines the impact of impairment on the ability to pick-up that information.

Conclusion: The recommendations provide a clear pathway for sports to develop an evidence-based system of classification for athletes with vision impairment.

Ravensbergen, H. J. C., Mann, D. L. & Kamper, S. J. Expert consensus statement to guide the evidence-based classification of Paralympic athletes with vision impairment: a Delphi study. Br J Sports Med 50, 386–391 (2016).

 # 76 A 10-year analysis of fight outcomes between athletes of different classes in the Paralympic Judo.

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Objectives. Paralympic Judo is a combat sport for athletes with visual impairments. It became an official Paralympic discipline in 1988 for men, and in 2004 for women. Following IBSA rules the classification panel groups athletes into three classes according to their vision ability: B3 – moderate vision loss, B2 – severe vision loss, and B1 – blind athletes. Athletes in Para Judo with different degree of vision impairment compete against each other in different weight categories. Many athletes, coaches, and officials argued that this fact can influence the outcome of a fight; and that B1 athletes have fewer chances of winning against B2 or B3 athletes. That may lead to a situation where B1 athletes have a fewer chance of being selected for the National Team and therefore will no longer stay in the sport. The goal of this study was to validate the above-mentioned assumptions and to determine the win:lose ratios in fights between athletes of different classes, and also to analyze the number of athletes in different classes.

Methods. We analyzed the outcomes of 1,936 fights from the official competitions over the last ten years. The results were obtained from the IBSA website. The win:lose ratio in fights B1 against B2, B1 against B3, B2 against B3 in both male and female athletes in all weight categories was analyzed. We calculated the percentage of competing athletes of different classes through all weight categories.

Results. B1 won B2 ratio was 34.5%, B1 won B3 ratio was 32.6%, whereas the B2 won B3 ratio = 50.5%, and B3 won B2 ratio = 49.5%. The number of B1 athletes decreased by 10.7% over this period: 25.9% in 2007 and 15.2% in 2016, the numbers of B2 and B3 athletes increased by 4,5% and 6,2% respectively. (Figure 1).

Conclusions. The results indicate a significant correlation between the level of vision function and the fight outcomes: blind athletes have fewer chances of winning against athletes with some retained vision. It might be because athletes' performance is significantly determined by vision impairment. Vision has a great impact on the functional capabilities of the athlete, such as the ability to train and to operate an effective daily routine. Athletes with partial vision loss of a different degree (B2 and B3) have comparable chances of winning each fight. Our study demonstrated that the total number of competing judo athletes increased over recent years, but the number of blind (B1) athletes is decreasing. That may be because of the reduced opportunities to win fights against B2 or B3 class athletes. Taken together this data highlights the importance of including functional assessment tests during classification in IBSA Judo. Therefore modification and improvement of classification procedures and/or technical rules of IBSA Judo will ensure fair competitions for all athletes. Further research of sport specific parameters such as coordination,

posture stability, etc., and assessment of the impact of vision loss on the training and daily activity of the athletes is necessary for the development of a sport specific evidence-based classification tests in IBSA Judo.

IBSA Judo results (Available at: http://www.ibsasport.org/sports/judo/results/)

 # 77 A comparison of 3 v 3 wheelchair basketball game formats for inclusion at the Commonwealth Games: a multidisciplinary approach

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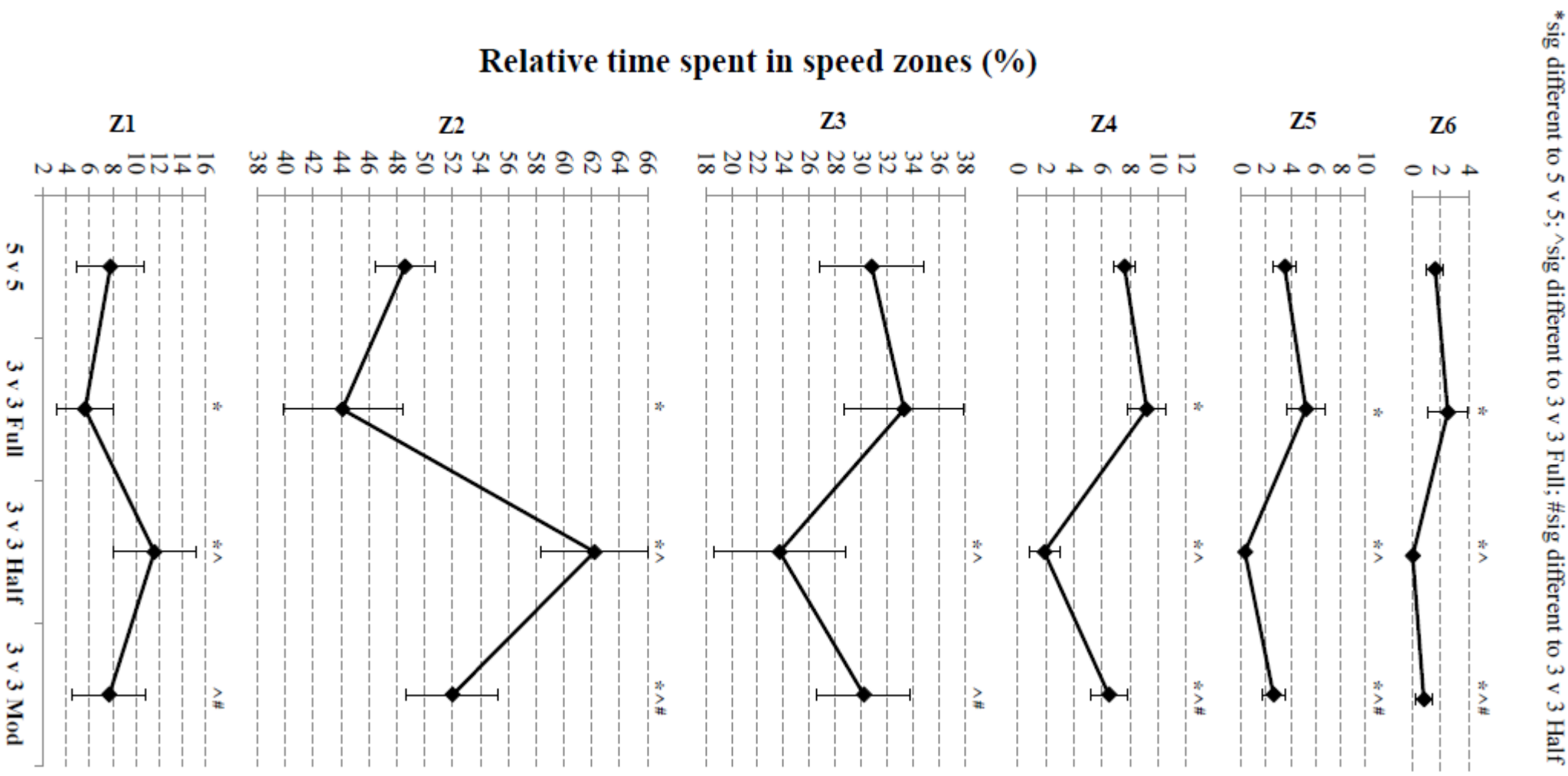
Wheelchair basketball is a 5 v 5 team sport, which is one of most popular sports on show at the Paralympic Games. The purpose of the current study was to compare the activity profiles and physiological responses of highly trained wheelchair basketball players during 5 v 5 wheelchair basketball to various 3 v 3 formats of the sport to help determine the most suitable format for inclusion at the 2022 Commonwealth Games. Fifteen U22 male international wheelchair basketball players (age: 19 ± 2 years; playing experience: 7 ± 3 years) volunteered to participate in the study. Players' activity profiles were monitored using an indoor tracking system (Ubisense) during 4 x 10 minute quarters of 5 v 5 wheelchair basketball. Physiological demand was assessed via heart rate (Polar Team Pro System) and ratings of perceived exertion (RPE, Borg CR-10). The same measures were also collected during 2 x 10 minute periods of each of the following 3 v 3 game formats: i) Full court (3 v 3 Full); ii) Half court (3 v 3 Half) and iii) 22 m court (3 v 3 Mod). All matches were officiated and rules were consistent across all game formats, although the shot clock reduced from 24- to 18-seconds and classification from 14 points to 8.5 points for the 3 v 3 formats. Repeated



measures ANOVA were used to determine statistical differences in activity profiles and physiological demand between game formats. A significant difference was accepted when $P < 0.05$. Players covered more distance during 3 v 3 Full (97.5 m/min) and less distance during 3 v 3 Half (68.6 m/min) than all other game formats ($P \leq 0.0005$). No significant difference was observed for

the distance covered during 5 v 5 and 3 v 3 Mod. Players reached significantly higher peak speeds during 5 v 5 (4.69 ± 0.31 m/s) and lower peak speeds during 3 v 3 Half (3.33 m/s) in relation to other formats (P ≤ 0.020). Athletes spent more time in lower speed zones (Z1-2) and less time in moderate to high speed zones (Z3-6) during 3 v 3 Half compared to all other formats (Figure 1). Despite notable differences in activity profiles minimal changes in physiological demand were observed between game formats. Mean heart rate was lower between 3 v 3 Half and 3 v 3 Full (146 ± 12 vs. 155 ± 14 beats/min; P = 0.001). Players RPE were significantly higher for both 5 v 5 and 3 v 3 Full compared to 3 v 3 Half and 3 v 3 Mod (P ≤ 0.048). The current results demonstrated that the 3 v 3 Full and 3 v 3 Mod provided the closest physical representation of 5 v 5 wheelchair basketball, since fewer significant differences in activity profiles and physiological responses were observed between these formats. Whereas 3 v 3 Half significantly under-represented the physical demands of 5 v 5 wheelchair basketball. These results can be used to help inform the most suitable game format of 3 v 3 wheelchair basketball for inclusion at the Commonwealth Games.

 # 78 Adaptive Behaviour assessment in the classification system for athletes with intellectual impairment – Do we need it?

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Introduction: Adaptive Behaviour (AB) is defined as the collection of conceptual, practical and social skills that aid people in everyday life [1]. Together with intellectual function, AB is one of the essential criteria in the diagnosis of intellectual disability; however, AB is not currently considered within the current IPC classification process of athletes with intellectual impairment (II) [2]. It has been well documented that individuals with II display significantly lower levels of Motor Proficiency (MP), including those with mild and borderline II [3]. However, the relationship between AB and MP has not been clearly defined. The aim of this paper is to explore what is currently known about the relationship between AB and MP, and if particular domains or subdomains of AB have greater relevance to MP.

Method: Two researchers independently performed a three step systematic search to include: (1) a database search on EBSCO (Sportdiscus, PsychINFO, CINAHL), EMBASE, Medline and the Cochrane database from 1996-2016 with search terms ‘adaptive behaviour’ or ‘adaptive behavior’ AND ‘exercise’ or ‘sport’ or ‘physical activity’ or ‘fitness’ or ‘motor’ or ‘movement’ or ‘physical education, (2) a snowball search through forward and backward analysis of relevant literature, and (3) a repeated database search for the year 2016 to identify relevant literature published in the later part of the year. An inclusion/exclusion criteria was established, including an open population sample (diagnosis, age, gender, etc.). Appropriate critical appraisal tools from the Joanna Briggs Institute were selected based on the study design of the final article selection.

Results: Twenty-two articles met the inclusion/exclusion criteria with a total population sample of 1,705 participants. Nine disabilities were represented in the studies, with none specifically targeting individuals with II. The quality of evidence was predominantly low (n=12) or moderate (n=8). Overall, 17 articles outlined a relationship between AB (its composite and/or domain scores) and MP, with 6 articles finding no relationship between. Results that measured sport performance relevant aspects of MP indicated correlations between the Eurofit Test Battery and the AB domain Daily Living Skills (r=-0.61 to -0.90); however, 2 randomised controlled trials found no significant changes to AB after a 10-12 week hippotherapy intervention (p=0.027 to 0.970).

Conclusion: Through a systematic review of current literature there may be a relationship between AB and MP, in addition to specific AB domains and sub-domains of greater relevance. However, the detailed nature of this relationship remains unclear,

with predominantly low to moderate quality of evidence, and conflicting results within the literature. There is a valid argument to support research into AB and its impact on sport performance in athletes with II, particularly as there is currently no empirical evidence exploring AB and general MP in individuals with II, and the majority of current literature does outline a relationship between. More research within this field is required before AB can be considered within the IPC classification process for athletes with II.

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79 "We're the Superhumans": Print and online media representations of the Rio 2016 Paralympics

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Over recent years there has been an increase in research exploring media representations of para-athletes (Bush et al 2013; Butler and Bissell, 2015; Cherney and Hardin, 2015; Ellis, 2009; Hardin and Hardin, 2004; Hodges et al, 2015; Misener, 2013; Silva and Howe, 2012; Smith and Thomas, 2005). The authors' previous study of media representations of an integrated parasport and able-bodied sporting event (the Commonwealth Games) revealed that the majority of textual output clearly conformed to the social model of disability being critical of structural, cultural and institutional impediments (McPherson et al, 2016). The study also found that there was a gendered dimension to coverage, whereby elite female para-athletes were associated with stardom and sexual appeal, achieved through a heavily gender-coded version of the dominant supercrip discourse (Hardin and Hardin, 2004). That research also identified gaps in our knowledge of media representations that we sought to address via a study of print and online media generated before and during the Rio 2016 Paralympic Games. From the 1st June-30th September 2016, using search parameters focused on Paralympics; Rio 2016 Paralympics; parasport; para-athletes; disability sport; and, disabled sport, we collated 500 articles from across the international press and other media outlets. We employed discourse analysis to explore the emerging themes arising from coverage of the Paralympic Games, paying particular attention to the way para-athletes were represented as "Superhumans" and the response within the print and online media to that narrative.

Early analysis suggests that the discourse of 'Superhumans', central to the promotional activity of the UK's Channel 4, was prevalent in the print and online media in advance of the Games. Though coverage was generally positive about the 'innovative' marketing campaign, there was evidence that disability rights campaigners and para-athletes themselves were concerned about being labeled as 'superhuman' especially at a time when, in the UK in particular, the rights of persons with disabilities are under threat. As one article in the UK newspaper, the Guardian suggests "In 2012 we hailed Paralympians as heroes. Now they face a grimly familiar cycle of cuts and contempt, as the clock turns back on compassion". There was also evidence that the value of the Paralympics as a vehicle for social change for people with a disability was also in the spotlight, both before and during the Games. We conclude that whilst significant progress has been made in the quantity and quality of

reporting on parasport, in some sections of the media industries there is remains a problematic reliance with the dominant supercrip narrative that does little to develop greater understanding of the realities of life for people with disabilities.

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81 The effects of two types BCAA supplementation on anabolic hormones response after heavy resistance exercise in disabled weight lifters

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Para powerlifting is one of those sports that are popular among the athletes with physical disability. This group of Athletes usually consumes different types of nutritional supplement in their sport life. Protein and amino acids are most common nutritional supplements taken especially by these types of athletes. Among different types of amino acids, BCAA have been shown to be anabolic compounds via their augmentation of translation initiation when ingested before, during, or immediately after an acute resistance exercise (RE) session. Therefore, the purpose of this study was to investigate the effects of two types of BCAA supplementation in conjunction with an upper body resistance exercise session on serum growth hormone and insulin like growth factor I.

21 disabled weight lifters (aged 24.95±1.69 years, body fat 22±13%, weight 80.3±3.05kg and height169.72±3.67cm) in a randomized and double-blind design, were allocated in three groups: two supplement groups (240 and 480 mg/1kg/bw) and placebo group (240 mg/1kgbw dextrose). After one week supplementation period, all subjects were participated in resistance exercise protocol with 80% 1RM. Venouse Blood samples were obtained in the four phases: 1) base, 2) 30min before exercise protocol , 3) 30 min after exercise protocol and 4) 2h after exercise protocol . Serum variables were expressed

In delta values as percent change and analyzed via a 3 (group) × 4 (time points) repeated Measures ANOVA and Bonferroni tests using SPSS18 and Minitab 15 at ≤0.05.

Result of statics show that there was significant effect between four phases (base, 30 min before exercise protocol, 30 min after exercise protocol and 2h after exercise protocol) in all group in serum GH and IGF-I ($P \leq 0.05$). but no significant change between 3 group after one week supplementation was observed ($P \geq 0.05$). the amount of IGF-I was increased in relate of supplementation and exercise together but the change was not significant (p=0/059).

The results show that supplementation of BCAAs (240 and 480 mg/kg/bw) has no significant effect ($P \geq 0.05$) on disabled weight lifter's GH and IGF-I. But these factors were significantly increased ($P \leq 0.05$) after one bout of resistance exercise.

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90 Biomechanics of Seated Throwing: Kinematic contributions of upper limb

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Background: Decisions made by seated athletes and their coaches regarding throwing frame design and technique are currently based using a combination of anecdotal evidence (e.g. comfort, trial and error (Frossard et al.2005).

A better understanding of the interaction between the seated athlete and their throwing frame is needed (Keogh & Burkett 2016). This will enable evidenced based decisions regarding throwing technique and frame design by the coach and athlete, to influence performance.

Throwing frame design is critical as it has the potential to influence the organism-led constraints (functional level) which would lead to changes in the co-ordination strategy, and hopefully, maximum performance (Keogh 2011).

The purpose of this case study was to describe movement pattern variability occurring at key events during the throwing movement (i.e. power and release positions) for 4 throwing configurations.

Methods: One Female elite level Class F34 athlete (Age 39 years, Height 1.69m, Mass 90.3kg) participated in this study.

The participant conducted her usual warm-up prior to throwing, and used her own throwing frame. A 3kg shot put was thrown 6 times from 4 throwing configurations (Figure 1). Distance thrown was measured and recorded after each trial.

A 21 camera Qualisys (250Hz) set-up was placed around the thrower, and three dimensional (3D) kinematic data was collected using (56) reflective markers placed on the participant joints including the put.

Data was processed in Qualisys before being exported to Visual 3D where joint angular velocities (trunk, shoulder, elbow and wrist) were extracted. Trials were analysed from the power position (determined as the point just prior to the final forward movement into the release) to the point of release, for 4 throwing configurations (Figures 2). The mean of the six trials was used

for analysis, joint angular velocities were time normalised and graphed (Figures 3 and 4). Shot put kinematics were extracted and graphed in the same way (Figure 5).

Outcomes: The joint angular velocity graphs (Figures 3 and 4) show variations in the movement characteristics between the 4 throwing configurations.

Peak trunk angular velocity is greater for the No Pole throwing configurations. Similarly, there appears to be more “trunk whip” enabling greater transfer of angular velocity from trunk to elbow, without a holding pole.

Trunk whip is thought to positively influence trunk muscle stretch, producing greater force and promoting muscle contraction (Judge et al. 2011). It should be as large as possible when the athlete is just exiting the power position (Bartoniez & Borgstöm 1995, Young & Li 2005).

This is further demonstrated when the velocity of the shot put is tracked (Figure 5).

Practical Applications: The data from this case study is suggesting that performance may be positively influenced by the athlete not utilising a holding pole. This is different to the findings of Burkett et al (2012) who found no differences between with or without holding pole in a non-disabled population. Lesser variations were shown between the front on and diagonal sitting positions.

This may be useful to the athlete and coach when deciding on throwing frame design and technique.

Figure 1 – Throwing Configurations 1 - 4

Throwing Configuration 1	**Description**	**Throwing Configuration 2**	**Description**
Front on without pole 	Athlete is seated in a front on position (both legs facing the front) and **does not** hold a pole with their non-throwing hand	*Diagonal without pole* 	Athlete is seated in a diagonal position (one leg to front and one to the side) and **does not** hold a pole with their non-throwing hand
Throwing Configuration 3	**Description**	**Throwing Configuration 4**	**Description**
Diagonal with pole 	Athlete is seated in a front on position (both legs facing the front) and holds a pole with their non-throwing hand	*Front on with pole* 	Athlete is seated in a diagonal position (one leg to front and one to the side) and holds a pole with their non-throwing hand

Figure 2 – Stages of identification and analysis of key throwing events

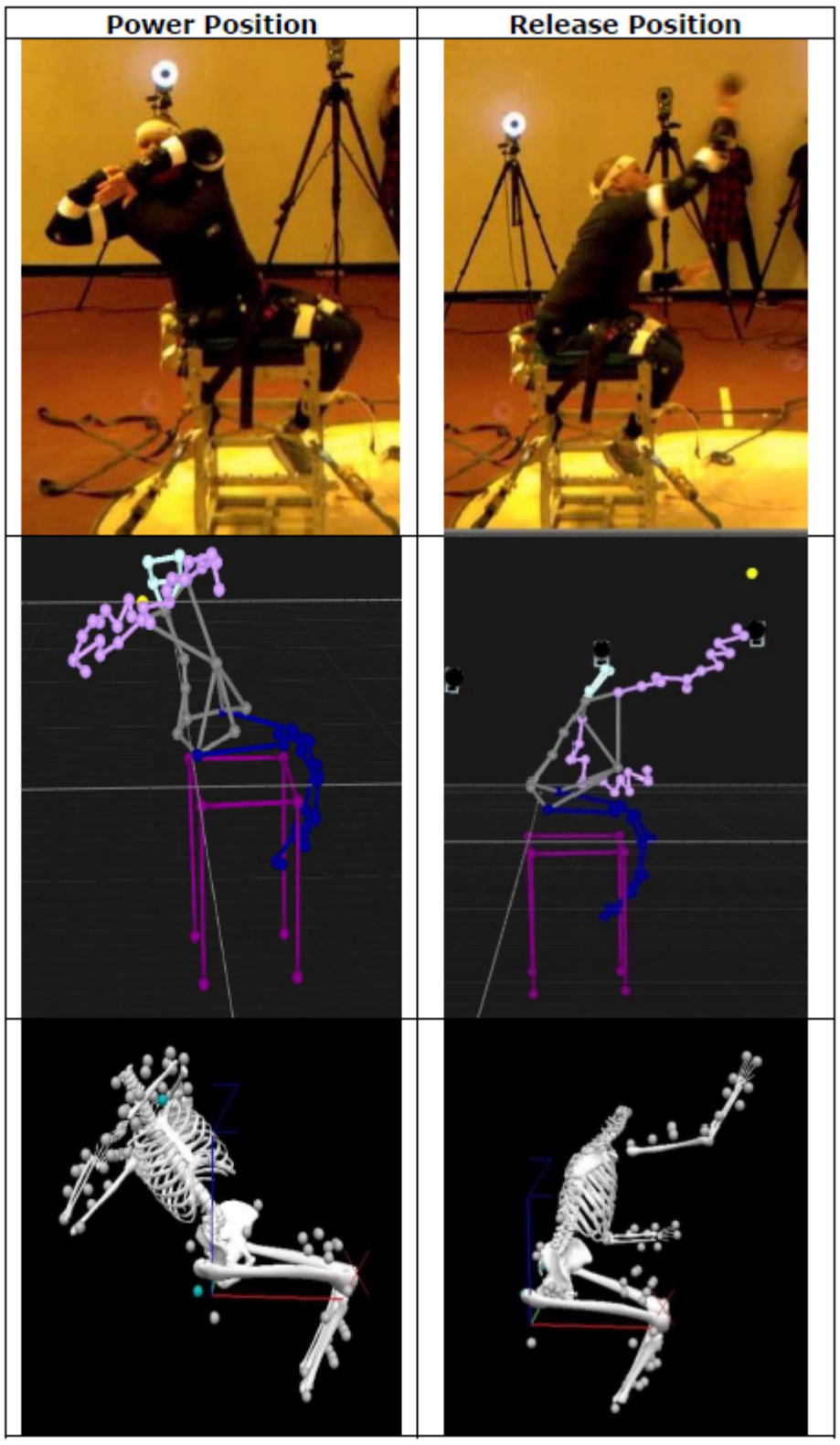


Figure 3 - Joint Angular Velocity (Trunk, R Shoulder, R Elbow, R Wrist) for 4 Throwing Configurations (time normalised)

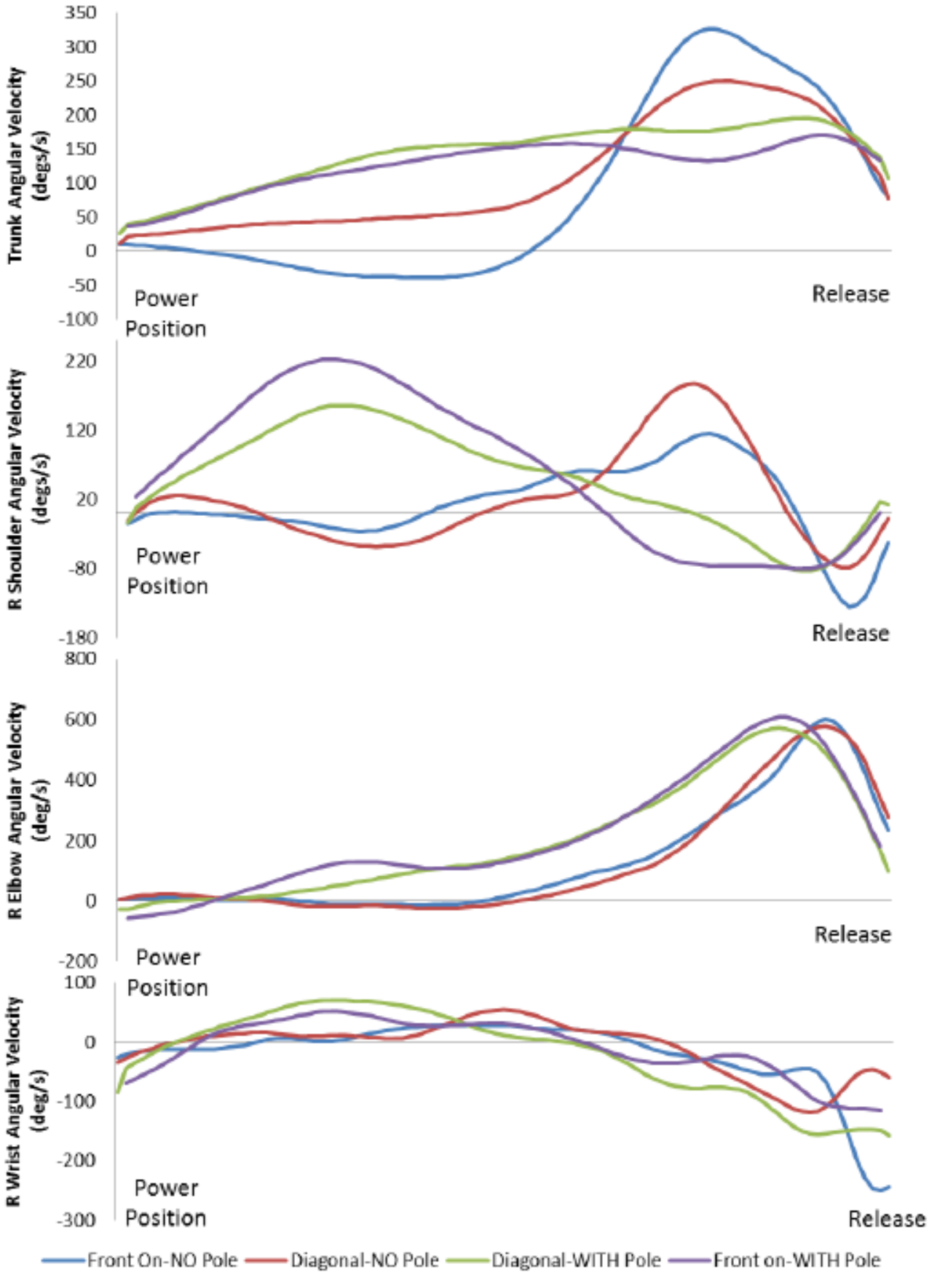


Figure 4 - Joint Angular Velocities for the 4 Throwing Configurations (time normalised)

