

**MASARYK
UNIVERSITY**

FACULTY OF SPORT STUDIES

**A Sport-Specific Model of
Classification for Para Karate:
Cumulative Research Portfolio**

Cumulative Habilitation Thesis

MGR. DUŠANA AUGUSTOVIČOVÁ, PHD.

Department of Sport Performance and Exercise Testing

Brno 2026

MUNI
SPORT

Bibliographic record

Author: Mgr. Dušana Augustovičová, PhD.
Faculty of Sport Studies
Masaryk University in Brno

Title of Thesis: A Sport-Specific Model of Classification for Para Karate:
Cumulative Research Portfolio

Year: 2026

No. of pages: 168

Key words: para sport, fair play, classification, performance, karate,
impairment

Annotation

The habilitation thesis summarises the results of research into performance and classification indicators for athletes with intellectual disabilities in para karate. Using multidisciplinary methods, tools for evaluating athletic performance were verified and a basis for classification was proposed in accordance with the requirements of the International Paralympic Committee (IPC). The results of this study were implemented in practice by the World Karate Federation (WKF). The research outcomes were presented by the author at the Head of Classification Meeting in Bonn too. The author was awarded the prestigious IPC Classification Award for classification development worldwide.

Abstract

This cumulative habilitation thesis synthesises a series of the peer reviewed research articles aimed at strengthening evidence-based classification in para karate. The main focus was on athletes with intellectual impairment, including Down syndrome and autism as the first two sport classes are proposed by the WKF to the program of the Paralympic Games Brisbane 2032. In line with International Paralympic Committee (IPC) expectations and relevant Virtus frameworks, the thesis combines competition and performance analysis with multidisciplinary functional testing to identify performance-relevant determinants in kata and to evaluate key parameters that could support fair and transparent class allocation in para karate. The work begins by clarifying current eligibility pathways and the practical challenges associated with classifying athletes with intellectual impairment in para karate. It then provides a sport-specific performance context by analysing kata selection patterns in top-level events by sport class. Based on this on this foundation, the thesis evaluates the measurement properties and applied feasibility of several candidate tools across domains relevant to kata performance, including low-cost video-based timing of technique execution (MyJump2), force-plate countermovement jump (CMJ) outcomes interpreted in terms of reliability and measurement error, and posturography-derived indicators of postural control. Cognitive and executive-function profiles are examined using a standardised test battery for intellectual-impairment classification, and a sport-specific kata memory test is introduced and assessed for reproducibility to reflect the cognitive demands of kata performance better. Empirical data were collected primarily during classification sessions at the World Para Karate Championships (Budapest, 2023), with complete participation at the event (approximately $n = 44$), complemented by analyses across multiple competitions. Overall, the findings support the feasibility of implementing a standardised, multidisciplinary assessment approach for classification research in para karate and provide preliminary evidence of differentiated functional profiles between sport classes (notably K21 and K22). At the same time, the results should be interpreted as initial evidence-based requiring further multi-event validation and threshold development before formal decision rules can be finalised. Preliminary procedures informed by this work have already been incorporated into the para karate classification manual as baseline elements for forthcoming classification rules, and additional integrative manuscripts are in preparation/submission to extend the programme through multivariable modelling and threshold work (cut-off points, MIC operationalisation, and decision accuracy).

Declaration

I declare that I am the topic **A Sport-Specific Model of Classification for Para Karate: Cumulative Research Portfolio** I compiled it myself. All sources and sources of information that I used to write this thesis have been cited in the text and are listed in the list of sources and literature used. AI was used to check English grammar.

In Brno 1st of March 2026

.....
Mgr. Dušana Augustovičová, PhD.

Acknowledgement

I want to thank my parents for their lifelong support, patience, and belief in my choices. Because of them, I was able to pursue my athletic and professional career, even when it was tough.

I also want to thank my coaches, who inspired and shaped me as an athlete and as a person with a clear vision and goal.

Thank you to my teachers, colleagues, friends, and husband for trusting me and for providing professional support and encouragement.

I appreciate the Department of Sports Performance and Diagnostics, particularly its head, for its ongoing support of my research activities and professional growth, culminating in my habilitation. I also acknowledge the Department of Athletics and Conditioning of the Faculty of Physical Education and Sport, Comenius University in Bratislava, for its long-term support, stimulating academic environment, and fundamental role in shaping my academic and professional trajectory.

I value all the suggestions, questions, and doubts that arose along the way. Even in challenging situations, I became more resilient, improved my professional skills, and better defined my path.

Finally, I would like to thank the World Karate Federation (WKF) for the opportunity to serve as chair of the Para Karate Commission and to help develop a classification system for athletes with disabilities.

CONTENT

List of Terms and Shortcuts	13
1 Introduction	15
2 Literature review	16
2.1 Historical and international development of para karate within the WKF	16
2.2 Development of karate evidence-based classification	17
2.3 Introduction to Para Sport Classification	17
2.4 Research in para sport in the context of evidence-based classification	24
3 Objective and Research Questions	29
3.1 Objective.....	29
3.2 Research questions	29
4 Methods	31
4.1 Study design.....	31
4.2 Sample	31
4.3 Data collection procedures.....	32
4.4 Statistical analysis.....	34
5 Results	35
5.1 Šport intelektuálne znevýhodnených: Oprávnenosť športovať na súťažiach intelektuálne znevýhodnených športovcov, športovcov s Downovým syndrómom, alebo autizmom	37
5.2 Kata selection trends in top-level para-karate competitions: a multi-championship study.....	48
5.3 Intra- and Inter-rater Reliability of MyJump2 App in Measuring the Speed of Specific Karate Techniques	50
5.4 Countermovement-Jump Test–Retest Reliability in Top-Level Para-Karate Athletes With Intellectual Impairment Using Kistler Force Plates.....	53
5.5 Postural control in top-level Para Karate athletes with visual and intellectual impairment: an observational study	55
5.6 Cognitive and Executive Functions of Top-level Para Karate Athletes With Intellectual Disability	58

5.7	Reliability of the Sport-specific Test for Intellectually Impaired Para Karate Athletes.....	60
6	Discussion	62
7	Conclusions	70
	References	72
	Appendix 1 Consent form	147
	Appendix 2 Classification of athletes with intellectual impairment (K21 and K22)	83

List of Terms and Shortcuts

IPC	– International Paralympic Committee
II	– Intellectual Impairment
VI	– Visual Impairment
WKF	– World Karate Federation

1 Introduction

The development of sport for people with disabilities is not only an essential step towards inclusion but also a complex challenge in establishing fair and functional classification systems. As an official discipline of the World Karate Federation (WKF), para karate has gradually established itself since 2006 as an independent competitive discipline emphasising inclusion, safety, and objective evaluation of athletic performance.

A fundamental shift towards the professionalisation of para karate occurred after its acceptance by the International Paralympic Committee (IPC) in 2015 among the recognised IPC sports and the subsequent implementation of key classification tools, including the world ranking system and the strategic plan for the development of para karate for the period 2020–2028. The design and implementation of these measures were led by the author of this habilitation thesis as part of her work as chair of the WKF Para Karate Commission (since 2020). In this role, she contributed to the discipline's professional direction and to the development of classification standards in accordance with the revised IPC Classification Code 2025.

The basic prerequisite for classification in parasport is evidence-based classification, i.e., the use of a multidisciplinary approach to collecting data that quantifies the impact of a specific disability on athletic performance. In the case of athletes with intellectual disabilities (ID), this task is particularly challenging, as their performance is influenced by a complex set of cognitive, motor, sensory, and behavioural factors. Although some international sports federations are addressing this issue, there is still no widely accepted classification model specific to these sports that adequately reflects the performance structure of these athletes.

This habilitation thesis addresses these challenges through a series of research studies conducted as part of the VEGA project No. 1/0611/23, "Model of sport-specific classification of athletes with intellectual disabilities in para karate" (2023–2025). The studies focus on identifying and validating parameters relevant for the classification of athletes in the kata discipline, including biomechanical, cognitive, balance, physiological, and performance indicators.

Although the author of this thesis is not the first author on all included publications, the author led the overarching research programme and coordinated the multidisciplinary research team and overall research workflow within the VEGA project. The contributions included conceptualising the research questions, designing and standardising the test battery and protocols, coordinating data collection during classification sessions, supervising analyses and interpretation, and translating the findings into applied outputs for the WKF (classification manual, draft rules documentation, and IPC-related compliance materials).

The synthesis of the presented results documents the link between applied research and the creation of classification standards in international sports practice.

This work aims to deepen knowledge in the classification of athletes with disabilities, specifically athletes with intellectual disabilities, and to support the development of functional, fair, and scientifically grounded classification systems in para karate.

2 Literature review

2.1 Historical and international development of para karate within the WKF

The inclusion of people with disabilities in karate began to take shape systematically within the World Karate Federation (WKF) in 2006, when the WKF government established a separate Para Karate Commission. Its main task was to develop, standardise, and promote karate as a fair and accessible sport for people with disabilities. This conceptual step was key to establishing para karate as a legitimate part of the WKF's international sports structure.

A significant milestone occurred in 2015 when the WKF was officially recognised by the International Paralympic Committee (IPC). This recognition strengthened para karate's status as a full-fledged sport, with growing global interest. Even before that, in 2012, para karate was introduced as part of a demonstration competition at the World Championships in Paris, paving the way for the organisation of the first official World Championships in para karate: in 2014 in Bremen (Germany) and in 2016 in Linz (Austria).

With growing interest in para karate, championships were held on all continents. In 2018, the European Championships were held in Novi Sad (Serbia) and the World Championships in Madrid (Spain). The concept then spread beyond Europe: the Asian Championships (Tashkent, 2022) and the African Championships (Casablanca, 2023), making para karate a global sport with a growing membership base.

The development of para karate did not stop at the level of event organisation. Following the World Championships in Dubai in 2021, an official world ranking system was introduced, enabling long-term evaluation of athletes and the development of qualification frameworks for future multi-sport events. In 2023, an educational program for classifiers was launched, reflecting the IPC's requirements for the professionalisation of the classification process in accordance with the principles of evidence-based classification.

A significant milestone was the signing of a partnership with the organisation Virtus: World Intellectual Impairment Sport in 2021, which focuses on supporting the development of para karate for athletes with intellectual disabilities (ID). Based on Virtus's recommendations, a new classification system was developed, comprising two sport classes: II1 and II2. This system was implemented at the World Championships in Dubai in 2021 and further tested during the Global Games 2023 under the auspices of Virtus.

Participation of athletes from classes II1 and II2 was also approved for Virtus Global Games 2024 in Vichy, representing another step towards their recognition within the broader Paralympic structures.

WKF Para Karate Strategic Plan 2020–2028

As part of the long-term development vision for para karate, WKF adopted a strategic plan for 2020–2028, which includes five key pillars (WKF Para Karate Strategic and Development Plan, 2022):

- **Competition activities:** expanding the number of continental and international events, including the introduction of a world ranking and preparations for potential inclusion in the programme of the Paralympic Games in 2028.
- **Research:** leading research projects focused on classification and safety, with an emphasis on evidence-based approaches and methodological support from IPC and Virtus.
- **Education:** implementing webinars, onsite training, e-learning, and certification programmes for coaches, referees, athletes, and their assistants.
- **Partnerships:** strengthening cooperation with IPC and Virtus, organising joint training sessions and classification workshops.
- **Development and funding:** expanding educational and development programmes to secure new resources to support para karate.

2.2 Development of karate evidence-based classification

The dynamic development of para karate in recent years, particularly the expansion of international championships and the growing sports base, has created an urgent need to introduce a professional, transparent, and evidence-based classification system. In light of efforts to include para karate in the Paralympic programme, classification is not only a technical but also a strategic aspect of the sport's development. The World Karate Federation (WKF), in collaboration with Virtus (WKF, 2023) has taken several steps since 2021 to implement sport-specific classification frameworks for athletes with intellectual disabilities. While the initial steps led to the creation of a fundamental distinction between sport classes II1 and II2, these were primarily based on general medical-psychological criteria. However, with increasing competition and the requirements of the International Paralympic Committee (IPC) for evidence-based classification, it is essential to supplement this framework with functionally validated sport-specific indicators that reflect the real impact of disability on sporting performance – specifically on kata techniques in karate. For this reason, the current research programme focuses on developing, piloting, and implementing testing protocols that enable sensitive differentiation between levels of disability while meeting the demands for objectivity, reliability, and ecological validity. This approach reflects the standards of the IPC and Virtus. It creates a scientific foundation for sport-specific classification, which should be a fundamental prerequisite for including para karate among Paralympic sports.

2.3 Introduction to Para Sport Classification

2.3.1 Purpose and Principles of Classification

2.3.1.1 Ensuring Fair Competition

Ensuring that competition outcomes in para sports are determined by athletes' skill, training, and preparation rather than by the degree of their impairment is a central tenet of current classification frameworks. The guiding principle, as outlined in international classification standards, is that eligible impairments should be accounted for so that each class contains athletes with comparable levels of performance disadvantage (Tweedy et al., 2016a). This alignment is fundamental to establishing equitable matchups in which success depends on maximising anthropometric, physiological, psychological, and technical attributes through optimal training, rather than on mitigating the impairment's inherently reduced impact. The balance between scientific precision and practical application in these systems requires careful assessment methods. The validity of impairment measures plays a particularly influential role in ensuring fairness; if a measure does not accurately reflect how an impairment limits sporting performance, athletes may be misclassified. For example, even when strength and range of motion (ROM) assessments have improved reliability through refined protocols, coordination measures for para swimmers remain challenging to standardise (Smith et al., 2021). This discrepancy indicates that certain domains of physical performance are more difficult to accurately capture, which could lead to inequitable classification outcomes if left unaddressed. Establishing normative performance ranges is an important step in gauging how impairments translate into sport-specific limitations (Wileman et al., 2024). However, such ranges alone cannot guarantee fairness unless they are supported by data gathered under conditions representative of actual competitive environments. Ecological validity must be considered; measures taken under artificial or inconsistent testing conditions risk misrepresenting an athlete's capabilities when performing in real competition (Wileman et al., 2024). A system grounded in evidence yet flexible enough to adapt to sport reality may better safeguard against this mismatch. Furthermore, standardised testing protocols must account for the multifaceted nature of sport performance. Selection of activity limitation measures should avoid undue influence from non-classifiable factors such as environmental variability or equipment provision (Tweedy et al., 2016b). This control helps isolate the genuine effect of impairment on performance. At the same time, modalities such as isometric strength tests and repetitive tapping tasks, frequently used to evaluate strength and coordination, highlight both the potential for objectivity and the diversity of measurement approaches across sports (Wileman et al., 2024). Fairness also depends heavily on preventing intentional misrepresentation during classification procedures.

In certain contexts, such as vision-impaired football, athletes have been documented presenting themselves as more impaired to gain a competitive advantage (Runswick et al., 2021). Addressing this requires protocols that are robust to manipulation, for example, by testing each eye separately with the best correction applied, alongside observational strategies where relevant. These preventive measures are integral not only for accuracy but also for maintaining trust in the system. Beyond individual measures, classification must remain responsive to variations within sport types. For para surfing, classification structures grounded explicitly in IPC-approved impairment types were developed to provide uniformity where none had previously existed; criteria were established to minimise the effects of training or equipment when assessing impairments (Johnson & David, 2021).

While para surfing differs from para karate in its demands and environment, the broader implication is clear: ensuring fair competition often requires bespoke adaptations informed by sport-specific constraints and activities. Research designs can further strengthen fairness

evaluation by comparing standardised test outcomes with performances under individualised competition conditions permitted by the rules (Tweedy et al., 2016b). Such comparisons can quantify whether individualised equipment positioning or technique provides a measurable advantage beyond what standard testing predicts. In para karate, although empirical data may still be lacking, applying this logic could involve evaluating whether certain stances or grips differentially benefit athletes with specific intellectual or physical impairments despite imposed standardisations. Reliability concerns cannot be overlooked. Limited sample sizes in existing classification research reduce confidence in generalising findings across diverse populations (Wileman et al., 2024). Broader recruitment across multiple nations and varying levels of impairment may yield more defensible norms from which fair classes can be constructed. Without adequately powered datasets, statistical variance may distort the operationalisation of fairness principles.

Injury management also intersects with considerations of fairness. High injury rates among para athletes require classification systems to account for scenarios in which acute injuries temporarily exacerbate impairments without altering their long-term status (Suci Syafatillah & Saputra Perdana, 2025). Misclassification arising from transient injury-related limitations would directly undermine competitive equity; thus, clinical review processes may need to be integrated into classifications during major events. Ultimately, fairness within classification is a dynamic goal. It relies on technical measurement accuracy, procedural integrity against manipulation, and adaptability to evolving sport-specific evidence bases. Intellectual impairments present particular complexity because disadvantage manifests through tactical understanding, consistency in technical execution, and psychological readiness, alongside physically observable metrics (Tweedy et al. 2016). These dimensions often require sophisticated modelling approaches that integrate layered determinants into predictive frameworks capable of guiding appropriate class allocation. Hence, ensuring fair competition involves a balancing act: measurements must be predictive enough to classify accurately while sensitive enough to detect meaningful differences linked specifically to impairments rather than unrelated factors; safeguards must keep manipulation at bay without overburdening legitimate competitors; classifications must reflect sport realities while maintaining standardisation across contexts (Runswick et al., 2021; Wileman et al., 2025a).

Developing such systems for para karate will necessarily involve translating the new IPC classification code (IPC CLASSIFICATION CODE, 2025) and these lessons from other sports, while crafting measures that reflect karate's unique cognitive-technical demands associated with intellectual impairment.

2.3.1.2 Distinction Between Classification and Medical Diagnosis

While both classification and medical diagnosis employ structured procedures to evaluate an individual's condition, their purposes, outputs, and implications for para sport performance differ fundamentally. Classification in para sport is a competitive system with the explicit aim of promoting fairness by grouping athletes in ways that ensure that variations in competitive outcomes are determined by factors such as skill, tactical execution, conditioning, and psychological readiness, rather than by the extent or nature of impairment (Burns, 2015). In

this sense, classification operates as a sport-specific functional assessment rather than a medical categorisation. It focuses on translating the impact of an impairment into a measure that predicts sporting performance within a given discipline, recognising that two athletes with the same medical condition may face very different limitations when performing sport-specific tasks.

Medical diagnosis, by contrast, is concerned with identifying health conditions for treatment planning, prognosis estimation, and healthcare management. It often involves anatomical or physiological testing unrelated to sporting performance. A medical label, such as cerebral palsy or Down syndrome, does not necessarily reveal how an athlete's technical ability in para karate kata will be affected during competition. The diagnostic process, therefore, does not automatically provide information relevant to determining which class an athlete should compete in. This gap between pathology and performance is why classification must go beyond simple diagnostic verification (Tweedy et al., 2016b).

In practice, these differences mean that classification procedures often begin with verifying eligibility through diagnostic confirmation, ensuring that the athlete has an impairment type recognised under criteria set by the International Paralympic Committee (IPC) or the relevant International Federation, and then proceed to assess how that impairment affects sport-specific activities (Burns, 2015).

For intellectual impairments in particular, this initial eligibility stage involve recognition through VIRTUS protocols, followed by a secondary process that assesses actual competitive functioning using domain-relevant tasks. In para karate, this could translate into evaluating how cognitive processing speed, tactical decision-making under pressure, and consistency of movement execution affect overall competitive efficacy (Van Biesen et al., 2026).

The necessity of separating diagnosis from classification becomes even more pronounced when considering heterogeneous conditions within a single impairment category. Two athletes diagnosed with autism spectrum disorder may exhibit markedly different cognitive profiles and motor coordination patterns; only through targeted functional measures can classifiers determine whether their performance disadvantages are sufficiently similar to compete in the same class. This is consistent with findings across other para sports, in which impairments classified under a standard diagnostic label demonstrate wide variability in performance outcomes (Wileman et al., 2024).

Furthermore, an overreliance on diagnosis risks creating classes based on medical similarity rather than competitive equity. For example, assigning all athletes with cerebral palsy to a single class ignores variations in muscle tone distribution, voluntary movement control, and balance capacity, which directly influence athletic abilities such as pushing speed in wheelchair basketball and stroke symmetry in swimming (Fliess Douer et al., 2021). Similar logic applies to intellectual impairments: identical IQ scores or psychological diagnoses do not encapsulate how situational judgment, anticipatory skills or memory retrieval speed might affect kata choreography retention or timing adaptability (Van Biesen et al., 2026).

A further distinction lies in temporal stability. Medical diagnoses typically describe long-term conditions that change slowly over time (e.g., degenerative disorders). In contrast,

classification status may need review whenever assessments suggest a change in how impairments interact with sport-specific demands. This review requirement aligns with recommendations that ongoing monitoring ensures validity as sports evolve through new equipment technologies or updated competition formats (Mann et al., 2021). Changes in rules or scoring systems may alter which performance determinants are most critical to success; classification frameworks must then update their functional thresholds accordingly without unnecessarily altering baseline medical eligibility criteria. Intentional misrepresentation also interacts differently across processes. While feigning symptoms is possible in both clinical and sporting contexts, classification systems face immediate competitive pressures, which may make such manipulation more prevalent and consequential (Powis & Macbeth, 2020). Unlike medical diagnosis, where consequences primarily affect treatment plans, distortion during classification could directly shift medal probabilities by positioning an athlete among competitors with greater functional limitations than their own.

