

# **A Needs Analysis and Recommendations for Physical Assessments and Training Adaptations for Judo Athletes with Visual Impairments: A Brief Review**

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## **Abstract**

This paper reviews the unique needs, performance aspects, and assessment recommendations for judo athletes with visual impairments. A needs analysis reveals the importance of custom training strategies and environmental adaptations to facilitate training and competition. Performance aspects, including time-motion analysis and match-related performance, are discussed to elucidate the specific demands and movement patterns in judo athletes with visual impairment. Additionally, recommendations are proposed to develop standardized protocols for physical assessment and skill evaluation, ensuring the optimization of training strategies. Collaborative research initiatives are recommended to further explore integrating multisensory stimuli and enhance athletic development in this population. By addressing the unique challenges judo athletes with visual impairment face and providing evidence-based recommendations for performance assessment and training optimization, this review contributes to advancing adapted sports science and promoting inclusivity and excellence in judo.

**Keywords:** Evidence-based recommendations, Physical assessment, Test adaptation, Paralympic Sport, Multisensory stimuli integration

## **1. Introduction**

Conventional judo debuted at the 1964 Olympics for males and the 1992 Olympics for females. In comparison, judo athletes with visual impairments didn't participate in the Paralympics until 1988 and 2004 for males and females, respectively (20). Judo for athletes with visual impairment is administrated by the International Blind Sports Federation (IBSA) and has various competitions at

continental (e.g., Para-Pan Games, Judo Asian Championships) and world levels (e.g., World Cups and Grand Prix). There is a specific ranking system to classify the visual impairment of athletes for the highest competition levels (World Championships and Paralympics) (26).

The technical characteristics and match structure for judo athletes with visual impairments are similar to conventional judo. However, some unique differences exist. For example, judo athletes with visual impairments start the match by gripping the opponent's judogi (judo-specific clothing) (Figure 1), and a visual classification is used to establish the functional class of athletes (Table 1). Furthermore, the number of weight categories has been reduced from seven to four to align with the abovementioned classification system. This change is based on various investigations that demonstrated the old competitive system (up to 2021) was inadequate for judo athletes with visual impairments as it failed to promote equity between athletes with different degrees of visual impairment (24,27,30,31,32,33,36).

*\*\*Insert Figure 1 here\*\**

Another aspect to explore for judo athletes with visual impairments is performance analysis, which encompasses physical attributes, technical skills, tactical strategies, psychological resilience, and other related elements. (12,28,42). Numerous studies have focused on physical performance (24,28,34,35) and competitive performance aspects, especially match-related performance (22,27) and time-motion behaviors (15,16,17). The key findings from these studies collectively underscore the multifaceted nature of performance judo athletes with visual impairments.

Based on current literature, this study aims to provide a brief review of judo athletes with visual impairments. This includes a needs analysis, recommendations for physical assessments, specified training practices, and identified research gaps.

*\*\*Insert Table 1 here\*\**

## 2. Time-motion analysis

Time-motion analysis has been widely explored in Olympic judo (8,12,37,38). It provides important information about the temporal structure of competition (e.g., effort duration, pause duration, effective combat time, effort: pause ratio, etc.). Furthermore, time-motion analysis provides valuable information to help create individual profiles of athletes (including opponents) and develop tactical strategies for competition (37,38). Various time-motion analysis research has been conducted on judo athletes with visual impairments in recent years (15,16,17,18,19), mainly considering total combat time, total pause time, standing combat time, and groundwork combat time. These variables represent the main dynamics of matches during official competitions. Table 2 shows the findings of these studies.

*\*\*Insert Table 2 here\*\**

In general, time-motion analysis data shows similarities between the groups (sex and sports class) of judo athletes with visual impairments. Only one study demonstrated that B1 athletes have a higher total pause time than partially sighted athletes (B2 and B3) (19). This may be explained by blind athletes requiring a longer time to prepare an attack or delay in displacement (sometimes requiring the referee's help) and preparing to restart the match compared to partially sighted athletes with better visual acuity to move faster.

Gutierrez-Santiago et al. (15) discovered that conventional judo athletes exhibited a longer total combat time (172 s) in comparison to visually impaired judo athletes (130 s). Moreover, the pause time required for executing a technical sequence was shorter for conventional judo athletes (12 s) than for visually impaired athletes (19 s). Additionally, the duration of work sequences was shorter for conventional judo athletes (18 s) than for visually impaired athletes (22 s). These findings offer significant insights into time motion disparities between conventional judo athletes

and those with visual impairments, which could guide the development and customization of individualized testing and training programs.