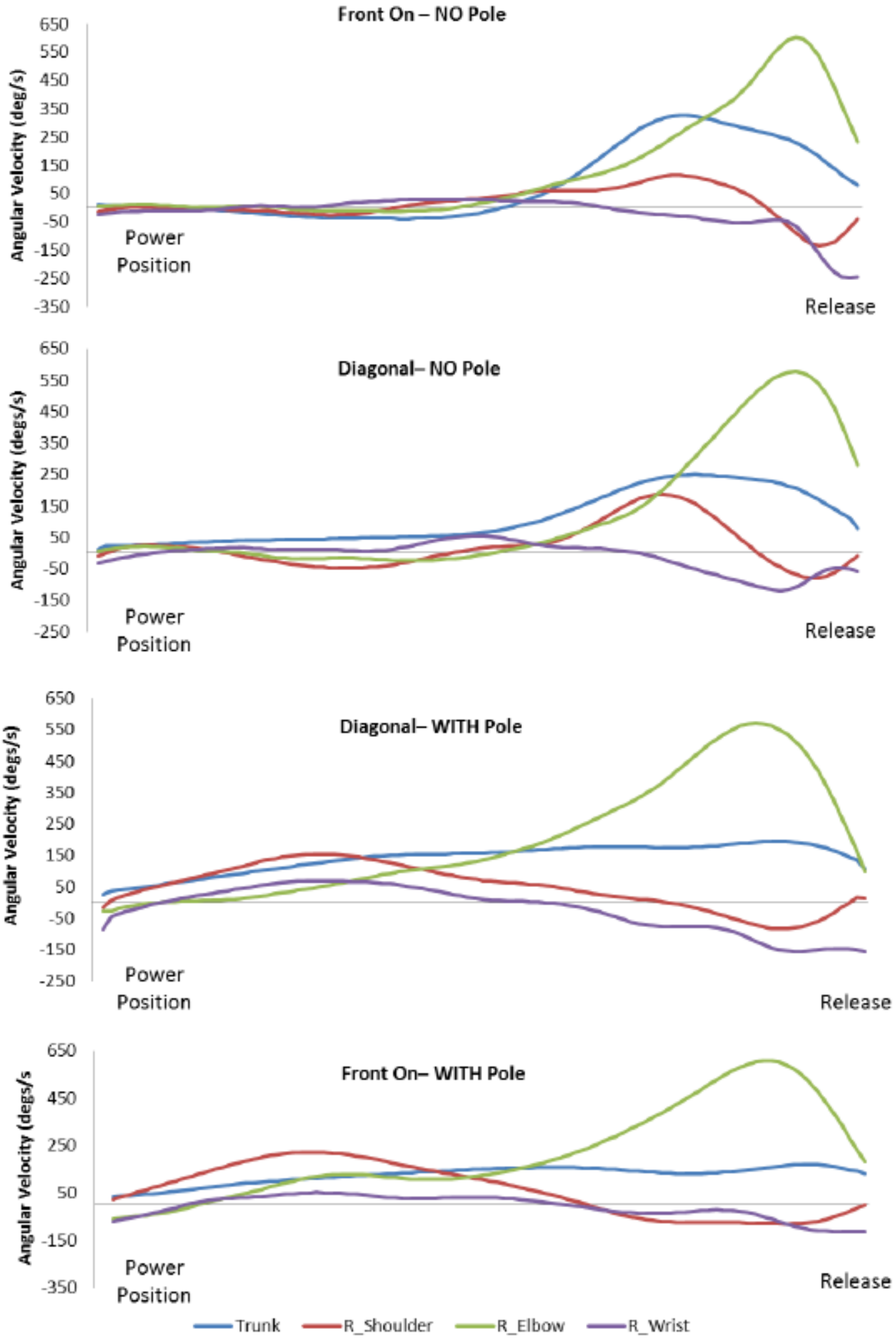
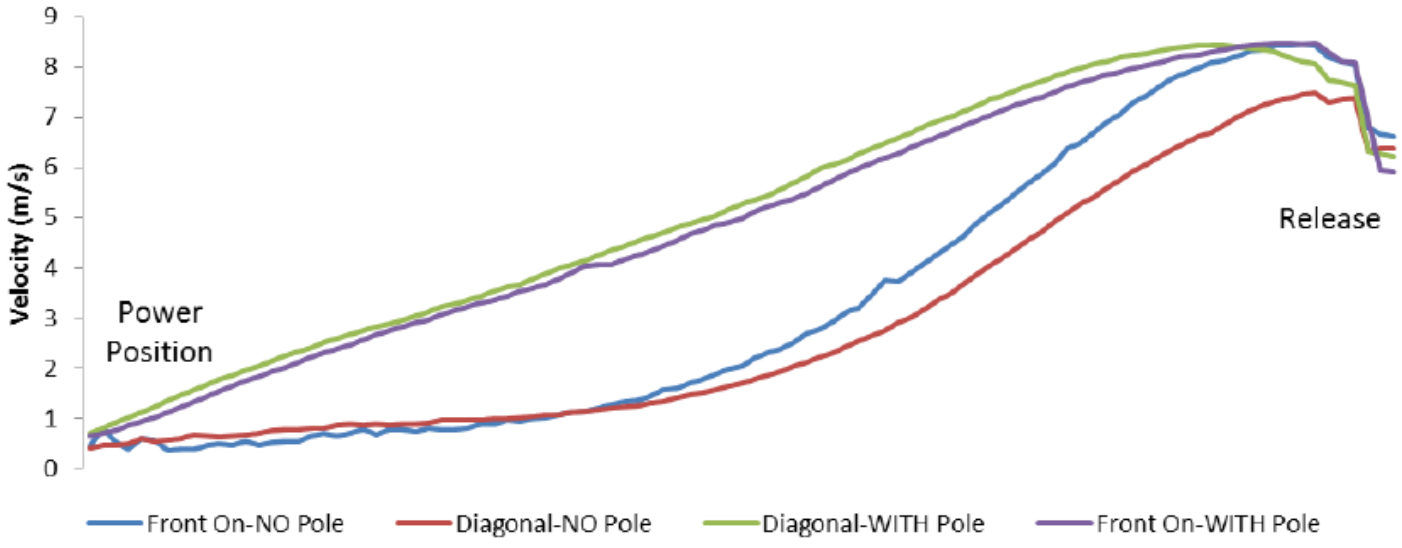


Figure 5 – Shot Put velocity for the 4 Throwing Configurations (time normalised)



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 # 92 Physical examination findings of elbow joints in para athletes participating in Oita International Wheelchair Marathon Race from 2013 to 2015.

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Athletes for wheelchair sports commonly experience elbow pain and most of them have a big concern about elbow joint injury induced by wheelchair propulsion. The arm damages in wheelchair athletes should decrease their sports performance and quality of life. Therefore, elbow joint injuries have to be diagnosed in early stage of elbow and shoulder damages and treated. However there have not been enough reports about elbow joint injury in wheelchair athletes. To investigate elbow joint injury and clinical practice, we studied physical examination in elbow joints for wheelchair athletes, involved elite athletes who competed at Paralympic Games before (Para-athletes). Seventy four wheelchair athletes (72 men and 2 women) who participated in Oita international wheelchair marathon race from 2013 to 2015. Their physical characteristics were: 49.4 ± 14.6

years age, 59. 6 ± 8.8 kg body weight, and 167.0 ± 8.8 cm height, and their history of participating in wheelchair marathon was 16.8 ± 9.9 years (means ± SD). Most of the participants were right-handers (right 70, left 4). Medical check items were interview (complain about motion pain, dominant hand and daily living), palpation, range of motion and physical examination. Motion pain, tenderness, Tinel's sign, ulnar nerve palsy and range of motion on elbow were recorded by well trained orthopedist. The 13 athletes had motion pain in either elbow and 54% of them had a motion pain on left side, though 31% of them had it on right side. The 19 athletes had tenderness in either elbow and 47% of the them had a tenderness pain on left side, though 16% of them had it on right side. The 79% of pain lesions was on left lateral epicondyle of humerus and significantly greater than right side. The 13 athletes had Tinel's sign in cubital tunnels of six right and seven left side. The two athletes had left ulnar nerve palsy. In all subjects, ranges of motion in both elbow joints were normal. The most athletes have no laterality of hand during transferring or changing the direction of wheelchair in daily life. We suggest that dominant hand should be stressed in daily use. Thus, daily use did not explain elbow problems in the wheelchair athletes. The present findings suggested that almost half of Para-athletes had humerus epicondyle tenderness or cubital tunnel symptoms and the left side would be dominant instead of normal range of motion of elbow joint. We suggest that wheelchair athletes had better to take physical examination of elbow to prevent and treat lateral epicondylitis regularly.

Okuma, Transition of physical fitness in wheelchair marathon competitors over several years. Paraplegia (1989)

93

RELATIONSHIP BETWEEN PASSIVE DRAG AND FRONT CRAWL PERFORMANCE TIME OF PARA SWIMMERS

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INTRODUCTION: Passive drag (Dp) is the resistance encountered when the swimmer's body moves through the water whilst holding a fixed position. Oh et al. (2013) reported a significant correlation between the Dp of Para swimmers and their IPC classification, that is, as the severity of swimming-specific impairment increased, so did the Dp. They also presented significant correlations between selected anthropometric measures and Dp. They reported the Dp of 46 different impairment groups and proposed a 'Passive Drag Band (PDB)' approach where swimmers were allocated within 10 bands (PDB 1-10) according to the amount of Dp (swimmers with greatest Dp in PDB 1, and vice versa). This study revealed that only 27.5% of swimmers were in the same IPC Class and PDB (Oh, 2015). Although these studies have highlighted the importance of assessing Dp when developing a fairer swimming classification system, they did not address the relationship between Dp and performance time (PT). In able-bodied swimming, Dp may reflect the amount of propulsion required to swim at maximal speed and therefore PT (Mason et al., 2009).

PURPOSE: To establish the relationship between PT and Dp for Para swimmers with different physical impairments.

METHODS: Dp of one hundred and fifty-three (91 males and 62 females) swimmers (IPC class 1 to 10, height 1.60 ± 0.25 m; mass 60.4 ± 12.2 kg) were measured using a motorised winch and an in-line load cell. Swimmers adopted their most streamlined position while being towed on the water surface at 1.5 m·s-1. Swimmers completed a minimum of three trials and the lowest drag value was used for the analysis. 50-m and 100-m freestyle times, collected from IPC SDMS database, were used as the PT. Pearson product correlations were calculated using SPSS v23.

RESULTS: Four groups were analysed: 50-m male (n=89, Dp 51.6±14.4 N; PT 38.0±15.7 s); 50-m female (n=61, Dp 46.8±14.0 N; PT 43.7±15.6 s); 100-m male (n=85, Dp 50.9±14.3 N; PT 80.4±31.8 s); 100-m female (n=61, Dp 47.1±14.1 N; PT

94.7±33.4 s). The Dp had significant correlations with PT for all cases (50-m Male: r=.80, p<.01; 50-m Female: r=.76, p<.01; 100-m Male: r =.78, p<.01; 100-m Female: r =.76, p<.01). The results support the findings of previous research findings of faster Para swimmers experiencing lower passive drag than slower ones (Chatard et al., 1992) at a given speed. Passive drag may therefore be a useful criterion when classifying physically impaired swimmers for competition.
CONCLUSION: There exists a strong positive relationship between passive drag and freestyle performance of Para swimmers.

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#: 97 Understanding Paralympic Athletes' Pathways: a preliminary investigation.

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BACKGROUND: Understanding the development of elite athlete pathways is complex and requires a multi-level approach (Andersen, Houlihan, & Ronglan, 2015). The interaction of these elements is also influenced by prevailing, and long term developed, the local culture, the political system, geography, cultural and historical context that the countries are inserted (Digel, Fahrner, & Burk, 2006; Houlihan & Green, 2007). Several researchers have attempted to outline athlete development frameworks and highlighted different stages (Balyi & Hamilton, 2004; Bloom & Sosniak, 1985; Cote, 2007; De Bosscher, Sotiriadou, & van Bottenburg, 2013; Gulbin, Croser, Morley, & Weissensteiner, 2013; Henriksen, Stambulova, & Roessler, 2010; Sotiriadou, Shilbury, & Quick, 2008; Wylleman, Alfermann, & Lavallee, 2004). However, most of these athlete development frameworks are sport generic and none thus far have attempted to outline Paralympic athlete development pathways.
AIM: The purpose of this study is to understand the development of Paralympic athletes' pathways, sport and impairment specific. This study therefore intends not to identify a 'one fits all approach' to athlete pathways, but to identify a set of broad principles that can be adapted to local circumstances in a culturally appropriate manner. The long term goal is then to develop a framework of reference for further exploration.
METHODS: A review of the scientific literature is currently being conducted and data were collected from 16 semi-structured in-depth interviews with international Paralympics experts.
RESULTS: Through content analysis, the preliminary results showed that Paralympic athletes pathways appear to be shorter than in mainstream sport, where Paralympic athletes normally progress faster through the sport system. Due to this fact, they might not have an efficient pathway of learning, improvement and training, which implicates in the athlete's development phases. In addition, most of the experts also suggested that the development pathways may differ significantly between athletes with congenital and acquired impairments with regard to the length, duration and entry age. Consequently, these findings illustrate that athlete pathways in parasport are not only sport specific, but also impairment specific.

CONCLUSION: With the purpose to develop elite athletes, countries need to improve systems and processes to attract, retain and nurture athletes with impairments. The results suggest that, in order to achieve such goal, better strategies and structures should be developed concerning elite para-athlete development pathways. Further research characterizing the factors that influence Paralympic athlete's pathways, the policies and support programs involved in different sports and impairments is needed.

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101 Integration of skill acquisition support: case-studies in Paralympic sport

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Australian Paralympic Committee

Skill acquisition is still a relatively new and emerging specialist discipline in the sport sciences, encompassing aspects from motor control and learning, biomechanics, psychology, neuroscience and performance analysis. Like other disciplines, current service support in Paralympic sport is limited, often based on theory adapted from able-bodied sport (cf. Paulson & Goosey-Tolfrey, 2016), and/ or based on finding from research programmes that are not representative of performance contexts (Churton & Keogh, 2013; Pinder et al., 2015). For example, a recent systematic review (Dehghansai, 2016) suggested that there was a single research study that had looked at acquisition of skills over a concerted period in an elite group of Paralympic (or equivalent level) athletes (Oudejans, Heubers, Ruitenbeek, & Janssen, 2012). The application of skill acquisition principles and research programmes is clearly an opportunity for considerable expansion in coach education to optimise practice designs in Paralympic sport. Of particular interest is the individualized nature of athlete impairments, requiring a flexible and creative approach. Here, we demonstrate how innovative approaches to integrating skill acquisition service support have been used in the preparation of Paralympic athletes in Australia, and discuss subsequent impact on coach and athlete

behaviour, as well as medal outcomes. Specifically, we outline how design thinking, combined with concepts from ecological dynamics in skill acquisition such as the constraints-led approach (CLA), were used with a range of athletes in the lead up to the Rio 2016 Paralympic Games. The application of key principles will be presented through a series of case-studies including athletics, table tennis and wheelchair rugby, to demonstrate the flexibility of skill acquisition support for a wide range of sports, athletes, and impairment types. Central to this approach, the CLA provided a functional framework for understanding interacting factors on athlete performance and learning (Chow, Davids, Button, & Renshaw, 2015). Despite the advocacy for a broad application of this approach in recent years, this has still had limited impact on Paralympic sport (see Churton & Keogh, 2013). Furthermore, following some recent misinterpretation (for an overview see: Renshaw, Araújo, Button, et al., 2016), we demonstrate that effective constraint-led support is not "hands-off", but constant careful and considered manipulation, facilitation and questioning. Case-studies will demonstrate how integrated support and skill development are maximised by considering the interaction of the individual (including impairment), task, and environmental factors. Research and applied implications will be discussed to guide future opportunities for skill acquisition in Paralympic sport. Notably, we argue for greater consideration of skill acquisition support in coach education, and that new research outlets for case-studies on elite athletes with disabilities will help to broaden our understanding of the impact of impairment on skill development.

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 # 103 Let Me Hear Your Body Talk: Narratives of Sport Physiotherapy and Paralympic Bodies

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Medical discourses regarding physical impairment have remained dominant despite rejection of the medical model of disability. The social model of disability has been unable to embrace the bodily experience of impairment. Without understanding the lived experience of the body of the Paralympic athlete, heteronormative discourses regarding sport and disability are reproduced. Personal narrative, provides opportunity to hear sporting bodies 'talk' and gain insight into the embodied sport experience. Through stories, understanding of the broader sociocultural factors that shape the embodied Paralympic sport experience can be realized, and alternative, non-medicalized discourses can be heard.

This presentation will consider alternative narratives of the embodied experience of Paralympic sport. Providing narrative of longstanding members of the Paralympic community generates insight into the lived experience of the athlete, re-claiming ownership of experience. Consideration will be given to larger socio- cultural realities surrounding impaired sporting bodies, and how sporting bodies are managed in medicalized spaces.

To examine the embodied sport experience, impairment and disability, I drew upon my involvement in six Paralympic Games, as sport physiotherapist. I developed a reflexive journal regarding my experience with Paralympic sport. Using self ethnography, I chronicled my Paralympic experience, reflecting on the ways in which sporting bodies were constructed by sport physiotherapy/medical professionals and athletes themselves. Analysis included coding to identify recurrent words, themes and discourses.

The research illustrates that real tensions exist for sporting bodies with impairment in medicalized spaces. Management of impairment as biological phenomenon is reflected in sport physiotherapy/medicine practices. Practitioners express discomfort when working with Paralympic athletes who experience greater impairment, and speak of insufficient expertise to meet the needs of these athletes. Repercussions for athletes may include reluctance to seek care due to perceived reticence. Denial of elite athlete status can occur when Paralympic bodies intersect with medical discourse. My ethnography illustrates an evolution of understanding of the para-sport body by physiotherapy/medical personnel and escalation of athlete expectations regarding services during Paralympic Games.

The centrality of the body is essential to understanding sport and disability. It is essential to foreground the embodied experience of Paralympic athletes and other members of the Paralympic community. Traditional homogenized stories of disability are subverted by alternative narratives of sport and disability.

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106 Detecting intentional misrepresentation when testing vision for classification

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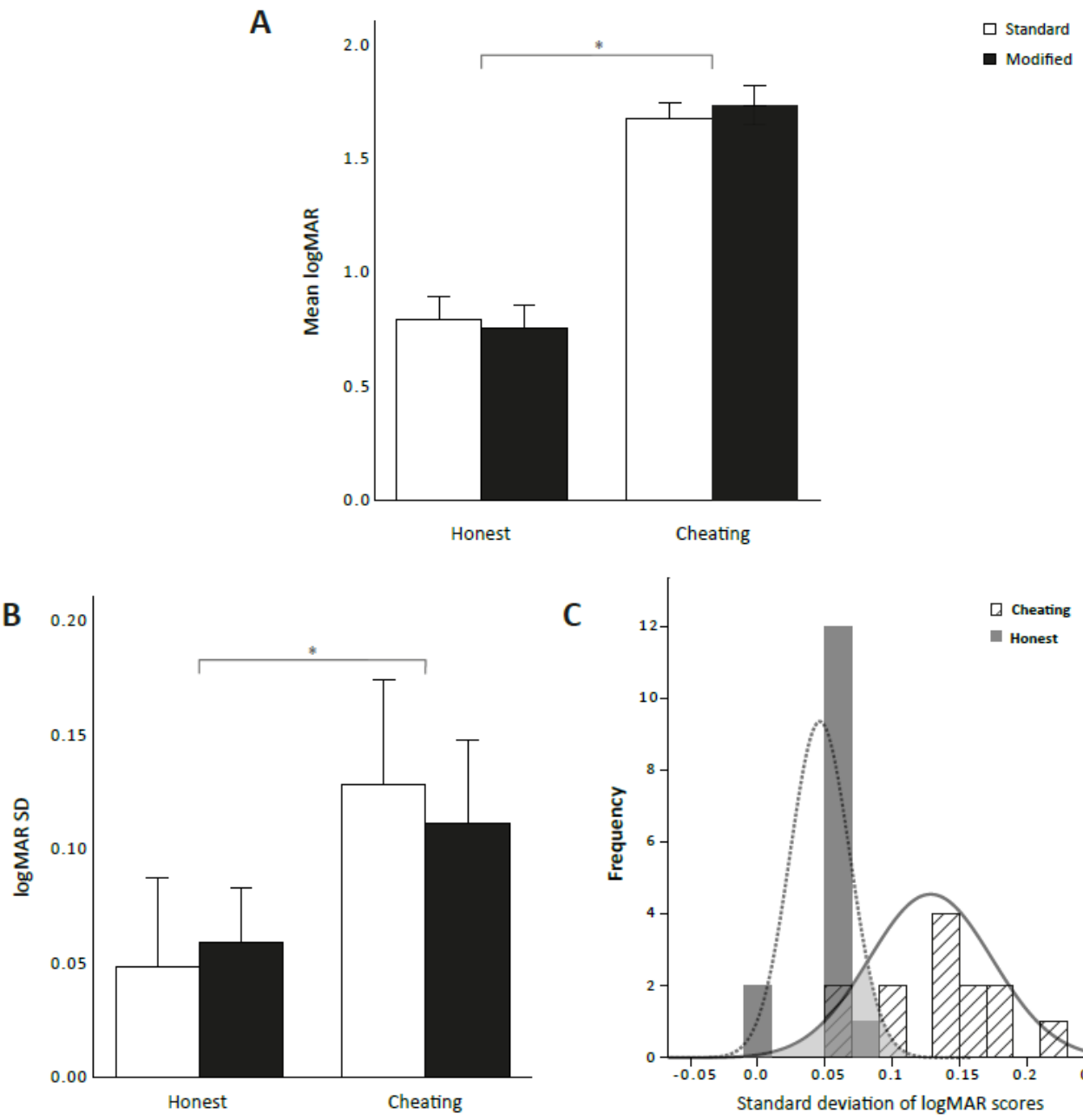
Most tests used for the classification of athletes with vision impairment (VI) are subjective in that their accuracy relies on the responses of the athlete, with the expectation that the athlete is providing their best effort. The reliance on subjective responses makes these tests potentially vulnerable to intentional misrepresentation, that is typically when an athlete would try to make their vision impairment appear to be worse than it actually is. A recent Delphi study that consulted a panel of experts in VI sport revealed a widespread concern about the rate of intentional misrepresentation in VI sport1. Therefore, a method to detect this type of misrepresentation is desirable. Purpose: The aim of this study was to investigate whether the intentional misrepresentation of vision could be detected when testing visual acuity in the presence of simulated impairment. Methods: We tested the visual acuity of 13 participants with simulated vision impairment using the Berkeley Rudimentary Vision Test (BRVT)2, the test most commonly used to classify vision impairment. The BRVT produces four estimations of visual acuity (measured in logMAR) that should ideally be identical when the task is performed at best effort. Variation (i.e. logMAR SD) across these estimates might give an indication of whether the participant is providing honest responses or not. We followed the standard test procedure for the BRVT and a modified procedure designed to make the test less predictable. For each procedure, there was an honest condition in which participants provided their best effort, and a cheating condition in which they attempted to make their visual acuity appear worse than it really was. Results: Participants were able to under-represent their level of vision; however, their responses were significantly more variable when cheating (Figure 1A). The variability in visual acuity estimations did not change when using the modified procedure designed to be less predictable than the standard procedure, demonstrating the robustness of the current BRVT procedure in the presence of cheating (Figure 1B). There was only limited overlap in the distributions of the logMAR SDs measured in the cheating vs. the honest conditions, indicating that the increased variability can reliably distinguish between honest and dishonest responses (Figure 1C). A cut-off of ≥0.1logMAR SD provided the most accurate detection of whether someone was cheating. Conclusion: The standard procedure used for the BRVT is robust to cheating. The variability in the estimations of visual acuity may prove to be a promising means for classifiers to detect intentional misrepresentation when testing for vision impairment.

Figure 1. Comparison of the BRVT outcomes while cheating and performing honestly when using the standard and modified BRVT procedures. A. Mean visual acuity; B. standard deviation in visual acuity; C. Distributions of the standard deviation of visual acuity. Lower logMAR values represent better visual acuity. Gaussian fits for the honest and cheating conditions are shown in panel C respectively by the dotted and solid lines, and the shaded area represent overlap. * Significant difference ($p<0.05$).



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 # 108 Defining key joints for performance in va'a paddling- The first step in creating a sport-specific evidence-based classification system for para-va'a

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INTRODUCTION: Para-va'a and para-kayak are the disciplines included in the relatively new sport Paracanoe. Para-kayak made its debut in the 2016 Paralympic Games. One of the conditions for para-va'a to also be included in the Paralympic Games is to comply with the International Paralympic Committees (IPC) Athlete Classification Code (IPC 2015) by developing a sport-specific classification system through evidence-based research focusing on the relationship between impairment and key performance determinants. The first step in creating the classification system for para-va'a is therefore to examine the three-dimensional (3D) kinematics and kinetics during va'a paddling to define the performance determining joints and in which

ranges of movement (ROMs) they move for power production. With this information new physical assessment tests can be developed which can examine these joints in sport-specific ROMs.

PURPOSE: The purposes of this study were a) to define the ROM and minimum and maximum angles in the lower limbs (hip, knee, ankle) and trunk in elite able- bodied va'a athletes (AV) and para-va'a athletes (PV) during va'a ergometer paddling and b) to correlate the separate joint angles values with power output for both groups; males and females separately.

METHOD: Ten international level AV (5 F and 5 M; 44 ± 3 years, 75 ± 8 kg, 1.78 ± 0.1 m) and 44 national or international level PV (13 F and 31 M; 35 ± 8 years, 72 ± 17 kg, 1.73 ± 0.17 m) participated in the study. A 12-camera optoelectronic system captured 54 reflective markers that were attached on anatomical landmarks in order to construct a 3D whole-body model. Reflective tape was placed on a piezoelectric force transducer that was connected to the rope from the ergometer flywheel close to the end of the paddle shaft permitting calculations of power. The athletes paddled at a high intensity level. Since the body sides move differently in relation to each other during the va'a paddling stroke, angles of the lower limbs were calculated for the bottom hand side and the top hand side (Figure 1).

RESULTS: The average joint angle ranges for AV were; trunk flexion (15-31°), trunk rotation (ROM 33°), trunk and pelvis rotation (ROM 47°), hip flexion top hand side (104-127°), hip flexion bottom hand side (105-125°), knee flexion top hand side (43-55°), knee flexion bottom hand side (31-51°), ankle plantar flexion top hand side (19-27°) and ankle plantar flexion bottom hand side (23-35°). Significant ($p < 0.05$) positive correlations were found for both genders between power output and; maximum and minimum trunk flexion, trunk flexion ROM, trunk and pelvis rotation ROM, bottom and top hand side hip flexion ROM and bottom hand side knee and ankle flexion ROM.

CONCLUSION: During va'a paddling greater movement of the trunk and the leg on the bottom hand side generate more power. The results therefore highlight the importance of including tests for assessment of trunk and leg function in para-va'a classification. Furthermore, the kinematic results from the AV can be used for sport-specific assessment of the performance determining joints in a new evidence-based classification system.