Thus, methods such as cross-validating impairment measures against observed competition behaviours are vital safeguards within the classification space, yet play little role in conventional diagnostic protocols. From an implementation perspective, adequate distinction translates into procedural sequencing: confirm eligible diagnosis to satisfy the governance requirements laid out by IPC or equivalent bodies; administer standardised activity limitation measures explicitly designed for the sport; use statistical analyses where feasible to identify which measures best predict performance outcomes (Stockley et al., 2022); interpret results collectively rather than relying solely on raw scores to avoid ceiling effects; and ensure that classifier training addresses both measurement principles and sport mechanics so that it can differentiate between clinically documented impairment severity and competitively relevant disadvantage (Wileman et al., 2024). By structuring it this way, classifications maintain legitimacy while avoiding medico-centric decisions that are unsuited to achieving fair matchups on the tatami. Therefore, while the procedures are intertwined at points, particularly during eligibility verification, the conceptual divide between classification and medical diagnosis must remain clear: one belongs fundamentally to medicine's remit of identifying health conditions; the other functions within sports science as an evidence-based grouping for equitable competition. Without this clarity, there is a risk of conflating pathological description with predictive modelling of competitive capability. This shortcut could erode the fairness objectives central to para karate and para sport at large.

2.3.1.3 Translation of Evidence into Rules

Translating empirical findings into functional classification rules within para sport, particularly in para karate for athletes with intellectual impairments, involves a layered process in which evidence must be interpreted not only in terms of measurement outcomes but also in terms of their operational utility on the competition floor. This step sits at the juncture between scientific research and applied governance; it connects the identification of sport-specific performance determinants with the actual codification of criteria that classifiers and event organisers will use. As indicated in previous sections, deterministic models developed in research cannot remain abstract; they must be expressed through rules that clearly delineate eligibility,

class boundaries, and competition procedures without sacrificing the scientific validity that underpins them. For rule translation to succeed, measures tested under controlled conditions must be mapped to decision points in classification protocols (Tweedy et al., 2016a). It is one thing to know that a given impairment measure correlates with competitive performance; it is another to define exact thresholds or cut-off scores that determine class assignment. In para athletics, such mapping has been achieved by establishing minimum impairment criteria (MICs) directly tied to quantifiable decrements in sport-relevant skills (Mann et al., 2021). Applying this logic to para karate would require identifying which cognitive-motor or perception-action measures show strong predictive capacity for kata outcomes, and then determining at what score or performance band an athlete's impairment places them in a different class. Without explicitly validated thresholds, there is a risk of arbitrary segmentation that could erode both fairness and legitimacy. The codification process must also consider factors beyond raw measurement data. Insights from wheelchair basketball classification highlight how even well-validated measures can lose stakeholder trust when improvements attributable solely to training result in reclassification (Fliess Douer et al., 2021). Rules, therefore, require provisions that distinguish between long-term functional change arising from rehabilitation or disease progression and short-term gains attributable solely to practice adaptation. For intellectual impairments in para karate, this could involve specifying which tests are considered resistant to trainability, thereby ensuring class stability despite skill acquisition over time.

2.3.2 Para Karate Classification

Classification in para karate is set in accordance with the WKF Classification Rules (Para Karate Classification Rules, 2021), which implement IPC standards and reflect the specifics of kata. A team of trained classifiers carries out the classification process and consists of the following key steps:

1. **Eligibility Assessment:**

The athlete must demonstrate a permanent disability that falls into one of the categories recognised by the IPC: physical (PI), visual (VI), or intellectual (ID) disability. The diagnosis must be supported by professional documentation (e.g., psychological, neurological, or ophthalmological report).

2. **Minimum Impairment Criteria – MIC:**

The athlete must meet predefined minimum functional limits specific to the type of disability. For example, ID requires an $IQ \leq 75$, onset before the age of 22, and significant limitations in adaptive behaviour; VI requires visual acuity $\leq 6/18$; PI requires, for example, grade 1–2 hypertonia, ataxia, or loss of amputation.

3. **Sport Class Allocation:**

Based on their functional profile, athletes are classified into one of the officially recognised sports classes. This process combines medical assessment, functional testing, and sports observation.

4. Extra Points Allocation:

In cases of physical disability, a "Compensation Score" may be assigned to adjust the performance rating based on the degree of functional limitation.

2.3.3 Sport Classes in Para Karate

In para karate, athletes can compete with three basic recognised disabilities and in four non-paralympic sports classes (Table 1).

Table 1 Description of the Para Karate sport classes

SPORT CLASS	TYPE OF DISABILITY	DESCRIPTION
K10	Visual Disability	Blindness or severe visual impairment (3/60 to total blindness). Mandatory wearing of opaque glasses.
K21	Intellectual Disability	IQ $\leq$ 75, onset before age 22, significant limitations in adaptive skills.
K22	Intellectual Disability + additional significant impairment	IQ $\leq$ 75, onset before age 22, significant limitations in adaptive skills, plus other significant disadvantages such as Down syndrome or cerebral palsy
K30	Physical Disability	Several functional classes for different types of physical disability (amputation, hypertension, ataxia, paraplegia).

All four sport classes have been implemented at the World Championships since 2021 and will gradually be extended to continental championships (Asia 2022; Africa, 2023). Classification is conducted by an official classification panel at the event venue, one or two days before the competition.

In terms of methodology, the WKF recognises classification as a dynamic field that requires regular review and development in light of new scientific knowledge. Since 2020, a strategic reform of the classification system has been underway with the aim of:

- support the development of sport-specific testing tools,
- ensure the validity and reliability of classification protocols (e.g., balance, explosive strength, cognitive function tests),
- explore the possibilities of implementing MIC cut-off points based on objective data (e.g., performance metrics, adaptive function scores),
- reflect on socio-ethical issues of eligibility for athletes with atypical forms of ID (Down syndrome, autism).

The relationship between classification and competition performance

The uniqueness of classification in para karate lies in the fact that meeting the minimum eligibility criteria is not just an administrative entry into the competition but directly influences the outcome of the evaluation in the kata competition discipline. The distinction between

performance influenced by trainable factors (technique, rhythm, dynamics) and performance determined by disability is therefore crucial for accurate classification. For this reason, research activities in the field of para karate are increasingly directed towards:

- neurocognitive analysis of performance (e.g., executive functions, working memory),
- quantification of motor parameters (e.g., jump height, balance, sensorimotor integration),
- statistical modeling of classification profiles (e.g., clustering by performance).

2.4 Research in para sport in the context of evidence-based classification

Research in classification in para sport has undergone a fundamental transformation from early, medically based models to current frameworks rooted in evidence-based classification research, aimed at minimising the impact of athletes' impairments on competition outcomes. The current model emphasises the development of reliable, valid, and sport-specific measures of impairment and activity limitation, which quantify impairment and isolate its influence from other performance factors. This chapter evaluates the development of evidence-based classification in para sport generally, discusses methodological challenges and advances in measurement – including muscle strength, vision, and biomechanical parameters – and identifies future research directions to enhance fairness and integrity in competitions. The analysis draws on a wide range of contributions, including advances in isometric strength testing, statistical classification techniques, machine learning methods, and biomechanical simulation (Beckman et al., 2017; Connick et al., 2018).

A new evidence-based classification model rigorously assesses the functional impact of disability on athletic performance. This evolution was motivated by the need to ensure equality and fairness in competitions, so that athletes' success depends on training and skills, not the degree of their disability (Beckman et al., 2017; Krabben et al., 2019). Earlier classification frameworks largely relied on clinical diagnoses and qualitative assessments, but discrepancies in inter-rater reliability and the inherent subjectivity of ordinal scales necessitated a shift to empirical measurements (Beckman et al., 2017; Tweedy et al., 2016a). In recent years, international governing bodies in para sports, such as the IPC, have mandated adherence to evidence-based classification principles, which has spurred an expansion of research efforts integrating scientific measurement theories and advanced statistical techniques into decision-making in para-athlete classification. (Connick et al., 2018).

Classification based on medical diagnoses assigned athletes to sports classes according to the type of their disability (Beckman et al., 2017; Connick et al., 2018). However, such classification has proven to be insufficient because it does not take into account the functional consequences of impairment that are specific to a particular sport. A more sophisticated approach is required, based on the model of the International Classification of Functioning, Disability and Health (ICF), which emphasises the interaction between health condition, body functions, and activity limitations (Connick et al., 2018; Mann & Ravensbergen, 2018). Evidence-based classification therefore requires researchers to develop tests that are not only objective and reliable but also tailored to the specific requirements of each sport (Ravensbergen et al., 2016; Reina et al., 2020).

The key components of an evidence-based classification system are the identification of minimal impairment criteria (MIC), which establish threshold values for eligibility, as well as the categorisation of athletes into classes that minimise performance differences solely attributable to impairment (Connick et al., 2018; Tweedy et al., 2016a). The development of such systems depends on obtaining reliable measurements that are free from the disruptive influence of adaptation to training. Finding or developing such sport-specific tests is a challenge that is particularly pronounced for tests assessing muscle strength, coordination, range of motion, and other biomechanical variables (Beckman et al., 2017; Mann & Ravensbergen, 2018). In addition, evidence-based approaches require integrating machine learning techniques and cluster analysis to objectively define class boundaries using multidimensional datasets of sports performance and disability-related variables (Connick et al., 2018; Ravensbergen et al., 2016).

One of the most challenging aspects of evidence-based classification of physically impaired athletes is accurately measuring reductions in muscle power. Although manual muscle testing is widely used for its simplicity and low cost, subjective assessment on an ordinal scale and thus low reliability among assessors limit its usefulness in the context of scientific classification (Beckman et al., 2017; Connick et al., 2018). To ensure that athletes achieve their true maximum performances during testing and thereby increase the reliability of the measurements, verbal encouragement and protocols of slow, gradual increases in strength are recommended (Beckman et al., 2017; Connick et al., 2018).

In addition, specialized tests have been developed for specific sports that focus on joint angles that have been shown to maximize force production, thereby providing a valid assessment of muscle strength reduction. Despite promising preliminary findings, however, there are still significant gaps in research regarding the validation of these tests across different degrees and types of impairment (Beckman et al., 2017; Mann & Ravensbergen, 2018). Furthermore, the impact of training on isometric strength measurements requires further investigation, as athletes may adapt to repeated testing, which could potentially increase their performance in tests without necessarily reflecting a true change in impairment (Tweedy et al., 2016a, 2018).

The classification of visual impairment (VI) presents unique challenges, as the currently used clinical measurements – specifically visual acuity and visual field – do not fully capture the functional limitations faced by athletes in a sporting context (Mann & Ravensbergen, 2018). As a result, research in VI classification is increasingly focusing on expanding the test set to include contrast sensitivity, depth perception, and motion detection, all of which have been shown to correlate with performance in sports with high visual demands (Mann & Ravensbergen, 2018; Ravensbergen et al., 2016). In addition, the use of eye patches in certain sports presents further challenges. For example, mandatory use of eye patches in some sports can level the playing field by standardising visual acuity during competition, but it also raises concerns about unnecessary restriction of athletes' residual vision, which complicates the classification process (Mann & Ravensbergen, 2018). Total blackout blindfolds were also introduced in para karate (Para-Karate Kata Competition Rules, 2023).

Another key issue in the classification of VI is the discussion of whether factors such as the age at which the athlete sustained the impairment (congenital versus acquired) should be considered, as these factors can influence performance through adaptive neural plasticity or mechanisms of sensory substitution (Mann & Ravensbergen, 2018; Ravensbergen et al., 2016). The integration of

comprehensive visual assessments into classification is crucial for accurate performance prediction and ensuring that athletes compete under conditions that truly reflect the impact of their impairment. (Connick et al., 2018). Currently, there are plans to sign an agreement between the WKF and IPC regarding the centralisation of athlete classification with VI, which will improve the reliability of classification in para karate.

The relationship between disability and athletic performance is often very complex. For this reason, advanced statistical methods and machine learning algorithms are increasingly used in classification research, capable of processing large amounts of diverse data. Techniques such as supervised learning (e.g., logistic regression, discriminant analysis) and unsupervised learning (e.g., cluster analysis) help to better understand how different types of disabilities influence performance. These methods enable the objective categorisation of athletes into functional classes based on measured parameters – thereby creating classification systems based on real data. (Connick et al., 2018; Patatas et al., 2020; Ravensbergen et al., 2016; Tweedy et al., 2016a).

Despite significant progress in evidence-based classification, several challenges impede its full implementation in practice. One of the main concerns is the reliability and validity of impairment measurements. For example, isometric strength tests are more objective than manual testing, but their results can be affected by training adaptation or fluctuations in performance throughout the day (Beckman et al., 2017; Mann & Ravensbergen, 2018). Furthermore, there is a lack of standardized and universally recognised protocols for assessing muscle strength, range of motion, or coordination across different sports, which complicates the development of standardized testing batteries (Beckman et al., 2017; Tweedy et al., 2016a).

Another significant challenge is the great diversity of impairments. Since dozens of types of disabilities are represented at the Paralympic Games, developing specific and sensitive tests to detect their impact on sporting performance in a particular sport requires ongoing research. Some diagnoses, such as hypertonia, ataxia, or athetosis, are particularly difficult to assess accurately because available tests cannot capture subtle differences in their manifestations, which increases the risk of inaccurate classification or overgeneralization (Beckman et al., 2017; Tweedy et al., 2018).

The introduction of evidence-based classification also encounters practical obstacles related to technical equipment. Many precise testing tools used for performance assessment and biomechanics are costly, require operation by highly specialised professionals, or are not easily portable, being too bulky or heavy. This significantly hampers their use in real-world classification outside laboratory conditions and at regular competitive events (Morriën et al., 2017). These practical issues emphasise the need for research focused on developing cost-effective, robust, and portable testing solutions that can be consistently implemented across various competitive contexts (Wileman et al., 2024)

The introduction of scientific principles into classification in para sports has brought about visible improvements, especially in sports such as wheelchair racing and football for athletes with cerebral palsy (Reina et al., 2016). In these disciplines, the classification increasingly relies on verified data – that is, on a combination of reliable impairment measurements, statistical models, and expert assessment. Such an approach gradually replaces subjective classification practices and leads to more transparent, consistent, and better justifiable allocation of sports classes (Tweedy et al., 2018). For example, research in the field of wheelchair racing has demonstrated that cluster analysis of

isometric strength measurements can establish boundaries for sports classes that more accurately reflect differences in functional performance compared to traditional classification methods (Tweedy et al., 2018).

Similarly, in American football for athletes with cerebral palsy, studies have shown that motor tests—such as change of direction speed, sprint speed, and coordination—correlate with the severity of the disability and competitive performance, providing a basis for refining athletic class profiles and establishing minimum disability criteria (Patatas et al., 2020; Ravensbergen et al., 2016). These advances demonstrate that evidence-based classification systems have great potential – they help to reduce subjective decision-making, increase fairness among athletes, and contribute to making para-sport more competitive and equitable (Ravensbergen et al., 2016; Tweedy et al., 2016a).

Although remarkable progress has been made in the pursuit of evidence-based classification in para sport, continued research, innovation, and interdisciplinary collaboration will be essential to address the remaining challenges. By adopting an approach that combines robust scientific methodologies with practical implementation strategies, the para-sport community can ensure that every athlete has the opportunity to compete on equal terms, embodying the true spirit of sport and the relentless pursuit of excellence.

An interdisciplinary approach in research is also used in sports for intellectually impaired individuals (Van Biesen et al., 2014, 2021, 2022; Van Biesen, Hettinga, et al., 2016a; Van Biesen, Mac-tavish, et al., 2016; Vivaracho et al., 2019) from which we drew upon in the development of the classification model in this framework study.

3 Objective and Research Questions

The set of research questions was designed to build a coherent evidence pathway aligned with the principles of evidence-based classification: (i) clear definition of eligible impairment groups and associated sport classes, (ii) identification of performance demands in the sport, and (iii) selection and evaluation of candidate assessment tools that are reliable and capable of distinguishing relevant functional differences between classes. The programme deliberately prioritises athletes with intellectual impairment because this group has historically required particularly robust, sport-relevant evidence to support fair eligibility decisions and class allocation, and because para karate aims to develop classification evidence consistent with IPC standards and relevant Virtus frameworks.

3.1 Objective

The research aims to contribute to evidence-based classification in para karate by designing, evaluating, and applying sport-specific and generic functional assessment tools for athletes with disabilities, with a primary focus on those with intellectual impairment. The research seeks to generate transparent, fair, and functionally sensitive evidence inputs aligned with International Paralympic Committee (IPC) standards and relevant Virtus frameworks.

3.2 Research questions

- 1. What sport classes and eligibility pathways are currently applied for para karate athletes with intellectual impairment (including Down syndrome and autism), and what practical challenges arise in eligibility assessment?**

Article: Šport intelektuálne znevýhodnených: Oprávnenosť športovať na súťažiach intelektuálne znevýhodnených športovcov, športovcov s Downovým syndrómom, alebo autizmom

- 2. Which kata are most frequently performed in top-level para karate competitions by sport class, and do patterns of kata selection differ between classes?**

Article: Kata selection trends in top-level para karate competitions: a multi-championship study

- 3. Is MyJump2 sufficiently reliable (intra- and inter-rater) for quantifying execution time of selected karate techniques, supporting its feasibility as a low-cost standardised assessment tool in para karate contexts?**

Article: Intra- and Inter-rater Reliability of MyJump2 App in Measuring the Speed of Specific Karate Techniques

4. **What is the within-session test-retest reliability and measurement error of key force-plate countermovement-jump (CMJ) metrics in top-level para karate athletes in sport classes K21 (intellectual impairment) and K22 (Down syndrome), and which CMJ outcomes demonstrate sufficient usefulness (typical error relative to smallest worthwhile change) for practical monitoring and potential application as evidence inputs in classification research?**

Article:: Countermovement-Jump Test-Retest Reliability in Top-Level Para-Karate Athletes With Intellectual Impairment Using Kistler Force Plates

5. **Do posturography-derived centre-of-pressure metrics from a standardised 30-second bipedal stance test discriminate between top-level para karate athletes across impairment groups/classes (e.g., VI, II1, II2)?**

Article: Postural control in top-level Para Karate athletes with visual and intellectual impairment: an observational study

6. **Do top-level para karate athletes in the K21 and K22 sport classes differ in their cognitive and executive-function profiles when assessed with a standardised test battery used in intellectual-impairment classification?**

Article: Cognitive and executive functions of top-level para-karate athletes with intellectual disability

7. **To what extent does the kata memory test provide reproducible scores (test-retest) when rated by the same observer, and is the resulting reliability adequate for consideration as a candidate assessment within evidence-based classification development?**

Article: Reliability of the Sport-specific Test for Intellectually Impaired Para Karate Athletes

4 Methods

4.1 Study design

Empirical data were collected during the classification process at the World Para-Karate Championships (Budapest, 2023). The study used an observational cross-sectional design, capturing measurements at a single time point during the event. Classification was conducted over two days, typically 1–2 days prior to the start of the elimination rounds, and the assessment schedule was organised to minimise disruption to athletes' competition preparations. Testing sessions were time-slotted to reduce fatigue and avoid interference with pre-competition routines. All procedures, including the purpose and timing of the measurements, were communicated to athletes in advance via official pre-event email communications.

4.2 Sample

One hundred and ten athletes were classified across all sport classes, representing 100 per cent of the World Championship participants in our research project. The distribution of intellectually impaired sport classes, gender, and nationality is shown in Table 2.

Table 2: Participants of intellectually impaired categories overview

	Category						Total		
	K21			K22					
	Female	Male	Total	Female	Male	Total	Female	Male	Total
CANADA	1		1	1		1	2		2
CROATIA	0	1	1	1	1	2	1	2	3
EGYPT	0	1	1	2	2	4	2	3	5
FRANCE	1	0	1	0	1	1	1	1	2
GERMANY		2	2		1	1		3	3
HUNGARY	3	2	5	3	3	6	6	5	11
CHILE		1	1		0	0		1	1
ITALY	1	0	1	0	3	3	1	3	4
KAZAKHSTAN	1		1	0		0	1		1
NETHERLANDS	1		1	0		0	1		1
PORTUGAL		1	1		1	1		2	2
SERBIA	0	1	1	1	0	1	1	1	2
SLOVENIA	0		0	1		1	1		1
SPAIN	1	1	2	1	1	2	2	2	4
USA	1	0	1	0	1	1	1	1	2
Total	10	10	20	10	14	24	20	24	44
AGE	27.8±9.3	26.6±4.0	27.2±7.0	28.9±6.2	26.4±6.1	27.4±6.2	28.4±7.7	26.5±5.3	27.3±6.5

Across the empirical studies included in this cumulative habilitation thesis, participants were eligible if they were male or female top-level para karate athletes competing at the WKF World Karate Championships (Budapest, 2023) and undergoing the official classification process. This

included athletes entered in the intellectual impairment classes K21/K22 who fulfilled Virtus eligibility requirements (impairment of intellectual functioning with $IQ \leq 75$, limitations in adaptive behaviour, and evidence of onset during the developmental period; with additional significant impairment verification for K22), and—where applicable—athletes in the visual impairment category with ophthalmologist confirmation and minimum impairment criteria consistent with recognised medical standards (visual acuity LogMAR 1.0 [6/60] or worse and/or visual field restriction $< 40^\circ$ in diameter).

