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THE ARTS AND SCIENCES OF JUDO

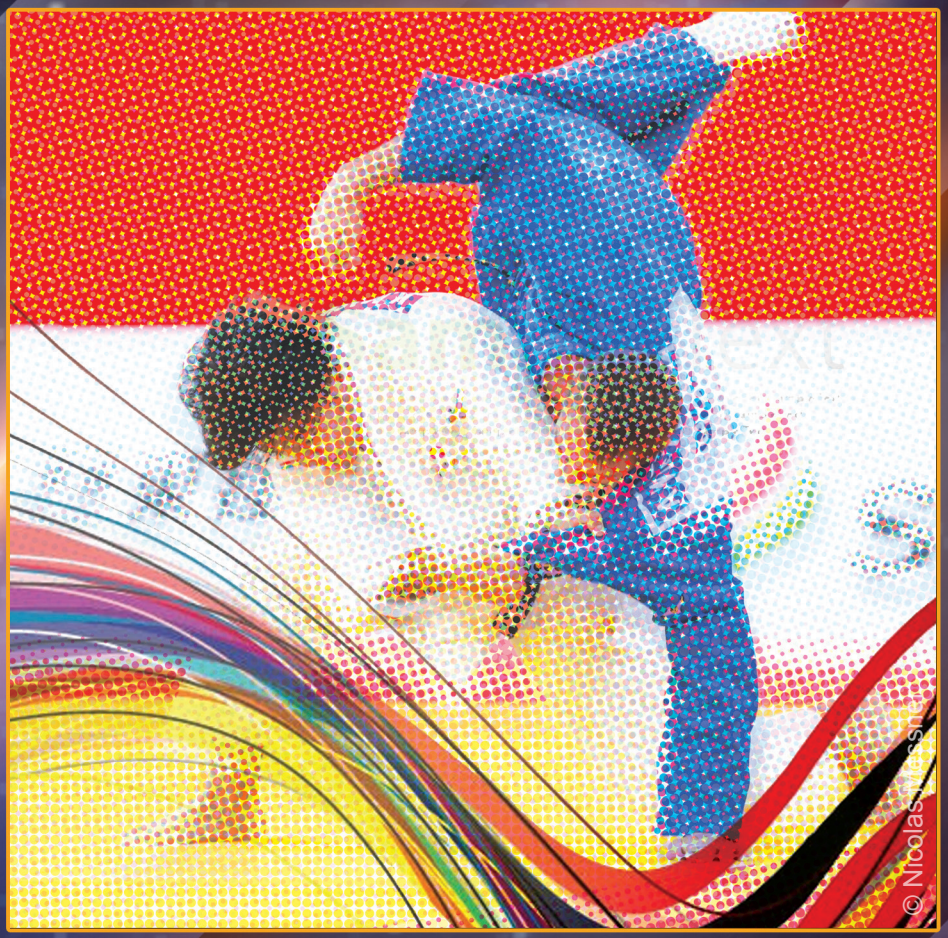

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Table of contents

The Relationship Between Balance and Coordination and the Training Level of Cadet Judoka
By Ivan Segedi, Marko Cetinić and Hrvoje Sertić p.4

Judo as a Way to Reduce Fear of Falling in Older Adults: *Yawara-chan Taiso*
By Mike Callan, Lucy Day, Janine Johnson, Ben Andersen, George Bountakis, Lindsay Bottoms. p.9

Towards Mental Training for Elite Judo Athletes
By Caio Amaral Gabriel p.18

Comparison of Key Performance Indicators Between Portuguese Olympic and Paralympic Judo Athletes
By Luís Monteiro, João Machado, Sarah N. Lanham, Emily L. Langford, Mark G. Abel p.22

Exploring the Experiences of Attending a Safe Falling Workshop Based on the Practice of *Ukemi*
By Katrina McDonald, Sharon Pexton, Kate Marks, Rachael Cubberley p.31

Legal Aspects of Serious Judo Accidents in Japan A Review of Decisive Judicial Precedents
By Yuji Nimura, Hideki Takami, Masaaki Kitaguchi, Yukihiro Yokoyama . . . . . p. 41

Effect of *Kumikata* on Grip Strength and Pinch Strength of Male University *Judoka*
By Junjiro Kubo, Koji Kobayashi . . . . . p. 52

The Effects of Judo Rule changes on Contestants' Performance: Paris Grand Slam Case Study
By Nuša Lampe, Husnija Kajmović, Jožef Šimenko & Fikret Bečić. p.56

The Relationship Between Balance and Coordination and the Training Level of Cadet Judoka

By Ivan Segedi, Marko Cetinić and Hrvoje Sertić

Abstract: *The aim of this paper is to determine if there is a difference in the level of balance and coordination training between judoka of different levels. Thirty (30) male judoka (aged 17+-2) participated in the research, divided into two groups according to their success on a national and international level (n1=14, n2=16), performing tests to observe balance and coordination. Tests used to assess balance consisted of: one basic test (standing on one leg longitudinally on a balance bench with eyes open - MBAU10) and four tests using the 'Gyko' inertial sensor system (1. standing on the left leg for 15 seconds; 2. standing on the right leg for 15 seconds; 3. standing on the left leg with closed eyes for 15 seconds; 4. standing on the right leg with closed eyes for 15 seconds), and the variables observed were: EA - ellipse area, MD - mean distance, ML MD - medio-lateral mean distance and AP MD – anterior-posterior mean distance. Tests to observe coordination consisted of: two basic tests (agility test on the ground - MAGONT and hexagonal obstacle test - HEXA) and one specific judo test for observing coordination (movement imitation test for throwing o-uchi-gari MSCO). Although no statistically significant difference (MANOVA) was found between the two observed groups of judoka, the results suggest that higher level judoka achieve better results in tests for balance and coordination. Statistically significant (ANOVA) differences were found in almost all balance variables measured with the "Gyko" device and in the MAGONT and MSCO coordination variables.*

Keywords: *balance; coordination; judo*

Judo is a combat sport in which the judoka, in a very intense activity, try to gain advantage over an opponent with attacks and counterattacks. A very large number of throwing techniques, hold down positions, arm locks and chokes make this sport very complex and technically extremely demanding, while at the same time making it very attractive. Since the longer part of the fight, which can be structurally divided into fighting in a standing position (fighting in a vertical position or plane) or in ground positions (fighting in a horizontal position or plane), takes place in a standing position (Franchini et al. 2010; Miarka et al., 2016), the focus of this paper will be the standing position. When we talk about fighting in a standing position, we can say that it represents constant and coordinated movements in order to stay on balance while also disrupting the opponent's balance, all with the purpose of executing a throw and gaining an advantage during transition to the ground or scoring *ippon* to conclude the fight in their favour. It is impossible to imagine a high-level *judoka* without excellent balance and coordination (Sertić, 2004). The ability of a judoka to achieve an advantage in a very high-intensity activity, by moving and preparing for an attack, stepping into ideal balance positions from which to pull opponents and move to perform throwing techniques, is an interesting area to investigate. Coordination and balance in the hypothetical equation of success in judo, if we consider only the motor space, occupy 22% and 12% of the total space respectively (Sertić, 2004), which represents a significant impact on the level of judo athletes if we consider it to be a success factor in competition. At the end of the day, the success of athletes in competitions is the only true indicator of the success of the previously implemented training process, planning and programming, which is certainly the biggest challenge for every coach. According to the authors (Behm et al., 2015), competitive results or success depends on morphological characteristics of the judoka, their training, and the abilities of their coaches to, through well-planned and targeted training, get the best out of their athletes at the crucial moments. It should be added that coaches should focus precisely on the development of certain motor skills at the optimal time of the long-term athlete development stages so they can achieve their best results in the senior age category. The development of coordination and balance skills starts from the younger age categories (Milanović, 2010). Therefore, according to the authors, the observation of cadet judoka is an interesting area of research, since it is in this category that they begin to achieve their first international successes, which can be reflected on during their continued sports careers, correlating with senior competitive results. Hyrsomalis's (2011) research proved that in certain sports

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there is a statistically significant connection between success in competitions and better results in balance tests. However, this was not found to be the case in judo. Furthermore, the influence of coordination on success in judo is also an under-researched area, so the aim of this paper is to determine whether there is a connection between the competitive success of cadet judo athletes and their results in balance and coordination tests.

MATERIALS AND METHODS

Thirty (30) judoka (17.3 ± 1.53) participated in the research and were divided into two groups in relation to the results they achieved at national and international level competitions, according to the official calendar of the Croatian Judo Federation: Group 1 - higher level judoka (Table 1) and Group 2 - other judoka (Table 2). After reviewing the results on the official website of the Croatian Judo Federation, it was determined that there were 14 participants in Group 1 and 16 participants in Group 2.

Table 1. Basic descriptive statistics of the participants (Group 1, n=14)

Variable	Group=1 Descriptive Statistics				
	Valid N	Mean	Min.	Max.	Std. Dev.
Age (year)	14	17,27	16,10	20,40	1,20
Weight (kg)	14	76,02	67,60	83,90	5,61
Height (cm)	14	180,01	170,80	190,60	6,24

Table 2. Basic descriptive statistics of the participants (Group 2, n=146)

Variable	Group=2 Descriptive Statistics				
	Valid N	Mean	Min.	Max.	Std. Dev.
Age (year)	16	17,41	14,10	20,60	1,82
Weight (kg)	16	70,00	58,70	81,10	6,07
Height (cm)	16	177,36	169,60	183,60	4,83

The primary criterion for participating in the research was that the candidates were healthy, i.e. that they had no medical restrictions according to the chosen medical doctor. A second criterion was that they practise judo actively and have participated in judo competitions for at least 5 years. We measured the height and body mass of the athletes selected for testing, to have the most homogeneous group possible. We assessed balance using a basic balance test: standing on one leg longitudinally on a balance bench with eyes open TEST MBAU10 (Metikoš et al. 1989) on the right leg - MBAU10_D and then on the left leg - MBAU10_L, and using the 'Gyko' device in four tests: 1. standing on the left leg for 15 seconds - L_OTV; 2. standing on the right leg for 15 seconds - D_OTV; 3. standing on the left leg with closed eyes for 15 seconds - L_ZAT; 4. standing on the right leg with closed eyes for 15 seconds - D_ZAT. The variables that were observed as relevant for assessing the level of balance in these tests included: EA - ellipse area (total area of movement of the centre of mass (COM)); D-MD - mean distance (average distance of COM from the initial position); ML MD – medio-lateral mean distance (average distance of COM from the initial position in the medio-lateral movement of the trunk); AP MD – anterior-posterior mean distance (average distance of COM from the initial position in the anterior-posterior movement of the trunk). Assessment of the level of coordination was carried out using two basic motor tests; MAGONT test - agility on the ground (Metikoš et al., 1989), hexagonal obstacle test (HEKS) - (Mackenzie, 2005); and one specific judo test to assess coordination; test MSCO - imitation of *o-uchi-gari* movement (Leško, 2014). The tests were performed barefoot on a judo mat. Each test was performed three times and statistics were gathered from the average values of three attempts. Before the implementation of the testing protocol, a standardised warm-up protocol was carried out, consisting of: easy running for three minutes, general preparatory exercises which included all body segments, *ukemi-waza* (falls) and then two judo-specific exercises: *uchi-komi* (entering the throw) and *pushi-gari* (entering the throw and lifting the partner from the mat).

The STATISTICA 14.0.0 software package was used for data processing and analysis. Basic descriptive parameters (mean, minimum, maximum and standard deviation) were calculated for all observed variables. The statistical significance of the differences between the groups of respondents was determined by multivariate analysis of variance (MANOVA). ANOVA was used for repeated measures and to determine differences for each individual variable.

The research was approved by the ethics committee of the Faculty of Kinesiology of the University of Zagreb, in accordance with the Declaration of Helsinki (approval no. 29/2021).

RESULTS

Observing the differences between the groups, no statistically significant difference was found (p=0.11), Table 3.

Table 3. Results of MANOVA for repeated measurements between observed groups

Effect	Test	Value	F	p
Group 1 and 2	Wilks	0,14	2,36	0,11

* No statistically significant difference was found between the two groups of judoka.

However, observing the variables separately, a statistically significant difference was observed in individual variables and a univariate analysis of variance was performed to observe the differences between individual variables, shown in Table 4. The smallest differences were shown in the MBAU10 test on the right and left leg, which may indicate insufficient sensitivity and precision of the test,

since statistically significant differences ($p<0.05$) were obtained in almost all variables for balance assessment using the 'Gyko' device, except for two: i.e. total area of CTT movement when standing on the left leg with eyes open (EA_L_OTV) and average distance of the CTT from the initial position in anterior-posterior trunk movement (AP_L_OTV) while also standing on the left leg with eyes open. In the variables for the evaluation of coordination, it can be noticed that there are greater differences in the tests that were conducted, which are more comparable to movement structures of a judoka in situational conditions.

Table 4. Results of ANOVA for repeated measurements for a single variable

Dependent Variable	F	p
MBAU10_D	0,00	0,99
MBAU10_L	0,16	0,70
EA_L_ZAT	5,98	0,02*
D-MD_L_ZAT	8,14	0,01*
ML_MD_L_ZAT	6,03	0,02*
AP_MD_L_ZAT	5,85	0,02*
EA_D_ZAT	10,48	0,00*
D-MD_D_ZAT	7,78	0,01*
ML_MD_D_ZAT	8,87	0,01*
AP_MD_D_ZAT	15,64	0,00*
EA_L_OTV	3,62	0,07
D-MD_L_OTV	6,70	0,02*
ML-MD_L_OTV	5,75	0,02*
AP-MD_L_OTV	1,16	0,29
EA_D_OTV	11,00	0,00*
D-MD_D_OTV	12,98	0,00*
ML-MD_D_OTV	12,49	0,00*
AP-MD_D_OTV	4,36	0,05*
HEKS	3,43	0,07
MAGONT	9,55	0,00*
MSCO	5,64	0,02*

* Marked values are significant when $p<0,05$

Table 5 shows the basic descriptive indicators of the observed variables for the assessment of balance and coordination in Group 1 (n=14) and Group 2 (n=16). Looking at the test results of Group 1 and Group 2 shown in Table 5, it can be noticed that the judoka of Group 1 achieved much better results than the judoka of Group 2 in variables where their eyes were closed. Furthermore, when comparing the results between the balance assessment variables, there are noticeably better results in the variables measured by the 'Gyko' device when the eyes are open, when compared with variables when the eyes are closed. Likewise, by observing the results, it can be concluded that higher level judoka, compared with other judoka, have better results in the balance assessment variables that are performed on the right leg. Taking into account that out of the 30 judoka examined, 29 of them declared themselves as right-handed and since their right guard is more dominant in judo, this was to be expected.

Table 5. Basic descriptive indicators of the observed variables between the groups of participants

Variable	Group 1 (n=14)				Group 2 (n=16)			
	Mean	Min.	Max.	Std.Dev.	Mean	Min	Max	Std.Dev.
MBAU10_D*	19,90	4,77	65,88	17,12	19,82	5,56	120,00	28,19
MBAU10_L*	15,57	4,61	48,80	14,01	18,84	4,42	120,00	27,98
EA_L_ZAT***	1217,47	57,09	4840,15	1392,40	2762,14	419,13	6664,36	1969,52
D-MD_L_ZAT**	4,83	1,17	11,55	3,07	8,58	2,80	18,24	3,99
ML_MD_L_ZAT**	7,28	1,81	15,18	4,67	11,13	4,00	17,47	3,90
AP_MD_L_ZAT**	4,34	1,13	10,41	2,89	7,43	2,48	16,89	3,95
EA_D_ZAT***	995,83	88,01	3270,95	951,13	2871,73	284,71	6215,21	1974,26
D-MD_D_ZAT**	4,78	1,06	8,92	2,66	8,21	3,21	15,37	3,87
ML_MD_D_ZAT**	6,27	1,42	13,78	4,10	11,31	5,09	23,15	5,04
AP_MD_D_ZAT**	3,48	1,45	7,46	1,57	7,45	1,82	14,09	3,46
EA_L_OTV***	216,33	11,92	649,44	190,05	378,45	49,58	768,80	264,15
D-MD_L_OTV**	1,86	0,50	3,33	0,94	3,07	0,84	5,49	1,51
ML-MD_L_OTV**	2,81	0,76	5,61	1,66	4,55	1,06	9,39	2,24
AP-MD_L_OTV**	2,31	0,87	4,92	0,93	2,74	1,30	5,55	1,23
EA_D_OTV***	139,18	8,24	335,39	101,94	371,70	92,40	786,50	243,96
D-MD_D_OTV**	1,58	0,48	3,63	0,77	2,89	1,39	4,60	1,15
ML-MD_D_OTV**	2,32	0,35	4,92	1,20	4,12	2,02	7,12	1,54

AP-MD_D_OTV**	2,14	0,86	4,27	0,95	2,91	1,54	4,84	1,03
HEKS*	11,45	10,34	13,96	1,04	12,34	10,60	15,86	1,51
MAGONT*	10,20	8,28	13,62	1,65	12,03	9,64	14,94	1,58
MSCO*	8,47	6,88	10,27	0,86	9,55	7,65	11,96	1,49

*Values for tests MBAU10, HEKS, MAGONT i MSCO are expressed in seconds (sec), ** values for tests D-MD, ML_MD and AP_MD are expressed in centimetres (cm), ***values for tests EA are expressed in square centimetres (cm^2).

DISCUSSION

Observing the results for the assessment of coordination and the tests with which it was examined, we can conclude that in order to determine the differences in judoka, it is important that the movement tests are similar to the movement structures of the sport itself. The hex test represents movement with a lot of jumps in different directions of movement, while, when performing the throwing technique, it is important to recognise the moment when it is optimal to start performing the throw without jumping. It begins with disrupting an opponent's balance and then coordinating the action of the whole body, taking the correct position over the opponent and scoring. Tests such as the backward polygon and the *o-uchi-gari* throwing movement itself represent similar movements in the situational conditions of the fight and thus better differentiate the higher level judoka from others. Although the authors (Lech et al. 2014, Krstulović et al., 2005) did not establish a statistical connection between success in the competition and the level of coordination, there are some indications that coordination partially influenced the observed. Of course, in addition to coordination and balance, other motor abilities should also be taken into account. When observing balance, if one would exclude the MAGONT test, a statistically significant difference between the two observed groups of judoka would be found, which tells us that with more sensitive and precise tests and devices, we could better determine and investigate the observed variables. Similar to our research, Witkowski (2014) found a statistically significant difference in dynamic balance between two groups of boys (14-15 years old): those who practise judo and those who do not actively engage in sports, when standing on the left leg. However, it is not clearly defined whether they are judoka with a dominant right guard. This is in contrast to the research by Paillard et al. (2002) where no statistically significant differences were found by tests for assessing static balance between judoka of different competitive levels, as in our research, but there is still a similarity in the results obtained where better ranked i.e., higher level judoka had better results in eyes-closed tests when compared with eyes-open tests. Morán-Navarro et al. (2015), studying elite wrestlers divided into two groups comprising competitors at a national level and those at international level, concluded that there are no differences in static and dynamic balance when exhausted compared with not exhausted. However, considering that participants in that study were older (19±2.6) and more experienced, with at least 8 years of training and participation in international competitions, such as European and World Championships, we can conclude that the experience and development of an athlete's performance influences the minimisation of differences between athletes of different competitive levels.

CONCLUSIONS

According to the results presented in the paper, it can be concluded that, although there is no statistically significant difference between judoka of different levels according to their success in competitions and the results achieved in tests for assessing balance and coordination, but by using more sensitive and precise technology and tests specific to judo movement structures, it is possible to see how the differences exist. Consequently, we can say that by training the observed abilities through different and complex forms of movement and exercises, individually and in pairs, we can influence the success of judoka in competitions. Furthermore, looking at how an athlete's career should culminate in the senior age category, where differences in quality at a high level is determined by nuances, it can be assumed that with precise and targeted planning and programming of training processes, we can influence an athlete's abilities to get them to reach the highest level at the desired moment. Certainly, future research should include judoka in junior and senior age categories to determine the differences in the level of judoka in different age categories and with different levels of success in competitions

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Judo as a Way to Reduce Fear of Falling in Older Adults: *Yawara-chan Taiso*

By Mike Callan, Lucy Day, Janine Johnson, Ben Andersen, George Bountakis, Lindsay Bottoms

Abstract: *The world faces challenges to maintain the quality of life of the growing elderly population. Research suggests that around one third of over 65s and half of those over 80, fall once per year, placing enormous financial burdens on health providers. Fear of falling can contribute towards the likelihood of a fall. Reducing fear of falling has been shown to reduce the number of falls.*

Judo-based falls reduction programmes from around the world which teach ukemi techniques to the elderly are discussed. The Yawara-chan taiso (YCT) method was developed in Japan and has been taught at the Kodokan. Evidence has shown it to be effective for improving quality of life.

This research conducted a pilot study to evaluate YCT with an elderly cohort to investigate the effect on their fear of falling and establish the potential for the use of YCT within the UK with a view to culturally exporting the programme. Participants were recruited into an intervention and a control group using a pre-test / post-test design. The intervention group (mean age of 76.43 years) took part in YCT sessions for a maximum of four sessions delivered by experienced judo coaches, the control group (mean age of 72.29 years) listened to a talk about fear of falling.

Data was collected using two established measures, the Fear of Falling Questionnaire Revised (FFQ-R) and the Falls Efficacy Scale International (FES-I). FFQ-R found a statistically significant reduced fear of falling compared to the control. The FES-I found a significant reduction in fear of falling post-intervention compared to pre-intervention.

The research showed that UK elderly participants completing YCT intervention reduced their fear of falling significantly. The practise of YCT can reduce fear of falling among elderly people outside Japan, this can have far reaching consequences for the benefit of global society.

Keywords: *judo; fall prevention; older people; fear of falling; injury prevention; ukemi*

By 2030 the world is predicted to have 1 billion older people (65+), accounting for 13% of the total population (Houry et al., 2016). This brings about societal challenges as well as the need to find ways to help reduce burdens and improve quality of life of these older people. Fall-related injuries are a significant cause of sickness and death in older people (McClure et al., 2005). Often just the fear of falling can provoke older people to fall more often (Jung, 2008; Minhui Liu et al., 2021; Young & Williams, 2015). So, it is clear that falls are an important problem for older people and society, and in his speech at the University of Southern California in Los Angeles during the 1932 Olympic Games, Jigoro Kano reminded the audience that the ultimate aim of judo is to benefit society (Callan, 2015; Gatling, 2021; Kanō, 1932).

Falls in society

Data suggests that 33% of people over 65, and 50% of people over 80, fall at least once a year (Dionyssiotis, 2012). Falls among the over 65s cost the National Health Service in the United Kingdom 4.6 million GBP per day and account for over 4 million hospital bed days per year (Hawley-Hague et al., 2021). The UK Government has placed particular emphasis on the need for older people to remain active stating that the future success and resilience of the UK will be determined in a large part by its ageing population (*Future of an ageing population*, 2016).

Falls in the home can lead to hospitalisation, or a decision to place the older person into care (Fenton, 2014; Houry et al., 2016). Consequently, older people are scared of falling. The impact of fear of falling results in the avoidance of activity (Jung, 2008; Lachman et al., 1998). Avoidance of activity can lead of loss of muscle strength leading to less ability to control movement, further compromising balance, increasing the likelihood of having a fall and increasing further the fear of falling. The fear of falling can contribute to psychological conditions such as depression (Painter et al., 2012). It can lead to less participation in social activities and increase feelings of isolation and loneliness with the consequent negative impact on mental health and wellbeing (Jette, 2012; Tricco et al., 2022).

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Fear of falling

If people experience a fall of some kind or know someone who has, this can result in increased fear and anxiety about falling, which can result in a change of attitudes and habits that lead to avoiding or reducing activities that the person feels could result in a fall (Lachman et al., 1998; Scheffer et al., 2008; Young & Williams, 2015). There is clear evidence of a relationship between fear of falling and falls incidence. Reducing fear of falling leads to reduced number of falls (Jehu et al., 2021).

A number of approaches have been developed to measure fear of falling (Huang & Wang, 2009). They include the Falls Efficacy Scale (FES) which has been validated to be applied in several languages, the Falls Efficacy Scale International (FES-I), which also has a seven-item short version (Kempen et al., 2008); the Activities-Specific Balance Confidence Scale (ABC) (Powell & Myers, 1995), the Geriatric Fear of Falling Measurement (GFFM) (Huang & Wang, 2009) and the Fear of Falling Questionnaire (FFQ). The FFQ has a shorter revised version, the Fear of Falling Questionnaire Revised (FFQ-R) (Bower et al., 2015).

Fear of falling has been defined as an ongoing concern about falling that ultimately leads to avoidance of the performance of daily activities (Tinetti & Powell, 1993). It has been classified as 'Post fall syndrome' (Murphy & Isaacs, 1982) or 'ptophobia', a phobic reaction to standing or walking (Bhala et al., 1982). Another common definition is that fear of falling is a patient's loss of confidence in his or her balance abilities (Jung, 2008).

Judo-based falls reduction

In judo, participants are taught how to unbalance their partner and throw them to the mat. Conversely participants are also taught how to avoid losing their balance, how to fall safely, and how to get up easily. Judo coaches are trained and qualified in teaching people how to avoid losing their balance, fall safely and get up (Bradic et al., 2017; Kodokan, 1955; Mifune, 1956). Evidence suggests a positive association between judo and Bone Mineral Density accrual in pre- and post-menopausal women (Borba-Pinheiro et al., 2013; Borba-Pinheiro et al., 2012; Pinheiro et al., 2013).

Ukemi can be translated as 'receiving the body', it is a system of breaking the fall from a throw, often known as breakfalls. Mastery of breakfalls is a fundamental skill in judo which enables the practitioner to continue to practise without injury. Advanced *judoka* throw with great intensity and power and thus, learning the safe way to fall from a young age is essential.

Judo coaches are experienced at teaching children how to fall by practising *ukemi* exercises and falls aimed at improving control of their body (Sterkowicz-Przybycień et al., 2014). Bountakis and Callan (2022) found that rhythm is an important element in a pedagogical approach to teaching *ukemi*.

There is an emerging body of evidence relating to the use of judo falls techniques (*ukemi*) (Lockhart et al., 2022), with older populations (Ciaccioni et al., 2019), consequently a number of solutions using judo are being developed around the world;

Developed in Spain, Adapted Utilitarian Judo (AUJ) uses technical elements of traditional judo adapted to the requirements of the older adult population (Campos-Mesa et al., 2020; DelCastillo-Andrés et al., 2016). AUJ has been shown to reduce the fear-of -falling syndrome (del Castillo Andrés et al., 2020; Toronjo-Hornillo et al., 2018) and to improve quality of life (DelCastillo-Andrés et al., 2018).

Judo4Balance is a judo inspired workplace programme based in Sweden, teaching techniques for safe landing when falling (Arkkukangas, Bååthe, Hamilton, et al., 2020), their research noted significant improvements in physical function and sustained competence in falling techniques (Arkkukangas et al., 2022). The studies suggest that a course of around 10-weeks can reduce fear of falling and improve self-efficacy and that this has more marked effect in groups who are more potentially vulnerable in the first place as a reduction in fear of falling was greater amongst people at the residential facility for the elderly than for those on the program run in the workplace (Arkkukangas et al., 2021; Arkkukangas, Bååthe, Hamilton, et al., 2020). Additionally, the research group found that women benefitted more from the programme than men, as female participants showed a greater reduction on their fear of falling. It may be that vulnerability to osteoporosis leads to anxiety about the dangers of falls amongst older women, this would require further study (Arkkukangas, Bååthe, Ekholm, et al., 2020).