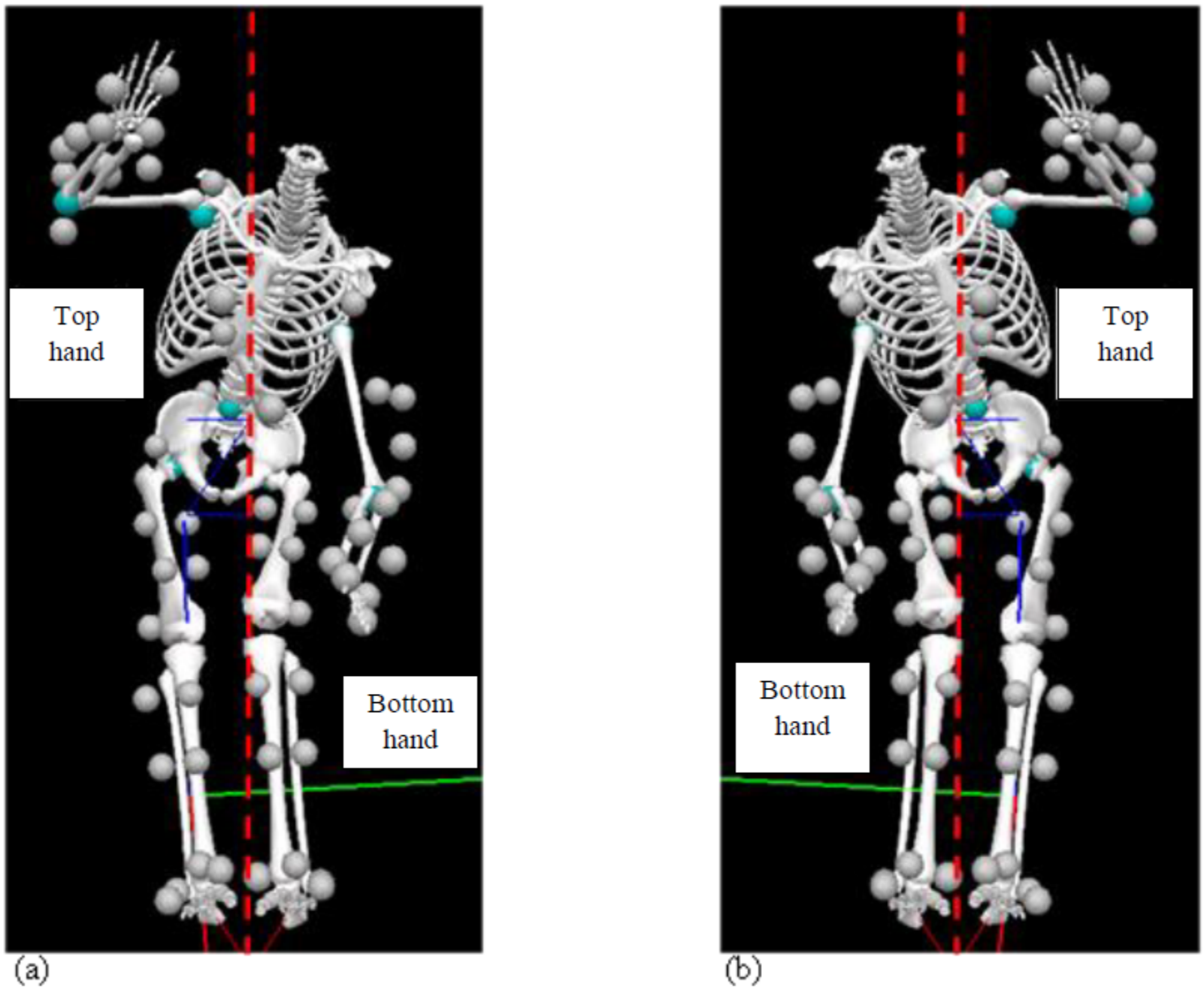

Figure 1. Description of top and bottom hand side for: (a) left-handed and (b) right-handed paddlers. Hand dominance is associated with the bottom hand on the paddle and the limbs on that side. For example a left-handed paddler (a), bottom hand limbs are on their left side and top hand limbs are on their right side, and vice versa for a right-handed paddler.

International Paralympic Committee (2015). IPC Athlete Classification Code- Rules, policies, and procedures for athlete classification.

 # 109 Evidence-based classification: Testing a performance indicator for Para World Sailing.

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A performance indicator for Paralympic sailing was developed as a method of separating physical ability independently from skill in Para world sailors. The indicator was applied to the 2016 Paralympic 2.4 metre competition.

Background: The need to develop standardised, sport-specific measures of performance is described by Tweedy et al. (2014) in their sequential 4-step process outlining how to initiate and develop evidence-based methods of classification. In the Paralympic 2.4mR sailing class, all athletes compete together under the 'Minimal Disability' classification. It was hypothesised that those with partial trunk muscle innervation would be disadvantaged in this

format due to difficulties counteracting the leaning angle of the boat while heading upwind (into the wind), particularly at higher wind speed.

Method: Using tracker timings from the 11 competition races of Rio 2016, 916 mark roundings were analysed. Times from the start of each heat were compared to downwind times to create a performance fraction for each sailor. The fractions were compared for the group of sailors with partial trunk muscle innervation vs those with full trunk muscle innervation.

Results: The mean fraction for the whole group ranged from 2.2 (upwind/downwind) at 10 knots wind speed to 1.3 to 1.4 between 12 to 17 knots and up to 1.8 at 23 knots. There was no significant ($p>0.01$) difference in the mean performance fraction between athletes with full trunk innervation vs partial trunk innervation.

Discussion: A previous study by Wilson and Vardy (2005) at the Athens Paralympics had suggested that decreased trunk control from partial innervation was a performance- limiting factor in heavy winds. This study refutes that previous suggestion and supports the current practice of using a minimum disability entry classification for all participants in the 2.4 metre class where transfer of body weight is not required.

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 # 110 The PAPAI-model: a promising tool to increase sports participation and physical activity levels of children and young people with disabilities

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Introduction: The model of PAPAI (Personal Adapted Physical Activity Instructor) was created by Finnish Sports Association of Persons with Disabilities (VAU) to find sport as a hobby to children and young people with disabilities and to increase their physical activity levels. The model was piloted and documented in Finland in 2016 as part of the European Union (Erasmus+) funded Sport Empowers Disabled Youth (SEDY)-project.

Methods: Altogether 367 children and young people with special needs aged 6-23 sent their application to get their own instructor (PAPAI). Out of them 288 received a PAPAI, who were students from the co-operating universities and schools or either volunteers. The experimental periods took place in Autumn 2016 in more than 60 cities or municipalities all around the Finland. Electronic questionnaire was used to capture participants sociodemographic background, physical activity levels, costs, sport participation as well as the factors associated to finding the hobby. In addition, a feedback survey was sent to PAPAIs after the experimental periods, and the periods were documented with photographs and hobby-try-out -diaries. Moreover, the feedback from teachers and municipality representatives was gathered with surveys.

Results: Altogether 155 (68% boys, mean age 12 years) of the applicants informed that they had completed the program, 54% reported that they found a new sport as a hobby and 61 % reported that their physical activity level had increased during the PAPAI-program. They tried altogether 37 different sports. PAPAIs were students and volunteers from the fields of physical education, pedagogic, rehabilitation and social welfare from 19 universities or institutes. The PAPAI's role was to help the participant to find suitable sport hobbies, make a hobby try-out plan and act as a support person during the try-outs. Out of the

201 PAPAIs two of three were females and studied physiotherapy. Most of the PAPAIs (87%) estimated that PAPAI-role was a useful experience for their future career and 85% would recommend the role of PAPAI for future students. The teaching and municipalities' personnel ranked the program as a promising intervention, but asked for more structure and common guidelines. Regional PAPAI-coordinators as mediators and problem solvers between families, students, teachers and sport clubs were reported as important part of the program. PAPAIs reported that it was hardest to find suitable hobby options. For the participants the most important success factors were: a good coach, successful experience, fun and joy, opportunity to do sports immediately after school day and having their voice heard on the hobby- try-outs.

Conclusion: The PAPAI-model is a win-win -situation for the family, the student and the sport providers. It respects the individual needs and situation of the family and the voice of the children and youth. To improve future sports participation an updated website which covers both inclusive and disability-specific hobby options is needed. Moreover, the mainstream sports providers should be given inclusion training. The PAPAI-model is currently being applied by the project partners in the Netherlands, Portugal and Lithuania.

SEDY-project http://www.hva.nl/kc-bsv/projecten/content2/sedy-project/sedy-project.html

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 # 111 Factors Determining Successful Organization and Participation of Special Schools Sports in Trans Nzoia Region, Kenya

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Background: Sports participation has been proved to be an effective way in promoting independency, inclusion to the society, accessibility and awareness of capabilities among persons with disabilities. Even so, disability sport participation rate in developing countries is still low with only an estimated 23% being represented internationally. Kenya has met reasonable milestones in promoting disability sports. However, primary and secondary school competitions have not been given attention commensurate to the needs, number and different abilities of learners with disabilities whose talents can be tapped and nurtured for greater representation. The study therefore set out to examine factors that determine successful organization and participation in primary and secondary school annual sports competitions.

Methodology: Descriptive survey research design sought information from 150 special schools sports organizers. These included; ministry of education officers, federation officials, head teachers, games teachers and volunteer coaches who were stratified and randomly selected. Questionnaires, interviews and actual observation were used to collect data. Data was organized using Statistical Package for the Social Sciences (SPSS) version 21 and analyzed by t-test and one way analysis of variance (ANNOVA)

Results: The study findings revealed that existence of a national disability sports structure ensured central organization of sports for learners with disability thus encouraging participation in the regions. Poor organizational skills (62.5%), lack of disability sport technical knowhow (60%), few participation opportunities in a year (80.5%) and limited facilities/Equipment (73%) were among the highest perceived challenges in successfully organizing disability sports in the region. Additionally, the study noted a significant difference in organizational skills between teachers/volunteer coaches/federation officials and ministry of education officers.

Conclusion: The findings highlighted the need for policy enhancement to promote disability sports. Training on adaptation and proper sports organization skills among the organizers and, provision of appropriate and adequate facilities/equipment will boost sports participation among learners with disabilities.

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113 Wheelchair tennis skill development, court-movement and physiological cost: effects of organised practice

P. Sindall; J.P. Lenton; B.S. Mason; K. Tolfrey; R.A. Cooper; M. Oyster; K.A. Martin Ginis; V.L. Goosey-Tolfrey

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The purpose of this study was to examine the effects of organised practice on tennis match-play responses and to consider the effects of racket-holding during practice. Sixteen able-bodied, inexperienced wheelchair tennis players, were monitored during repeated bouts of tennis match-play (60-min) interspersed with a single bout of organised practice. Practice involved sport-specific wheelchair mobility drills completed with (R) or without (NR) a tennis racket. Graded and peak exercise tests were completed in a controlled laboratory environment. Individual linear HR : V̇O2 relationships were used to estimate on-court oxygen uptake (V̇O2). A data logger was used to record distance and speed. Significant main effects for match revealed an increase from PRE to POST practice for distance (overall: 34.5 ± 6.9 vs. 37.5 ± 6.9 m, $P < 0.05$; forwards: 20.5 ± 6.9 vs. 24.2 ± 6.9 m, $P < 0.05$) and speed (peak: 2.22 ± 0.35 vs. 2.51 ± 0.35 m·s-1, $P < 0.005$; average: 0.58 ± 0.12 vs. 0.63 ± 0.11 m·s-1, $P < 0.05$). Significant PRE to POST practice increases in self-confidence were observed in 4 out of 5 outcomes ($P <0.05$). Lower distance and speeds were achieved during R practice with a lower peak physiological response. Independent of racket-strategy, organised practice increases match-play court-movement and raises self-confidence in tennis-specific mobility and shot-play with no associated increases in mean physiological cost. Changes are desirable and represent enhanced court-mobility. Differences between R and NR practice characteristics provide options for enhancement of tennis skill and optimisation of health outcomes.

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 # 114 Salivary Biomarkers and Training Load in Training and Major Competition: A Case Study of 4 Paralympic Swimmers

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Introduction: Responses to training stress are highly individualised with athletes recovering from the same training stimulus differently (1). Stress response can also be attributed to competition where increased physiological and psychological stress can negatively impact on performance and recovery. Salivary biomarkers are easily accessible and non-invasive measures which can be quantified quickly and repeatedly (2). Saliva contains immunity and stress biomarkers including immunoglobulin A (IgA), alpha-amylase (AA) and cortisol (cort) which have been used to monitor training and competition stress responses (3, 4). To understand the training/recovery needs of Paralympic athletes and the impact of major competition, this case study examined training loads and salivary biomarker responses in preparation for and during the Rio 2016 Paralympic Games.

Methods: Four Paralympic swimmers provided bi-weekly saliva samples during three distinct phases of training (baseline, intensified training and taper) with daily saliva samples collected in the 10 day Paralympic competition phase. Saliva samples were analysed for IgA, AA and cort using an IPRO (IPRO Interactive, Wallingford, UK) oral fluid collector kits. Training loads were measured during all four phases using session-RPE method proposed by Foster et al. (5).

Results: Compared to baseline training, significant increases in mean concentrations of IgA, AA and cort were observed during intensified training in line with increases in mean training load (Table 1). Salivary IgA did not decrease in response to increased training load suggesting swimmers were not immuno- compromised during the intensified training phase (Figure 1). In response to competition all three biomarkers values were further increased from baseline during Paralympic Games despite training load decreasing during this phase (Figure 1). Mean training load decreased during taper and competition and in response salivary biomarkers decreased during taper but significantly increased during competition.

Discussion: The results demonstrate that performance in major competition such as Paralympic Games induces a stress response in athletes. Previous research has identified a significant increase in sAA in response to competition (3). Similarly the findings from this case study demonstrated a significant response in sAA levels during competition period compared to baseline. With a decrease in training stress in this phase it is reasonable to associate the response with increased psychological stress of participating in a competition as significant as a Paralympic Games. Despite widespread research examining salivary biomarkers in athletic populations, little research has been conducted on the immunological and stress hormones in response to major competition and training stress in Paralympic athletes. Findings from this case study suggest that coaches and support staff should recognise the stress response associated with participation in major competition despite training loads decreasing. More intense recovery protocols may be necessary as competition progresses to enable athletes to optimally perform across all ten days of competition

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116 Investigation of motion perception in elite skiers with visual impairment

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University of Waterloo; International Paralympic Committee Snow Sports

Perception of motion is crucial in sports like Alpine and Nordic skiing, because athletes are constantly moving during competition and need to respond quickly and accurately to their environment. This makes skiing a highly challenging sport for athletes with visual impairment(1). Standard clinical assessments of vision are static and do not test temporal visual functions even though a large portion of an individual's daily life activities, like crossing the road or driving, require the perception of motion. Furthermore, some research suggests that motion perception may be particularly important for motor coordination(2, 3). Two measures of motion perception are global motion perception and dynamic visual acuity. Global motion tests, quantify the signal to noise ratio required to accurately identify the direction of a series of dots moving in a coherent, uniform direction (signal) amongst an array of randomly moving dots (noise)(4,5, 6). This becomes progressively harder when the proportion of signal-to-noise dots decreases. The smaller the proportion of signal-to-noise dots required to detect the direction of the signal dots, the better the global motion perception. Dynamic visual acuity quantifies the smallest amount of detail an individual can identify in a moving target. Individuals are asked to recognize moving objects, such as letters or numbers, which get progressively smaller in size(7).

The objectives of this study are to examine 1) the relationships between temporal vision tests (global motion perception, dynamic visual acuity) and standard static clinical tests of vision (visual acuity, contrast sensitivity, visual fields) in individuals with visual impairment, and 2) the relationship between motion perception, dynamic visual acuity and skiing performance in elite Alpine and Nordic skiers with visual impairment.

Global motion perception, dynamic visual acuity, static visual acuity, contrast sensitivity and visual are being measured binocularly in elite Alpine and Nordic skiers with visual impairment at the Para Alpine and Para Nordic World Championships in 2017. Motion detection tests are being conducted for two different types of motion; vertical (up or down) and radial (in or out).

Global motion perception and dynamic visual acuity will be compared with the clinical functions measured in this study to examine how temporal vision tests are related to static visual tests in individuals with visual impairment. Skiers' performance on the motion perception tests will also be compared with their athletic performance (including race times and international rankings) during the 2017-2018 skiing season.

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 # 118 Inclusive Skating: a case study in the social and economic challenges and opportunities that arise when creating new Paralympic sports and the lessons to be learned for future development.

Margarita Sweeney-Baird

Inclusive Skating

Inclusive Skating has implemented an innovative classification system that allows all disabilities to be included in sports events. Consequently, many athletes with multiple disabilities and genetic syndromes participate in Inclusive Skating events and clubs. Meeting the care needs of Inclusive athletes and managing this in a cost effective manner has required an innovative and flexible approach to participation development, training and the operation of events. These systems will be described in the case study. Thereafter, the contrast between the Inclusive Skating systems and those developed by able bodied sports and the Paralympics is considered. Examples of factors to be identified in the case study and then contrasted include: the use of group lessons and training, the number of accredited facilitators and carers per athlete; the cost implications of increasing care needs for development of Paralympic athletes and events, the average age of participation of athletes with genetic syndromes as compared to the general population, the involvement of clubs and support networks. In conclusion the lessons that can be learned from this case study for future policy development and decision making will be considered.

Www.inclusiveskating.org world rankings and events pages.

 # 120 Using an online peer learning group to support the development of a parasport coaching community.

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Researchers are often criticized for being removed from “real issues”. The present case is an example of how the collaboration between researchers, practitioners, and sport participants from a National Sport Organization (NSO) implemented a synergetic project to tackle real issues. Duarte et al. (in press) found three barriers for disability sport coach development: (1) few training opportunities, (2) few occasions for social interactions between coaches, and (3) high costs associated with professional development. This project was designed according to a body of evidence related to the benefits of social learning in order to overcome these barriers.

Project: The project consisted of three phases. First: Establish common goals. The peer learning group (PLG) is composed of 21 group members including: national, provincial, and regional coaches; NSO staff; and researchers. The PLG members were interviewed to map their learning interests and verify learning priorities. Second: Design tailored learning opportunities. To deliver learning opportunities based on the coaches’ interest, a collaborative website was put in place to (a) centralize communication among PLG members, (b) assess interest in specific topics, and (c) build a coaching resources database (e.g., videos, tools, etc). Third: Assess the benefits of these learning activities. Wenger-Trayner et al.’s (2011) framework was used to

assess the learning value created through the members' participation in the PLG. Data collection consisted of individual interviews with the coaches, observations during key competitions, group meetings, webinars, and online virtual discussions.

Benefits: Prior to the initial implementation of the PLG, coaches reported it had been a year since their last interaction with a group of peers. Some benefits resulting from the PLG are: the website hosted 28 discussion topics with an average participation of 5.4 comments each from up to 10 coaches discussing the same topic. A total of 17 coaches participated in at least one of the offered webinars or meetings. The six-month follow-up interviews revealed 10 coaches having downloaded resources from the website, and six coaches reporting changes to their practices based on the drills presented by the national team coaches. During the first 10 months of the project, 156 PD credits were granted. According to one coach, "the project created a community that has given people information that they would never have accessed otherwise."

Best Practices: In order for a PLG to work, efforts need to come from three groups. The researchers worked as social learning facilitators, such a role is important to organize the schedule and the virtual platform, prompt coaches to select topics and dates available, and assess the benefits of the interactions. The NSO provided enabling resources such as experts from the integrated support team, recognized the PD credits, and provided the webinar platform. The members of the PLG actively participated in many ways: from choosing topics relevant to them and sharing personal strategies to solve common issues. Without the involvement from these three groups, the PLG would not likely have been as productive.

Cregan, K., Bloom, G. A., & Reid, G. (2007), DePauw, K. P., & Gavron, S. J. (2005), Duarte & Culver (2014), Duarte, Culver, Trudel, and Milistetd (in press), Wenger-Trayner, E., Wenger-Trayner, B., & De Laat, M. (2011)

 # 123 Validation of arm coordination impairment tests for wheelchair rugby classification.

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INTRODUCTION: Classification of wheelchair rugby athletes is crucial to minimise the impact of impairment on the outcome of the competition. The wheelchair rugby classification system has been developed for athletes with spinal cord injury and is focussed on muscle strength impairment. However, over the years, athletes with other health conditions, resulting in other neuromusculoskeletal impairment types, including coordination impairment, entered the sport. Classification of athletes with coordination impairment relies on class deduction from the maximum score based on classifiers expert opinion. No impairment tests for arm coordination are used for wheelchair rugby classification. Clinical tests for coordination impairment are focussed on activities in daily life that are irrelevant for wheelchair rugby. Therefore, coordination impairment tests (single joint repetitive movement tests, RMT) for the arms were developed. However, the validity of these tests in relation to coordination impairment and in relation to activity limitation in wheelchair rugby needs to be established.

PURPOSE: To assess the validity of the RMT for classification of wheelchair rugby athletes, and to assess whether the RMT indeed quantify coordination impairment.

METHODS: Nine wheelchair rugby athletes with coordination impairment performed 5 single joint RMT, the spiral test and the finger-nose test. The RMT consist of repetitive movements of the fingers, wrist, forearm, elbow and shoulder of each arm separately. If the athlete can perform coordination tasks correctly, the number of movements in 20 s. will be counted. For the finger-nose test the number of correct hits in 20 s. is the outcome. The outcome of the spiral test is the time needed to perform the test in seconds, added with 3 s. for each time a line is touched and with 5 s. for each time a line has been crossed. All tests

were videotaped and analysed by two researchers independent of each other. A third researcher evaluated the video in case of disagreement.

To assess the validity, Spearman's rank correlation between RMT and the class deduction determined by the classifiers was determined. To assess whether RMT measure coordination impairment, Spearman's rank correlation between RMT and the finger-nose test and spiral test were determined. The cut-off for a strong correlation was ≥ .60.

RESULTS: The correlation coefficient between RMT and the class deduction determined by the expert opinion of the classifiers was ($r = .64$, $p = .07$).The correlation coefficient between the RMT and the spiral test and finger-nose test was ($r = .79$, $p = .048$; $r = .75$, $p = .07$). The inter-observer reliability of the RMT was >.99 ($p = .001$).

CONCLUSIONS: The correlations between RMT and the spiral test and finger-nose test were strong, which means RMT quantify coordination impairment. The correlation coefficient between RMT and the class deduction determined by the expert opinion of the classifiers were strong, which means that the RMT are specific for wheelchair rugby. Therefore, RMT can be implemented to impairment testing in wheelchair rugby classification.

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 # 124 How the cognitive-motor dual-task paradigm can contribute to the development of evidence-based classification systems for athletes with intellectual impairment.

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Evidence-based classification requires the development of valid measures of impairment*. For athletes with intellectual impairment (II), cognitive functions are currently assessed by means of single measures. In most sports, however, athletes frequently encounter situations in which they must perform multiple tasks simultaneously. Therefore, the dual-task (DT) paradigm is an ecologically valid approach for the assessment of cognitive function in conjunction with motor demands. The purpose of this study was to explore how the DT paradigm can contribute to the development of evidence-based classification systems for athletes with II. A pilot study included 206 male and female elite athletes with and without II, matched for sport, age and training volume (140 males, 66 females, M age =23.2 ± 4.1 years, M training experience = 12.3 ± 5.7 years. The motor task required balancing on one leg on a balance beam, and the cognitive task was a multiple object tracking (MOT) task assessing dynamic visual search capacity. All participants performed each test in single condition first, and then simultaneously (dual task). Statistics were performed using a 2 (impairment: ID vs AB) x 2 (condition: single vs dual) ANCOVA with training volume as covariate to assess the dual task cost for balance and MOT performance. The results showed reduced balance ($F = 55.9$, $p < .001$) and reduced mental tracking skills ($F = 86.3$, $p < .001$) in II-athletes compared to the control group in the ST condition. As expected, II-athletes had limited resources to successfully combine cognitive demands with the balance task; and balance was prioritized.

The assessment of MOT in a DT paradigm, provided insight in how impaired intelligence constrains the ability of athletes with II to successfully perform at the highest levels in the complex and dynamical sport environment. The dual task paradigm can be a useful methodology in the development of evidence-based systems of classification for II-athletes. suggestions for further research will be presented with a variety of cognitive and motor components, and sport-specific applications.

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 # 125 The influence of lower limb impairments on RaceRunning performance in athletes with hypertonia, ataxia and athetosis; towards an evidence-based classification of RaceRunning as a para athletics event.

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RaceRunning is an emerging disability sport with athletes competing at national and international events. It is especially popular amongst athletes with moderate to severe levels of Cerebral Palsy (CP) and related conditions, a group currently underrepresented in the Paralympic Games. CPISRA aims to develop RaceRunning as a para athletics event. Our aim was to analyse the association between a range of impairment measures and RaceRunning performance as a first step towards an evidence based classification for this event.

Twenty-nine athletes (24 with CP, 2 with TBI/brain tumour, 3 unknown; age 25 (SD9) years) from CPISRA classes RR1, RR2 and RR3 with at least one year experience in RaceRunning took part. Ethical approval was obtained from the University Research Ethics Committee. A neuro-paediatric physiotherapist and IPC athletics national classifier assessed manual lower limb muscle strength (MMT), selective voluntary motor control (SCALE), spasticity (ASAS and MAS) and passive extension of the hip (Hext) and knee (Kext). RaceRunning (RR) speed was derived from the athlete's fastest 100 m time at the 20th International RaceRunning Cup, corrected for leg length [1]. Spearman's rho between performance and impairment measures was calculated. Statistical significance was accepted for $p<0.05$.

MMT, using an ordinal scale taking into account the active range in which the athlete was able to produce force, (ranging from 0 to 17 per muscle) correlated significantly with RR speed for the hip flexors (rho=0.38), knee extensors (rho=0.41) and hip abductors (rho=0.45), but not the hip extensors (rho=0.28). MMT summed over all 4 muscle groups revealed a stronger association (rho=0.50), with similar correlations for the most and least affected leg (rho=0.48 & rho=0.51).

The SCALE components for hip and knee and ankle joints correlated significantly with RR speed (rho=0.43, rho=0.40, rho=0.39 respectively) while the scores for the subtalar joints and toes did not (Rho<0.3). The total SCALE score (both legs) also correlated significantly with RR speed (rho=0.44). The total SCALE for the least affected leg correlated slightly stronger with RR speed than the most affected leg (Rho=0.39, Rho=0.24).

Both measures of spasticity, the ASAS and MAS, showed very similar trends. For both measures, spasticity in the adductors and gastrocnemius was significantly correlated with RR speed with rho ranging from 0.51 to 0.59 but this was not the case for hamstrings and quadriceps (rho <0.23). Correlations with RR speed were similar for the most and least affected leg for both ASAS and MAS (rho ranging from 0.51 to 0.56) with the total score showing correlations of 0.55 (ASAS) and 0.54 (MAS).

KExt and HExt significantly correlated with RR speed (Rho=0.52, Rho=0.40), with the least affected leg showing slightly stronger correlations (knee: rho=0.56 vs. rho=0.45; hip rho= 0.45 vs. rho=0.28).

These results show that lower limb spasticity, isometric strength, flexibility and selective motor control impact performance in RR athletes and thus support the use of these measures in RR classification. Further research is required into other impairment measures, such as upper body control and lower limb coordination.