Exclusion criteria comprised any medical or orthopaedic problems that could compromise participation or performance in the testing protocols; any additional paper-specific eligibility or feasibility conditions are reported in the respective manuscripts.

4.3 Data collection procedures

The testing was carried out by a team of ten examiners, three of whom were official classifiers trained under the auspices of the WKF from Germany, Slovakia and USA. The remaining team members came from scientific and research institutions in Slovakia, the Czech Republic, and Belgium. All examiners were proficient in at least one foreign language (English); two also spoke German, and one team member was fluent in six languages (including French, Spanish, and Italian), which greatly facilitated smooth communication with participants from different countries and continents.

To ensure smooth running and technical support, two volunteers from the local organising committee (LOC) were also present to assist athletes in navigating, completing electronic questionnaires, and moving between rooms.

The testing took place simultaneously in three separate rooms, ensuring sufficient privacy, a quiet environment, and the standardised conditions required for the precise execution of the individual test protocols. The tests were sequenced to respect the classification logic and participants' physical exertion levels. A complete overview of the tests used is presented in Table 3.

All participating athletes ($n=110$) were informed in advance via the official communication channels of the World Karate Federation (WKF) that the event would include research on the development of evidence-based classification, an essential component of sports classification for inclusion in the Paralympic Games programme (Appendix 1). Before the competition, each participant was asked to complete an online questionnaire administered via the REDCap platform. The questionnaire included a digital version of the informed consent form, and participants could proceed to the next section only after providing consent. The software automatically translated the questions and information into participants' native languages, and those who required assistance in completing the questionnaire were provided with it. If, for various reasons, it was not possible to complete the consent form in advance, participants could complete the questionnaire on site using a computer set up in the waiting corridor outside the classification room.

Table 3: Table of tests and procedures used during the classification session

Domain	Test	K10 Visual impairment	K21 & K22 Intellectual impairment	K30 Physical impairment
<i>Administrative/medical</i>	Questionnaire	Yes	Yes	Yes
<i>Administrative/medical</i>	Interview	Yes	Yes	Yes
<i>Administrative/medical</i>	Documentation check	Yes	Yes	Yes
<i>Administrative/medical</i>	Medication check	Yes	Yes	Yes
<i>Physical performance</i>	Handgrip strength	Yes	Yes	Yes
<i>Physical performance</i>	CMJ / vertical jump	Yes	Yes	Yes
<i>Balance</i>	SWAY balance test	Yes, with and without blindfolds	Yes	Yes
<i>Cognitive (generic)</i>	Signal Reaction Time	No	Yes	No
<i>Cognitive (generic)</i>	Choice Reaction Time	No	Yes	No
<i>Executive function</i>	Inhibition task	No	Yes	No
<i>Attention</i>	Flanker task	No	Yes	No
<i>Motor control</i>	Force Block Test	No	Yes	No
<i>Motor speed</i>	Finger tapping	No	Yes	No
<i>Sport-specific</i>	Karate sequence/memory task	No	Yes	No
<i>Sport specific</i>	Wheelchair reach test	No	No	Yes
<i>Sport specific</i>	Wheelchair manoeuvrability	No	No	Yes
<i>Sport-specific</i>	Kata performance	Yes	Yes	Yes

**Note: Not all test outcomes are reported in this habilitation thesis, as analyses for some measures are reserved for manuscripts that are currently unpublished.*

Consent and ethical declarations

Subsequently, during classification, all participants signed a separate written consent form for the WKF, authorising the use of data collected during the classification process for research purposes. The study was approved by the Ethics Committee of the Faculty of Physical Education and Sport at Comenius University under the number EK/052023.

4.4 Statistical analysis

Statistical analyses were conducted in IBM SPSS (Windows/Macintosh; versions 21–23), with significance set at $p < .05$. Before inferential testing, distributional assumptions were assessed using the Shapiro–Wilk or Kolmogorov–Smirnov tests, supplemented, where relevant, by visual inspection of Q–Q plots and histograms.

Descriptive statistics were reported as mean $\pm$ SD for approximately normally distributed variables and as median [IQR] for non-normally distributed variables; outliers were identified using IQR-based decision rules. Where required to meet model assumptions, selected variables were log-transformed before multivariate analyses. Between-group comparisons were performed using parametric approaches (e.g., t-tests and MANOVA) when assumptions were met, and non-parametric approaches (e.g., Kruskal–Wallis tests with Mann–Whitney post hoc tests and Holm adjustment for multiple comparisons) when they were not.

Effect sizes were reported as appropriate to the analysis (e.g., Cohen's d , partial η^2 , and r). Reliability-focused studies quantified measurement properties using intraclass correlation coefficients (ICCs; including absolute-agreement models), alongside indices of absolute reliability/error (e.g., SEM, typical error, CV%), and interpretability thresholds (e.g., SWC, MDC). Agreement was also examined using Bland–Altman plots in rater-based protocols.

The full statistical specifications (including any paper-specific deviations) are reported in the Methods/Statistical Analysis sections of each included article.

5 Results

This cumulative thesis comprises seven publications that constitute a single, coherent research programme conducted under VEGA project No. 1/0611/23 and led by the author of the thesis. Accordingly, Table 4 summarises each included article in relation to its corresponding research question and its contribution as evidence input to the proposed sport-specific classification model, and it specifies the author's substantive contributions to the design, implementation, analysis, and translation of each study.

Table 4: Summary of included publications and author contributions (portfolio)

No.	Publication (short title)	Journal type and indexing	Linked RQ	Main evidence input	Author position	Contribution
1	Eligibility pathways and governance in athletes with intellectual impairment (incl. DS/autism)	Journal article (Journal of Physical Education and Sport)	RQ1	Defines the population and eligibility logic; clarifies practical challenges in eligibility assessment for II/DS/autism in para karate	Sole author; first and corresponding author	Conceptualisation; Methodology; Project administration; Supervision; Writing—review & editing; Knowledge translation (alignment with IPC/Virtus frameworks; implications for MIC/eligibility processes).
2	Kata selection trends in top-level para karate	Journal article (WoS Q1; multi-championship analysis)	RQ2	Sport-demand profiling (ecological validity): identifies kata performed by sport class; informs observation templates and sport-specific test design	First and corresponding author	Conceptualisation; Methodology; Formal analysis (oversight); Supervision; Writing—review & editing. Programme linkage: interprets selection patterns for class-relevant performance constraints.
3	MyJump2 reliability for technique execution time	Journal article (IDO MOVEMENT FOR CULTURE. Journal of Martial Arts Anthropology; WoS Q3 – Sport)	RQ3	Measurement-property evidence for a low-cost, field-deployable tool (intra-/inter-rater reliability)	Co-author; corresponding author; supervisor of the first author (doctoral researcher)	Conceptualisation; Methodology; Investigation (protocol development/coordination); Supervision; Writing—review & editing. Programme linkage: positions technique timing as a scalable evidence input for classification research.

No.	Publication (short title)	Journal type and indexing	Linked RQ	Main evidence input	Author position	Contribution
4	CMJ test–retest reliability using Kistler force plates (K21/K22)	Journal article (Adapted Physical Activity Quarterly, 2025; WoS Q2)	RQ4	Reliability, measurement error, and usefulness of force-plate CMJ metrics as candidate evidence inputs	Co-author (2nd)	Conceptualization; Methodology; Investigation (classification-session data collection coordination); Data curation; Supervision; Writing—review & editing; Project administration; Funding acquisition (via VEGA programme leadership).
5	Postural control in top-level para karate athletes with VI and II	Journal article (BMC Sports Science, Medicine and Rehabilitation, 2025; WoS Q1)	RQ5	Discriminative capacity of posturography-derived COP outcomes across impairment groupings; provides baseline balance indicators for evidence-based classification	Co-author (4th/last)	Conceptualization; Methodology; Investigation (classification-session testing coordination); Supervision; Writing—review & editing; Knowledge translation (implications for feasibility and future thresholds).
6	Cognitive and executive functions in top-level para karate athletes with II	Journal article (Psychology of Sport and Exercise; online/accepted 2026; DOI indicates 2025; WoS Q1)	RQ6	Class-related cognitive/executive profiles using a standardised II battery; identifies constructs relevant to kata performance, a candidate toll for general classification of	Shared first authorship; corresponding author	Conceptualization; Methodology; Investigation (testing delivery/coordination); Supervision; Writing—review & editing; Project administration. Programme linkage: integrates generic cognitive evidence into the sport-specific classification pathway.
7	Sport-specific kata memory test reliability (II/DS)	Conference abstract (ECSS Book of Abstracts, 2025)	RQ7	Reproducibility of an ecologically relevant sport-specific cognitive test (kata memory); candidate tool for sport-specific classification, stage 3	First author; presenter	Conceptualization; Methodology; Project administration; Supervision; Writing—review & editing; Knowledge translation (implications for implementation and subsequent MIC/threshold development).

5.1 Šport intelektuálne znevýhodnených: Oprávnenosť športovať na súťažiach intelektuálne znevýhodnených športovcov, športovcov s Downovým syndrómom, alebo autizmom

Dušana Augustovičová^{1,2}

¹Univerzita Komenského v Bratislave, Fakulta telesnej výchovy a športu

²Masarykova Univerzita v Brne, Fakulta sportovních studií

Publikované v: *Telesná výchova & šport*

Rok vydania: 2023

Metriky časopisu:

- ISSN tlačený: 1335-2245; ISSN elektronický: 2730-017X sclib.svkk.sk+3Sekarl+3sites.google.com+3
- Dvojročná periodicita (vychádza 2× ročne, júl a december) od roku 2022 v elektronickej podobe sites.google.com+2Fakulta telesnej výchovy a športu UK+2
- Vedecký a odborný recenzovaný časopis“ sclib.svkk.sk+3Sekarl+3sites.google.com+3
- Indexácia: časopis je uvedený v slovenskej databáze periodík, podľa záznamu v SEKARe a Ústrednom katalógu periodík; je tiež registrovaný v databáze ROAD (Register of Open Access Scholarly Resources) portal.issn.org+1

DOI / Link: [Google Drive – článok TV&Š](#)

Príspevok k cieľom habilitačnej práce:

- Tento článok rozpracováva tému oprávnenosti športovcov s intelektuálnym znevýhodnením – vrátane osôb s Downovým syndrómom či autizmom – v súťažiach v rámci kategórie ID.
- Napĺňa cieľ práce v oblasti legitimizácie klasifikačných kritérií a posilňuje argumentáciu pre potrebu „evidence-based“ klasifikácie.
- Príslušný článok sa zameriava na širšiu diskusiu kategórie oprávnenosti, čo predstavuje východzí teoretický základ pre formovanie MIC a modelov triedenia v ďalších empirických štúdiách v slovenskom jazyku, aby boli informácie o klasifikácii prístupné pre slovenskú a českú športovú obec

Úvod

Potvrdenie spôsobilosti a klasifikácia sú nevyhnutné postupy pre spravodlivú súťaž v parašporte. Klasifikáciu musia podstúpiť všetci športovci, ktorí majú ambíciu súťažiť na medzinárodných podujatiach vysokého významu a vykonáva sa za účelom minimalizovať rozdiely v úrovni znevýhodnenia medzi športovcami (Tweedy & Vanlandewijck, 2011) a za dodržiavania prísnych pravidiel jeden, alebo dva dni pred súťažou špeciálne vyškoleným tímom odborníkov (klasifikátormi). V paralympijských športoch je klasifikácia povinná. Klasifikáciu športovcov s intelektuálnym znevýhodnením, Downovým syndrómom, alebo autizmom riadi celosvetová organizácia VIRTUS, ktorá je členom Svetového paralympijského hnutia a podľa najnovších výskumov v tejto oblasti by sa mala skladať zo štyroch krokov (Van Biesen et al., 2021).

V počiatočných klasifikáciách však prevládal medicínsky (na základe diagnózy) a funkčný prístup. Tieto systémy, ktoré sa väčšinou spoliehali na odborný lekársky posudok, boli z veľkej časti teoretické a chýbal v nich popis vzťahu medzi znevýhodnením športovca a jeho športovým výkonom. To vyvolalo obavy o vhodnosti použitia týchto prístupov (Tweedy, 2002). Preto Medzinárodný paralympijský výbor (MPV) a kódex klasifikácie športovcov zaviedol požiadavku, aby všetky para športy iniciovali multidisciplinárny výskum s cieľom vyvinúť vlastný systém klasifikácie špecifický pre daný šport a potrebu, aby tieto systémy boli založené na dôkazoch a teda výskume.

Jedno až tri percentá svetovej populácie tvoria ľudia s II (Paschos, 2008), ktorí by mali mať možnosť vybrať si zo širokého spektra športov, v ktorých môžu dosiahnuť majstrovstvo na najvyššej kvalitatívnej úrovni. Športy v ktorých boli zaradené športové triedy s II boli do programu PH vrátené v Londýne 2012. A to až potom, čo splnili dve základné podmienky:

1. osvedčené, platné a spoľahlivé postupy hodnotenia znevýhodnenia, a
2. implementácia špecifických kritérií na hodnotenie minimálneho znevýhodnenia v športe.

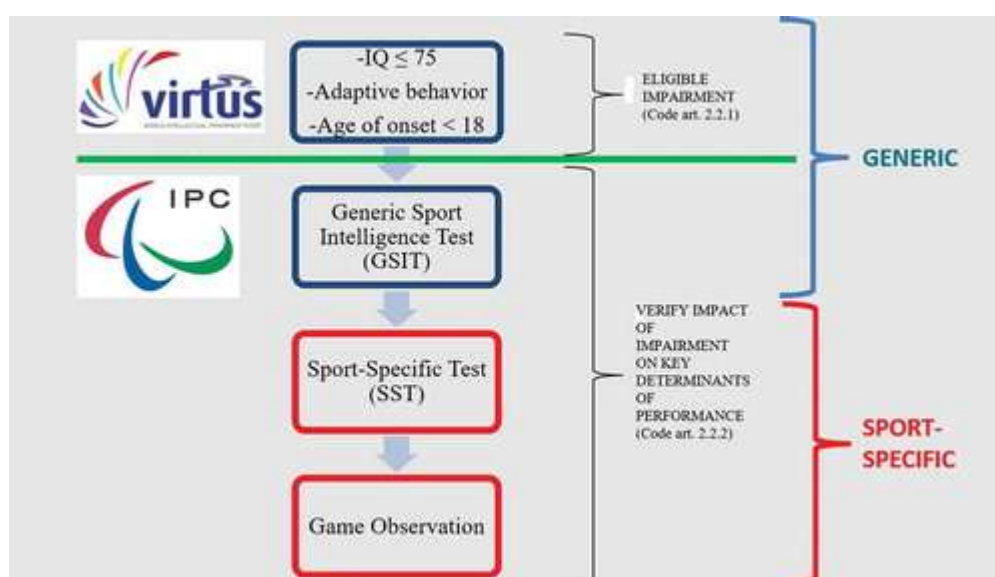
Každý klasifikačný systém medzinárodnej športovej federácie musí uvádzať, ako znevýhodnenie vplýva na kľúčové determinanty ŠV v konkrétnom športe.

Prvé dva zo štvorkrokovej klasifikácie sú spoločné pre každý II-šport a druhé dva kroky sú špecifické pre daný šport. Posúdenie prvého kroku vykonáva VIRTUS, zatiaľ čo ďalšie tri kroky by mal vykonať klasifikačný panel ustanovený medzinárodnou športovou federáciou (obr. 1).

1. splnenie minimálnych kritérií. VIRTUS uznáva definíciu II poskytnutú Svetovou zdravotníckou organizáciou a Americkou asociáciou pre mentálne a vývojové poruchy (AAIDD), ktorá stanovuje tri podmienky, ktoré by mal športovec preukázať: $IQ \leq 75$, obmedzenie v

- prispôsobenom správaní a postihnutie musí byť evidentné už počas vývinového obdobia (do 22. roku života).
2. Hodnotenie športovej inteligencie športovca vykonaním všeobecného kognitívneho testu. Hodnotenie športovej inteligencie sa zameriava len na kognitívne schopnosti, ktoré sú v športe nevyhnutné, pričom ostatné všeobecné kognitívne faktory nie sú relevantné v športových situáciách.
 3. Športovci vykonajú športovo špecifický test, v ktorom sa hodnotia kľúčové determinanty ŠV.
 4. Pozorovanie počas súťaže. Hodnotenie športovca prostredníctvom pozorovania (napr. celková športová zdatnosť, fyzický profil, technické a taktické schopnosti) dopĺňa hodnotenie športovca.

Vplyv znevýhodnenia na športový výkon sa v jednotlivých športoch líši. Stolní tenisti s II vykazovali zníženú taktickú zdatnosť v porovnaní s hráčmi bez II (Van Biesen et al., 2014). Čo sa týka plaveckých výkonov, technické zručnosti sú ovplyvnené oslabením. Plavci s Downovým syndrómom mali iné variácie intracyklickej rýchlosti a nižší index koordinácie ako športovci bez II, čo ovplyvnilo silový gradient aj výkon (Marques-Aleixo et al., 2013). V behoch na dlhé trate športovci s II vykazovali ťažkosti pri udržiavaní bežeckého tempa, chýbala im schopnosť udržať vopred plánovanú submaximálnu rýchlosť (Van Biesen, Hettinga, et al., 2016a).



Obr. 1 Konceptuálny model klasifikácie športovcov s intelektuálnym znevýhodnením (Van Biesen et al., 2021)

Športové triedy (skupiny)

Intelektuálne znevýhodnenie je globálny (alebo zastrešujúci) termín pre celý rad kognitívnych a vývinových porúch. Preto VIRTUS, aby zabezpečil čo možno najspravodlivejšiu súťaž, minimalizovanie vplyvu znevýhodnenia na športový výkon VIRTUS rozdeľuje II športovcov do troch „kategórií“, športových tried:

III Športovci s mentálnym postihnutím

Toto je skupina pre športovcov s intelektuálnym znevýhodnením s najdlhšou tradíciou a je zahrnutá (v niektorých športoch) do paralympijských hier (PH). Športovci klasifikovaní v tejto športovej triede môžu na PH súťažiť v plávaní, atletike a stolnom tenise v S14, T/F20 a triede 11. Klasifikácia do tejto športovej triedy je založená na výskume a usmerneniach Svetovej zdravotníckej organizácie (WHO) a Americkej asociácie pre mentálne a vývojové postihnutia (AAIDD).

Aby mohol byť športovec zaradený v tejto športovej triede musí spĺňať tieto podmienky:

- IQ 75 alebo nižšie,
- Významné obmedzenia v adaptívnom správaní vyjadrené v koncepčných, sociálnych a praktických adaptačných schopnostiach,
- Znevýhodnenie musí byť diagnostikované pred dovŕšením 22. roku života (t. j. vo vývinovom štádiu života).

Športovci v skupine III1 musia počas súťaže prekonať určité výzvy. Patria medzi ne napr. udržať správne tempo počas pretekov, taktika a adaptácia na zmeny v súťaži, ako sú body vzletu pri skokoch a pod.

III2 Športovci s mentálnym znevýhodnením a významným dodatočným znevýhodnením ako napr. Downov syndróm

Je veľmi bežné, že ľudia s intelektuálnym znevýhodnením majú aj fyzické a/alebo zmyslové znevýhodnenia, ako je detská mozgová obrna alebo zrakové znevýhodnenie. Ďalšie pridružené znevýhodnenia môžu zahŕňať rozdiely v anatomických a svalových štruktúrach, problémy so srdcovo-cievny, či dýchacím systémom. Intelektuálne a telesné/zmyslové znevýhodnenia sa často ovplyvňujú spoločne, čo znamená, že športovci sa musia prispôbiť a prekonať viacero prekážok naraz.

Downov syndróm je najbežnejšou formou geneticky identifikovaného intelektuálneho znevýhodnenia. Aby mohol byť športovec zaradený v tejto športovej triede musí spĺňať podmienky triedy III1 a musí mať pridružené iné závažné znevýhodnenie.

