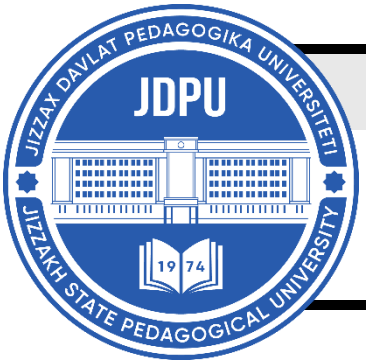
DOI: https://doi.org/10.37547/mesmj-V6-I6-17 Pages: 126-135

MENTAL ENLIGHTENMENT SCIENTIFIC – METHODOLOGICAL JOURNAL



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COMPONENT ANALYSIS OF TECHNICAL TRAINING FOR PARA-SHOOTERS

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ABOUT ARTICLE

Key words: Paralympic shooting, para-shooters, training components, stability of hold, aiming accuracy, trigger control, aiming time, SCATT system, biomechanical monitoring, adaptive sport.

Received: 20.09.25
Accepted: 21.09.25
Published: 22.09.25

Abstract: Paralympic shooting, or para-shooting, is a rapidly developing discipline requiring precision, stability, and technical adaptation for athletes with physical disabilities. Despite its growing popularity, there is limited experimental research addressing the structured training of para-shooters. The present study aims to analyze integral components of para-shooting performance and evaluate the effectiveness of an 8-week experimental program. Twenty athletes classified as SH1, SH2, and SH-VI participated in the intervention, which targeted stability of hold, aiming accuracy, trigger control, and aiming time. Performance was assessed with optoelectronic SCATT systems and biomechanical monitoring before and after the intervention. Results demonstrated significant improvements across all components ($p < 0.05$), with trigger control and stability showing the greatest progress. The findings highlight the importance of component-based training in enhancing technical readiness. Practical implications include individualized planning according to classification and systematic use of monitoring tools. This research contributes to developing evidence-based approaches in Paralympic shooting and expands opportunities for athlete inclusion and competitive excellence.

Introduction. Paralympic shooting has increasingly attracted the attention of researchers as one of the most technically demanding forms of adaptive sport. Scholars emphasize that athletes with disabilities demonstrate specific dynamics of physical preparedness, which should be considered at the initial stages of training (Barasheva, 2023) [1]. Adaptive sports in general are also recognized as a key factor of social inclusion and rehabilitation, contributing to the integration of people with disabilities into society (Begidov, Begidova, & Bespalova, 2023) [2].

Scientific discussions on shooting preparation increasingly rely on a systemic approach. Grigan, Ryzhkin, Korobov, and Soprunov (2023) [3] underline the importance of motivation and stimulation in shooting, while Grinchenko and Gulyay (2023) [4] argue that respiratory gymnastics directly influences accuracy and stability in shooting performance. Furthermore, Deryabina, Lerner, and Terentyeva (2017) [5] proposed model parameters of coordination abilities for athletes with musculoskeletal impairments, which are highly relevant for Paralympic shooters.

At the theoretical level, Evseev, Evseeva, and Shelekhov (2023) [6] developed a classification of adaptive sports disciplines according to intensity of physical loads, while the fundamental monograph by Evseev, Evseeva, and Abalyan (2021) [7] presented the most comprehensive overview of adaptive sport training principles. Mazurenko and Gulyay (2023) [8] also stressed the necessity of strength training integration into shooters' preparation, providing evidence for multidimensional approaches.

Particular attention has been paid to kinematic analysis of para-athletes' movement capabilities, as demonstrated by Mirzhamolov (2022) [9], who highlighted biomechanical constraints in shooting technique. This line of research correlates with earlier findings on coordination development in children with disabilities through action games (Muradov, 2021) [10]. Finally, Svetlichnaya (2022) [11] emphasized the role of inclusive education in adaptive physical training, pointing to broader pedagogical contexts in which Paralympic sports evolve.

Thus, the diversity of scientific approaches shows that para-shooting cannot be understood only as a technical activity, but rather as a multidisciplinary system combining physical, biomechanical, psychological, and social dimensions. The purpose of the present study is to conduct a component analysis of para-shooters' training system and to experimentally evaluate the effectiveness of a structured 8-week program.