A key difference from conventional judo is that athletes with visual impairments start combat while gripping the opponent's judogi (30). This adaptation aims to support judo athletes with visual impairments to commence combat and use other sources of information to inform their technical-tactical performance (e.g., tactile-kinesthetic and auditory sensitivity) (24,25). However, these rule adaptations (up to 2021) are insufficient in providing equity between judo athletes with different degrees of visual impairment. Previous studies have shown that blind judo athletes are disadvantaged when competing against partially sighted opponents in match-related performance (27,28,30,36).

### **3. Match-Related Performance in Judo Athletes with Visual Impairments**

The performance of judo athletes with visual impairments in official competitions has been studied increasingly, focusing on identifying differences between sports classes and competitive performance (Table 3).

*\*\*Insert Table 3 Here\*\**

Most studies in Table 3 demonstrated that blind athletes (i.e., B1 groups) were significantly less likely to perform as well as those partially sighted (B2 and B3). Krabben et al. (30) showed that blind judo athletes from the 2014 and 2015 World Championships obtained 2% and 8% of medals compared to B2 (52% and 56%) and B3 (46% and 37%,  $p < 0.001$ ) classified athletes, respectively. This important study outlined key data concerning visual impairment differences and how this affects success in elite-level competition, which helped drive change in the recent classification system updates. Similarly, Mashkovskiy et al. (36) performed a retrospective analysis over 10 years of judo with visual impairment competitions. They found that B1 athletes won only 34.8% of matches against B2 athletes and 31.8% against B3 athletes, while partially sighted athletes have

comparable chances of winning matches (50.6% considering B2 vs. B3;  $p < 0.05$ ). Furthermore, the percentage of B1 athletes participating in world judo competitions declined from 25.9% to 19.4% over the same period, while B3 athletes increased by 5.8% ( $p < 0.05$ ).

Kons et al. (22) analyzed match-related performance (340 competitive matches) in judo athletes with visual impairments at the 2012 and 2016 Paralympics. The data focused on scoring, penalties, efficiency index, technical variation, temporal structure, and type of medals. Results showed that B1 athletes have lower scores, efficiency, and shorter time to lose than partially sighted athletes (B2 and B3). Also, odds ratios showed blind athletes (B1) were 3.5 to 8 times less likely to win medals than partially sighted athletes (B2 and B3). For judo-specific techniques, Kons et al. (27) found that at the 2016 Paralympics, there was a lower win ratio, throws per match, and technical variability in performance ( $p < 0.001$ ) for B1 compared to B2 and B3 judo athletes with visual impairments. More recently, Kons et al. (28) investigated the 2020 Paralympics and identified lower performance concerning win ratio, scoring index, and index of qualitative variation ( $p < 0.001$ ) for B1 compared to B2 and B3. Furthermore, a simulated analysis based on the current classification system (from 2022) demonstrated that J1 had a lower win ratio, scoring index, and variability in groundwork performance than J2 ( $p < 0.001$ ). These results show that athletes of different functional categories (visual acuity) have different profiles, justifying the change of competing between categories to now within categories.

Other investigations have shown a relationship between visual measures and match-related performance in competitive situations. For example, Krabben et al. (32) analyzed the 2012 and 2018 World Judo Championships data and identified a significant yet small negative correlation between win ratio and visual acuity ( $r = -0.33$ ). However, no significant relationship was found between the win ratio and the visual field ( $r = -0.30$ ), showing the meaningful effects of visual acuity on the win ratio. Separately, Krabben et al. (33) examined the association between win ratio and visual measures tests (visual acuity, contrast sensitivity, light sensitivity, depth perception, motion perception, visual search, and central visual field) and verified a significant correlation only

between win ratio and visual acuity ( $r = -0.33$ ), emphasizing the significance and importance of vision tests in the classification process for judo athletes with visual impairments.

In summary, studies relating to the match-related performance of judo athletes with visual impairments show that blind groups (B1 or J1 currently) perform worse than partially sighted athletes. As functional categories have different profiles, evidence supports that athletes with varying degrees of visual impairment must not compete against each other (as has happened until 2021) due to the effect of the visual field on competitive performance and to promote equity amongst athletes. Accordingly, future research is needed to investigate the impact of the new classification system.