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 # 126 Speed profiles in wheelchair court sports; comparison of two common methods for measuring wheelchair mobility performance

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Most wheelchair mobility performance (WMP) research is based on methods that either rely on global references, like radio frequency based indoor tracking systems (ITS), (Rhodes et al., 2014) or on wheelchair bound inertial sensors (van der Slikke et al., 2015). Tracking systems provide position data, enabling tactical team analyses, but lack the option to calculate higher order outcomes like acceleration, due to limited sample frequencies. Inertial sensor based methods like the WMP monitor (WMPM) allow for easy and accurate measurement of WMP, but provide no information on absolute field position. In this study, we compared outcomes of both methods regarding speed, to gain insight in the level of agreement between devices.

The WMP of 5 players was monitored using an ITS (Ubisense, ~8 Hz) with a tag on the footplate and simultaneously with sensors on wheels and frame (WMPM, 200 Hz). Being part of a larger study on basketball game innovations, measurements (6x 10 min.) were performed during different 3 v 3 game formats. For each measurement, distance covered, speed and time in six fixed speed zones was calculated. Additionally, WMPM outcomes were also recalculated (WMPM2) to align with the ITS, so with adjusted filter frequency and a relocated reference position on the footplate instead of the frame centre for calculated distance & speed.

The average distance calculated per ~10 min. game time was 882.3 m for the ITS, 837.8 m for the WMPM and 883.4 m for WMPM2. The root mean square errors (RMSEs) between speed calculated by the ITS and the WMPM were 0.41 m/s and 0.33 m/s for WMPM2. The difference of time in speed zones varied from 0.1 −15.7% between ITS and WMPM and 0 − 9.0% between ITS and WMPM2 (see Table 1).

The difference in reference point on the wheelchair affected the calculated speed and distance slightly (≤ 2.6%), since frame rotations added to the speed in the ITS and not in the WMPM. Once adjusted, systems provide very similar distance and average speed data (≤ 0.1%), although individual differences up to 7.6% occur. The RMSE of 0.41 m/s for the WSPM and 0.33 m/s for the WMPM2 is acceptable for this type of measurements. The position of the reference point causes a very low percentage of time in the lowest speed zone (<0.5 m/s) for the ITS and WMPM2, because when not moving forward, often turns still cause some speed. With the ITS system, the sample frequency used also acts as a low-pass filter, drawing the speed signal towards the average, so with more time assigned to the corresponding speed class (0.5 − 1.5 m/s). These results provided an insight to what extent research outcomes obtained with both methods are interchangeable. For distance, average speed, speed profiles and higher speeds zones (> 2.5 m/s), both methods provide similar outcomes. For comparison of lower speed zone outcomes, a recalculation of WMPM outcomes (to WMPM2) is advisable. The type of method used for future research is depending on the research question, with a focus on field position (ITS) or acceleration profiles (WMPM). Furthermore, this study proved the feasibility of a hybrid solution incorporating both methods, hence providing the best of both worlds and possibly serving as the new standard for mobility performance in court sports.

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128 Understanding propulsive shoulder forces and scapular kinematics during manual wheelchair use

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Shoulder pain and inefficient propulsion are common and disabling problems for wheelchair users, yet little is known about how the interaction between wheelchair configuration and users affects shoulder girdle biomechanics (1,2,3,4). This can impact significantly on performance during activities of daily living (ADL) and sport. The overall aim of this project was to establish methods for the multi-system measurement of shoulder motion during three submaximal speeds of wheelchair propulsion. To that end experienced wheelchair rugby athletes in their own ADL wheelchair were tested in a highly standardized experimental setup, to reliably measure upper-body kinetics and kinematics. Specifically, we tested if movement patterns of the scapula and propulsion technique-related parameters, during submaximal manual propulsion, differed for three submaximal speeds of wheelchair propulsion.

We recruited 10 active males, manual wheelchair-reliant for both ADL and sport (n=5 with shoulder pain, of which n= 3 unilateral). Each participant performed three 4-min submaximal bouts (3, 4 and 6 km.h-1 (T1), repeated following a 20 min rest (T2)) in their personal ADL wheelchair mounted on a wheelchair ergometer. An instrumented measurement wheel examined propulsion kinetics and technique parameters while three-dimensional kinematic analysis was used to assess scapulothoracic rotations (internal/external and upward/downward, anterior/posterior tilt) over propulsive cycles. Differences across speeds for the aforementioned parameters were assessed using one-way repeated measures ANOVA with Tukey post-hoc tests.

Push frequency, peak force, contact angle, cycle time and power output were all significantly different between each propulsion speed ($p<0.05$; Effect size = 0.38 to 0.98). Common to all speeds was an internally rotated and anteriorly tilted scapula. Peak internal rotation of the scapula occurred during the recovery phase of the propulsion cycle and the scapula moved towards a neutral or posteriorly tilted position at ~50% propulsion cycle. Mean (~3º) and peak (~4º) scapular internal rotations were significantly greater at 6 km.h-1 than either of the other speeds.

Clear differences are shown between propulsion technique for the three speeds. Wheelchair users adapt their propulsion technique to the increased power demands because of the higher velocity. Fortunately, the increase in power is not paralleled by a proportional change in peak force, by using of a larger contact angle and an increased push frequency the necessary work is spread out over a larger push distance instead.

This work has established methods and generated an initial database to enable future work understanding how wheelchair configurations can be manipulated to prevent shoulder girdle pain and improve propulsive efficiency. The collected data are also suitable for inverse dynamical modelling, making it possible to look at the net joint moments and glenohumeral reaction forces in relation to propulsion speed and wheelchair set up. Especially the changes in scapular internal rotation with increased speed are expected to influence the direction of the glenohumeral reaction force.

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130 The acute physiological and metabolic responses of individuals with Cerebral Palsy to Racerunning training

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Regular exercise can confer numerous health and fitness benefits in individuals with Cerebral Palsy (CP) and there are many Paralympic sports that CP athletes participate in. However, some individuals with CP can be excluded and a relatively novel sport that is becoming popular is Racerunning (RR). RR is an activity for people with CP employing a pedal-less trike that supports the upper body and trunk, enabling propulsion using the legs. However, there is very limited research into RR, especially field-based. The aim of this pilot study was to explore some of the physiological and metabolic responses to habitual RR training in individuals with CP.

Five participants (age 18 ± 4 years, height 1.61 ± 0.09 m, body mass 49.0 ± 12.5 kg, RR experience 5 ± 1 years, Gross Motor Function Classification Score 3.6 ±0.9), one of whom was an international RR competitor and world-record holder, were recruited. Participants performed three habitual training sessions comprising a 2 mile run and 2 x 100 m sprints (session 1), 6 x 200m sprints (session 2) and 5 x 100m sprints (session 3). Percentage of age predicted heart rate maximum (HRmax) and GPS derived running velocity quantified training responses. Portable online gas analysis measured metabolic responses for 10 min pre- and post- training in session 3.

Average session intensity was 75.3 ± 8.9%, 69.0 ± 15.3%, and 66.0% HRmax (one participant only) for sessions 1-3, respectively. The 2 mile run was completed in 19.6 ± 6.1 min at a mean intensity of 85.6 ± 7.9% HRmax and velocity of 9.8 ± 3.8 km.h-1. Peak intensity during session 2 sprints was 94.9 ± 7.9% HRmax, dropping to 71.0 ± 12.5% HRmax in the recovery periods. Mean sprinting velocity was 9.9 ± 1.9 km.h-1. Resting VO2 prior to session 3 was 0.30 ± 0.05 L.min-1 and respiratory exchange ratio (RER) was 1.04 ± 0.04. Post-training, VO2 was 0.37 ± 0.05 L.min-1 and RER 0.96 ± 0.06.

The results suggest that individuals with CP are comfortably able to perform activities at a sufficient intensity to promote fitness and performance adaptations, as well as highlighting some technical challenges with data collection in this environment. The findings represent novel data on the acute responses to RR training. Further data is currently being collected which will add to the data reported here, and it is expected that this expanded data set will be available for presentation.

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131 Pathways to the Paralympic Games: Sporting journeys of New Zealand Para athletes with a limb deficiency

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Characteristics associated with sport expertise have been well researched for able-bodied athletes, however, little has been documented on the development of sport expertise for Para athletes. It is important to understand the sporting journeys of successful Para athletes to better support the development of our Paralympians of the future. The “Pathways to the Paralympic Games” research project sought to explore the sporting experiences of New Zealand Paralympians. This paper focuses on sport expertise development in Para athletes with a limb deficiency. In-depth, semi-structured interviews were

conducted with recent Paralympians with a limb deficiency to identify athlete pathways, as well as facilitators and barriers to sport participation and sporting success in this population. Preliminary findings of key themes, and implications for the Para sport sector will be discussed.

 # 133 The evaluation of muscle balance using two different methodologies in Athletics Paralympic Athletes

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The unbalanced condition of the muscles is associated with injuries in high performance sport. Studies shows this problem in Olympic and Paralympic Athletes. The evidence demonstrates association between non-symmetry in isokinetic strength of extensors/flexors of the knee and muscle injuries, Tensiomyography (TMG) results with unbalance of the quadriceps and biceps femoral are associated with knee injuries. The aim of this study was to investigate the relation between the results of isokinetic of the knee and the TMG of quadriceps and biceps femoral in Brazilian Sprinters with visual impairment and their guides. Methods: The 14 volunteers (7 male guide runners and 7 elite VI athletes – 4 male and 3 female) were tested in 2 different days. The first day they did the knee isokinetic test in 3 speeds (60/180, 300 grade/second) with a Biodex dynamometer system. The parameters for unbalance isokinetic strength were: H/Q relationships (≤48%) and bilateral relationship (≥20%) (Silva et al. 2012). The TMG was used to evaluate the Radial displacement of the muscle belly (Dm); contraction time (Tc) was collected for both the rectus and biceps femoris in both sides, using a Tensiomyographer device (TMG Measurement System, TMG-BMC Ltd). An accurate pressure transducer was positioned perpendicular to the muscle axis. Statistics: Means and standard deviations are given as descriptive statistics. The groups were compared with the Wilcoxon Test and the correlations between isokinetic knee strength (twelve peak torque parameters and H/Q relation and sides difference) and TMG parameters (Dm and Tc, and sides difference) were evaluated using the Spearman Correlation. All analyses were executed using the SPSS for windows version 15. Statistical significance was set at $p<0.05$. Results: The Guides had better results of strength in all angular velocities than the VI athletes. Relation of H/Q in VI had 6 athletes and 5 guides with unbalance (flexion weaker) and 2 guides with bilateral problem in slow velocity. The Guide had faster contraction in reto and biceps femoral and radial displacement of the reto muscle was greater in Guides and the biceps had the most expressive displacement in VI athletes. The correlation of the Guide showed a greater number of significant associations, the H/Q relationship (180 and 300o/sec) (0.738-0.833) and the rectus TMG (DM and Tc), difference of Biceps (Dm and Tc) and bilateral isokinetics (60 and 180 o/sec) (0.738-0.835). The correlations in VI athletes didn't have the same consistence and the difference between the two sides (Right and left side of Tc biceps and rectus femoris) (0,743-0.771) and (Td biceps and rectus– 0,731-0,851). Conclusion: The results do not allow the use of the data in a similar way, in what concerns to identify the deficits and differences of the muscular pattern. Another studies with different TMG protocols may indicate other possibilities.

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 # 136 Shoulder internal and external range of motion and position sense of sitting volleyball players versus healthy players and non-athletes

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Introduction: Sitting volleyball is a high demanding sport activity for the disabled athlete. Although the shoulder joint in this sport is responsible for both performing volleyball skills and moving on the floor (1) and as a consequence, may sustain further musculoskeletal injuries (2), its physical and neuromuscular conditions has been minimally investigated in the literature. Therefore the aim of this study was the comparison of shoulder joint internal/external rotation range of motion and position sense in sitting versus healthy volleyball players.

Methods: This research consisted of 54 young male participants (18 sitting volleyball players, 18healthy volleyball players and 18 non-athletes). The active internal and external rotation ranges of motions were recorded with photogrammetry. Shoulder position sense has been assessed using reproduction of 45˚ external rotation (absolute error) (3). All tests were performed in supine position and were analyzed using AutoCAD 2013.

Results: The results showed that shoulder external rotation range of motion showed no difference between groups. There were significant between-group differences in internal rotation range of motion (p=0.001), internal to external rotation ratio (p=0.001) and error of reproduction angle of 45˚ external rotation (p=0.002). Post hoc tests revealed that the Internal rotation range of motion and internal to external rotation ratio is significantly higher among sitting volleyball players than healthy players and non-athletes and the error of reproduction angle of 45˚ external rotation is significantly lower in disabled athletes compared with healthy volleyball players.

Discussion and conclusions: This study indicated that sitting volleyball players have more accurate shoulder position sense than both healthy volleyball players probably because the use of upper extremity for weight bearing and moving in the field in addition to performing volleyball drills and skills (1). These moving tasks may also be a contributing factor for shoulder internal rotation range of motion and internal to external rotation ratio of sitting volleyball players to be higher than healthy volleyball players. It can be concluded that playing sitting volleyball could be an effective way to maintain and also to develop shoulder joint position sense, range of motion and muscle balance for people with disability in lower extremity.

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Poster Presentations

The following abstracts appear precisely as they were submitted. They have not been editor for e.g. language, spelling or grammar, and the IPC does not take any responsibility for the content

6 A qualitative audit of outcomes of national vs international classification of British athletes (2012-2016).

P. Broomhead; K. Allen

UK Athletics Classification Advisory Group Chair; World Para Athletics Level 4 International Classifier

UK Athletics (UKA) runs a national classification programme for British athletes using the same testing procedure as the World Para Athletics (WPA). The purpose of this qualitative audit was to compare the classification outcome of athletes who have undergone international classification with their national classification to identify differences in outcome. The results act as a method of quality assurance for the national programme and inform on-going training for national classifiers. Ethical approval was not sought for this audit.

135 UKA athletes were identified as having undergone international classification from September 2012 to September 2016. The athletes' national and international classification cards were compared. For the athletes identified as having their classification changed at international level, information was collected on whether the national card used the new IPC format, length of time competing before classification, frequency of training and evidence of a technical assessment and observation in competition. Where appropriate the Ashworth spasticity scores and co-ordination tests were compared for athletes with Cerebral Palsy (CP).

12 UKA athletes had their classification changed at international level from their previous classification at national level. 7 athletes moved up to a more competitive class and 5 moved down a class. Athletes who underwent re-classification due to rule changes or for medical reasons were then excluded. Of the 135 athletes who were classified internationally during the audit period, only 1 was found not eligible.

Results suggest that the length of time that an athlete has been training at national classification compared to international classification does not influence the outcome. Ashworth scores for hypertonia differed between national and international classification for all CP athletes. It was more likely that a technical assessment and observation in competition was completed at international level. Since 2012, the degree of detail & justification documented has improved at both national & international level, however, recording of observation assessments is an area that continues to be developed & improved.

Future training of national level classifiers will concentrate on:

- Standardising testing methods, using WPA guidance (3) including: testing spasticity, co-ordination testing, muscle testing & observation of movement
- Accurate recording of findings & detailed justification of decisions on class

The CPD training programme for all classifiers will develop:

- Observation skills
- Justification of class in complex presentations
- Practical skill development

The audit sample size was small, making it difficult to draw conclusions. Although it may not be possible to achieve 100% compatibility due to the subjectivity & poor inter-rater reliability of some tests, the UKA national classification programme provides a high level of accuracy for all athletes.

The results of this audit provide a bench mark for future audits, which will be repeated on a 2-yearly basis, & delivered information to support topics for the training & continual professional development of national classifiers.

IPC Athletics Classification Rules & Regulations 2016

https://www.paralympic.org/sites/default/files/document/160428154429528_2015_12+IPC+Athletics+Classification+Rules+and+Regulations_WEB2.pdf

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 # 7 Test of Gross Motor Development-3 (TGMD-3) with the Use of Visual Supports for Children with Autism Spectrum Disorder: Validity and Reliability

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The validity and reliability of the Test of Gross Motor Development-3 (TGMD-3) were measured, taking into consideration the preference for visual learning of children with autism spectrum disorder (ASD). The TGMD-3 was administered to 14 children with ASD (4-10 years) and 21 age-matched typically developing children under two conditions: TGMD-3 traditional protocol, and TGMD-3 visual support protocol. Excellent levels of internal consistency, test-retest, interrater and intrarater reliability were achieved for the TGMD-3 visual support protocol. TGMD-3 raw scores of children with ASD were significantly lower than typically developing peers when using the TGMD-3 traditional protocol, however, significantly improved using the TGMD-3 visual support protocol. This demonstrates that the TGMD-3 visual support protocol is a valid and reliable assessment of gross motor performance for children with ASD.

Fig. 1 Locomotor skills picture task cards (run, gallop and hop)

Fig. 2 Locomotor skills picture task cards (skip, horizontal jump and slide)

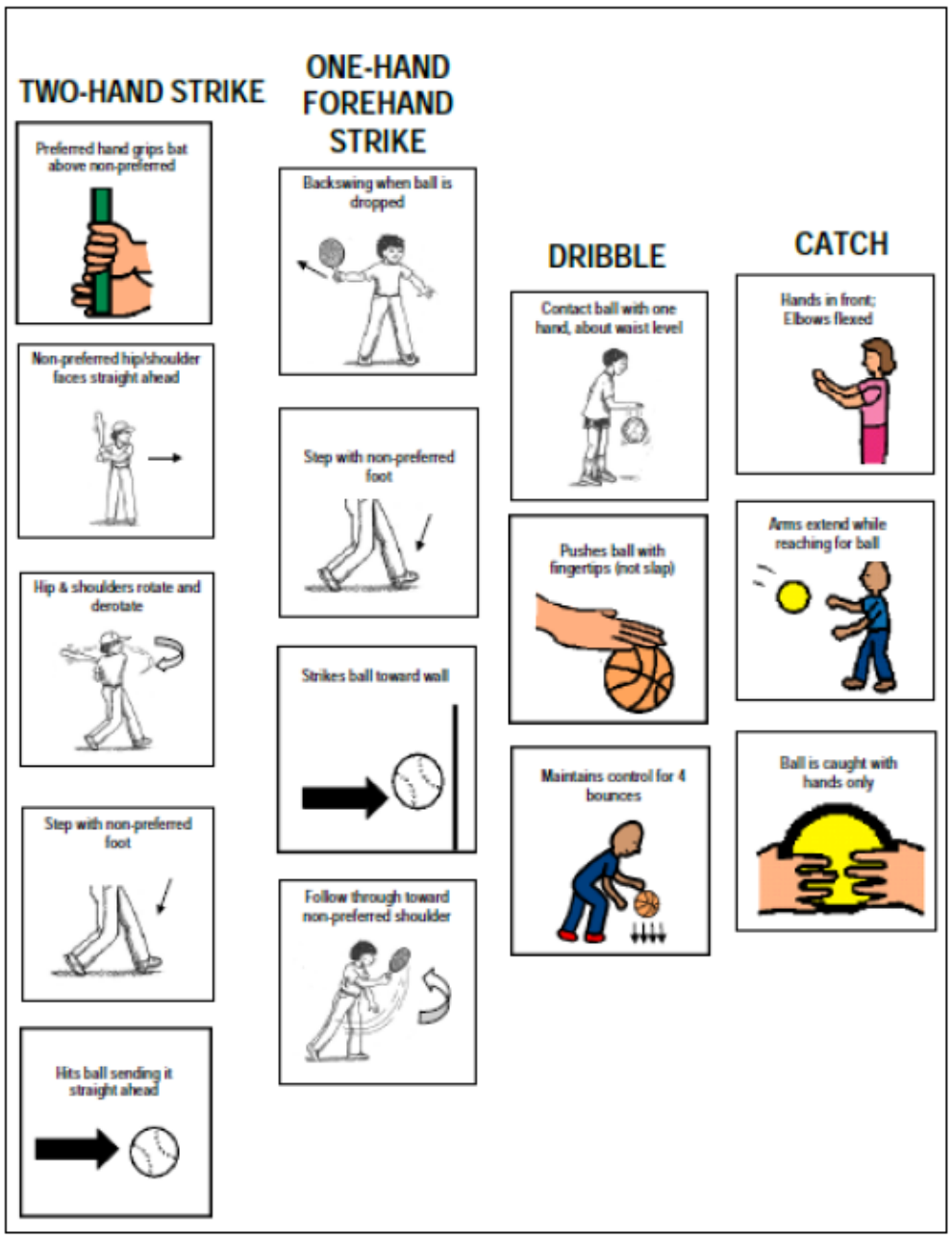

Fig. 3 Ball skills picture task cards (two-hand strike, one-hand forehand strike, dribble and catch)

Fig. 4 Ball skills picture task cards (kick, overhand throw and underhand throw)

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 # 9 Inter-rater reliability between national and international classification in Brazilian wheelchair Rugby players.

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International Wheelchair Rugby Federation (IWRF); Brazilian Wheelchair Rugby Association (ABRC)

Introduction: The development of Wheelchair Rugby in Brazil started in 2008 with the foundation of the Brazilian Wheelchair Rugby Association (ABRC). One of the challenges was the creation of a national Classification Department. Since the foundation, the IWRF Classification Manual has been translated to Portuguese, national classifiers observed classification during international tournaments and international classifiers from Canada and Argentina participated in classification in Brazil. Despite all the Brazilian classifiers knowledge, coaches and athletes still complain, believing that the results of the classifications at national and international level are not the same.

Therefore the goal of this study is to assess the reliability between national and international classification in Brazilian athletes.

Methods: Cross sectional study of all Brazilian players who had been classified at a national level and who were also classified at an international level. Data about the national and international sports class were collected through the database available on the website of the ABRC and IWRF. Cohen's kappa coefficient was calculated to assess the reliability between the national and international sports class. The agreement level was set at 0.60. The data were processed with Statistical Package for Social Sciences (SPSS).

Results: In the IWRF Master list - July 2016 contained 40 classified Brazilian athletes. 14 players were excluded: 9 because they were classified at an international level in 2005, before the foundation of the Classification Department in Brazil. And 5 athletes were excluded because their international class was not completed (no confirmed international sport class status). The sports classes of the remaining 26 athletes were assessed. All athletes were male, 22 (84.6%) were still active in wheelchair rugby by the time of the assessment. The Brazilian classification panel scored 10 (38.4%) athletes as "low point", 12 (46.2%) as "midpoint" and 4 (15.4%) as a "high point". The international classification panel scored, respectively 10 (38.4%), 12 (46.1%) and 1 (15.4%). There was a divergence of scores in 6 (23.1%) of the classification. The data showed that there was substantial agreement between the final scores of the Brazilian panel and the international panel 0.709 ($p<0.001$).

Conclusion: After the analysis, a few disagreements were observed, being only in the "low points", where such disagreements are due to the asymmetries in the upper limbs of the athletes. Thus, it can be concluded that the Brazilian classification panel, which follows the same criteria of the international, despite the short time since its creation, is as reliable as the IWRF bank.

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 # 10 Exploring Psychosocial Factors of Athletes' Transition into Parasport

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Participation in parasports is associated with enhanced health, self-perceptions, quality of life, and social integration for individuals with physical disabilities (Blauwet & Willick, 2012; Groff, Lundberg, & Zabriskie, 2009; Muraki, Tsunawake, Hiramatsu, & Yamaski, 2000; Perrier, Sweet, Strachan, & Latimer-Cheung, 2010) Despite these myriad benefits, there remain challenges with the uptake of parasport participation at both the individual (Martin Ginis et al., 2010) and societal (Misener, 2015; Purdue & Howe, 2012) levels. To address this concern, the present study explored, from the perspectives of elite parasport athletes, psychosocial factors associated with transitioning into parasport. Methods: A 20-item Parasport Transition Questionnaire was made available to interested Canadian parasport athletes online through Provincial Sports Organizations in the Fall 2015. Items targeted factors relating to disability background, age of onset of parasport, social support, motivations to

engage in parasport, and barriers to initiating and maintaining participation in parasports. Results: 39 athletes (Mage = 28.6 years; 44.7% male) completed the questionnaire, with the majority reporting to have an acquired physical disability (56.4%), and English-speaking (71.1%). Athletes' first exposure to parasports was reported to be at a mean age of 18.4 years, with those with a congenital disability participating in parasports much earlier than athletes with an acquired disability (mean = 13.3 years vs. 22 years). Most athletes (61.5%) were currently competing in either wheelchair basketball or various disciplines of para-swimming. The majority (77%) of athletes were competing at the elite level in the same parasport that that they were first introduced to as novices. Health care professionals (i.e., physiotherapists) and coaches were reported to be the primary influencers of the athletes' first exposure to parasports. The most frequent type of support provided by these
individuals consisted of coaching and mentoring, emotional and psychological support, and informational support. The most commonly reported motivating factors for initiating parasports was the general perceptions of sport playing an integral role in the athletes' lives (e.g., competition, self-improvement), and the personal enjoyment and 'love' the athletes' had for sport. The biggest obstacle for parasport initiation and continued participation was lack of available resources (i.e., locating a program, facility, equipment, or qualified coach).

Implications: This is the first study to examine factors related to elite athletes' experiences with transitioning into parasport. Knowledge gained from this cross- sectional study can be used as a catalyst to develop opportunities for facilitating the process of recruiting and supporting individuals with physical disabilities into parasport.

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 # 13 Outome of the integration of para-cycling at UCI and national cycling federations after ten years

Louis Barbeau

UCI

In 2007, UCI took over the governance of para-cycling which was prior under IPC's responsibility. The goal was to ensure a better development of para- cycling all over the world, with an increase of cycling nations embracing this discipline, and make sure para-cycling would benefit from the same support other cycling disciplines have both at the international and national levels. National Cycling Federations (NCF) were then asked to integrate as much as possible para- cycling within their structure.

10 years later, some NCF have fully integrated para-cycling, whereas in other countries, National Paralympic Committees (NPC) still plays a very important role with regards to the discipline, and have agreements with their MCF on some aspects of para-cycling, which were identified as minimal requirements by UCI, such as registration of athletes at World Cups and World Championships, national team jersey, registration of events on the UCI calendar and promotion of the sport.

The question therefore, after this period, is what was the impact of this transfer of governance, both at the UCI level and at the national level? Has the sport benefited from this transfer of governance, and how?

The presentation will outline the overall portrait of the situation of the sport in 2017, in terms of growth and provide examples of how para-cycling has grown overall and in some nations, according on the model which was adopted by the different nations. A closer look will be given to areas such as athletes' development and performance, coaching, officiating, classification, events, communications and promotion, as well as management, to see to which extent integration has achieved and what has been the outcome.

 # 19 "Socio-economic determinants of Paralympic participation and success" An African perspective.

MATECK-MA-BILOLOO

CAMEROON NATIONAL PARALYMPIC COMMITTEE (CNPC)

Success at the Paralympic Games is the result of the performance ratio. This report comes from the report on participation, which comes from the report to the preparation. This is all the more true for para-sport, because of the socio-economic burdens that weigh on this category of people with regard to the forms of stigmatization they are subjected to daily. An individual is stigmatized because he has a disability that discredits him in his relationship with the other. These stigmatizations weigh not only on people with disabilities, but on the sport that could be practiced by them. The social uses of disability make it possible to carry out stratification between sports for able-bodied persons and sports for disabled people. The valid competitor being the preferred competitor and the invalid competitor being the marginal competitor. These forms of stigmatization emanate from both the state and the ordinary citizen. They are not only the act of the other, but are the product of the harmful living conditions of the handicapped person in the countries of the south.