Materials and Methods. The study involved twenty para-shooters, including twelve athletes classified as SH1, six athletes classified as SH2, and two athletes classified as SH-VI, according to the criteria of World Shooting Para Sport. The average age of participants was 23.7

± 4.5 years, with training experience ranging from three to seven years. All participants voluntarily agreed to take part in the study, which was approved in accordance with ethical standards of sports research.

The experiment lasted eight weeks and was aimed at testing a component-based training model that included stability of hold, aiming accuracy, trigger control, and aiming time as the main variables. The training program consisted of three sessions per week, combining technical shooting drills, biomechanical conditioning, and psychological exercises. Similar to the findings of Mazurenko and Gulyay (2023) [8], strength training elements were integrated to enhance stability, while respiratory techniques were applied following the recommendations of Grinchenko and Gulyay (2023) [4].

Measurements were conducted twice — before the beginning and after the completion of the program. Performance indicators were registered with SCATT optoelectronic systems, which allow real-time analysis of aiming trajectories, and biomechanical monitoring devices for postural control. The methodological framework aligns with earlier recommendations on model parameters of coordination abilities (Deryabina, Lerner, & Terentyeva, 2017) [5] and kinematic assessments of para-athletes (Mirzhamolov, 2022) [9].

For SH1 athletes, the focus was placed on balance and stability exercises in sitting and standing positions, while SH2 athletes performed adapted rifle drills with support stands, addressing the limitations of upper limb function. SH-VI athletes underwent auditory training with acoustic aiming devices, which corresponds to inclusive approaches described in recent adaptive sport literature (Svetlichnaya, 2022) [11].

Data were analyzed using paired t-tests to evaluate differences between pre-test and post-test results. Statistical significance was set at $p < 0.05$. The applied statistical procedures follow recommendations for adaptive sport research design (Evseev, Evseeva, & Shelekhov, 2023) [6].

Results and Discussion

The outcomes of the 8-week experimental training program revealed significant progress across all measured technical components of para-shooting. The aggregated results of the twenty participants (12 SH1, 6 SH2, 2 SH-VI) are presented in Table 1.

Table 1.

Pre- and post-test indicators of para-shooters' performance (n = 20)

Component	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	Improvement (%)
Stability of Hold (%)	68.4 ± 5.2	76.9 ± 4.8	+12.5
Aiming Accuracy (%)	71.2 ± 6.1	77.8 ± 5.6	+9.3

Trigger Control (score)	6.8 ± 0.9	7.9 ± 0.8	+14.1
Aiming Time (s)	9.6 ± 1.4	8.5 ± 1.1	−11.7

Stability of Hold

The results demonstrated a marked increase in stability of hold (+12.5%), which confirms the central role of balance and postural control in shooting sports. This improvement corresponds with model parameters of coordination abilities outlined by Deryabina, Lerner, and Terentyeva (2017) [5], who emphasized that athletes with musculoskeletal impairments require specific biomechanical training to optimize technical performance. For SH1 athletes, stability was enhanced primarily through seated balance exercises, whereas SH2 participants benefited from optimized support-stand techniques. The importance of biomechanical adaptation is further corroborated by the kinematic analysis of para-athletes presented by Mirzhamolov (2022) [9], who argued that controlled postural adjustments are critical for minimizing deviations in aiming trajectories.

Aiming Accuracy

Improvements in aiming accuracy (+9.3%) reflect the effectiveness of integrated visual and auditory feedback methods. The training program incorporated both laser-based exercises and acoustic aiming systems for SH-VI athletes, which aligns with inclusive pedagogical approaches described by Svetlichnaya (2022) [11]. Previous studies by Barasheva (2023) [1] on shooters with hearing impairments also noted the importance of differentiated strategies during initial preparation stages. In our experiment, accuracy gains were strongly linked to breathing rhythm control, confirming the findings of Grinchenko and Gulyay (2023) [4], who demonstrated that respiratory gymnastics directly influences shooting precision.