In the Netherlands there has been a programme of Martial Arts Falls Training based on judo for a number of years. Their studies have shown a reduction in hip impact forces during falls by beginners that were given a 30 minute lesson in breakfall techniques (Weerdesteyn et al., 2008). The group also showed a 27.5% reduction in impact force during breakfalls performed by experienced *judoka* (Groen et al., 2007). Fear-of-falling has also been shown to reduce in Italian studies (Ciaccioni et al., 2017) following a 4 month judo programme for older adults, as well as technical improvement in breakfall technique. Interestingly the study found increased enjoyment by the participants (Ciaccioni et al., 2020; Ciaccioni et al., 2021). A collaboration with the IJF Academy and a range of academic and judo experts explored a pilot Coach-Centred Educational programme to empower judo coaches working with older people (Ciaccioni et al., 2022).

The Centre of Research Excellence in Frailty and Healthy Ageing at the University of Adelaide, Australia, have been

working in collaboration with Adelaide University Judo Club and the Government of South Australia to deliver the programme 'Dynamic balance for life!'. Their research is ongoing (ORSR, 2022).

At Kokushikan University, Japan, research explored the benefits of 'judo kenko' exercises developed by the judo department and the health and well-being centre. The research used near-infrared spectroscopy to measure physiological changes in participants (Moriwaki et al., 2020). They found improvements to cognitive performance of patients with dementia and increased blood flow immediately after exercise as well as more longer-term improvements in circulation, strength, and coordination. Additionally it was found that people new to judo also showed improvements in hip, knee and ankle flexibility and strength (Moriwaki et al., 2018).

Yamara-chan taiso

Also developed in Japan is the *Yawara-chan taiso* system (Kamitani, 2018a), a judo-based fall prevention programme aimed to improve stability, coordination and safer falling for older people, designed by Dr Takeshi Kamitani from the Japan Community Healthcare Organization Hospital, an orthopaedic surgeon and doctor for the All-Japan Olympic judo team. *'Yawara-chan taiso'* was featured by the IJF media Team and is supported by Kosei Inoue (Lausen, 2019). The name is based on a manga character, Yawara Inokuma, a fashionable judo girl, which led to the nickname *'Yawara-chan*' given to Ryoko Tani (Tamura), winner of five Olympic medals and the word, '*taiso*', which means gymnastic exercises in Japanese.

The exercises are based on safe falling techniques (*ukemi*). The sessions have been delivered regularly at the Kodokan, 384 people participated in the programme between July 2016 to July 2019. This adapted programme of exercises for older people has shown to be effective for improving quality of life through a positive physical and mental response. Research found significant improvements in physical functioning, social functioning, and physical component summary scores, along with a 94.8% level of satisfaction (Sakuyama et al., 2021). The impact of *Yawara-chan taiso* on Fear of Falling has not yet been explored.

Aim

The studies evaluating the effectiveness of the *Yawara-chan taiso* programme have been conducted with Japanese participants, this research sought to conduct a pilot study to establish the potential for the use of this programme in the UK, with a view in the future of culturally exporting the programme. Therefore, the aim of this research was to evaluate the use of the *Yawara-chan taiso* programme in the UK with a cohort of elderly participants to investigate the effect on their fear of falling.

METHOD

Participants

Through advertising at organisations and groups that facilitate activities for older people, fifteen participants volunteered to participate in the study (see Table 1 for the participant characteristics). Seven participants were allocated to the intervention group and eight to the control group. Of the 7 intervention participants, 6 were female. Out of the 8 control participants, 2 were female. The key inclusion criterion was a minimum age of 55 years. All participants completed the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) (Warburton et al., 2018) to confirm they were medically stable to participate. Participants who had serious disease or complications during exercise would have been excluded from the study, however none were identified. Participants provided written informed consent and ethical approval (protocol number: aLMS/SF/UH/03872(1)) was obtained by the Health, Science, Engineering and Technology Ethics Committee at the University of Hertfordshire, in accordance with the principles outlined in the Declaration of Helsinki.

Table 1. Participant characteristics by age, gender, number of sessions completed, history of falls, and weekly activity levels

	Intervention n=7		Control n=8	
Age in years (mean ±SD, median (range)	76.43 ±3.77, 77 (71-83)		72.29 ±12.90, 67.5 (58-101)	
Gender	6 (86%) Female 1 (14%) Male		2 (25%) Female 6 (75%) Male	
History of Falls	<1 1-4 >4	n=3 n=2 n=2	<1 1-4 >4	n=5 n=3 n=0
Weekly Activity Levels	<1 hour 1-2 hours >2 hours	n=3 n=1 n=4	<1 hour 1-2 hours >2 hours	n=7 n=0 n=1

Note. SD = Standard Deviation

Study design

The study utilised a pre-test/post-test design with an intervention group and a control group. In this study the dependant variable was the participants feedback from two questionnaires designed to assess the extent of an individual's fear of falling. The intervention group completed these questionnaires before and after a 4-week programme. The intervention was the *Yawara-chan taiso* programme (Kamitani, 2018b) which consisted of four, 45-minute practical sessions delivered over a 4-week period; one session held per week. The sessions were run in a sports hall on judo *tatami* (mats) and led by two judo coaches with over 60 years' experience between them. The curriculum was developed by experts from the All-Japan Judo Federation Medical Commission and consists of 12 exercises based on *ukemi* and *tai-sabaki* movements.

No adverse events were reported from undertaking the judo programme.

To facilitate comparison in efficacy, the control group did not participate in the *Yawara-chan taiso* programme. They were given a single 45-minute talk on fear of falling research titled 'Falls in the elderly: A judo-based solution'. During the talk participants watched a short video showing demonstrations of the *Yawara-chan taiso* exercises. Participants completed both questionnaires before and after the talk.

Questionnaires

Assessing the fear of falling in older people has become an important tool for identifying individuals at greater risk of falling, as research continues to show that a persistent concern for falling down is a legitimate predictor of falls occurring as well as a predictor of a reduction in physical activity, mobility and consequently, an increase in frailty (M. Liu et al., 2021).

Two questionnaires were used to assess changes in perceived fear of falling across both study groups: the Fear of Falling Questionnaire-Revised (FFQ-R) and the Falls Efficacy Scale-International (FES-I), both of which are internationally accepted tools for measuring fear of falling.

The FES-I self-reporting questionnaire was developed by members of the Prevention of Falls Network Europe and has been widely shown to be a valid and reliable tool for assessing an individual's concerns around fear of falling in relation to normal daily activities (Delbaere et al., 2010). Participants answer 16 questions with a minimum possible score of 16 (no concern about falling) and a maximum score of 64 (severe concern about falling).

FFQ-R is a self-reporting questionnaire developed by Bower et al. (2015) as a revised, shorter version of the Fear of Falling questionnaire. In their research the questionnaire showed to be an effective tool for assessing fear of falling in older people. Consisting of 6 questions scored on a Likert scale of 1 (strongly disagree) to 4 (strongly agree), the possible score ranges from 6 to a maximum of 24 with a high score demonstrating a greater concern for falling.

Statistical Analysis

Data are presented in tables as means ±SD in tables and means ±95% confidence intervals in figures for all participants. Data were analysed using a statistical software package (SPSS version 27, IBM, Armonk, NY, USA). Data normality was checked using a Shapiro-Wilk test and all data were found to be normally distributed. Statistical significance was set at $P<0.05$. Although the study was only a pilot study and was underpowered, statistical analysis was undertaken to explore the effect sizes and potential differences which exists between groups.

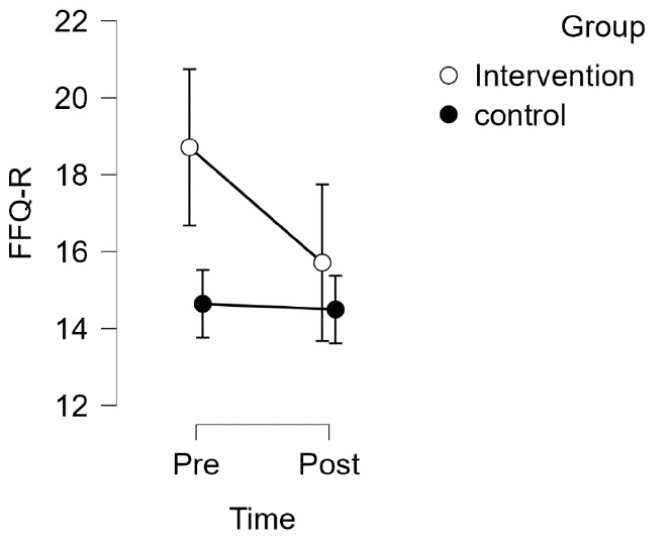
A mixed factorial 2-way (time x intervention) analysis of variance (ANOVA) with Bonferroni corrected post-hoc analyses was used to determine where the differences existed. Partial Eta-Squared (ηp^2) was used to report effect size for ANOVA where effects were classified as small (0.01–0.05), moderate (0.06–0.13), and large (>0.14) (Cohen, 1988). Multiple paired-samples t-test using a Bonferroni correction measured differences of means for physiological variables and total performance score between conditions. Additional assessments were made using Pearson correlation coefficients as follows: age and pre/post scores; age and reduction in scores; number of sessions completed and pre/post scores.

RESULTS

Participant Characteristics

Participant characteristics were identified in Table 1. Participants in the intervention group completed a mean average of 3.14 ±0.64 sessions, with all participants in the control group attended the 1 talk.

As can be seen in Figure 1, there was a statistically significant interaction between the intervention and time on FFQ-R, $F(1,12)=4.98$; $P=0.045$, partial $\eta p^2 =0.293$. The FFQ-R was statistically significantly reduced post intervention (15.7 ±4.2) compared to pre (18.7 ±3.2; $P=0.037$, $\eta p^2 = 0.521$) for the FFQ-R intervention group, whereas there was no change from pre (14.4 ±3.1) to post (14.3 ±3.5; $P=1.00$, $\eta p^2 =0.013$) in the control group.



*Denotes significant difference from pre.

Figure 1. Mean ±95%CI FFQ-R for the intervention group and the control group from pre to post

Across all 15 participants a significant moderate correlation was found between age and the initial fear of falling as measured by the FFQ-R, before any intervention of $r = 0.62$, $P=0.01$ (Figure 2).

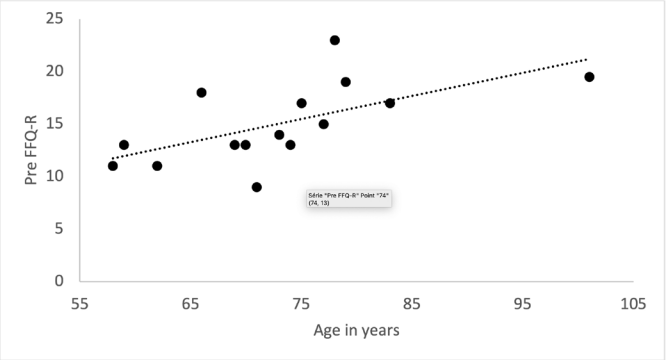


Figure 2. Correlation between age and initial fear of falling (FFQ-R)

There was a tendency for a moderate negative correlation between age and the difference in FFQ-R was found in the intervention group (r= -0.58, P=0.1) (see Figure 3).

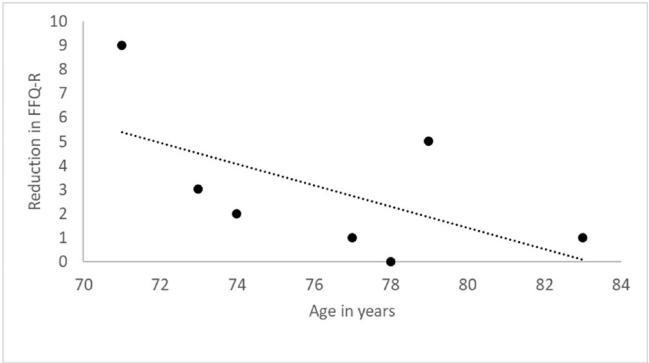


Figure 3. Correlation between age and reduction in fear of falling (FFQ-R)

Falls Efficacy Scale-International (FES-I)

One of the participants in the intervention group completed the FES-I erroneously so these results were disregarded, and 6 participants were used for analysis. As can be seen in Figure 4 there was no significant interaction between group and time $F(1,12)=1.59$; $P=0.23$, $\eta p^2 = 0.117$. There was no main effect for group ($P>0.05$) but there was a main effect for time ($P=0.04$) with pre being significantly greater for FES-I than post.

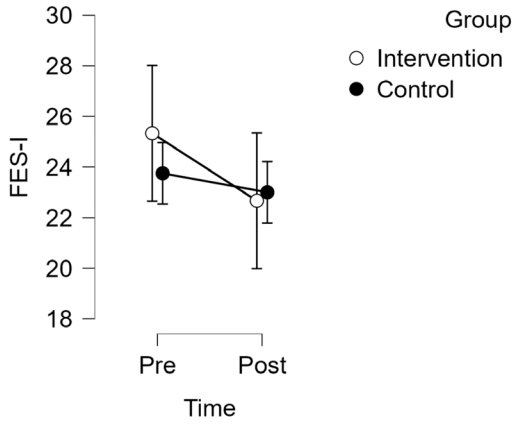


Figure 4. Mean ± 95%CI values for FES-I in the intervention and control group

There was no correlation between age and reduction in FES-I (r= 0.01; P=0.98) in the intervention group. There was no correlation between age and FES-I scores in the intervention group (r=0.20; P=0.694). There was a tendency for weak negative correlation between the reduction in fear of falling and number of sessions completed (r= 0.36; P=0.13).

KEY FINDING AND DISCUSSION

This research sought to evaluate the use of the *Yawara-chan taiso* programme and the results show that there is a significant reduction in fear of falling when measured by the FFQ-R test after only 3 – 4 sessions.

This research sought to establish the potential for the use of the *Yawara-chan taiso* programme in the UK through a small study. The aim of the research was to investigate the effect on the fear of falling of a cohort of elderly participants.

The results showed that UK participants with a mean age of 76 completing the *Yawara-chan taiso* intervention showed a bigger reduction in fear of falling compared to a control group. This was found in both measures of fear of falling with the FFQ-R indicating a significant reduction. There was also a significant reduction in fear of falling in the intervention group over time as measured by the FES-I. This is an indicator that the use of a judo-based intervention reduces the fear of falling in elderly populations. It is already established that reducing fear of falling leads to reduced number of falls (Jehu et al., 2021), and so this research shows that participation in a judo-based falls programme is very likely to lead to a reduced number of falls.

Whilst this is a small sample for a pilot study, the results indicate that a larger study to measure the impact of the judo-based intervention outside Japan is warranted. With larger participant numbers it may be possible to adjust for the different gender balance in the intervention and control cohorts. Four sessions were enough to show a reduction in fear in the sample, further studies would enable participation over a longer period and hopefully indicate an even greater effect.

Indications were that prior to any intervention, fear was correlated to age, with older participants having a greater fear of falling. This would perhaps be expected. However, the reduction in fear of falling appeared to reduce with age. In other words, the younger participants in their early 70s within the cohort showed a greater benefit in terms of impact on their fear. Those in their late 70s or 80s saw a reduction that was less marked. A larger cohort might allow this relationship to be explored further and could possibly lead to an indication as to the optimum age for participants to engage in the programme.

The International Judo Federation has member federations spread across 207 countries and dependencies. The federations govern the work of judo teachers and coaches with their domains. The technical content of the *Yawara-chan taiso* curriculum is based on simple *ukemi* exercises that judo coaches teach every day to beginners. So, we are confident that judo coaches with the skills to teach *Yawara-chan taiso* classes to the local elderly populations are spread across the whole world. As cited in the introduction, we are aware of excellent peer-reviewed work by teams of researchers and *judoka* in several countries already, seeking to provide evidence that the use of judo-based interventions can affect the numbers and severity of falls with elderly populations. Taken as a body of work, the evidence is compelling.

CONCLUSION

In his speech at the University of Southern California during the 1932 Los Angeles Olympic Games (Kanō, 1932), Jigoro Kano made two important points that are relevant to this research. Firstly, that the judo principles of maximum-efficiency and mutual welfare and benefit can be used for the benefit of society. Judo can be part of the solution for society in addressing the global issue of falls in the elderly. Secondly, he makes the point that the judo principles of maximum-efficiency and mutual welfare and benefit "must be fostered by the educational forces of every country in which judo should have a prominent part" (Kanō, 1932).

This research has shown that *Yawara-chan taiso*, a judo-based safe falls solution, developed in Japan can reduce fear of falling among older people outside of Japan. The implications of this study can have far reaching consequences for the benefit of society and should be shared with education partners across all the IJF member federations.

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Towards Mental Training for Elite Judo Athletes

By Caio Amaral Gabriel

Abstract: *This research note aims to present the potential benefits of mental training for elite judo athletes and advocates the implementation of mental training policies and programmes within judo organisations as a key organisational factor that can be controlled for the benefit of health and performance of elite judo athletes and in favour of the international sporting success of nations. Five key benefits are presented, demonstrating the challenges that elite athletes face and then how mental training can contribute to solving these challenges based on existing studies and theories. These five benefits can inform the decision-making of managers of judo organisations and the formulation of management policies associated with mental training. In addition, the benefits presented can also be considered as testable hypotheses for future research. In the context of elite judo, mental training has the potential to (1) increase athletes' control over mental health; (2) teach athletes to self-generate positive emotions, thereby broadening their repertoires of thoughts-actions to task-oriented coping strategies, building resilience, thus leading athletes to an upward spiral dynamic characterised by the optimisation of health, well-being and performance; (3) undo the effects of negative emotions; (4) mitigate the debilitating physiological effects of critical moments of competition; (5) reduce perceived exertion and increase resilience to mental fatigue in training and competitions. Finally, the research note concludes by calling managers of judo organisations and coaches to action, mainly encouraging the implementation of mental training policies and programmes for the benefit of judo athletes' development.*

Keywords: *judo; mental training; sport management; sport psychology*

INTRODUCTION: MIND MATTERS

The achievement of medals in elite international competitions increasingly depends on the efficiency of managers with identifying and using all the factors that can be controlled for the benefit of the development of athletes (De Bosscher et al., 2006). This managerial efficiency is crucial to optimise results in a context where more and more nations have actively participated in the main international judo competitions (Mazzei et al., 2012), where few are the winning athletes (Digel, 2013), and have implemented a more strategic approach to the development of athletes to differentiate themselves from other nations (Green & Houlihan, 2008). In this sense, Mazzei et al. (2020) sought to identify the organisational factors that influence international sporting success specifically in elite judo. Among the factors identified is athletic career and post-career support, involving specialised support from multidisciplinary professionals who contribute to the development of athletes, including psychological support.

Indeed, emerging studies, although they exist only in a modest amount, have shown that psychological aspects can play a key role in the performance of judo athletes and that, for this reason, mental training is important to optimise the health and performance of judo athletes (Lee et al., 2022; Rossi et al., 2022; Ziv & Lidor, 2013). Furthermore, the psychological aspect of athletic development is encompassed in the fundamental principles and frameworks of the Olympic/Paralympic Movements (IOC, 2021), is in the IOC consensus on mental health in elite athletes (Reardon et al., 2019) and, more broadly, on youth athletic development (Bergeron et al., 2015), in short, as a necessity and a right of athletes, as a fundamental ethical principle of Olympism and as a basic universal principle of good governance.

However, although judo athletes and coaches recognise the influence and importance of the mind for success in competitions (Silva et al., 2018a; Silva et al., 2018b; Silva et al., 2017; Rutkowska, 2012) and the psychological aspect is encompassed in fundamental principles and frameworks of the Olympic/Paralympic Movements and also in IOC consensus, mental training still does not seem to be a consolidated management policy within judo organisations and is not always integrated with other aspects of athletic training (Bompa et al., 2019). In part, this may be because, in the context of judo, the benefits of mental training for success in competition remain elusive. For this reason, by elucidating the possibilities of mental training and presenting its benefits for managers, coaches and athletes, this research note aims to contribute as a step towards the consolidation of management policies associated with the implementation of mental training programmes in judo organisations.

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THE BENEFITS OF MENTAL TRAINING FOR ELITE JUDO ATHLETES

Increased Control Over Mental Health

Elite athletes seek to improve performance while maintaining and strengthening mental health (Henriksen et al., 2020). However, with mental health services focused on treatment rather than promotion (Barry et al., 2019), judo athletes may not know what to do in daily life to maintain and strengthen mental health. This is relevant because it is increasingly recognised that the treatment approach, while fundamental, alone, is insufficient to address the growing global burden of mental health challenges and to optimise health and wellbeing at a populational level (Barry et al., 2019). For this reason, mental training can promote health and wellbeing and empower judo athletes by developing the competence and autonomy to improve control over mental health in daily life, through teaching various techniques, tools, strategies and soft skills.

Broadening of Facilitative Coping Strategies and Building Resilience

With psychological research mostly focused on negative emotions (Linley et al., 2006), the potential of positive emotions to optimise the health and performance of athletes is rarely explored empirically. Based on Fredrickson's (2013) broaden-and-build theory, Thompson et al. (2021) provided evidence that positive emotions broaden the athlete's thoughts-actions repertoire for task-orientated coping, which is associated with superior sport performance (Nicholls, Taylor, et al., 2016) and psychological wellbeing (Nicholls, Levy, et al., 2016). Micro-moments of positive emotions, however brief, accumulate over time (Fredrickson, 2013), building resilience in athletes (Thompson et al., 2021), helping them overcome challenges throughout their careers and achieve high levels of performance (Sarkar & Fletcher, 2014). Furthermore, in athletes, positive emotions predict building personal resources and facilitative coping strategies, which in turn predict more positive emotions (Thompson et al., 2021). For this reason, mental training, by teaching athletes to self-generate positive emotions, leads them towards an upward spiral dynamic (Fredrickson, 2013), optimising health, wellbeing and performance.

Undo the Effects of Negative Emotions

Athletes are just as likely and sometimes more likely than the general population to present with mental health challenges and clinical diagnoses. Moreover, elite sport presents several risk factors that can favour the development and/or maintenance of mental health challenges (Prior et al., 2022; Rice et al., 2016). In this sense, Henriksen et al. (2020) listed the potential mental health challenges that athletes may experience specifically in each phase of the Olympic/Paralympic quadrennial cycle. Thus, elite athletes may be at maximum risk of developing mental health challenges during the peak of their competitive years (Prior et al., 2022). Fortunately, the undo hypothesis (Fredrickson, 2013) states that positive emotions serve as useful resources to regulate negative experiences in daily life, i.e., positive emotions undo the effects of negative emotions. Thompson et al. (2021) provided evidence of this undo effect in athletes. Thus, mental training, by teaching judo athletes to self-generate positive emotions, can help to undo the effects of negative emotions that they may experience throughout their careers.

Mitigation of the Debilitating Physiological Effects of Critical Moments of Competition

Athletes can present a psychological profile composed of certain primary higher-order variables that, independently or interactively, can make them more vulnerable to specific instances and situations throughout the competition in which psychological factors and mental toughness are more crucial, i.e., critical moments of competition (Carlstedt, 2004). Without these critical moments being worked out with judo athletes, they can succumb to physiological reactivity and attenuation of motor performance, impairing performance in combat. Thus, mental training can have a prophylactic effect by first identifying a judo athlete's critical moments of competition and then, based on their psychological profile of primary higher-order variables, designing tailored interventions to mitigate the potentially debilitating physiological reactivity of the identified critical moments.

Reduced Perceived Exertion and Increased Resilience to Mental Fatigue

Mental fatigue impairs endurance performance (Van Cutsem et al., 2017). To help address this issue, brain endurance training (BET) (Marcora et al., 2015) is a specialised training modality in which the brain is overloaded with cognitive demands at the same time a physical exercise is performed, to reduce perceived exertion (Barzegarpoor et al., 2021) and increase the athlete's resilience to mental fatigue (Dallaway et al., 2021). Studies have shown that integrating mental training with physical training (i.e., BET) improves endurance performance over physical training alone (Dallaway et al., 2021; Barzegarpoor et al., 2021; Marcora et al., 2015) and can be a promising training strategy to provide a competitive advantage for elite judo athletes.

CONCLUSION

Mental training is an organisational factor that can be controlled and implemented by management policies and has the potential to optimise the health and performance of elite judo athletes. The initiative to implement mental training policies and programmes in judo organisations contributes to safeguarding athletes throughout their careers and post-careers, protecting the integrity of sport in the context of judo and promoting a more sustainable and positive experience of being an athlete. While the management of mental training is the responsibility of specific people (e.g. Mental Health Officer, Judo Mental Coach), the psychological aspect of athletic training is everyone's

business (Henriksen et al., 2019). All judo stakeholders must be aware of the influence and importance of the mind for the personal development, health, wellbeing and performance of judo athletes. For that reason, this research note encourages mainly judo managers, coaches and athletes to recognise mental health as a core component in judo organisations; to consider mental health as a key performance indicator; to invest in research in this area; to implement mental training policies and programmes for the benefit of athlete development; and to integrate mental training as part of the training of athletes.

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Comparison of Key Performance Indicators Between Portuguese Olympic and Paralympic Judo Athletes

By Luís Monteiro[1,2], João Machado[1], Sarah N. Lanham[3], Emily L. Langford[4], Mark G. Abel[2,3]

Abstract: *The aim of this study was to compare the physical fitness and sport specific skills of blind vs. norm visual judo athletes. Twelve athletes from the Portuguese judo men's team, six from the Paralympic team (mean ± SD; Age: 28.5 ± 5.4 yr., Body mass: 69.0 ± 5.5 kg; Height: 1.73 ± 0.06 m) and six from the Olympic team (Age: 25.7 ± 3.2 yr., Body mass: 70.7 ± 6.6 kg, Height: 1.72 ± 0.06 m). Power and rate force development (RFD) were assessed in bench press, row and squat exercises and with a vertical jump. Strength was assessed via isometric handgrip strength. Shoulder and lower body flexibility were assessed with a tape and one baseline sit & reach testing box. Cardiorespiratory fitness ($VO_{2máx}$) was assessed using a treadmill. The "Special Judo Fitness Test" (SJFT) was used to evaluate sport specific skills. Body composition was measured via skinfolds. Performance outcomes were compared between groups with Mann Whitney U tests The level of significance was set a $p<0.05$. Handgrip strength, maximal strength, bench press strength and power and SJFT were greater in the normal vision group ($p<0.05$). There were no group differences between blind and norm visual athletes in $VO_{2máx}$, flexibility, and lower body RFD in vertical jump and squat assessments. In conclusion, upper body strength and power and technical-tactical performance outcomes were lesser among visually impaired athletes, with no difference in aerobic capacity, flexibility, and lower body power parameters. These findings identify key bio motor abilities that may be targeted in an exercise program for blind judo athletes.*

Keywords: *judo; physical fitness; SJFT; strength; power; $VO_{2máx}$; blind vs. normovisual*

The proliferation of adapted judo programs for visually impaired athletes has garnered continuous growth in the number of participants in this sport. As a result of this growing popularity, several adapted international judo competitions are now being held (Morales et al., 2021). Paralympic judo was first included on the Paralympic program at the 1988 Seoul Games. Women's events were added to the 2004 Paralympic Games in Athens. The sport is now widely practiced by male and female athletes in more than 40 countries (IBSA, 2020). In contact sports such as, judo or wrestling, kinaesthetic information is considered equally or more important than vision (and other senses), making those sports particularly suitable for individuals with vision impairment (Kuznetsova & Barabanshchikova, 2006; Starosta, 2013). In Paralympic judo, visually impaired athletes compete in various weight categories for men and women and in two different levels. This means judoka with less vision impairment had a competitive advantage over those with more severe impairment.

There are two main differences between Paralympic judo and Olympic judo: combatants have contact with each other at the start of the match and the mat has a different texture (Evgeny Mashkovskiy et al., 2020). The athletes try to execute a perfect technique which scores an immediate win (*ippon* – a perfect point in Japanese), or to score more points than the opponent. Lesser scores can be awarded when a technique does not merit an *ippon*. If neither judoka completes an *ippon* by the end of the four-minute match, the winner is the one with the highest score.