From the above, it can be said that the performance of disabled athletes in Africa is conditioned by social representations, which means that we cannot bet on it. These deleterious conditions prevent him/her from projecting himself/herself into his/her preparation and participation. There are several obstacles and constraints on the performance of people with disabilities in Africa: the inadequacy of social and sports infrastructures, the absence of para-sport organizations and associations in remote areas (which are certainly full of people with disabilities and sure athletic potential). Finally the Paralympic Games represent an opportunity for the able-bodied who sequester the composition of the delegations, to use people with disabilities like trophies to access any kind of benefits reserved for disabled athletes.

Keywords: performance, stigmatization, stratification, competitor, para-sport.

Ervng Goffman, "Stimate, les usages sociaux des handicaps", november 2008

 # 23 Factors influencing evolution of classification and technical rules in parasports

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1. Coventry University; 2. Sechenov First Moscow State Medical University

There are factors, which have the potential to make a significant impact on the evolution of classification and technical (C&T) rules in parasports: (1) an increase in the number of impairment types participating in particular sports; (2) media influence; and (3) the promotion of inclusion.

(1) Some sports were initially designed for athletes with a specificimpairment, e.g. wheelchair rugby for those with a high level of spinal cord injury. The existing eligibility criteria often allow for athletes with other types of impairment (e.g. multiple amputations, cerebral palsy, multiple sclerosis) to participate. Methods for assessment of new impairment types are sometimes not included in the current rules. Classifiers have to rely on personal expertise. The outcomes of classification may be biased and lead to a situation where some athletes may find themselves in an unfair competition. The best solution is to do formal research to improve and develop the C&T rules. However this may be a costly and time-consuming process. In the meantime, if we do not allow other impairment types to participate in the sport under investigation during this time, it might negatively affect the promotion of the sport, as the aim of the Paralympic movement is to get as many people as possible playing parasport.

(2) There is a tendency amongst the media to focus on the least impaired athletes when broadcasting parasport events, because their performances most closely align with public perceptions of what elite sport should look like. This may reinforce the view that the athletes in lower classes are less interesting to the public and that may put pressure on those responsible for C&T rules to eliminate these classes from some events. It is important that spectators are educated to understand and appreciate the organisational structure of parasport, which is not about simply identifying the best athlete in a particular sport or event, but about identifying the best athlete in that sport or event within each classification group, and that athletes from each class have the same value.

(3) There have been examples of athletes with disabilities practicing sports at the elite level, including participation in the Olympic Games. These examples demonstrate conception of 'inclusion'. At the same time some non-disabled individuals have shown an interest in taking part in parasport, in order to gain new experiences, both physical and emotional. This, therefore, raises the idea that for inclusion to be truly effective it should be a two-way process, allowing not only for people with impairments to take part in non-disabled sports and events, but also for non-disabled individuals to take part in parasports alongside their disabled counterparts. Currently, classification is performed in order to minimise the impact of differences in severity and type of impairment on sports performance in individuals with disabilities in order to ensure both fair competition and the possibility for everyone to participate. However, in a two-way inclusion model it may will be necessary to equalise the difference between non-disabled athletes and the athletes with a disability, which will require significant changes in C&T rules.

 # 25 Declassified: Disability Identities and the Paralympic Classification System

A. Bundon; A. Ashfield; E. Hunton; B. Smith; N. Diaper; V. Goosey-Tolfrey

The University of British Columbia; The English Institute of Sport; The English Institute of Sport; The University of Birmingham; The English Institute of Sport; The Peter Harrison Centre for Disability Sport (Loughborough University)

The IPC and other para-sport stakeholders have spent considerable resources and energies developing a classification system intended to "minimize the impact of impairments on sport performance and to ensure the success of an athlete is determined by skill, fitness, power, endurance, tactical ability and mental focus." However, little attention has been paid to the psycho-social effects that classification may have on individual athletes and specifically the potential consequences of labeling an athlete 'unclassifiable' or 'declassified.' This paper draws on the findings from Project PRISM (Para-Athlete Retirement: Insights, Support and Management) to understand the experiences of athletes who had forced or undesired sport retirements due to being declassified or being found to be
'unclassifiable.' We discuss the implications of these findings on the formation and maintenance of athletic and disability identities.

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Smith, B., Bundon, A. & Best, M. (2016). Disability Sport and Activist Identities: A Qualitative Study of Narratives of Activism Among Elite Athletes with Impairment. Psychology of Sport and Exercise. 26, 139-148.

 # 26 PROFILE OF THE ATHLETE'S PARTICIPATION ON THE FIRST BRAZILIAN PARALYMPIC GAMES FOR UNIVERSITY STUDENTS.

DECIO ROBERTO CALEGARI; VANILTON SENATORE; CLAUDIO DHIEL NOGUEIRA; MARCIA CAMPEÃO; JOSÉ IRINEU GORLA; IVALDO BRANDÃO VIEIRA.

UNIVERSIDADE ESTADUAL DE MARINGA; COMITE PARALIMPICO BRASILEIRO; COMITE PARALÍMPICO BRASILEIRO; UNIVERSIDADE FEDERAL RURAL DO RIO DE JANEIRO; UNIVERSIDADE ESTADUAL DE CAMPINAS: COMITE PARALÍMPICO BRASILEIRO.

The increasing access of athletes to higher education courses motivated the Brazilian Paralympic Committee to propose the creation of the Brazilian Paralympic Games for University Stuidents. For that, a previous research was carried out in which 98 university students with disabilities contributed to the definition of the modalities that would be played in the 2016 São Paulo Paralympic Games for Universities, which had 152 registered athletes and 97 participants, besides 5 guides, 24 technicians, 10 staffs and 9 universities representatives. The purpose of this study was to establish the profile of the participants of the first edition of the 2016 São Paulo Paralympic Games for Universities, held at the Brazilian Paralympic Committee Training Center in São Paulo from December 8th to 11th, 2016. Of the 96 participants, 28 were women (29.2%) and 68 were men (70.8%). Regarding the type of disability, 78 university students with physical disabilities, 17 with visual impairment and only one with intellectual disabilities participated at the Games. Of the total number of participants 36 (37.5%) had never participated in the Brazilian Paralympic Committee event and 26 (27.1%) had no Functional Classification. In terms of sports, 34 opted for Athletics, 12 for Boccia, 3 for Judo, 40 for Swimming and 7 for Table Tennis. Only 19 chose to compete in one more sport: 4 in Athletics, 1 in Boccia, 2 in Judo, 6 in Swimming and 6 in Table Tennis. The geographical distribution presented a larger number of participants from the Southeast Region (64.6%) (62 = SP / 45, RJ / 10, MG / 5 and ES / 2), South Region 14.6% (14 = SC / 9, PR / 3, RS / 2), Northeast Region 12.5% (12 = CE / 6, PB / 4, RN / 2) and Central West Region 8.3% 1). The low participation of women continues to be the main challenge to be overcome and the strategy of dividing scheduling of the competitions by schedules facilitated participation in two sports and should increase this option for the next edition. The prevalence of university students from the Southeast and the lack of enrollment in the North Region reflect the geographical challenges of the democratization of the Para sports, but the participation of the Northeast region, almost reaching the same number of participants in the South Region, as well as the good number of University students in the region Central West are signs that the policies of inclusion and social valorization of people with disabilities have found in the Paralympic Sport an effective tool. New data should be analyzed in the publication of the article and physical and motor evaluation during the event will allow the establishment of epidemiological parameters. It is possible to state that even though it is an event destined for university students, the high incidence of participants competing for the first time can characterize this competition as a talent revealer. The highest expectation is focused on the ability of the event to stimulate athletes who can not make the transition to the High Yield in the School Paralympics to continue practicing the Paralympic Sport while encouraging the athletes to reconcile their training with their professional training.

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 # 27 Maximal relative strength and power correlated to linear acceleration over 20 m in female wheelchair basketball players

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Canadian Sport Institute Ontario; Wheelchair Basketball Canada

INTRODUCTION: In wheelchair basketball, acceleration is a critical performance factor, as greater accelerative capacity may provide superior ability to gain positional and tactical advantage. This advantage may ultimately lead to greater offensive/defensive success. As acceleration of a given mass is directly related to amount and direction of force applied to that mass, it is reasonable to suspect that those athletes with greater strength (i.e. maximum force production capacity irrespective of time) and power (i.e. ability to generate force rapidly) capacities may be able to accelerate their chairs faster than those with lesser abilities. Based on Newton's Second Law of Motion, it was hypothesized that strength and power relative to the system mass (sum of athlete and wheelchair mass) would be negatively correlated to 20 m sprint time. METHODS: Fourteen national-calibre female wheelchair basketball players were laser-timed for maximal linear speed over 20 m in their individual competition chairs. Each athlete performed 3 trials, with the best of these trials being taken for analysis. To test force production capabilities, athletes completed a load-velocity profile on the bench press exercise with incremental loads of 5 kg. Mean velocity and power outputs were quantified by way of linear position transducer (Tendo), and extrapolated to determine the athletes' maximum bench press strength (1RM), and peak power outputs (Pmax). Pearson correlation analysis was utilized to assess the relationship between variables. RESULTS: A strong inverse correlation was found between the athletes' maximum relative strength (1RM/system) and 20 m sprint time ($r = -0.781$). A similarly strong inverse correlation was also found between the athletes' maximum relative power production capacity (Pmax/system) and 20 m time ($r = -0.776$). Beyond this, it was found that athletes' relative Pmax abilities were highly related to their relative 1RM ($r = 0.879$). DISCUSSION: These findings support that, in female wheelchair basketball athletes, maximal relative strength and power capacities play an important role in the ability to accelerate linearly over a 20 m distance. Furthermore, in this cohort, our data suggests that approximately 77% of the variation in relative power output capacity was accounted for by variations in maximum relative strength. Further investigation is required to determine how these relationships vary temporally in response to training, fatigue, and technical changes.

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29 Comparing visual function of visually impaired skiers in different lighting conditions

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Lighting can greatly affect a person's quality of vision and can significantly change how individuals see, particularly people with low vision. Outdoor lighting is highly variable and can significantly impact individuals' mobility and navigation.[1,2] Many athletes with visual impairment (VI) are affected by changing light conditions while competing and training, particularly in outdoor sports such as Alpine and Nordic skiing.[3] However, the current classification system only includes visual acuity and visual field measurement under standard clinical indoor illumination, which is much dimmer than that of a bright sunny day, and does not evaluate how an athlete's visual function might change in different lighting conditions on the course. Tests such as light sensitivity, glare sensitivity, and glare recovery can provide more information about the impact of bright light on visual function yet, none of these tests are currently used in classification. Therefore, the purpose of this study was 1) to determine whether or

not light sensitivity, glare sensitivity, and glare recovery tests can be conducted under natural (i.e. binocular) viewing conditions, and 2) to determine if light sensitivity, glare sensitivity, and/or glare recovery are related to performance in VI skiers.

Binocular tests of light sensitivity, glare sensitivity, and glare recovery were developed for this study to permit the testing of vision under natural viewing conditions. Light sensitivity, glare sensitivity, and glare recovery will then be measured in skiers with VI competing at the 2017 Para Alpine and Para Nordic World Championships and in a group of age and gender matched controls. Light sensitivity is being tested by increasing the task lighting on the visual acuity chart and on the line of sight of the participant to a level that is close to outdoor illumination on an overcast day. Glare sensitivity is being tested by moving the light source near the eyes and making it brighter than the lighting on the visual acuity chart. Glare recovery is being tested by measuring visual acuity 1 minute after removing the glare source. The main outcome measures in both populations (athletes and controls) are the changes in visual function from baseline (measured at normal room light levels) to the additional conditions (light and glare sensitivity, glare recovery). Additionally, researchers will compare the results of the light sensitivity, glare sensitivity and glare recovery testing with skiers' performance during competition.

The results of this study will demonstrate how light sensitivity compares with glare sensitivity and glare recovery when these functions are measured under natural viewing conditions in individuals with and without visual impairment. Furthermore, it will add to our understanding of the impact of the different light conditions on the performance of Alpine and Nordic skiers with VI. Finally, this study will provide new methods for binocular light sensitivity and glare sensitivity/glare recovery testing that can be used clinically.

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31 Equi+poise gait analysis system

T.Daniels

Farriers Registration Council; Worshipful Company Of Farriers

The system I would like to present is an invention that I am in the process of putting together. There is a patent pending (UK Patent Application GB1620638.5) and feel it will progress the science of equine and also rider biomechanics. The system that is being developed is a series of cameras and pressure plates. I myself am a qualified farrier (Dip WCF), and at present I am studying towards the Higher Diploma in Farriery. I will continue with my studies to pass the BACs (honours) in Farriery.

The gait analyses system is a system of multiple camera views which tracks and follows the equine. This will then analyse the biomechanics of the horse, but also the cameras can slow down all rider functions, and analyse the balance and posture of all riders. This can then be shown to the trainers and riders alike and could easily be presented on the slightest changes possible.

The system was developed to enable, firstly farriers to balance the horses motion/ biomechanics with the slightest of changes to shoes/ trimming. It can also be used to aid in equine lameness issues, which is needed for any horse especially those competing at high levels.

In addition to this, the system would also have thermal imaging properties to show changes in heat, which could firstly show a strain on the horse i.e. ligaments, bones, which would need to be helped. Also the thermal imaging I feel could show stresses on riders which possibly could aid from choice of technology to help the riders and their choice of saddles.

The final reason for my system is majorly resulting in research, as any research done on a horse to present is either by static cameras or motion sensors. This cannot fully show the biomechanics of any equine in many trott and no real research has been made in canter. The cameras would be oriented several from the side view, one in front, one from the rear view, and a final footage above.

So I feel my system could aid in any equine Para-Olympic team by firstly enabling the horses to last longer, as we know the horses are specially trained and may stop a team if the horse breaks, or goes lame. I also feel the way the footage received can be slowed down and aid massively in fine tuning any instructor/rider capability. With use of both the high definition and thermal imaging properties could aid in product development for best performance of the equine and para-olympian. The footage could also be emailed to any trainer or expert if needed as would be detailed in several different angles.

The system should be ready for use and collating research data by July 2018, which I feel being 2 years off the Olympics gives riders the best opportunity to enhance their ability and allow any further product development.

 # 37 The Trunk: Strength ratios / Strength in German Elite-Para-Badminton-players (Standing Classes and Wheelchair Classes)

H.Felder; F.Geise; M.Froehlich

Olympic Training Centre Rhineland-Palatinate/Saarland, Germany / Saarbruecken; University Kaiserslautern, Institute for Sport Science, Germany / Kaiserslautern; University of Applied Sciences - Prevention and Public Health, Germany / Saarbruecken

Strength and trunk instability due to impairments, disabilities and handicaps can have adverse effects on posture, function and movement: this can influence the performance of Badminton-Players in wheelchair classes as well as in standing classes. The trunk and shoulder girdle are the foundation of the upper extremities. With a solid foundation from which to move off, the upper extremity (shoulder, elbow, wrist, hand), which have a major importance for Badminton- Players, will show greater power, endurance and efficiency and therefore having a reduced chance of injury. Because of this relationship between (sitting) stability and functional performance the purpose of this study is to investigate the trunk muscle strength and trunk muscle strength ratios obtained from German Elite Para- Badminton-Players. The study focusses on the question which are specific strength-ratios in Para-Badminton.

 # 39 A QUANTITATIVE VOLUME OF ACTION MEASUREMENT FOR WHEELCHAIR BASKETBALL

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Volume of Action (VoA) is the limit to which a player can move voluntarily in any direction, and with control return to the upright seated position, without holding the wheelchair for support or using the upper extremities to aid the movement[1]. VoA forms the basis of the current International Wheelchair Basketball Federation classification method, which places athletes on a

scale ranging from 1-4.5 (most limited to least limited) in 0.5-point increments[1]. Currently, VoA is determined through qualitative in-practice and in-game visual inspection by a qualified classifier. The IWBF places importance on improving the classification system's validity and reliability, and as such, quantification of VoA would seem prudent. Discrete reaching tasks, and more recently centre of pressure (COP)-based measurements have been used to objectively quantify an athlete's movement relative to their base of support. Previous research in this area suggests that people with proximal spinal lesions are less able to move their COP relative to their base of support than those with distal ones [2]. Therefore, the purpose of this study was to determine if a quantitative method for VoA could discriminate between athletes currently classified below 2.5 points (LC) and those currently classified above 2.5 points and above (HC). 11 males and 3 females (age 25 ± 5 years, Mass 70.13 ± 14.4 kg) currently enrolled in the National Wheelchair Basketball Academy program were grouped into High Class (HC, n=6) and Low Class (LC, n=8) players exhibiting IWBF classifications of 2.5 points and above, and below 2.5 points respectively. The athletes were instructed to sit quietly for 5 seconds, and then leaned forward, backward, side to side and diagonally by pivoting at the hip joints to trace a circle [2]. All testing took place on a n in-ground force plate (Advanced Mechanical Technology Inc., Watertown, MA, USA), and COP was calculated using a custom-built MATLAB (Mathworks, Natick, MA, USA) program. The area bounded by the average COP in one-degree increments yielded a cumulative area score (FR-CA) and was compared between HC and LC groups using descriptive statistics (Microsoft Excel 2013, Microsoft Corporation, Redmond, WA, USA). The FR-CA scores for the HC (range 50-80.8 mm2) group were larger than those of the LC (range 2-31 mm2) group. The FR-CA discriminates between HC and LC wheelchair basketball players. More quantitative tests (such as the FR-CA) could be developed and refined to assist in decreasing the potential of inter- classifier bias in the assessment of function in Paralympic athletes. In this way, the game can be validly leveled and true differences in athletic ability will determine sport outcomes.

Group	n	Age (years)	Mass (kg)
LC	8	23 ± 6	65.91 ± 9.9
HC	6	26 ± 5	75.05 ± 18.14

Table 1. Subject Group Data.

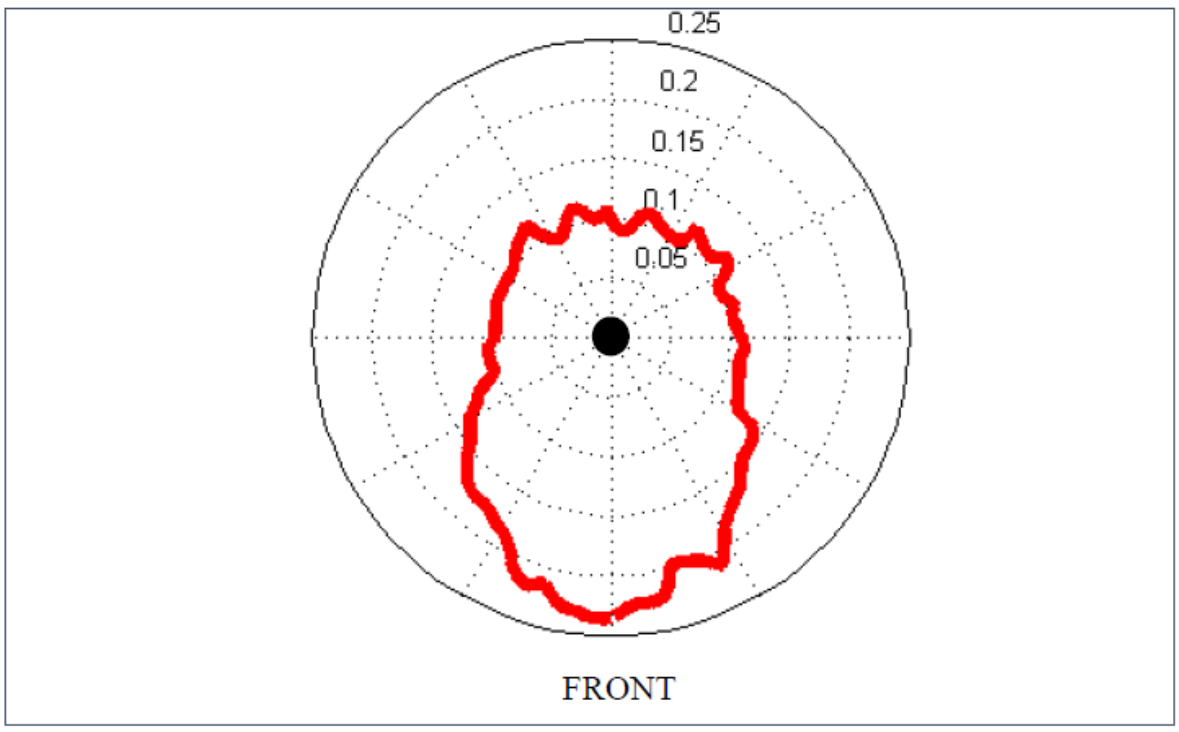

Figure 2. Sample Centre of Pressure data (red) for a single trial. Black dot indicates centre of pressure for quiet sitting during the start of the same trial. FR-CA is the area inside the red polygon.

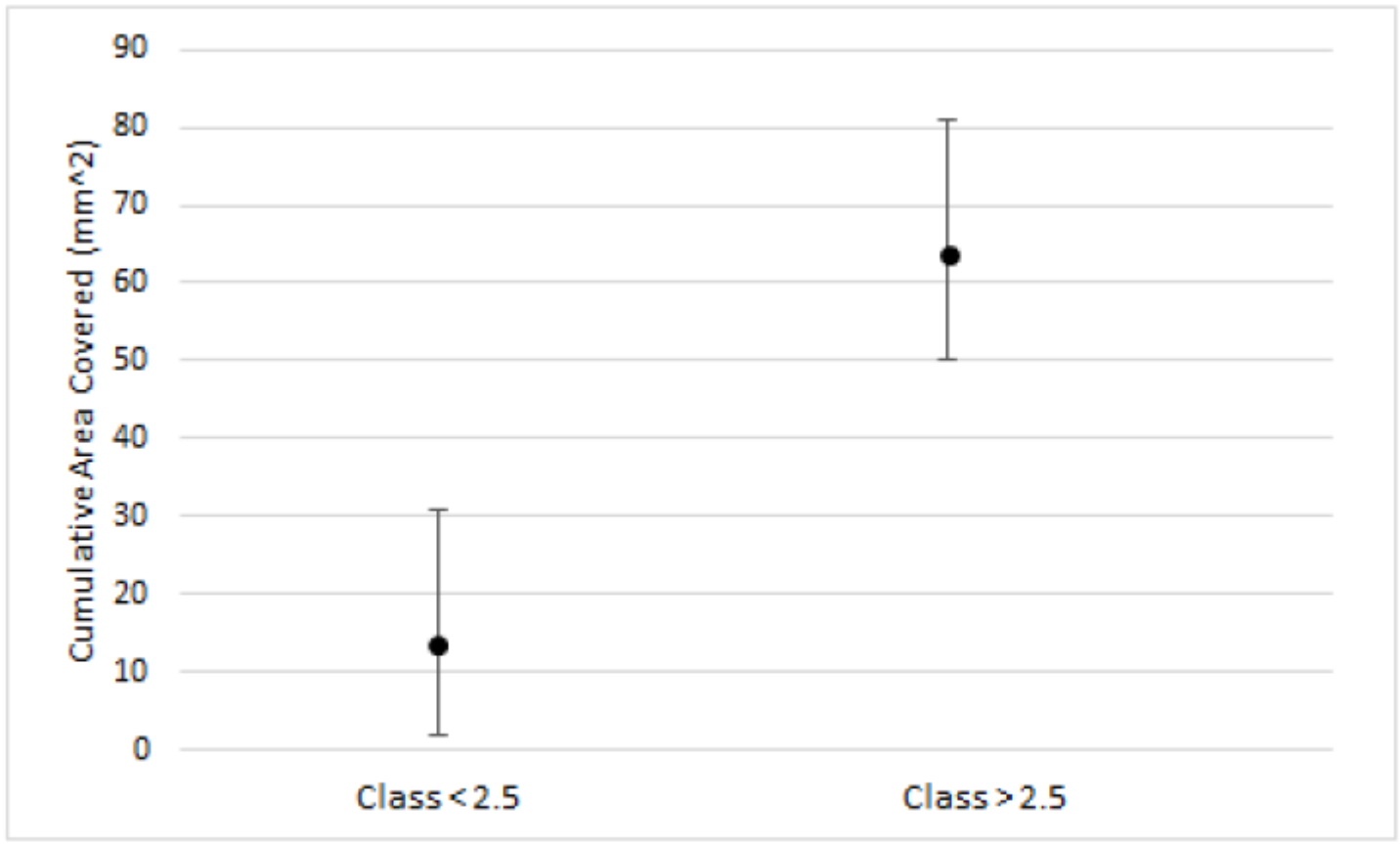

Figure 3. Average (black dot) and range (vertical hash lines) of FR-CA scores for HC (Class > 2.5) and LC (Class < 2.5).

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 # 40 Paralympic Boccia App.

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Introduction: Boccia is a Paralympic sport for people with cerebral palsy and with impairments that affect motor skills, who are wheelchair users. The athletes throw colored balls with the aim to position as close as possible to a white target ball. According to the physical condition and skills of the sport, players are divided into classes: BC1, BC2, BC3 and BC4 through a functional classification. Classification is a process by which players are evaluated functionally to determine eligibility, grouping of players into classes and allowing game result of the athlete's skill and training. The knowledge of the characteristics of the sport, rules, equipment, characteristics of the athletes and their functional classes is of fundamental importance for the adhesion and popularization of the Paralympic Boccia. With the development of mobile devices, applications have become essential tools for information, dissemination, guidance, knowledge, and rapid and interactive updating. Objective: To create an application for the dissemination of quick, objective and trustworthy information that involves the Paralympic Boccia. Methodology: A ballpoint colored logo was created to represent the application's quick recognition. The application used the Appmachine website for the development of presentation style and menu, for design creation, connection tools, testing and publishing. The information included in the application was based on the website of the entities related to the sport, the updated

scientific literature, the rules of competition BISfed/2015 and 2017, and functional classification BISfed/2013. Results: The mobile app developed for IOS, Android and Windows Phone operating systems presented a quick and objective interface with the potential to guide people with disabilities, physical education teachers, technicians, classifiers and the general public. The app provider information about the entities related to the sport, the rules of the game, the specificity of the different functional classes and the characteristics and equipment used in the Paralympic Boccia. Final Considerations: Publicity and knowledge about Paralympic Boccia, through an application, can help in the expansion and popularization of this sport.

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 # 45 Developing a Para Dance Sport National Classifier Base: A Canadian Journey

S. A. Gulasingam; E. Newell; I. Kulbatski

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Purpose: Sports are a recognized portal in rehabilitation, reintegration and improving quality of life among individuals with impairments. Wheelchair Dance, one of such, has been recognized as a sport by the International Paralympic Committee (IPC) with recent rebranding to Para Dance Sport (PDS). In spite of more than 29 participating nations and growing popularity, the sport is still in its infancy in Canada with no formal classification system or classifiers in place.

Objective: To develop a classifier education process in keeping with IPC-PDS guidelines to advance PDS in Canada.

Methods: Following a general call for applications by the national PDS body WHEEL-DANCE, Canada (2016), a certified IPC para-athletics classification trainer conducted a full day national classification workshop in accordance to IPC-PDS classification (IPC-PDSC) rules and regulations posted on IPC website in consultation with IPC-PDSC officials. Training was followed by hands-on classification of PDS athletes.

Results: The PDS classifier training program led to: development of Canadian PDSC form; induction of 4 National Classifiers comprising one physician, two physiotherapists, one administrator; successful conduction of inaugural

Canadian PDS competition; 10 athletes and 11 classifications including 1 "Not Eligible Review"; 7 national and 3 international athlete classifications; 2 athletes assigned “Class 1” and 7 “Sports Class 2”. There were no sport class revisions, post first appearance.

