# *INNOVATION CHALLENGE: MONITORING DAY-TO-DAY LOADS OF WHEELCHAIR ATHLETES*

***ADDITIONAL INFORMATION – September 2023***

**INTRODUCTION TO THE INNOVATION CHALLENGE:**

- This is a partnership between the Victorian Institute of Sport ('VIS') and the Australian Sports Technologies Network ('ASTN') to help uncover potential solutions that could help effectively and reliably monitor the day-to-day loads of wheelchair athletes, both in and out of training / competition.

- We plan to identify up to 10 early-stage concepts, minimum viable products (MVPs) or existing solutions through the VIS and ASTN networks to then pitch to the executive teams at a Demo Day.

- The VIS and ASTN will then provide the opportunity for selected technology innovators and start-ups to potentially partner directly with the VIS (and the broader Australian paralympic network) to pilot the solution into the day-to-day monitoring of wheelchair athletes.

**THE VIS & WHEELCHAIR ATHLETE CHALLENGE:**

For many able body sports involving running, cycling, rowing or even strength training there are already technology solutions, tools and programs in the market to monitor the training, competition and day-to-day loads of athletes. However, for wheelchair athletes this is not necessarily the case.

Unlike able body athletes, general day-to-day movements and stresses of wheelchair athletes are likely to have a greater impact on their overall daily loads and fatigue, and negatively impact performance in training and competition. It is currently difficult to quantify loads of wheelchair athletes on a day-to-day basis.

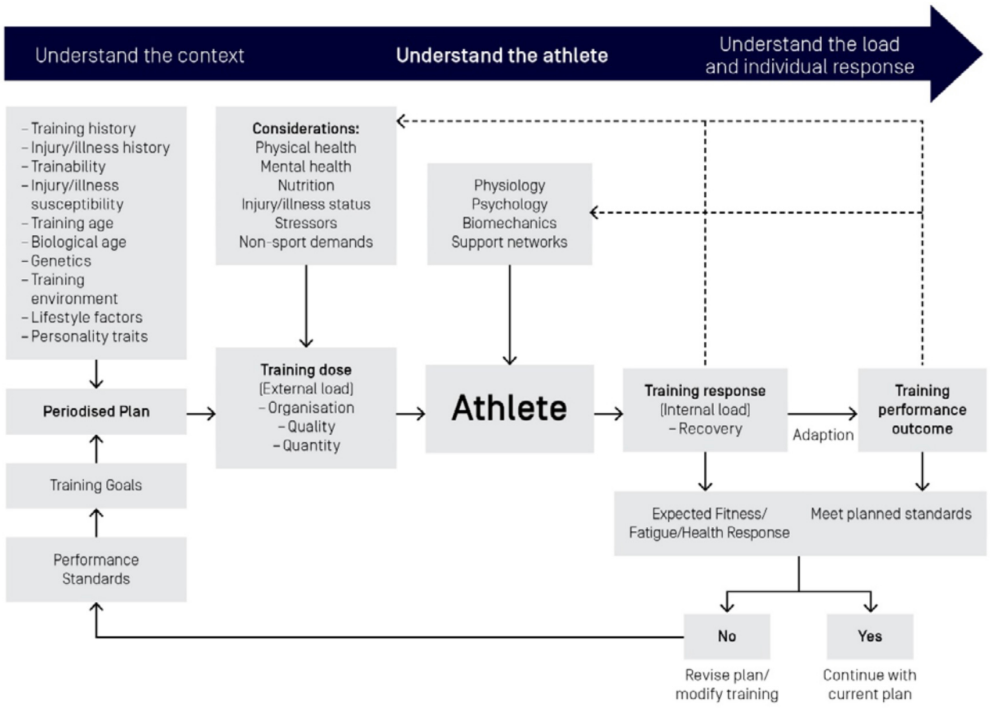
The aim of this challenge is to:

- Define (and potentially standardise) what is considered and quantified as 'load' for wheelchair athletes and users;
- Effectively and reliably monitor loads of wheelchair athletes and users;
- Potentially separate and quantify training and competition loads vs day-to-day movement and activity loads of wheelchair athletes.

***Definition of External and Internal Loads***

Simplified, the Australian Institute of Sport (AIS) define 'External Load' as the training dose (quantity, quality, organisation), often measured using GPS, LPS, IMU, accelerometers etc. 'Internal Load' is loosely defined as the training response (expected fitness, fatigue or health response). The most commonly collected objective data providing quantifiable 'Internal Load Metrics' is heart rate (as heart rate variability or %max in zones), closely followed by lactate and respiration measures.

**Figure 1: Individual characteristics, training dose, performance and planning considerations of training load in relation to loading and unloading phases of training. Adapted from Smith [2003][15], Impellizzeri et al. [2019][16], Pickering et al. [2019][17] and Impellizzeri et al. [2020].[18]**




Source: Australian Institute of Sport (AIS)

- Ongoing studies have resulted in the adoption of a commercially available system to monitor internal load measures of wheelchair athletes. Current internal load measures (e.g., sRPE, HR) are reflective on systemic load whereas alternates that can quantify more localised loads on key areas of the body (i.e., shoulder muscle, physiological or mechanical load for example) would be highly novel and beneficial.
- Basic external load measures such as distance can be very misleading when quantifying load in WCBB and in some respects be the sport's version of 'junk miles' in AFL. Athletes can accrue significant distances just rolling around on court between stoppages etc, which don't incur meaningful muscular or physiological load. Similarly, players can sometimes just spin on the spot in the chair in dead periods of the game which would heavily inflate external load but provide little insight on demands of the sport or load incurred. Meanwhile, there are times where players will be producing a lot of mechanical load without any movement of the chair, i.e., fighting for position, which could be an important part of quantifying WCBB loads.
- Simply put, we can somewhat measure the training responses, but there is no accessible marker of external load to accurately prescribe or monitor training dose for wheelchair athletes.