Judo is governed by the International Blind Sports Federation (IBSA) and follows the International Judo Federation (IJF) rules used at other top-level, able-bodied judo events, with slight modifications for athletes with a visual impairment. The key elements of Paralympic judo are balance, touch proprioception, and combative instinct, all of which are highly developed qualities possessed by athletes with a visual impairment. Competitive Paralympic judo demands extreme physical and strategic performance and competitors must use different techniques to overcome or immobilize their opponent. A combatant must combine quick moves with strength and agility to score points. Athletes must maintain balance and reaction while

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countering an opponent's rush. Point-scoring moves occur in attack and counterattack. Throwing techniques and ground holds include hold downs, arm locks, and choke holds. Kicking and punching are not permitted.

Research has been conducted to identify key performance indicators of judo athletes. Iteya et al. (2005) reported that high-level female Japanese judo athletes performed better in a specific sleeve pulling action task compared with lower-level athletes, suggesting that upper-body muscle power may be considered as a discriminant factor. Monteiro et al. (2011, 2013) also reported that upper-body muscle power and rate force development was considered as a discriminant factor in male top-elite judo athletes.

Despite existing research describing the physical and physiological fitness of Olympic judo athletes, studies on Paralympic Judo athletes are scarce. Therefore, the purpose of this study was to compare the physical, neuromuscular and sport-specific skills of visually impaired Paralympic judo athletes versus Olympic judo athletes. This information will identify deficiencies in key performance indicators among visually impaired judo athletes that may targeted in an exercise program to enhance judo performance. We hypothesized that blind judo athletes would have lower physical, neuromuscular, and sport-specific abilities compared to the norm visual athletes.

Table 1. Comparison of demographic characteristics between blind and normal vision participants

	Blind (n=6) Mean ± *SD*	MRank	Normal Vision (n=6) Mean ± *SD*	MRank	P-value
Age (yr)	28.5 ± 5.4	7.42	25.7 ± 3.2	5.58	0.394
Height (m)	1.73 ± 0.06	6.75	1.72 ± 0.06	6.25	0.818
BM (kg)	69.0 ± 5.5	6.17	70.7 ± 6.6	6.83	0.818
BMI (kg/m2)	23.4 ± 1.7	5.50	23.9 ± 1.3	7.50	0.394
Fat mass (%)	11.1 ± 1.6	6.67	10.6 ± 2.5	6.33	0.937

BM = body mass; BMI = Body mass index

METHOD

Participants

Six Paralympic and six Olympic judo athletes from the Portuguese National Team, free from injury, participated in this study. The functional classes and demographic characteristics of the subjects are presented in Table 1. The athlete or a legal representative signed the consent form. The study was approved by the Local Ethics Committee.

Study design

This study utilized a cross-sectional design to descriptively compare performance metrics between blind and normal vision judo athletes. Judo athletes were assessed during a training camp and in a laboratory in three testing session, with 48 hours between sessions. In the first session, after a standardized warm-up, the athletes performed the tests in the following order: squat and countermovement jumps (SJ and CMJ), jump squat (JS), bench press (BP) and rowing (R) exercises (with assessment of power, velocity, maximal strength, and rate force development (RFD), handgrip strength, and flexibility. During the second session, participants performed an aerobic capacity test on a treadmill, and during the third day, athletes performed the Special Judo Fitness Test (SJFT).

Procedures

Body mass (kg) and height (cm) were measured according to an established protocol (Marfell-Jones et al., 2006) and the norms established by the International Society for the Advancement of Kinanthropometry (ISAK). Body mass was measured to the nearest 0.5 kg, using a Secca body scale (model 761 7019009, Vogel & Halke, Hamburg, DE), and standing height was measured to the nearest (0.1 cm) using a Siber-Hegner anthropometric kit (DKSH Ltd., Zurich, SW). Body mass index (BMI) was computed using the standard formula. Individual measurements were collected, in all participants, by the same ISAK evaluators (intra-observer technical error of measurements: height, R≥0.98).

Hand grip strength (kg) was measured with a maximal isometric handgrip strength test using a dynamometer (Takei Physical Fitness Test, TKK 5001, GRIP–A, Tokyo, Japan). Participants performed the test with the shoulder abducted and elbow at 90 degrees. The assessment was conducted with each hand twice and the highest values achieved by left and right hand were used in the data analysis (Dortkamph, 1987).

Flexibility was assessed by the sit and reach test (Wells & Dillon, 1952). Each subject was seated barefoot on the floor with the hips flexed and knees extended, and soles of feet placed flat against the sit and reach box. Participants overlapped their hands and reached forward along the measuring line as far as possible. The score of the test was recorded to the nearest centimetre.

Shoulder flexibility was assessed by measuring the distance between the hands (to the nearest one centimetre) placed contralaterally behind the back. The right arm was abducted and externally rotated to reach down the back. Simultaneously, the left arm was adducted and internal-

ly rotated behind the back with the palm facing outwards and the fingers pointing upwards. The closest position of the hands was held for 2 seconds. If fingers from contralateral hands made contact the distance of overlap was measured.

Vertical jump height was used to assess lower body power and determined using the jump squat (JS) and countermovement jump (CMJ). In the JS, participants were required to remain in a static position with a 90° knee flexion angle for ~2 s before jumping, without any preparatory movement (Loturco et al., 2017). In the CMJ, the participants were instructed to execute a downward movement followed by a complete extension of the legs and were free to determine the countermovement amplitude to avoid changes in jumping coordination. The Squat Jump and Countermovement Jump were executed with the hands on the hips. The elasticity index was calculated by (CMJ SJ*100 / SJ), (Lara et al., 2006). All jumps were performed on a contact platform “Boscosystem® Chronojump” (versão 1.7.0, Barcelona, Spain). A total of five attempts were allowed for each jump, interspersed by 15 s intervals. The best attempts of the SJ and CMJ were used for further analysis.

terval was provided between sets. To determine strength and power, a linear transducer (Chronojump, Sensor Dynamic Measurement System, Spain) was attached to the Smith machine bar. The peak power, strength, and rate force development values obtained in each exercise were used in the data analysis. Power load was measured and defined as, the best load value in relation to 1 RM, when the best average power was manifested, at an average velocity of 1 m/s.

Aerobic capacity ($VO_{2máx}$) was assessed using a maximal graded exercise treadmill (Quasar HP Cosmos) test. The protocol began with two minutes of resting metabolic data collection, followed by a two-minute warm-up at 4 km/h, after which the treadmill velocity increased to 8 km/h and 1% incline, with subsequent increments of 1 km/h every minute up to 16 km/h. From this stage onwards, the treadmill incline increased by 1% every minute. The test was terminated upon volitional exhaustion, after which the participant performed a 2 min cool down while walking for two minutes at 4 km/h. Gas collection was performed using a “Hans Rudolph” mask connected to the “Jeager Vyntus CPX” gas analyzer. Heart rate was collected by an electrocardiogram. The blind athletes did not lose the reference of the treadmill, performed the test with one of the hands placed on the side of the treadmill.

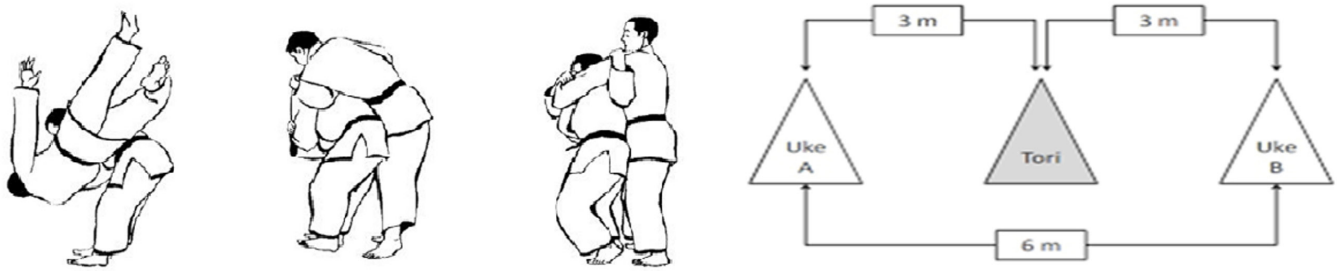

Figure 1. SJFT test scheme - Throw *Ippon-Seoi-Nage* (Sterkowicz, 1995).

Bar mean propulsive power (MPP) was assessed in the JS, bench press (BP) and prone bench pull (PBP) exercises on a Smith machine. Participants were instructed to execute 3 repetitions at maximal velocity for each progressive load, starting at 0% of charge in the BP till 1 RM (Velocity: 0.15 m/s) and 20 kg of charge on PBP (velocity: 0.25 m/s) and at squat till 1 RM (velocity: 0.30 m/s). In the squat, participants executed a knee flexion until the thigh was parallel to the ground and, after the command to start, jumped as fast as possible without their upper back losing contact with the bar. During the BP, participants were instructed to lower the bar in a controlled manner until the bar lightly touched the chest and, after the command to start, moved the bar as fast as possible. In the PBP, participants were required to assume a standing position, maintain the trunk parallel to the ground with the knees slightly flexed while pulling the bar against the chest after holding the bar with the arms extended (i.e., initial position). A 5 min in-

The special judo fitness test (SJFT) is an intermittent judo specific test using the *ippon-seoi-nage* technique. The test utilizes the following protocol: two judokas (ukes) of similar stature and body mass to the performer are positioned 6 m away from each other while the performer (tori) is 3 meters away from the judokas that will be projected. The test is divided into 3 periods of 15 seconds (A). 30 seconds (B) and 30 seconds (C) with intervals of 10 seconds between them. During each of the period’s, Tori projects the partners as many times as possible. Immediately after the end of the test and one minute later, the athlete's heart rate is checked. The SJFT index is calculated using the sum of the heart rate value immediately after and 1 minute after the assessment, divided by the number of projections carried out in three periods. Thus, a lower index value demonstrates superior cardiovascular efficiency during judo tactics. The classification criteria are very poor; poor; regular; good; great.

Statistical analyses

Data are presented as mean ± standard deviation (SD) and the "Ranks" table shows the size of the samples, the average of the orders (Mean Ranks). Comparison of group differences in physical fitness, neuromuscular performance, and SJFT were evaluated using the non-parametric test of Wilcoxon Mann Whitney U test, due to small sample size. The level of significance was set at $p<0.05$. Statistical analyses were performed with SPSS software (Version 26, SPSS Inc. Chicago, IL).

Results

Table 1 provides a group comparison of the blind and normal visual judo athletes' age, height, body mass, BMI and relative fat mass. No significant differences were observed, as expected, as each group had two athletes within each weight category (60, 66, & 73 kg). Table 2 presents the strength, power and rate force development of blind vs. norm visual athletes in the bench press exercise. Norm visual athletes demonstrated higher values than Blind athletes in 1RM ($p = 0.002$), in the load where the maximum power ($p = 0.041$) was manifested, in the average force ($p = 0.002$) and in average power ($p = 0.002$). At maximum power, although there were no significant differences, marginal differences were observed ($p = 0.093$). In the remaining variables there were no statistically significant differences.

Table 2. Comparison of bench press neuromuscular performance outcomes between blind versus normal vision judo athletes

	Blind (n=6)		Normal Vision (n=6)		
	Mean ± *SD*	MRank	Mean ± *SD*	MRank	P-value
1RM (kg)	78.3±17.5	3.50	109.2±9.2	9.50	**0.002†**
Power load (kg)	39.2±4.9	4.42	46.7±8.2	8.58	**0.041†**
% 1RM (Power charge)	51.4±7.8	8.17	43.1±7.4	4.83	0.132
PV (m/s)	4.83±0.46	6.67	4.74±0.75	6.33	0.937
MV (m/s)	1.98±1.11	4.83	3.13±0.64	8.17	0.132
PF (N)	1200.7±307.7	5.00	1452.0±197.6	8.00	0.180
MF (N)	758.7±185.5	3.50	1079.0±97.6	9.50	**0.002†**
PP (W)	736.5±138.2	4.67	916.1±204.9	8.33	0.093
MP (W)	472.3±71.9	3.50	572.5±113.4	9,5	**0.002†**
RFD (N/s)	83,842±23,046	5.67	96,108±22,473	7.33	0.485

1RM = one repetition maximum; PV = peak velocity; MV = mean velocity; PF = peak force; MF = mean forçe; PP = peak power; MP = mean power; RFD = rate force development; †Significant main effects for condition ($p = 0.05$). All data are reported as mean ± *SD*.

Table 3 presents the values of the of strength, power and RFD of blind versus norm visual groups in the prone bench pull exercise. Visually sighted athletes presented higher values than blind athletes in the load where the maximum power was performed ($p = 0.009$) in the RFD ($p = 0.026$). In the remaining variables there were no significant differences.

Table 3. Comparison of neuromuscular performance outcomes in the prone bench pull exercise of blind versus normal vision judo athletes

	Blind (n=6)		Normal Vision (n=6)		
	M ± *SD*	MRank	M ± *SD*	MRank	p value
1RM (kg)	95 ± 20.7	5.00	110.0 ± 8.9	8.00	0.180
Power load (kg)	40.8 ± 8.6	3.92	50.8 ± 2.0	9.08	**0.009†**
% 1RM (Power charge)	43.5 ± 6.3	5.33	46.6 ± 5.1	7.67	0.310
PV (m/s) (20 kg)	3.03 ± 0.90	6.50	2.77 ± 0.44	6.50	1.000
MV (m/s)	1.62 ± 0.88	5.50	1.89 ± 0.34	7.50	0.394
PF (N)	1510.0 ± 347.9	4.83	1926.7 ± 417.1	8.17	0.132
MF (N)	983.8 ± 172.8	5.17	1136.7 ± 163.6	7.83	0.240
PP (W)	1280.5 ± 287.1	7.83	1096.7 ± 378.1	5.17	0.240
MP (W)	596.7 ± 87.8	4.83	706.3 ± 140.7	8.17	0.132
RFD (N/s)	78883.3 ± 32221.4	4.17	121442.0 ± 30520.7	8.83	**0.026†**

1RM = one repetition maximum; PV = peak velocity; MV = mean velocity; PF = peak force; MF = mean forçe; PP = peak power; MP = mean power; RFD = rate force development; †Significant main effects for condition ($p = 0.05$). All data are reported as mean ± *SD*.

Table 4 presents a comparison of neuromuscular performance variables of blind versus visually impaired participants in the squat exercise. There were no differences in squat neuromuscular outcomes between groups.

Table 4. Comparison of neuromuscular performance outcomes in the squat exercise of blind versus normal vision judo athletes

	Blind (n=6)		Normal Vision (n=6)		
	M ± *SD*	MRank	M ± *SD*	MRank	p value
1RM (kg)	127.5 ± 14.7	4.0	146.7 ±11.5	7.0	0.167
Power load (kg)	92.5 ± 11.7	4.5	103.3 ± 15.3	6.0	0.548
% 1RM (Power charge)	72.9 ± 9.6	5.5	68.9 ± 9.6	4.0	0.548
PV (m/s) (20 kg)	2.08 ± 0.23	4.0	2.36 ± 0.06	7.0	0.167
MV (m/s)	1.30 ± 0.10	4.5	1.38 ± 0.14	6.0	0.548
PF (N)	1866.8 ± 308.6	4.2	2030.9 ± 111.1	6.7	0.262
MF (N)	1275.6 ± 154.5	4.2	1472.6 ± 123.2	6.7	0.262
PP (W)	1609.6 ± 371.2	4.2	1953.8 ± 246.5	6.7	0.262
MP (W)	661.0 ± 109.8	4.2	783.5 ± 108.2	6.7	0.262
RFD (N/s)	92577.0 ± 22893.3	4.7	105137.3 ± 24542.1	5.7	0.714

PV = peak velocity; MV = mean velocity 1RM = one repetition maximum; PF = peak force; MF = mean forçe; PP = peak power; MP = mean power; RFD = rate force development; †Significant main effects for condition (p = 0.05). All data are reported as mean ± *SD*.

In the Figure 2 and Figure 4 we observed the differences between blind and norm visual judoka.

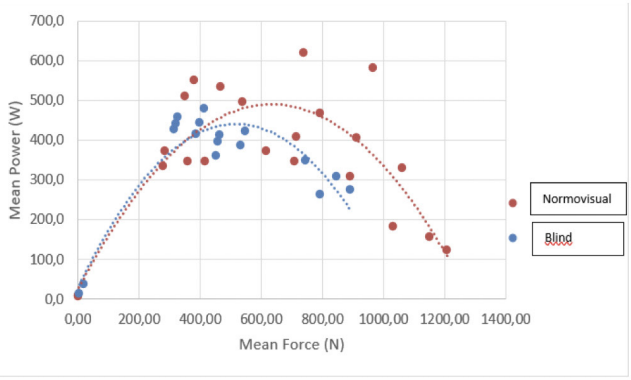

Figure 2. Power Curve of Blind *vs.* Norm visual athletes in the bench press exercise

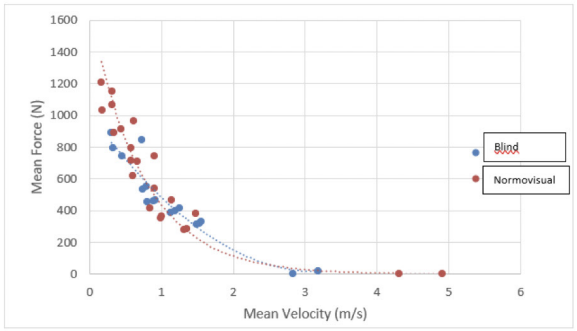

Figure 3. Velocity Curve of Blind *vs.* Norm visual athletes in the bench press exercise

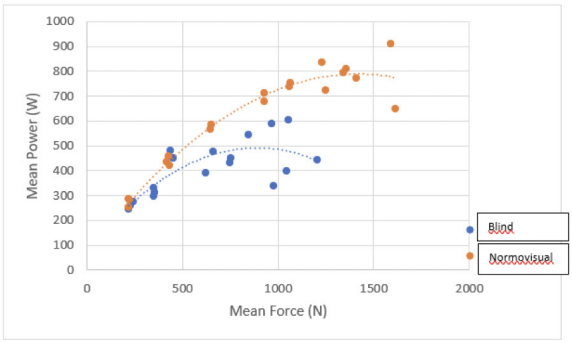

Figure 4. Power Curve of Blind *vs.* Norm visual athletes in the squat exercise

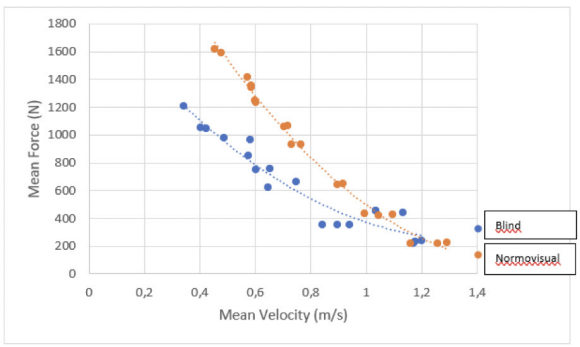

Figure 5. Velocity Curve of Blind *vs.* Norm visual athletes in the squat exercise

Table 5 displays a comparison of physical fitness and SJFT outcomes in blind and norm visual judo athletes. Handgrip strength (p = 0.015-0.041) and the CMJ elasticity index (p = 0.017) were greater in normal vision group. There were no group differences in other physical fitness outcomes. In addition, normal vision athletes performed a greater number of throws in each period (p = 0.009-0.026) and produced a lower SJFT index (p = 0.026) compared to blind athletes.

Table 5. Comparison of physical fitness and Special Judo Fitness Test (SJFT) outcomes of blind versus normal vision judo athletes

		Blind (n=6)		Normal Vision (n=6)		
		M ± *SD*	MRank	M ± *SD*	MRank	p value
$VO_{2máx}$ (ml/kg/min)	51.6 ±6.1	4.83	57.5 ± 4.8	8.17	0.132	
HG (kg)	Right	48.2 ±5.0	4.00	54.1 ± 1.5	9.00	**0.015†**
	Left	44.8 ±9.3	4.33	54.8 ± 4.4	8.67	**0.041†**
SJ	Height (cm)	34.2 ±6.6	5.83	32.1 ± 6.3	6.20	0.931
	MV (m/s)	2.6 ±0.2	5.83	2.5 ± 0.2	6.20	0.931
CMJ	Height (cm)	34.4±5.9	5.17	36.1 ± 8.2	7.00	0.429
	MV (m/s)	2.6 ±0.2	5.17	2.6 ± 0.3	7.00	0.429
	PP (W)	3161.1± 579.7	5.17	3469.1± 647.5	7.00	0.429
Elasticity Index (%)		1.3±9.0	5.17	12.0 ± 4.4	7.00	**0.017†**
Flexibility (cm)	Sit and reach	43.3±6.7	4.92	50.0 ± 9.5	8.08	0.132
	Rigth shoulder	-3.2±9.4	7.67	-11.0 ± 9.9	5.33	0.31
	Left shoulder	-1.2±8.6	8.33	-9.5 ± 6.1	4.67	0.093
SJFT	T115 (#)	4.2±0.8	3.83	5.7 ±0.5	8.60	**0.009†**
	T230 (#)	9.2±0.8	3.83	11.0 ±0.9	9.17	**0.009†**
	T330 (#)	8.7±1.4	4.17	10.7 ±0.8	8.83	**0.026†**
	HR1 (bpm)	171.5±11.3	5.00	180.2 ±5.2	8.00	0.180
	HR2(bpm)	141.7±11.4	5.67	144.2 ±5.8	7.33	0.485
	Index (%)	14.4±1.8	8.83	11.9 ±0.6	4.17	**0.026†**

HG – Hand grip; SJ = squat jump; MV = mean velocity; CMJ = countermovement jump; CMJ PP = peak power; SJFT = Special Judo Fitness Test; T1 = number throw in 15 sec; T2 = number throw in 30 sec; T3 = number throw in 30 sec; HR1 = heart fate in final of test; HR2 = heart fate one minute after final of test; †Significant main effects for condition (p = 0.05). All data are reported as mean ± *SD*.

DISCUSSION

This study compared the sport-specific and physical performance capabilities of Paralympic versus Olympic judo athletes. Regarding judo performance, the visually impaired athletes performed fewer projections than norm visual athletes. These outcomes may be related to the need for visually impaired athletes to be guided and to lose time in approaching the uke and its respective grip. Furthermore, the SJFT index, according to the Percentile Reference Tables (Sterkowicz, 1995) indicated that the blind athletes were in the Low level and the norm visual athletes were in the Good level, thus having a substantial difference between them. This difference may be due to the blind athletes' impaired special references and potential hesitation fear of the abyss, to a retraction and consequently to a decrease in speed and power. In this regard, it is worth mentioning the study carried out by Brazilian researchers (Loturco et al., 2017, 2017a) who precisely compared these two groups in relation to the strength and power.

Regarding neuromuscular performance, blind athletes had lower scores than norm visual athletes in several strength and power-based outcomes in the bench press and prone bench pull exercises, but not the squat exercise. This may be due to the resistance training exercises that the visually impaired athletes may be limited to perform the exercises. Furthermore, the visually impaired athletes, have several limitations in the orientation of their training, as they are conditioned to the presence of a guide, outside the mat and throughout the training in the scope of development of different motor skills.

Regarding handgrip strength, norm visual athletes presenting higher values than the visually impaired. In relation to the literature, the few reference values in blind athletes (Andrade et al., 2014; Karakoc, 2016), show significant differences with those with normal vision, however the values of these studies are lower in relation to the athletes in our study (Blind, 40.70 ± 9.26 kg vs. Norm visual, 46.67 ± 5.65 kg). The decreased grip strength among visually impaired athletes may be due to lesser training stimuli utilized (Mayda, Karakoc & Ozdal, 2016).

Regarding cardiorespiratory endurance, the recovery levels in SJFT (difference between HR1 and HR2) in normal vision group were higher than the visually impaired group (M = 36 vs. M = 29.8 bpm, respectively), which indicates better cardiorespiratory endurance and improved ability to recover after exertion. This assertion is supported by the greater $VO_{2máx}$ values expressed by the norm visual group (Norm visual group: 57.5 ± 4.8 vs. Visual impaired group: 51.6 ± 6.1 ml/kg/min). In fact, the results of our study, in relation to cardiac adaptation to effort, are in line with those obtained by others (Mayda, Karakoc, & Ozdal, 2016; Loturco et al., 2017). It is known that due to lack of stimulation, the physical and psychological development of blind individuals is often lower than that of sighted individuals (Mayda, Karakoc & Ozdal, 2016).

In the evaluation of the SJ performance, the values, despite being slightly higher in visually impaired athletes, compared to normal-vision athletes (34.2 cm to 32.1 cm), were not statistically different. The literature presents SJ values slightly lower than National Teams with blind and visually impaired judoka (Spera et al., 2019), but also without significant differences between the two groups of sighted and blind athletes (33.74 ± 7.16 cm and 27.34 ± 7.79 cm; p = 0.387). Regarding the CMJ, the values were also similar between the two groups, with normal-vision athletes presenting small differences (36.1cm vs. 34.4 cm), which agrees with the literature. Karakoc (2016) in your study also founded similar results between the two groups, without statistically significant differences, despite having higher values compared to the national team, 41.25 ± 5.86 cm and 38.05 ± 7.25 cm. Regarding lower body power, outcomes were similar between the two groups. However, the elasticity index, which represents the elastic-explosive manifestation strength (CMJ) and the difference with SJ is the use of elastic energy. It measures the elastic capacity. This index allowed the evaluation of contractile and elastic component of the lower limbs' musculature (Francisco eta al., 2010; Pradas et al., 2013). This elasticity index was significantly greater in the norm vision group. It seems that the muscle-elastic components, including the short-stretch muscular cycle (SSC), are considered important factors in the ability to generate optimal levels of lower-body muscle power (Komi & Nicol, 2000). The explosive actions of the lower limbs during the throw can be decisive in a sport that the result can be decided in an only action (*ippon*).

According to Loturco et al. (2017), this may be a possible explanation for the similarities in leg strength and the differences in muscle power measures between these two groups. Considering that the muscular strength capacity is more important than the maximum strength for the effective execution of judo techniques (Loturco et al., 2017). As opposed to maximal strength (which can be developed through traditional strength training) "maximum muscular strength development" appears to depend on a full integration of physical (i.e., neuromuscular) and technical training strategies. While blind athletes rely solely on proprioceptive and kinaesthetic information before initiating throw techniques, Olympic judo athletes are able to add the use of visual information related to the opponent's displacement and actions. Therefore, it is possible that blind athletes need to apply more force (for longer) during the execution of techniques while sighted athletes can better anticipate the opponent's displacement by efficiently using their inertial body force throughout the movement, which results in "higher frame rates" (Loturco et al., 2017). Regarding flexibility, there were no differences between groups.

It is important to highlight the need to develop speed in blind athletes since the time to generate high levels of strength force in attack and counter-attack judo techniques is short (Monteiro, 2013). The development of muscle power in Paralympic athletes should be prioritized in strength training as a way to improve performance in the number and efficiency of specific Judo techniques performed at high speed. In addition to the effectiveness in executing the techniques, the most powerful athletes are equally capable of performing a greater number of throws during a specific judo test. Although confirming the importance of muscle strength in judo performance, the results also demonstrate the need to invest more in the development of this neuromuscular capacity in blind athletes. The higher power observed in the blind athletes in most of the tests carried out, evidenced their ability to apply higher values of force at higher speeds, which possibly indicates their higher level of competitiveness. During the execution of throwing techniques, the judo athletes need to generate high levels of power to move the opponent's body mass and surpass his/her opposing forces (Franchini et al., 2011; Zaggelidis & Lazaridis, 2012; Monteiro, 2013; Loturco et al., 2017). From a biomechanical perspective, this optimal power production is achieved using both lower- and upper-body muscles (Franchini et al., 2013; Monteiro, 2013). In the Figure 4 we observed the differences between blind and norm visual judoka, it becomes reasonable to search for more efficient and applied strength-power training methods. As such, training at the optimum power zones might be a suitable and useful strategy for Paralympic judokas (Loturco, 2017).