#### **4. Physical Assessments for Judo Athletes with Visual Impairments**

Few studies have specifically explored the physical performance of judo athletes with visual impairments, while several studies have compared conventional athletes with visual impairments. For example, Almansba et al. (3) compared the body posture of 10 judo athletes with visual impairment, 14 national-level conventional judo athletes, and 14 non-athletes. All participants performed a unipodal posture test (equilibrium test) in situations with eyes closed alternately and eyes open randomly. The main results showed that conventional and visually impaired judo athletes had better postural control than non-athletes (with eyes closed) ( $p = 0.009$  to  $p = 0.014$ ). While with eyes open, the results were similar across groups, demonstrating that balance is improved with judo experience.

In a case study, Kons et al. (23) analyzed the differences in maximum isometric handgrip strength, vertical jump protocols (SJ and CMJ) performance, and balance assessed from the center of pressure in the base position of judo combat. Two judo athletes participated in the study, one completely blind and one sighted with similar physical characteristics (age, time spent practicing judo, height, body mass, and fat percentage). Results showed superior vertical jumps and handgrip strength performance for the sighted athlete ( $\Delta = 0.05$  to  $19.06$ ). However, for balance, the

visually impaired athlete demonstrated superior results for less oscillation in variables associated with the center of pressure, indicating greater proprioceptive adaptation than fully sighted athletes (effect size = 0.53 to 16.4). However, more studies of larger sample sizes are needed to analyze other factors that may have influenced these findings, such as the type of disability (acquired or congenital), characteristics of practicing the sport, and level of independence in daily living activities.

Karakoc et al. (21), investigated the differences between conventional and visually impaired judo athletes' muscular strength and flexibility levels. Thirty-two athletes participated in this study, 20 without visual impairment and 12 with B3 classified visual impairment. The athletes performed vertical and horizontal jump assessments, the sit-and-reach test, abdominal strength, and maximum isometric handgrip strength (right and left hand). Results showed significantly higher results in an upper limb strength test, handgrip strength on both sides for judo athletes with visual impairments than those without ( $p < 0.050$ ). The athletes with visual impairments were classified as B3, indicating the least visual impairment (in acuity and visual field). Therefore, their vision likely had minimal influence on their test performance.

In a longitudinal study conducted by Loturco et al. (34), the physical performance variation of 17 Brazilian Paralympic judo athletes with visual impairment was assessed during a three-year cycle. All athletes underwent physical assessments in preparation for the World Championships (August 2014), the ParaPan American Games (July 2015), and before the 2016 Paralympics (January and March 2016). The assessments included vertical jumps (countermovement jumps [CMJ], and squat jumps [SJ]), half-squats, bench presses, and pull-downs (in the prone position). Results showed the mean propulsive power in the jump-squat was *likely higher* before the 2016 Paralympics when compared to results before the World Championships (effect size = 0.77) and the ParaPan American Games (effect size = 0.53), which may have contributed to a successful Paralympics, where four silver medals were won.

In the recent review, Kons et al. (29) highlighted that several studies have used upper and lower limb tests to assess the physical performance of judo athletes, mainly to obtain acute and chronic responses related to training and official/simulated combat situations. Tests such as upper and lower limb muscle power and handgrip strength are some assessments used with judo athletes in a broad perspective (29). Based on this perspective, Figure 2 recommends adapting physical tests, considering handgrip strength, medicine ball throw, CMJ, and SJ based on tactile and auditory stimuli.

*\*\*Insert Figure 2 Here\*\**

In summary, only a few investigations have considered physical performance in visually impaired judo athletes. Therefore, suggestions for assessing their physical capabilities may help provide a more accurate prescription of training loads and, consequently, long-term physical fitness adaptations.

Sports-specific tests are an alternative to assessing the physical performance of athletes, considering the need for specificity to transfer sporting physical performance (9). Some judo-specific tests have been validated and widely implemented (29), such as the Special Judo Fitness Test (SJFT). The SJFT assesses the physical performance of judo athletes from different perspectives, including the segregation of athletes based on their performance level (15), sex (2), diurnal variation of performance (10), weight categories (40), and monitoring long-term adaptations related to the physical performance (1).