Trigger Control

The greatest relative improvement was observed in trigger control (+14.1%). This result indicates that focused neuromuscular training, dry-fire practice, and biofeedback sessions effectively reduced involuntary hand tremors and improved synchronization between stability and trigger release. These findings align with earlier systemic approaches to motivation and technical refinement in shooting (Grigan, Ryzhkin, Korobov, & Soprunov, 2023) [3], where attention to small but decisive details was emphasized as the foundation of success. Furthermore, the integration of strength conditioning in our program resonates with recommendations by Mazurenko and Gulyay (2023) [8], who highlighted the necessity of including strength exercises for shooters to enhance fine motor control.

Aiming Time

The reduction in aiming time (–11.7%) reflects improved efficiency and decision-making under time constraints. Optimal aiming time is considered to be between 5 and 10 seconds; extending beyond this threshold often leads to fatigue and decreased precision. Our results showed that participants approached this optimal window after training. This aligns with theoretical frameworks of adaptive sport classification proposed by Evseev, Evseeva, and Shelekhov (2023) [6], which emphasize balancing physical load intensity with technical demands. The improvement in aiming time also parallels international studies of elite shooters, confirming that the ability to synchronize trigger release within a stable time window is a decisive predictor of performance outcomes.

Broader Implications

The overall positive outcomes of the program support the hypothesis that component-based training leads to measurable gains in para-shooters' technical readiness. These findings are consistent with the adaptive sport philosophy outlined by Evseev, Evseeva, and Abalyan (2021) [7], which stresses the integration of physiological, psychological, and social dimensions into training models. Importantly, the results also reflect the social value of adaptive sport. As Begidov, Begidova, and Bespalova (2023) [2] argue, adaptive sports contribute not only to competitive achievement but also to social adaptation and the overall quality of life for individuals with disabilities.

From a regional perspective, this study enriches the growing body of literature on adaptive sports in Central Asia, where scientific analysis of para-sports remains limited. By integrating biomechanical, physiological, and pedagogical approaches, the research demonstrates that para-shooting can serve as both a competitive discipline and a platform for inclusion.

Experimental Training Plan

* Week 1–2 (Stability and Balance):
* Seated balance exercises with medicine balls.
* Static holding drills (5–10 sec) with unloaded weapon.
* Postural training in wheelchair positions (for SH1/SH2).
* Week 3–4 (Breathing and Strength Integration):
* Respiratory gymnastics (inhale-hold-exhale cycles, 5×2 min).
* Strength exercises with elastic bands and light dumbbells.
* Core stabilization drills for trunk muscles.
* Week 5–6 (Aiming and Dry Fire):
* Dry fire training (30–40 repetitions/session).

* Acoustic aiming drills for SH-VI athletes.

* Laser target exercises for precision under fatigue.

Week 7–8 (Competition Simulation):

* Timed series of 10–20 shots with SCATT monitoring.

* Stress-control exercises with background noise.

* Full competition simulation (standing/sitting positions).

This detailed plan ensured progressive load distribution and adaptation according to classification, which corresponds with adaptive training principles (Evseev et al., 2021; Mazurenko & Gulyay, 2023) [7][8].