In this sense, despite the impossibility of holding official judo tournaments involving Olympic and Paralympic judokas simultaneously, according to our results, it seems reasonable to consider that Olympic athletes are more efficient and effective than visually impaired Paralympic athletes in performing throw techniques observed in the SJFT and anecdotally during training sessions and competitions. From this observation, it is possible to assume that the competitive performances of Paralympic Judo athletes can improve significantly after the adequate development of muscle strength and power. The lower performance in the evaluation of some parameters of physical fitness and in the specific physical abilities presented

by blind judokas may be related to the visual impairment of these athletes. The possible cause is the susceptible to affect the performance of blind athletes in general and specific exercises of physical fitness and strength neuromuscular system, but also because the characteristics inherent to Olympic athletes, although they are also six, are due to a selection from a much larger and more competitive sample.

In summary, the results showed that norm visual Olympic and Paralympic judo athletes present different physical fitness and specific physical abilities with superior performance in Olympic athletes. We believe that this fact may have important implications for sport science, helping coaches of Paralympic judo athletes to better select general and specific training strategies aimed at increasing the competitive level of these athletes. Accordingly, it is important, that athletes performed strength-power training sessions at optimum power zones (i.e., range of loads where power production is maximized) (Loturco et al., Monteiro et al., 2011; Monteiro et al., 2014; Monteiro, 2013), which is recognized as a very effective strategy to develop the force components at both ends of the force-velocity curve (i.e., low-force/high-velocity and high-force/low-velocity portions) (Loturco et al., 2016a).

CONCLUSION

Blind Portuguese judoka have an adequate physical fitness, but with lower fitness levels compared to norm visual athletes, which could likely be improved with targeted strength and neuromuscular training. The differences in power and neuromuscular outcomes between blind and norm visual athletes may be associated with the visual-proprioceptive difference, which possibly leads to disparities between their technical-tactical strategies in the "initiating an attack". In summary, the results showed that Olympic and visual impairment present different levels of strength and power outcomes in most of the tests performed, with superior performance in Olympic athletes. These findings may have implications for sport science in helping Paralympic coaches to select appropriate neuromuscular and fitness training strategies to increase the competitive level of their elite athletes. Considering the limitations of this study, namely the small sample, longitudinal studies should be conducted to investigate the effects of physical fitness training programs in groups of high-performance Paralympic judo athletes to improve their specific judo performance.

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Exploring the Experiences of Attending a Safe Falling Workshop Based on the Practice of *Ukemi*

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Abstract: *Across the world, the impact of falling is experienced, not only by the individual that fell, but across the whole support network that is activated. The cost of falls is experienced at governmental level, through hospitals, up to and including individual family units and it is recognised that everyone will fall. Age has become a significant risk factor for falls, with much focus being given to fall preventative measures and exercise interventions that reduce both the rate of falls and the number of people who have falls. The purpose of this research was to explore whether participants could learn the principles of safe falling after attending a one-hour workshop but also to understand how they experienced the workshop. Two men and ten women with an age range 64-82 years, (72.2 ±5.8) attended the hour-long workshop based on ukemi from the sport of judo. Prior to the workshop the participants completed a pre-exercise readiness questionnaire, Fear of Falling Questionnaire Revised (FFQ-R) and the Falls Efficacy Scale International (FES-I). Eleven participants took part in the follow up interview, which were analysed through reflective thematic analysis (RTA). Two themes and two subthemes were generated: Practice, practice, practice and Is fear of falling a bad thing. Participants enjoyed the workshop experience, and all were able to recall the main principles of safe falling. The findings from the RTA suggest that one hour is not enough for techniques to become instinctive and illuminate a more nuanced relationship between the participants relationship to the fear of falling and their own physical abilities. Implications of these findings are discussed relative to the duration of judo-based intervention programmes, the importance of using judo coaches and judo mats and how next to progress the Safe Falling Programme.*

Keywords: *judo; safe falling; ukemi qualitative research*

Worldwide there are an estimated 68,4000 fatal falls a year and whilst not fatal, 37.3 million falls are severe enough to require medical attention, which places a significant financial burden on global health services (World Health Organization [WHO], 2021). A fall is defined by the World Health Organization (2021) as "*an event which results in a person coming to rest inadvertently on the ground or floor or other lower level.*" Age is a significant risk factor for falls and in fall rate, the death rates from falls are highest for adults over 60 years, with 30% of people aged 65 and over falling at least once a year rising to 50% of all those aged 80 and over (Public Health England, 2017; WHO, 2021). Alongside the physical consequences of accidental falls within the elderly population, falling can have a profound physical, psychological, and social impact amongst older adults with evidence suggesting greater long-term impacts on quality of life and life satisfaction in comparison to non-fallers (Stenhagen et al., 2014). In recognition of the importance of this issue globally, several preventative strategies have been implemented including gait, balance and functional training, home modification, multifactorial interventions, vitamin supplementation and Tai Chi (WHO, 2021).

Research has focussed on the potential for exercise interventions, with evidence suggesting exercise can reduce both the rate of falls and the number of people who have falls (Pereira & Kanashiro, 2022). Programmes that primarily involve balance and functional exercises can reduce the rate of falls by 23% (Sherrington et al., 2020). Programmes lasting less than six months did not result in a reduced risk of falling, whereas those lasting from 6-12 months or over 12 months, reduced the risk of falling by 33% and 36% percent (Finnegan et al., 2018). Studies suggest that most effective programmes were the ones with a longer duration (i.e., over six months) and a greater the frequency of intervention (Periera & Kanashiro, 2022). Interest in Tai-Chi and fall prevention has developed with studies suggesting that Tai Chi appears to prevent the risk of falls in the older population (Hu, et al. 2016).

Across the world researchers are exploring other martial arts, including judo and how it can improve falling risk factors (e.g., Weerdesteyn et al., 2006; Groen et al., 2010; Del Castillo-Andres et al., 2018; Callan, 2019; Ciaccioni et al., 2021). Studies have taken place in the Netherlands (Weerdesteyn et al., 2006), Italy (Ciaccioni et al., 2020),

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Japan (Sakuyama, et al., 2021), Spain (Toronjo-Hornillo et al., 2018), and Sweden (Arkkukangas et al., 2021). Elements from judo have been utilised throughout all the studies, with researchers taking on different aspects and incorporating them into their programmes. The Judo4Balance programme created in Sweden (Arkkukangas et al., 2020a; 2020b; 2021) aimed to improve strength, balance and safe falling techniques. These studies used the judo inspired programme, Judo4Balance, offering ten-week (Arkkukangas et al., 2021) and four-month programmes (Arkkukangas et al., 2020a). Participants in both programmes benefited from a range of psychological and physical improvements through completing the programme in particular around fall prevention. The 10-week programme had a large participant age range, from 18 to 68 years, and all significantly improved fall function, fall related self-efficacy and falling techniques. The authors suggest that as fall technique significantly improved after a 10-week programme this comparatively short duration should be explored further in future research (Arkkukangas, et al., 2020b). The second study was of longer duration (four months) and had 28 participants, who were of more advanced age (60-88 years). Whilst there was a significant improvement in their falling techniques, only 50% of participants reported improvement in fall related self-efficacy. This suggests that the programme had important benefits, yet there remain questions around how to improve fall related self-efficacy if improved falling technique does not necessarily increase this.

Ciaccioni et al., (2019) further explored the benefits of judo training with a four-month programme for 16 older adults (69.7 ± 4.2 years). The purpose was to utilise judo as a multimodal physical activity, and to focus on gait analysis. The participants improved their waist circumference, flexibility and upper and lower limb strength in comparison to the control group. However, there was no significant difference between the two groups in fear of falling following the intervention. The authors suggest that the novice judoka did perceive more safety in their daily life, but this was only reported anecdotally. Whilst the study found physical improvements the author identified that exploration of the psychological effects was needed to gain deeper understanding of this seemingly contradictory outcome. These psychological aspects were explored in more depth by Ciaccioni et al. (2021). They investigated the effects of completing a four-month judo-based programme on fear of falling, exercise motivation and enjoyment in a group of 16 mixed older adults (69.3 ± 3.9years). Whilst technical ability significantly improved alongside enjoyment and motivation, the fear of falling measured by Visual Analogue Scales (VAS) and Fear of Falling (FOF) was again unchanged.

In Spain, the Adapted Utilitarian Judo programme (JUA) has been developed (DelCastillo-Andres et al., 2018). This programme adapted traditional judo, with a focus on progressions, *ukemi* (a technique in judo for falling safely by breaking the fall) and on active aging. It has been used with subjects with fear of falling syndrome (FOF) and to look to improve the quality of life. The JUA was used to teach older adults the strategies for falling, reducing the impact of a fall over an 8-week period, with 60-minute sessions twice weekly (Toronjo-Hornillo et al., 2018). The sample included 12 women, aged 57-83 years (71.5 ± 8years), assessing their fear of falling through the 16-item version of falls Efficacy Scale-International (FES-I), pre and post intervention. The authors report a significant improvement in individuals' perceived fear of falling and indicate that it is possible to teach fall control to older adults using principles from judo.

In contrast to these short programmes of activity intervention, *Yawarachan* was delivered in Japan from July 2016-March 2020 (Sakuyama, et al., 2021). Data was reported over a 9-month period, with 53 participants taking part and being observed in the judo-based exercise programme. The sample were split into high and low movement ability groups based on their response to a Short-From Health Survey 36. Further data was collated via 384 responses to a questionnaire with participants that also took part in the exercise programme. The results showed that *Yawarachan* developed habitually and with a high satisfaction level, with no reported injuries and an improved quality of life.

The oldest published programme we found which included a judo element to its intervention was the Nijmegen Falls Prevention Program (Weerdesteyn et al., 2006) from the Netherlands. It has been developed by a multidisciplinary team of physical therapists, occupational therapists, researchers, rheumatologist, and judoka. Adapted to work with elderly patients with osteoporosis (Smulders et al., 2010) and to prevent falls in people after strokes (van Duijnhoven et al., 2012), the Nijmegen Falls Prevention Program (NFPP) consists of three elements: an obstacle course, walking exercises and the training of fall techniques. The NFPP have also developed a course to instruct allied health professionals in the theoretical and practical background of the programme (Dutch Institute of Allied Health Care, n.d.).

Overall, these studies suggest that there are multiple physical benefits to older adults' participation in judo programmes, including improved strength and falling techniques. The psychological impact is less well understood in particular the meaning older adults ascribe to both falling, being taught to fall safely and how fear of falling affects them. How interventions such as the afore mentioned studies affect older participants' attitudes to falling needs greater investigation, potentially using a different methodology. Previous studies all used quantitative methods, qualitative approaches can offer "*new insights and understandings about individual and social complexity, evaluation of the effectiveness of programs or policies*" (Saldana, 2011, p.4) and so could illuminate these less understood areas.

This study uses qualitative methods to gain greater understanding and insight (Saldana, 2011) into the effec-

tiveness of a short safe falling intervention (a one-hour workshop), participants' experience of the workshop, and subsequently participants' attitudes and feelings to falling. The intervention focusses on a specific aspect of judo, *ukemi* and aimed to teach the principles in a one-hour workshop

METHODS

Theoretical assumptions
This study is underpinned by an interpretivist perspective, which seeks to understand the socially constructed realities of specific groups (Willis, 2007). In line with this, qualitative interviews (Smith & Sparkes, 2016) were used to gather data on how attending a short 'Safe Falling Workshop' would influence attendees' attitudes to falling. Data gathered was analysed by reflective thematic analysis (RTA) (Braun and Clarke, 2019).

Procedure
Following University ethical approval, the Safe Falling Workshop was advertised to members of the University of the Third Age (U3A) as part of their summer programme. The U3A is a charitable, community organisation open to anyone who is no longer in fulltime work. According to their 2019 membership survey the average age is 73.6 years (University of the Third Age [U3A], 2019) (as previously identified this age group is of high risk to falling and fall related injury). Two men and ten women with an age range 64-82 years, (72.2 ±5.8) attended the hour-long workshop. The workshop was run by a qualified judo coach with 22 years of experience and who has designed and run this workshop on four previous occasions. Prior to the workshop, participants completed the pre-exercise readiness questionnaire, Fear of Falling Questionnaire Revised (FFQ-R) (Bower et al., 2015) and the Falls Efficacy Scale International (FES-I) (Yardely, 2005) and they were asked if would like to take part in follow-up telephone interviews.

Eleven participants agreed to be interviewed, with nine taking part. Interviews were chosen to gather data as they can provide rich and fresh knowledge about our lives which in turn can impart meaning (Smith and Sparkes, 2016). Telephone interviews were chosen after taking into consideration both the interview and respondent's contexts (Oltman, 2016). Oltman (2016) suggests sensitive topics, in this case personal fear of injuries, may be less embarrassing and respondents less likely to confirm to a socially expected response. Ease of attending, where the cost or arrangements to additional travel for a face-to-face interview may discourage participation was also taken into consideration. The interviews were semi-structured and used an interview guide that was pilot tested before the interviews. The participant's FES-I and FFQ-R survey results were also integrated into the interviews as an elicitation device (Smith and Sparkes, 2016) to encourage the conversation.

Data analysis
In line with the philosophical assumptions of the study and the drive to prioritise qualitative data collection methods, the FES-I and FFQ-R survey results were not analysed to produce descriptive statistics, they were utilised to inform the interview guide and to promote to the attendees the opportunity to consider their attitudes to falling and to provide insight and provoke dialogue during the interviews (Smith & Sparkes, 2016).

The data from the interviews was analysed using RTA (Braun & Clarke, 2019). RTA was selected as it is in line with the interpretivist paradigm (Braun & Clarke, 2019). As the role of the researcher is central to RTA it is important to clarify the authors' perspectives who were engaged with the analysis. The first author is a judoka of 31 years' experience and an academic with expertise using RTA. The second author is a post-graduate research student with experience of RTA and who acted as a critical friend. In this role they offered critical feedback and encouraged the reflexivity of the primary researcher throughout the process of analysis (Smith & McGannon, 2018). The third author is a post-graduate research student who conducted the literature review and provided support across the project. The fourth author is a qualified physiotherapist who assisted in the research design.

There are six stages of RTA, and the result is generation of patterns of shared meaning from the data (Braun & Clarke, 2019). These themes share a central meaning and are presented as a realist tale (King, 2016) in the findings.

Rigour
For this study rigour was considered in line with the philosophical assumptions. Reflexivity was included throughout the study, including study design, data collection and analysis and through the discussions carried out with the critical friend (Smith & McGannon, 2018). In addition, member reflections were gathered to acknowledge potential gaps in the data and provide new knowledge (Smith & McGannon, 2018). The findings were discussed with professionals who had experience in fall prevention and safe falling within elderly care. This reflective process also allowed for the exploration of naturalistic generalisability of the findings (Smith, 2018).

FINDINGS

The purpose of this study was to explore whether participants could learn the principles of safe falling through a one-hour workshop and to understand how they experienced the workshop. Following the interview guide which was informed from the data from the FES-I and FFQ-R survey results, nine interviews were conducted on the telephone, with 162 minutes of data collected. Overall participants enjoyed the workshop experience, and all were able

to recall the main principles of safe falling. Some expressed that the fact it was based on judo had been an initial barrier at first, as they knew little about the sport, but had attended, nonetheless. Five of the participants reported that they had a fear of falling prior to the workshop and five had experienced a fall. The findings from the RTA suggest that one hour is not enough for techniques to become instinctive and illuminate a more nuanced relationship between the participants relationship to the fear of falling and their own physical abilities. Two themes, and two subthemes were generated as can be shown in Table 1.

Table 1. The findings from RTA Themes

Theme	Subtheme
Practice, practice, practice	An hour is not enough
Is fear of falling a bad thing	Acknowledge physical ability matters

"*Practice, practice, practice – overcoming instinctive behaviours and making safe falling techniques habitual takes repetition and practice, as falling happens quickly in real life. This requires a safe place to do this, such as having mats available, and more opportunities to practice or be taught the techniques.*"

Theme: Practice, practice, practice

All participants could remember at least two of the basic falling principles, "*I think it has given me some basic tools that I hope I will be able to use, you know, in the situation of falling*", with most finding it enjoyable as well as useful, "*I enjoyed doing them or once we got the stuff that I felt really related*". The data suggests that the principles of safe falling could be taught in an hour, though most participants expressed doubt over whether they would be able to execute what they had learnt in the moment of a fall. This was for two main reasons. Firstly, falling happens unexpectedly and quickly in real life, with experiences such as "by the time I realised what was happening, I was already on the floor" or "*I didn't even save myself at all, because I just went so fast*" commonly expressed. This speed of falls was a factor that made participants doubt that they would have time to recall and employ the movements that they had been taught.

The second reason that made participants doubt they could now fall safely was instinct, with participants in agreement that more practice was needed to overcome instinctive behaviours and to make the safe falling moves intuitive. With comments such as, "*My only concern is that it's not instinctive because of the lack of practice*" and "*My only query is how am I going to remember it when it happens? Or am I going to do it?*" Participants did seem confident though that with more practice they could improve their outcomes, "*I mean, obviously, just in one hour, you only just learning some very basics that you need to sort of keep reinforcing them to make it instinctive.*" Some thought that they could practise on their own, "*my suggestion though I haven't got round to it yet. If you did some every day. If you did some of it, it would become instinctive.*" Others thought that actual practise was necessary but an issue, "*The only thing is, you know, you've got to make it instinctive. And we talked a bit about, you know, being able to, and that's just practice, and it's where do you practice? How do you practice that sort of thing?*" The idea of safe practice was a concern for a few participants with them expressing how useful the mats had been, but this was difficult to replicated at home, "*I might if I practised a bit more. It's actually hard to practice falling without a nice mat to fall on*" and "*One of the problems, of course, is that it's not so terribly easy to practice on your own, because you don't have all the mats*". Taken the data suggested the workshop could teach the principles of safe falling in an hour, but the action of performing safe falling would take longer to learn.

"*An hour is not enough- lots of information to take in and techniques to learn meant it was a tiring hour and not enough time to reinforce techniques*".

Subtheme: An hour is not enough

The idea that more practice could be achieved through a longer, single workshop was not something any participant thought would be helpful, conversely stating "*I mean, you could make it longer but I think then people would be tired, especially older people*". Most agreed it was probably too much for the hour to remember it all successfully, "*I think it was very packed for the amount of time we had.*" Some participants did suggest reducing the time per session but having more sessions, "*my recommendation would be to have two sessions, have three quarters of an hour*" and others suggested to reduce the number of *ukemi* taught, "*I would love to see it reduced by sort of like 20% or to move two or three moves.*" The duration or intensity of the workshop was a factor that many participants found a challenge with a lot to take in, "*I did feel we covered a lot in a short space of time, quite a rush.*"

"Is fear of falling a bad thing? - Awareness of physical limitations is both good and bad with some participants feeling better about taking more care e.g., walking more slowly, holding the handrail or using a walking stick after becoming more familiar with both the techniques and the implications of falling".

Theme: Is fear of falling a bad thing?

The hour workshop created an environment where participants were not only learning safe falling techniques but were able to explore their own limitations. This produced a finding that adds a distinction not explored in previous literature. The participants began to express that being aware of the dangers of falling or their own frailties empowered them to take more care and be safer when moving around. Many found that they had to swallow some pride when in public, "*I go upstairs and now I know I must hold the handrail and not worry what people are thinking*" or that they no longer worried that they had adapted their ways of moving, "*I fear my fear of falling is such that now I walk very slowly*". Acknowledging that a 'fear of falling' as such was a useful form of awareness, was a development particu-

larly amongst the older participants. For them learning the techniques was helpful but that being made more aware of the dangers and so becoming more careful was probably as useful as the safe falling techniques themselves. This was summarised by one participant, "*I think taking care is probably the best thing for me.*"

"*Acknowledge physical ability matters - Differentiation was good, but different classes for different abilities could be more appropriate. Lack of physical abilities such as strength, balance or flexibility were highlighted by inability to perform some of the basic movements and some participants felt was noticeable in the mixed ability group. This physical challenge was both taxing for some and left some of the least able participants a little demoralised afterwards.*"

Subtheme: Acknowledge physical ability matters

The age range amongst participants attending was around 20 years, with participants in their 60s to 80s. As expressed previously, this age difference did influence the meaning that participants ascribed to the workshop, however physical ability was also a key influence. The ability to complete the moves and fully take part in the workshop directly related to participants' physical abilities, "*I think it's some techniques that perhaps doesn't work with my age group and inadequate ability to do, want to control what my body's doing.*" It also impacted how the workshop made them feel. Whilst for some becoming aware of their frailties made them more empowered to look after themselves, for others they experienced frustration because they could not perform all the movements and progressions, "*Where I really started to get into trouble was when we had to, to begin by being in a sort of crouching position. But I was not easily able to get into that position without wobbling.*" Others felt they could not do the progressions of the movements as they just could not get into the positions, "*It was quite difficult when you when we did to crouch down because my knees aren't very, quite stiff*". Whilst other participants noted that they would have liked to do the progressions exercises with a partner, but other people were not confident, they "*were a bit reluctant to do the paired activities, which I think was because they felt maybe they hadn't progressed enough leading up to them*".

The participants expressed that the instructor had done a good job of differentiation, "*I think given the range of ability there that Kayla [pseudonym] managed extremely well.*" Several suggested that perhaps the workshop could be split by ability as it was difficult for some and others could have done more, "*I think that would have made a difference to, to be able to split that out a bit. Because some people, there was one lady in particular, was [just] sitting there. She said, after three quarters of an hour, she said, No, I'm done. I've had enough whereas I could have gone on.*"

Summary of the findings

The reflexive thematic analysis has provided an insight into the interview data and extrapolated interesting views collated into themes. The themes that developed from the interview data permitted an insight into how the over 60s experienced a safe falling workshop and their views on fear of falling. The opportunity to gather qualitative data on this area has shown the rich data that can be captured and the importance of asking participants rather than just measuring on them.

DISCUSSION

It is recognised across the world that age is a significant factor for falls and in fall rate (Public Health England, 2017; WHO, 2021), and that falls present the largest cause of emergency hospitalisation in older people and have a significant impact on long term health (Public Health England, 2017). The Health Foundation indicate that in the next 25 years, in England alone, the number of people older than 85 will double to 2.6 million (Raymond et al., 2021). To try and reduce the global economic cost, but also to acknowledge the profound physical, psychological, and social impact on individuals after a fall, research has focussed on the potential for exercise interventions (Pereira & Kanashiro, 2022). However, "*it is important to note that despite the benefits of targeted exercise training, participants within these programs still fall*" (Moon & Sosnoff, 2016, p.3). Focussing the exercise interventions within the sport of judo offers the opportunity to teach participants not only fall preventative techniques but most importantly the chance to learn effective falling strategies (Ciaccioni et al., 2020).

Previous studies have utilised judo as an exercise intervention tool and have shown improved gait (Ciaccioni et al., 2020), positively impacted bone mineral density (BMD), enhanced balance and quality of life (Borba-Pinheiro et al., 2012; Sakuyama et al., 2021) and reduced participants fear of falling (Ciaccioni et al., 2021; Toronjo-Hornillo et al., 2018). This study looked to address three specific areas which differ from current literature, these are: safe falling principles from judo and specifically *ukemi*, a shorter duration of delivery and a qualitative data collection. This differing approach has illuminated three important areas for discussion.

Duration and movement ability

The study found that it is possible to teach an adaptation of judo, in this case the specific principles of safe falling from *ukemi*, to an older population in a one-hour workshop. However, the findings suggest that in an hour workshop even though the principles of safe falling could be taught, there are two factors that need to be considered, which are the application of the principles and movement ability levels. The participants felt that an hour was long enough to understand the principles but was not long enough to ensure that they were confident that they could reproduce them if they fell. To feel more confident, they wanted to have more opportunity to practice the principles they had been shown. Current studies vary in the length of time and volume of sessions, for example, Toronjo-Hornillo et al. (2018) delivered their intervention twice weekly over an eight-week

period, whereas Borba-Pinheiro et al. (2012) delivered their programme over twelve months, so future research should investigate the length of time needed to ensure participants' confidence in their ability to replicate the principles as part of a falling process. Previous studies have utilised an adaptation of judo interventions that not only cover safe falling through *ukemi*, but they also looked to impact fall preventative measures such as gait (Ciaccioni et al., 2020), bone mineral density (BMD), enhanced balance and quality of life (Borba-Pinheiro et al., 2012). The diversity of these interventions to include fall preventative measures, even if they are from judo, limits the potential comparison between this more focussed study and other studies. More research is needed to determine on how long it takes for falling principles to become innate and employed in a fall.

One of the considerations for future Safe Falling workshops, which resonated from the findings was to split participants into movement abilities to maximise participants development in the intervention. Sakuyama et al. (2021) divided their participants into high and low movement ability groups using the Short-Form Health Survey 36 Version 2 (SF36 Ver2) questionnaire. The resultant groups were used to highlight how each ability group reacted to the *Yawarachan* intervention. The findings from the one-hour Safe Falling workshop not only adhere to the use of movement ability levels as an evaluation measure of an intervention, but it also suggests that movement abilities should be assessed before an intervention. This information can then be used to inform delivery, for example, so that the progression and regression of the exercises can be maximised for enjoyment, motivation and learning. This insight is invaluable as previous studies (Toronjo-Hornillo et al., 2018; Arkkukangas et al., 2020a; Ciaccioni et al., 2021) discuss the age range and mean age of participants but not what level of mobility they started the intervention with. Incorporating a pre-participation mobility assessment will raise awareness of delivery adaptations that are needed dependant on participants level of mobility and help inform targeted interventions and progress research.

Delivery

During the interviews, the delivery mechanism and specifically the coach was praised by participants for being inclusive and engaging in the workshops. In all studies that used an adaptation of judo, trained judo coaches were used to deliver the exercise intervention, with several studies repeating the high satisfaction (Sakuyama, et al., 2021) and enjoyment (Ciaccioni et al., 2021). Though without a qualitative measure this could not be determined if solely from the coach and/or the judo exercise intervention. The challenge within current published studies, is the lack of a standardised protocol being utilised. Each study refers to judo as the foundation to their exercise intervention, whilst four studies have named their intervention: Judo-4Balance (Arkkukangas et al., 2020a; 2020b; 2021), Adapted Judo Program (Borba-Pinheiro et al., 2012; Ciaccioni et al., 2020; 2021), Adapted Utilitarian Judo programme (JUA) (DelCastillo-Andres et al., 2018; Toronjo-Hornillo et al., 2018), and *Yawarachan* (Sakuyama et al., 2021). During the description of intervention, or in the protocol/method, different judo activities were advised, such as *ukemi* (Toronjo-Hornillo et al., 2018; Arkkukangas et al., 2020a; Sakuyama, et al., 2021), kata (Ciaccioni et al., 2021), *uchi komi* and *kuzushi* (Borba-Pinheiro et al., 2012; DelCastillo-Andres et al., 2018; Ciaccioni et al., 2020). Some protocols provide more details, such as Ciaccioni et al. (2020) who list the activities, including judo postures, judo walking styles and types of *kata*. Whilst Sakuyama et al. (2021) and DelCastillo-Andres et al. (2018) each included images as part of their studies. These details enable a greater understanding to their intervention and potential for replication, but this range of protocols illustrate that currently there is no consistent programme being followed.