For judo athletes with visual impairment, the SJFT was recently validated by Kons et al. (24), who proposed an adaptation using two stimulus types: sound and tactile. Twenty national and international judo athletes (including Brazilian Paralympic Judo Team representatives) performed the SJFT in three situations: no stimulus, sound stimulus (using palms), and tactile stimulus (tape with a string glued to the dojo). Results showed good to excellent reliability for both adaptations

(sound and tactile) for the number of throws ( $ICC = 0.91-0.95$ ) and heart rate values ( $ICC = 0.76-0.90$ ). Paralympic athletes performed best during the sound stimulus, followed by tactile and no stimulus. When comparing visual sports classes in judo, blind athletes (B1) performed lower in the no-stimulus and tactile stimulus tests than athletes with less visual impairment (B2 and B3). However, no differences were found between classes during the sound stimulus tests, suggesting that a sound stimulus may be used irrespective of the classification of visual impairment. Subsequently, Kons et al. (25) tested the adapted SJFT (sound and tactile stimulus) and the standard SJFT in judo athletes with acquired and congenital visual impairment. Results showed that both groups responded better in the adapted SJFT irrespective of the stimulus compared to the unadapted SJFT.

The results of these studies highlight that coaches should adapt judo-specific physical testing using simple and inexpensive means to ensure they are valid for visually impaired judo athletes. Accordingly, adaptations are recommended concerning the type of impairment. Figure 3 illustrates respective assessments based on specific adaptations for visually impaired judo athletes, including contrast color stimulus (Panel A), tactile stimulus (Panel B), and sound stimulus (Panel C). As shown in Figure 1, contrasting colors (i.e., blue and yellow) may benefit athletes classified in J2 (current classification system), while sound and tactile stimuli are more so for the J1 group. However, further investigations should be conducted to support or refute these suggestions.

It is important to highlight that to enhance the assessment of judo athletes with visual impairments, it is advised that practitioners integrate specialized technologies designed to improve sports performance in combat sports (39). For example, the *MyJump* app provides an accurate and reliable evaluation of jump performance, including the CMJ, SJ, and drop jump, which serve as useful proxy measures for over-arching athleticism in athlete populations (29). Similarly, *MyLift* and *Ergonauta* encoders are effective tools for assessing and monitoring training during key barbell exercises such as bench presses, rows, and squats. These tools offer precise feedback that can aid in programming for targeted adaptations related to judo performance. This suggestion is supported by

the evident increase in these technologies and methods increasingly utilized in combat sports in recent years (39).

*\*\*Insert Figure 3 Here\*\**

## **5. Practical Applications: Training Protocols and Adaptations for Judo Athletes with Visual Impairment**

Training perspectives for visually impaired judo athletes can be enhanced by integrating sensorial and auditory stimuli into training sessions (24). These stimuli compensate for the limited visual input, allowing athletes to perceive and respond to their environment effectively (25). Athletes can develop a heightened sense of spatial awareness and positioning during training drills and sparring sessions by incorporating tactile cues, such as textured mats or markers on the judogi (31).

Additionally, auditory cues, such as verbal instructions from coaches or the sounds of opponents' movements, can provide valuable information for athletes to anticipate and react to their opponent's actions. Judo athletes with visual impairment can enhance their performance by incorporating these sensorial and auditory stimuli into their training routines (24,25).

Time-motion analysis and indicators of match-related performance can provide information on various aspects of training, such as the frequency and duration of specific techniques, transitions between different phases of combat, and periods of rest or recovery (15,17,38). This data can help coaches and athletes better understand the physical demands of judo competition and develop training strategies to improve endurance, speed, agility, and other key physical attributes required for success (29,41). Furthermore, time-motion analysis and parameters related to the match performance can be used to evaluate the effectiveness of different training drills and exercises, allowing coaches to identify the most beneficial activities for enhancing performance and refining technical skills. Visually impaired judo athletes can optimize their preparation for competition by incorporating time-motion analysis into their training programs. Table 4 shows protocols used by

judo athletes and possible adaptations for judo athletes with visual impairment based on the auditory and tactile adaptations.

***\*\*Insert Table 4 Here\*\****

The assessment based on the adapted SJFT with auditory or tactile stimuli can improve athletes' responsiveness to non-visual cues, enhance their sensory perception and awareness, and develop their ability to react quickly and decisively to auditory or tactile stimuli during competition (24). This type of training (*e.g.*, integrating auditory and tactile stimuli) can also help judo athletes with visual impairment become more proficient in interpreting and responding to environmental cues, essential skills for effective performance in judo. Additionally, incorporating auditory or tactile stimuli into SJFT-based training sessions can increase challenges and variability to the training program, keeping athletes engaged and motivated while providing feedback on their physical fitness and technical skills (29). This type of training can help judo athletes with visual impairment develop confidence and self-assurance in their ability to perform in judo competitions.

