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An insight into the rule-defining process of Paralympic Karate and its benefits on karate and people with disabilities

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A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

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Abstract

Background & Study Aim: On the battlefield in ancient Japan, there were no referees to say "Stop!" to cease combat. If warriors (samurai) sustained an injury on the battlefield, they would have to keep fighting, so they had to seriously think of ways that would allow them to fight even in instances in which they have lost function of a upper limb or are forced to fight from a sitting position (due to lower limb injury or loss). Therefore, we could say that budo (Japanese martial arts) has had an open system for the disabled since the very beginning, and anyone can practice budo today. The aim of this study is a new proposal on how to assess karate competitors with disabilities, which might replace the current 3-grade point system used by the World Karate Federation.

Material and Methods: A functional assessment (21-grade point adding system) based on range of motion and speed of technique was developed that analyzes video of competitors with Kinovea software.

Results: The results show that the margins of error are too high for a reliable functional assessment of the 21-grade point adding system. However, video analysis of movements is bringing considerably more data about competitor performance than traditional methods of observation.

Conclusions: The proposed functional assessment through video analysis may give karate referees better insight than the current mandatory system. This is therefore bringing us closer to fairer regulations that cannot otherwise be reached.

Keywords: kata • pure visual analysis • video recording • wheelchairs

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INTRODUCTION

On the battlefield in ancient Japan, there were no referees to say "Stop!" to cease combat. If warriors (samurai) sustained an injury on the battlefield, they would have to keep fighting, so they had to seriously think of ways that would allow them to fight even in instances in which they have lost function of a upper limb or are forced to fight from a sitting position (due to lower limb injury or loss). Therefore, we could say that *budo* (Japanese martial arts) has had an open system for the disabled since the very beginning, and anyone can practice *budo* today [1].

Budo practitioners with disabilities can acquire not only improved mobility, balance, muscle control, walking ability and performance in daily activities, but they also exhibit less fear, more self-efficacy, and a healthier self-image [2].

One of the goals of *budo* practitioners is to participate in competitions. The competitions are not regulated in a way that limits or prohibits the participation of people with disabilities. Thus, competitors with disabilities could participate and achieve results in these competitions. However, most people with disabilities are unfit for these competitions, so special competitions for them are required [3]. From the 2020 Olympic Games in Tokyo, karate will officially become an Olympic discipline, which is not the case in the 2020 Paralympic Games. As for the other martial arts, judo has been an official discipline in the Paralympic Games since 1988, and taekwondo will become an official discipline in 2020.

Karate has already started preparations for becoming an official discipline at the Paralympic Games. The Japan Karatedo Federation (JKF) started an annual event, the All Japan Karate Competition for the Disabled, in 2005, and The World Karate Federation (WKF) organized the first World Karate Championship for disabled practitioners in Bremen in 2014. In 2015, the World Karate Federation became a recognized international federation by the International Paralympic Committee (IPC) [4].

Judo for the blind in the Paralympic Games does not classify the athletes by their visual ability level, but only by weight. The reason for this is that even when athletes are not categorized by their ability to see, their contact in terms of holding the opponent's uniform is safe and fair. The International Judo Federation (IJF) only set the rule that allows athletes to hold each other's uniform when competing [5]. However, it is difficult to import such a kind of system in karate *kata* competitions because in them, body movements are evaluated, and victory or defeat is decided by the result of the evaluation.

In the first World Karate Championship for the disabled, the WKF decided to hold the wheelchair user class kata competition using the 3-grade point adding system in reference to the ICD-10 (International Classification of Diseases) criteria [6].

We accepted the simple categorization of wheelchair user by the World Karate Federation (WKF), that keeps the value of medals, and the point adding system, that keeps fairness, and are working on improving them. The meaning of "simple categorization that keeps the value of medals" is, when we divide this category into more detailed classes, according to the level of disability, the number of competitors in one of the classes will be small. The meaning of the Paralympic Games is not to praise persons with disabilities, but to praise the world's top athletes.