What is clear from the aforementioned judo studies, is the vital inclusion of qualified coaches but also the importance of having somewhere to practice that is appropriate and has mats. The theme of '*practice, practice, practice'* reiterates this point as the participants discussed "*It's actually hard to practice falling without a nice mat to fall on.*" For their feasibility study, Arkkukangas et al. (2020a) found they had a high interest from older adults when the study was hosted at the local judo club. This resulted in a long waiting list of participants due to the number wishing to practice in this environment and the challenges of availability, linked also to the targeted group. For any future research being undertaken with judo focused intervention programmes, the importance of having qualified judo coaches and appropriate mats to deliver on should remain of the highest priorities. Arkkukangas (2021) reaffirms this view, suggesting that well-designed programmes are supported by professionals, but also adds that they could also be supported by technology. In addition to face-to-face delivery, participants in the one-hour Safe Falling workshop did express the view that it would have been useful to have something to take away from the workshop to aid remembering the principles and to help inform further practice. This idea warrants further exploration, with Arkkukangas and Cederbom (2021) highlighting the need to transition to digital support for falling programmes in the future.

Fear of falling

A fundamental aspect of this study was the qualitative method. Being one of the only studies that has investigated how the participants experienced the judo-based intervention has resulted in several unique findings. Before commencing any judo-based intervention, nearly every previous study presented data on age and gender but where they varied was in the evaluation instrument they used. This was often dependant on whether they were looking at a specific variable, for example Borba-Pinheiro et al. (2012) examined bone mineral density, balance and quality of life so used a dual-energy X-ray absorptiometry, the Osteoporosis Assessment Questionnaire (OPAQ) and a static balance test with visual control. However, many studies looked to examine fear of falling and to investigate if a judo-based exercise program could prevent falls in the elderly (Sakuyama et al., 2021). Yet each used a different measurement, such as Visual Analogue Scales

(VAS) (Ciaccioni et al., 2021), Short-From Health Survey 36 (Sakuyama et al., 2021) and even when discussing fear of falling, Toronjo-Hornillo et al. (2018) called it the Fear of Falling Syndrome (FOF) and used the Falls Efficacy Scale-International (FES-I) questionnaire, whereas Arkkukangas et al. (2020a) used the Falls Efficacy Scale-Swedish version (FES-S) to measure the participant's self confidence in their ability to perform activities without falling and a Short Physical Performance Battery (SPPB). This range of inventories and assessments used again makes comparing studies challenging. The quantitative measures being utilised to examine judo-based interventions need to be scrutinised, with the Judo4Balance programme reporting it had no significant difference in the fall-related self-efficacy (Arkkukangas et al., 2021). Overall, such measures were unable to adequately represent the complicated relationship many participants had with their abilities, and their feelings of fear around falling.

Bower et al. (2015) have suggested a revised version of the Fear of Falling Questionnaire (FFQ-R), which moves away from specific situations and measurements of self-efficacy and to refocus on fear, this may offer an alternative to FES-I The FFQ-R and FES-I were both used in the current study to inform the interview guide; however, the quantitative data is not presented. The interview data did highlight a nuanced findings and could impact the selection of future evaluation instruments, as the participants reported that their fear of falling was a useful form of awareness that encouraged the adoption of safe strategies, rather than something purely negative. This acknowledgement from the participants and from the member reflections suggest that awareness of personal ability and risk is beneficial alongside taking precautions. This finding was revealing, suggesting that having a healthy fear and acceptance of aging and needing support, resulted in participants being careful and actually promoted independence. This finding also supports future studies should focus on any actual fear and fall acceptance (Moon & Sosnoff, 2016) rather than the self-confidence reporting mechanisms.

The last element to discuss is a philosophical point about falling, in terms of how a fall is defined and if teaching safe falling or *ukemi* is actually examining safe landing. The World Health Organization defines a fall as "*an event which results in a person coming to rest inadvertently on the ground or floor or other lower level*" (WHO, 2021). Similarly, ProFaNE (Prevention of Falls Network Europe) has a definition of "*an unexpected event in which the participant comes to rest on the ground, floor, or lower level*" (Sherrington et al., 2020). Moon and Sosnoff (2016) conducted a review of safe landing strategies during a fall and noted that landing strategies have a significant effect on reducing impact load during a fall. This would suggest, if a fall is defined as inadvertent or unexpected, the implementation of practiced safety strategies would not be defined as falling, as the activities are practiced. However, Moon and Sasnoff (2016) suggest that the strategies for safe falling could be learnt for effective landing, including martial arts rolling, and warrant further investigation to check effectiveness and suitability. In re-examining the definition of *ukemi*, a technique in judo for falling safely by breaking the fall, this encompasses safe falling in its ability to break the fall and its principles teach the safe landing from the fall, which is then practiced.

Summary

Taking a slightly different approach to a judo-based exercise intervention brought forth interesting insights. Although the Safe Falling workshop only focused on *ukemi*, it is not clear for any judo-based intervention the length of time that is needed to see the desired changes. It was also suggested that before any intervention commences the participants are evaluated and their mobility level reviewed. The importance of judo coaches and judo mats was discussed as highly significant, whilst future thought is needed to examine if a standardised protocol could be used and what measures for evaluative purposes are needed and if fear of falling should be perceived in such a negative light.

CONCLUSION

The purpose of this study was to explore whether participants could learn the principles of safe falling after attending a one-hour workshop and to also understand how they experienced the workshop. The findings from this study suggest that the judo technique of *ukemi* and judo coaches should have a role in safe falling training, but that more time is needed to practice and learn to apply the principles from *ukemi* if a fall occurs. When discussing the FES-I and FFQ-R questionnaires and the participants' general feelings around fear of falling a nuance was uncovered. The participants felt that undertaking the questionnaires and discussing fear of falling made them more aware of their own abilities and helped them to adjust to a more accepting view of aging and the need for support in some areas, which has prompted them take greater care whilst facilitating their independence. The findings intimate that utilising principles from *ukemi* to teach safe falling to an older population is possible and can result in an enjoyable, engaging and beneficial activity.

Future directions

There are three distinctive areas for the development for this research. The first is to continue working with the over 65s and to work on positive aging using judo-based exercise intervention programme. This programme will not only delivery safe falling but will use judo as a fall preventative intervention. A protocol for this should be written from all the previous research (Toronjo-Hornillo et al., 2018; Ciaccioni et al., 2020; Sakuyama, et al., 2021; Arkkukangas et al., 2021) and it could be taught to judo coaches across the world, who could then help their local community dwelling population.

The second area is to continue utilising the principles from *ukemi* to teach safe falling workshops across the lifespan

and to offer these workshops to different demographics for instance in other sports such as rugby or in schools as part of physical education programmes (DelCastillo-Andres et al., 2018). The final area is to influence the World Health Organization to recognise judo as a way to teach safe falling. This large-scale project would need to involve other sectors to achieve this with professionals such as physiotherapists and carers being taught by judo coaches how to teach people to fall safely using the principles from *ukemi*. This would ensure an effective way to scale-up the programme enabling the intervention to become part of routines in caring for older people (Sherrington et al., 2020). This is an ambitious project, but the one judo is capable of achieving.

Limitations

The limitations for this study are that the participants who took part in the workshop were a small number of people and mostly women, yet this was combated through richness of the qualitative data collective through interviewing. As part of the intervention pre and post FES-I and FFQ-R were collected, but they were not reported as part of the results and a mixed method approach may have brought different insight. Only delivering a workshop on a short duration has meant that it is unclear of how long participants would need to feel comfortable applying the principles which they were taught. However, it has been insightful to recognise that the principles could be taught in an hour, yet their application in a fall would need longer to be practiced.

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Legal Aspects of Serious Judo Accidents in Japan: A Review of Decisive Judicial Precedents

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Abstract: *The news of 110 fatal judo accidents in high schools shocked the Japanese judo community in 2010. As civil and criminal trials of judo accidents gradually increase, the legal aspects of serious judo accidents in Japan are studied to investigate the cause of accidents and the possible liability of teachers.*

Three keywords, 'judo,' 'compensation for damages' and 'judo accident' were used to search for judicial precedents of judo accidents between 1st April 1948 and 31st May 2020, from 2 database retrieval systems. Civil trials for 20 cases of intracranial bleeding and 5 cases of spinal cord injury remained suitable for close inspection of the documents. All 25 cases are divided into 4 groups according to whether the defendant's liability is found or denied and the site of serious injuries, respectively. Defendants were found liable in 14 cases of intracranial bleeding and 2 cases of spinal cord injury. The length of judo practice experience of the 14 victims with intracranial bleeding was less than 3 months in 9 cases. O-soto-gari and seoi-nage were the major cause of intracranial bleeding, whereas seoi-nage and kesa-gatame caused spinal cord injury. Teachers were responsible for the following matters: 1. Beginners without sufficient training of ukemi, 2. Physical and skills gaps between the opponents, 3. Absence of teachers in the dojo during practice, 4. Teachers' ignorance of head injuries. The court first found a coach guilty of a fatal judo accident in 2010.

The Japanese qualification system should be changed to prevent serious judo accidents.

Keywords: *serious judo accident; student safety; acute subdural hematoma; spinal cord injury; civil trial; criminal trial; Japan*

Serious head injuries among judo practitioners had already been reported in a Japanese medical journal in 1988. However, any information about the miserable outcome of the victims has not been transmitted to the All Japan Judo Federation (AJJF) (Nishimura, et al., 1988). Ryo Uchida has posted his collected data about serious judo accidents that occurred since 1983 in Japanese junior and senior high schools and updated his website every year since September 2009 (http://www.dadala.net, 2009). He reported that 110 students died of judo injuries in schools in the 27 years from 1983 to 2009. The 110 fatal accidents occurred during 14 physical education classes and 96 extracurricular activities in judo clubs in 37 junior high schools and 73 senior high schools, respectively (Uchida, 2010). This big news "about 4 high school students die each year as a result of judo injuries" became widely known to the public. In addition, a serious judo accident was broadcast on television in December 2009. After these events, Japan Judo Accident Victim Association (JJAVA) was founded on 27th March 2010, in Tokyo, to support judo accident victims and their families and to lobby for improved judo safety. JJAVA also showed the stunning report of Uchida on their website which shocked the world (http://judojiko.net, 2010), (Ozawa, 2011). Due to the active work of JJAVA, the number of reported civil cases gradually increased and the 'judo accident' became an important social issue. On the other hand, the new curriculum guideline of the Ministry of Education, Culture, Sports, Science, and Technology of Japan was revised in March 2009 and indicated that the compulsory learning of Budo (martial arts) was scheduled to start in April 2014.

The Medical Committee of AJJF studied the reported cases of judo accidents, investigated the cause of judo accidents, and published the third version of the 'Safety Guidance of Judo' in 2011, to revise the section on head injuries and present a support manual for managing concussion (All Japan Judo Federation, 2011). Then the number of fatal judo accidents gradually decreased and there were no deaths of children in the 3 years from 2012 to 2014, although it gradually increased again in the next year. As JJAVA actively posted judo accidents and their related civil cases on their website, criminal trials gradually increased and the first judgment of conviction for a fatal judo accident was rendered on 5th October 2011. Furthermore, a schoolteacher received a conviction for inflicting bodily injury and was sentenced to imprisonment in 2021 (The Mainichi Shinbun, 2021).

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In this article, the legal aspects of serious judo accidents in Japan are studied to investigate the judicial records which discussed and documented the cause of judo accidents, the outcome of injured athletes, and the possible liability of the schoolteachers, coaches, students, high school and/or competition organizer. It is expected that this study will increase awareness of the potential for serious judo accidents in consideration of the issues contributing to those occurrences, which could lead to the reduction and prevention of serious judo accidents.

Across the world researchers are exploring other martial arts, including judo and how it can improve falling risk factors (e.g., Weerdesteyn et al., 2006; Groen et al., 2010; Del Castillo-Andres et al., 2018; Callan, 2019; Ciaccioni et al., 2021). Studies have taken place in the Netherlands (Weerdesteyn et al., 2006), Italy (Ciaccioni et al., 2020),

MATERIALS AND METHODS

Two keywords, 'judo' and 'compensation for damages' were used to search for judicial precedents of judo accidents from 2 database retrieval systems: Hanrei Hisho Internet (LIC CO., Ltd.) and D1-Law. com (DAI-ICHI HOKI CO., LTD.) which records the official text of Japanese court decisions (https://www.hanreihisho.com/hhi/, 2021), (https://www.daiichihoki.co.jp, 2021). Eight hundred and eighty-four cases were retrieved as search results among 383,357 previous decisions from 1st April 1948 to 31st May 2020. After making further special references to another keyword, 'judo accidents,' 40 full texts of Japanese court decisions remained suitable for close inspection of the documents, to study the legal aspects of judo accidents in Japan. The cause of accidents, diagnosis and treatment of injuries, the length of judo practice experience, the outcome for injured athletes, and the possible liability of the relevant persons concerned were investigated. Twenty-five serious head and spinal cord injuries were selected from the 40 civil cases for further investigation, while 15 civil cases of bodily injuries of the arm, leg, and tooth and of intentional choking out by a coach, were excluded from the further investigation because they were not injuries specific to judo but common sports injuries. The selected 25 cases included 20 of intracranial bleeding and 5 of spinal cord injuries and were separated into 2 groups based on whether or not the defendants' liability was found in the civil trials. The defendants, including schoolteachers, coaches, students, high schools, and/or competition organizers, were found liable for their obligation to student safety in 14 cases of intracranial bleeding during practice or competition and 2 cases of spinal cord injuries during physical education lessons. On the other hand, no liability was found in 6 cases of intracranial bleeding and 3 cases of spinal cord injuries during practice or competition (Figure 1).

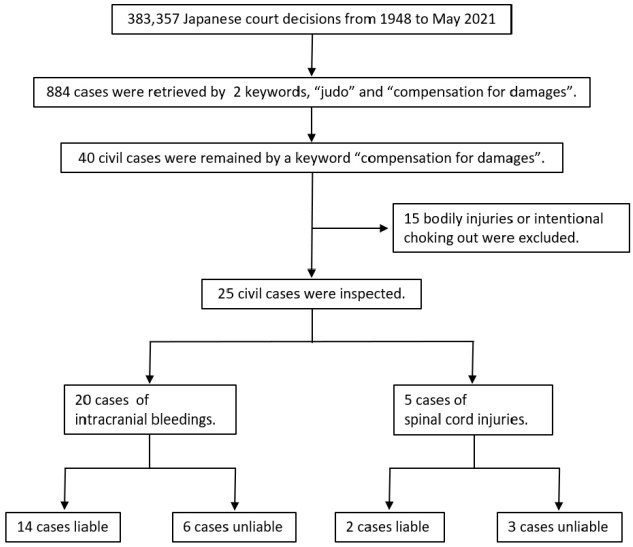

Figure 1. Retrieval results of Japanese court decisions
Twenty-five civil cases were divided into 4 groups according to the defendant's liability and the site of serious injuries, respectively.

RESULTS

The gender ratio was 22 males to 3 females for the victims and 21 males to 1 female for the opponents (gender was unknown in 3 cases). The median age of the victims was 15 years old, ranging from 11 to 25 years old, whereas that of opponents was 16 years old ranging from 13 to 41 years. The length of judo practice experience of 20 victims with intracranial bleeding was less than 3 months in 12 cases. On the other hand, most of the opponents were black belt students or schoolteachers (Figure 2).

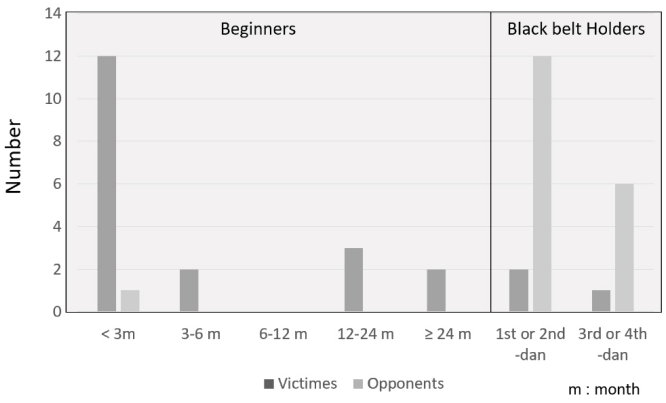

Figure 2. Length of judo practice experience or belt ranks for victims and opponents in cases of serious judo accidents with intracranial bleeding
Sixty percent of victims had less than 3 months of judo experience, whereas most of the opponents were black belt holders

Cases Finding Liability For Serious Head and Spinal Cord Injuries in Civil Trials

The liability was found in 14 cases of intracranial bleeding and 2 cases of spinal cord injuries (Table 1).

Table 1. Serious head and spinal cord injuries in cases finding liability (n=16)

No.	Date of judgment	Date of accident	Victim		Opponent		Cause of accident	Diagnosis and treatment	Issues and evidence
			Age/ Gender	Detail of experience	Age/ Gender	Detail of experience			
1	20/7/ 1970	26/6/ 1966	13/M	1.5 mo.	16/M	1st dan	seoi-nage during Yakusoku-geiko	ASDH DC	Absence of teachers Insufficient skills of Ukemi
2	09/9/ 1974	04/5/ 1865	16/M	16 days	17/M	1st dan	Seoi-nage after choking out	ASDH, AEDH Temporal bone Fr	Prohibited choking for beginners Illegal actions of students
3	08/12/ 1993	30/9/ 1986	15/M	4 days	15/M	1st dan	O-uchi-gari during Yakusoku-geiko	ASDH DC	On the 4th day of the lesson on Ukemi
4	04/8/ 1994	30/7/ 1986	12/M 62.6 kg	3 mo. 146.9 cm	14/M 62.2 kg	1st dan 165.4 cm	Throw by O-soto-gari to a wooden floor	ASDH, DC Brain contusion	Absence of teachers Abuse training by a senior student
5	30/1/ 1997	20/6/ 1994	12/M	2 mo.	-/-	Student	Seoi-nage, Harai-goshi, Uchimata during Nagekomi	ASDH Brain contusion	Absence of teachers Insufficient skills of Ukemi
6	27/3/ 2009	18/10/ 2003	12/F 75 kg	6 mo. 175 cm	13/M 117 kg	1st dan 175 cm	Harai-goshi during Randori Second impact syndrome	ASDH DC	Absence of teachers Ignorance of the danger of ASDH
7	07/8/ 2009	18/10/ 2003	12/M	3 years	15/M	1st dan	O-soto-gari during Nagekomi	ASDH DC	Coach's ignorance of head injury
8	17/12/ 2009	31/7/ 2002	16/F	3 mo.	-/M	3rd dan Teacher	Tai-otoshi	ASDH DC	Teacher's ignorance of head injury
9	22/9/ 2011	27/5/ 2008	11/M 43 kg	20 mo. 146 cm 4th kyu	41/M 83 kg	Coach 189 cm 4th dan	Tai-otoshi during Randori	ASDH DC	Big physical and skills gaps *Guilty in the criminal trial
10	27/12/ 2011	24/12/ 2004	15/M	14 mo. White belt	26/M	22 years Teacher	Kouchi-gari, Ippon-seoi-nage, Seoi-nage after choking out	ASDH, DC Brain contusion	Big physical and skills gaps Physical punishment?
11	13/9/ 2012	08/8/ 2008	15/M	14 mo. White belt	-/F	1st dan	O-soto-gari during Randori Second impact syndrome?	ASDH DC	Early comeback from 1st concussion Teachers' ignorance of danger of ASDH
12	03/7/ 2013	03/5/ 2008	15/M	1 mo.	15/M	-	O-soto-gari, Harai-goshi during Nagekomi	ASDH DC	Second accident after concussion Teachers' ignorance of concussion
13	05/2/ 2015	29/7/ 2009	12/M	2.5 mo.	-/M	Teacher	O-soto-gaeshi during Randori	ASDH DC	Teacher overlooked strange signs of the student during Randori
14	20/8/ 2015	09/5/ 2015	15/M	16 days	15/M	23 days	Uchimata during randori on the 17th day	ASDH, DC Brain contusion	Insufficient skills of Ukemi Inadequate training program
15	22/7/ 2011	17/11 2006	16/M	8 times (Ukemi)	16/M	8 times (Ukemi)	Seoi-nage during Yakusoku-geiko	Cervical cord injury	Insufficient lesson of Ukemi Inadequate program for beginners
16	09/5/ 2020	04/10/ 2013	16/M 53 kg	3 mo. 160 cm	16/M 106 kg	3 years 180 cm 1st dan	Kesa-gatame during lesson of a practice match	Central spinal cord injury at L1	Big physical and skills gaps between the opponents

M: male, F: female, m: month, ASDH: acute subdural hematoma, DC: decompressive craniectomy, Fr: fracture, L1: first lumber vertebra

No. 1 – 14: Head injuries during practice.

No. 15, 16: Spinal cord injuries during physical education lesson

The offensive techniques involved in serious judo accidents are shown in Table 2. *O-soto-gari* (major outer reap) and *seoi-nage* (shoulder throw) were involved in the moment of hitting the head leading to intracranial bleeding with unconsciousness. On the other hand, throwing by *seoi-nage* and holding with *kesa-gatame* (scarf hold) were involved in spinal cord injury.

After losing consciousness, the 14 victims were transferred to a nearby hospital and diagnosed with acute subdural hematoma (ASH), in all cases. Brain contusion was complicated in 4 of them. One of them also had a right temporal bone fracture with epidural hematoma. Urgent decompressive craniectomy (DC) was carried out for 12 of the 14 victims. The remaining 2 died 6 hours later wi-

thout surgical treatment (Table 1, Case No. 2) or 6 days after the accident (Table 1, Case No. 4). Two students developed spinal cord injuries. One of them injured the cervical cord and another injured the spinal cord at the level of the first lumbar vertebra.

The outcome of intracranial bleeding is miserable. Five students died of acute subdural hematoma 1, 6, 6, 13, and 26 days after serious head injuries, respectively. 9 students survived DC, however, marked neurological disabilities have remained postoperatively for a long period. Persistent unconsciousness was found in 1 student, vegetative state in 2, hemiplegia in 2, quadriplegia in 3, and higher brain dysfunction in 4. Two students with spinal cord injuries partially recovered from their disabilities after continuous rehabilitation (Table 1, Table 2).

Table 2. Offensive techniques and outcome of victims in cases finding liability (n=16)

	Intracranial bleeding (n=14)				Spinal cord injury (n=2)	
Opponents	Students (n=10)		Teacher (n=4)		Student (n=2)	
Offensive techniques	O-soto-gari	4	Tai-otoshi	2	Seoi-nage	1
	Seoi-nage	3	O-soto-gaeshi	1	Kesa-gatame	1
	Uchimata	1	Seoi-nage,	1		
	O-uchi-gari	1	etc.			
	Harai-goshi	1				
Outcome						
Fatal case	5 (35.7%)				-	
Persistent neurological disabilities	9 (64.2%)				2 (100%)	

Issues and evidence in serious judo accident cases were reviewed in court to decide the liability of the schoolteachers who violated the teachers' obligation to student safety. The points of issues were discussed by analyzing the daily activities in each judo club and 5 points were revealed as possible causes attributable to serious judo accidents (Table 3).

Table 3. Issues and evidence in civil trials – Cases finding liability

Points at issue	Intracranial bleeding (n=14)	Spinal cord injury (n=2)
Teachers' ignorance of head injury	6 (43%) *	-
Teachers' absence in the dojo	4 (28.6%)	-
Insufficient skills (Ukemi)	4 (28.6%)	1 (50%)
Physical and skills gaps	2 (14.3%) **	1 (50%)
Abusive and/or illegal action	3 (21.4%) ***	-

* Typical second impact syndrome in 3 cases. ** 1 case was guilty in a criminal trial.

*** 1 of 3 cases was not prosecuted in the criminal trial.

Details of Liable Cases

Two important cases are described herein. A very serious judo accident caused by violent judo practice occurred in a public high school *dojo* (Table 1, Case No. 2). When a 16-year-old, first-grade student 'A,' with only 16 days experience of judo training, requested to quit the high school judo club, a 17-year-old, second-grade student 'B,' with black belt (first dan), resorted to abusive *randori* (free practice). B continued to throw A with *seoi-nage*, *ko-uchi-gari* (minor inner reap), and *o-soto-gari* for 15 minutes and choked out A twice. After reviving 'A' from fainting by means of *kuatsu* (traditional resuscitation technique) (Nimura, Higaki, Motohashi & Yokoyama, 2021), B threw 'A' again with *seoi-nage*. A hit his head hard on the *tatami*, lost consciousness and died of intracranial bleeding in an ambulance on the way to a nearby hospital 6 hours after the accident. The autopsy revealed that the cause of death was ASH and right temporal bone fracture with epidural hematoma. The civil court found that the schoolteachers and student 'B' were liable for the damages based on the violation of the teachers' obligation for student safety and the illegal action of student 'B'. Although choking techniques were prohibited from being used against beginners, it was debated whether the lynching took place in the *dojo* or not. Eventually, this was denied because of 2 teachers' presence in the *dojo* when the incident took place.

The next case was a serious but preventable head injury with second impact syndrome or repeated damage (Table 1, Case No. 8) (Cantu & Register-Mihalik, 2011; McCroy & Berkovic, 1998; McCroy, Davis & Makdissi, 2012; Saunders & Harbaugh, 1984). Victim 'C' was a 16-year-old, first-grade, female student at a public high school. C joined the school judo club activity on 24th April 2002. 'C' attended a summer training camp after 3 months of experience with judo training. On the second day of the camp, 'C' was thrown and hit her head on the *tatami* and developed a headache, nausea, and vomiting which persisted for 3 days. On the fifth day, however, a schoolteacher recommended 'C' participate in the final practice. The teacher threw 'C' with *tai-otoshi* (body drop) and 'C' lost consciousness while developing a tonic convulsion. Although 'C' survived urgent DC for ASH, 'C' has been in a persistent vegetative state postoperatively. The Saitama District Court ruled that the teachers were not responsible for the accident because it was impossible to foresee the minor injury of ASH. However, the Tokyo High Court overturned the Saitama District Court's ruling. The mechanism of ASH and associated symptoms of the disease were discussed in court while referring to the medical records of the hospital and related papers on head injuries. The reason for the high court's decision was as follows:

1. Fatal judo accidents during extracurricular activities in school have already been reported,
2. It was possible for the schoolteachers to predict the occurrence of minor injuries of ASH,
3. The schoolteachers should have taken 'C' to the hospital and should not have recommended 'C' to participate in the practice.

As shown in Table 1, 2 cases of serious spinal cord injury occurred during the practice of judo in physical education class for first-year students in a senior high school. A 16-year-old male student was thrown with *seoi-nage* after 8 classes of *ukemi* (breakfall) and developed hemiplegia due to cervical spinal cord injury. The opponent was also a first-year student (Table 1, Case No. 15). Another case was a 16-year-old male student weighing 53 kg with a

height of 160 cm, with half a year of experience in judo training in physical education class. The victim developed paraplegia due to central spinal cord injury at the level of the first lumbar vertebra while being held with *kesa-gatame* (scarf hold). The opponent was also a 16-year-old male student but weighed 106 kg and was 180 cm tall (Table 1, Case No. 16). The district court found the teachers' breach of obligation for student safety in physical education due to insufficient lessons of *ukemi* and big physical and skills gaps evident between the 2 students in each case, respectively (Table 1).

Cases Denying Liability For Serious Head and Spinal Cord Injuries in Civil Trials

Defendants were found not liable in 9 civil cases for 6 incidents of intracranial bleeding and 3 incidents of cervical spinal cord injury. Five cases of ASH, 1 case of epidural hematoma, and 2 cases of associated brain contusion were diagnosed at the time of admission to the hospital or during urgent craniotomy. The cervical spinal dislocation was found at the level of the 5th and 6th cervical spinal bones in 1 case and the 4th and 5th cervical spinal bones in 2 cases (Table 4).