II3 Športovci s autizmom

Autizmus alebo porucha autistického spektra, PAS (angl. Autism Spectrum Disorder, ASD) je neurologická a vývojová porucha, ktorá zasahuje oblasť interakcie k ostatným ľuďom, komunikáciu voči okoliu a správanie k ostatným ľuďom. Napriek tomu, že PAS môže byť diagnostikovaný v ktoromkoľvek veku, opisuje sa ako "vývojová porucha", pretože príznaky sa najčastejšie prejavujú v prvých dvoch rokoch života. Povedomie o autizme a ASD rastie na celom svete u dospelých aj detí. Približne 60 až 70 percent detí s diagnostikovaným autizmom má tiež diagnostikované intelektuálne znevýhodnenie. Niektorí ľudia však nemajú intelektuálne znevýhodnenie a tento stav sa predtým označoval ako Aspergerov syndróm alebo sa niekedy nazýva vysoko funkčným autizmom.

VIRTUS vytvoril príležitosť na zmenu života a umožnila ľuďom s autizmom súťažiť a športovať na najvyššej výkonnostnej úrovni. Aby mohol byť športovec zaradený v tejto športovej triede musí spĺňať tieto podmienky:

- Formálna diagnóza autizmu (ASD) vykonaná kvalifikovaným lekárom s použitím akceptovaných diagnostických techník diagnostiky autizmu.

Čo potrebuje športovec na to aby mohol byť klasifikovaný VIRTUSom?

Je potrebné vyplniť formulár Žiadosť a doložiť:

- Fotka na pas,
- Fotokópia pasu,
- Psychologické správy:
 - Významné narušenie intelektuálneho fungovania – musí sa posúdiť pomocou medzinárodne uznávaného a odborne spravovaného IQ testu ako napr.:
 - Wechsler Intelligence Scale – WISC (vo veku 6 – 16 rokov) a WAIS (vo veku 16 – 90 rokov) vrátane regionálnych variácií ako HAWIE, S-SAIS a MAWIE. (Poznámka: WASI nie je akceptovaný)
 - Progresívne matice Raven (Poznámka: CTZ nie je akceptovaná)
 - Významné obmedzenia v adaptívnom správaní Vineland Adaptiv Behavior Scale, ABAS alebo AAMR adaptívne škály správania.
- Povinné len pre športovcov s Downovým syndrómom)

- Cytogenetický test (potvrdenie trizómie 21),
- FAST assesment,
- Potvrdenie o asymptomatickosti AAI (röntgen krčnej chrbtice).

- Aksović, N., Dobrescu, T., Bubanj, S., Bjelica, B., Milanović, F., Kocić, M., Zelenović, M., Radenković, M., Nurkić, F., Nikolić, D., Marković, J., Tomović, M., & Vulpe, A. M. (2023). Sports Games and Motor Skills in Children, Adolescents and Youth with Intellectual Disabilities. In *Children* (Vol. 10, Issue 6). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/children10060912>
- Arbour-Nicitopoulos, K. P., Bruno, N., Orr, K., O'rourke, R., Wright, V. 2, Renwick, R., Bobbie, K., & Noronha, J. (n.d.). *Quality of Participation Experiences in Special Olympics Sports Programs 1*.
- Augustovicova, D., Hadza, R., Magyar, A., Biesen, D. Van, & Hruby, M. (2025). *Kata selection trends in top-level para-karate competitions : a multi-championship study*.
- Beckman, E. M., Connick, M. J., & Tweedy, S. M. (2017). Assessing muscle strength for the purpose of classification in Paralympic sport: A review and recommendations. In *Journal of Science and Medicine in Sport* (Vol. 20, Issue 4). <https://doi.org/10.1016/j.jsams.2016.08.010>
- Burns, J. (2015). The impact of intellectual disabilities on elite sports performance. *International Review of Sport and Exercise Psychology*, 8(1), 251–267. <https://doi.org/10.1080/1750984X.2015.1068830>
- Burns, J., Van Biesen, D., Dreegia, W., & Johanna, F. (2020). *The Impact of Cognitive Functions and Intellectual Impairment on Pacing and Performance 4 in Sports*. www.idealproject.org
- Cabeza-Ruiz, R., Sánchez-López, A. M., Trigo, M. E., & Gómez-Píriz, P. T. (2020). Feasibility and reliability of the Assessing Levels of Physical Activity health-related fitness test battery in adults with intellectual disabilities. *Journal of Intellectual Disability Research*, 64(8), 612–628. <https://doi.org/10.1111/jir.12756>
- Campanella, M., Cardinali, L., Ferrari, D., Migliaccio, S., Silvestri, F., Falcioni, L., Bimonte, V., Curzi, D., Bertollo, M., Bovolon, L., Gallotta, M., Guidetti, L., Baldari, C., & Bonavolontà, V. (2024). Effects of Fitlight training on cognitive-motor performance in élite judo athletes. *Heliyon*, 10 7. <https://doi.org/10.1016/j.heliyon.2024.e28712>
- Cavaggioni, L., Ardigò, L., Castiglioni, P., Trecroci, A., Casalini, L., Formenti, D., & Merati, G. (2024). A crossover study on attentional focus and gross motor performance in individuals with Down syndrome. *PLOS ONE*, 19. <https://doi.org/10.1371/journal.pone.0305267>
- Cavaggioni, L., Formenti, D., Casalini, L., Granito, F., Magro, C., Manente, A., Canton, S., Lovecchio, N., Castiglioni, P., & Merati, G. (2025). Exploring the relationship between cognitive abilities and motor performance in athletes with intellectual disabilities. *Frontiers in Sports and Active Living*, 7. <https://doi.org/10.3389/fspor.2025.1601355>
- Chaabène, H., Hachana, Y., Franchini, E., Mkaouer, B., & Chamari, K. (2012). Physical and physiological profile of elite karate athletes. In *Sports Medicine*. <https://doi.org/10.2165/11633050-000000000-00000>
- Cheng, H. Y. K., Shieh, W. Y., Yu, Y. C., Li, P. W., & Ju, Y. Y. (2023). Video-Based Behaviorally Coded Movement Assessment for Adolescents with Intellectual Disabilities: Application in Leg Dribbling Performance. *Sensors*, 23(1). <https://doi.org/10.3390/s23010179>

- Connick, M. J., Beckman, E., & Tweedy, S. M. (2018). Evolution and development of best practice in paralympic classification. In *The Palgrave Handbook of Paralympic Studies*. https://doi.org/10.1057/978-1-137-47901-3_18
- Coswig, V., Silva, A. D. A. C. E., Barbalho, M., de Faria, F. R., Nogueira, C. D., Borges, M., Buratti, J. R., Vieira, I. B., Román, F. J. L., & Gorla, J. I. (2019). Assessing the validity of the MyJUMP2 app for measuring different jumps in professional cerebral palsy football players: An experimental study. *JMIR MHealth and UHealth*, 7(1). <https://doi.org/10.2196/11099>
- Downs, S. J., Boddy, L. M., McGrane, B., Rudd, J. R., Melville, C. A., & Foweather, L. (2020). Motor competence assessments for children with intellectual disabilities and/or autism: A systematic review. In *BMJ Open Sport and Exercise Medicine* (Vol. 6, Issue 1). BMJ Publishing Group. <https://doi.org/10.1136/bmjsem-2020-000902>
- Fliess Douer, O., Koseff, D., Tweedy, S., Molik, B., & Vanlandewijck, Y. (2021). Challenges and opportunities in wheelchair basketball classification– A Delphi study. *Journal of Sports Sciences*, 39(sup1). <https://doi.org/10.1080/02640414.2021.1883310>
- Frutos, J. G.-D., López-Plaza, D., Martínez-Noguera, F., Sanz-Matesanz, M., Martínez-Rodríguez, A., & Martínez-Aranda, L. (2025). Specific Physical and Nutritional Preparation of a Professional Kata Karate Athlete: A Case Study with a Bronze Medallist from the Pan American Games. *Nutrients*, 17. <https://doi.org/10.3390/nu17020306>
- García-Fresneda, A., Theodorou, A. S., Panoutsakopoulos, V., Jordán, M. A. T., Padullés, J. M., Padullés, X., & Kotzamanidou, M. C. (2022). Step regulation in Paralympic long jumpers with intellectual impairment. *European Journal of Adapted Physical Activity*, 15. <https://doi.org/10.5507/EUJ.2022.004>
- Gilderthorp, R., Burns, J., & Jones, F. (2018). Classification and Intellectual Disabilities: An Investigation of the Factors That Predict the Performance of Athletes With Intellectual Disability. *Journal of Clinical Sport Psychology*. <https://doi.org/10.1123/jcsp.2017-0018>
- Ioannides, C., Despotopoulou, C., Hadjicharalambous, M., & Zaras, N. (2024). Effects of Warm-Ups with Weighted Vests and Resistance Bands on Physical Fitness and Combat Ability of Kumite Karate Athletes. *Sports*, 12(3). <https://doi.org/10.3390/sports12030079>
- IPC CLASSIFICATION CODE (2025). [https://www.paralympic.org/sites/default/files/2025-02/IPC Classification Code and International Standards 01_01_2025.pdf](https://www.paralympic.org/sites/default/files/2025-02/IPC%20Classification%20Code%20and%20International%20Standards%2001_01_2025.pdf)
- Johnson, M. E., & David, H. M. (2021). Development of evidence-based classification for para surfers with physical impairments: A narrative review. *PM&R*, 14(10), 1227–1240. <https://doi.org/10.1002/pmrj.12674>
- Kobayashi-Cuya, K., Sakurai, R., Sakuma, N., Suzuki, H., Ogawa, S., Takebayashi, T., & Fujiwara, Y. (2023). Bidirectional associations of high-level cognitive domains with hand motor function and gait speed in high-functioning older adults: A 7-year study. *Archives of Gerontology and Geriatrics*, 117, 105232. <https://doi.org/10.1016/j.archger.2023.105232>
- Krabben, K. J., Ravensbergen, R. H. J. C., Nakamoto, H., & Mann, D. L. (2019). The development of evidence-based classification of vision impairment in Judo: A Delphi study. *Frontiers in Psychology*, 10(FEB). <https://doi.org/10.3389/fpsyg.2019.00098>
- Lee, R., Pinder, R., Haydon, D., Winter, L., & Crowther, R. (2024). What gaps exist in biomechanics and motor control research in Paralympic sports? A scoping review focussed on performance and injury risk. *Journal of Sports Sciences*, 42, 2073–2082. <https://doi.org/10.1080/02640414.2024.2415214>

- Leisman, G., Moustafa, A., & Shafir, T. (2016). Thinking, Walking, Talking: Integratory Motor and Cognitive Brain Function. *Frontiers in Public Health*, 4. <https://doi.org/10.3389/fpubh.2016.00094>
- Liu, J., Yu, H., Cheung, W., Bleakney, A., & Jan, Y.-K. (2025). A systematic review of pathophysiological and psychosocial measures in adaptive sports and their implications for coaching practice. *Heliyon*, 11. <https://doi.org/10.1016/j.heliyon.2025.e42081>
- Mann, D. L., & Ravensbergen, H. J. C. (2018). International Paralympic Committee (IPC) and International Blind Sports Federation (IBSA) Joint Position Stand on the Sport-Specific Classification of Athletes with Vision Impairment. *Sports Medicine*, 48(9). <https://doi.org/10.1007/s40279-018-0949-6>
- Mann, D. L., Tweedy, S. M., Jackson, R. C., & Vanlandewijck, Y. C. (2021). Classifying the evidence for evidence-based classification in Paralympic sport. In *Journal of Sports Sciences* (Vol. 39, Issue sup1). <https://doi.org/10.1080/02640414.2021.1955523>
- Marques-Aleixo, I., Querido, A., Figueiredo, P., Vilas-Boas, J. P., Corredeira, R., Daly, D., & Fernandes, R. J. (2013). Intracyclic velocity variation and arm coordination assessment in swimmers with Down syndrome. *Adapted Physical Activity Quarterly*, 30(1). <https://doi.org/10.1123/apaq.30.1.70>
- Meijer, J., De Jonge, M., Leenen, S., Van Beek, P., De Kort, E., Vugs, B., & Andriessen, P. (2025). From movement to mind: Early fine motor skills are associated with cognitive performance at school age in very preterm infants. *Early Human Development*, 201, 106197. <https://doi.org/10.1016/j.earlhumdev.2025.106197>
- Molinaro, L., Taborri, J., Montecchiani, M., & Rossi, S. (2020). Assessing the Effects of Kata and Kumite Techniques on Physical Performance in Elite Karatekas. *Sensors (Basel, Switzerland)*, 20. <https://doi.org/10.3390/s20113186>
- Moreno-Azze, A., Prad-Lucas, E., Soñén, D. F., De La Fuente, F. P., & Falcón-Miguel, D. (2023). Plyometric Training's Effects on Young Male Karatekas' Jump, Change of Direction, and Inter-Limb Asymmetry. *Sports*, 12. <https://doi.org/10.3390/sports12010001>
- Morriën, F., Taylor, M. J. D., & Hettinga, F. J. (2017). Biomechanics in paralympics: Implications for performance. In *International Journal of Sports Physiology and Performance* (Vol. 12, Issue 5). <https://doi.org/10.1123/ijsp.2016-0199>
- Para Karate Classification Rules (2021). <https://www.wkf.net/structure-statutes-rules>
- Para-Karate Kata Competition Rules, 1 (2023). <https://www.wkf.net/structure-statutes-rules>
- Paschos, D. (2008). Intellectual Disability: Understanding its Development, Causes, Classifications, Evaluation, and Treatment. *Child and Adolescent Mental Health*, 13(4). https://doi.org/10.1111/j.1475-3588.2008.00513_3.x
- Patatas, J. M., De Bosscher, V., Derom, I., & Winckler, C. (2020). Stakeholders' perceptions of athletic career pathways in Paralympic sport: from participation to excellence. *Sport in Society*. <https://doi.org/10.1080/17430437.2020.1789104>
- Pinilla, J., Pérez-Tejero, J., Sampedro, J., Refoyo, I., Lorenzo, A., Lorenzo, J., Van Biesen, D., & Vanlandewijck, Y. (2016). Influence of intellectual impairment (II) on basketball players' capacity to solve a game situation: towards evidence-based classification systems in II-basketball. *Psychology*, 8(2), 121–134.
- Powis, B., & Macbeth, J. L. (2020). "We know who is a cheat and who is not. But what can you do?": Athletes' perspectives on classification in visually impaired sport. *International Review for the Sociology of Sport*, 55(5). <https://doi.org/10.1177/1012690218825209>

- Puce, L., Zmijewski, P., Bragazzi, N., & Trompetto, C. (2024). Comparative Pacing Profile and Chronometric Performance in Elite Swimmers with Intellectual Impairments and Able-Bodied Athletes. *Life*, 14. <https://doi.org/10.3390/life14121623>
- Ravensbergen, H. J. C. R., 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(7). <https://doi.org/10.1136/bjsports-2015-095434>
- Reina, R., Iturricastillo, A., Castillo, D., Urbán, T., & Yanci, J. (2020). Activity limitation and match load in para-footballers with cerebral palsy: An approach for evidence-based classification. *Scandinavian Journal of Medicine and Science in Sports*, 30(3). <https://doi.org/10.1111/sms.13583>
- Reina, R., Sarabia, J. M., Yanci, J., García-Vaquero, M. P., & Campayo-Piernas, M. (2016). Change of direction ability performance in cerebral palsy football players according to functional profiles. *Frontiers in Physiology*, 6(JAN). <https://doi.org/10.3389/fphys.2015.00409>
- Ren, J., Wu, Y., Chan, J., & Yan, J. (2013). Cognitive aging affects motor performance and learning. *Geriatrics & Gerontology International*, 13. <https://doi.org/10.1111/j.1447-0594.2012.00914.x>
- Scharfen, H.-E., & Memmert, D. (2019). The Relationship Between Cognitive Functions and Sport-Specific Motor Skills in Elite Youth Soccer Players. *Frontiers in Psychology*, 10. <https://doi.org/10.3389/fpsyg.2019.00817>
- Smith, R., Connick, M., Beckman, E., Hogarth, L., & Nicholson, V. (2021). Establishing the reliability of instrumented trunk impairment assessment methods to enable evidence-based classification in Para swimming. *Journal of Sports Sciences*, 39(sup1). <https://doi.org/10.1080/02640414.2021.1930699>
- Staiano, W., Bonet, L. R. S., Romagnoli, M., & Ring, C. (2023). Mental fatigue impairs repeated sprint and jump performance in team sport athletes. *Journal of Science and Medicine in Sport*. <https://doi.org/10.1016/j.jsams.2023.10.016>
- Stockley, R., George, L. B. S., Alexander, J., & ... (2022). A synthesis of potential impairment assessment tools for Para dressage classification. *European Journal of ...*
- Thomas, J., Hall, J., & Guess, T. (2025). Countermovement Jump Performance Is Altered by Visual and Auditory Cognitive Dual Tasking in Recreationally Active Young Adults: A Cross-Sectional Study. *Journal of Sport Rehabilitation*, 1–10. <https://doi.org/10.1123/jsr.2024-0265>
- Tweedy, S. M. (2002). Taxonomic theory and the ICF: Foundations for a unified disability athletics classification. *Adapted Physical Activity Quarterly*, 19(2). <https://doi.org/10.1123/apaq.19.2.220>
- Tweedy, S. M., Beckman, E. M., & Connick, M. J. (2014). Paralympic Classification: Conceptual Basis, Current Methods, and Research Update. *PM&R*, 6(8S). <https://doi.org/10.1016/j.pmrj.2014.04.013>
- Tweedy, S. M., Connick, M. J., & Beckman, E. M. (2018). Applying Scientific Principles to Enhance Paralympic Classification Now and in the Future: A Research Primer for Rehabilitation Specialists. In *Physical Medicine and Rehabilitation Clinics of North America* (Vol. 29, Issue 2). <https://doi.org/10.1016/j.pmr.2018.01.010>
- Tweedy, S. M., Mann, D., & Vanlandewijck, Y. C. (2016a). Research needs for the development of evidence-based systems of classification for physical, vision, and intellectual impairments. In *Handbook of Sports Medicine and Science: Training and Coaching the Paralympic Athlete*. <https://doi.org/10.1002/9781119045144.ch7>

- Tweedy, S. M., & Vanlandewijck, Y. C. (2011). International Paralympic Committee position stand-background and scientific principles of classification in Paralympic sport. In *British Journal of Sports Medicine* (Vol. 45, Issue 4). <https://doi.org/10.1136/bjsm.2009.065060>
- Van Biesen, D., Augustovičová, D., Pineda, R. C., Nemček, D., & Burns, J. (2026). Cognitive and executive functions of top level para-karate athletes with intellectual disability. *Psychology of Sport and Exercise*, 82. <https://doi.org/10.1016/j.psychsport.2025.102998>
- Van Biesen, D., Burns, J., Mactavish, J., Van de Vliet, P., & Vanlandewijck, Y. (2021). Conceptual model of sport-specific classification for para-athletes with intellectual impairment. *Journal of Sports Sciences*, 39(sup1), 19–29. <https://doi.org/10.1080/02640414.2021.1881280>
- Van Biesen, D., Hettinga, F. J., McCulloch, K., & Vanlandewijck, Y. (2016). Pacing profiles in competitive track races: Regulation of exercise intensity is related to cognitive ability. *Frontiers in Physiology*, 7(DEC). <https://doi.org/10.3389/fphys.2016.00624>
- Van Biesen, D., Mactavish, J., Kerremans, J., & Vanlandewijck, Y. C. (2016). Cognitive predictors of performance in well-trained table tennis players with intellectual disability. *Adapted Physical Activity Quarterly*. <https://doi.org/10.1123/APAQ.2015-0122>
- Van Biesen, D., Mactavish, J., & Vanlandewijck, Y. (2014). Tactical proficiency among table tennis players with and without intellectual disabilities. *European Journal of Sport Science*, 14(5). <https://doi.org/10.1080/17461391.2013.825645>
- Van Biesen, D., McCulloch, K., & Vanlandewijck, Y. (2018). Comparison of shot-put release parameters and consistency in performance between elite throwers with and without intellectual impairment. *International Journal of Sports Science & Coaching*, 13, 86–94. <https://doi.org/10.1177/1747954117707483>
- Van Biesen, D., Van Damme, T., Pineda, R. C., & Burns, J. (2022). The impact of intellectual disability and sport expertise on cognitive and executive functions. *Journal of Intellectual Disabilities*. <https://doi.org/10.1177/17446295211036331>
- Vivaracho, I., Vanlandewijck, Y., & Van Biesen, D. (2019). Initial steps towards evidenced-based classification for Taekwondo poomsae athletes with intellectual impairments: a pilot study. *European Journal of Adapted Physical Activity*, 11(2), 1–14. <https://doi.org/10.5507/euj.2018.006>
- Wang, Z., Wang, J., Guo, J., Dove, A., Arfanakis, K., Qi, X., Bennett, D., & Xu, W. (2023). Association of Motor Function With Cognitive Trajectories and Structural Brain Differences. *Neurology*, 101. <https://doi.org/10.1212/wnl.0000000000207745>
- Weng, W.-H., Yeh, N.-C., Yang, Y.-R., & Wang, R.-Y. (2025). Effects of motor-cognitive training on cognitive function and gait performance in older adults with dementia: a systematic review and meta-analysis. *Scientific Reports*, 15. <https://doi.org/10.1038/s41598-025-09582-y>
- Wileman, T. M., McKay, M. J., Hackett, D. A., Watson, T. J., Fleeton, J., & Fornusek, C. (2024). Guiding Evidence-Based Classification in Para Sporting Populations: A Systematic Review of Impairment Measures and Activity Limitations. *Sports Medicine*, 55(2), 341–391. <https://doi.org/10.1007/s40279-024-02132-y>
- Wileman, T., McKay, M., Hackett, D., Watson, T., Fleeton, J., & Fornusek, C. (2024). Guiding Evidence-Based Classification in Para Sporting Populations: A Systematic Review of Impairment Measures and Activity Limitations. *Sports Medicine (Auckland, N.z.)*, 55, 341–391. <https://doi.org/10.1007/s40279-024-02132-y>
- WKF. (2023). *WKF joins Virtus to further develop Para-Karate*. <https://www.wkf.net/news-center-new/wkf-joins-virtus-to-further-develop-para-karate/1415>

WKF Para Karate Strategic and Development Plan (2022). <http://www.wkf.net>

Zago, M., Mapelli, A., Shirai, Y., Ciprandi, D., Lovecchio, N., Galvani, C., & Sforza, C. (2015). Dynamic balance in elite karateka. *Journal of Electromyography and Kinesiology : Official Journal of the International Society of Electrophysiological Kinesiology*, 25 6, 894–900. <https://doi.org/10.1016/j.jelekin.2015.10.002>

Zaino, M., Shaaban, E. E., Shubayr, N., & El-Setouhy, M. (2025). Adapting and Validating a Motor Intelligence Assessment Tool for Children with Intellectual Disabilities: Prioritizing Movement and Sensory-Motor Integration. In *International Journal of Statistics in Medical Research* (Vol. 14).