However, karate *kata* athletes who are recognized as a single unit by ICD-10 could have different motor functions. For instance, people with cerebral palsy are in only one group according to ICD-10, but they could be evaluated by specified motor tests to see the differences in their motor capabilities. ICD-10 does not distinguish the difference between these participants. It is clear that a more detailed point adding system for them will make the competitions fairer for the athletes themselves. Therefore, based on presented assumptions, we formed another approach. We discussed and focused on the wheelchair user class *kata* competition. Means and ways of improving the system for karate competitions for disabled athletes have been discussed since 2014.

This paper is based on the presentation titled "What will 'Paralympic Karate' bring to karate and people with disabilities?: A look at the rule-defining process" that was given at the Japanese Academy of Budo on September 8, 2017 [7]. Our discussion is seeking to create a new path for the future of Paralympic Karate [8].

Budo (Budō) – originally a term denoting the "Way of the warrior", it is now used as a collective appellation for modern martial arts of ***kendō, jūdō, kyūdo*** and so on. The primary objective of these "martial ways" is self-perfection (***ningen- kesei***) [15].

Kata – prescribed patterns or sequences of techniques [15].

Technique – *noun* a way of performing an action [16].

Paralympic Games, Paralympics – *plural noun* an international sports competition for athletes with disabilities, held every four years in the same year as the Olympic Games [16].

Performance – *noun* the level at which a player or athlete is carrying out their activity, either in relation to others or in relation to personal goals or standards [16].

Technique– *noun* a way of performing an action [16].

Tactics – *plural noun* the art of finding and implementing means to achieve immediate or short-term aims [16].

Poomse (kata in karate) – it is traditionally understood as the style of conduct which expresses directly or indirectly mental and physical refinements as well as the principles of offense and defence resulting from cultivation of taekwondo spirit and techniques. Nowadays, poomse is involved in competition in the taekwondo technique modality [17].

The aim of this study is a new proposal on how to assess karate competitors with disabilities, which might replace the current 3-grade point system used by the World Karate Federation.

MATERIAL AND METHODS

This is not a standard experimental study, but is a conceptual, methodological approach to specific issues. As a point of reference in creating a functional assessment, the range of motion and speed of techniques from healthy individuals (karate master level) were analysed. The discussion of issues was then divided into six sections, which includes both a description of each step and conclusions.

RESULTS

Step 1: 21-grade point adding system

We designed a 21-grade point adding system based on a body function assessment using a typical goniometer measurement. This system has more grades so is therefore more precise than the 3-grade system. We think a system based on function assessment is fairer when compared to one based on ICD-10. For instance, some competitors may be in the same cerebral palsy category, but some can walk without crutches and some use a wheelchair. We also made a list for checking body functions with a maximum of 120 points, and a table for converting those to added points of 0.0 to 2.0 (Table 1).

Step 2: Paralympic Games for athletes

These points (0.0-2.0) are not divided uniformly; they are divided for Paralympic level competitors. The Paralympic Games is for the world's top athletes and is not for giving an opportunity to all the disabled. Therefore, bedridden-level disabled have as little chance of participating in the Paralympic Games as ordinary able-bodied people would at the Olympic Games (Figure 1).

Table 1. Part of a schema of functional assessment with a point chart [2].

Adding points	Total points	Part	Movement	Range (degrees)	Points
0.0	0-4	Neck	Rotation right	41–	0
0.1	5-9			21 to 40	1
0.2	10-14			20-0	2
0.3	15-20		Rotation left	41–	0
0.4	21-26			21 to 40	1
0.5	27-32			20-0	2
0.6	33-38	Shoulder	Forward flexion right	141-180	0
0.7	39-44			101-140	1
0.8	45-50			81-100	2
0.9	51-56			–80	3
1.0	57-62		Forward flexion left	141-180	0
1.1	63-68			101-140	1
1.2	69-74			81-100	2
1.3	75-80			–80	3
1.4	81-86		Abduction right	160-141	0
1.5	87-92			140-111	1
1.6	93-98			90-111	2
1.7	99-104			–89	3
1.8	105-110		Abduction left	160-141	0
1.9	111-116			140-111	1
2.0	117-120			90-111	2
The functional test total points 0-120				–89	3