Table 4. Serious head and neck injuries in cases denying liability (n=9)

No.	Date of judgment	Date of accident	Victim		Opponent		Cause of accident	Diagnosis and treatment	Issues and evidence
			Age/ Gender	Detail of experience	Age/ Gender	Detail of experience			
17	28/9/ 1984	22/3/ 1973	15/M	3 years 1st kyu	-/M	4th dan Teacher	O-uchi-gari → Uchimata during Yakusoku-geiko	ASDH Brain contusion	No breach of student safety
18	09/4/ 1981	12/1/ 1972	17/M	6 mo.	16/M	1st dan	O-soto-gaeshi during Randori	AEDH Brain contusion	Skills gaps between the 2 students Unexpected accident
19	04/9/ 1997	25/7/ 1987	13/M	2.5 mo.	14/M	7 years 1st dan	O-soto-gari during Randori	ASDH, DC	No breach of teacher's obligation for student safety
20	15/2/ 2013	03/5/ 2008	15/M 52kg	24 days 164 cm	15/M 105kg	1st dan 170 cm	O-soto-gari, Harai-goshi during Nagekomi	ASDH DC	Comeback program from concussion was not available at the time of the accident
21	29/3/ 2013	28/7/ 2007	15/M	-	Defendant: AJJF		Concussion 3 days before examination of Kata	ASDH DC	Kata examination is not authorized to AJJF but to Kodokan.
22	21/8/ 2019	22/5/ 2015	12/M	1.5 mo.	Defendant: AJJF		O-soto-gari during Yalusoku-geiko	ASDH DC	O-soto-gari is not a prohibited technique for junior high school students
23	29/3/ 1979	11/5/ 1973	16/M	1st dan 70 kg	18/M	1st dan 85-90 kg	Head dive Uchimata during Randori	C5/C6 fracture dislocation	No breach of the teacher's obligation for student safety
24	29/10/ 1979	26/9/ 1971	19/F 57kg	1st dan 166 cm	9/M 90kg	1st dan 177 cm	Head dive Hane-goshi during the competition	C4/C5 fracture dislocation	Unexpected accident
25	29/9/ 2004	24/5 1998	25/M 70kg	3rd dan 172 cm	-/M 92kg	3rd dan 174 cm	Seoi-nage during competition	C4/C5 fracture dislocation	No breach of organizer's obligation for safety management of competition

M: male, mo.: month, AJJF: All Japan Judo Federation, ASDH: acute subdural hematoma, AEDH: acute epidural hematoma, DC: decompressive craniectomy, C: cervical spin

The length of judo practice experience of 5 victims with intracranial bleeding was 24 days, 1.5 months, 2.5 months, 2.5 years, and 3 years (first *kyu*, brown belt), respectively. The victims with cervical cord injury had opponents, in all incidents, who were black belt students or schoolteachers (Figure 2).

The offensive techniques involved in serious judo accidents are shown in Table 5. *O-soto-gari* was the major cause of hitting the head leading to intracranial bleeding. On the other hand, *uchi-mata*, *hane-goshi* (hip spring), and *seoi-nage* were involved in cervical cord injury in 3 cases during *randori* or competition. The outcomes of the above serious judo injuries were miserable. Vegetative state, prolonged unconsciousness, and quadriplegia with incontinence persisted permanently. One student died of ASH 5 days after being thrown with *o-soto-gari* during *yaku-soku-geiko* (Table 5).

Table 5. Offensive techniques and outcome of victims in case denying liability (n=9)

	Intracranial bleeding (n=6)				Spinal cord injury (n=3)			
Opponents	Students (n=5)		Teacher (n=1)		Students (n=2)		Adult conmpetitors (n=2)	
Offensive techniques	O-soto-gari	3	Uchimata	1	Uchimata	1	Seoin-nage	1
	O-soto-gaeshi	1					Hanegoshi	1
	Kata	1						
Outcome								
Fatal case	1 (16.7%)				-			
Persistent neurological disabilities	9 (64.2%)				3 (100%)			

Issues and evidence in serious judo accidents were reviewed in the court and the following 3 points were the bases for denying liability:

1. Unexpected accidents can occur during *randori* and competition even in the presence of teachers or referees in the *dojo* because combat sports include intrinsic

risks of injury and there is a limit to the scope of obligation for safety management of judo,
2. Cervical dislocation incidentally occurred during *randori* or competition,
3. Intracranial bleeding incidentally occurred by hitting the head during *randori*, *nage-komi* or *yaku-soku-geiko*, although physical and skills gaps were evident between the opponents.

Details of Non-liable Cases

Two important civil cases are described herein. The first case was a beginner's head injury (Table 4, Case No. 19). A victim was a 13-year-old, first-year male student 'X' in a junior high school who joined the judo club activity on 20th April 1987. X started *randori* on 21st May. On the other hand, the opponent 'Y' was a 14-year-old, second-year male student with judo practice experience for 7 years (first dan). Although there were obvious technical gaps between the 2 students, the teacher matched 'Y' against 'X' in *randori* on 25th July. 'X' was thrown with *o-soto-gari*, hit their head on the *tatami*, and lost consciousness. Although 'X' survived an urgent craniotomy for severe ASH, mental retardation, memory impairment, and abnormal behavior persisted. On 31st October 1991, the Hiroshima District Court ruled that the teacher did not violate his obligation to student safety. However, on 16th March 1996, the Hiroshima High Court overturned the District Court's ruling and found the teacher's negligence in the safety management of judo club activity because there were obvious technical gaps between the 2 students. Finally, on 4th September 1997, the Supreme Court overturned the High Court's ruling and upheld the District Court's decision. Issues and evidence of this case were discussed in each court and summarized as follows. Although the victim was a beginner in judo practice, with 2.5 months of experience, the teacher permitted 'X' to practice *randori* after confirming his developed skills of *ukemi*. Therefore, the Supreme Court decided that this head injury took place by accident and could not have been foreseen and denied the teacher's violation of obligation for student safety.

The second case (Table 4, Case No. 20) was also an important case of head injury. The victim 'E' was a 15-year-old, first-year, male student weighing 52 kg and 164 cm tall. E joined the judo club activity of a public senior high school on 9th April 2008. 'E' was thrown, developed a headache, and was diagnosed with a concussion on 16th April. However, 'E' restarted daily practice 7 days later and developed a headache again on 26th April. The persistent symptom was associated with nausea and continued until the day before the accident. Another first-year male student 'F' (first dan), weighed 105 kg and was 170 cm tall, threw victim 'E' with *o-soto-gari* and *harai-goshi* (hip sweep) during *nage-komi* 14 days after being diagnosed with a concussion. 'E' lost consciousness and an urgent craniotomy revealed massive ASH. Postoperatively 'E' suffered from persistent disturbance of consciousness, quadriplegia, and incontinence. The Yokohama District Court ruled that the teacher did not violate his obligation for student safety, although there were physical and skill gaps between the 2 opponents, 'E' and 'F'. Issues and evidence of this case were discussed in the court. Victim 'E' was diagnosed with a concussion 1 week after joining the judo club and restarted practice 1 week later. 'E' developed headaches and nausea in the following week. Although these symptoms are typical neurological signs of head injuries, so-called second impact syndrome, the teacher did not stop 'E' from practicing (Cantu, 1995; McCroy, 2001; McCroy & Berkovic, 1998; Saunders & Harbaugh, 1984). In the court, however, the teacher's responsibility was denied because of the following reasons:

1. A revised version of safety guidelines for a comeback program from concussion was published by the AJJF in 2011,
2. Kanagawa Prefecture High School Athletic Federation provided safety guidelines for a concussion on 7th April 2012,
3. A revised version of "Ten Proposals for Taking Care of Causalities with Head Injuries" was published in 2003 by the Neurosurgical Committee, Japanese Society of Clinical Sports Medicine.

However, this reference had not been intended for judo teachers but for medical workers (Ogino, 2005).

According to the above, the District Court decided that the teachers were not legally liable for the resulting harm in the safety management of judo club activities.

Criminal Cases for Serious Judo Accidents

Four criminal cases were found in the last 15 years and the first sentence was passed in 2011 on a criminal charge of inflicting bodily injury resulting in death. Those 4 criminal cases and examination by the Committees for the Inquest of Prosecution in judo accidents are reviewed herein.

From Criminal Trial to Civil Trial

A serious judo accident occurred in a public junior high school *dojo* in Yokohama on 24th December 2004 (Table 1, Case No. 10). A 26 -year-old schoolteacher 'T' continued to throw a 15-year-old, third-year, male student 'K' by *ko-uchi-gari* (minor inner reap), *seoi-nage*, *ippon-seoi-nage* (one-armed shoulder throw), *tai-otoshi* (body drop) and finally choked out 'K'. After partially reviving from unconsciousness, 'T' threw 'K' again with the same techniques. Finally, 'T' failed to choke out 'K' with *sode-guruma-jime* (sleeve wheel strangle). However, 'K' fell and lost consciousness while developing convulsions. 'K' was transferred to a nearby medical center and was diagnosed with cerebral contusion with ASH. 'K' survived DC while suffering long-term neurological sequelae including higher brain dysfunction. As the parents of 'K' complained that 'T' was a habitual offender of physical punishment and violence and this must be a case of abuse and violence, Kanagawa Prefectural Police sent this case to Yokohama District Public Prosecutors Office on suspicion of inflicting bodily injury, on 2nd July 2007. However, on 27th 2009, the public prosecutors decided not to prosecute the case due to a lack of evidence of bodily punishment and

intentional injuries during *randori*. The prosecutors said that the teacher's action did not go beyond the reasonable use of force applied during judo practice. The parents requested an examination by the Committee for the Inquest of Prosecution and the Committee decided that non-prosecution was unjust. However, Yokohama District Public Prosecutors Office decided again not to prosecute this case. As the statute of limitations (5 years) for the prosecution of this case on suspicion of professional negligence resulting in bodily injury was to expire in a week, examination by the Committee for the Inquest of Prosecution could not be requested and the non-prosecution of this case was confirmed on 23rd December 2009 (Table 6).

On the other hand, in the civil trial of this case, clear evidence was confirmed that big physical and skills gaps were observed between the schoolteacher and the student: Kodokan Cup champion versus junior high school student wearing a white belt. On 27th December 2011, the Yokohama District Court found that the public school must pay 89,198,598 Yen compensation for damages caused by a violation of the teacher's obligation to student safety.

Table 6. Comparison between the two cases of examinations by the Committees for the Inquest of Prosecution in judo accidents

Criminal trial	Case No.10	Case No.9
Judo accident Victim Assailant	December 24, 2004 15-year-old male student 26-year-old schoolteacher	May 27, 2008 11-year-old male student 41-year-old judo coach (4th dan)
Sending documents to the prosecutors	July 2, 2007 Kanagawa Prefectural Police to Yokohama District Public Prosecutors' Office	September 8, 2010 Nagano Prefectural Police to Nagano District Public Prosecutors' Office
The decision of the Prosecutors	October 27, 2007 Non-prosecution due to insufficient grounds for charging	April 25, 2012 Non-prosecution
Conclusion of Committees for Inquest of Prosecution	December 2, 2009 Unjust non-prosecution	July 26, 2012 Suitable for Prosecution
The decision of the Prosecutors	December 17, 2009 Non-prosecution again	December 14, 2012 Non-prosecution again
Conclusion of Committees for Inquest of Prosecution	The limitation period for public prosecution expired	March 7, 2013 Suitable for Prosecution again
District Prosecutors' Office	December 23, 2009 Non-prosecution was confirmed	May 21, 2013 Mandatory prosecution
Judgment of District Court		April 30, 2013 One year imprisonment with suspension for 3 years
Civil trial		
Date and place	Yokohama District Court on December 27, 2011	Tokyo High Court on September 22, 2011
Compensation for damages	89,198,958 yen for violation of the teacher's obligation to student safety	280 million yen for violation of the instructor's obligation to student safety

The First Serious Judo Accident Tried in Civil and Criminal Courts

An 11-year-old boy 'G' joined a judo school in a city gymnasium at Matsumoto city in Nagano Prefecture and attended judo practice for 1 year and 8 months (table 1, case no. 9). During *randori*, a 41-year-old coach 'H' with a grade of fourth Dan, weighing 83 kg and, 180 cm tall, threw 'G' with *kata-eri-tai-otoshi* (one collar body drop) on 27th May 2008. Although 'G' did not hit his head on the *tatami*, 'G' developed convulsions and lost consciousness. 'G' was transferred to a nearby hospital and diagnosed with ASH. Although 'G' survived urgent craniotomy, 'G' has suffered from persistent severe quadriplegia and higher brain dysfunction. In the civil trial, the Matsumoto branch of the Nagano District Court ruled, on 16th March 2011, that 'H' had to pay 243 million Yen in damages due to his negligence in the safety management of the judo practice. In the appeal trial at the Tokyo High Court, both sides accepted the settlement recommendation to pay 280 million Yen to cover damages.

On the other hand, Matsumoto Police Station of Nagano Prefectural Police sent this case to the Nagano District Public Prosecutors Office on 8th September 2010, on suspicion of professional negligence resulting in bodily injury. However, the public prosecutors decided not to prosecute this case for lack of evidence. Then the parents requested for examination by the Committee for the Inquest of Prosecution on 11th May 2012 and the Committee decided this case was suitable for prosecution. However, the public prosecutors decided again not to prosecute this case. The parents requested again for re-examination by the Committee on 9th January 2013 and the Committee decided again this case was suitable for prosecution. This case became the 8th case of mandatory prosecution in Japan, on 21st May 2013. Finally, the Nagano District Court sentenced the coach on 30th April 2014, to a year of imprisonment with suspension for 3 years. (Table 6, Table 7, Case 1).

Table 7. Criminal of judo accidents

	Case 1	Case 2	Case 3
Date and place of accident	May 27, 2008 Judo school in Matsumoto City gymnasium	November 10, 2010 Private dojo in Osaka city	September 25, 2020 Junior high school dojo In Takarazuka city
Victim: Age, Gender, Length of experience	11-year-old, male 1 year and 8 months 146 cm, 43 kg	6-year-old, male 3 months	a. 12-year-old, male b. 13-year-old, male
Assailant: Age, Gender Degree	41-year-old, male Coach, 4th dan 180 cm, 83 kg	36-year-old, male Coach, 1st dan	50-year-old, male Schoolteacher, 3rd dan
Judo techniques used	Kataeri-Tai-Otoshi	Ashi-barai	a. Kataha-jime, Seoi-nage b. Kesa-gatame, Ashi-barai
Injuries: 1) Diagnosis and treatment 2) Outcome	Acute subdural hematoma with unconsciousness Urgent craniectomy Higher brain dysfunction, Severe quadriplegia	Acute subdural hematoma with unconsciousness died on November 17, 2010	a. Compressive fracture of the 5th thoracic bone b. Neck and leg contusion c. 3 months to heal d. 1week to heal
Criminal charge	Professional negligence resulting in injury	Professional negligence resulting in injury and death	Bodily harm
Final judgment Date and place	1 year imprisonment with suspension for 3 years Nagano District Court on April 30, 2014	A fine of 1 million yen Osaka District Court on October 5, 2011	2 years imprisonment with suspension for 3 years Kobe District Court on February 15, 2021

The First Criminal Trial for a Judo Accident During Practice

On 10th November 2010, a 36-year-old judo coach 'P,' first dan pretending to be fourth dan, tried to train a 6-year-old boy 'Q' and threw 'Q' with *ashi-barai* (foot sweep) many times for 20 minutes in P's private *dojo*. As Q had only 3 months of experience with judo, and without sufficient training in *ukemi*, Q hit his head on the *tatami*, lost consciousness, and died of ASH on 17th November 2010. On 18th May 2011, the Osaka Summary Court ruled that the summary indictment from Osaka District Public Prosecutors Office for professional negligence resulting in death by 'P' was unjust and requested a regular trial. The criminal trial was transferred to the Osaka District Court and the Court sentenced P to a fine of 1 million Yen on 5th October 2011 (Table 7, Case 2).

The First Criminal Charge Against Bodily Harm by a Schoolteacher in a Junior High School *Dojo*

The fourth criminal case of a judo accident occurred on 25th September 2020 in a junior high school judo club. A 50-year-old schoolteacher 'U,' third dan, discovered that 2 students of the judo club ate popsicles from the judo club fridge without permission and 'U' was very angry with these students. 'U' used judo techniques as corporal punishment for these students in the school *dojo*. U choked out one of them and slapped him to wake him up and continued throwing and holding. The student suffered a compressive fracture of the thoracic spine which would take 3 months to heal completely. 'U' used *ne-waza* (ground techniques) to punish the other student, causing neck and leg contusions that took a week to heal completely. 'U' was arrested on suspicion of injuring his students on 13th October 2020 and was charged with inflicting bodily harm. On 15th February 2021, Kobe District Court sentenced 'U' to 2 years imprisonment with suspension for 3 years (Table 7, case 3). The AJJF dismissed 'U' from membership (The Mainichi Shinbun, 2021).

DISCUSSION

Japan's judo population has declined in the past 16 years from 202,025 in 2004 to 121,532 in 2020, with a 60.2% reduction rate. Also, the registered populations of Japanese senior and junior high school students have been declining, from 38,432 to 17,613 and from 48,485 to 24,702, with reduced rates of 45.8 % and 50.9 %, respectively. On the

other hand, serious judo accidents have been broadcast and become an important social issue in the last decade, which might be one of the causes of population decline.

The AJJF established a certified judo coaching qualification system in 2003 to improve coaches' quality and the causes of catastrophic head and neck injuries were studied by medical committee members of the AJJF (Kamitani, Nimura, Nagahiro, Miyazaki & Tomatsu, 2011). However, serious judo accidents have not decreased, and this has given rise to social criticism. JJAVA was established in 2010.

Causative factors of serious head and spinal cord injuries were discussed in civil trials and the courts decided that schoolteachers and coaches were responsible for the following matters because they violated their obligations to student safety:

1. Beginners and/or first-year students without sufficient training in *ukemi* (Table 1, case no. 1, 2, 3, 5 & 14),
2. Obvious physical and skills gaps between opponents (Table 1, Cases No. 9 & 10),
3. Absence of teachers in the *dojo* during practice (Table 1, Cases No. 1, 2, 3, 4, 5, 6, 12 & 14),
4. Teachers' ignorance of head injuries (Table 1, Cases No. 6, 7, 8, 11, 12 & 13).

Repeated concussions and the so-called "second impact syndrome (SIS)" were discussed in courts (Table 1, Cases No. 11 & 12). SIS was first described by Saunders and Harbaugh in 1984. It happens when the brain swells rapidly, shortly after a person suffers a second concussion before syndromes. SIS was believed to be the catastrophic consequence of repeated head injury in sports, however, it has been a controversial disease entity, recognized as a complication of recurrent concussion (Cantu, 1995; McCrory, 2001; McCrory & Berkovic, 1998; McCrory, Davis & Makdissi, 2012; Saunders & Harbaugh, 1984). The fear of this condition has driven many of the current return-to-play guidelines following concussion (Cantu & Register-Mihalik, 2011; Nagahiro & Mizobuchi, 2014). The AJJF also described this important issue of returning to play following concussion in the third version of 'Safety Guidance of Judo' in 2011. We believe that serious judo accidents can be prevented if the AJJF takes the above matters into consideration and operates the certified judo coaching qualification system properly.

On the other hand, the court held teachers not liable for serious judo accidents, for the following reasons:

1. No breach of teachers' obligations for student safety (Table 4, Case No. 23), although there were physical and skills gaps between the 2 students (Table 4, Case No. 18, 19 & 20), or there was a causal relationship between the injury and the teacher's throwing (Table 4, Case No. 17). It is suspected that the scope of teachers' obligations for student safety was decided conservatively in those days,
2. Safety guidelines for the comeback program from concussion had not been established at the time of the accident although the victim showed a typical 'so-called second impact syndrome' (Table 4, Case No. 20),
3. No evidence of violation regarding the obligation of the tournament organizer with regard to the safety management of competitions (Table 4, Case No. 21, 24 & 25),
4. *O-soto-gari* is not a prohibited technique for junior high school students (Table 4, Case No. 22).

Results of criminal trials for serious judo accidents gradually changed after the Yokohama case (Table 1, Case No. 10) and the Nagano case (Table 1, Case No. 9). In these trials, the parents of the victims requested examination by the Committee for the Inquest of Prosecution and the Committee deliberated the legal liability carefully for serious head injuries to the students, caused by the negligence of the judo teacher or coach. The final conclusions were different between the above 2 cases, "unjust non-prosecution" and "suitable for prosecution", respectively. Case No. 9 received a second guilty judgment in the 8 cases of mandatory prosecution and the first sentence of imprisonment in the case of mandatory prosecution in Japan. It might be difficult to distinguish between judo lessons and violence when people involved were wearing judo uniforms and practicing judo at a school *dojo*. Also, people cannot see the difference between punishing, relentless, abusive training and discipline. However, the above 2 cases could trigger a change in prosecution and judicial decisions for judo accidents begin to be affected not only by the third version of 'Safety Guidance of Judo' published by the AJJF in 2011 but also by the impact of social media and a new public movement to appeal the judo accidents to criminal trials. In the light of the fact that people are randomly selected from the general public to participate in the Committee for the Inquest of Prosecution, the legal judgment might have been affected by the impact of social media, as shown in tables 6 and 7. Indeed, the Osaka Summary Court requested the Osaka District Public Prosecution Office to hold a regular trial when the court received the summary indictment for a fatal judo accident in 2010. This case became the first criminal trial for a judo accident in Japan, where the judgment was rendered in October 2011. The year 2010 itself was memorable for the birth of JJAVA and a change in legal and court processes.

On 21st April 2021, a serious judo accident occurred in Taichung, Taiwan. A 7-year-old boy 'W' had attended judo lessons for 2 weeks and developed a severe head injury during judo practice. A 68-year-old coach 'H' instructed some older classmates to throw 'W' repeatedly, who hit his head on the floor several times. Although 'W' complained of a headache and vomited, 'H' continued to throw 'W' more than 10 times until 'W' collapsed un-

conscious on the floor. 'W' was rushed to the hospital and an urgent craniotomy revealed severe intracranial bleeding. Postoperatively 'W' remained in a vegetative state for 70 days and died on 29th June 2021 (BBC news, Taipei, 7th May 2021; BBC news, Taipei, 30th June 2021). After the incident, the Chinese Taipei Judo Federation revealed that 'H' had not acquired a coaching license and used children to commit a crime. Authorities are expected to file charges of injury causing death. There is the same problem of 'fatal judo accidents by a schoolteacher or a coach' in Japan and Taiwan.

Although the AJJF established a certified judo coaching qualification system in 2013, to improve coaches' qualities, serious judo accidents have not been extinguished under the present certified judo coaching qualification system in Japan. It is unfortunately obvious that judo teachers have been the biggest risk factor for serious judo accidents in Japan. In France, only certified teachers can teach sports. Judo diplomas must be recognized by the State in terms of content and certification. There are different diplomas according to the kind of teaching targeted (animation, competition up to regional level, elite level, and technical advisor for France Judo). The teaching of these diplomas is done in sports centers (CREPS, Centre de Resources, d'Expertise et de Performance Sportive) controlled by the Ministry of Sports. In addition, there are also diplomas for benevolent people (3 levels), club assistants, occasional substitute teachers, and temporary authorization in the countryside, for instance. The teaching of these diplomas is organized by France Judo. Now it is time to change the qualification system in Japan while referring to the advanced British and French systems and those of other countries where fatal judo accidents have been prevented (British Judo, 2022; Callan, 2015; https://www.formation-bpjeps.com; Hamada & Cadot, 2015; Judo Canada, 2020).

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Effect of *Kumikata* on Grip Strength and Pinch Strength of Male University *Judoka*

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Abstract: *Judo performance is strongly influenced by the technique and strength of the grip dispute. However, few studies have investigated these factors. The purpose of this study is to investigate the effect of the kumikata on the grip strength and pinch strength in male university judoka.*

The subjects of this study were 37 male university judoka. The grip strength and pinch strength of the judoka were measured. The latter was measured using a dedicated device with the first finger and the thumb as well as the third finger and the thumb. We also conducted a survey on the judo kumikata (right or left style). The grip strength of the tsurite was significantly higher than that of the hikite. The pinch strength between the third finger and the thumb of the tsurite was significantly higher than that of the hikite. The pinch strength between the first finger and the thumb was not significantly different between the tsurite and the hikite.

It was shown that male university judo players have a higher grip strength for the tsurite than for the hikite and the pinch strength for the third finger and thumb is higher for the tsurite than for the hikite.

Keywords: *tsurite; hikite; judo; pinch strength*

Judo is a sport that requires strength, power and endurance of the entire body. In particular, high level *judoka* have been reported to have high anaerobic capacity and upper body strength (Franchini et al., 2011; Little, 1991). Using ultrasound measurements, Kubo et al. (2006) reported that international level *judoka* had larger muscles in the upper arm compared to competitors at lower levels. In this paper, Kubo et al. (2006) speculated that international level *judoka* may be able to maintain an advantageous distance from their opponent, due to their well developed upper arms.

The first contact with an opponent in judo is to grasp the judo uniform (*judogi*). It has been reported that around 50% of judo matches involve the grip dispute for grasping an advantageous site on the opponent (Giovani et al., 2010). Judo performance may be strongly influenced by the technique and strength of the grip dispute. According

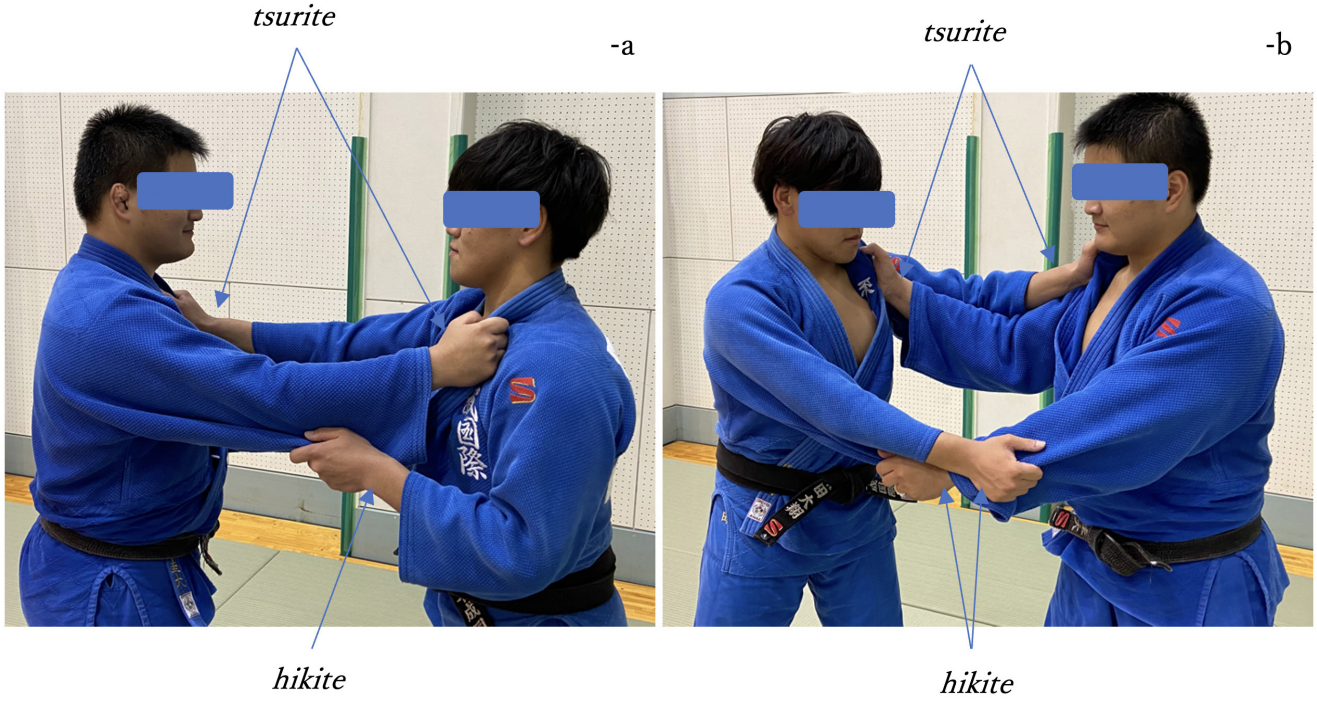

Figure 1. Judo *kumikata* style: *tsurite* and *hikite*
-a: ai-yotsu, same kumi-kata on both players.
-b: *kenka-yotsu*, different kumi-kata on both players.