5.2 Kata selection trends in top-level para-karate competitions: a multi-championship study

Published in: *BMC Sports Science, Medicine and Rehabilitation*

Year of publication: 2025

Journal characteristics:

- An open-access peer-reviewed scientific journal
- The study has the character of a multi-championship analysis

Contribution to the aims of the habilitation thesis:

- The article situates performance in para karate within a sport-specific context by examining which kata are most frequently performed at top-level competitions in individual sport classes.
- It fulfils the objective of the habilitation thesis in the area of *sport-demand profiling* by identifying the actual competitive demands of kata and by providing an ecologically valid foundation for the development of observational templates and other sport-specific assessment procedures.
- The results contribute to the interpretation of performance limitations associated with specific sport classes and constitute an important starting point for the development of evidence-based classification in para karate.

RESEARCH

Open Access



Kata selection trends in top-level para-karate competitions: a multi-championship study

Dusana Augustovicova^{1,2*}, Radovan Hadza¹, Adrian Magyar³, Debbie Van Biesen⁴ and Michal Hruby²

Abstract

Purpose Para-karate has been gaining popularity rapidly; however, scientific research on the subject remains limited. This study aims to examine the kata preferences at top-level para-karate events and explore the relationship between sport class (type of impairment) and kata selection.

Methods Data was collected from nine events—four World Para-Karate Championships (2016, 2018, 2021, 2023) and five European Para-Karate Championships (2018, 2019, 2021, 2022, 2023). A total of 906 katas were performed: 567 by males and 339 by females. Descriptive statistics and chi-square tests were used for analysis.

Results Top-level para-karate athletes utilized 62 katas (61%) from the official WKF list (102 katas). The most popular katas were Gojushiho Sho (19.9%), Unsu (11.5%), Kanku Sho (9.5%), Suparinpei (6.7%), and Jion (6.2%). A significant relationship was found between sport class and kata selection ($p \leq 0.05$). The most popular kata for K30 was Unsu (15%), while K10 and K21 + K22 classes predominantly chose Gojushiho Sho (16.6% and 30.3%, respectively).

Conclusions Kata selection for para-karate athletes is influenced by the type of impairment. Intellectually impaired athletes and their coaches often select a single, challenging kata with a balanced fast-to-slow movement ratio, such as Gojushiho Sho, to optimize performance.

Highlights

This work provides an insight into the preference of kata according to the sports class of competitors and their coaches in the monitored period of para-karate top-level competitions which does not differ of non-impaired competitors in recent years.

Keywords Intellectual impairment, Physical impairment, Visual impairment, Classification, Down syndrome

*Correspondence: Dusana Augustovicova, augustovicova.dusana@gmail.com

¹Comenius University in Bratislava, Bratislava, Slovakia

²Masaryk University in Brno, Brno, Czech Republic

³Hungarian University of Sports Science, Budapest, Hungary ⁴KU Leuven, Leuven, Belgium



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

5.3 Intra- and Inter-rater Reliability of MyJump2 App in Measuring the Speed of Specific Karate Techniques

Published in: *Ido Movement for Culture. Journal of Martial Arts Anthropology*
Year of publication: 2026

Journal characteristics:

- A peer-reviewed scientific journal
- The study has the character of a methodological reliability analysis focused on sport-specific performance assessment

DOI / Link: <https://doi.org/10.14589/ido.26.1.7>

Contribution to the aims of the habilitation thesis:

- This article contributes to the sport-specific assessment of karate performance by evaluating the intra- and inter-rater reliability of the MyJump2 app in measuring the speed of selected karate techniques.
- It fulfils the objective of the habilitation thesis in the area of methodological rigour and sport-specific diagnostics by verifying whether an accessible digital tool can provide consistent, objective, and reproducible measurements in karate performance assessment.
- The results provide an important methodological basis for the use of accessible technology in karate research and practice and contribute to the development of valid and reliable sport-specific testing procedures.

© *Yoshin Academy*

“Ido Movement for Culture Journal of Martial Arts Anthropology”,

Vol. 26, no. 1 (2026), pp. 53–64

DOI: 10.14589/ido.26.1.7

KINESIOLOGY & COACHING

Radovan Hadza^{1(ABCDEF)}, Dusana Augustovicova^{2(ADE)}, Michal Hruby^{3(DE)},

Rastislav Styriak^{4(B)}, Adrian Novosad^{5(DE)}

ORCID: 0000-0002-5596-8508

Comenius University, Faculty of Physical Education and Sport, Bratislava (Slovakia)

ORCID: 0000-0003-0206-6815

Comenius University, Faculty of Physical Education and Sport, Bratislava (Slovakia)

Masaryk University, Faculty of Sport Studies, Brno (Czech Republic)

ORCID: 0009-0002-2321-3239

Masaryk University, Faculty of Sport Studies, Brno (Czech Republic)

ORCID: 0009-0002-5075-2262

Elementary School, Nemocnicna, Povazska Bystrica (Slovakia)

ORCID: 0000-0002-4707-8775

Comenius University, Faculty of Physical Education and Sport, Bratislava (Slovakia)

Corresponding author: Dusana Augustovicova, PhD., Comenius University, Faculty of Physical Education and Sports, Nabrezie armadneho generala Ludvika Svobodu 9, Bratislava 814 69, Slovakia; e-mail: augustovicova.dusana@gmail.com, phone: +421 908 736 720

5.4 Countermovement-Jump Test–Retest Reliability in Top-Level Para-Karate Athletes With Intellectual Impairment Using Kistler Force Plates

Published in: *Adapted Physical Activity Quarterly*

Year of publication: 2025

Journal characteristics:

- A peer-reviewed scientific journal focused on adapted physical activity, disability sport, and related research
- The study has the character of a brief research note with a methodological focus on test–retest reliability in sport-specific athlete assessment

DOI / Link: <https://doi.org/10.1123/apaq.2024-0149>

Contribution to the aims of the habilitation thesis:

- This article contributes to the objective assessment of neuromuscular performance in para karate by evaluating the test–retest reliability of countermovement-jump variables in top-level athletes with intellectual impairment using Kistler force plates.
- It fulfils the objective of the habilitation thesis in the area of methodological rigour and evidence-based sport-specific diagnostics by verifying the stability and reproducibility of force plate-derived measurements in an elite para-karate population.
- The findings provide an important methodological basis for the use of countermovement-jump testing in monitoring performance and neuromuscular readiness in para karate and contribute to the development of valid and reliable assessment procedures in athletes with intellectual impairment.

Corrected June 18, 2025, and December 18, 2025

— see <https://doi.org/10.1123/apaq.2025-009>

3

Human Kinetics



Adapted Physical Activity Quarterly, 2025, 42, 663–677

<https://doi.org/10.1123/apaq.2024-0149>

BRIEF RESEARCH NOTE

Countermovement-Jump Test–Retest Reliability in Top-Level Para-Karate Athletes With Intellectual Impairment Using Kistler Force Plates

Radovan Hadza,¹ Dusana Augustovicova,^{1,2} Ana Carolina Paludo,² Debbie Van Biesen,^{3,4} and
Michal Hrubý²

Faculty of Physical Education and Sports, Comenius University, Bratislava, Slovakia; Faculty of Sports Studies, Masaryk University, Brno, Czech Republic; ³Department of Rehabilitation Sciences, Faculty of Movement and Rehabilitation Sciences, KU Leuven, Leuven, Belgium; ⁴Virtus World Intellectual Impairment Sport, Virtus Academy, Sheffield, United Kingdom

This study investigated the test–retest reliability of the countermovement-jump (CMJ) test using Kistler force plates to assess explosive power in top-level parakarate athletes with intellectual impairment (II) or Down syndrome (DS). Fortyfour athletes (II, $n = 20$; DS, $n = 24$) were evaluated during the 2023 World Karate Championships. Each performed two CMJs with a 1-min rest between. Key parameters measured included jump height, force index, and maximal rate of force development. Results showed no significant differences between test and retest for either group. Athletes with II exhibited better reliability metrics (e.g., intraclass correlation coefficient [ICC] = .381–.953) compared with DS (ICC = .029–.64). The study concludes that the CMJ test is highly reliable for assessing explosive power in athletes with II, while DS requires careful protocol adjustments to enhance reliability, ensuring consistent data for coaches and sport scientists.

Keywords: explosive power, Down syndrome, jump height, disability sport

© 2025 The Authors. Published by Human Kinetics, Inc. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License, CC BY-NC 4.0, which permits the copy and redistribution in any medium or format, provided it is not used for commercial purposes, the original work is properly cited, the new use includes a link to the license, and any changes are indicated. See <http://creativecommons.org/licenses/by-nc/4.0>. This license does not cover any third-party material that may appear with permission in the article. For commercial use, permission should be requested from Human Kinetics, Inc., through the Copyright Clearance Center (<http://www.copyright.com>).

Hadza  <https://orcid.org/0000-0002-5596-8508>

Paludo is now with the Department of Psychology, University of Cyprus, Nicosia, Cyprus,  <https://orcid.org/0000-0001-8771-4580>

Van Biesen  <https://orcid.org/0000-0002-2754-4679>

Hrubý  <https://orcid.org/0009-0002-2321-3239>

Augustovicova (dusana.augustovicova@uniba.sk) is corresponding author,

5.5 Postural control in top-level Para Karate athletes with visual and intellectual impairment: an observational study

Published in: *BMC Sports Science, Medicine and Rehabilitation*

Year of publication: 2025

Journal characteristics:

- An open-access peer-reviewed scientific journal
- The study has the character of an observational study focused on postural control in para-karate athletes with visual and intellectual impairment

DOI / Link: <https://doi.org/10.1186/s13102-025-01429-3>

Contribution to the aims of the habilitation thesis:

- This article contributes to the understanding of sport-specific performance determinants in para karate by examining postural control in top-level athletes with visual and intellectual impairment.
- It fulfils the objective of the habilitation thesis in the area of evidence-based sport-specific diagnostics by identifying functional aspects of balance and postural stability that may influence karate performance in athletes with eligible impairments.
- The findings provide an important basis for the interpretation of impairment-related limitations in para karate and contribute to the development of valid and ecologically relevant assessment procedures within the broader framework of evidence-based classification.

RESEARCH

Open Access



Postural control in top-level Para Karate athletes with visual and intellectual impairment: an observational study

Henrieta Horníková¹, Radovan Hadža^{1*}, Michal Hrubý² and Dušana Augustovičová^{1,2}

Abstract

Background Although the World Karate Federation (WKF) lacks a standardized test battery, Para Karate classification follows International Paralympic Committee (IPC) principles, with balance recognized as a key physical ability affecting kata performance. This study aimed to compare postural stability across categories and classes of top-level Para Karate athletes and to provide evidence supporting classification refinement.

Methods Fifty-nine athletes competing at the 2023 World Para Karate Championship were classified into three groups: visually impaired (VI, $n = 24$, age 23.8 [20.6] years), intellectual impairment (II1, $n = 17$, 26.5 [9.7] years), and intellectual impairment with additional impairment (II2, $n = 18$, 28.0 [11.3] years). A 30-second bipedal stance test with eyes open was used to assess total path and area of the centre of pressure (CoP), including anterior-posterior (AP) and medio-lateral (ML) directions. Non-parametric Kruskal-Wallis H test and Mann-Whitney U test were used for analysis.

Results Significant group differences were observed for total CoP path ($H_{(2)} = 13.205$, $p < 0.001$) and area ($H_{(2)} = 12.929$, $p = 0.002$). II1 athletes demonstrated significantly lower CoP path than VI ($p_{\text{adj}} = 0.001$), with better AP stability compared to both groups. II2 class had lower total CoP area than VI ($p_{\text{adj}} < 0.001$). They showed the lowest area in AP direction compared to both VI and II1 ($p_{\text{adj}} = 0.002$ and $p_{\text{adj}} = 0.040$, respectively).

Conclusions The 30-second balance test proved to be sensitive to between-group differences in postural control among impairment types. VI athletes exhibited greater CoP path than II1 athletes and greater CoP area than II2 athletes, highlighting the need for targeted balance training. In the AP direction, II1 athletes showed better control in path length compared to both groups, while II2 athletes outperformed them in sway area. However, the area parameter demonstrated limited reliability, and its results should therefore be interpreted with caution. Based on these findings, detected inter- and intra-group variability may contribute to building a robust evidence base for future classification development of Para Karate athletes.

Highlights

The 30 s bipedal balance test showed class-specific stability differences with considerable variability within classes, supporting its use in Para Karate classification and guiding impairment-specific balance training.

Keywords Athlete classification, Balance assessment, Centre of pressure, Kata performance, Posturography

*Correspondence: ¹Department of Track and Field and Sport Conditioning, Faculty of Radovan Hadža

Physical Education and Sport, Comenius University, Bratislava, Slovakia, radovan.hadza@uniba.sk

²Department of Sport Performance and Exercise Testing, Faculty of Sports Studies, Masaryk University, Brno, Czech Republic

5.6 Cognitive and Executive Functions of Top-level Para Karate Athletes With Intellectual Disability

Psychology of Sport & Exercise 82 (2026) 102998



Contents lists available at ScienceDirect

Psychology of Sport & Exercise

journal homepage: www.elsevier.com/locate/psychsport



Cognitive and executive functions of top level para-karate athletes with intellectual disability

Debbie Van Biesen^{a,c}, Dušana Augustovičová^{d,e,*}, Roi Charles Pineda^a, Dagmar Nemček^f, Jan Burns^{b,c}

^a KU Leuven, Faculty of Movement and Rehabilitation Sciences, Department of Rehabilitation Sciences, Research Unit Adapted Physical Activity and Psychomotor Rehabilitation, Leuven, Belgium

^b Center for Sport, Physical Education and Activity Research, Canterbury Christ Church University, Canterbury, United Kingdom

^c Virtus Academy, Virtus World Intellectual Impairment Sport, Sheffield, United Kingdom

^d Faculty of Physical Education and Sport, Comenius University Bratislava, Slovakia

^e Faculty of Sport Studies, Masaryk University in Brno, Czech Republic

^f Department of Special Education, Faculty of Education, Comenius University Bratislava, Slovakia

Co-first authors: Dušana Augustovičová^{12*} and Debbie Van Biesen^{3*}

*designated as co-first authors

Published in: *Psychology of Sport and Exercise*

Year of publication: 2025

Journal characteristics:

- A peer-reviewed international scientific journal
- The journal is indexed in Web of Science (SSCI), Scopus, and PubMed
- According to the 2023 journal metrics, it was ranked in Q1 in the categories *Psychology (Sport)* and *Sport Sciences*

DOI / Link: <https://doi.org/10.1016/j.psychsport.2025.102998>

Contribution to the aims of the habilitation thesis:

- This article contributes to the understanding of cognitive determinants of performance in para karate by analysing executive functions in athletes with intellectual impairment and by comparing the K21 and K22 sport classes.
- It fulfils the objective of the habilitation thesis in the area of evidence-based classification by providing scientific support for class differentiation based on functional characteristics rather than diagnosis alone.
- The findings, particularly the association between inhibitory control and kata performance, underline the importance of incorporating cognitive abilities into the development of classification rules in para karate.

- The study represents an important contribution to the conceptual model of classification in athletes with intellectual impairment proposed by Van Biesen, particularly through the identification of sport-relevant cognitive determinants of performance such as decision-making, reaction time, working memory, and inhibition.

5.7 Reliability of the Sport-specific Test for Intellectually Impaired Para Karate Athletes

Presented at: 30th Annual Congress of the *European College of Sport Science (ECSS)*

Conference date: 1–4 July 2025

Publication type: Oral presentation published in the *Book of Abstracts*

Editors: Marcora, S., Narici, M., Paoli, A., De Vito, G., Tsolakidis, E., Thompson, J.L., Ferrauti, A., Piacentini, M.

Authors: Augustovicova, D., Hadza, R., Hruby, M.

Contribution to the aims of the habilitation thesis:

- Although published as a conference abstract, this contribution represents an important part of the habilitation research trajectory, as it was selected for oral presentation at the annual congress of the European College of Sport Science, one of the leading international scientific forums in sport science.
- Its presentation at ECSS enabled direct discussion of the methodological approach and preliminary findings with the international scientific community, thereby providing expert feedback that supported the refinement of the research design and interpretation of results.
- The study contributes to the aims of the habilitation thesis in the area of sport-specific diagnostics by examining the reliability of a sport-specific test intended for para karate athletes with intellectual impairment.
- It represents an important preliminary step in the development of valid and reliable assessment procedures tailored to the functional and performance characteristics of this athlete population.
- At the same time, this contribution laid the groundwork for subsequent empirical research and represents an important transitional output between methodological pilot work and full-scale peer-reviewed publication in the area of evidence-based classification and sport-specific assessment in para karate.

INTRODUCTION: Para-karate has emerged as a competitive sport for athletes with intellectual impairments (II) and Down Syndrome (DS), supported by classification systems to ensure fair participation. Following the re-inclusion of II athletes in the Paralympics (London 2012), the IPC mandated evidence-based classification systems to enhance fairness in competition. To support the WKF's goal of including para-karate in the Paralympic program, this study aimed to develop reliable kata memory-specific tests to assess memory determinants in para-karate.

METHODS: The study included 41 para-karate kata athletes with II or II and DS, who participated in the WKF World Championships in Budapest 2023. Assessments took place before the competition, on a 6x6m Tatami Mat, recorded from three perspectives. Athletes practiced a karate sequence three times before performing it independently. Performance was evaluated on: (1) correct execution of movements according to the original pattern, (2) correct direction of movements, (3) errors involving incorrect limb use (-0.5 per error), and (4) hesitations disrupting flow (-0.5 per hesitation). Kata memory scores were calculated as the sum of correctly executed and directed movements, with penalties for errors. To assess intra-rater reliability, performances were evaluated by the same observer via video analysis with a one-week interval. Statistical analysis included Cohen's Kappa for ordinal data and the Wilcoxon T-test to evaluate differences, with significance set at $p < 0.05$ was conducted.

RESULTS: Descriptive analysis showed a mean kata memory test score of 8.75 ± 1.1 in the first assessment and 8.80 ± 1.0 in the retest, with scores ranging from 5 to 10 across participants. It indicates minimal variability, underscoring the tests reliability in assessing kata memory performance. The consistency of scoring across different time points supports the potential for its inclusion in official classification processes. A Kappa value of 0.98 indicated almost perfect agreement between test and retest evaluations, demonstrating exceptional intra-rater reliability. No significant differences were found between test and retest evaluations ($p > 0.05$), supporting the consistency of the specific memory test.

CONCLUSION: The developed test demonstrates high reliability for assessing memory determinants in para-karate athletes with II or DS. These findings highlight the robustness of the test, suggesting it could play a vital role in standardizing classification systems for para-karate. Future research should focus on validating the test across a broader population and exploring its sensitivity to subtle differences in cognitive performance, ensuring its applicability in diverse competitive environments. This will further enhance the fairness and transparency of para-karate classification processes.