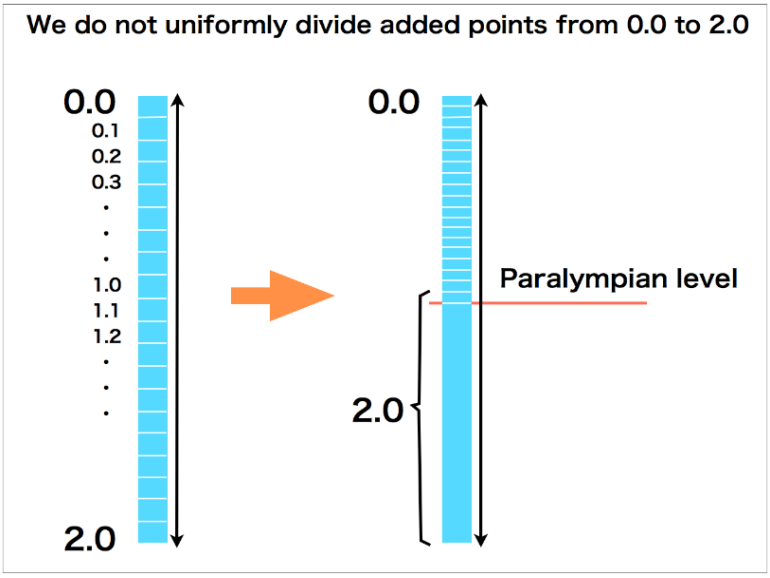

Figure 1. Description of added points distribution [2].

Step 3: Checking system for the functional test

Even though there is no evidence to suggest that competitors with disabilities are cheating in the body function assessment in order to get more points added, we still designed a checking system that utilizes free Kinovea motion analysis software. By using Kinovea to analyse competition videos, we can recognize how much the competitors can extend their arms (Figure 2). It is necessary to build trust among the competitors and eliminate doubts of others potential cheating. That is the essence of this checking system: it is not strictly to discover cheating. This kind of analysis is not as accurate as a biomechanical assessment. Judges should therefore not rigidly stick to a measurement obtained from only one perspective, but rather analyse different approaches to movements in order to get a broader perspective of competitor performance.

Figure 2. Example of elbow extension assessment using Kinovea [2].

Step 4: Usage of Kinovea in judging

We found that Kinovea is not only effective as a checking system, but also as a functional assessment before competitions. The results of the analysis provide the referee with important information. Checking the functional levels of competitors using the same method before competitions would provide us with more information about their actual abilities, both pre- and post-competition, as well as verify their veracity. We also added an assessment for the number of punches able to be thrown in three seconds, also measured by Kinovea. An assessment of the performance of a master level karateka allowed us to determine the maximal speed of a punch and the number able to be done during a three-second period [3]. This could be accurately assessed by a frame by frame analysis, which cannot be done without video (Figure 3). From karate's perspective, we thought that the execution of techniques is more important than muscle strength, range of motion, or overall level of disability. Contrary to functional assessment and range of motion, which are dependent on the level of specific body parts and joints, speed (duration of punch) presents the overall capability of a competitor.

Step 5: Difficulties in judging

We took videos of the assessment to determine the number of punches able to be made in three seconds and found that a fast punch is not always better than a slow one. We concluded that, from karate's perspective, a slow punch might demonstrate better technique than a fast, poorly executed one.

Step 6: Process of acknowledging the movements of competitors lacking upper limbs

As our presupposition is that wheelchair-class competitors cannot control their wheelchairs,

Number of repetitions	Average strike time (s)	Points (level)
10	–0.3	0
9	0.3-0.33	1
8	0.34-0.38	2
7	0.39-0.42	3
6	0.43-0.50	4
5	0.51-0.60	5
4	0.60-0.75	6

Figure 3. An example of a punch analysis used to determine strike time (speed) with a grading system [2].

this matter will not be taken into consideration. However, when a wheelchair that can be controlled by users moving their centre of gravity starts being used in the near future, we will also consider accepting competitors lacking an upper limb or limbs. We took video from the side of a *kata* performance by a competitor who was lacking an arm. It was analysed with Kinovea and from that we tried to create an assessment criteria based on the movement of the competitor's trunk, scapula, and shoulder. This is because trunk and shoulder movements are a key part of karate's upper limb techniques.