Conclusions: The first Canadian PDS classifier training program, a precedent for PDSC in Canada resulted in development of national PDSC form, induction of 4 national classifiers, inaugural Canadian PDS competition and creation of PDSC repository.

IPC websites on Para Dance Sport classification rules and regulations and para Dance sport "Classification"

 # 47 VALIDATING THE CATAPULT S5 ACCELEROMETER

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Purpose: Measuring wheelchair speed in wheelchair basketball is important in developing further understanding of game demands. There are several ways speed can be measured, however, recent focus on Inertial Movement Sensors (IMU) has proven promising and affordable to wheelchair basketball teams. Both x- IMU and Shimmer IMU have been used and validated, which sample at rates greater than 256 Hz (Slikke, 2016). It is unknown if the Catapult S5 sensors, which sample at 100 Hz provide comparable results. The purpose is to validate the speed output between Catapult S5 and x-IMU sensors.

Methods: Participants (n=5) performed two tests. The first test involved participants pushing at 5 and 8 km/h for a duration of 2 minutes. The second test involved participants pushing at 6 and 10 km/h around an 80m octagonal circuit, for 160m. Three x-IMU were mounted on the chair, one on each wheel and one on the frame center (Slikke, 2015). S5 sensors were mounted concurrently at the same locations and secured. Speed and distance were derived from previous methods (Slikke, 2016) T tests and (one way) anova’s were used to compare sensor and ergometer values.

Results: There were no differences found between speed and distance travelled recorded by the ergometer, x-IMU and S5 sensor setup during fast – $F(2,12)=0.14934$, $p>0.863$ and slow – $F(2,12)=0.0908$, $p>0.091$ parts of the test . A slight, but not significant increase in the speed at both slow – 1.2%, $p<0.19$ and fast speeds – 1,5%, $p<0.063$, as well with total distance at fast – 1.5% and $p<0.071$) and slow – 0,9%, $p<0.20$ speeds between x-IMU and S5 sensor output.

Discussion/Recommendations: There were no differences found in velocity output between the x-IMU and S5 IMU mounted sensors. However, as the frame orientation changed, the validity of the S5 sensor to measure frame orientation needs further investigation. This might suggest that a higher sample frequency on the frame is important to ensure the validity of the wheelchair speed.

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 # 48 Practical knowledgh of a blind football goalkeeper applied to verbal instructions

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PURPOSE: Blind football, whose international rules were unified in the early 1980s mainly in Europe and South America, became an official Paralympic sport as “Football 5-a- side” in the Athens 2004 Paralympic Games. Though the Japan Blind Football Association was formally inaugurated in 2002 and the Association has been enhancing and promoting the sport, we could not participate at the Rio 2016 Paralympic Games. Thus far in Japan, blind football has been researched mainly by game analyses but only a few researches were on the consciousness and attention of players during playing games.

In this study, qualitative and exploratory analyses on the consciousness of the representative goalkeepers of Japan, who have competed at many international games so far, were conducted using a semi-structured interview (hereinafter called interview) method where their consciousness during playing games was analyzed based on the utterance data by approaching their inner process in developing a game plan.

METHODS: The representative goalkeepers of Japan who have competed at many international games so far were interviewed on their athletic experience in blind football. In this study, a qualitative research was conducted using a semi-structured interview method (Flick, 2002). In the interview, the goalkeepers were requested to explain the awareness as a goalkeeper of blind football as well as the content, caution and verbal-expression style of the instructions on defense to field players. Their responses were all recorded in an IC recorder. It is believed that the reliability of the interview data was ensured by transcribing the recorded interview data with interviewees’ permission and getting confirmation on the documented data from them. It is also believed that the reliability of the data analyses was ensured by having discussions several times with multiple researchers and confirming the consistency of the results of the analyses.

RESULTS &CONCLUSIONS: As a result of the analysis by M-GTA on the goalkeeper’s vocal directions in a blind football game, we obtained the following six categories. It was “Understanding the proficiency level of a player”, “Sharing images”, “Communicating information”, “Grasping circumstances”, “Understanding strategy”, “Determining attitude and mind-set as a goalkeeper”. We could obtain the basic materials leading to improvement of competition power, which are relating to the consciousness as a goalkeeper in blind football and the caution in making verbal instructions and are involving in the differences in the character as a goalkeeper of blind succor from that of soccer or futsal, detailed checking of the communication content, and careful implementation of useful meaning generation activities in games.

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Flick,Uwe(2002)Shitsuteki kenkyu nyumon.shunjyusha.94-102.in japan〈Flick,Uwe(1995)QUALITATIVE FORSCHUNG.Rowohlt Taschenbuch Verlag GmbH〉Originally Published

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49 BIOMECHANICAL EFFECT OF ROBOTIC EXERCISE FOR BOCCIA PLAYERS

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Background: The application of robots for rehabilitation has been developing over the past decade. In neuro-rehabilitation, motor learning has become an important topic. We propose to apply this technology to develop the sports performance for boccia players. To maximize the effect of motor learning, we need to clarify the key muscle and adequate intensity.

Objective: Examination of a new method of robotic exercise that employs a motion capture system to calculate kinematic parameters.

Design: A cross-sectional study of individual cerebral palsy as a case study. One boccia player with cerebral palsy (male; age, 22 years; height, 1.51 m; body weight, 52kg; type, spastic diplegia; locomotion level, electric wheel chair; Boccia level, BC2) participated in the study.

Methods: We employed a motion capture system to calculate kinematic parameters of a cerebral palsy patient in throwing movement assessments. This method allows the comparison of motor performances before and after exercise. A Hybrid Assistive Limb (HAL) was employed for the exercise. HAL is a powered exoskeleton bionic device that is controlled by surface EMG of the hip flexor, hip extensor, knee flexor, and knee extensor muscle of the subject. HAL consists of a CPU, interface units, surface EMG, plantar pressure sensors, four motor units, a Lithium polymer battery and exoskeletal of lower body (Figure.1) . We focused on the activation of the gluteus maximus muscle. The subject demonstrated good feedback from surface EMG. The tasks were squatting and walking. The numbers of the exercises were 500 repetitions and 500 steps.

Results: Boccia ball velocity at release after exercise was greater than that before exercise. The range of motion of the shoulder during throwing after exercise was greater than that before exercise. In contrast, range of motion of the anterior inclination of the trunk during throwing after exercise was less than that before exercise.

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Huang YZ.. What do we learn from the influence of motor activities on the after-effect of non-invasive brain stimulation?. Clin Neurophysiol. . 2016;127:1011-2.

 # 53 Sports Clinic for Athletes with Disabilities in Taiwan

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Athletes with disabilities are extremely vulnerable to sport injuries mixed with musculoskeletal overuse injuries, especially with vivid development of disabled sports and their increasingly vigorous intensity. However, medical support systems for these athletes are limited worldwide.

A dedicated sport medicine clinic for athletes with disabilities was operated between Aug 2015 and Dec 2016 by the Department of Physical Medicine and Rehabilitation of MacKay Memorial Hospital, a medical center in Taipei, Taiwan.

Disability Classification and Health Management Center, Taiwan, for people with disabilities, in which medical and sports professionals work together as classifiers to enhance the quality of sport classification and promote overall health for people with disabilities.

Demographics of the 13 athletes with disabilities

Factor			Number of patients
Sex	female		5
	male		8
Age	20-39 years old		3
	40-59 years old		10
Disease	poliomyelitis		9
	spinal cord lesion		2
	others		2
Sport	table tennis		7
	field athletics		1
	archery		1
	wheelchair dance		1
	para-badminton		3
Main condition	shoulder pain	rotator cuff lesion	5
		acromioclavicular sprain	1
	hip pain	synovial chondromatosis	1
	elbow pain	osteochondritis dissecans	1
	arm pain	cervical radiculopathy	1
	arm weakness	cervical radiculopathy	1
	back pain	tethered cord syndrome	1
	leg weakness	spondylolisthesis	1
	finger pain	ligament sprain	1

This clinic was operated once or twice a month on Saturday by one PMR attending physician/disabled sport classifier, with one PMR resident doctor and one nurse. This clinic provided diagnosis of sport injuries and concomitant overuse injuries, aided by on-site musculoskeletal ultrasonography, radiography service and advanced imaging if indicated. Non-operative treatments were provided in the same session right after discussion and planning with athletes. Surgical consultations with sports surgeons could be done on the same day if indicated. A case manager and nurse would follow up via phone call after athletes' clinic visits.

Information of this dedicated clinic was spread through the internet, social media, and personal networks of individual athletes, sport clubs and teams.

Information regarding athletes' main complaint, associated musculoskeletal conditions, underlying medical conditions, related impairments and disabilities, their sport activities and sport classes, assistive devices and occupational activities were obtained. Their unmet medical needs and any barriers for their sport participation were also recorded. Besides, data about the diagnoses and treatments in this clinic were retrieved from medial records.

Among the 20 patients examined in 5 clinic sessions in the first 5 months, 13 of them were athletes specialised in one disabled sport and 7 were patients with stable disability who sought advices for sport participation or musculoskeletal problems. The followings are some key features of the 13 athletes with disabilities: 1) Male were more than female. 2) Two-thirds of the athletes were at their forties and fifties. 3) Seventy percent of them had poliomyelitis, while spinal cord lesion and other physical problems constituted only small portions. 4) Wheelchair athletes outnumbered standing athletes. 5) Major disabled sports attended were table tennis and para-badminton. Field athletics, archery, and wheelchair dance had fewer athletes presented in the clinic. 6) Most of them had chronic disabling pain from three or more active musculoskeletal problems among which rotator cuff tear of shoulders was the most common, followed by elbow, seating and hip problems. A thorough consultation /examination for this population is very time-consuming. 7) Rare conditions also happened, such as hip synovial chondromatosis, recurrent tethered cord of operated myelomeningocele, spondylolisthesis in achondroplasia athletes. These conditions required a high degree of suspicion to diagnose.

A significant portion of athletes reported satisfactory outcomes after treatments, leading to recoveries in daily functions and sport performance.

Sports Med. 2016 Aug; 46(8):1141-53

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54 Treating elbow locking in a para-table tennis sitting athlete

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Case: Table tennis is not a sport generally considered with a high risk of injury. However, wheelchair athletes in para-table tennis use upper limbs for both playing and for daily wheelchair propulsion, transfer and crutch use. Their upper limb injuries, if not treated well, may lead to sacrificed sports performance and self-care function. A 56-year-old male paraplegic player with complete thoracic spinal cord injury plays para-table tennis in class 4 competitions. He had frequent painful lockings at the elbow of his right playing arm, compromised his training and mobility. He had corticosteroid injections to the common extensor tendons of elbow but symptoms persisted. Physical examinations showed limitation at elbow flexion and extension. Imaging confirmed intra-articular loose body within and osteoarthritis of right humeroulnar joint. Intra-articular corticosteroid injection to the humeroulnar joint controlled pain and eliminated lockings well. Range of motion was restored. The player resumed regular table tennis training.

Discussion: Although not as common as lateral epicondylitis, intraarticular loose body and early-onset osteoarthritis can cause remarkable function loss of para-athletes. Non- surgical managements are suggested before seeking surgical treatments. The incidences of intraarticular loose body, osteoarthritis of elbow are unknown in wheelchair table tennis athletes. Further evidences are warranted to prevent or postpone joint diseases in young wheelchair athletes.

Med Sci Sports Exerc. 1991 Aug;23(8):889-91

 # 56 Thirst sensation can be used to identify moderate hypohydration in athletes with a visual impairment

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Assessment of hydration status is important because of the role water plays in various physiological functions. In field settings, urinary measures of hydration status such as osmolality (U_{osm}) and specific gravity are commonly used by practitioners. Yet, the need for technical equipment limits the use of these techniques if athletes train independently. Alternative methods available to athletes include the assessment of hydration via urine colour, and thirst sensation. However, the former technique remains problematic for athletes with a visual impairment (VI).The use of thirst sensation has received attention as a potential marker of hydration status, yet remains to be investigated in athletes with a VI, for whom it could be readily applicable. Therefore the aim of this study was to investigate the use of ratings of thirst, and symptoms related to thirst, as markers of hydration status in athletes with a VI. Following ethical approval, eleven athletes with a VI (22 ± 4 years, 1.76 ± 0.11 m, 72.1 ± 13.0 kg, 44.45 ± 4.92 $ml{\cdot}kg^{-1}{\cdot}min^{-1}$) volunteered to take part, all were games players (Cricket and Goalball) to an international standard. Participants completed a single 24 h trial with fluid restriction throughout, reporting to the laboratory at 13:00 on Day 1. Body mass (BM), U_{osm} and thirst sensations were assessed upon arrival (13:00) and pre-bed (22:00) on Day 1, followed by 'Upon waking' (08:00), pre (11:00) and post (12:00) a battery of field tests on Day 2. Participants were provided with dry foods for dinner on Day 1 and breakfast on Day 2. Following the exercise on Day 2 was a rehydration period where participants were free to eat and drink ad libitum, prior to final BM, U_{osm} and thirst monitoring at 13:00 on Day 2. Thirst was assessed using a 12-item Thirst Sensation Scale (TSS, Table 1) with items ranked from 0 (not at all) to 9 (very, very). Repeated-measures ANOVA with Bonferroni post-hoc found significant BM loss and increase in U_{osm} from 22:00 on Day 1 onwards ($P \leq 0.010$). Following the rehydration period, BM (71.4 ± 12.6 kg) was not significantly different to 'Upon arrival' (72.1 ± 13.0 kg) the previous day (P_{-1}= 0.197), however, U_{osm} was still significantly elevated (836 ± 121 vs 298 ± 237 mOsm·kg, P = 0.002). BM loss prior to the field testing on Day 2 was 2.5 ± 0.4%. Receiver operating characteristics analysis revealed "How thirsty do you feel?" was the only TSS item able to distinguish between euhydration and hypohydration of 2% BM loss with sensitivity and specificity greater than 85%. This corresponded to a rating of 5 or above. Ratings of thirst were significantly increased at each time point compared to arrival ($P \leq 0.004$) on Day 1, except at the end of the rehydration period (13:00) on Day 2 (P = 0.170). Group-averaged, Fisher-transformed correlation between BM loss and thirst rating was r= 0.816. In conclusion, findings suggest that ratings of thirst can be used as a marker of hydration status by athletes with a VI. Athletes can be recommended to use first-morning ratings of thirst to inform subsequent drinking behaviour if assessment of urinary indices is not possible. Furthermore thirst ratings can complement urinary measures to allow a more informed assessment of hydration status to be made.

Table 1: Thirst Sensation Scale

How dry does your mouth feel now?
How irritated does your mouth feel now?
How bad does your mouth taste now?
How much of a chalk-like taste do you have in your mouth now?
How dry does your throat feel now?
How scratchy does your throat feel now?
How chapped do your lips feel?
How thirsty do you feel now?
How pleasant would it be to drink some water now?
How full does your stomach feel now?
How alert do you feel now?
How well can you concentrate right now?

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58 A Study of the Spatial Perception of Japanese Blind Football Players

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Objective: Blind football, whose international rules were unified in the early 1980s mainly in Europe and South America, became an official Paralympic sport as “Football 5-a- side” in the Athens 2004 Paralympic Games. The Japan Blind Football Association was established in 2002 and has been active in strengthening the national team, discovering promising players, and promoting training and Paralympic educational projects, etc. Thus far in Japan, blind football has been researched mainly by game analyses but only a few researches were on the consciousness and attention of players during playing games.

In this study, using semi-structured interviews (hereinafter called “Interviews”), the present study aimed to make an exploratory analysis of the spatial perception of blind football players representing Japan, including how they construct that awareness during a game.

Method: Interviews were targeted at games that players could recall towards practicing retrospective introspection (Flick, 2002). In the Interviews with players who represented Japan, we asked them to recall past games and explain the predictions they made while playing and their composition process. Their responses, which were captured on an IC recorder, revealed their spatial perception and how they constructed it during a game. The verbatim data was carefully interpreted based on the spatial consciousness of the athlete and carefully interpreted the meaning of the data and categorized the concept. It is believed that the reliability of the interview data was ensured by transcribing the recorded interview data with interviewees’ permission and getting confirmation on the documented data from them. It is also believed that the reliability of the data analyses was ensured by having discussions several times with multiple researchers and confirming the consistency of the results of the interpretation.

Results and Discussion: The following results were obtained from data interviewing the spatial consciousness of blind football players. The findings showed how the spatial perception of a blind football player involves not only his own senses but also surrounding factors such as the head coach, caller, opponents, and teammates, all of which are assimilated. It was interpreted that space functions as a code among the members and is based on an arbitrary form that continuously updates how it is perceived（Maruyama,1981）. We were thus able to obtain basic data about enhanced competitive skill for dissemination.

This work was supported by JSPS KAKENHI Grant Number (26350794, 26350795) and we acknowledge them with thanks.

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59 CAREER DECISION-MAKING PROCESS OF US AND JAPANESE PARALYMPIANS

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In an athlete's world, while achievement in sport is important, planning for a career after sport cannot be overlooked. According to one group of researchers (JSC, 2014), a number of Canadian athletes and coaches harbored concerns about their careers after retirement from their sport, and at times, these concerns negatively affected their athletic performance. According to Lent, Brown and Hackett (1994), personal and environmental factors can also influence career decisions. Based on the results of these studies, it was predicted that for Paralympians, factors such as the working environment can influence their self-efficacy and outcome expectancies related to their careers. Depending on their disability, either the athletes themselves or the company they wish to work for, may fail to utilize their abilities, potentially creating barriers and limitations to their assigned job responsibilities.

The purpose of the study is to collect information on the post-athletic-retirement work careers of Paralympic athletes including their current work status, reasons they chose the careers they did, and any career planning support they received while they were actively competing. The researchers will conduct interviews based on Social Cognitive Career Theory (SCCT: Lent et al., 1994) to ascertain factors Paralympians deem to be highly important when making career decisions. This study relies on in-depth interviews as the primary means of data collection. A phenomenological design utilizes in-depth, exploratory interviews as its primary means of collecting data (Rossman & Rallis, 2003). Semi-structured interviews with 20 retired former Paralympian athletes from the United States and Japan will be conducted. Each interview will take place in one designated time period, with breaks between question sets. The three parts of the interview are (a) personal life history including demographics and career experiences, (b) experiences regarding retirement from competition and (c) career perceptions and expectations.

This study will examine the process by which Paralympians make career decisions when planning for their retirement from competition and can assist sport organizations with developing programs to aid Paralympians in their post-competition careers. Since differences may exist in the process of post-retirement career decisions for Paralympians compared to Olympic or professional athletes, it can be said that this research is quite meaningful in terms of potentially enhancing employment opportunities for persons with disabilities.

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62 The Interpersonal Communication of Elite Goalball Athletes: A Qualitative Study

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Goalball is a unique sport because games are played in silence to allow the athletes to hear the ball moving. While the ball is in play, only the athletes on the court can speak to one another. This study focuses on the communicative interactions occurring within and surrounding goalball games as well as how participation in athletic activities is related to elite goalball athletes' perceptions of their communicative interactions with others. Data were gathered at the 2016 Malmö Men's Intercup in Sweden, and through a series of interviews conducted in the United States. Specific questions addressed by this study include: How do elite goalball athletes perceive themselves? How do they communicate with others? How do others perceive elite goalball athletes? How are these athletes communicated with and described by others? How do these perceptions by self and others affect the interpersonal communication of elite athletes both on and off the goalball court?

In previous goalball studies, researchers have focused primarily on the mechanics of the sport (Stamou et al. 2007; Bowerman et al. 2011; Gulick and Malone 2011; Scherer et al. 2012). Prior studies of blind sports participation have not focused specifically on goalball (Ponchillia et al. 2002; Ponchillia et al. 2005; Eddy and Mellalieu 2003; Osvath et al. 2007; Dane-Staples et al. 2013). Autoethnographic work has described the lived experiences of Paralympians (Howe, 2008; Peers 2012), but not from the perspective of blind athletes. And studies addressing elite athletes' perceptions of Paralympic participation have not included goalball players (Brittain 2004; Hardin and Hardin 2003; Howe and Jones 2006; Purdue 2013; Purdue and Howe 2013).

A study by Mastro et al. (1996) examining 1992 USA Paralympians' perceptions of one another did include thirty blind athletes. Blind athletes were found to be the least preferred by other Paralympians both because they were perceived as the most different from other athletes and because blind athletes can't "start a conversation with someone they cannot see" (p. 207). This research ignored the issue that sighted people, who can begin conversations through eye contact as well as speech, often exclude individuals who are blind. We believe there is a lack of understanding of the interpersonal communication of elite blind athletes.

The first author is a professor of Communication Studies and conducted ethnographic research at the 2016 Malmö Men's Intercup where national goalball teams from Sweden, Finland, Turkey, Germany, Denmark, Algeria, and Japan participated. This study included on-site field notes as well as interviews with athletes, coaches, referees, spectators, and volunteers. The second author is an elite goalball athlete and won a silver medal at the 2016 Paralympic Games in Rio. He is also a Ph.D. candidate in Political Science studying disability politics and has conducted a series of interviews with members of Team USA about their perceptions of interpersonal communication. They have previously published a book chapter titled "An Inside Look at an Invisible Paralympic Sport: Giving Voice to Goalball Athletes' Lived Experiences" (Jenks & Jenks, 2015).

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63 The Conceptualisation of Medical and Health Legacies

K.S. Jung; D. Legg; F. Tajima; J-L. Chappelet

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This study focuses on developing the concepts of medical and health legacies as a planned and positive legacy in the Paralympic Movement. Medical legacy is broadly defined as medical care for Paralympians while health legacy is referred to as health care for the community. This study aims to identify the flow of impacts from medical and/or health care for Paralympians to the public health care and, thus, clarify if the planned medical and health legacies can be applied in a Japanese context following the 2016 Rio Paralympic Games. Using a one-nation-focused case study, information was obtained through interviews with Japanese medical staff members. The main elements of medical legacy that were identified include athlete-related medical care, sharing experiences on and conducting medical care for Paralympians, and establishing a classification and anti-doping system. Health legacy was related to both the health care for Paralympians and the public, which includes increasing physical and mental health through participation sports. Thus, as it relates to public health improvement and/or health promotion, healthy life expectancy is likely to be improved. Therefore, medical and health legacies in the Japanese context have contained in a wider range of

medical and health care. Most interviewees claimed that their experiences with the Paralympic athletes were applied to the public medical/health care. The longer time he/she has been involved in Para-sports, the higher percentage of positive attitude he/she has had toward its application.

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 # 64 Differences in muscle activation pattern and joint kinematics of upper limb between elite and recreational wheelchair athletes during wheelchair sprint

K. Kawabata, T. Mitsui, T. Ibusuki, Y. Nishimura, Y. Kamijo and F. Tajima

PURPOSE: Muscle activation pattern of the upper limbs and an efficient propulsion technique to push a hand rim are critical factors determining sprint performance in wheelchair athletes requires. Our purpose was to compare EMGs responses of upper-limb muscles and joint kinematics of upper limb between elite and recreational athletes during wheelchair sprint.

METHOD: Four males with spinal cord injury (all T53) participated in this study. Two of them were elite wheelchair athletes who had an experience with entering the Paralympic Games. The other two were recreational wheelchair athletes. To investigate muscle activation pattern of upper limb during wheelchair sprint, EMGs of six upper-limb muscles (trapezius, deltoideus, and latissimus dorsi) were recorded during last ~50 m of 200-m wheelchair sprint. Joint angular velocity of upper limb was evaluated by two high-speed cameras to capture upper-limb movements simultaneously. Then wheelchair velocity, cycle period, and angular velocities of trunk, shoulder, and elbow joints were calculated. Cycle period was divided into propulsive phase; from the time at contacting the rim to the time at releasing it, and recovery phase; from the release to the next contact.

RESULTS: Wheelchair velocities were ~8.2 m/s for elites, ~20% higher in elites than recreational athletes. Cycle periods were ~0.50 s for elite athletes, seemed to be similar to that for recreational athletes. But durations of the propulsive phase were ~0.13 s in elites, ~0.30 s shorter than recreational athletes. Both elite and recreational athletes took a posture of forward rotation of trunk during the first propulsive phase. Then backward rotation of trunk started ~0.07 s after the onset of the propulsive phase and forward rotation of trunk started again ~0.15 s after the onset of recovery phase in elites. But, backward rotation of trunk started at around the release in recreationals and forward rotation of trunk during the recovery phase was ~0.07 s later than elites. Horizontal shoulder adduction and abduction occurred almost at the same timing of forward and backward rotation of trunk, respectively, in both athletes. Elite and recreational athletes first took a posture of elbow extension during the propulsive phase. Elbow flexion started 0.10s after the onset of the recovery phase in both elites at the same timing as a peak angular velocity of backward rotation of trunk, but at almost the same as starting backward rotation of trunk or

horizontal shoulder abduction in recreationals. Elbow extension during recovery phase started just before contacting in elites, at the same timing as peak angular velocity of horizontal shoulder adduction, but ~0.03 s earlier in recreational than elites during recovery phase. Muscle activities of trapezius, deltoideus, and latissimus dorsi were presented corresponding to the periods of forward rotation of trunk and horizontal shoulder adduction during the recovery phase in elites, while these muscle activities appeared before releasing in recreationals.

CONCLUSION: These results suggest that muscle activation pattern and joint kinematics of upper limb in elite athletes are likely to be more efficient than recreationals.

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66 The characteristics of fundamental physical fitness of Paralympic athletes in Japan

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Recently, many researchers are interested in the Paralympian's specific abilities or adaptations that acquired to compensate their disabilities. Although their scientific approaches have been found unknown possibilities of the athletes, we are still not enough to identify their fundamental properties. For example, we found no information about systematic comprehension of fundamental physical fitness with the national Paralympians in Japan. The aim of this study was to determine the characteristics of fundamental physical fitness of Japanese Paralympic athletes.

Forty hundred fifty seven certified athletes with disabled (308 men and 149 women) belong to each 29 national federation participated in this study. All athletes categorized into 5 types of disabilities (sitting [SI], sitting with severely disabled [SIS], standing [ST], visual impairment [VI], intellectual disability [ID]). Sitting athletes performed grip force, medicine ball throw, shoulder joint flexibility, button-press reaction time, and wheelchair 5-minutes run test, whereas another athletes performed grip force, long jump distance, seated forward bend, whole body and button-press reaction times, and 20 m shuttle run. Both reaction times were performed with visual and auditory stimulus tasks.

The values of each physical fitness reflected sports characteristics. In male athletes, for example, alpine skiing, wheelchair basketball, wheelchair tennis, track and field were relatively higher both grip force (51.2~ kg) and each anaerobic power (long jump distance: 237.5~ cm, medicine ball throw: 654.1~ cm), whereas powerlifting, cycling, badminton (SI) showed only high values of the grip force (50.0~ kg). Although both reaction times were slightly different across the all sports, swimming (ST), blind soccer, goal ball were shorter whole body reaction time and blind soccer, badminton, sitting volley ball were shorter button-press reaction time with auditory stimulus. In 20 m shuttle run, cross-country skiing, track and field with ID showed high endurance capacity whereas in wheelchair 5-minutes run test, wheelchair basketball, wheelchair tennis, badminton recorded the running distance over 780.0 m. Additionally, Paralympic medalists showed top level of each physical fitness with the exception of reaction times and 20 m shuttle run.

