Para-cycling research 2020

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Background

The progress of the Paralympic movement has developed into each sport having their own classification system. This has led to a large variability in the definition of key terms, measuring methods, etc. To coordinate classification in different sports, the International Paralympic Committee (IPC) developed the *IPC Classification Code* (2015) that aims to "support and coordinate the development and implementation of accurate, reliable and consistent sport focused classification systems". The official position of research in classification was described in *Background and Scientific Rationale for Classification in Paralympic Sport* (2009), meaning that all Paralympic classification systems must: be based on scientific evidence, define minimum impairment criteria and eligible impairment types (by sport), be consistent with taxonomy and terminology of International Classification of Functioning, Disability and Health (ICF), and classify impairments according to the extent of activity limitation (for more information: www.paralympic.org/classification-research). The aim of this research project in para-cycling is to generate scientific evidence for para-cycling classification.

Overview of the para-cycling research project

The classification research in para-cycling (H, C and T-classes) has been assigned to The Swedish School of Sport and Health Sciences (GIH) in Stockholm, Sweden, and Vrije University (VU) in Amsterdam, the Netherlands, with support of and regular contact with UCI (Figure 1). GIH is doing research in the C- and T-class, and the VU in the H-class. The timeline for this project and implementation of new findings stretches over several years, as evidence-based classification is an ongoing process. The results of the current research will be presented as an advice report to UCI at the end of the research project in 2022.

The project started in 2018. The first data collections (described below) were conducted during the seasons of 2018 and 2019, in the H, C, and T-classes. The rest of the year, the research team is analyzing the data by running statistical analyses and thoroughly investigating the outcomes. Data collection continues in 2020 and onwards, to cover more areas important to para-cycling. The results of this work will lead to scientific papers published in various international peer-reviewed scientific journals, available for anyone to read. Results will also be presented at international conferences by the research team.

As a way to directly communicate results to athletes and federations, information will be continuously presented via UCI's website as well as via the classification forums. More importantly for para-cycling, these results will be compiled to form an advice report written to UCI by the researchers. Important to know is that no conclusions will be drawn until we have all information needed to produce scientific evidence for para-cycling classification.

Presentations and published papers are steps on the way and the complete work will be carefully considered before outlining the advice report.

Figure 1. From left to right: Gilles Peruzzi (head of track, para-cycling and indoor cycling, UCI), Professor Dr. Anton Arndt, Johanna Liljedahl (PhD student), Fabrizio Solomita (master student), Rae Teffo (classification coordinator UCI), Dr. Sonja de Groot, Dr. Carla Nooijen, Rafael Muchaxo (PhD student), Associate Professor Dr. Anna Bjerkefors.

Research conducted regarding C- and T-classes

Data collection

Data collection in the C-class began in the season of 2018 when the research team attended two road para-cycling events (World Cup, Emmen; World Championships, Maniago) and collected data from 37 C-class cyclists. In 2019, data collection continued at two more events (World Cup, Ostend; World Championships, Emmen) in 60 C-class cyclists, which gives a total of 97 C-class cyclists. In 2019, the data collection in the T-classes was also started. The research team attended two events (World Cup, Ostend; World Championships, Emmen) and collected data in a total of 23 T-class cyclists.

Methods and equipment

The data collection was designed with regards to current classification determinants in the C- and T-classes. This includes collecting data on muscle strength, coordination, and performance on the bike both during racing and in standardized testing conditions on a cycling ergometer. Additional data collection that is needed to be able to draw conclusions will be collected further on; this is merely the first step. The tests for the C- and T-classes were carried out with advanced lab equipment, shipped to each event from the research lab at GIH in Stockholm, Sweden. To evaluate leg strength we used force transducers (Kistler Instruments AG, Switzerland) that measure force (in Newton, N). The force transducers are a reliable and objective way of assessing force. The participants performed tests that measured maximal muscle strength in the legs: isometric (static) leg push and leg pull, isometric knee extension and isometric hip extension (Figure 2). This data will be compared with classification data as well as tests of other performance parameters to determine relationships between impairments and function. All data collected were transferred to and analyzed in various software (Figure 3).

Figure 2. The four isometric strength tests conducted in the C- and T-class during 2018 and 2019, measuring maximal voluntary muscle strength. The arrows show the direction of force. Upper left: Isometric leg push and pull. Lower left: Isometric knee extension. Right: Isometric hip extension.