Kinovea has the function to track a point by placing a marker on the body and track its movement while a technique is being performed. This can be carried out on the side of the amputation. Figure 4 shows the bias occurring with the analysis of the protraction movement due to confusion with other parts of the *karate-gi*. This software recognizes skin colour, so if a competitor has some part of his or her limb remaining and exposed, it can be detected. If this is not possible, a coloured marker, such as a circle sewed with thread, would need to be attached to the *karate-gi*.

However, a problem with this is that as a *karate-gi* is not tight fitting, the shoulder can freely move in it. One solution might be making the *karate-gi* a bit tighter, rolling up the sleeve, or using a sleeveless *karate-gi*. Even then, the assessment will not be perfect, but it would undoubtedly be better.

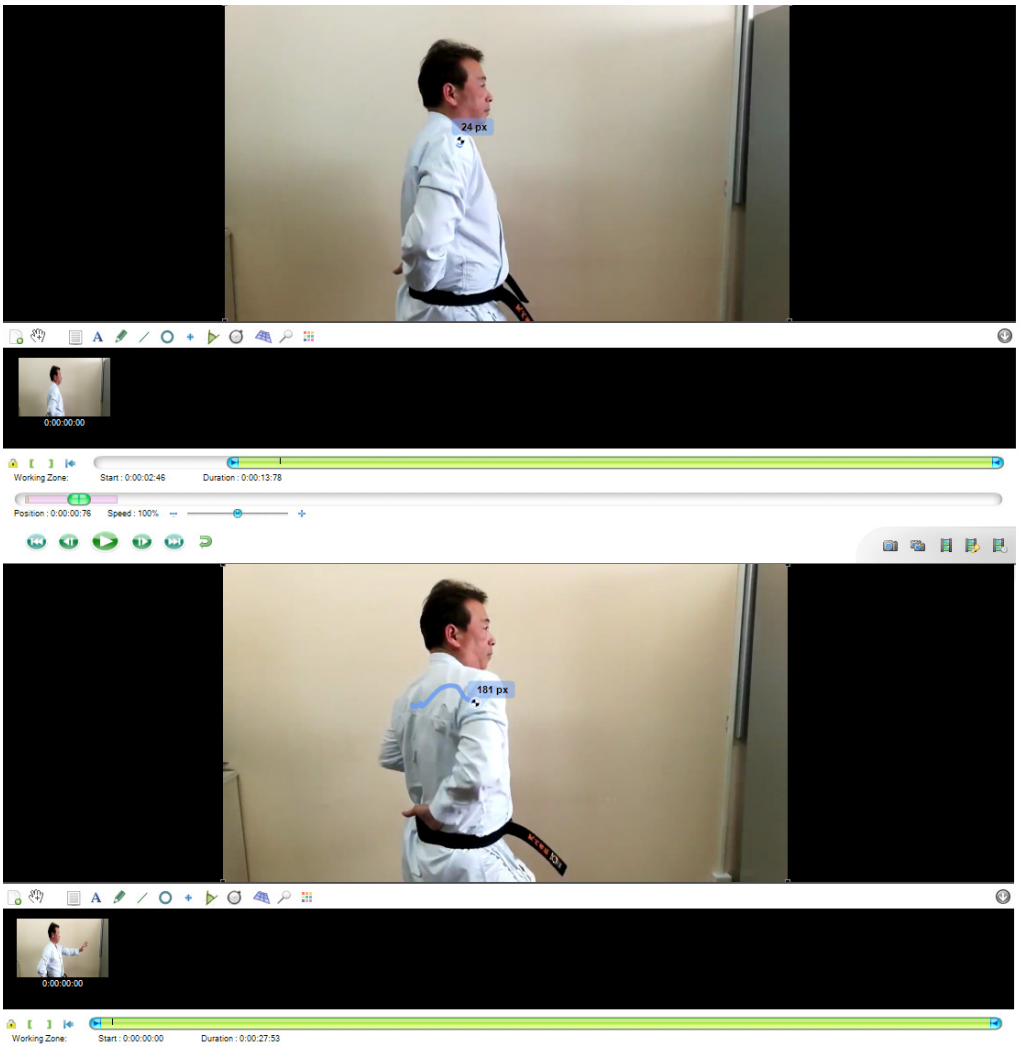

Figure 4. Marker tracking assessment and evidence of difficulties in tracking body parts when wearing a *karate-gi*. The top picture shows the elevation of the scapula, and the bottom shows the protraction movement.