In conclusions, the fundamental physical fitness reflected sports characteristics or performance level for Japanese Paralympic athletes. In particular, track and field, wheelchair basketball, wheelchair tennis, alpine skiing showed high capacity of physical fitness. However, there were some problems to estimate their capacity. For example, amputee athletes

were relatively low values in long jump distance and 20 m shuttle run. This may be due to the restriction imposed by amputee rather than their fitness capacity. Moreover, the distance of wheelchair 5-minutes run test seemed to influence by the difference of wheelchair type. Future studies should verify these problems.

 # 68 Maximizing sporting performances throughout interaction between sports medicine and sports science in Boccia BC4 athlete gold medalist for 2016 Rio Paralympic Games

Mr. Lam Chun Ying, Martin

Over the past twenty years, Hong Kong have substantial increases in the levels of government support and improved performances of many athletes in Boccia. It is also important to have knowledge on how to structure all multidisciplinary support to improve the performances in athletes. Leung Yuk Wing, who was the gold medalist in 2016 Rio Paralympic Game in Boccia BC4 individual event, received multidisciplinary support of Sports medicine and Sports science from *Hong Kong Paralympic Committee and Sports Association for the Physically Disabled*. Behind every successful boccia athlete, there is often a team of individuals who help make it possible for them to play the sport. However, it is equally important to have a team of individuals who provide professional sports science and sports medicine knowledge to improve an athlete's performance. The abstract will share our experience on how we apply all multidisciplinary on the athletes, which included rehabilitation, strength and conditioning, physiological training, game analysis, technology and psychological services before and during the Paralympic Games.

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 # 69 Forward Dynamic Optimization of Paralympic Wheelchair Curling

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This research sought to quantitatively evaluate how the central nervous system of a Paralympic athlete with a spinal cord injury resolves kinematic redundancies during multibody movements (i.e., neural motor control). A novel biomechanical model of a tetraplegic Paralympic athlete was developed using subject-specific body segment parameters. Angular joint kinematics throughout a specified Paralympic sport movement (i.e., wheelchair curling) were experimentally measured using inertial measurement units. Neural motor control of the Paralympian was mathematically modelled via forward dynamic optimization. The predicted kinematics from different optimization objective functions were compared with those experimentally measured throughout the wheelchair curling movement in the interests of quantifying the neural motor control employed by the Paralympian. Of the optimization objective functions under consideration, minimizing angular joint accelerations resulted in the most accurate predictions of the kinematic trajectories and the shortest optimization

computation time. The implications of these findings are discussed in relation to motor learning, and optimal equipment design through predictive simulation.

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 # 71

Lessons from DoD Warrior Games: Challenges Preparing Tactical Athletes for Paralympic Field Event Competition

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United States Department of Defense Warrior Games

In recent years the United States Military has become more involved in adaptive sports programs with clear benefits to the rehabilitation of injured tactical athletes(1, 2). Injured military have been identified as prime recruiting into Paralympic competition due to their pre-injury fitness level, work ethic, and systemic support for adaptive sport travel expenses and sport specific technology. However this population has unique considerations for coaching and training due to the high rates of comorbid traumatic brain injury, PTSD, and chronic pain(3). Additionally many tactical athletes have higher rates of sleeping disturbance(4), tobacco (5) and caffeine dependence(6).

The United States Military has developed rehabilitation workflows, such as Warrior Transition Units, which provide opportunities for injured tactical athletes to engage in adaptive sports programs, and qualify for national competition. However tactical athletes have limited exposure to Paralympic trained coaches, classification, specialized equipment and rules, such as, use and coaching progressions of a throwing frame.(7) This presentation will discuss specific techniques for training tactical athletes who are interested in participating in Paralympic field events. Recommendations for athlete identification, training environment, and lesson plans will be addressed.

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 # 75 What is happening beyond the classification room? A holistic approach to classification in the Para sports

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The ability of classifiers to achieve accurate and fair classifications for athletes is limited by those factors that they can test and observe during competition. There are also some external or environmental factors such as sleep, access to training facilities, nutrition, etc., that may have a strong impact on performance, as has been shown in numerous previous studies (Greenleaf et al., 2001; Kubiak, 2012; Dahl, 2013; Williams, 2010).

For example, impairments of a different nature may differently affect two major characteristics of sleep – duration and quality. An athlete with a SCI will have urinary incontinence and lack of bowel control, which will cause emotional disturbances, disturbance of sleep, and other negative impacts upon their quality of life (Grimby et al., 1993; Ann & Broome, 2003). Also, such athletes need more time to prepare themselves in the morning, and more time to do their routines during the day and in the evening, which may also result in a decrease in time available for sleep, especially during a competition, when there is a tight schedule and time is limited. Taken together, alterations in sleep quality and a decrease in sleeping time will, in all probability, have a negative effect on sports performance. It should be stressed that, in this described example, sleep quality was impacted not by personal habits of the individual, but by the nature of their impairment, and this must be taken into account. Studies have shown that sleep problems are more common in individuals with SCI than in normative samples (Jensen et al., 2009). At the same time, athletes with amputations usually have no issues with urination and defecation, and need less time to perform their daily routines. These athletes can ensure good sleep management and therefore ultimately may perform better.

Classification has developed a long way from its medical-based roots, i.e. allocation of classes according to the medical condition, to a functional and evidence- based system that evaluates and compares the functional abilities of individuals, supported by evidence gathered in properly organized scientific research (Tweedy & Vanlandewijck, 2011). Perhaps the next step in the evolution of classification will be a holistic approach that will take into consideration all factors: physical, psychological, social and environmental, and include them in the final allocation of an individual classification. Clearly, such an idea may have limitations, amongst which a major one would be the significant increase in the number of variables that would need to be included should such a holistic approach be implemented. Every parameter would have to be well enough evidenced to be included in the classification system, and gathering evidence for all of them might well take an indefinably long time. Some factors, such as accessibility to training facilities, would likely vary hugely across countries and development of clear criteria for their assessment seems implausible. To sum up, it should be stressed that impairment has a direct and an indirect impact on sports performance, and sometimes this should be taken into account when making final decisions about classification

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80 A study on auditory reaction time and accuracy of auditory spatial localization in blind football players

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Background & objective: Auditory spatial localization is important for blind football players to execute motor skills. An earlier study (Velten et al. 2016) indicated that blind football players categorize directions of sound source more precisely than blind nonathletes and sighted individuals. In addition, sighted football players have faster simple auditory reaction time (ART) than nonathletes (Akhani et al. 2015). However, it is not clear whether blind football experience or football experience contributes to the accuracy of auditory spatial localization and consequently to faster auditory response. The purpose of the present study was to investigate ART and accuracy of auditory spatial localization in blind football players compared with sighted football players.

Methods: Participants consisted of blind football players (n=10, age = 27.6 ± 5.3 years, a mean playing experience = 8.0 ± 4.2 years; five of them were B1 players, four of them were B2 players and the other was B3 player) and sighted college football players (n=11, age = 19.2 ± 1.2 years, a mean playing experience = 12.4 ± 2.8 years). All participants were blindfolded with eye mask throughout the experiment and instructed to stand on a sensor mat surrounded by four sound speakers located on front-left, front-right, back-left and back-right at a distance of 1.68 m from the participant. The speakers were adjusted to ear height of each participant. The participants executed a goal-directed step towards the speaker which produced a 1000 Hz beep as soon and as accurately as possible after detecting the direction of sound. Three different tasks were conducted in this study, namely simple, 2-choice and 4-choice ART tasks.

Results: The blind football players had significantly faster ART than the sighted football players in 2-choice ($p < .01$) and 4-choice ($p < .01$) tasks, but not in simple ART task. The percentage of step response toward the correct direction was significantly larger in the blind football players than in the sighted football players in 2- choice ($p < .01$) and 4-choice ($p < .05$) tasks.

Discussion: The earlier study (Velten et al. 2016) indicated that blind football players categorize directions of sound source more precisely compared with sighted nonathletes. In the present study, higher response accuracy was observed in the blind football players compared with sighted football players, which suggests that accuracy of auditory spatial localization is enhanced through the experience of blind football. In addition, the difference in ART between the groups was shown in selective tasks such as 2-choice and 4-choice ART tasks, but not in simple ART task. These findings suggest that blind football players are superior to sighted football players in executing motor skills in localizing sounds quickly from multiple auditory sources.

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82 Integrated Governance in Canadian Sport: A Case Study of Swimming

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INTRODUCTION: Social inclusion and accessibility for persons with a disability are at the forefront of many political agendas nationally and provincially/territorially in Canada. In recent years there has been a push towards a more aligned sport system where parasport is more clearly integrated, yet there remains numerous gaps in understanding how these objectives can be met. From one perspective the idea of an integrated streamlined system seems appropriate, yet on the other the need for clear understanding of parasport systems and structures necessitates distinct governance mechanisms (Misener & Molloy, 2017). Little to no research has explored the organizational structures of parasport organizations to understand the governance of integration of parasport and able-bodied sport that would shed light on the challenging structures of managing parasport. Thus, we use the case of one sport – swimming – in Canada that has been integrated for all abilities under one governing body to explore this issue. Swimming Canada brought para-swimming and able-bodied swimming under the jurisdiction of one national governing body, claiming to be "fully integrated" since 1993 (Swimming Canada, 2017). We use the case of swimming to examine the mechanisms of governance for integration throughout the delivery system.

METHOD: A multi-level intrinsic case study of parasport integration within the governance of swimming in Canada at a national, provincial, and community level is used. Purposive semi-structured interviews, archival records and document analysis were used (Yin, 2013). Interviewees included staff members at various levels, coaches, sport builders and other individuals in leadership positions. Documents and archival records such as National and Provincial annual reports, strategic plans, and policy documents were analyzed to provide historical context, governance structures, and system implementation strategies.

FINDINGS AND DISCUSSION: Despite the socio-political shift towards integration in sport governing bodies to provide a more equitable and inclusive environment, a universal understanding of integration remains unclear. It is apparent in this case that the idea of integration continues to evolve with the dynamic political agenda in sport. In the case of Swimming Canada, integration began from a drive toward functional classification and unifying all national teams under a single governing body. Since this initial arrangement within Swimming Canada, roles of staff members have continued to evolve towards the current organizational structure of shared responsibility and inclusion across all disciplines. While some governance mechanisms (i.e. media and communications strategy and staff organizational structure) are in place to support integration, there are many challenges regarding distinction of para-swimming and para-athletes within the overall model of governance. We highlight some key findings regarding the importance of role clarity, clear policy guidelines, and mechanisms that adequately support parasport pathways and support personnel.

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85 Sport wheelchair installation and its effect on joint loading and push performance

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Purpose: Sport wheelchair installation has been found to affect propulsion efficiency and upper extremity loading [1,2]. The purpose of this study was to determine the effect of varying wheelchair centre of gravity (CoG), seat dump angle (DMP), and wheel width (WW) on both performance and joint loading parameters in straight line pushing.

Methods: Kinematic (Qualisys AB, Gothenburg, Sweden) and kinetic data (Out-front, AZ, USA) were collected from eight National Wheelchair Basketball (WCBB) Academy athletes. Participants completed two standard velocity trials (50% & 80% of

vmax), two maximal 5-push efforts and one 30 second maximal effort on a wheelchair ergometer (Keku Sports, Quebec, Canada) in wheelchair configurations that were greater than (high), less than (low), and the same (stock) as their current setup for each of CoG, DMP and WW (total of eight configurations). Performance metrics analyzed were: three push distance (3PD) and velocity (3PV) as well as 30 second distance covered (30SD) and peak velocity (PV). Joint loading metrics analyzed were bilateral kinetic loading rate (KLR) and peak shoulder adduction (SH-ADD) and flexion (SH-FLEX) moments.

Results: Group level effect size analyses found small increases in KLR with high and low CoG and DMP and a small decrease with high WW. Small increases in SH-ADD were found in the high DMP condition and small decreases with low DMP and CoG conditions. SH-FLEX showed a small increase with high DMP and a small decrease with high WW. Group level effect size analyses of performance metrics showed small increases in 3PD in high CoG and low DMP conditions and a small decrease in low CoG. 3PV, PV and 30SD all demonstrated small decreases in the low CoG condition.

Summary & Conclusion: Group level analyses indicated systematic differences in performance and joint loading metrics as a result of changes in wheelchair installation. These data will be used to inform chair installation for incoming wheelchair basketball athletes. Individual's responses to chair changes were interpreted on a case-by-case basis. These findings were used to determine the effectiveness of installation change on straight line pushing mechanics.

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88 Heart Rate Variability in Athletes of the Brazilian CP Football Team: A Pilot Study

NOGUEIRA,C.D; VIEIRA,I.B; CALEGARI,D.R; VITAL,R; CAMPEÃO,M.S; GORLA,J.I

UCB – Castelo Branco University – Rio de Janeiro; CPB – Brazilian Paralympic Committee – Brasília; UEM – State University of Maringá – Paraná; UFRRJ – Federal Rural University of Rio de Janeiro – Rio de Janeiro; ANDE – National Association of Sport for the Disabled – Rio de Janeiro; UNICAMP – State University of Campinas – São Paulo

Introduction: CP Football is an acyclic sport characterized by intermittent efforts with short recovery intervals between actions, intercalating high and low intensity efforts. Physiological adaptations have also been monitored through autonomic nervous system responses, analyzed from heart rate variability (HRV), which can provide useful information regarding changes in training status. Objective: To analyze the heart rate variability (HRV) profile in athletes of CP Football. Methodology: The study included 14 athletes of the Brazilian CP Football Team that won the bronze medal in Rio 2016. The HRV measurements were performed at rest in the supine position for ten minutes using the FIRTSBEAT model SPORTS Team 4.6 ®. The RR intervals of rest in the supine position were obtained during a training phase in two moments. Results: Mean RR of pre (991.78 ± 136.70) and post (909.55 ± 202.86); RMSSD pre (61.98 ± 37.09) and post (40.89 ±24.46); LF pre (1316.40 ± 1273.53) and post (851.60 ± 941.09); HF pre (1732.60 ± 2085.08) and post (773.40 ± 987.01) and pre LF / HF (773.40 ± 987.01) and post (2.23 ± 2.47). Conclusion: It can be concluded that HRV may be useful for monitoring the effects of football training on parasympathetic modulation. Heart rate variability analysis can provide a detailed state of cardiac autonomic behavior, being sensitive to periods of stress and recovery, and can help to understand when an athlete is under-recovered, or near to situations like overtraining.

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 # 89 Intimal Carotid Thickness and Body Fat Percentage in Athletes of the Brazilian Boccia Paralympic Team: A Pilot Study

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Introduction: Boccia Paralympic is a sport designed for athletes with a severe degree of physical disability, which implies greater exposure to secondary health conditions, such as gradual and harmful increase of fat percentage. Sports practice is considered as one of the greatest preventive and mitigating factors for these conditions. Objective: To investigate the percentage of body fat and the carotid arteries of Boccia Paralympic athletes. Methodology: Nine (9) athletes participated in the study, six (6) males and three (3) females, all of them members of the Brazilian Boccia Paralympic Team. Body composition was estimated using the Dual Energy Radiological Absorciometry (Hologic QDR 4500A, software version 11.1: 3, Waltham, MA, USA). Ultrasonographic assessment of the carotid arteries was evaluated using a Vivid 3 Pro Doppler ultrasound device from General Electric equipped with a linear multi-frequency vascular transducer of 7 to 12MHz. Results: ECEMD male values (ECIMD = 0.525 + 0.04 mm and ECIME = 0.539 ± 0.03 mm) and female values (ECIMD = 0.5015 + 0.08 mm and ECIME =0.506 + 0.20 mm) were within the normal range established for individuals without physical disability and below the cut-off point for cardiovascular risk (0.82 mm). When associated with fat percentage values (male: 43.25% +10.54 and female 42.3% + 5.44), it can be seen that there is no significant correlation, which can be explained by the training practice Sports. Our values are slightly above the values presented by McPhee et al. (2015) who analyzed 14 individuals with cerebral palsy (ECIM 0,490 + 0,100 mm), however the study sample cited is heterogeneous and does not include athletes. This is the first study to present this analysis in athletes. Conclusion: We conclude that Boccia Paralympic athletes present thickness values of the mean carotid artery layer within the range considered normal.

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 # 91 STANDARISED ATHLETIC PERFORMANCE TESTING AND SPORT-SPECIFIC ASSESSMENT IN PARA-TAEKWONDO: APPLICATION TO CLASSIFICATION AND EVALUATING ATHLETE MIS-REPRESENTATION

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INTRODUCTION: Taekwondo is a dynamic martial art that recently gained official sport recognition for the 2020 Paralympic Games. Important performance characteristics include speed, agility, explosive power, and dynamic balance. A number of

standardised athletic performance tests are commonly used in various sports for baseline and progress assessment, however the relationship of these tests has not been determined in taekwondo. Also, taekwondo-specific fitness assessment and its application to Paralympic classification has not been examined.

PURPOSE: We aimed to gain a better understanding of the application of standardised athletic testing to taekwondo classification and explored the role of newly developed taekwondo-specific fitness testing in technical assessment. We further present the application of one standard balance test and a taekwondo technical test used to assist classifiers in identifying athletes who may misrepresent their physical impairments that affect full-contact taekwondo sparring.

Methods: Sixteen Para Taekwondo athletes (10 males, 6 females) were recruited from 3 countries (Russia, Turkey, and France). After warm-up, all athletes performed standardised tests, such as the standing long jump, hexagon test, and non-standardised taekwondo specific tests (in-place front kick drill, and the pro-TKD test).

Results: Mean results for the long jump, hexagon, on the spot kicking, and pro-TKD test for the males were 214.9+20 cm, 13.5+1.6 s, 108.1 + 9.2 kicks, 24 + 8.6 kicks and the females were 140.5 + 21.3 cm, 16.1+1.9 s, 98.3 + 11.7 kicks, 15.8 + 8 kicks, respectively.

Conclusions: Meaningful differences were observed for the standing long jump between collegiate aged male athletes (2.34 + 0.59 m) (Beekhuizen et al., 2009) and our male Para Taekwondo participants (d=0.45) as well as collegiate aged female athletes (1.74 + 0.59 m) and our female Para Taekwondo participants (d=0.76). A meaningful difference (d=1.08) was also observed in comparison to combined male and female hexagon agility test times between our study participants (14.5 +2.1 s) and college students (12.46 + 1.62 s) (Peterson et al., 2006). Currently no normative data exist for comparison of the taekwondo-specific fitness tests.

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94 Relationship between throwing distance and performance of Boccia players with cerebral palsy.

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Background: In sports for severely disabled persons such as with cerebral palsy, there was very little study to focus on improvement for the competition ability. Especially, there are no studies on boccia to clarify the method of training.

Objective: To clarify the relationship between the throw distances and competition performance of boccia athletes in order to establish the training program based on the evidence.

Design: A cross-sectional study. Forty athletes, classified BC1, BC2 class who competed in the 15th Japan Boccia Championships and are certified athletes for Japan Boccia Association participated in this study.

Methods: Participants threw the boccia ball three times as far as possible. The means of their throwing distance were compared with the athletes that participated in final (Group I; 17 persons) and lost in the preliminary round (Group II; 23 persons).

Results: The means of their throwing distance were compared with the athletes that participated in final (Group I; 17 persons) and lost in the preliminary round (Group II; 23 persons). The means of throwing distance were 12.46 ± 4.96 m (Group I) and 7.47 ± 2.32 m (Group II) respectively, and significant difference was observed between the two groups ($p < 0.005$).

Conclusion: Boccia is a target sport, and throwing far requires more effort for the athletes than when throwing at a short distance. The results of this study suggested that the long distance throwing training is effective to improve the competition performance of boccia athletes.

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96 Reviewing Long Term Athlete Development for Parasport Athletes: Considerations and Future Directions

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Introduction: Long Term Athlete Development (LTAD) is a Canadian sport policy pertaining to athlete development and sport participation pathways across the lifespan (Balyi et al., 2005). The adoption of LTAD as a sport policy has lead to provincial and national sport organizations needing to adopt variations of the LTAD model for their sport in order to qualify for government funding and support. LTAD consists of seven states that proposes individuals progress through in the development process. These stages are 1) Active Start, 2) Fundamentals, 3) Learn to Train, 4) Train to Train, 5) Train to Compete, 6) Train to Win, 7) Active for Life. The LTAD was developed with the primary consideration of able bodied athletes and thus on able bodied sport assumptions. The LTAD is proposed to be also appropriate for parasport with the addition of two additional stages early in the process: 1) Awareness and 2) First Contact/Involvement). Balyi et al. 2013 suggest that athletes with either congenital or acquired disabilities progress through the same stages as their able-bodied counterparts…however acknowledge that things are a bit more complex for people with acquired disabilities. Considering these statements, little empirical or practical investigation has occurred pertaining to whether the LTAD is appropriate and applicable for parasport, and parasport athletes.
Purpose: The purpose was to provide an overview of the current literature that currently exists pertaining to the LTAD for either able bodied or parasport athletes. The LTAD takes in to account physiological, psychological, and environmental factors that influence the effectiveness of the execution and implementation of the LTAD in sport settings.
Methodology: A series of studies were compiled and reviewed for specific outcomes pertaining to the LTAD; These factors include: Physiological, psychological, environmental, and coaching.
Findings and Discussion: Current empirical literature assessing any aspects of LTAD is limited in general for able bodied athletes, let alone parasport athletes. Ford et al. (2011) highlights some of the limitations of the LTAD model which include the fact it is unidimensional, there is a lack of empirical evidence on which the model is based upon, and interpretations of the model are restricted due to the data used relying on “questionable assumptions and erroneous methodologies” (p.389). From a physiological perspective, Ford et al. stresses that the LTAD model should be viewed as a “work in progress and caution is urged to ensure the model does not become to enshrined as fact” (p. 390). As such, the authors encourage scientists to continue to question, test, and revise, the model and practitioners should not be deterred from gathering valid and reliable evidence. Long Term Athlete Development on the surface seems well-intended and a plausible theory for athlete development. However good science mandates that theories be tested, validated, and confirmed. The LTAD although well intended, has yet to be systematically and rigorously tested through empirical research protocols as a valid theory for parasport athlete development.

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98 The Paralympic World Powers: an analysis of the medals claimed at Rio 2016 Paralympic Games

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Rio 2016 Paralympic Games (PG) was the fifteenth edition and only the United States, Great Britain, Germany, Australia, France, the Netherlands and Italy took part in all editions, allowing them to be classified as Traditional World Powers in Paralympic sports. However, emerging nations such as China, Poland, Ukraine, Russia and Brazil have been demonstrating their strength and started to positioning themselves among the top ten in the overall medal table. Due to this fact, these nations are now considered as Emerging World Powers.

This study aims to describe the distribution of the medals won by the traditional and emerging world powers in the Rio 2016 Paralympic Games, as well as to show the sports that directly influenced the distribution of these medals.

The research presents descriptive methods. Data collection was performed by searching primary sources of dissemination from the International Paralympic Committee and Rio 2016 website.

Due to the high number of events in sports such as Athletics, Swimming, Cycling, Table Tennis, Powerlifting and Wheelchair Fencing, many countries commonly select them as target sports for setting up the strategies for the Paralympic cycle, in order to achieve better positions in the final medal table. China is the world biggest power and its strategy was focused on individual events in sports such as Athletics, Shooting, Swimming, Table Tennis and Wheelchair Fencing. Great Britain's strategy focused on eleven sports. However, the main challenge for Great Britain was ensure the continuity of the good practices planned and executed in London 2012. This strategy guaranteed to Great Britain an increase of gold medals from 34 in 2012 to 64 medals in Rio. Another example is Ukraine, which showed its strength in 7-a-side Football and in other nine sports, however, it is arguable that part of Ukraine success is to some extent, due to the Russian absence, thus guaranteeing a transfer of some medals won by Russia in 2012. Regarding team sports, the United States showed hegemony in Sitting Volleyball and Wheelchair Basketball. Australia claimed its medals in eight sports, highlighting Sailing and Wheelchair Rugby. On the other hand, Germany has set up its strategy on sports as Cycling, Athletics and Triathlon, advancing two positions in the medal table. The Netherlands choose to focus their results in seven sports, especially in Wheelchair Tennis. Hence, the participation of the host country was an interesting case. Despite the increasing number of medals won in total, from 43 in London 2012 to 72 in Rio 2016, as well as the increase number of finals disputed and the diversification of sports that won medals, the number of gold medals decreased. Brazil's gold medals were concentrated in sports such as Athletics, Swimming and Football 5-a-side, taking the 8th place in the final medal tally. The results of this study also showed that based on the 22 sports that took part in the Rio 2016 PG, only 23% were not dominated by these World Powers.

The case of Rio 2016 PG should serve as a support for other nations that seek to increase elite sports performance through a thoughtfully strategic planning aiming better performances to the next Paralympic cycle, taking a sport-specific approach.

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102 Representative test design and individual analysis in wheelchair rugby

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Research in biomechanics and motor learning suggests traditional group analyses appear to be masking important and meaningful individual differences (Schöllhorn et al., 2009). These differences are likely to be magnified in Paralympic populations, and there is a need for individualised approaches in applied settings (Pinder et al., 2015). Due to the restrictions in the peer-review process, where statistical power often outweighs individual assessments, much of the available research in disability sport has minimal practical application (cf. Churton & Keogh, 2013; Paulson & Goosey-Tolfrey, 2016). For example, common testing protocols focus on an individual's physiological adaptation; however, often these constrain athlete behaviour, resulting in performance that is not representative of game-play. Here, we use wheelchair rugby (WCR) as a task vehicle to demonstrate the importance of representative testing and individualised approaches to assessment. The main aim for players in WCR is to avoid opposition blocks and carry a ball over a line to score; hence acceleration from standstill is crucial to performance (Mason et al., 2010). A large sample of experienced elite WCR players (n=24) completed a series of 5m sprints in two conditions: i) a self-paced start (a typical sprint testing protocol), and ii) a reactive start including a turn on the spot to simulate a key aspect of game-play. Video analysis was used to measure key kinematic and performance variables with a focus on the first three strokes. Additionally, accelerometers (x8m-3mini, Gulf Data Concepts, USA) were secured to the frame to monitor peak accelerations. Preliminary results demonstrate that small changes to task design can result in significant changes in kinematic and performance variables. For example, peak accelerations in the reactive start were significantly higher than in the self-paced start for the mid-point players' second strokes (0.55g compared with 0.48g, $p<.01$, $d=1.86$) and third strokes (0.57g compared with 0.51g, $p<.05$, $d=0.93$). This difference of +0.05g (averaged across the first three strokes) corresponds to traveling an extra 0.25m, a change in performance that could be the difference in making or escaping a block. No differences in peak acceleration were evident for the high- or low-point groups; crucially, however, this analysis masks individual differences. For example, an experienced low- point player displayed large increases (80-158%) in peak acceleration across all strokes during the self-paced test. This finding is likely due to the development of a propulsion approach that maximizes their performance when accelerating from standstill in self-paced (testing) situations, with this athlete's results in the reactive test comparable with other low point players. Findings demonstrate the importance of careful test design for capturing representative performance data for research, classification, and performance enhancement in Paralympic sport. Implications of this and similar research will be discussed, along with a call for changes to current peer-review expectations, or development of new outlets for applied research on elite athletes with disabilities.

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104 Why spiritual health is a necessity for para-athletes?

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Each person has a spiritual dimension that motivates, energizes, and influences every aspect of her/his life. Spiritual well- being is the ability to find meaning, value, and purpose. People with strong spiritual beliefs seem to resolve their grief more rapidly and completely after experiences of pain and suffering. It also may help boost immune system functioning, facilitate healing and recovery, and prevent infection after surgery. Individuals with life-threatening or chronic health conditions can benefit greatly from spirituality practices. As para-athletes encounter with difficult conditions especially while experiences of pain and suffering, it seems to pay more attention to their spirituality be able to promote their health physically, mentally and emotionally.