Finally, integrating specialized technologies and apps incorporating sensory and auditory stimuli can greatly assist coaches and athletes in assessing the physical performance of judo athletes with visual impairments. For example, the *MyJump* app provides precise evaluations of jump performance (39), which are crucial for understanding the lower limb explosive strength capabilities of judo athletes (29). Additionally, using encoders to monitor training related to specific judo movements, such as bench presses, rows, and squats, has proven highly effective in enhancing long-term physical performance (34). This approach not only improves training outcomes but also ensures that athletes can develop their physical capacities in a targeted and measurable way (1,34,35).

## **6. Conclusion and Suggestions for Future Research**

Based on this review, coaches and practitioners should adopt time-motion and match-related analysis to illustrate and track the long-term competitive performance process. Time-motion

analysis provides valuable data on the specific movement patterns and intensity levels, while match-related performance shows judo-specific actions (technical and tactical) during matches. Coaches can use this information to design training sessions incorporating drills that mimic the duration, intensity, and frequency of actions observed in competition. This approach enhances athletes' ability to adapt to the dynamic nature of judo matches and optimize their performance. Considering the physical demands placed on visually impaired judo athletes, it is crucial to design effective training programs. Coaches can also use assessments to identify the specific physical attributes (e.g., strength, endurance, specific judo performance) required for optimal performance. Tailoring training sessions to target these physical demands can enhance athletes' physical preparedness and performance.

Adaptations of physical tests for visually impaired judo athletes are recommended based on contrast color, tactile, and auditory stimulus. Practical applications encompass implementing environmental adaptations, such as contrast color markings and tactile cues. Future investigations should aim to explore sensorimotor integration studies and evaluate the effectiveness of these interventions. This will help inform recommendations for multisensory training approaches and collaborative research initiatives to enhance performance outcomes and promote inclusivity in judo training environments.

By implementing these strategies and recommendations, judo coaches, strength and conditioning (S&C) coaches, researchers, and athletes can enhance the training and competitive experiences of judo athletes with visual impairment, thus promoting inclusivity, accessibility, and sporting excellence.

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### **Figure Legends:**

**Figure 1.** Starting match position for judo athletes with visual impairments

**Figure 2.** Flowchart for physical tests adaptations considering judo athletes with visual impairments.

**Figure 3.** Demonstration of possible adaptations of Special Judo Fitness Test for visually impaired judo athletes based on specific stimuli. Contrast color stimulus (Panel A), tactile stimulus (Panel B), and auditory stimulus (Panel C).

**Figure 1.**



Figure 2.