The study was supported by the Ministry of Education, Science, Research, and Sport of the Slovak Republic, VEGA project no. 1/0611/23.

6 Discussion

Across the portfolio, the seven research questions form a coherent “evidence pathway” aligned with the logic of evidence-based classification: first clarifying eligibility and how it is operationalised, then specifying what performance in kata requires, and finally evaluating candidate measures for reliability, discrimination, and practical feasibility. This structure aligns with established conceptual and methodological guidance for Paralympic classification research, in which valid, standardised measures must be linked to sport-specific activity limitations and, ultimately, to class allocation and eligibility thresholds. The need for robust, evidence-based classification systems is further underscored by the continued expansion and professionalisation of Para sport, which necessitate objective tools for fair competition and athlete grouping. Furthermore, the development of sport-specific assessments, such as the kata memory test described, is crucial for refining classification protocols, particularly for athletes with intellectual impairments, where generic cognitive tests may not fully capture performance-relevant attributes (T. Wileman et al., 2024). This aligns with the broader push towards evidence-based classification, emphasising the identification of key determinants of para-karate performance through standardised, objective measures (Augustovicova et al., 2025).

RQ1 Population definition and eligibility governance (diagnosis/MIC context)

The eligibility-focused paper (RQ1) provides the governance and definitional foundation for the thesis by clarifying the sport-class structures and practical eligibility challenges faced by para karate athletes with intellectual impairments (including Down syndrome and autism). This “front-end” work is necessary because evidence-based classification depends on a defensible distinction between (i) eligible impairment and (ii) sport-specific impact of impairment, alongside transparent procedures to reduce misclassification risk (Burns, 2015; Van Biesen et al., 2021). This logic reflects the broader II-classification architecture promoted within the Paralympic movement (diagnostic verification plus evidence that the impairment limits sport proficiency). Such systems are critical for ensuring equitable competition by grouping athletes with similar levels of functional ability due to their impairment, thereby ensuring that success is primarily determined by athletic prowess and training rather than the extent of disability (Tweedy et al., 2014).

Kata selection patterns by sport class (performance-demand evidence)

The kata selection study contributes sport-demands evidence by describing which kata are performed most frequently in top-level para karate and whether selection

patterns differ by sport class. This analysis is crucial for understanding the specific demands of each sport class and informing the development of class-specific assessment tools (Augustovicova et al., 2025). By identifying commonly performed kata, researchers can better tailor evaluation criteria to reflect the actual competitive environment, ensuring classification methods are ecologically valid and relevant to athletic performance (Pinilla et al., 2016). This understanding enables the development of targeted training programs and the refinement of classification protocols to ensure fair competition among para-karate athletes across varying levels of intellectual impairment (Puce et al., 2024). For example, athletes in classes with less challenging elements may focus on fewer, simpler katas. In contrast, those in more advanced classes may undertake more complex routines that require greater time and effort (Augustovicova et al., 2025). This data can directly inform the design of classification tests that accurately differentiate between impairment levels based on sport-specific performance requirements (Stockley et al., 2022). Such biomechanical and physiological measures, alongside refined classification tools, are crucial for gaining insights into technical optimisation and injury prevention, which ultimately contribute to performance enhancement (Morriën et al., 2017).

This matters for classification because functional tests should be anchored to tasks and constraints that truly represent competitive performance. Mapping kata frequency and selection tendencies also helps interpret later findings: if sport classes systematically differ in what is performed at the highest level, this can influence observed performance profiles and provides a practical rationale for prioritising specific movement and balance demands when designing or selecting candidate assessments. Research shows that athletes with intellectual impairments (II) generally perform at lower levels compared to those without such impairments across various sports, including track events, swimming, and shot-put, with differences linked to cognitive and physical factors affecting pacing, technique, and consistency (Puce et al., 2024; Van Biesen et al., 2018; Van Biesen, Hettinga, et al., 2016b). For example, elite runners with II demonstrate lower velocities and distinct pacing profiles compared with non-impaired runners, indicating difficulty self-regulating exercise intensity during competition (Van Biesen, Hettinga, et al., 2016b). Similarly, swimmers with II exhibit slower chronometric performance but often maintain pacing strategies similar to those of able-bodied athletes. However, variability is higher in subgroups with additional impairments, such as Down syndrome (Puce et al., 2024). Overall, intellectual impairments affect competition performance through limitations in cognitive functions critical for pacing, decision-making, and motor control, which supports the need for tailored classification systems to ensure fair competition among para athletes (Burns, 2015; Gilderthorp et al., 2018; T. Wileman et al., 2024). This highlights the necessity of developing sport-specific assessments that account for these inherent differences to ensure equitable and valid classification across all Para sports (Cavaggioni et al., 2025;

T. Wileman et al., 2024). Thus, while cognitive functions are recognised as critical for sports performance, particularly in areas like pacing and decision-making, the interaction of these functions with other elements shaping specialised motor skills, such as motivation, environment, and acuity, warrants further investigation (Burns et al., 2020; García-Fresneda et al., 2022).

RQ3 → Measurement foundations for low-cost sport-specific assessment (technique speed)

The MyJump2 reliability study (RQ3) provides measurement-property evidence for a low-cost method to quantify the execution speed of selected karate techniques. Within an evidence-based pathway, reliability (intra- and inter-rater) is a prerequisite: if a tool cannot measure consistently, it cannot credibly support classification decisions. This aligns with broader classification guidance emphasising objective, reliable and practically deployable measurement approaches—critical in field-based classification contexts. Moreover, assessing motor intelligence in individuals with intellectual disabilities is often hindered by a lack of reliable, adaptable tools, underscoring the need to develop robust, sport-specific assessments that identify sensory-motor deficits and movement priorities (Zaino et al., 2025). Such tools are crucial for distinguishing between impairments that genuinely affect sport performance and those that do not, thereby refining the accuracy of classification systems (Arbour-Nicitopoulos et al., n.d.; García-Fresneda et al., 2022). This is particularly relevant in sports such as basketball, where players with intellectual impairments exhibit significant limitations in decision-making and execution in game situations compared with their able-bodied counterparts, underscoring the need for assessment methods that capture these nuanced performance discrepancies (Pinilla et al., 2016). The use of field tests with standardised game situations could therefore be highly beneficial for a more comprehensive understanding of the impact of intellectual impairment on sport-specific performance, particularly in time-sensitive and decision-making contexts (Pinilla et al., 2016). In para karate, it is therefore beneficial to have a tool that enables the examiner to assess the movement quality and efficiency of specific techniques in a standardised and objective manner. This aligns with the need for ecologically valid field assessments, as highlighted by comparisons of tools such as MyJump2 and contact mats, which can be deployed in diverse scenarios (Coswig et al., 2018). This methodological choice enhances ecological validity and allows practical application during championships, overcoming some limitations associated with laboratory-based methods (Coswig et al., 2019). Additionally, it is beneficial to have not only the cognitive test, which requires a specially trained classifier and computer tools, but also a very inexpensive measurement with which we can assess how the II affects general movement in karate, such as kicks or punches. This approach enables evaluation of specific motor skills relevant to karate, providing an objective measure of how intellectual impairments affect the execution and efficiency of fundamental techniques (Aksović et al., 2023). This includes an

assessment of both gross motor competence and specific lower-extremity strategic control, which are often affected in individuals with intellectual disabilities (Cheng et al., 2023; Downs et al., 2020). Therefore, we selected to measure key determinants of karate kata, such as speed, power, and balance, using plates such as Kistler force plates or kinvendeltas, which have high reliability for assessing these parameters, providing a robust foundation for identifying performance-limiting factors in para-karate athletes with intellectual impairments. However, these assessments must be easily understood and executed by athletes with intellectual impairments, often necessitating simplified instructions, demonstrations, and visual aids (Cabeza-Ruiz et al., 2020).

RQ4 → In our cohort, several force-plate CMJ variables demonstrated acceptable-to-excellent within-session reliability. In contrast, others showed larger measurement error, highlighting the importance of careful metric selection when CMJ is used as a candidate evidence input. Balance and power are important determinants of karate kata performance in both intact and para karate athletes. Therefore, we selected to measure these domains using a single highly reliable instrument that provides classifiers with strong evidence for decision-making and is easy to transport internationally for classification. In the literature, we see that elite karatekas demonstrate superior motor performance, including better body stability and joint mobility, with kata athletes showing greater ankle mobility and improved stability under challenging conditions such as eyes closed, which reflects enhanced balance control (Molinaro et al., 2020; Zago et al., 2015). In para karate, physical impairments, especially in lower limbs, negatively affect dynamic balance control and joint angular velocity, key components for kata execution, leading to slower and less powerful movements compared to able-bodied athletes (Bertozi 2020). Muscle explosive power, particularly in the upper and lower limbs, is vital for high-level karate performance, influencing the execution speed and strength of techniques in kata (Chaabène et al., 2012).

Counter-movement jump is frequently used to assess explosive lower-body power in karate athletes. Studies have used CMJ to evaluate the effects of plyometric training, recovery strategies, and physical preparation on karate performance, demonstrating its relevance for measuring jump height and power in intact karate athletes. (Frutos et al., 2025; Moreno-Azze et al., 2023). Improvements in CMJ performance have been linked to enhanced karate-specific physical abilities, such as jump height and strength, which are important for executing techniques effectively (Frutos et al., 2025; Ioannides et al., 2024). Therefore, using "CMJ" in the context of karate performance is appropriate and well-supported in the literature.

Reliability, error, and usefulness of force-plate CMJ metrics (K21/K22). The CMJ force-plate paper (RQ4) strengthens the evidence pathway by quantifying test-retest reliability and measurement error in a cohort of top-level para karate athletes in K21 and K22. Beyond reporting reliability alone, the framing of measurement error in terms of practical usefulness supports its translation into applied decision-making (e.g., whether a given outcome is sufficiently stable to be used for monitoring and,

potentially, as an evidence input in classification research). This is directly consistent with classification research priorities that call for valid and precise measures before setting thresholds or evaluating impairment–performance relationships, and the classification system can readily distinguish between II1 (K21) and II2 (K22) sport classes.

RQ5 → Discriminative capacity of posturography in II and VI groups

The postural-control study (RQ5) contributes **construct/discriminant evidence** by testing whether standardised centre-of-pressure outcomes distinguish between impairment groups/classes (e.g., VI, II1, II2) under a controlled stance protocol. Conceptually, this addresses the “does impairment type meaningfully differentiate functional performance relevant to the sport?” question, which is central to evidence-based classification. It also complements the measurement-property work by moving from “can we measure it reliably?” toward “does it discriminate in the expected direction between groups?”. Posturography has demonstrated discriminative capacity to distinguish among impairment groups across various para sports contexts, supporting its use in evidence-based classification systems. For example, static posturography effectively differentiated fallers from non-fallers in patients with Parkinson’s disease by measuring centre-of-pressure variables under controlled stance conditions, indicating its sensitivity to functional differences related to impairment (Cavaggioni et al., 2025). Although direct studies using posturography to discriminate between impairment groups, such as intellectual impairment (II) and visual impairment (VI), in para sports are limited, the approach’s ability to detect meaningful differences in balance and postural control suggests it could be applied similarly across para sport classifications. (Kobayashi-Cuya et al., 2023). Research highlights the need for standardised, reliable measurement protocols and further validation to confirm that posturography outcomes align with functional performance differences relevant to specific sports and impairment types (Lee et al., 2024). Additionally, integrating posturography with other biomechanical and motor control assessments may enhance classification accuracy and support tailored training or rehabilitation strategies for para athletes (Liu et al., 2025). Overall, posturography shows promise as a discriminative tool in para sports, but more targeted research is needed to establish its effectiveness across diverse impairment groups.

Furthermore, for classification, we need to connect motor performance and cognitive performance. Current research indicates a bidirectional relationship between motor performance (e.g., countermovement jump, CMJ) and cognitive functioning—each can influence the other rather than one being solely dependent on the other. Cognitive abilities, including attention and working memory, are positively associated with complex motor skills and CMJ performance in both athletes with intellectual disabilities and youth athletes (Cavaggioni et al., 2024; Scharfen & Memmert, 2019). Mental fatigue or cognitive load can acutely impair CMJ and other motor performances, suggesting that cognitive state directly affects motor output (Staiano et al., 2023;

Thomas et al., 2025). External focus of attention (a cognitive strategy) enhances CMJ performance relative to internal focus, particularly among individuals with intellectual disabilities (Cavaggioni et al., 2024). Motor training and higher baseline motor function are linked to slower cognitive decline and better cognitive outcomes in older adults and clinical populations (Kobayashi-Cuya et al., 2023; Meijer et al., 2025; Wang et al., 2023). Improvements in motor skills, including CMJ, through specific training can also enhance executive functions and cognitive performance, as seen in both young athletes and older adults (Campanella et al., 2024; Meijer et al., 2025; Weng et al., 2025). Early fine motor skills predict later cognitive performance in children, supporting the idea that motor development can drive cognitive gains (Meijer et al., 2025).

Longitudinal and cross-sectional studies show reciprocal associations: changes in motor performance predict changes in cognitive function and vice versa, across the lifespan (Kobayashi-Cuya et al., 2023; Leisman et al., 2016; Wang et al., 2023). Neural and developmental evidence suggests shared brain networks and mutual reinforcement between motor and cognitive domains (Leisman et al., 2016; Ren et al., 2013; Scharfen & Memmert, 2019).

RQ6 → Cognitive and executive-function profiling in K21 vs K22

The cognitive/executive-function paper (RQ6) provides impairment-relevant functional profiling using a standardised test battery consistent with established II-classification approaches (generic cognitive domains plus executive functioning). This or a similar battery was used in other sports, such as taekwondo (Vivaracho et al., 2019) and futsal (Filgueiras et al., 2023). Impairment-relevant functional profiling directly aligns with the established conceptual basis for II classification, in which eligibility requires both verification of II and evidence that cognition-related limitations constrain sport proficiency. The findings therefore provide evidence for identifying which cognitive domains are most plausibly linked to para karate performance, and whether K21 and K22 display distinct profiles that may justify differentiated assessment or thresholds.

These cognitive profiles, while distinct, may reflect bidirectional motor-cognitive interactions rather than impairment-driven differences alone, as motor training can enhance cognitive outcomes and vice versa. Thus, without isolating sport-specific kata demands or longitudinal performance linkages, differentiated thresholds risk overemphasising cognition at the expense of integrated functional profiles. Therefore, we developed and introduced the sport-specific memory kata test, which minimises direct rehearsal effects by using sequences not used in any kata or commonly trained during practice.

RQ7 → Sport-specific kata memory test reliability (classification feasibility)

The kata memory test adds a **critical piece: a sport-specific, cognitively loaded task designed to reflect the technical**—cognitive demands of kata performance, with very high intra-rater test–retest agreement. This sits squarely in the “sport-specific testing” phase advocated in II-classification frameworks and addresses the frequent critique that purely generic cognitive tests may lack ecological validity for a particular sport. Together with RQ2, it strengthens content validity (the test reflects kata demands) and begins to address feasibility for implementation during classification sessions. Despite using novel sequences, the test may still be influenced by athletes' extensive prior motor training and general technical proficiency, potentially confounding pure cognitive profiling and requiring further validation against competition kata performance to confirm its discriminant utility.

Overall, this thesis provides a set of evidence inputs that are immediately suitable for para karate classification research and the standardised implementation on events. Specifically, the portfolio delivers (i) a clearly articulated eligibility and governance context for athletes with intellectual impairment; (ii) sport-demand profiling through kata-selection patterns that support ecological validity when designing observation templates and sport-specific tasks; and (iii) candidate assessment tools with demonstrated measurement quality, including reliable low-cost technique timing, reproducible force-plate CMJ outcomes with quantified measurement error and practical usefulness, robust postural-control metrics capable of discriminating between impairment groupings, and a highly reproducible sport-specific kata memory assessment. Collectively, these outputs strengthen procedural standardisation and provide empirically grounded functional profiles that begin to differentiate relevant sport classes (notably K21 and K22) across cognitive and selected physical domains. Importantly, the findings have already had direct applied impact: preliminary results and the associated test battery have been adopted within the para karate classification manual as baseline procedures, providing the first structured platform for introducing these tests into the forthcoming classification rules; the corresponding cut-off points and decision thresholds are in final development and will be published in the near term (appendix 2). In parallel, this evidence base has supported key governance milestones, including submission of the IPC compliance survey and the IPC Paralympic bid documentation. At the same time, the translation from promising evidence inputs to full classification-decision readiness requires further work: derivation and cross-validation of cut-off points, formal operationalisation and validation of Minimum Impairment Criteria (MIC) decision rules, evaluation of sensitivity/specificity and misclassification risk, confirmation of robustness across multiple events and classifier teams (including inter-rater reliability), and multivariable modelling that integrates cognitive, motor, balance, and sport-specific determinants of kata performance. Additional integrative

manuscripts are in preparation/submission, extending these studies through multi-variable modelling and threshold work (cut-off points, MIC operationalisation, and decision accuracy).

Limitations of the thesis

A key limitation of this thesis is that data were collected primarily from top-level para karate athletes assessed at a World Championship in a single-event / single-championship classification context. Although participation at the event was complete (i.e., all eligible athletes were assessed), the resulting sample size was modest in absolute terms (approximately $n = 44$), which may limit statistical power and the generalisability of findings to the broader population of athletes with intellectual impairment across different performance tiers and competitive environments. In addition, assessments were conducted shortly before competition by a team new to many athletes, which may have introduced situational stress and novelty effects (e.g., heightened arousal, unfamiliar procedures, and reduced test familiarity) that could have influenced selected cognitive and motor outcomes despite standardisation efforts. For these reasons, the results should be interpreted as a strong initial evidence base rather than definitive population norms, and ongoing work extending testing to lower-performance-level athletes will be essential to confirm robustness, refine thresholds, and strengthen external validity.

7 Conclusions

This habilitation thesis synthesises a programme of research examining performance- and classification-relevant parameters in para karate, to contribute evidence inputs for an evidence-based classification model aligned with International Paralympic Committee (IPC) standards and relevant Virtus frameworks. Using a multidisciplinary approach that combines cognitive, motor, balance, and biomechanical assessments, the work identifies functional domains plausibly linked to kata performance and that demonstrate measurable variation across the sport classes currently recognised by the World Karate Federation (WKF).

Across the presented studies, several consistent findings emerge. First, athletes competing in K21 and K22 exhibit distinct functional profiles across selected domains, supporting the premise that these classes reflect distinct performance-related characteristics rather than administrative labels. In particular, published analyses indicate that K21 athletes outperform K22 athletes on measures of cognitive processing speed, visuospatial processing, and reasoning, while associations between specific executive-function indicators (notably inhibitory control) and kata performance suggest that selected cognitive constructs may be relevant to high-level kata execution.

Second, objective postural-control assessment using a standardised 30-second bipedal stance test demonstrates sensitivity to impairment-group differences (e.g., VI versus intellectual-impairment groupings), with the strongest differentiation observed in centre-of-pressure path metrics and in the anterior-posterior direction; however, some sway-area parameters show limited reliability and therefore require cautious interpretation and further validation.

On the basis of these findings, the thesis proposes a structured framework for para karate classification research that integrates: (1) verification of diagnosis and Minimum Impairment Criteria (MIC), (2) standardised functional assessment using a combined generic and sport-specific test battery, (3) interview and history to contextualise functional presentation, and (4) structured observation of kata performance in competition. The model was piloted in an applied setting (the World Championships context) and provides an operational template for consistently collecting evidence inputs during classification sessions.

Importantly, this thesis should be interpreted as a staged contribution to a broader research trajectory. Not all collected test outcomes are analysed in the present thesis, as additional manuscripts using these datasets are in preparation or under review. These forthcoming works will extend the current evidence base by integrating more comprehensive analyses, expanding performance linkage, and testing multivariable models that better reflect the multifactorial nature of kata performance.

Implications and priorities for further research

To progress from candidate evidence inputs to implementable classification decision rules, the following directions are prioritised:

- **Cut-off development and decision accuracy:** Derivation and validation of cut-off points supporting MIC and/or class allocation, including sensitivity/specificity analyses and error trade-offs under real-world classification constraints.
- **MIC refinement and robustness testing:** Formal evaluation of MIC stability across events, assessors, and athlete subgroups (including heterogeneity within Down syndrome and autism profiles), with explicit reporting of uncertainty and misclassification risk.
- **Measurement quality expansion:** Additional reliability studies (including inter-rater, inter-site, and longitudinal stability) and responsiveness analyses to determine whether candidate measures are sufficiently stable for classification while remaining sensitive to meaningful functional differences.
- **Performance linkage in ecologically valid contexts:** Prospective studies linking functional test profiles to competition-derived performance components (beyond aggregate kata score), and exploration of dynamic or sport-specific balance assessments to complement static posturography.
- **Longitudinal evidence:** Follow-up studies examining how functional profiles and performance evolve over time, including the implications for sport class status (Confirmed vs Review) and for athlete development pathways.

