

The BASES Expert Statement on Assessment of Exercise Performance in Athletes with a Spinal Cord Injury

Produced on behalf of the British Association of Sport and Exercise Sciences by Dr Vicky Goosey-Tolfrey FBASES, Dr Christof Leicht, Dr John Lenton, Nik Diaper and Dr Barry Mason.

Introduction

The evolution of Paralympic sport has led to greater integration of sports science support programmes between Paralympic and non-Paralympic sports. It is becoming increasingly common for practitioners and coaches to work with both Paralympic and non-disabled athletes. While this approach should be encouraged, it is imperative that such integration does not come at either the cost of specificity of support or the acquisition of specialist knowledge. This is particularly true for impairments where normal physiological function is affected, e.g., in spinal cord injury (SCI). The following statement therefore highlights key considerations in assessing athletes with SCI.

Spinal cord injury and its impact on exercise capacity

The level (i.e., location along the spine) and completeness (complete/incomplete) of a SCI defines remaining motor, sensory, and autonomic function. In a sporting context, the extent of this

remaining function determines the potential ability of an athlete and subsequent performance. Those with a motor complete tetraplegia only have partial voluntary control of their upper limbs, with severe impairments of the trunk. Those with a motor complete paraplegia have full control of their upper limbs, with the control of their trunk proportional to the level of lesion. As the innervation of respiratory muscles is impaired in those with high level paraplegia and tetraplegia, a reduced respiratory function is observed in these individuals (Janssen & Hopman, 2005). Furthermore, a loss of autonomic function occurs in those with lesions above the 6th thoracic vertebra (T6), resulting in a reduced maximum heart rate (HR). Lost autonomic function further causes a reduced ability to sweat that can further compromise thermoregulation and performance. It is worth mentioning that not all spinal cord injuries result in total loss of function below the level of lesion, and the whole spectrum between 'full function loss' and 'no function loss' can be observed in those with incomplete lesions (Bhambhani, 2002).

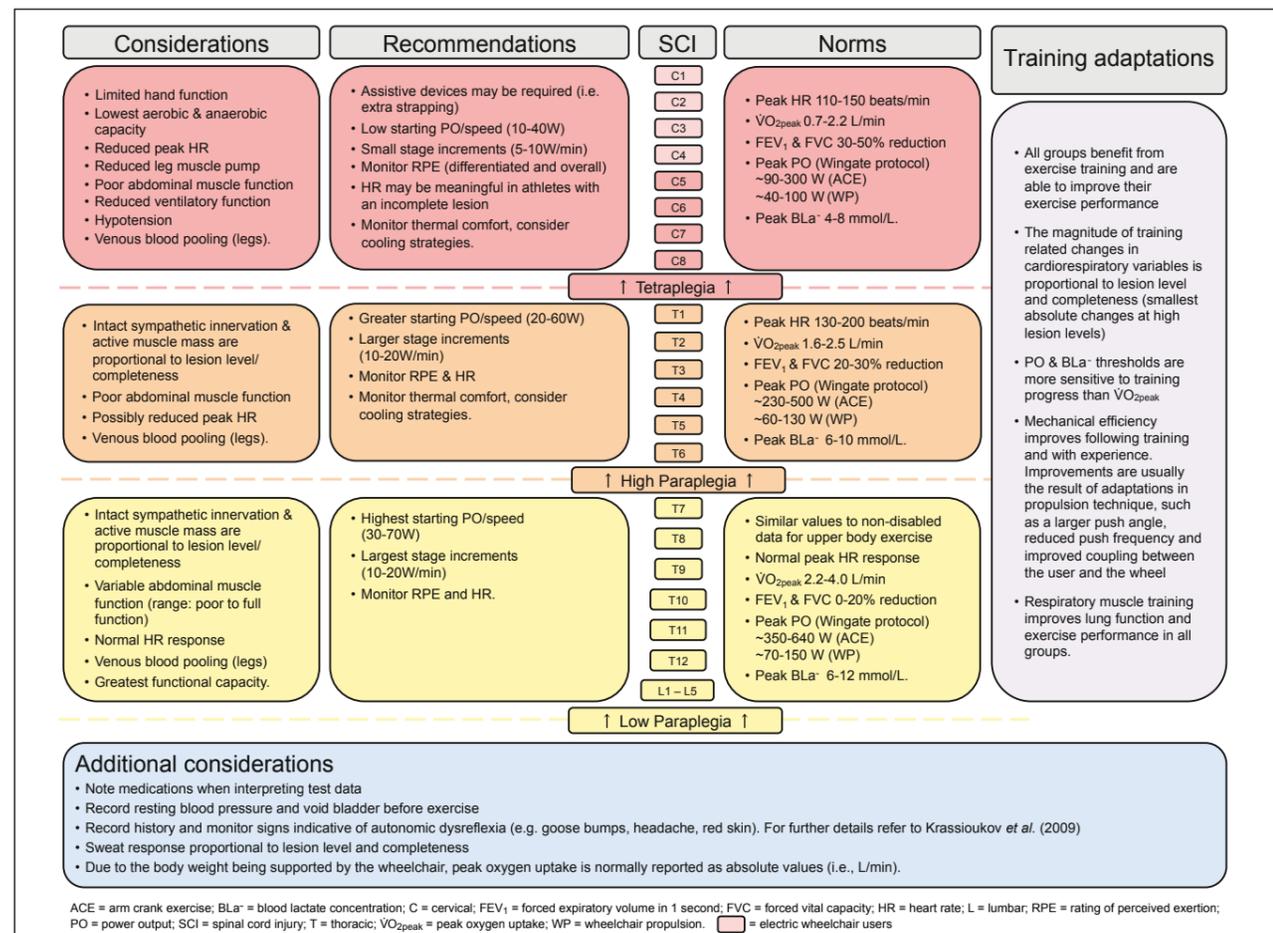


Figure 1. Assessing exercise performance in athletes with a SCI. Note: Data from athletes with complete lesions. Recommendations are for arm cranking graded exercise tests to exhaustion.