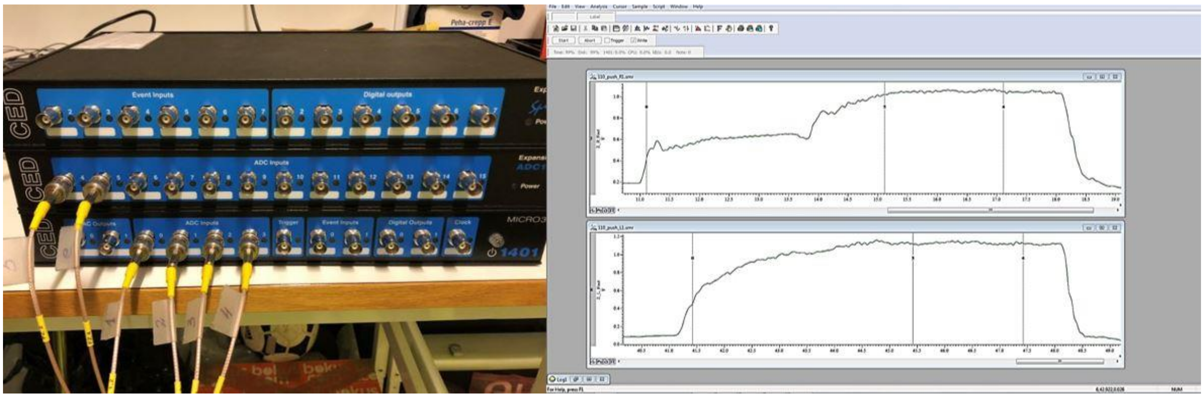

Figure 3. Left: Equipment that transmits and converts signals from the force transducers. Right: An example of strength test data once it has been loaded into the analysis software.

For the cycling tests, a cycling ergometer (Cyclus2, RBM Electronics, Leipzig, Germany) was used (Figure 4). The ergometer measures power output (Watt, W), cadence (rpm), pedal force (Newton, N). We collected data on peak and average power output during a 20 seconds maximal sprint test on the ergometer, measured the maximal strength in each leg separately, and performed a maximal cadence test. Results from the individual time trials from each event were obtained to be able to compare the test results with each participant's race performance. The coordination tests were performed using a force plate (MARS, Kistler Instruments AG, Switzerland) that register individual taps on the force plate (Figure 4). We measured coordination by letting the cyclists tap with their feet as quickly as possible on the force plate during 20 seconds for six trials, in different sequenced order as instructed by the research team. The coordination measurements provide valuable information in regards to cyclists with different types of brain injury, and help gain a better understanding on how different types of impairments compare. The same test was also conducted in para-cyclists that had other impairment types, for example impaired strength or leg amputation.

Figure 4. Left: The 20 seconds maximal sprint test, the dynamic maximal strength test and the 6 seconds maximal cadence test for the C- and T-class were all carried out on the Cyclus2 ergometer. Right: The force plate registers even light taps and will give information about the cyclist's leg coordination in the tapping tests, for example speed, and differences between left/right leg.

Research conducted regarding H-classes

Data collection

Data collection in H-classes started in the season of 2018, when the research team attended two road para-cycling events (World cup, Emmen; World Championships, Maniago) and collected data in 35 handcyclists. The aim of the 2018 research was to investigate the influence of trunk strength on handcycling performance. Data collection in H-classes continued at two more events in 2019 (World Cup, Ostend; World Championships, Emmen), where the research team collected data in 64 handcyclists. The aim of the 2019 research was to investigate the influence of arm strength on handcycling performance.

Methods and equipment

Currently, one of the main determinants during classification in handcycling, especially in athletes with impaired strength, is the level of trunk function. Therefore, one of the first steps of the research in handcycling classification was to investigate the influence of trunk strength.

Participants performed different tests aimed at evaluating trunk strength during trunk flexion and extension. Besides assessing muscle strength according to current classification procedures, i.e. using the Manual Muscle Test, the main test involved the use of a handheld dynamometer (Figure 5). This device allows us to measure the amount of force produced while pressing the trunk against the measuring plate (Newton). It was used by pressing against it with the chest during trunk flexion and with the back during trunk extension.

Figure 5. Left: A handheld dynamometer, device used to measure force produced during flexion. Right: An example of one of the trunk flexion tests conducted during 2018 events. In this example, the participant flexed the trunk pressing the handheld dynamometer with the chest. The peak of force produced during flexion was recorded by the measuring device.