This article offers some guidelines for effective assessment, planning and implementation. Numerous guides, instruments, and scales are used to assess spirituality and religious beliefs, practices, and levels of participation. Examples of elements that could be included, will discuss in this article.

Once the assessment has been completed, the information gained can be used to formulate an effective plan for spiritual health promotion. Following a spiritual assessment a plan for promoting spiritual care will be developed. Interventions can include some actions which discuss in this article.

The most obvious way to measure the effectiveness of spiritual intervention is to ask the client directly and carefully observe her/his physical, verbal and nonverbal cues.

Spirituality is an important dimension of well-being for para-athletes which should be paid more attention.

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105 Developing evidence-based classification for swimmers with vision impairment

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Background: A panel of experts across all VI sports recently expressed a strong desire to improve the way that vision impairment (VI) is classified1. The panel agreed that VI classification currently does not fulfil the aim of classification, which is to minimise the impact of eligible impairments on the outcome of competition”1,2. For a sport-specific classification system to fulfill this aim, the relationship between impairment and performance needs to be known for that specific sport. In para-swimming, eligible VI athletes are placed into one of three classes depending on whether they have low (S13), moderate (S12), or severe (S11) vision impairment. These classes were created on the basis of the World Health Organisation criteria for low vision and blindness, and therefore it remains unknown how suitable the classes are for the purposes of swimming, and in particular how increasing levels of vision impairment impact swimming performance. Purpose: The aim of this project was to investigate the relationship between vision impairment and swimming performance. Methods: This project consisted of two

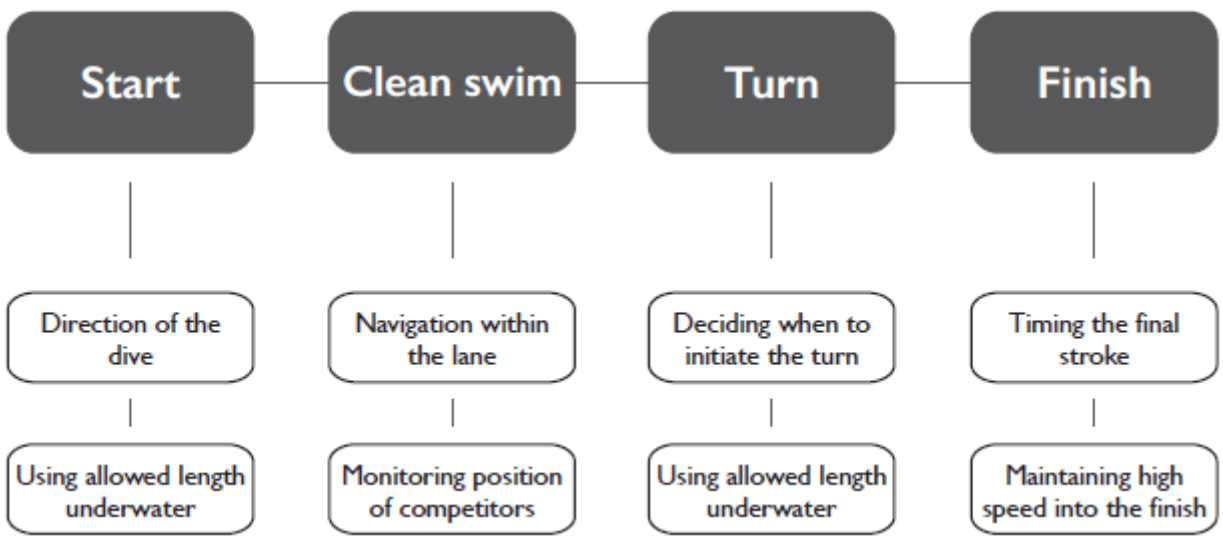
studies, a Delphi study to help guide the design of the subsequent experimental study. Delphi study: We consulted a panel of VI swimmers, coaches, and administrators to gather their insights about (1) the aspects of visual function they believed impact swimming performance, and (2) the components of a swimming race that would be impacted by the presence of vision impairment. Experimental study: Elite-level VI swimmers competing in the 100-metre freestyle were invited to participate. They were tested on a newly developed vision-test battery which evaluated aspects of vision the expert panel felt were most important for swimming performance. The vision test results were then compared to particular elements of the swimmers' performance at a major international competition. Results: The expert consultation revealed that in addition to the two aspects of visual function that are currently used for classification (visual acuity and visual field), impairments to depth perception, light sensitivity, contrast sensitivity, and motion perception are most likely to impact swimming performance (Figure 1A). The panel agreed that the timing of the turn and the ability to navigate within the lane (Figure 1B) were the aspects of a swimming race most likely to be affected by vision impairment. Results from the experimental study show a significant relationship between impairments in (i) contrast sensitivity, (ii) depth perception, and (iii) motion perception and overall swimming performance in the 100-metre freestyle. Conclusion: New tests of visual function (e.g., depth perception, contrast sensitivity, and motion perception) are likely to be necessary to better account for the impact of vision impairment on swimming performance. The results will guide the potential inclusion of these tests into a new sport-specific system of classification in swimming.

Figure 1. Findings from the Delphi study. A. Aspects of vision that the expert panel felt were important enough for inclusion in a future classification system. B. Elements of a swimming race affected by vision impairment.

A

Aspects of visual function	Important enough to include	Not important enough to include
Depth perception	***92 %***	***8 %***
Light sensitivity	***71 %***	***29 %***
Contrast sensitivity	***67 %***	***33 %***
Motion perception	***67 %***	***33 %***
Dynamic visual acuity	58 %	42 %
Ocular stability	50 %	50 %
Ocular coordination	44 %	56 %
Aspects of visual function	42 %	58 %

B



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107 EFFECT OF MANDIBLE POSITION IN DIRECTION AND FORCE OF BALL THROWING IN PARALYMPIC BOCCIA

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Introduction: The Paralympic Boccia is a game of strategy for people with cerebral palsy or with severe locomotor dysfunction who use wheelchairs. The position of the player, especially the positioning of the head and teeth has been studied because they affect the movement of the cervical spine. Dental occlusion is the contact of the upper and lower teeth at the closing of the mouth. The centric relation is the relation of the condyle of the mandible in the temporal bone provided by the balance between the muscles of the face. The use of a device to reposition the mandible in centric relation promotes neuromuscular deprogramming, which can alter the posture of the head and influence the movement of upper limbs. Objective: To evaluate the influence of mandibular repositioning in centric relation in direction and force of ball throwing by athletes of the BC1 and BC2 classes of the Paralympic boccia. Methodology: Occlusion evaluation was performed in athletes (n=3) and to reposition the mandible in centric relation was made a intraoral device in acrylic resin. For the evaluation of the ball throwing, the white ball was positioned 4m and 8m away from the athlete. Ten throws were made with a soft ball at each distance and the measurements were collected. The direction was measured with a manual scale and the force was measured with a calibrated laser scale. The intraoral device was placed between the teeth and the throws were performed again at the same distances. Student T Test ($\alpha = 0.05$) was used to evaluate the results. Results: In the evaluation of the occlusion, all athletes presented malocclusion with a difference between the maximum intercuspation and the centric relation, but without painful symptoms. No statistical difference was found in the direction and force of ball throwing under the conditions evaluated (P>.05). Final Considerations: The use of the intraoral device for mandibular repositioning did not interfere in the direction and force of ball throwing by athletes of classes BC1 and BC2 of the Paralympic boccia. The increase of the sample and the use of intraoral myorelaxant occlusal splint to stabilize the mandible associated with changes in posture may improve the performance in the ball throwing of athletes of the Paralympic boccia.

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112 Determining Cut-off Score for Functional Testing in Para-Badminton Lower Limb Impairment Sport Class

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Introduction: Para-badminton is one of the exciting new sports in the upcoming Tokyo Paralympic 2020. There are 2 wheelchair classes (WH1 and WH2), 2 standing with lower limb impairment classes (SL3 and SL4), 1 standing with upper limb impairment class (SU5) and 1 short stature class (SS6).

Objective: This study aimed to determine the cut-off score of the functional test that differentiates the SL3 and SL4 classes.

Methods:

Eighteen (18) internationally ranked athletes with confirmed status were selected to participate in this study. They were 8 from SL3 class and 10 from SL4 class. Each of them had to perform the important movements in badminton; forward forehand, forward backhand, backward forehand, backward backhand, side stepping, jumping, forward and backward run. Likert scale (1 – 5) scoring was given to each movement and the total score calculated. The score was described in median (IQR) and Mann-Whitney test used to compare between the sports classes. We used ROC analysis together with Youden's index to determine the cut-off score.

Results:

The median age of the athletes was 32.0(IQR: 24.0 - 40.0). The impairments of the athletes include impaired muscle power, Impaired passive range of movement, limb deficiency, leg length difference and cerebral palsy. Total movement score (26.0[IQR: 26.0 - 27.5]) for SL3 was significantly lower than SL4 (39.5 [IQR: 37.0 -43.0]). The AUC of the total score was 99.4% (95%CI: 96.9% - 100%). A cut-off score of 34 and above is taken as class SL4.

Conclusion:

The scoring of badminton movements i.e. functional classification can be used in additional to the physical examination in determining the sports classes in the lower limb impairment for para-badminton.

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115 THE PROFILE OF SCIENTIFIC PRODUCTION ON PARALYMPIC SPORT

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The goal of this paper is to present the main results of a research that had as a goal to investigate the profile of the scientific production on Paralympic sport, contrasting the Brazilian production with the world production, having as a source the Scopus databases. The research considered the articles published by the end of December 2016. It had as descriptors the official name of the sport disciplines of the Sochi Games (2014) and Rio (2016). The search considered only the title, abstract or keywords of the articles. We have used both Boolean and proximity operators to facilitate the search. We have also used the term "Paralympic" alone and associated to the he name of the Paralympic disciplines to identify sports that have equivalent names in conventional sports. The databases identified 1123 articles. Brazil ranks fifth in terms of production (81 articles), behind Australia (99), Canada (121), United States (201) and United Kingdom (310). The world's most productive institutions are

Loughborough University (62), KU Leuven (23) and University of the Sunshine Coast (23). Two Brazilian Universities are in the top eight most productive institutions in the world: Universidade Estadual de Campinas (21) and Universidade Federal de São Paulo (19) . The first article indexed in the Scopus databases was published in 1967 and the first article by Brazilians was issued in 1997. The world production on Paralympic sport has been growing since then, taking a significant leap in 2007 and 2009, with some oscillations upwards and down from then on. In the case of the production of Brazilians, it had a significant growth starting in 2009. The sports with most production are: Wheelchair Basketball (29%), Athletics (20%) and Wheelchair Rugby (11%) and Swimming (8%). Fifty two percent of the articles do not refer directly to any sport discipline in their titles, abstracts or keywords, which indicates that they probably did not focus on any sport in particular. The production of Brazilians is concentrated in Athletics (24%), Wheelchair basketball (20%), Wheelchair rugby (12%), and Swimming (12%) (some articles discus more than one discipline). While some modalities have a considerable number of articles, others have close to nothing. Examples of this are Shooting and Triathlon that count with only two articles each. Brazil stands out in the production of articles on judo and football 5-a-side. In the first case, from the four existing articles, three have Brazilians as authors. In the second case, from the nine existing articles, seven are by Brazilians. In terms of area of knowledge, most articles by world researchers (54%) and by Brazilians (68%) concentrate in medicine and health professions. Articles with a focus on social sciences appear only in 13% of the world production and in 11% of the production of Brazilians. This study reveals that Brazil has an important role in production of knowledge on Paralympic sports. It also indicates a need for a more balanced production on different sports and a more diverse base on different areas of knowledge so that this production can thoroughly contemplate the diversity and complexity involved in Paralympic sport.

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 # 117 Wayfinding and Assistive Technologies that support Paralympic Athletes and the Paralympic Community and Games Attendees informed by Universal Design

Sally Swanson

Sally Swanson Architects, Inc.

Sally Swanson, Principal, Sally Swanson Architects, Inc. (SSA) provides a framework for approaching transit-oriented and Olympic/Paralympic sports venues/town/village wayfinding through real-life case study examples and best practices. Without successful wayfinding, athletes are impeded from performing at their best. Lacking an accessible path-of-travel proves exhausting and confusing for any user having difficulty navigating the path of travel. Rio, in particular, with its cobblestone streets and lack of wayfinding at venues presented a challenge.

With simple, straightforward examples in which Universal Design (UD) informed wayfinding solutions and created environments that are enjoyable, easy to use, and accessible regardless of disability, SSA will introduce guidelines for design of transit stations & Olympic/Paralympic sports venues/town/village to enhance the user experience through implementation of applicable UD Principles. SSA wrote Transit UD Guidelines for the American Public Transportation Association to identify challenges that people with sensory and/or mobility impairments experience when traveling to, riding and getting from transit; illustrates how assistive technologies create solutions for an Olympic/Paralympic community of athletes, para-athletes, and Games attendees'

mobility challenges; and, offers case studies of (a) Olympic/Paralympic implementation of UD standards, and, (b.) TransLink, Metro Vancouver for which SSA developed UD Accessibility Guidelines (UDAG). The Guidelines follow UD principles and contain scoping and technical requirements for accessibility to site, facilities, and buildings with particular emphasis on providing full and equal access to riders with disabilities.

SSA also reports on findings from the Rio 2016 Paralympics looking at the Rio Metro, how it was designed with persons with disabilities in mind, supported attendance at the Paralympic Games, and ways in which wayfinding and assistive technology was integrated into the transit system design.

For 2018 PyeongChang, South Korea Olympic/Paralympic Village, SSA created UD standards for town/village circulation and construction, helping to achieve innovative barrier-free housing and athletic spaces to ensure that an accessible path of travel is fully realized.

Ms. Swanson was on the planning/design team commissioned to prepare Russia's IOC bid to host the 2014 Sochi Winter Games, which meaningfully advanced the cause of barrier-free design.

As a Paralympic reporter, sponsored by the Disability Rights Education and Defense Fund (DREDF) and approved by the IOC, SSA has witnessed and recorded the success stories from Paralympic events including Beijing 2008, Vancouver 2010, London 2012, Sochi 2014, and Rio 2016.

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Exploring Perceptions of Sport Professionals with a Physical Disability: A Stereotype Content Analysis

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Introduction: Stereotypes help us interpret the world and influence how we feel and act towards social groups. The overgeneralizations and misjudgments fuelled by negative stereotypes may pose significant social barriers, however, positive stereotypes can mitigate the effects of negative stereotypes and improve self-concept. Able-bodied athletes and professionals are generally stereotyped differently than people with a physical disability (i.e., higher competence, but lower warmth; Arbour, Latimer, Ginis, & Jung, 2007), but little is known about how sport professionals with a physical disability (specifically, Paralympians) are stereotyped and the reactions elicited from such perceptions. Therefore, this study examines whether Paralympians are perceived differently than other athlete groups.

Methods: In the Stereotype Content Model (SCM), stereotype content is comprised of two primary dimensions, competence and warmth (Fiske, Cuddy, & Glick, 2002). Varying combinations of competence and warmth elicit a predictable set of feelings about the stereotyped group. Using standard SCM protocol, 302 able- bodied Canadian adults rated their beliefs regarding how four athlete groups (i.e., Olympians, Paralympians, recreational athletes, and recreational athletes with a physical disability) are perceived by others and the emotional reactions they elicit.

Measures: SCM constructs, were assessed with sub-measures rated on 5-point scales: a) Stereotypes: competence, warmth, and b) Feelings: contempt, admiration, pity, envy. Multivariate analyses of variance (MANOVA) and Bonferroni post-hocs were conducted to examine differences between athlete groups.

Results: The MANOVA for stereotypes was significant, $F(6,2274) = 44.67$, $p < .001$. Paralympians were rated significantly higher on competence than recreational athletes with a physical disability ($p = .003$) and significantly higher on warmth than both able-bodied groups ($p < .001$). The MANOVA for affective reactions was also significant, $F(12,2624) = 86.37$, $p < .001$. Paralympians

were rated significantly higher on admiration than both non-professional groups; however, they scored higher on pity and lower on envy than both able-bodied groups ($p < .001$).

Discussion: Paralympians were perceived as competent and warm, and elicited feelings of admiration. These findings highlight how stereotypes regarding Paralympians overlap with positive dimensions typically associated with physical disability (high warmth) and professional (high competence) stereotypes. Unfortunately, despite being perceived positively and eliciting some positive affective reactions, the Paralympian stereotype also elicited more pity and less envy than able-bodied groups. This suggests that able-bodied people may be more inclined to draw from physical disability stereotypes in forming impressions about sport professionals with a physical disability. These findings call for future research in determining what factors may influence the Paralympian stereotype (e.g., advertisement content) and further challenges para-sport promoters to explore how SCM scores may become equalized between athlete types.

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121 Psychological and social problems in initiation and development stage of career development among elite Japanese para-athletes

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The study of athletes' career development is a topic of considerable growth in psychological research. However, the majority of such studies investigate samples of athletes without disabilities. Research on elite para-athletes is a largely neglected topic. As Stambulova et al. (2009) mentioned, sports systems and culture are key factors behind sport career development and transition. However, the effects of macrosocial factors in Japan on sport career development and transition of para-athletes is unclear. Therefore, the main purpose of this study was to examine the psychological and social challenges in sport career development for elite Japanese para-athletes, from the perspective of the present situation in the country. We used a qualitative design to explore psychological and social problems in the initiation and development stage of sport career development in para-athletes. We conducted semi-structured interviews with seven male and seven female elite para-athletes. The collected data were analyzed using the KJ method (affinity diagram), focusing on problems the participants experienced and how they coped with them during the initiation and development stage. We identified four diagrams the participants drew upon to construct their career stories in this stage: initiation for children with disability, development of athletic identity, change of sense of values, and development of athletic identity after onset of disability. Some participants suggested it is crucial to provide children with disabilities with the opportunity to recognize their abilities through sports experiences in the early stages of their sport career development. However, some participants noted many problems exist in the present situation in Japan; for example, there too few opportunities to provide young individuals with disabilities with a range of sports they can take part in, and with the appropriate equipment. Para-athletes with acquired disabilities experienced difficulty accepting their situations after loss because information in Japan on how they could live independently with disabilities was insufficient. Furthermore, the presence of sports careers before onset of a disability impeded development of appropriate athletic identity, because such athletes found it easy to win using the skills they had already acquired and tended to estimate para-sports as not being at a high level. Identification of problems para-athletes experienced during their sport career development would provide a foundation from which to create a support system in Japan for elite para-athletes that includes assistance with this development.

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Table 1. Relationship between IQ level and Physical Fitness in men and women

		Flexibility	*Balance*	*muscle endurance*	*Long jump*	*Vertical jump*	*Plate Taping*	*Hand grip*	*25-m dash*	*VO2max*
Women	*Correlation*	*0.001*	*0.228*	*0.110*	*0.218*	*0.152*	*-0.245*	*0.180*	*-0.183*	*0.243*
	Sig.	*0.997*	**0.001*	*0.125*	**0.003*	**0.035*	**0.001*	**0.012*	**0.015*	**0.002*
	N	*195*	*195*	*195*	*189*	*194*	*195*	*193*	*176*	*155*
Men	*Correlation*	*0.171*	*0.140*	*0.186*	*0.270*	*0.324*	*-0.273*	*0.297*	*-0.239*	*0.273*
	Sig.	**0.031*	*0.079*	**0.023*	**0.001*	**0.001*	**0.001*	**0.001*	**0.003*	**0.002*
	N	*159*	*159*	*149*	*157*	*160*	*160*	*159*	*155*	*173*
Total	*Correlation*	*0.082*	*0.188*	*0.145*	*0.250*	*0.242*	*-0.259*	*0.209*	*-0.205*	*0.233*
	Sig.	*0.124*	**0.001*	**0.007*	**0.001*	**0.001*	**0.001*	**0.001*	**0.001*	**0.001*
	N	*354*	*354*	*344*	*346*	*354*	*355*	*352*	*331*	*328*

*$p < 0.05$,

127 The effect of Classification on Wheelchair Mobility Performance in Wheelchair Basketball

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In adapted sports, there is an ongoing quest to attain regulations for fair competition given the heterogeneous group of athletes. In wheelchair basketball, a single competition is achieved by classifying athletes based on their impairment and its expected effect on match play. But are the eight classes (1 – 4.5) in the current classification system still necessary? Although game performance is clearly affected by classification level, other factors like field position are known to interact on that relationship (Vanlandewijck et al., 2004). Solely regarding the wheelchair mobility aspect of performance, this abstract describes the effect of classification on performance in an unconstrained field test versus match play.

Using inertial sensors (Figure 1), the wheelchair mobility performance of 47 athletes was measured in a standardized field test representing all important aspects of a wheelchair basketball match (de Witte et al., 2017). The performance outcomes measured were 1) avg. forward speed; 2) best forward speed; 3) avg. forward acceleration in the first 2m; 4) avg. rotational speed in a curve; 5) best rotational speed in a turn; 6) avg. rotational acceleration; These field test outcomes were compared to the measurements of 29 wheelchair basketball athletes during actual basketball match play. When grouped by classification (low-mid-high), groups showed significant ($p<0.05$) differences in 5 performance outcomes in the field test and all 6 in the match. Post ANOVA tests revealed that in the field test 5 wheelchair mobility performance outcomes differed significantly ($p<0.05$) between low and mid classified athletes and no outcomes differed between mid and high classified athletes. These differences clearly show in the wheelchair mobility performance plots displayed in Figure 2 (right). In the match measurements 3 out of 6 outcomes differed significantly between low and mid classified athletes. Differences between adjacent classes are less prominent, with a more even rise in performance with increase in classification (Figure 2, left).

There is a clear difference in performance patterns between unconstrained field test and match play, likely related to match specific factors, field position in particular. If wheelchair mobility performance is regarded as one of the most important factors in the wheelchair basketball match, results of this study could be enforced to argue for a reduced number of classifications, typically with a separation between the current low class (1-1.5) athletes and the rest. This type of class division is in line with the conclusion of Vanlandewijck et al. (1995) pinpointing the viability of a reduction in the number of classes. If match

wheelchair mobility performance is regarded, differences between classifications are subtler, but it is unclear if this is an effect of physical capacity or an effect of typical match requirements as determined by field position. Bearing in mind that match performance does not equal best performance, the field test used in this research seems a valuable tool for accurate estimation of best wheelchair mobility performance levels.

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 # 129 The impact of lower limb impairment on RaceRunning athletes' ability to accelerate and run at speed during the 100 m sprint.

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RaceRunning athletes use a running bike to propel themselves forward using a variety of techniques. The design of the running bike enables athletes with impaired balance to race. RaceRunning is particularly popular amongst athletes with Cerebral Palsy (CP) and related conditions. CPISRA aims to develop RaceRunning for inclusion as a para-athletics event. This study analyses the association between impairment measures and two aspects of RaceRunning performance: the start and the ability to run at speed.

Twenty three athletes (18 with CP, 2 with TBI/brain tumour, 3 unknown; age 26 (10) years; GMFCS II-V) from all current CPISRA classes with at least one year experience in RaceRunning took part. A neuro-paediatric physiotherapist and IPC athletics national classifier assessed manual lower limb muscle strength (MMT), selective voluntary motor control (SCALE), spasticity (ASAS and MAS), passive extension (PE) of the hip and knee, functional step length on a stationary RaceRunning bike, 4 items related to balance and gait from the Gross Motor Function Measure (GMFM) and functional mobility (FMS for 5, 50 and 500m).

Sport-specific performance measures were obtained by video analysis (120 frames per second) of the 100m sprints during the 3rd CPISRA Open European Championships and 20th International RaceRunning Cup. Average speed over the first 10

metres (starting speed) was calculated as well as the speed on a section further along the 100m track (37-40m; running speed). Spearman's and Pearson's correlation between impairment and performance measures were calculated. Correlations with $p<0.05$ (one-tailed) were regarded as statistically significant.

RaceRunning athletes covered the first 10m in 4.6s (1.1). Average speed over the first 10m was significantly correlated with MMT (rho=.55), SCALE (rho=.46), MAS (rho=-.54), ASAS (rho=-.59), functional step length (r=.36), FMS5 (rho=.49), FMS50 (rho=.47) and FM500 (rho=.47). No significant correlations were found with hip and knee extension and the GMFM items.

When the athletes reached the 37-40m section, they had achieved a speed of 4.1 m/s (1.1). All athletes had reached their average race speed or higher at this point. Running speed at 37-40m was significantly correlated with MMT (rho=.54), SCALE (rho=0.40), MAS (rho=-.62), ASAS (rho=-.66), FMS5 (rho=.53), FMS50 (rho=.60), FMS500 (rho=.57), and the GMFM items (rho=.50). Hip (rho=.34) and knee extension (rho=.35) just failed to reach significance (p=0.06). No significant correlation was found with functional step length.

There was a strong correlation between the speed over the first 10m and the speed at 37-40m (r=.94), and both performance measures correlated strongly with the average speed over the entire race (0-10m r=.92; 37-40m r=.99).

These results show that spasticity, muscle strength impairment and selective control appear to be activity-limiting factors in the initial acceleration phase of a 100m sprint in RaceRunning athletes with CP and related conditions. The same factors limit performance during the subsequent phase of the race, with the level of spasticity showing a particularly strong relationship with the ability of the RaceRunning athletes to run at speed.

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134 Principle 6 of the Olympic Charter and the Inclusion of People with Disabilities

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Principle 6 of the Principles of Olympism in the Olympic Charter states that the "Olympic Charter shall be secured without discrimination of any kind, such as race, color, sex, sexual orientation, language, religion, political or other opinion, national or social origin, property, birth or other status " (IOC, 2016, p. 12). The reference to "or other status" can be interpreted as including people with disabilities involved in the Olympic Games as well as people involved with the Paralympic Games, Special Olympics and Deaflympics (Wolff, Legg, & Hums, 2016). Given the recent successful movement led by Athlete Ally (2014) to include sexual orientation in Principle 6, how then could the disability sport community and the general disability community move to initiate a call to establish a more specific reference to disability within Principle 6 of the Olympic Charter?

Recommendation 7 in the IOC's strategic initiative Agenda 2020 states a desire to "Strengthen relationships with organizations managing sport for people with different abilities" (IOC, 2014, p.

8). Formally including people with disabilities in the Olympic Charter would provide a specific example of strengthening relationships to reinforce and amplify the roles and contributions of people with disabilities within the Olympic Movement. Additionally the new IOC Sport and Active Society Commission has a mission that promotes "Using sport to improve physical activity in the population, giving access to sport as a right for all, and on engaging in sports activities with a special focus on youth" IOC, 2017, para. 1). This new Commission also embraces sport for all and opens the door for the inclusion of people with disabilities in sport and physical activity at all levels. The IPC has also released a position statement on human rights (2006).

Guided by the efforts and activities that have advanced inclusion in the areas of race, gender and sexual orientation within the Olympic Movement, this presentation will examine how and why people with and without disabilities can bring voice and action to promote disability inclusion in the realm of sport, specifically in the Olympic Charter and the Olympic Movement. If the Olympic Movement belongs to all, certainly one can make the case that includes people with disabilities (Wolff, Legg, & Hums, 2016). This change would affirm the premise of both Article 30.5 of the United Nations Convention on the Rights of Persons with Disabilities (2006) and the newly revised UNESCO Charter on Physical Education, Physical

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