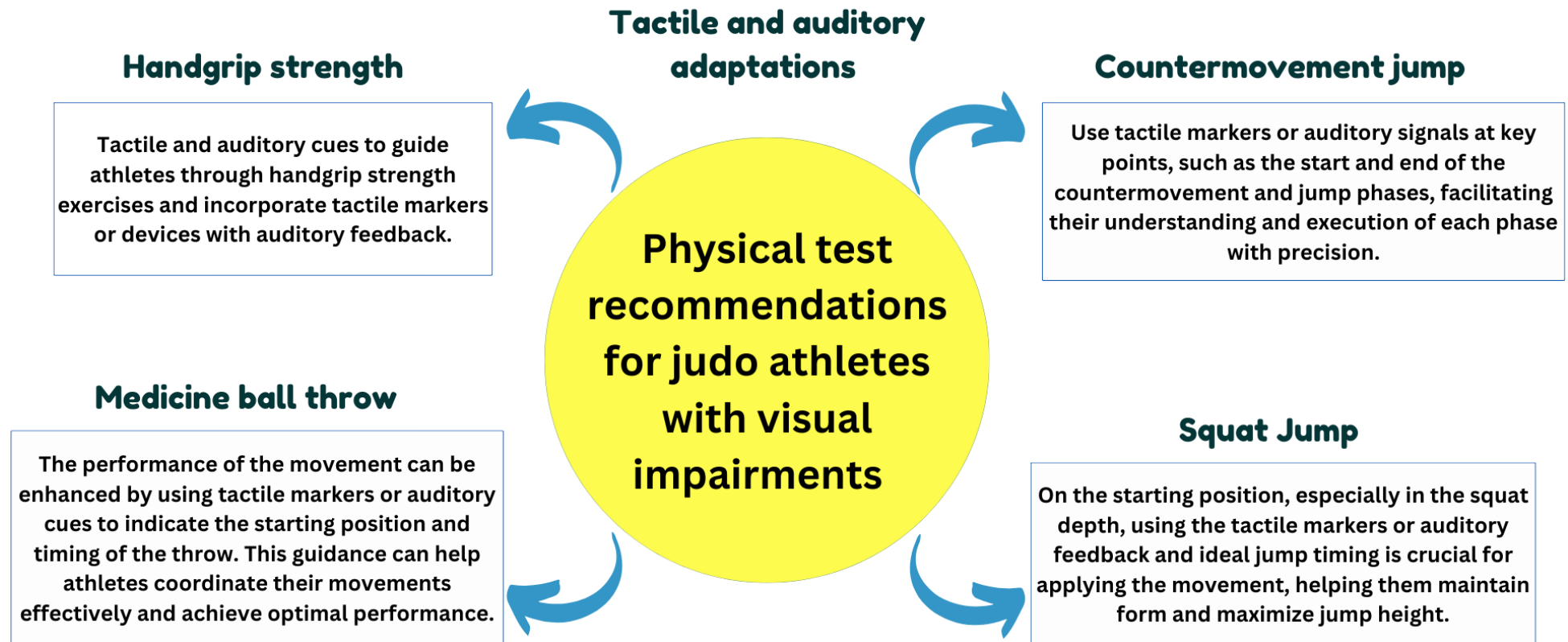
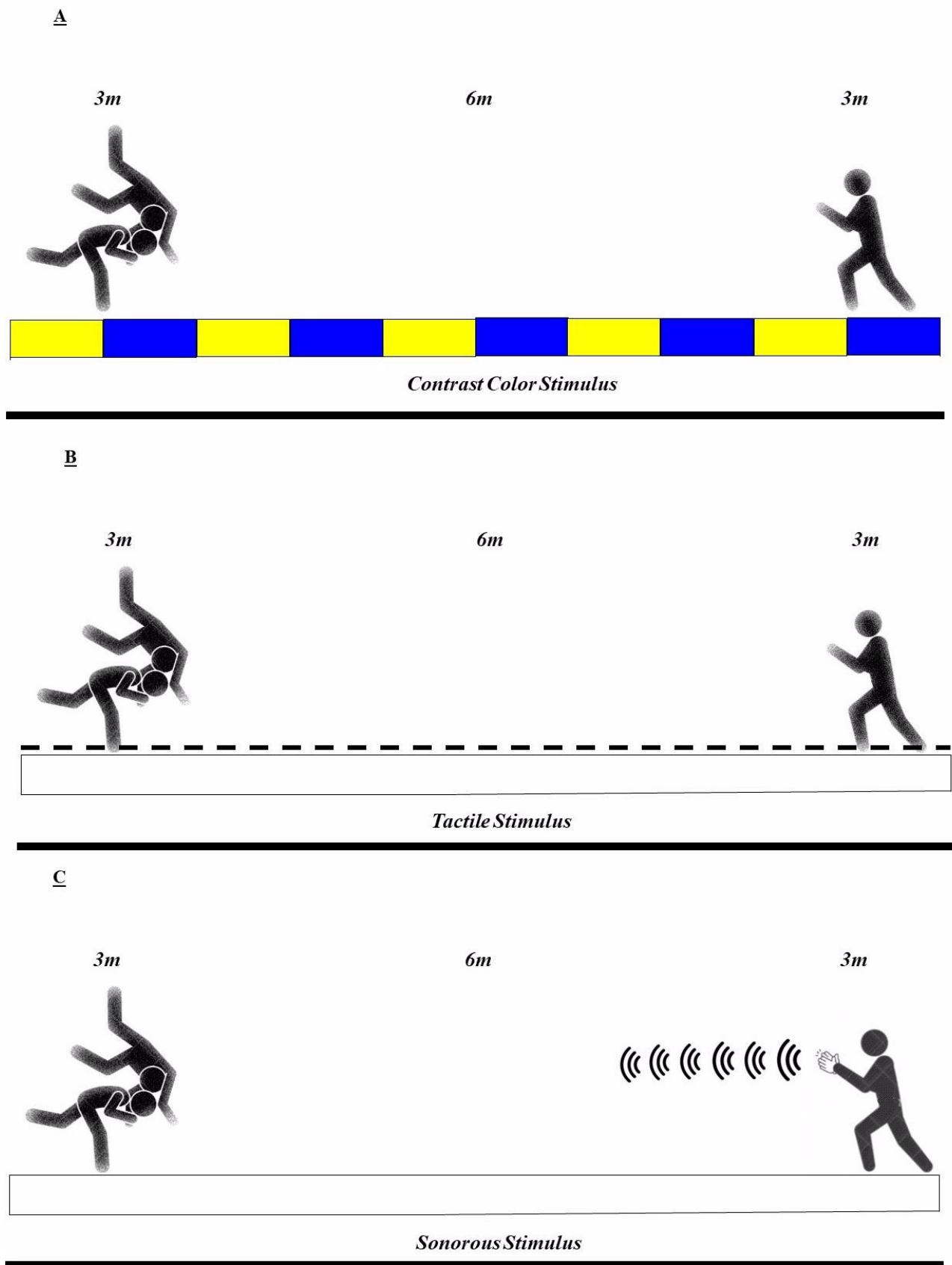