Overall, the research presented here provides an applied, functionally oriented evidence base that supports ongoing refinement of para karate classification. The cumulative outputs (published and forthcoming studies) are intended to strengthen transparency, reproducibility, and functional relevance in classification decision-making, consistent with IPC expectations for evidence-based systems and the long-term objective of supporting para karate's continued sport development.

References

- Aksović, N., Dobrescu, T., Bubanj, S., Bjelica, B., Milanović, F., Kocić, M., Zelenović, M., Radenković, M., Nurkić, F., Nikolić, D., Marković, J., Tomović, M., & Vulpe, A. M. (2023). Sports Games and Motor Skills in Children, Adolescents and Youth with Intellectual Disabilities. In *Children* (Vol. 10, Issue 6). Multidisciplinary Digital Publishing Institute (MDPI). <https://doi.org/10.3390/children10060912>
- Arbour-Nicitopoulos, K. P., Bruno, N., Orr, K., O'rourke, R., Wright, V. 2, Renwick, R., Bobbie, K., & Noronha, J. (n.d.). *Quality of Participation Experiences in Special Olympics Sports Programs 1*.
- Augustovicova, D., Hadza, R., Magyar, A., Biesen, D. Van, & Hruby, M. (2025). *Kata selection trends in top-level para-karate competitions : a multi-championship study*.
- Beckman, E. M., Connick, M. J., & Tweedy, S. M. (2017). Assessing muscle strength for the purpose of classification in Paralympic sport: A review and recommendations. In *Journal of Science and Medicine in Sport* (Vol. 20, Issue 4). <https://doi.org/10.1016/j.jsams.2016.08.010>
- Burns, J. (2015). The impact of intellectual disabilities on elite sports performance. *International Review of Sport and Exercise Psychology*, 8(1), 251–267. <https://doi.org/10.1080/1750984X.2015.1068830>
- Burns, J., Van Biesen, D., Dreegia, W., & Johanna, F. (2020). *The Impact of Cognitive Functions and Intellectual Impairment on Pacing and Performance 4 in Sports*. www.idealproject.org
- Cabeza-Ruiz, R., Sánchez-López, A. M., Trigo, M. E., & Gómez-Píriz, P. T. (2020). Feasibility and reliability of the Assessing Levels of Physical Activity health-related fitness test battery in adults with intellectual disabilities. *Journal of Intellectual Disability Research*, 64(8), 612–628. <https://doi.org/10.1111/jir.12756>
- Campanella, M., Cardinali, L., Ferrari, D., Migliaccio, S., Silvestri, F., Falcioni, L., Bimonte, V., Curzi, D., Bertollo, M., Bovolon, L., Gallotta, M., Guidetti, L., Baldari, C., & Bonavolontà, V. (2024). Effects of Fitlight training on cognitive-motor performance in elite judo athletes. *Heliyon*, 10 7. <https://doi.org/10.1016/j.heliyon.2024.e28712>
- Cavaggioni, L., Ardigò, L., Castiglioni, P., Trecroci, A., Casalini, L., Formenti, D., & Merati, G. (2024). A crossover study on attentional focus and gross motor performance in individuals with Down syndrome. *PLOS ONE*, 19. <https://doi.org/10.1371/journal.pone.0305267>
- Cavaggioni, L., Formenti, D., Casalini, L., Granito, F., Magro, C., Manente, A., Canton, S., Lovecchio, N., Castiglioni, P., & Merati, G. (2025). Exploring the relationship between cognitive abilities and motor performance in athletes with intellectual disabilities. *Frontiers in Sports and Active Living*, 7. <https://doi.org/10.3389/fspor.2025.1601355>
- Chaabène, H., Hachana, Y., Franchini, E., Mkaouer, B., & Chamari, K. (2012). Physical and physiological profile of elite karate athletes. In *Sports Medicine*. <https://doi.org/10.2165/11633050-000000000-00000>

- Cheng, H. Y. K., Shieh, W. Y., Yu, Y. C., Li, P. W., & Ju, Y. Y. (2023). Video-Based Behaviorally Coded Movement Assessment for Adolescents with Intellectual Disabilities: Application in Leg Dribbling Performance. *Sensors*, 23(1). <https://doi.org/10.3390/s23010179>
- Connick, M. J., Beckman, E., & Tweedy, S. M. (2018). Evolution and development of best practice in paralympic classification. In *The Palgrave Handbook of Paralympic Studies*. https://doi.org/10.1057/978-1-137-47901-3_18
- Coswig, V., Silva, A. D. A. C. E., Barbalho, M., de Faria, F. R., Nogueira, C. D., Borges, M., Buratti, J. R., Vieira, I. B., Román, F. J. L., & Gorla, J. I. (2019). Assessing the validity of the MyJUMP2 app for measuring different jumps in professional cerebral palsy football players: An experimental study. *JMIR MHealth and UHealth*, 7(1). <https://doi.org/10.2196/11099>
- Downs, S. J., Boddy, L. M., McGrane, B., Rudd, J. R., Melville, C. A., & Fowweather, L. (2020). Motor competence assessments for children with intellectual disabilities and/or autism: A systematic review. In *BMJ Open Sport and Exercise Medicine* (Vol. 6, Issue 1). BMJ Publishing Group. <https://doi.org/10.1136/bmjsem-2020-000902>
- Fliess Douer, O., Koseff, D., Tweedy, S., Molik, B., & Vanlandewijck, Y. (2021). Challenges and opportunities in wheelchair basketball classification– A Delphi study. *Journal of Sports Sciences*, 39(sup1). <https://doi.org/10.1080/02640414.2021.1883310>
- Frutos, J. G.-D., López-Plaza, D., Martínez-Noguera, F., Sanz-Matesanz, M., Martínez-Rodríguez, A., & Martínez-Aranda, L. (2025). Specific Physical and Nutritional Preparation of a Professional Kata Karate Athlete: A Case Study with a Bronze Medallist from the Pan American Games. *Nutrients*, 17. <https://doi.org/10.3390/nu17020306>
- García-Fresneda, A., Theodorou, A. S., Panoutsakopoulos, V., Jordán, M. A. T., Padullés, J. M., Padullés, X., & Kotzamanidou, M. C. (2022). Step regulation in Paralympic long jumpers with intellectual impairment. *European Journal of Adapted Physical Activity*, 15. <https://doi.org/10.5507/EUJ.2022.004>
- Gilderthorp, R., Burns, J., & Jones, F. (2018). Classification and Intellectual Disabilities: An Investigation of the Factors That Predict the Performance of Athletes With Intellectual Disability. *Journal of Clinical Sport Psychology*. <https://doi.org/10.1123/jcsp.2017-0018>
- Ioannides, C., Despotopoulou, C., Hadjicharalambous, M., & Zaras, N. (2024). Effects of Warm-Ups with Weighted Vests and Resistance Bands on Physical Fitness and Combat Ability of Kumite Karate Athletes. *Sports*, 12(3). <https://doi.org/10.3390/sports12030079>
- IPC CLASSIFICATION CODE (2025). [https://www.paralympic.org/sites/default/files/2025-02/IPC Classification Code and International Standards 01_01_2025.pdf](https://www.paralympic.org/sites/default/files/2025-02/IPC%20Classification%20Code%20and%20International%20Standards%2001_01_2025.pdf)
- Johnson, M. E., & David, H. M. (2021). Development of evidence-based classification for para surfers with physical impairments: A narrative review. *PM&R*, 14(10), 1227–1240. <https://doi.org/10.1002/pmrj.12674>

- Kobayashi-Cuya, K., Sakurai, R., Sakuma, N., Suzuki, H., Ogawa, S., Takebayashi, T., & Fujiwara, Y. (2023). Bidirectional associations of high-level cognitive domains with hand motor function and gait speed in high-functioning older adults: A 7-year study. *Archives of Gerontology and Geriatrics*, 117, 105232. <https://doi.org/10.1016/j.archger.2023.105232>
- Krabben, K. J., Ravensbergen, R. H. J. C., Nakamoto, H., & Mann, D. L. (2019). The development of evidence-based classification of vision impairment in Judo: A Delphi study. *Frontiers in Psychology*, 10(FEB). <https://doi.org/10.3389/fpsyg.2019.00098>
- Lee, R., Pinder, R., Haydon, D., Winter, L., & Crowther, R. (2024). What gaps exist in biomechanics and motor control research in Paralympic sports? A scoping review focussed on performance and injury risk. *Journal of Sports Sciences*, 42, 2073–2082. <https://doi.org/10.1080/02640414.2024.2415214>
- Leisman, G., Moustafa, A., & Shafir, T. (2016). Thinking, Walking, Talking: Integratory Motor and Cognitive Brain Function. *Frontiers in Public Health*, 4. <https://doi.org/10.3389/fpubh.2016.00094>
- Liu, J., Yu, H., Cheung, W., Bleakney, A., & Jan, Y.-K. (2025). A systematic review of pathophysiological and psychosocial measures in adaptive sports and their implications for coaching practice. *Heliyon*, 11. <https://doi.org/10.1016/j.heliyon.2025.e42081>
- Mann, D. L., & Ravensbergen, H. J. C. (2018). International Paralympic Committee (IPC) and International Blind Sports Federation (IBSA) Joint Position Stand on the Sport-Specific Classification of Athletes with Vision Impairment. *Sports Medicine*, 48(9). <https://doi.org/10.1007/s40279-018-0949-6>
- Mann, D. L., Tweedy, S. M., Jackson, R. C., & Vanlandewijck, Y. C. (2021). Classifying the evidence for evidence-based classification in Paralympic sport. In *Journal of Sports Sciences* (Vol. 39, Issue sup1). <https://doi.org/10.1080/02640414.2021.1955523>
- Marques-Aleixo, I., Querido, A., Figueiredo, P., Vilas-Boas, J. P., Corredeira, R., Daly, D., & Fernandes, R. J. (2013). Intracyclic velocity variation and arm coordination assessment in swimmers with Down syndrome. *Adapted Physical Activity Quarterly*, 30(1). <https://doi.org/10.1123/apaq.30.1.70>
- Meijer, J., De Jonge, M., Leenen, S., Van Beek, P., De Kort, E., Vugs, B., & Andriessen, P. (2025). From movement to mind: Early fine motor skills are associated with cognitive performance at school age in very preterm infants. *Early Human Development*, 201, 106197. <https://doi.org/10.1016/j.earlhumdev.2025.106197>
- Molinaro, L., Taborri, J., Montecchiani, M., & Rossi, S. (2020). Assessing the Effects of Kata and Kumite Techniques on Physical Performance in Elite Karatekas. *Sensors (Basel, Switzerland)*, 20. <https://doi.org/10.3390/s20113186>
- Moreno-Azze, A., Prad-Lucas, E., Soñén, D. F., De La Fuente, F. P., & Falcón-Miguel, D. (2023). Plyometric Training's Effects on Young Male Karatekas' Jump, Change of Direction, and Inter-Limb Asymmetry. *Sports*, 12. <https://doi.org/10.3390/sports12010001>

- Morriën, F., Taylor, M. J. D., & Hettinga, F. J. (2017). Biomechanics in paralympics: Implications for performance. In *International Journal of Sports Physiology and Performance* (Vol. 12, Issue 5). <https://doi.org/10.1123/ijsp.2016-0199>
- Para Karate Classification Rules (2021). <https://www.wkf.net/structure-statutes-rules>
- Para-Karate Kata Competition Rules, 1 (2023). <https://www.wkf.net/structure-statutes-rules>
- Paschos, D. (2008). Intellectual Disability: Understanding its Development, Causes, Classifications, Evaluation, and Treatment. *Child and Adolescent Mental Health*, 13(4). https://doi.org/10.1111/j.1475-3588.2008.00513_3.x
- Patatas, J. M., De Bosscher, V., Derom, I., & Winckler, C. (2020). Stakeholders' perceptions of athletic career pathways in Paralympic sport: from participation to excellence. *Sport in Society*. <https://doi.org/10.1080/17430437.2020.1789104>
- Pinilla, J., Pérez-Tejero, J., Sampedro, J., Refoyo, I., Lorenzo, A., Lorenzo, J., Van Biesen, D., & Vanlandewijck, Y. (2016). Influence of intellectual impairment (II) on basketball players' capacity to solve a game situation: towards evidence-based classification systems in II-basketball. *Psychology*, 8(2), 121–134.
- Powis, B., & Macbeth, J. L. (2020). "We know who is a cheat and who is not. But what can you do?": Athletes' perspectives on classification in visually impaired sport. *International Review for the Sociology of Sport*, 55(5). <https://doi.org/10.1177/1012690218825209>
- Puce, L., Zmijewski, P., Bragazzi, N., & Trompetto, C. (2024). Comparative Pacing Profile and Chronometric Performance in Elite Swimmers with Intellectual Impairments and Able-Bodied Athletes. *Life*, 14. <https://doi.org/10.3390/life14121623>
- Ravensbergen, H. J. C. R., 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(7). <https://doi.org/10.1136/bjsports-2015-095434>
- Reina, R., Iturricastillo, A., Castillo, D., Urbán, T., & Yanci, J. (2020). Activity limitation and match load in para-footballers with cerebral palsy: An approach for evidence-based classification. *Scandinavian Journal of Medicine and Science in Sports*, 30(3). <https://doi.org/10.1111/sms.13583>
- Reina, R., Sarabia, J. M., Yanci, J., García-Vaquero, M. P., & Campayo-Piernas, M. (2016). Change of direction ability performance in cerebral palsy football players according to functional profiles. *Frontiers in Physiology*, 6(JAN). <https://doi.org/10.3389/fphys.2015.00409>
- Ren, J., Wu, Y., Chan, J., & Yan, J. (2013). Cognitive aging affects motor performance and learning. *Geriatrics & Gerontology International*, 13. <https://doi.org/10.1111/j.1447-0594.2012.00914.x>
- Scharfen, H.-E., & Memmert, D. (2019). The Relationship Between Cognitive Functions and Sport-Specific Motor Skills in Elite Youth Soccer Players. *Frontiers in Psychology*, 10. <https://doi.org/10.3389/fpsyg.2019.00817>

- Smith, R., Connick, M., Beckman, E., Hogarth, L., & Nicholson, V. (2021). Establishing the reliability of instrumented trunk impairment assessment methods to enable evidence-based classification in Para swimming. *Journal of Sports Sciences*, 39(sup1). <https://doi.org/10.1080/02640414.2021.1930699>
- Staiano, W., Bonet, L. R. S., Romagnoli, M., & Ring, C. (2023). Mental fatigue impairs repeated sprint and jump performance in team sport athletes. *Journal of Science and Medicine in Sport*. <https://doi.org/10.1016/j.jsams.2023.10.016>
- Stockley, R., George, L. B. S., Alexander, J., & ... (2022). A synthesis of potential impairment assessment tools for Para dressage classification. *European Journal of ...*
- Thomas, J., Hall, J., & Guess, T. (2025). Countermovement Jump Performance Is Altered by Visual and Auditory Cognitive Dual Tasking in Recreationally Active Young Adults: A Cross-Sectional Study. *Journal of Sport Rehabilitation*, 1–10. <https://doi.org/10.1123/jsr.2024-0265>
- Tweedy, S. M. (2002). Taxonomic theory and the ICF: Foundations for a unified disability athletics classification. *Adapted Physical Activity Quarterly*, 19(2). <https://doi.org/10.1123/apaq.19.2.220>
- Tweedy, S. M., Beckman, E. M., & Connick, M. J. (2014). Paralympic Classification: Conceptual Basis, Current Methods, and Research Update. *PM&R*, 6(8S). <https://doi.org/10.1016/j.pmrj.2014.04.013>
- Tweedy, S. M., Connick, M. J., & Beckman, E. M. (2018). Applying Scientific Principles to Enhance Paralympic Classification Now and in the Future: A Research Primer for Rehabilitation Specialists. In *Physical Medicine and Rehabilitation Clinics of North America* (Vol. 29, Issue 2). <https://doi.org/10.1016/j.pmr.2018.01.010>
- Tweedy, S. M., Mann, D., & Vanlandewijck, Y. C. (2016a). Research needs for the development of evidence-based systems of classification for physical, vision, and intellectual impairments. In *Handbook of Sports Medicine and Science: Training and Coaching the Paralympic Athlete*. <https://doi.org/10.1002/9781119045144.ch7>
- Tweedy, S. M., Mann, D., & Vanlandewijck, Y. C. (2016b). Research needs for the development of evidence-based systems of classification for physical, vision, and intellectual impairments. *Training and Coaching the Paralympic Athlete*, 122–149. <https://doi.org/10.1002/9781119045144.ch7>
- Tweedy, S. M., & Vanlandewijck, Y. C. (2011). International Paralympic Committee position stand-background and scientific principles of classification in Paralympic sport. In *British Journal of Sports Medicine* (Vol. 45, Issue 4). <https://doi.org/10.1136/bjsm.2009.065060>
- Van Biesen, D., Augustovičová, D., Pineda, R. C., Nemček, D., & Burns, J. (2026). Cognitive and executive functions of top level para-karate athletes with intellectual disability. *Psychology of Sport and Exercise*, 82. <https://doi.org/10.1016/j.psychsport.2025.102998>
- Van Biesen, D., Burns, J., Mactavish, J., Van de Vliet, P., & Vanlandewijck, Y. (2021). Conceptual model of sport-specific classification for para-athletes with intellectual impairment. *Journal of Sports Sciences*, 39(sup1), 19–29. <https://doi.org/10.1080/02640414.2021.1881280>

- Van Biesen, D., Hettinga, F. J., McCulloch, K., & Vanlandewijck, Y. (2016a). Pacing profiles in competitive track races: Regulation of exercise intensity is related to cognitive ability. *Frontiers in Physiology*, 7(DEC). <https://doi.org/10.3389/fphys.2016.00624>
- Van Biesen, D., Hettinga, F., McCulloch, K., & Vanlandewijck, Y. (2016b). Pacing Profiles in Competitive Track Races: Regulation of Exercise Intensity Is Related to Cognitive Ability. *Frontiers in Physiology*, 7. <https://doi.org/10.3389/fphys.2016.00624>
- Van Biesen, D., Mactavish, J., Kerremans, J., & Vanlandewijck, Y. C. (2016). Cognitive predictors of performance in well-trained table tennis players with intellectual disability. *Adapted Physical Activity Quarterly*. <https://doi.org/10.1123/APAQ.2015-0122>
- Van Biesen, D., Mactavish, J., & Vanlandewijck, Y. (2014). Tactical proficiency among table tennis players with and without intellectual disabilities. *European Journal of Sport Science*, 14(5). <https://doi.org/10.1080/17461391.2013.825645>
- Van Biesen, D., McCulloch, K., & Vanlandewijck, Y. (2018). Comparison of shot-put release parameters and consistency in performance between elite throwers with and without intellectual impairment. *International Journal of Sports Science & Coaching*, 13, 86–94. <https://doi.org/10.1177/1747954117707483>
- Van Biesen, D., Van Damme, T., Pineda, R. C., & Burns, J. (2022). The impact of intellectual disability and sport expertise on cognitive and executive functions. *Journal of Intellectual Disabilities*. <https://doi.org/10.1177/17446295211036331>
- Vivaracho, I., Vanlandewijck, Y., & Van Biesen, D. (2019). Initial steps towards evidenced-based classification for Taekwondo poomsae athletes with intellectual impairments: a pilot study. *European Journal of Adapted Physical Activity*, 11(2), 1–14. <https://doi.org/10.5507/euj.2018.006>
- Wang, Z., Wang, J., Guo, J., Dove, A., Arfanakis, K., Qi, X., Bennett, D., & Xu, W. (2023). Association of Motor Function With Cognitive Trajectories and Structural Brain Differences. *Neurology*, 101. <https://doi.org/10.1212/wnl.0000000000207745>
- Weng, W.-H., Yeh, N.-C., Yang, Y.-R., & Wang, R.-Y. (2025). Effects of motor-cognitive training on cognitive function and gait performance in older adults with dementia: a systematic review and meta-analysis. *Scientific Reports*, 15. <https://doi.org/10.1038/s41598-025-09582-y>
- Wileman, T. M., McKay, M. J., Hackett, D. A., Watson, T. J., Fleeton, J., & Fornusek, C. (2024). Guiding Evidence-Based Classification in Para Sporting Populations: A Systematic Review of Impairment Measures and Activity Limitations. *Sports Medicine*, 55(2), 341–391. <https://doi.org/10.1007/s40279-024-02132-y>
- Wileman, T., McKay, M., Hackett, D., Watson, T., Fleeton, J., & Fornusek, C. (2024). Guiding Evidence-Based Classification in Para Sporting Populations: A Systematic Review of Impairment Measures and Activity Limitations. *Sports Medicine (Auckland, N.z.)*, 55, 341–391. <https://doi.org/10.1007/s40279-024-02132-y>
- WKF. (2023). *WKF joins Virtus to further develop Para-Karate*. <https://www.wkf.net/news-center-new/wkf-joins-virtus-to-further-develop-para-karate/1415>

- WKF Para Karate Strategic and Development Plan (2022). <http://www.wkf.net>
- Zago, M., Mapelli, A., Shirai, Y., Ciprandi, D., Lovecchio, N., Galvani, C., & Sforza, C. (2015). Dynamic balance in elite karateka. *Journal of Electromyography and Kinesiology : Official Journal of the International Society of Electrophysiological Kinesiology*, 25 6, 894–900. <https://doi.org/10.1016/j.jelekin.2015.10.002>
- Zaino, M., Shaaban, E. E., Shubayr, N., & El-Setouhy, M. (2025). Adapting and Validating a Motor Intelligence Assessment Tool for Children with Intellectual Disabilities: Prioritizing Movement and Sensory-Motor Integration. In *International Journal of Statistics in Medical Research* (Vol. 14).