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to some reports, the grip strength of high level *judoka* is different from that of low level *judoka* (Bonitch-Góngora et al., 2013). However, according to other reports, there is no such difference (Franchini et al., 2005). Hence, there is no consensus on the relationship between *judoka* grip strength and performance levels. Therefore, it is assumed that not only muscle strength but also technology strongly influences the manner of gripping the *judogi*. Here, technology refers to the manner of gripping.

Traditionally, in judo practice, it is desirable to focus mainly on the second, third and fourth fingers when grasping the *judogi*, while the first finger should be relaxed (Sacripanti, 2011). If judo players were to grip the *judogi* as taught traditionally, in this manner, the pinch strength between these three fingers (second, third and fourth fingers) and the first finger may differ. However, following a period of research, no study has been found to verify this technique and the strength. Furthermore, the technique and the strength will also differ depending on the difference between the *tsurite* and the *hikite*. In judo, the *tsurite* is used to grasp the opponent's collar, whereas the *hikite* is used to grasp the opponent's sleeve (Figure 1).

The purpose of this study is to investigate the effect of the *kumikata* on the grip strength and pinch strength of male university judoka.

METHODS

Subjects

The subjects of this study were 37 male university judoka. All *judoka* had been practicing for more than 6 years and belonged to the same university team. Prior to this study, the purpose and content of the study, the risks of participation and the fact that there would be no disadvantages due to withdrawal, were specified in a document and explained verbally. Subsequently, informed consent was obtained. This study was conducted after obtaining the approval of the ethics committee of an international university.

Measurement of body profile and survey of *kumikata*

Height and weight measurements and *kumikata* (right group, left group) surveys were conducted. Height was measured in units of 1 mm using a digital height meter. Bodyweight was measured in units of 0.1 kg using a digital scale.

Measurement of grip strength and pinch strength-

Maximum grip strength was measured using a dedicated isometric grip strength measuring device (Takei Scientific Instruments Co., Ltd. Grip-D). While being measured, participants were instructed that the hand should not be in contact with the side of the body. The maximum pinch strength was measured using a dedicated measuring instrument (SAKAI Medical Co., Ltd. MT-140).

The pinch strength between first finger and the thumb and that between the third finger and the thumb were measured (Figure 2). According to the coaching method, it is desirable to grip with three fingers on the little finger side (Sacripanti, 2011).

Figure 2. Pinch strength measurement

Hence, we measured the pinch strength with the thumb and the third finger, which is the middle finger among the three and was considered as the representative finger. In addition, we measured the pinch strength between the first finger and the thumb. It is desirable to grip with the first finger relaxed (Sacripanti, 2011). Muscle strength was measured with both left and right hands. All the muscle strength measurements were taken twice, after sufficient practice, and the average value was used for the subsequent analysis. The calculated values were analysed separately for the *tsurite* and *hikite*.

Statistical analysis

The grip strength and pinch strength for each of the *tsurite* and *hikite* hands were tested for differences in means using a paired t-test. A P-value of <0.05 was considered statistically significant and all the P-values were two-sided. All the statistical analyses were performed using SPSS Statistics ver. 23.0 (IBM Japan, Ltd., Tokyo, Japan) software.

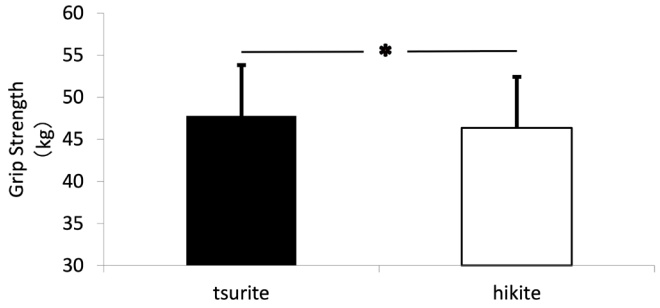
RESULTS

The average age, height and weight of the *judoka* were 18.9±1.1 years, 1.70±0.06m, and 80.1± 13.5kg. Regarding the judo *kumikata*, the right-style group included 29 participants and the left-style group included 8 participants. The grip strength of the *tsurite* was significantly higher than that of the *hikite* (Table 1, Figure 3). The pinch strength between the first finger and the thumb was not significantly different between the *tsurite* and the *hikite* (Table 1, Figure 4-a). The pinch strength with the third finger and the thumb was significantly higher for the *tsurite* than for the *hikite* (Table 1, Figure 4-b).

Table 1. Grip strength, first-pinch strength, and third-pinch strength of *tsurite* and *hikite*

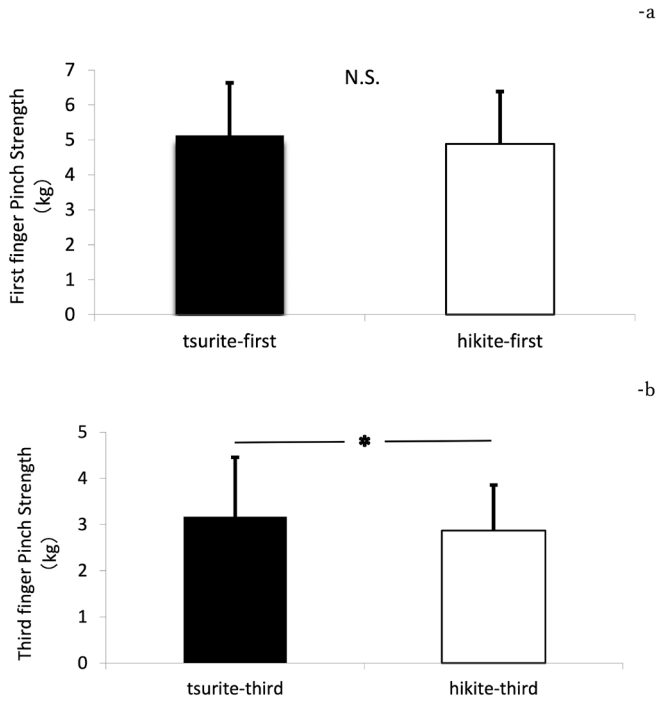
	Tsurite	Hikite	p-value
Grip Strength (kg)			
mean ± sd	47.78±6.1	46.35±6.1	0.048*
range (min-max)	32.0-59.5	28.5-60.0	
standard deviation			
First-Pinch Strength (kg)			
mean ± sd	5.12±1.5	4.88±1.5	0.10
range (min-max)	2.80-9.25	1.45-8.00	
Third-Pinch Strength (kg)			
mean ± sd	3.16±1.3	2.86±0.9	0.040*
range (min-max)	1.45-7.15	1.40-5.45	

* p < 0.05; First-Pinch Strength: Pinch strength between the first finger and the thumb. Third-Pinch Strength: Pinch strength between the third finger and the thumb.



* p < 0.05

Figure 3. Grip strength of *tsurite* and *hikite*



* p < 0.05

Figure 4. First finger and third finger pinch strength of *tsurite* and *hikite*

-a: First finger pinch strength is the strength of the pinch between the first finger and the thumb.
-b: Third finger pinch strength is the strength of the pinch between the third finger and the thumb.

DISCUSSION

It is thought that this is the first study investigating grip strength and pinch strength, which are considered important for the judo grip dispute. It is believed that for judo athletes, gaining an advantage in the grip dispute has a significant impact on their chances of winning or losing a match.

Although high grip strength is considered necessary for the judo grip dispute, previous studies have shown that there is no consistent view regarding grip strength and judo performance (Bonitch-Góngora et al., 2013; Franchini, et al., 2005). In this study, it was found that the grip strength of the *tsurite* hand is higher than that of the *hikite* hand (Table 1, Figure 3). This is the first study to report differences in grip strength between the *tsurite* and the *hikite*. The fact that the grip strength measurements in previous studies did not consider the *tsurite* and *hikite* hands (Franchini et al., 2018; Honorato et al., 2021) may be related to inconsistent results. Whereas some previous studies on grip strength in judo athletes have analysed the grip strength separately for dominant and non-dominant hands (Honorato et al., 2021), this study did not analyse dominant and non-dominant hands because the focus was to identify the differences related to the grip strength between the *tsurite* and *hikite* hands.

The *hikite* grips the opponent's sleeve, whereas the *tsurite* grips the opponent's collar (Figure 1). Because the *tsurite* grips the opponent's collar, which is close to the opponent's torso, it is necessary to control the opponent at all times. In addition, during *kenka-yotsu* style (Figure 1-b), there are many cases in which both parties use the *tsurite* grip but fail to use the *hikite* grip (subject to penalties). Therefore, it is conceivable that during judo practice, the *tsurite* may account for more time than the *hikite* in maintaining a constant exertion of force and gripping the *judogi*.

With respect to the pinch strength, the pinch strength of the third finger of the *tsurite* was higher than that of the *hikite* (Table 1, Figure 4-b). As for the pinch strength of the first finger, there was no statistically significant difference between the *tsurite* and the *hikite*, although the p-value was 0.1 (Table 1, Figure 4-a). It was inferred that during judo practice and matches, the grip strength of the *tsurite* is loaded on the fingers, especially near the third finger. In judo teaching methods, it is recommended that when gripping an opponent's *judogi*, the grip should be firm with the three fingers on the little finger side and the first finger should be relaxed (Sacripanti, 2011). It was inferred that the difference in this study was due to this difference in the daily gripping technique, especially in the higher pinch force of the third finger on the *tsurite* hand side.

A previous study on muscle hypertrophy reported that the training volume is a significant factor influencing muscle hypertrophy (Schoenfeld et al., 2019). Although this study did not measure the muscle mass related to the grip strength and pinch strength, it was inferred that in the tsurit, and the pinch strength of the third finger of the tsurite, a certain level of muscle force is constantly exerted, causing muscle hypertrophy and resulting in increased muscle strength compared to the *hikite*.

In this study, we measured only the muscle strength with grip and pinch. Muscle strength is proportional to the physiological muscle cross-sectional area (Maughan et al., 1984). Chishaki et al. (2022) reported that in middleweight judoka, the forearm muscle groups of athletes at higher levels of competition were thicker than those at lower levels of competition. Kubo et al. (2006) reported that high-level judo athletes have thicker bicep muscles than low-level athletes. However, both Chishaki's and Kubo's studies measured only the muscle thickness, using ultrasound (not the muscle strength). Future studies on grip and pinch strength in judo athletes should include the measurement of the related muscle mass using Magnetic Resonance Imaging and ultrasound methods, in addition to the measurement of the grip strength and pinch strength.

CONCLUSION

It was shown that male university *judoka* have a higher grip strength for the *tsurite* than for the *hikite* and the pinch strength for third finger and the thumb is higher for the *tsurite* than for the *hikite*. The results of this study suggest that the manner in which judo athletes perform the *kumikata* (free sparring) during their daily practice affects their grip strength on the *tsurite* and pinch strength on the third finger. It is not clear whether training to increase the grip strength on the tsurite, especially the pinch strength on the little finger side, would increase the ability to engage in the judo grip dispute.

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The Effects of Judo Rule changes on Contestants' Performance: Paris Grand Slam Case Study

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Abstract: *The International Judo Federation (IJF) has changed the rules many times to protect athletes, increase the intensity of the contest, provide equal opportunities for all athletes, and encourage greater media coverage. This research aims to determine the effects of changes in judo rules on contestants' performance via time, techniques, penalty distribution and attack efficiency indexes at the Paris Grand Slam between 2020 and 2022. The sample is comprised of (n=295) male fights from Paris GS 2020 and (n=152) female fights from Paris GS 2022, as well as (n=427) female fights from Paris GS 2020 and (n=175) male fights from Paris GS 2022 encompassing contestants in all seven weight categories for each gender. The results have shown some specific differences in female and male senior contestants in individual penalties and in senior contestants' technique subgroups. However, regarding the overall attack index, no specific effects were discovered, as well as the attacking efficiency index in individual throwing and ground techniques. For senior female contestants, yoko shiho gatame, uchi mata and ōuchi gari have remained the top three most efficient techniques but exhibited different efficiency indexes in the two competitions. In senior male contestants, the most successful techniques in Paris GS 2020 were seoi nage, sumi otoshi and uchi mata, while in Paris GS 2022 they were sode tsurikomi goshi, ōuchi gari and uchi mata. Based on the results, one can notice specific effects on contestants' performances, indicating that coaches and contestants must adapt quickly to the new rules during training and competitions.*

Keywords: *combat sports; sports regulation; gender; transformation; analysis; efficiency*

Rules are regulations that determine all necessary conditions to be met so contestants can compete. In addition, rules determine specific relationships between participants at competitions (athletes, referees, coaches, public), their relationships to the competition area and equipment, and adaptation to the fight period (Arias, et al., 2011). Angus (2006) highlights that the rules in judo are important as they protect contestants from getting hurt, provide equal opportunities for all contestants to perform their best and with the greatest intensity during fights, and present a friendly sport for the audience. Today's commercialisation and globalisation force the International Judo Federation (IJF) to follow the newest trends present in every segment of life. Factors significantly influencing changing judo rules are media influence, competition attractiveness, technological development and contestants' ability at different competition levels (Lampe, 2015).

Due to the development of athlete performance and the vision of coaches, IJF refereeing rules are seen in an 'endless' document which aims to keep the essence of *Kōdōkan* judo within modern-day judo (Lascau, 2022). Another interpretation is that judo rules not only protect athletes and sport in general but also promote it as a dynamic and attractive sport to the public and media (Barta, 2022). For an easier understanding of the development of judo rules after the Second World War, when judo started to be widely recognised, a chronological overview is presented (Brousse & Matsumoto, 2002; Hargrave, 2003; Hoare, 2009; Lampe, 2015; IJF, 2008,2009,2010, 2013,2015,2017,2018, 2020, 2022; Bareto, et al., 2022). In 1950 leg and neck locks were forbidden. In 1957 three weight categories were introduced: -68kg, -80kg and +80kg. In 1960 standardised referee terminology was introduced in the Japanese language along with referee uniforms. In 1965 new weight categories were introduced -63kg, -70kg, -80kg, -93kg, +93 kg and an open category. In 1967 five new weight categories were introduced along with the open category. For *hajime* at the beginning of the fight, a hand gesture was no longer used.

In 1972 a 1 metre wide red boundary line was introduced to indicate a warning zone, followed by a protective area 2.5 metres wide. Additionally, the scoreboard for points and penalties was introduced. The role of assistant referees became more prominent, as they were given the right to oppose the main referee in cases of noticing mistakes or disagreements when assigning points. In 1974 *yūkō* and *kōka* were introduced as mid-level technical points, with *shidō* and *chūi* as mid-level penalties. Before these changes, referees had to remember all techniques and points during the fight. The duration of contests was extended from six to eight minutes and the semi-final and final fights to ten minutes. In the case of a tie, the winner would be the contestant with the lower number of penalties. In 1975 kneeling was no longer allowed in the

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case of *keikoku* penalty or while fixing the judogi. In 1976 rules on penalties were more clearly defined, penalties were standardised for forbidden actions. Additionally, falling backwards with the opponent clinging to one's back assigns higher technical scores for the opponent with a potential risk of neck and head injury. While transitioning from *newaza* to *tachi waza*, the fight pauses.

In 1977 weight categories for men were: -60kg, -65kg, -71kg, -78kg, -86kg, -95kg, +95 kg. In 1978 a throwing technique in which the performer 'head dives' into the tatami was punishable by disqualification (*hansoku-make*) due to the potential for head, neck and spinal injuries. Medical assistance for a contestant was allowed for five minutes to help with the injury. The rule by which, in the case of a tie, a contestant with fewer penalties was awarded victory, was abandoned. Again, referee voting to announce victory was introduced (*hantei*). In 1979 eight weight categories were introduced: -60kg, -65kg, -71kg, -78kg, -86kg, -95kg, +95kg and open category. *Jūdōgi* control was introduced for all, prior to competition, with additional rules for tidying long hair and wearing the correct colour of t-shirt for female contestants. Also, a double repechage system was introduced, which enabled those defeated in the first round to be able to take third place after being victorious in the repechage. In 1992 women's weight categories were introduced for the first time at the Olympic Games, in Barcelona: -48kg, -52kg, -56kg, -61kg, -66kg, -72kg and +72kg. In 1997 the weight categories for male seniors were changed to: -60kg, -66kg, -73kg, -81kg, -90kg, -100kg, +100kg. For female seniors the weight categories were adapted to: -48kg, -52kg, -57kg, -63kg, -70kg, -78kg, +78kg. Additionally, wearing blue and white *jūdōgi* was introduced so the contestants would be easily recognisable on television. The first contestant called wore blue *jūdōgi*, while the second wore white.

In 2003, in the case of a tied result, golden score was introduced and this overtime period was limited. If the scores were still tied, the referee would decide the winner by *hantei*/decision. In 2006 the system of penalties changed to include only two penalties: minor (*shidō*) and grave penalty (*hansoku make*). In 2007 the red boundary line was eliminated so that the contestants' area was divided into only two parts: a contest area (from 8X8m to 10x10m) and a safety area at least 4 metres wide. Where two or more adjoining contest areas were used, a common safety zone was allowed, to satisfy the minimum distance of 4m between them. In 2008 the lowest technical score was removed (*koka* - 3 points). In 2010 the International Judo Federation (IJF, 2009) made a decision to forbid all throwing techniques with gripping below the belt and to disqualify contestants in cases against the rule (*hansoku make*). The golden score period was shortened from 5 to 3 minutes. *Koka* (3 points) was eliminated and *shido* penalties were scored differently: *shidō* (no result), *shidō* = *yūkō*, *shidō* = *waza ari* and *shidō* = *ippon*. Scoring in *osaekomi* situations was as follows: 15-19 seconds = *yūkō*, 20-24 seconds = *waza ari*, and 25 seconds = *ippon*. *Shidō* could be given for: avoiding holding an opponents' *jūdōgi*, taking a defensive stance or unconventional grip without any immediate attack, preventing the opponent from holding a *jūdōgi* for longer than 5 seconds, interlocking the opponent's fingers from one or both hands, pulling the opponent downwards to the floor with no intention to throw, a false attack or deliberately loosening one's own *jūdōgi* or belt without the referee's permission. In 2010, Computer Assisted Refereeing (Care) System technology was introduced to start the analysis of referees' decisions and to improve objectivity. Three referees remain in the contest area and in the case of a dispute, it would be analysed by a referee commission. In 2011 the rule of wearing blue and white *jūdōgi* was changed: the first contestant would wear the white *jūdōgi* and the second one a blue *jūdōgi* (white *jūdōgi* is traditional and the first *judoka* called to a contests are usually the best competitors). In 2013 there was only one referee on the tatami, while two assistant referees were sitting at the table with video surveillance, staying in contact with the main referee via radio communications. All techniques involving grabbing the legs in *tachi waza* were forbidden. A referee deciding on the winner (*hantei*) was revoked and the golden score period was limitless.

The time for performing a pinning technique (*osaekomi waza*) was reduced to 20 seconds for *ippon*, 15-19 seconds for *waza ari* and 10-14 seconds for *yūkō*. In cases where *judoka* initiated *osaekomi waza* within the contest area and later went outside, they were considered valid. Penalties no longer brought extra points, as in 2013, but if the fight ended as a tie, an athlete with the higher penalty points would lose. New penalties were awarded for different inappropriate grips (*kumikata*). In 2015 the fight lasted for 5 minutes. *Jūdōgi* checks ensured *jūdōgi* sleeves covered the entire arm, including wrists, unlike before when there was 5 cm tolerance allowed. The weigh-in was the day before the competition but athletes were weighed again on the day of the contest. In this second weigh-in, athletes were not allowed to exceed their weight category by more than 5% (IJF, 2015). Additionally, in 2015 an update to athletes' entry to the competition arena was introduced where the venue speaker(s) announced the players as they entered the FOP and also the result of the contest. If the athlete entry is from the left of *jōseki*, the first athlete called is the one in the blue *jūdōgi*, followed by white. If they enter from the right, the first athlete is called in the white *jūdōgi*, followed by blue *jūdōgi*, (IJF, 2015).

In 2017 the fight duration was shortened to 4 minutes for both men and women. Additionally, *yūkō* was eliminated from the scoring and only *ippon* and waza ari scores remained. Situations that once were declared *yūkō* were now *waza ari*, and two *waza ari* were no longer regarded as *ippon*. For *ippon* in *osaekomi*, it was necessary to hold for 20 seconds and for *waza ari* from 10 to 19 seconds. *Shidō* penalties were reduced to 3 per person, per fight (3 *shidō* = *hansoku make*) and it was possible to apply the points and penalties simultaneously. The winner was de-

termined by either a technical result or the greater *shidō* accumulation. While still in a position to get the point, *judoka* had the opportunity to remain in a gripping exchange for up to 45 seconds without penalties. All unconventional gripping positions (pistol grip, pocket grip, belt grip, one side grip, cross grip) were allowed only with an immediate attack, otherwise an athlete would be penalised by *shidō*. The first leg grip in *tachi waza* was punishable with a *shidō* and the second with *hansoku make*. Leg grips were allowed in *newaza* (both athletes should have both knees on the ground) and if any technique which was initiated while standing, it was terminated. Athletes outside the contest area with one leg would be penalised if there was no immediate attack or if they did not return to the contest area. In cases when an athlete initiated *osaekomi waza* within the contest area and then left this area while the opponent could evade his immobilisation in a continuous movement, this action would be awarded points. Each situation of falling while clinging to one's back to avoid the opponent from getting points is considered an *ippon*. In situations where a *sutemi waza* technique was applied as a counterattack, the *judoka* who falls first on to the mat could not score unless there was clear control of the movement during the throw. Since 2018 two *waza ari* were equivalent to *ippon* (*waza ari awasete ippon*) and *shidō* no longer decided the winner in golden score. In order to get *ippon* for a specific throwing technique, 4 criteria had to be met: speed, force, landing on the back and controlled until the end of the landing. The use of the head to avoid falling was penalised with *hansoku make*, except in cases where the action was unintentional, which happens with throws which are hard to avoid; one hits their head on the floor (*seoi otoshi, sode tsurikomi goshi, koshi guruma*). Grabbing a leg or *jūdōgi* trousers was penalised with *shidō*. In the case of performing *shime waza* by using excessive force over-stretching the opponent's leg, the fight would be interrupted to come closer to the opponent's head. If there was no score and a sustained lack of action by both athletes, it was possible to punish them with a double *hansoku make* and both athletes would be disqualified from the competition.

In 2020 if there were throw interruptions or if it was performed on one side of the body, it could only be considered as *waza ari*. The *seoi nage* technique became a part of the rule that an athlete was not to be penalised in the case of unintentionally hitting their head on the mat during the throw. *Osaekomi waza* performed with arms and legs around the neck, without control of the opponent's arms or shoulders, had to be stopped. Performing the *kata sankaku* manoeuvre with the intention to throw the opponent would be peanalised with *hansoku make* and if it was initiated in *newaza*, the fight had to be stopped.

By the beginning of 2022, the International Judo Federation presented new judo rules for the Olympic cycle 2022-2024 (IJF, 2022), by adopting 12 decisions. The advantage of the IJF rules update was the continuity of the action, landing and applying judo techniques in an accepted *gokyō* system. This also applied to explanations for *waza ari*, new penalties, the possibilities of skilful *kumikata* changes, and the safety of *judoka*, especially when using their heads during throwing techniques (Messner, 2022).

The effects of rules changing in judo from the technical and tactical aspects, points, penalties, fight dynamics, grips (*kumikata*), and the performances of both genders at different competition levels were subjected to a significant amount of research (Boguszewski, 2011; Adam, et al., 2011; Franchini, et al., 2013; Gonçalves et al., 2015; Miyake et al., 2016; Ceylan & Balci, 2017; Calmet et al., 2017; Callan & Claes, 2018; Calmet et al., 2018; Katicips et al., 2018; Dal Bello et al., 2019; Stanković et al., 2019; Pan et al., 2021; Brabec et al., 2021; Kajmović et al., 2022 and Barreto, et al., 2022).

The Paris Grand Slam (formerly 'Tournoi de Paris Ile-de-France'), the beginnings of which date back to 1971, is regarded as one of the most prestigious grand slam competitions. The IJF recognised it as a Super-A tournament and it changed its name in 2002. The Paris Grand Slam has also been subjected to investigations re the effects of rule changes in judo, such as the research by Katicips, et al. (2018), who analysed the effects of rule changes at the Paris Grand Slam, comparing three editions (2011, 2016 and 2017). Therefore, the Paris Grand Slam is considered the event where the effects of rule changes at the highest level are most evident and tested. Thus, this research aims to determine the effects of judo rule changes on competitors' performances with specific reference to time, techniques, penalty distribution and attack efficiency indexes at a Paris Grand Slam.

METHODS

Sample

Video analysis of contests was used throughout the study. The sample included the following gender and category breakdown:

In women's categories, n=295 for Paris GS 2020 and n=152 for Paris GS 2022. The distribution of analysed contests by weight category was: -48kg (n=37), -52kg (n=43), -57kg (n=53), -63kg (n=44), -70kg (n=45), -78kg (n=31), +78kg (n=42), for Paris GS 2020. At the 2022 edition it was: -48kg (n=19), -52kg (n=21), -57kg (n=29), -63kg (n=25), -70kg (n=23), -78kg (n=18), +78kg (n=17).

In men's categories, n=427 for Paris GS 2020 and n=175 for Paris GS 2022. The distribution of analysed contests by weight category was: -60kg (n=46), -66kg (n=69), -73kg (n=79), -81kg (n=73), -90kg (n=64), -100kg (n=53), +100kg (n=43), for Paris GS 2020. At the 2022 edition it was: -60kg (n=21), -66kg (n=25), -73kg (n=34), -81kg (n=26), -90kg (n=26), -100kg (n=24), +100kg (n=19).

Sample Variables
Variables used in the analysis were:

1. Fight duration (time)
2. How the fight ended (with a decision before regular time, with a difference in positive scores at the end of the 4-minute contest duration, or in golden score)
3. Points and penalties
4. Individual distribution of penalties
5. Overall attack efficiency index in *nage-waza* and *newa-za* (Sa)
6. Subgroups of judo techniques
7. Attack efficiency index (AEI) of each individual throwing and grappling technique (*Kawamura & Daigo, 2000*).

Data Collection Method
The data was collected using notational analyses of video recordings of contests from the Paris Grand Slams of 2020 and 2022, taken from the platform https://judobase.ijf.org. Each variable was assessed by two observers who had been watching for: circumstances which forced a referee to assign points or penalties, movements of referee's hands when awarding points or penalties, the scoreboard which highlighted the duration of the match. Observers met the following criteria: twenty years of competitive judo, coaching experience, minimum grade of 4th dan, referee, judo researcher.

Ethical Issues
All the data used for analysis was taken from the official website (www.judobase.org) of the IJF. The data was obtained in a secondary form and not generated by experimentation. Additionally, personal identification or countries of the athletes whose matches were analysed were not reported. Therefore, there is no ethical issue with using or interpreting the data (Morley & Thomas, 2005, Calmet et al., 2017, Ceylan et al., 2021).