Results of the trunk strength test were then compared with the performance during a 20 seconds sprint using a lab ergometer (Cyclus 2, RBM Electronics, Leipzig, Germany) (Figure 6) and with average velocity during the time-trial competition.

Figure 6. The 20 seconds sprint was conducted in the participant's handbike attached to an adapted cycling ergometer (Cyclus2).

During 2019, the research team aimed to investigate how handcycling performance is influenced by arm strength, another determinant during current classification. We were able to build an original system to measure strength during varied conditions, similar to recumbent handcycling.

The participants performed different isometric strength tests assessing the amount of force applied during pulling and pushing (Newton). Additionally, different conditions were performed to compare the impact of equipment setup on these two tasks (Figure 7). For example, participants performed both the pushing and pulling tasks under different strapping conditions (with or without a high chest strap) and under different lower limb support (with or without a footrest attached). Strength data will be compared with the performance during a 20 seconds sprint using a lab ergometer (Cyclus2, RBM Electronics, Leipzig, Germany) and with average velocity during the time-trial competition.

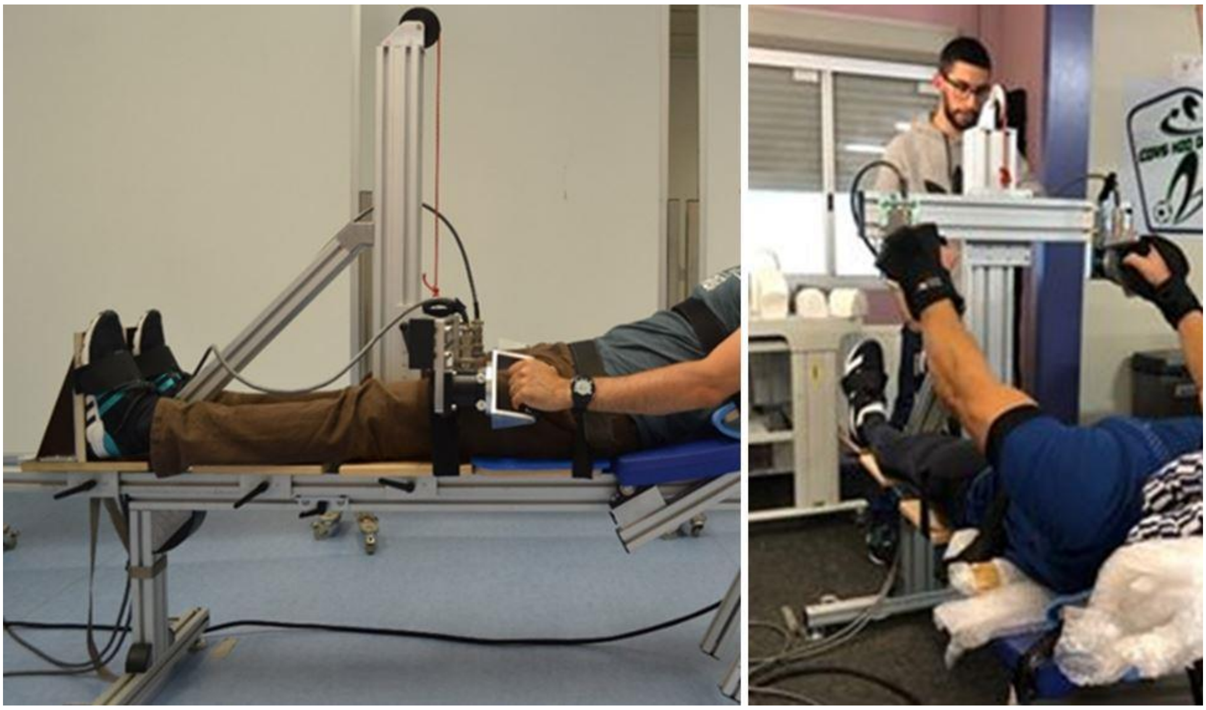

Figure 7. An example of one of the arm strength tests conducted during the events in 2019. Left: The position in the pulling task. Right: The position in the pushing task.

Delphi study

A combined C-, T-, and H-classes project is planned to take place in 2020-2021. This project involves collecting opinion from a group of experienced individuals from para-cycling and related fields. The process requires the application of a series of questionnaires with the aim of reaching consensus over specific topics – Delphi study.