Figure 3.



**Table 1.** Visual classification and competition system criteria for judo athletes with visual impairments according to IBSA regulation, considering the old classification (until 2021) and current classification system.

|                               | Visual Acuity (LogMAR)    | Visual Field (radius)                       | Competition system        |
|-------------------------------|---------------------------|---------------------------------------------|---------------------------|
| Old Classification System     |                           |                                             |                           |
| B1                            | Poorer than 2.6           | Cannot be B1 with only loss of visual field | Competing together        |
| B2                            | 1.5 to 2.6                | Less than 5 degrees                         |                           |
| B3                            | 1.0 to 1.4                | Less than 20 degrees                        |                           |
| Current Classification System |                           |                                             |                           |
| J1                            | Less than or equal to 2.6 | Not applicable                              | Group competes separately |
| J2                            | 1.3 to 2.5                | Less than 60 degrees                        |                           |

**Table 2.** Findings of studies investigating time-motion analysis in judo athletes (male and female) with visual impairments.

| Study                          | Number of matches/sex              | Combat time (s)                                  | Pause time (s)                                   | Standing combat time (s)                     | Groundwork combat time (s)                   |
|--------------------------------|------------------------------------|--------------------------------------------------|--------------------------------------------------|----------------------------------------------|----------------------------------------------|
| Gutierrez-Santiago et al. (15) | 219 (n=92 male and n=25 female)    | 266 (male)<br>242 (female)                       | 158 (male)<br>172 (female)                       | 82 (male)<br>54 (female)                     | 60 (male)<br>84 (female)                     |
| Gutiérrez-Santiago et al. (16) | 184 (male)                         | 266 ± 248.5                                      | 158 ± 151.7                                      | 82 ± 73.6                                    | 60 ± 49.4                                    |
| Gutiérrez-Santiago et al. (17) | 133 (female)                       | 208.3 ± 178.8                                    | 57.29 ± 50.58                                    | 65.3 ± 51.8                                  | 47.0 ± 37.7                                  |
| Gutierrez-Santiago et al. (18) | 365 (n=232 male and n=133 female)  | 257.67 ± 226.27                                  | 157.06 ± 141.89                                  | 90.4 ± 70.7                                  | 43.8 ± 38.3                                  |
| Gutierrez-Santiago et al. (19) | 232 (n= 172 male and n=60, female) | 290.15 ± 253.13 (B1);<br>243.35 ± 212.62 (B2/B3) | 206.87 ± 163.56 (B1);<br>137.77 ± 128.06 (B2/B3) | 91.80 ± 64.51 (B1);<br>89.83 ± 73.57 (B2/B3) | 52.29 ± 43.25 (B1);<br>40.40 ± 35.86 (B2/B3) |