DISCUSSION

Even if karate for disabled people has appeared in competitions for many years, the current evaluation system has plenty of room for improvement. There are only two martial arts that are official events at the Paralympic Games – judo and taekwondo. As judo is only for visually impaired individuals, it could not serve as any frame of reference for this analysis. However, taekwondo will have a classification rule for athletes with upper limb impairments for the Paralympic Games, which are based on the categorization of not only the type of disability, but also by participants who are tested using various functional assessments, so for now, this classification is fairer [9]. Moreover, the rules include the possibility of a disability worsening, meaning a regression in motor and cognitive functioning, so the assessment is for a specific period of time, after which there will be a reassessment. This point is important and should also be included in the assessment of karate athletes.

The difference in their approach is that they stay with a manual assessment, the biases of which we pointed out in the introduction, as there could be differences between the "laboratory" condition of evaluating participants and their actual sporting performance. This is similar to "in vitro" and "in vivo" experiments where there could be significant differences in obtained results. A laboratory assessment, even if it forces a participant to be active during the performance, lacks psychological components, mostly motivation and actual competition pressure. This could be a major factor for some people with disabilities, mostly with neurologically originating disabilities, as their mental state strongly affects their motor performance. For example, some may have increased spasticity due to psychological pressure, so their laboratory evaluation will be greater than their actual ability to move during a competition performance. For participants without disabilities, the popular battery of tests is The International Physical Fitness Test (IPFT) [10]. However, it is not possible or necessary to adapt it for people with disabilities for Paralympic Karate. The difference in the approach lies in the type of competition. Taekwondo in the Paralympic Games will be combat (*gyeorugi*) for competitors with an upper limb impairment [11]. These competitors can walk so they do not need the dynamic physical assessment for the disabled. However, this is not required for Taekwondo forms (*poomsae*) because there is no opponent. Karate forms (*kata*) also do not require any interaction with an opponent, so the type of assessment does not require any form of dynamic strength or endurance performance. Only the ability to execute a technique is needed, so a range of motion analyses with spatio-temporal indices is sufficient. By adding the psychological component described above, we concluded that a video analysis of a performance in a minor competition, or even the analysis of the first training video of the performance, could be above any system which is in use now.

It is not innovative to use a camera and video analysis in sports for monitoring training and performance [12]. However, it is usually used for technical and tactical analysis to give proper feedback to athletes. For performance-specific quantitative analysis of motor performance, a more advanced biomechanical analysis is used with markers that register spatio-temporal variables for high accuracy [13]. The software that we propose is a compromise between pure visual analysis of recorded performance and a highly accurate analysis [14]. However, it is unable to apply a sophisticated biomechanical analysis, which is very costly and requires a special area for motion capture.

There are lots of challenges that need to be met in order to check the validity of this concept. First of all, analysis of the actual competition needs to be assessed using this method by at least three judges, setting an intra-class correlation of their scores, checking if the proposed system serves as a reliable assessment tool, and acknowledging it as valid throughout different competitions. Setting angles, points, and execution times presented in each step of this method requires training for judges in using this software, and checking if their "motor vision" is on a comparable level for such an evaluation. Finally, after classifying groups of participants, checking the level of fairness will be the last test. We are presenting all these criteria here as an invitation for other researchers to carry out research as the science needs to be verifiable, and repeated results by different groups serve as a strong factor in proving the validity of such concepts.

CONCLUSIONS

Even if we were able to assess the disability levels of competitors, it would still be difficult to make a completely fair point adding system. This is

because keeping a balance between points added and lost due to disabilities in a competition is difficult as a karate performance consists of many connected factors. One simple pattern of assessment is insufficient to properly categorize all competitors. As functional level even varies in-between certain disabilities, the functional assessment of separate body parts may bring a different combination of abilities with the same amount of points. The proposed functional assessment through video analysis may give karate referees a better insight than the current mandatory system, which is therefore bringing us closer to fairer regulations that cannot otherwise be reached.

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