Appendix 1 Information Sheet and Consent Form



Project Name	The model of sport-specific classification in para-karate	Reporting Period
Responsible Organisations	Comenius University in Bratislava, Faculty of Physical Education and Sport, and the World Karate Federation	2023-2026
Prepared by	Dr. Dusana Augustovicova	Study QR code
Comenius University	Faculty of Physical Education and Sport in Bratislava, Slovakia	
VIRTUS	dusana.cierna@uniba.sk	
WKF	Tel. +421 908 736 720	
KU Leuven		

HIGHLIGHTS

- **Your participation is very important in developing future classification systems for athletes across the four competition classes.**
- **This is a requirement for potential future inclusion in high-level Paralympic Competition.**

Dear athlete, coach, and support staff,

You are invited to participate in our research project. In this letter, you will find all the information you need to decide whether to participate. It is essential that you understand why this study is being conducted and what is expected of you.

This study was approved by the Ethical Committee of the Faculty of Physical Education and Sport in Slovakia (**UK5/2023**).

Background information and purpose of the study

This research aims to foster more inclusivity and equity in high-level sports for elite athletes with a disability. This highly relevant research area contributes to a more inclusive society. Although opportunities for involvement in sports are improving for athletes with a disability, at the highest level, there is still a significant portion of people with disabilities that have less access than people without disabilities to competition at the highest level in their sport.

The World Para-karate Championship is an international sports competitive event for high-level athletes that has become more inclusive in recent years since high-level competition is offered for athletes in four classes.

To be able to proceed toward the future inclusion of para-karate in the Paralympic Games, it is required to have an evidence-based classification system in place. For evidence-based classification, there needs to be a system in place that can demonstrate the impact of impairment on key determinants of sport performance. Therefore, research is required to support the development of standardized assessment tools for the assessment of impairment, and performance, and to establish the relation between impairment and performance in athletes disability.

This project is a first step (pilot study) aiming to create understanding regarding the performance and performance variability of athletes with a disability and/or additional health impairments. In this project, the differences in performance among the athletes in current sports classes will be analyzed, and anthropometric, sport-specific, and athletic profiles of the athletes will be determined (e.g., their training history, body composition, and motivation to train and compete).

PROCEDURES

Why are you invited?

You are invited because you are an athlete competing in one of the four classes in the World Karate Championships. In this study, we collect information from all registered athletes across all sports classes because we are interested in your performance, athletic profile, and training history.

What do I have to do?

If you consent to participate in this study, you will be given access to a digital questionnaire that surveys your sports, competition, and training history. Before being given access, you must have read this information letter and signed the consent form, confirming that you agree to participate. Completing the questionnaire will take about 10–15 minutes. Completing the rest of the measurements about 10 – 60 minutes. The exact time depends on your personal situation, sport class, and the answers you provide.

The questionnaire includes questions about general information such as your age and gender, along with questions about your training history, your athletic profile, and years of experience in your sport. Body composition will be measured using Inbody, which uses bioelectrical impedance analysis. Kistler Force plates will measure your postural balance to assess your physical abilities, while Opto Jump will measure the height of your counter-movement jump. For peak upper limb strength and nervous fatigue, a K-grip developed by Kinvent will be used. Additionally, a generic battery will measure your sports intelligence.

Do you have to participate?

No, you do not have to participate in this study. Your participation is voluntary, and you may withdraw or stop completing the questions at any time without giving a reason. Questionnaires that are not fully completed will be deleted and will not be used as part of this study.

Risks, benefits, and compensation

No specific health risks or individual benefits are associated with participation in this study.

Your participation is very important in developing future classification systems for athletes across the four competition classes.

This is a requirement for potential future inclusion in high-level Paralympic Competition.

Information on the processing of your personal data

Personal data about you will be collected and processed as part of your participation in this study.

These include personal data such as age, gender, competition class, height, weight, training volume, body composition, CMJ height, power, fatigue, and among others. This data will be processed in accordance with the General Data Protection Regulation (GDPR).

Only personal data necessary for the purposes of this research will be collected and processed. In particular, the research aims to map your athletic profile, training history, and sport performance.

The data collected could be reused as part of future scientific research.

Your data will be pseudonymized as part of this study. This means that your data will be coded and can not be linked to your identity by any other person outside the research team. It will not be possible to identify you in the scientific output of this research, such as publications.

The legal basis for processing your data is the public interest. This means that the research will increase knowledge and insight that will benefit society (directly and indirectly).

The researchers will keep your data for ten years after the end of the research at a secure storage location at Comenius University (Slovakia). After this period, the personal data will be permanently deleted if they are no longer necessary to conduct the research.

Your Rights

You always have the right to ask for more information about using your data.

Within the framework of this research, Comenius University is cooperating with the World Karate Federation and Virtus, but no individual non-coded data will be shared with them. Therefore, they will also be unable to link the data to specific individuals.

Contact details

Comenius University, Faculty of Physical Education and Sport acts as the data controller in the context of this research. More specifically, only the researchers Dusana Augustovicova and Debbie Van Biesen can access your personal data. In case of specific questions about this research, including the processing of your personal data, you can contact them.

Coordinator

Dr. Dusana Augustovicova

Faculty of Physical Education and Sport in Bratislava, Slovakia

dusana.cierna@uniba.sk

Tel. +421 908 736 720



Appendix 2 Classification of athletes with intellectual impairment (K21 and K22)

APPENDIX 2: CLASSIFICATION OF ATHLETES WITH INTELLECTUAL IMPAIRMENT (K21 and K22)

This Appendix establishes the classification framework for Athletes with Intellectual Impairment competing in Para Karate, under the authority of the **World Karate Federation (WKF)**. It sets out the eligibility requirements, impairment assessment procedures, minimum impairment criteria, and Sport Class allocation. These are defined in alignment with the standards of **VIRTUS**—the IPC-recognised International Federation responsible for athletes with intellectual impairments.

The classification process for this athlete group is structured into a **four-phase pathway**, ensuring a robust, evidence-based determination of eligibility and class assignment.

1. Eligible Impairment

Table of Eligible Impairments for Athletes with Intellectual Impairment

Sport Class	Impairment Type	Definition	Examples of Underlying Health Conditions / Diagnostic Criteria
K21 (II1)	Intellectual Disability	A neurodevelopmental condition characterised by significant limitations in both intellectual functioning and adaptive behaviour, which must originate before the age of 22.	1. Significant impairment in intellectual functioning: $IQ \leq 75$ (≥ 2 SD below the population mean). 2. Significant limitations in adaptive behaviour: ≥ 2 SD below the mean in either: - Conceptual, social, or practical skills - OR global composite of these areas. 3. Onset before age 22. Diagnostic references: AAIDD 2010, WHO ICD-10, ICF 2001. Examples: Intellectual developmental disorder; unspecified intellectual disability.
K22 (II2)	Intellectual Disability with Significant Additional Impairment	Athletes with an intellectual disability who also have additional lifelong functional impairments that substantially affect sports performance.	1. Confirmed diagnosis of Trisomy 21 or Translocation Down Syndrome OR 2. Diagnosed Intellectual Disability (as per II1 criteria) AND meet the threshold of significant functional limitation on the VIRTUS FAST Assessment Tool.

Additional Criteria:– Medical clearance: Symptomatic Atlantoaxial Instability (AAI) must be excluded.Examples: Down syndrome (Trisomy 21); Intellectual Disability + neurological or musculoskeletal comorbidities.

2. UHC Assessment (Underlying Health Condition Verification)

In the context of intellectual impairment, the verification of an **Underlying Health Condition (UHC)**—specifically, a disorder of intellectual development—is a mandatory component of athlete eligibility. The WKF relies on the established expertise and governance of **Virtus**, the IPC-recognized International Federation for athletes with intellectual impairments, to oversee this step.

2.1. Independent Medical Review via Virtus Panel

The medical verification of the UHC is conducted by the **Virtus Independent Eligibility Assessment Panel**, comprising qualified experts in psychiatry, psychology, and related disciplines. This panel is responsible for validating the clinical documentation submitted by or on behalf of the athlete in accordance with Virtus procedures and the IPC Classification Code.

2.2. Submission Process and Role of National Eligibility Officer (NEO)

Athlete eligibility submissions must be completed through the official **Virtus Eligibility Application Form** and submitted via the designated **National Eligibility Officer (NEO)** of the athlete's country. The NEO plays a key role in ensuring that all documents meet the submission standards of Virtus and are complete prior to review by the eligibility panel.

- Where a National Federation is an active Virtus member, the responsibility for athlete registration and eligibility confirmation lies with that Federation's appointed NEO.
- In nations where no Virtus member organization is present, or where no NEO has been appointed, **WKF may act as the interim NEO**, facilitating the athlete's submission and communication with Virtus to ensure procedural compliance.

2.3. Required Documentation for Underlying Health Condition (UHC) Verification

In order to verify the presence of a relevant Underlying Health Condition (UHC) in line with the eligibility requirements for Para Karate, athletes must submit the following documentation as part of their application to the **VIRTUS Eligibility Panel**, either through their **National Eligibility Officer (NEO)** or via **WKF acting as NEO** in case there is no VIRTUS member in their country.

For K21 – Athletes with Intellectual Disability

Athletes must submit:

1. Diagnostic Report

- A medical or psychological report confirming a **formal diagnosis** of **Intellectual Disability** in accordance with one of the following international standards:
 - *ICD-10: F70–F79* (Intellectual Developmental Disorder)
 - *ICD-11: 6A00*
 - *DSM-V: Intellectual Developmental Disorder*

2. Cognitive Function Assessment

- A **Full-Scale IQ test report** performed by a **licensed psychologist** using a standardised, internationally recognised tool:
 - **WISC-V (Wechsler Intelligence Scale for Children)**
 - **WAIS-IV (Wechsler Adult Intelligence Scale)**
 - **Stanford-Binet Intelligence Scales (5th edition)**
- The result must demonstrate **significant intellectual impairment**, defined as a **Full-Scale IQ score ≤ 75** .

3. Adaptive Behaviour Assessment

- A report from a **validated adaptive functioning tool**, showing **significant limitations** in **at least one** of the following domains: **Conceptual**, **Social**, or **Practical** skills.
- Accepted tools include:
 - **Vineland Adaptive Behavior Scales (VABS-II or VABS-III)**
 - **Adaptive Behavior Assessment System (ABAS-II or ABAS-III)**
- Scores must be **≥ 2 standard deviations below the mean**.

4. Proof of Developmental Period Onset

- Documentation (school or medical records) showing that the intellectual impairment was evident **before the age of 22**.

For K22 – Athletes with Down Syndrome and Additional Impairment

Athletes must submit **all of the above (for K21)**, plus:

5. Formal Diagnosis of Down Syndrome

- A medical report confirming a diagnosis of:
 - **Trisomy 21**, or
 - **Translocation Down Syndrome**
 - *(Note: Mosaic Down Syndrome = eligible for K21 only)*

6. Atlantoaxial Instability (AAI) Clearance

- A **radiology report and clinical statement** from a qualified medical professional confirming the athlete is **free of symptomatic AAI**.

7. VIRTUS FAST Assessment

- Completion of the **Functional Assessment Screening Tool (FAST)** to demonstrate **significant additional functional impairment** beyond intellectual disability.
- This tool evaluates motor coordination, physical strength, and additional neurological limitations affecting sport performance.

Only athletes who are deemed *Nationally Eligible* by Virtus may proceed to Sport Class evaluation under the WKF classification system.

2.4. Re-Assessment and Validity Periods

Eligibility may be subject to **review or expiration**, particularly for younger athletes, those with borderline diagnostic profiles, or those presenting incomplete documentation. WKF will rely on Virtus determination regarding the validity or expiration of the athlete's UHC eligibility status.

3. Eligible Impairment Assessment

3.1. Interview and Athlete History

The classification panel initiates the process with a detailed **semi-structured interview**, which includes:

Medical History Review

Confirmation of diagnosis details, medications, implants, devices, and their functional implications.

Disclosure of comorbidities and conditions that could influence classification outcomes.

Training History & Sport Activity Limitations (TSAL) Survey

Length of time training in karate (both para and mainstream contexts).

Previous sport participation, classification history (if any), and competition experience.

Description of how the impairment limits sport-specific activities.

Support Needs and Learning Profile

Assessment of support requirements in training or competition settings (e.g., routines, repetition, visual cues).

Discussion on learning rate, motor planning, and memory issues.

This phase is conducted in English with a translator if necessary. For minors or athletes requiring assistance, a support person may accompany them without interfering in the assessment.

3.2 Documentation Verification

Athletes must present documentation that confirms a **diagnosis of Intellectual Disability (ID)**, using internationally recognized standards. All submissions must be pre-validated through the VIRTUS system before WKF classification can proceed.

For K21 (Intellectual Disability):

- Diagnostic report confirming an ID under **ICD-10 / ICD-11 or DSM-V** criteria.
- **Full-scale IQ report** (e.g., WISC, WAIS, Stanford-Binet) indicating a score ≤ 75 .
- **Adaptive behavior assessment** (e.g., VABS or ABAS) showing ≥ 2 SDs below the mean in at least one domain (conceptual, social, practical).
- Documentation of **onset before age 22**.

For K22 (Intellectual Disability + Additional Impairment):

All K21 documents **plus**:

- Cytogenetic report confirming **Trisomy 21 or Translocation Down Syndrome**.
- Statement confirming absence of symptomatic Atlantoaxial Instability (AAI).
- Additional **functional impairment** assessment using the **FAST** tool (per VIRTUS protocol).

3.3 Functional Assessment Protocol

a. Generic Sport Cognition Test Battery (GSCT)

This standardized battery evaluates the cognitive abilities most relevant to karate. Each test assesses a specific cognitive domain with pre-defined cut-off scores:

COGNITIVE DOMAIN	TEST	SCORING METRIC	CUT-OFF
PROCESSING SPEED, INHIBITION	Flanker Test	Correct responses in 30 sec	
MEMORY AND LEARNING	Corsi Block-Tapping	Sequence length	
PSYCHOMOTOR SPEED	Finger Tapping Test	Taps in 10 seconds	
EXECUTIVE FUNCTIONING (PLANNING)	Tower of London	Correct problem solutions	
VISUAL REASONING	Block Design	Total score	
FLUID REASONING	Matrix Reasoning	Correct solutions	

b. Sport-Specific Functional Tests

Star Excursion Balance Test (SEBT)

Evaluates dynamic balance in 8 directions, mimicking embusen patterns in kata. Scored 0–3 based on ability to maintain posture and complete movements.

Karate-Specific Technique Execution

Sequence of 4 techniques in Zenkutsu Dachi (forward and backward) within a spatial constraint (marked rectangle).

Scored on speed, coordination, and spatial awareness.

Kata-Specific Memory Test

Athlete memorizes and reproduces a set kata sequence after 3 practice rounds.

Assessed on:

Correct execution (5 pts)

Directional accuracy (5 pts)

Hesitations (-0.5 per instance)

Wrong side execution (-0.5 per instance)

Total score categorized 0–3 based on a 10-point scale.

Freely Chosen Kata Demonstration

At least 10 techniques from the athlete's competition kata performed at full intensity.

Used to verify fluency and support reclassification if needed.

All tests are video recorded from frontal and sagittal planes for documentation, quality assurance, and appeals.

3.4 Scoring and Class Allocation

Each functional domain is assigned a score (0–3), and the average is used to inform the final extra points and the recommendation for:

Sport Class (K21 or K22)

Sport Class Status (Confirmed or Review)

Classification outcomes are reviewed by the panel, with any disagreement defaulting to the **more functional** class and automatic **Review** status.

4. Minimum Impairment Criteria (MIC)

4.1 K21 – Athletes with Intellectual Disability

To meet the MIC for Sport Class **K21**, an athlete must demonstrate all three of the following, as established by the Virtus eligibility process:

1. **Intellectual Functioning:** A confirmed **IQ score of 75 or lower**, measured via a standardized, norm-referenced psychometric test (e.g., WISC-V, WAIS, Stanford-Binet).
2. **Adaptive Behavior:** Performance at or below **two standard deviations** from the mean in at least one domain (conceptual, social, or practical) or overall score on validated scales such as **Vineland Adaptive Behavior Scales (VABS)** or **Adaptive Behavior Assessment System (ABAS)**.
3. **Age of Onset:** Documentation showing that the impairment originated during the **developmental period (before age 22)**.

Athletes must provide valid documentation in English or with certified translation. Only those who fulfill all three components will be considered to have met the MIC.

4.2 K22 – Athletes with Intellectual Disability and Additional Significant Impairment

To meet the MIC for **Sport Class K22**, an athlete must first fulfill the criteria for K21 **and** provide evidence of an additional permanent impairment significantly limiting functional ability. The following are required:

1. **Diagnosis of Down Syndrome** (Trisomy 21 or Translocation type, confirmed by cytogenetic testing).
2. A medical statement certifying the athlete is **free from symptomatic Atlantoaxial Instability (AAI)**.
3. Completion of the **Virtus Functional Assessment Screening Tool (FAST)**, confirming **significant functional limitations** beyond intellectual impairment alone.

The Classification Panel must evaluate documentation, observe functional deficits in cognitive-motor integration, and confirm that the athlete presents **substantial activity limitations** beyond those seen in K21.

5. Sport Classes and Assessment Methodology

5.1 Assessment Methodology

The WKF Classification Panel will determine the athlete's sport class through a combination of:

- Review of documentation and VIRTUS eligibility status
- Interview and athlete history survey
- Standardized cognitive testing (GSCT)
- Sport-specific technical skill observation

- Functional movement analysis (e.g., SEBT)

Each athlete is scored across multiple domains. Classification outcomes are based on how the **Eligible Impairment impacts the execution of karate-specific tasks and movements**.

5.2 Adaptive Equipment

Currently, no Adaptive Equipment is permitted or recognized in the assessment or competition environment of Para Karate for intellectual impairment classes.

- **K21 and K22** athletes **do not** use Adaptive Equipment as part of sport class eligibility or performance enhancement.
- If, in future iterations, the use of visual markers or auditory cues is permitted for learning or safety purposes, such modifications must be:
 1. **Declared during evaluation**;
 2. **Documented and tracked** as part of the athlete's classification record.

5.3 Observation Assessment

Observation Assessment (OA) **is a required phase** in the Para Karate classification process.

It includes:

- **Observation of kata demonstration** during official classification sessions or competition.
- Review of:
 - Motor planning and sequencing
 - Coordination under pressure
 - Retention and reproduction of learned sequences
 - Cognitive-motor integration under competition-like conditions

Observation Assessment may affect sport class status (e.g., Review vs Confirmed). The Classification Panel records observations using standardized scoring sheets and video capture for audit purposes.

5.3 Observation Assessment

Observation Assessment (OA) **is a required phase** in the Para Karate classification process.

It includes:

- **Observation of kata demonstration** during official classification sessions or competition.
- Review of:
 - Motor planning and sequencing
 - Coordination under pressure
 - Retention and reproduction of learned sequences
 - Cognitive-motor integration under competition-like conditions

Observation Assessment may affect sport class status (e.g., Review vs Confirmed). The Classification Panel records observations using standardized scoring sheets and video capture for audit purposes.

5.4 Definition of Sport Classes

WKF defines the intellectual impairment sport classes as follows:

SPORT CLASS	DEFINITION
K21	Athletes with an intellectual disability who meet the Minimum Impairment Criteria (MIC) and exhibit notable limitations in information processing, technical execution, motor learning, and decision-making . These athletes may struggle to consistently recall, apply, and sequence movement patterns, and their karate techniques typically lack fluidity, precision, and refinement , particularly under time constraints or pressure.
K22	Athletes who meet the criteria for K21 and present with Down Syndrome or an equivalent significant additional impairment . This group demonstrates more pronounced restrictions in physical coordination, strength, balance, and expressive motor control , which further amplify challenges in movement smoothness, technical accuracy, and performance reliability. Karate technique in K22 athletes is often fragmented, lacks rhythm , and is substantially impacted by both cognitive and physical limitations .