Delphi studies can take place in different periods of research, either prior to data collection or after data analysis. By merging the results of the data collections that the research team has conducted and is planning to conduct, we intend to provide a considerable amount of scientific evidence that will be discussed with the panel of participants in the Delphi study. Additionally, we have recently shared an online questionnaire where everyone involved in para-cycling had the opportunity to provide feedback. This questionnaire will also contribute in shaping the Delphi study.

Future plans and projects

Research regarding C- and T-classes

Data collection in non-impaired cyclists is planned to take place in 2021, using the same tests as previously mentioned. This will add reference frames to the research, which is important information when analyzing data on classes, impairments and the minimal impairment criteria.

A research project in collaboration with The Polytechnic University in Turin, Italy, has been looking at the development of equipment that can be used to measure the impact of upper body impairments, for example arm amputation. This project has resulted in an original custom-built handlebar equipped with force transducers (Kistler Instruments AG, Switzerland) (Figure 8). The first test conducted using the handlebars aimed at replicating different arm impairments to get the first results in this research area of how the upper limbs affect cycling performance. Moreover, a scientific paper describing race results in relation to classes in para-cycling has been published. You can read the paper [here].

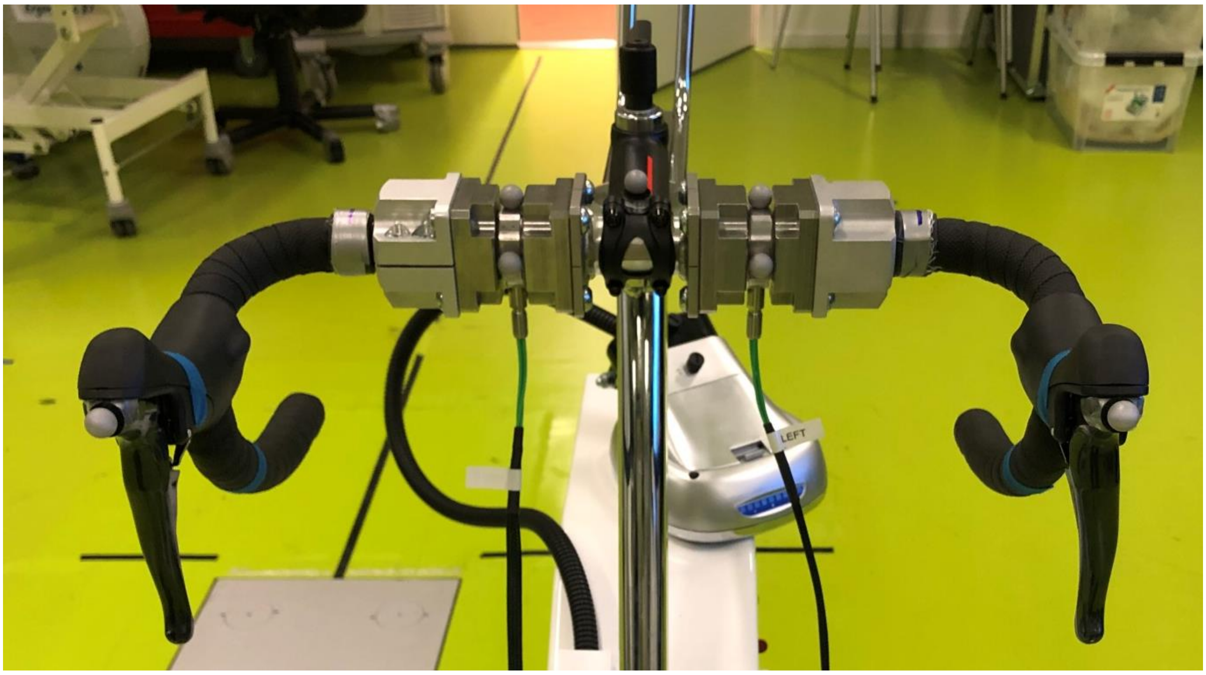

Figure 8. A bicycling handlebar equipped with force transducers, developed in collaboration with The Swedish School of Sport and Health Sciences (Stockholm, Sweden) and The Polytechnic University of Turin (Turin, Italy).

Research regarding H-classes

Side-projects using similar and additional tests in able-bodied participants have been conducted. This allows the team to perform extra analysis and investigate even more topics. For example, we have been studying the impact of hand function by measuring performance under different handgrip conditions. Additionally, it is planned to investigate the handcycling performance using a 3D ergometer. These side-projects are aimed to be included in future presentations. Furthermore, a scientific paper with the aim of describing race results among handcycling classes has been accepted and is soon to be published.