Reliability
For reliability purposes, observers' analysis of final block contests for female and male contestants (final, bronze medal contests, semi-finals and two repechage fights) were compared. In total, seven fights for each weight category were included. The reliability (Cohen Kappa) between two observers regarding female competitors was .970 and for male competitors it was .954. This indicated the high level of inter-rater reliability between observers.

Statistical Data Analysis
Data was analysed with the help of the T-test for independent samples and Pearson's chi-squared test (Field, 2005). For the analysis of the strength of the relationship, Cramer's V test was used. For all the tests a significance of $p < 0.05$ was considered. Data was processed using SPSS 22.0 Premium (IBM Corporation, Armonk, USA).

For determining the overall efficiency index (Sa) between the throwing techniques and groundwork techniques for female and male senior competitors, the formula (1) from Adam, Smuraj, & Tyszkowski, (2011) was used.

$$Sa = M/n \qquad (1)$$

Where M = total number of points, n = the number of contests.

The attack efficiency index (AEI) for each throwing technique performed successfully and each groundwork technique performed successfully was calculated with the help of formula (2) by Adam, Klimowicz & Pujszo (2016).

$$AEI = 7 \times M + 10 \times M / n \qquad (2)$$

In which case:
7 points = *waza ari*
10 points = *ippon*
M = the number of effective attacks
n = the number of analysed fights.

Results
T-test results indicated that there are no statistically significant differences between the duration of fights in (Figure 1) Paris GS 2020 female contestants (M=3.02; SD= 1.71; Paris GS 2022 M=3.36; SD= 2.06; t=-1.846, df= 436, p=.066) and in (Figure 2) male contestant Paris GS 2020 (M=3.13; SD= 1.71; Paris GS 2022 M=3.41; SD= 1.97; t= -1.764, df= 593, p=.078).

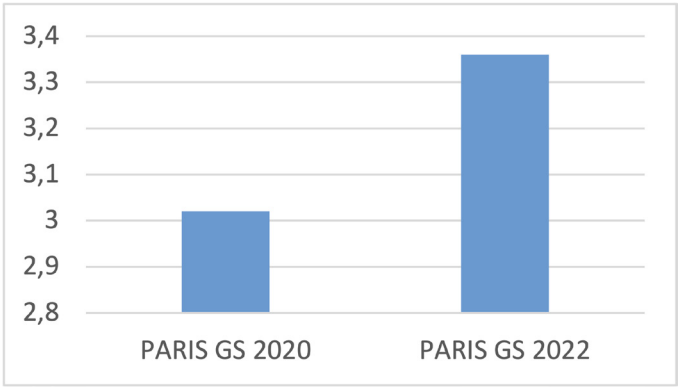

Figure 1. Fight time in minutes - female

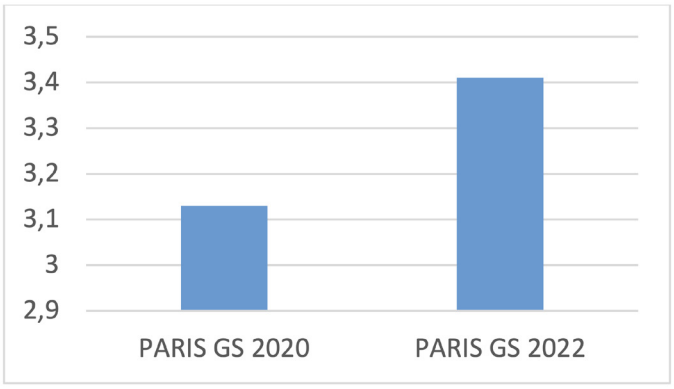

Figure 2. Fight time in minutes - male

The results of the Paerson Chi-square test indicated significant differences (Figure 3) in the way female competitors' contests ended (χ^2 =6.29, df=2, Sig=.043, Cramer's V=.120, Sig=.043) while for male competitors (Figure 4) these differences were not present (χ^2 =2.63, df=2, Sig=.268, Cramer's V=.067, Sig=.268).

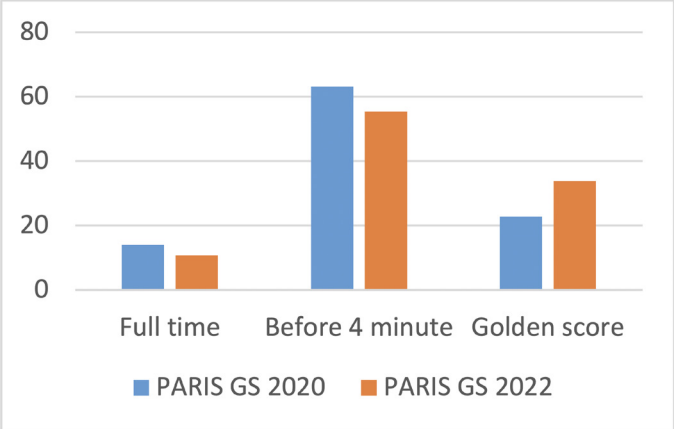

Figure 3. End of the fight - female

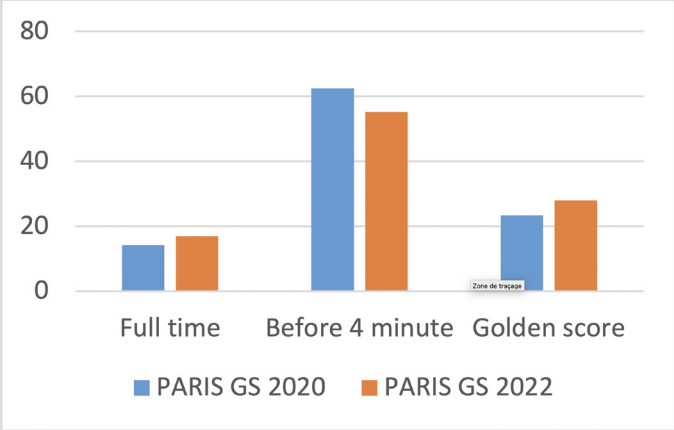

Figure 4. End of the fight - male

The results of Paerson Chi-square test have indicated no differences (Figure 5) in achieved points and penalties with female competitors (χ^2 = 7.467; df= 6; Sig.= .280; Cramers V= .075: Sig.= .280) or male competitors (Figure 6) (χ^2 = 10.744; df=6; Sig.= .097; Cramers V= .074: Sig.= .097).

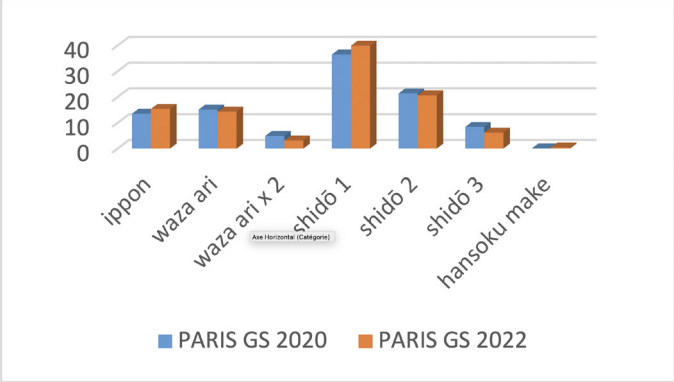

Figure 5. Points and penalties – female

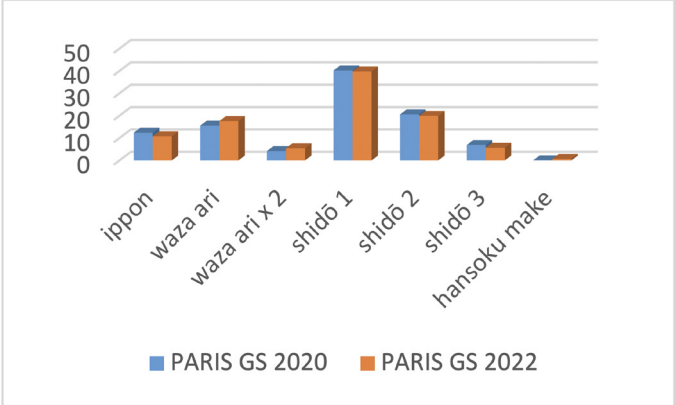

Figure 6. Points and penalties – male

Pearson chi-square test indicated that there are significant statistical differences (Figure 7 and Figure 8) in the variables of individual penalties in female competitors (χ^2 =65,6; df: 19; Sig.= .000; CramerS V= .271; Sig.= .000) and male competitors (χ^2 =80,1; df: 21; Sig.= .000; CramerS V= .246; Sig.= .000).

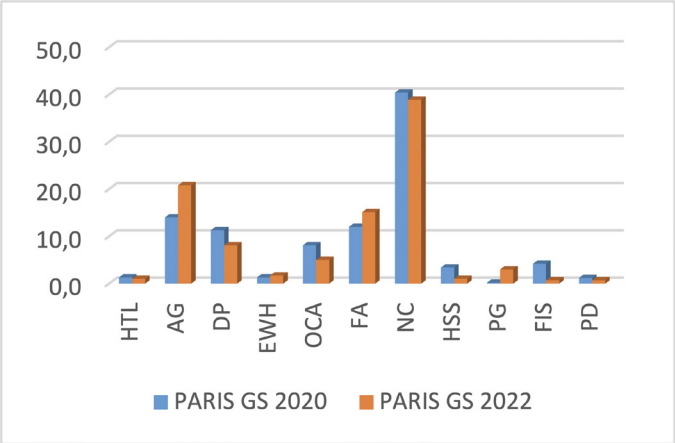

Figure 7. Individual penalties - female

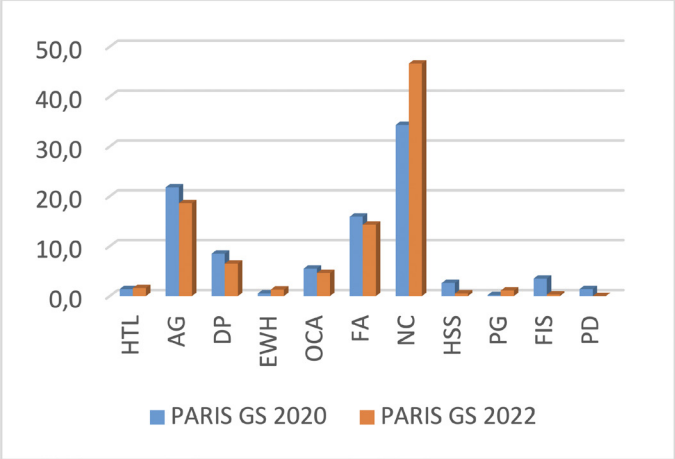

Figure 8. Individual penalties - male

Legend: HTL- Hold Trouser Leg, AG - Avoid Grip, DP - Defensive Posture, EWH - Escape With Head, OCA - Outside Contest Area, FA - False Attack, NS - Non Combativity, HSS - Hold Same Side, PG - Pistol Grip, FIS - Fingers In Sleeve, PD - Pull Down

T-test results for independent samples have indicated that there are no statistically significant differences in the AEI of female competitors (Figure 9) in *nage waza* (t=-1.333, df= 69, p=.187) and *newaza* (t= -1.333), df= 20, p=.970) as well as in the *nage waza* of male competitors (Figure 10) (t= -1.212, df= 74, p=.229), while in *newaza* (t= -2.073, df= 25, p=.049) statistically significant differences were observed.

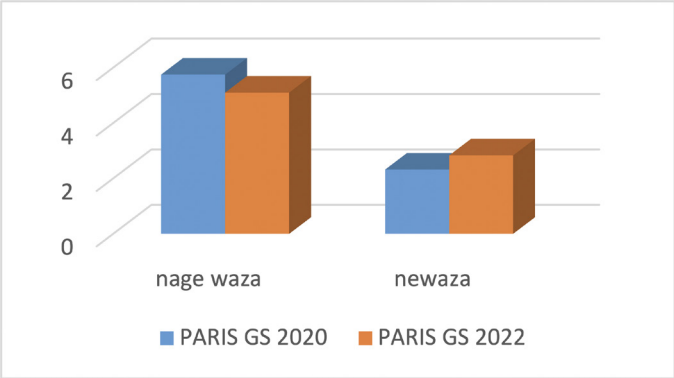

Figure 9. Attack efficiency index in *nage waza* and *newaza* (Sa) - Female

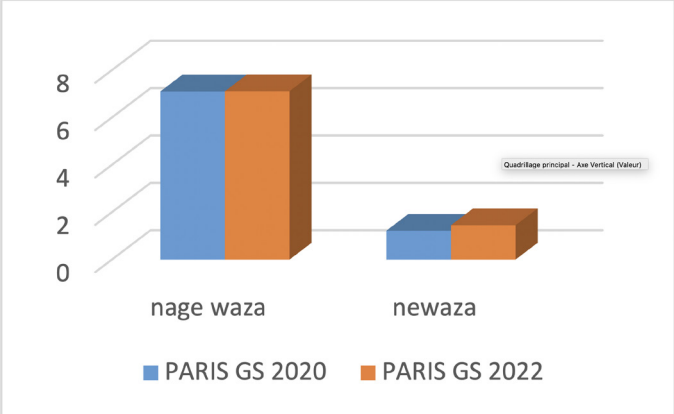

Figure 10. Attack efficiency index in *nage waza* and *newaza* (Sa) - Male

Pearson Chi-square test results did not show any significant differences (Figure 11) in variable subgroup of throwing techniques and groundwork techniques in female competitors ((χ^2 = 12.680; df= 7; Sig.= .080; Cramers V= .169: Sig.= .080), while in male competitors (Figure 12) there were statistically significant variables (χ^2 =15.137; df=7; Sig.=.034; Cramers V= .153: Sig.= .034) in subgroups of throwing techniques and groundwork techniques.

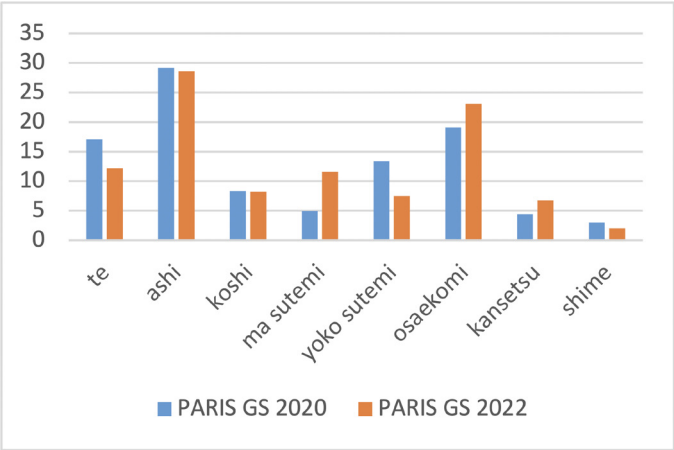

Figure 11. Subgroups of judo techniques - Female

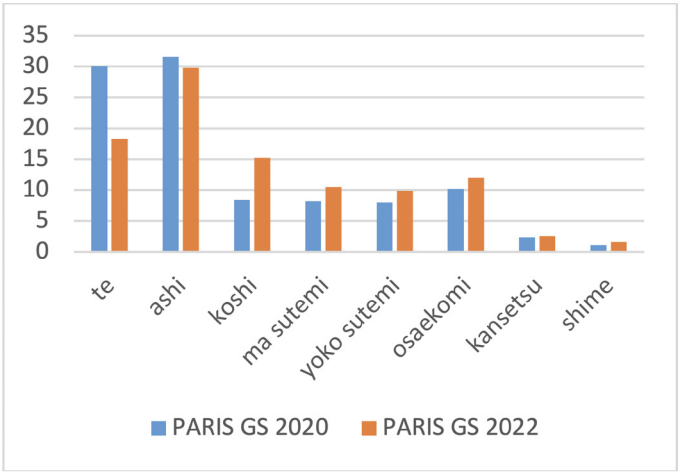

Figure 12. Subgroups of judo techniques - Male

Table 1 indicates the attack efficiency index (AEI) for individual throwing and grappling techniques performed by female and male competitors. For senior female competitors in Paris GS 2022, two techniques have proven to be most efficient: *yoko shihō gatame*, where AEI has risen in 2022, and *uchi mata*, where AEI has drastically risen in 2022. Õ*uchi-gari* has retained the same AEI level, however, in 2022 the groundwork technique *jūji gatame* has taken a high third place.

Table 1. Attack Efficiency Index (AEI) of individual throwing and grappling techniques

FEMALE				MALE			
Paris GS 2020	AEI	Paris GS 2022	AEI	Paris GS 2020	AEI	Paris GS 2022	AEI
YSG	0.75	YSG	0.88	SON	0.67	STO	0.69
UMA	0.49	UMA	0.87	SOT	0.62	OUG	0.56
OUG	0.46	JGT	0.52	UMA	0.60	UMA	0.54
SOT	0.41	SON	0.49	OUG	0.52	SUG	0.47
JGT	0.40	OUG	0.45	KSK	0.38	OGO	0.47
SMK	0.34	KKE	0.37	ISN	0.35	SOT	0.45
ISN	0.32	SUG	0.31	KUG	0.33	KSK	0.44
OSG	0.30	KSH	0.30	STO	0.32	KUG	0.37
KKE	0.27	TNG	0.29	UNA	0.28	ISN	0.35
KKS	0.27	TNO	0.22	SUG	0.26	KSH	0.29
SON	0.26	YOT	0.22	TOS	0.23	JGT	0.28
KSK	0.25	KKS	0.22	YSG	0.22	YSG	0.27
HRG	0.25	OGO	0.20	DAB	0.22	TNG	0.27
KUG	0.25	OSG	0.20	JGT	0.21	UMM	0.25
TNG	0.21	SOO	0.18	KGU	0.21	KKE	0.25
OSM	0.20	AGU	0.18	KKE	0.18	UMK	0.19
TNO	0.20	UMK	0.15	UMK	0.18	SON	0.17
OEJ	0.20	UGO	0.15	KKS	0.16	KGU	0.17
TSG	0.17	STO	0.15	SMK	0.15	SOO	0.17
STO	0.16	KEG	0.13	TGO	0.15	OSO	0.17

Legend: Legend: YSG yoko shihō gatame, UMA uchi mata, OUG ōuchi gari, SOT sumi otoshi, JGT jūji gatame, SMK soto makikomi, ISN ippon seoi nage, OSG ōsoto gari, KKE kuzure kesa gatame, KKS kuzure kami shihō gatame, SON seoi nage, KSK kosoto gake, HRG harai goshi, KUG kouchi gari, TNG tomoe nage, OSM ōsoto makikomi, TNO tani otoshi, OEJ okuri eri jime, TSG tate shihō gatame, STO sode tsurikomi goshi, SUG sumi gaeshi, KEG kesa gatame, TOS tai otoshi, KSH kami shihō gatame, YOT yoko otoshi, OGO ōgoshi, SOO seoi otoshi, AGU ashi guruma, UMK kouchi makikomi, UGO uki goshi, OSO ōsoto otoshi, UNA ura nage, DAB deashi harai, KGU kata guruma, TGO tsuri goshi, UMM uchi mata makikomi.

DISCUSSION

This research aimed to define the effects of changes in judo rules on competitors' performances between the Paris Grand Slam 2020 and that of 2022. The fight ratio percentage was the most impacted by, with female contestants 66% vs. 34% Paris GS 2020 vs. 2022, and male contestants at 70.9% at Paris GS 2020 vs 29.1%. The first reason is that 2020 was an Olympic year and the contestants were gathering points for the Olympic Games. The second reason was the COVID-19 pandemic. Due to these factors, a decreased number of fights and participants was noted in the 2022 event.

The average contest duration analysis showed no significant differences between female and male contestants. A detailed analysis of 12 decisions, which brought forth the changes in the rules, revealed that the time component was not impacted in any of them. Doppelhammer & Stöckl (2020) retrieved similar data on the effects of rule changes in 2017 and 2018 in regards to the duration of the fights and no differences were noticed between the 2015 Astana World Championships and the 2018 Baku World Championships. Gonçalves, Monteiro, Chambel, & Cardoso (2015) analysed the effects of rule changes in judo between the world championship of 2013 and 2014, where the duration of contests for women was reduced from 5 to 4 minutes and new penalties were introduced (*shidō*). The analysis suggested that the overall time (including breaks) of fights (in all weight categories) was reduced from 273 to 233 seconds. Likewise, the real-time (without a break) was reduced from 199 to 179 seconds.

Analysing the awarded points and penalties in senior female contests, one can state that there was an increase in *ippon* points awarded but a decrease in *waza ari* and *waza ari awasete ippon*. This could be interpreted as there being more direct attacks performed and scored by *judoka*. Regarding penalties, there was an increase in awarding *shidō* 1 and a slight decrease in awarding penalties *shidō* 2 and *shidō* 3 at Paris GS 2022. In male seniors, there was a noticeable decrease in *ippon* points awarded and an increase in *waza ari* and *waza ari awasete ippon*. A slight decrease was noted in the awarding of *shidō* 1, *shidō* 2 and *shidō* 3. In general, the rule changes in judo in 2020 had some, but not statistically significant, effects.

It was noticed, following an individual penalties analysis for female seniors, that in 2022 there was an increase in penalties for pinning sleeves, avoidance, grips and pistol grip, but a decrease for penalties given for holding the same side and fingers in sleeve. On the other hand, in male seniors at the Paris GS 2022, an increase in penalties for pinning sleeves and non-combativeness was noticed, while penalties for holding the belt, holding same side, fingers in sleeve, pulling down, and bending the opponent's fingers have decreased noticeably. In the context of Decision 4, regarding landing simultaneously on 2 elbows, for female competitors at Paris GS 2022, out of the overall number of penalties, *shidō* was awarded 0.34%, while for male competitors at Paris GS 2022, it was reported at 1.1%. Data showed that the particular method of falling, targeted by the rule change, was not frequent. However, it is still useful in preventing arm and/or elbow and/or shoulder and/or neck injuries. One can state that the competitors and coaches have adapted to this new situation because they are aware that they will be awarded a penalty and the opponent a *waza-ari* and in such circumstances, they can lose the contest. Decision 12 stated that techniques with head diving are dangerous and will be penalised with *hansoku make*. In female competitors there were none but in male competitors there were 0.53% (2) at Paris GS 2022. Considering that these techniques present dangerous situations for the spine, disqualification is justified, to prevent the application of these techniques. Based on individual penalty indicators, one can state that changes in the rules in 2022 have had specific effects on the individual penalties of both female and male competitors. Ceylan and Balci (2017) researched the effects of new rule applications in judo by comparing points and penalties at the Paris GS between 2016 and 2017. The results indicated that the frequency of *ippon* and *hansoku make* being awarded did not significantly change after the new rule applications, with both men and women. The previous rule change brought forth the rise of *waza ari* points for both groups, while the total number of *shidō* was reduced in men's fights.

With analysis of subgroups of judo techniques in female seniors at Paris GS 2022, a decrease in the efficiency of hand, side sacrifice techniques and choking techniques was noticed, while rear sacrifice, grappling and joint lock techniques rose. However, the application of foot and rear techniques remained at the same level as in 2020. In senior male contestants in 2022, a decrease in the efficiency of hand techniques was also noticed and a slight decrease in foot throwing techniques, while an increase was noticeable for side, sacrifice throws to the side and rear, gripping, joint lock, and choking techniques. The most probable reason for these observations is the banning of reverse *seoi nage* and *sumi otoshi* (Decision 5). We can assume that this forced competitors to compensate for the forbidden techniques with the application of other judo techniques. Data indicates that in the 2020 Paris GS, these forbidden techniques were used by women, for *sumi otoshi* 4.7% (14) and by men in 5.23% (26) of the total points awarded for throwing techniques. It is also related to Decision 6, which does not award points or penalties for reverse *seoi nage*. The female competitors at Paris GS 2020 applied reverse *seoi nage* up to 1.01% (3) and male competitors up to 1.1% (5) out of the total number of points for throwing techniques. However, these numbers do not present a significant effect. Nevertheless, the foundation for this decision was that, as uke, during the fall, does not have the possibility to escape, this situation often leads to falling on the head, which increases the occurrence of injuries.

Usage of *seoi nage* throwing techniques, when eliminating reverse *seoi nage*, rose at Paris GS 2022, while the efficiency of *seoi otoshi* as a counter technique to tori's attack decreased in 2022. The only constant regarding the attack efficiency index (AEI) was the leg throwing technique *uchi mata* which was in third place in both competitions. *Seoi nage* throws at Paris GS 2022 fell to seventeenth place. *Seoi otoshi*, the technique which came second in 2020, at the Paris GS 2022 was in sixth place. *Ōuchi-gari* rose to second place and *sumi gaeshi*, the sacrifice technique, moved to a higher place in 2022. Martins et al. (2019) analysed the 2017 senior world championships and the techniques used most often were: *seoi nage*, *ōuchi-gari*, *uchi mata*, k*ōuchi-gari*, *ippon seoi nage*, *kōsoto gake*, *sode tsurikomi goshi*, *sumi otoshi*, *ōsoto gari*, *sumi gaeshi* and *tai otoshi*, while the throwing techniques performed by gripping below the belt were no longer attractive, all because of the change of judo rules.

Doppelhammer & Stöckl (2020) researched the effects of rule changes between world championships in 2015 and 2018. Men increased the number of *ippon* scores from 0.17 in Astana in 2015 to 0.23 in Baku in 2018, but this was not the case for women. There were no statistically significant differences between the two tournaments in the number of *waza ari* (+ *yūkō*) points, for men or women. There were no differences between the number of *shidō* for the entire female sample as well. However, male competitors significantly lowered the number of *shidō* actions in 2018. In 2015, out of the entire number of analysed fights, 31.2% were decided by *ippon*. In 2018 the percentage was 43.5%. Likewise, *ippon* fight decisions in male fights rose from 19.5% in Astana in 2015 to 26.3% in Baku in 2018, but this was not the case for women's fights. The number of *shidō* actions in a fight indicated a significant decrease in Astana in 2015, where 21.4% of fights were decided in that way, while in Baku in 2018 only 7.1% of all fights were decided by *shidō*.

Pan et al. (2021) analysed rule changes between judo world championships in 2017 and 2019. In male competitors, the use of *koshi waza* and *yoko sutemi waza* was significantly increased and the use of ma *sutemi waza* significantly decreased. *Koshi waza* and *yoko sutemi waza* in male competitors was significantly higher than before the change of rules and the rate of use of *ma sutemi waza* was significantly lower than before the rule changes. In senior female competitors, the use of *koshi waza* was significantly increased, while the use of *ashi waza* and *ma sutemi waza* was significantly reduced. The rate of using *koshi waza* in female competitors' fights after the change of rules was significantly higher than before the change of rules and the rate of using *ashi waza* and *ma sutemi waza* was significantly lower than those before the rule changes. The greatest rate of throwing techniques was for *koshi waza*, followed by te waza and *ashi waza*.

It should be noted that this analysis was done during the so-called 'transition period,' with competitors adapting to the new rules. Therefore, full results of the effects of rule changes in judo will be gained by analysing the qualification cycle for the next Olympic Games. Furthermore, further research should also examine the analysis of the rule changes on different age groups for both genders.

CONCLUSION

Based on the results gained, effects on certain performances in female and male competitors at the Paris GS tournament in 2022 were noticed. Technique-wise, for senior female competitors, *yoko shihō gatame*, *uchi mata* and *ōuchi-gari* have remained the first three most efficient techniques but exhibited different efficiency indexes in the competitions. In senior male competitors, the most successful techniques in Paris GS 2020 were *seoi nage*, *sumi otoshi* and *uchi mata*, while in Paris GS 2022 those changed to *sode tsurikomi goshi*, *ōuchi-gari* and *uchi mata*. These changes have forced coaches and athletes to adapt fast, through the training process and in competitions and they tried to make their fights more innovative by applying judo techniques and new technical and tactical fighting methods. In this way, looking for new *'do'* roads in judo is a constant process, of which Jigoro Kano Shihan would be very proud.

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