**Table 3.** Match-related performance studies in judo athletes with visual impairments.

| Study               | Sample/matches                          | Variables                                                                                                                                                                   | Main results                                                                                                                                               |
|---------------------|-----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Kons et al. (22)    | 244 Para athletes/ 340 total matches    | Efficiency<br>Frequency of Ippon<br>Frequency of Wazari<br>Frequency of Shido<br>Percentage of standing and groundwork techniques                                           | The odds ratio of a winning medal was 3.5–8 times less in blind athletes (B1) than in partially sighted athletes (B2 and B3)                               |
| Kons et al. (27)    | 129 Para athletes/ 175 total matches    | Win ratio<br>Throws per match<br>Technical variability ratio<br>Index of Qualitative Variation<br>Total match time<br>Time to reach a score<br>Time to receive a penalty    | Win ratio, throws per match, and technical variability ratio are higher for partial-sighted judo athletes (B2 and B3) than blind (B1).                     |
| Kons et al., (28)   | 136 Para athletes/ 182 matches          | Win ratio<br>Scoring index<br>Technical variability ratio in standing<br>Technical variability ratio in groundwork<br>Penalties per match<br>Index of Qualitative Variation | The variability index performance discriminates the J1 and J2 judo athletes with visual impairment in the simulated analysis.                              |
| Krabben et al. (30) | 432 Para athletes (no matches reported) | Percentage of Medals                                                                                                                                                        | Blind judo athletes with visual impairment win far fewer medals in world championship competitions (2014 and 2015) than their partially sighted opponents. |

|                          |                                        |                                                                                                                                                           |                                                                                                                                                                                                                  |
|--------------------------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Krabben et al., (31)     | 53 Para athletes (no matches reported) | Win ratio<br>Visual Acuity<br>Contrast Sensitivity<br>Light Sensitivity<br>Depth Perception<br>Motion Perception<br>Visual Search<br>Central Visual Field | Visual acuity is the best predictor of performance, based on the negative relationship between visual acuity and win ratio ( $r = -0.33$ )                                                                       |
| Krabben et al. (32)      | 617 Para athletes/<br>3101 matches     | Win ratio<br>Visual acuity<br>Visual Field                                                                                                                | A negative relationship was found between win ratio and visual acuity ( $r = -0.33$ ), and decision tree analysis suggested splitting the data into two groups with a visual acuity cut-off of 2.5 logMAR units. |
| Mashkovskiy et al., (36) | 1162 Para athletes/<br>1936 matches    | Percentage of wins<br>Percentage of athletes in each Class                                                                                                | B1 athletes lose more matches over 10 years compared to B2 and B3 Para athletes                                                                                                                                  |

**Table 4.** Judo protocols for training and proposed adaptations for judo athletes with visual impairment.

| Reference              | Type of training           | Protocols                                                                                                                                                                      | Auditory Adaptations                                                                                                                                                                                                                                                | Tactile Adaptations                                                                                                                                                                                                                                                                                             |
|------------------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Baudry and Roux. (4)   | Uchi-komi circuit training | 40-s all-out hikidashi uchikomi combined with other judo-specific exercises (e.g. nage-komi), generating work-to-rest ratios of 1:1, 1:3 and 1:5                               | Use a metronome or rhythmic clapping to help athletes maintain a consistent pace during uchi-komi drills. Additionally, encourage partners to use auditory signals such as "ready," "go," and "stop" to coordinate movements.                                       | Begin uchi-komi drills with athletes maintaining close contact with their partners, emphasizing the importance of feeling the opponent's balance and weight shifts. Additionally, resistance bands should be incorporated to help athletes practice movements and grips, providing consistent tactile feedback. |
| Franchini et al., (11) | Uchi-komi                  | 1 x 30 repetitions<br>1 x 60 repetitions<br>5 x 30 seconds                                                                                                                     |                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                 |
| Franchini et al., (13) | Uchi-komi                  | 2 blocks of 10 x 20s all out/10s between sets and 5 min between blocks                                                                                                         |                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                 |
| Branco et al., (5)     | Randori                    | 4 x 5 minutes randori with 5-minute intervals                                                                                                                                  | Utilize textured tapes or patches on judogi (judo uniforms) at key gripping points to help athletes quickly locate and maintain grips. Additionally, ensure that athletes begin in close contact, with one hand on the opponent's sleeve and the other on the lapel | Provide clear and concise verbal instructions to guide movements, such as 'right hand higher' or 'step forward with your left foot.' Utilize sound signals to indicate the start and stop of rounds or specific training phases.                                                                                |
| Callister et al., (6)  | Randori                    | 1-hour randori                                                                                                                                                                 |                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                 |
| Callister et al., (7)  | Randori                    | 3–7 randori (3-minute duration and 30-second intervals)                                                                                                                        |                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                 |
| Sikorski. (39)         | Randori                    | 15-minute kakari-geiko (successive attacks with light defense from the opponent) and 25–30 minutes randori with “no strength” application (5–6 matches with 1-minute interval) |                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                 |