Guidance on exercise testing in wheelchair athletes

Assuming a similar training status and completeness of injury between athletes, the highest exercise capacity is found in those with low level paraplegia, followed by high level paraplegia, and tetraplegia (Goosey-Tolfrey & Leicht, 2013). As a result, physiological tests must be tailored to each individual athlete (see Figure 1). For example, the start load/speed and increments of a graded exercise test to exhaustion must be individually determined. This helps to keep test times within a given range and allows the collection of sufficient submaximal exercise data independent of injury level. Further, exercise modality impacts on certain parameters; arm crank ergometry for example is mechanically more efficient than wheelchair propulsion, therefore resulting in a higher power output (Bhambhani, 2002).

The athlete and his/her equipment

Performance in wheelchair sports is not only dependent on the physical capacity of the athlete, but also on the equipment s/he uses and the interaction between the two. Modifications to areas of the wheelchair such as the camber angle and size of the main wheels, as well as the positioning of the seat can all have an impact on the mobility performance of the athlete (Mason *et al.*, 2013). Therefore, it is imperative that configuration changes in wheelchairs and other equipment (e.g., hand-bikes) are noted between any physiological or sports performance assessments. Standard checks in equipment should also ensure that tyre pressure is controlled between sessions, as this can affect the rolling resistance and subsequently the physiological demand. Where ecological validity is deemed important e.g., for sports-specific and field-based testing, it is imperative that testing takes place using the athlete's own equipment. However, it is important to note that some tests, originally developed for non-disabled athletes, may not provide a direct indication of aerobic capacity. For example, the multistage fitness test requires athletes to have exceptional wheelchair propulsion agility skills (Goosey-Tolfrey & Tolfrey, 2008). That said, in cases where ecological validity is less important it is acceptable to test individuals on an arm crank ergometer. This allows for the assessment of physical capacity/performance, independent of specialised/customised equipment and could be useful when assessing physiological potential.

Conclusions

In general, practitioners can employ the same underpinning training and testing principles as for non-disabled athletes yet with subtle but significant alterations. Understanding the relationship between the impairment and performance is essential when considering the needs of the individual.

- Peak oxygen uptake (VO_{2peak}) and other related physiological measures such as peak power output, ventilation rate and blood lactate concentration exhibit an inverse relationship to lesion level and completeness.
- Using VO_{2peak} as a key variable to monitor training progress should be questioned, especially in athletes with tetraplegia, whose aerobic capacity is reduced. Blood lactate monitoring and analysis of submaximal performance may be more meaningful for longitudinal observations in this group.

- Peak HR is reduced for athletes with lesion levels above T6. Therefore, training thresholds based upon HR reserve may be more appropriate than those based on absolute heart rate zones derived from the non-disabled population. For athletes with tetraplegia, monitoring of rating of perceived exertion (RPE), rather than HR is advocated.
- For repeat testing, it is crucial to note factors such as chair set-up (camber, sitting height, tyre pressure) as changes in these variables may influence rolling resistance and therefore test results. ■

words:

Dr Vicky Goosey-Tolfrey FBASES



Vicky is a Reader and Director of the Peter Harrison Centre for Disability Sport at Loughborough University. She is a BASES accredited sport and exercise scientist

Dr Christof Leicht



Christof is a Research Associate for the Peter Harrison Centre for Disability Sport at Loughborough University. He studies exercise physiology and immunology in disability sport.

Dr John Lenton



John is a Research Assistant for the Peter Harrison Centre for Disability Sport at Loughborough University. He attended the Beijing 2008 Games supporting wheelchair tennis.

Nik Diaper



Nik is the EIS Head of Sport Science and Sport Medicine for Paralympic Sports. He is a BASES accredited sport and exercise scientist.

Dr Barry Mason



Barry is a Research Associate for the Peter Harrison Centre for Disability Sport at Loughborough University. He is a BASES accredited sport and exercise scientist.

References:

- Bhambhani, Y. (2002). Physiology of Wheelchair Racing in Athletes with Spinal Cord Injury. *Sports Medicine*, 32(1), 23-51.
- Goosey-Tolfrey, V.L. & Leicht, C.A. (2013). Field-based physiological testing of wheelchair athletes. *Sports Medicine*, 43(2), 77-91.
- Goosey-Tolfrey, V.L. & Tolfrey K. (2008). The multistage fitness test as a predictor of endurance fitness in wheelchair athletes. *Journal of Sports Sciences*, 26(5), 511-517.
- Janssen, T.W.J. & Hopman, M.T.E. (2005). Spinal cord injury, in J.S. Skinner (ed.), *Exercise testing and exercise prescription for special cases: Theoretical basis and clinical applications*. 3rd ed., pp. 203-219. Baltimore: Lippincott Williams and Wilkins.
- Krassioukov, A., Warburton, D.E.R., Teasell, R. & Eng, J.J. (2009). A systematic review of the management of autonomic dysreflexia following spinal cord injury. *Archives of Physical Medicine and Rehabilitation*, 90(4), 682-695.
- Mason, B., van der Woude L.H. & Goosey-Tolfrey, V.L. (2013). The ergonomics of wheelchair configuration for optimal performance in the wheelchair court sports. *Sports Medicine*, 43(1), 23-38.