***Requirements of Suitability***

A review of the technology used for load and performance monitoring in wheelchair court sports found wheelchair mounted Inertial Measurement Unit (IMU) are most reliable and versatile for measuring wheelchair mobility performance and estimates of workload (Van der Slikke et al, 2023). However, these units may result in an abundance of sometimes hard to interpret kinematic data (Van der Slikke et al, 2016).

A suitable solution will ultimately need to provide objective information to coaches, sports scientists or engineers and wheelchair athletes. This information will impact decisions on training programs of wheelchair athletes as well decisions on day-to-day movements and activities to enable these athletes to maximise their training and competition performances.

Furthermore, athletes with lower severity impairments, bound to a wheelchair for daily use, require workload monitoring on a regular basis to avoid overuse injuries caused by infrequent exposure to optimal and progressive loading (Van der Slikke et al, 2023). Research by de Vries et al (2023) stated a key area of interest for future research "will be the development of an accurate and easy to use device or app for physical activity screening, health tracking for individuals or meeting activity goals in discussion and agreement with clinicians and therapists". Therefore, a solution may also have translational benefits for wheelchair users in the community by potentially understanding what adequate daily loads are for maintaining health and fitness as well as acceptable daily loads in occupational environments.

**Requirements**:

- Track indoor movement (directional, speed and distance)
- Individual analysis with ability to categorise by impairment category eg. amputee Vs paraplegic (will affect dominant turning strategy and therefore elicit different force outputs)
- Ability for group analysis
- Key metrics in WC Basketball competition: Meterage Per Minute, Maximum Velocity (m/s), , accelerations, decelerations, and rotational movements (place the most demands on the athletes) Measurement of force output (eg. Power meter)
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- Other metrics to be measured (may broaden range of sports to include WC rugby & tennis): Total Distance (m), Player Load Per Metre + Peak + Total Player Load (if power not possible, but must use modified algorithm to account for lack of vertical movement) overall load, top speed and collisions, connection + release of wheel, # strokes, distance per stroke, optimisation & efficiency of strokes, approximation of power, changes in acceleration, peak acceleration, rotational velocity (max and ave).

**PREFERRED DEVELOPMENT PHASE OF THE TECHNOLOGY INNOVATION & STARTUP PROJECTS**:

- Based on the knowledge of the VIS team it is deemed unlikely that there is an existing commercial solution in the market to address the Challenge.
- It is likely that the solution will involve development and / or use of a wearable device or equipment-based sensor (used on wheelchair) that collects load data on specific biomechanical measures. It is likely that data would be downloaded and available real-time to coaches and athletes via an App or API, providing insights and benchmarks that can influence training as well as day-to-day movement activities of the wheelchair athletes.

- Therefore, candidate applications are likely to come from technology innovators, startups and potentially researchers in the following stages of development:
- Research – A faculty or research department within a university or research institute that has technical expertise to adapt existing technologies or capabilities to address the challenge.
- Concept - A team with technical and / or technology expertise that presents a potential concept or solution that they have the capability to develop.
- Pre-minimum viable product – A solution that is in development potentially for another use case that may meet some of the functional / technical requirements but requires further adaption or development to address the Challenge.
- Adaption of existing technologies / solutions – an organization that has developed a solution/s for other use cases that could be adapted or modified to address the Challenge.
- It is likely that the selected candidate will need time, resources and funding to develop the solution for the challenge. VIS will need to work with the selected candidate to provide feedback and resources (i.e. coaches and athletes) to help develop and validate the solution.
- The VIS or ASTN will not own or have an equity position in the technology or solution developed to address the challenge. However, the VIS and ASTN may play a role in securing innovation grant funds to support the development of the technology (e.g. VIS/ AIS / Paralympic innovation funding or other grant / funding sources).
- With this Challenge the VIS see that they are providing technology innovators and startups with the opportunity to validate, test and / or integrate a solution with a key sports brand in the Australian market.
- In return for supporting the project the VIS would likely request a royalty-free usage period to pilot and use the solution before considering a commercial arrangement. At its discretion, the VIS can provide connections into other state-based paralympic sporting bodies and the national paralympic body if the solution is deemed valuable.
- The VIS (and partners) may also request to have an exclusivity period of use for competitive purposes.

**References**:

de Vries, Wiebe H. K., Rienk M. A. van der Slikke, Marit P. van Dijk, and Ursina Arnet. (2023) Real-Life Wheelchair Mobility Metrics from IMUs. *Sensors 23*, no. 16: 7174. https://doi.org/10.3390/s23167174

Rienk M. A. Van der Slikke, Paul Sindall, Victoria L. Goosey-Tolfrey & Barry S. Mason. (2023) Load and performance monitoring in wheelchair court sports: A narrative review of the use of technology and practical recommendations. *European Journal of Sport Science*, 23:2, 189-200, https://doi.org/10.1080/17461391.2021.2025267

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