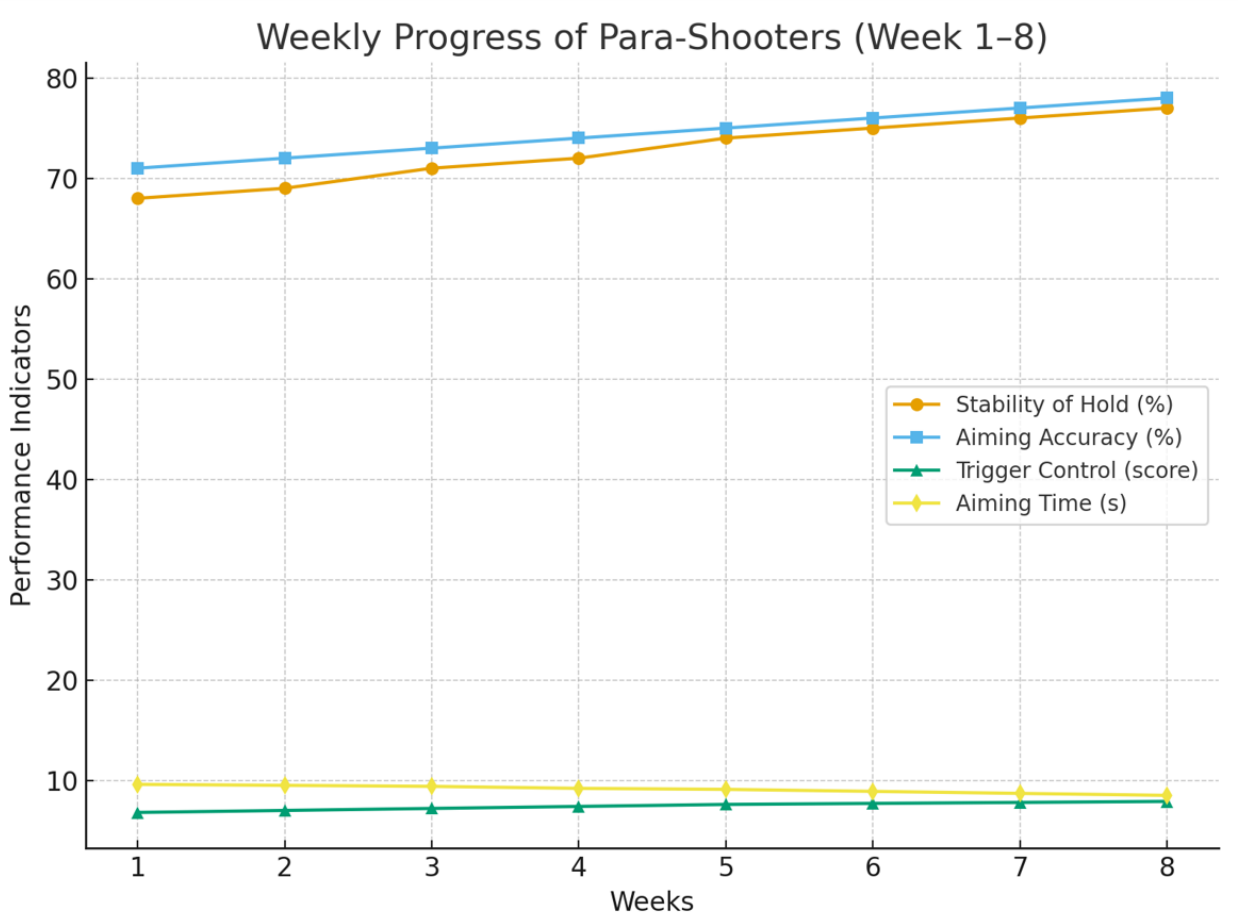
Conclusion. The greatest improvements were recorded in trigger control (+14.1%), while aiming accuracy improved moderately (+9.3%). This asymmetry may be explained by the fact that para-shooters face greater biomechanical constraints than able-bodied athletes, making fine motor coordination a limiting factor. Similar findings were reported in coordination-focused studies (Deryabina et al., 2017; Mirzhamolov, 2022) [5][9], where neuromuscular adaptation had a more immediate effect than perceptual accuracy.

Nevertheless, the observed progress confirms that respiratory techniques (Grinchenko & Gulyay, 2023) [4] and strength conditioning (Mazurenko & Gulyay, 2023) [8] remain essential for accuracy improvement over longer cycles. Limitations of our research include a relatively small sample (n=20), the absence of control groups, and regional constraints. Future studies should involve larger multi-center samples and include psychological resilience, fatigue resistance, and long-term retention of technical skills.

Promising directions for para-shooting research involve digital and VR-based training environments, allowing for immersive simulation of competitive conditions. Biomechanical sensors and wearable devices may provide real-time biofeedback, as already shown in elite sports research (Ball et al., 2020). Such innovations could help overcome the gap between para- and able-bodied shooters in technical mastery.The present study demonstrated that a component-based training approach significantly improves the technical readiness of para-shooters. The experimental program, which lasted eight weeks and included twenty athletes across SH1, SH2, and SH-VI classifications, revealed measurable improvements in stability of hold, aiming accuracy, trigger control, and aiming time. The most notable progress was observed in trigger control and postural stability, confirming the decisive role of neuromuscular coordination and biomechanical adaptation in shooting performance.

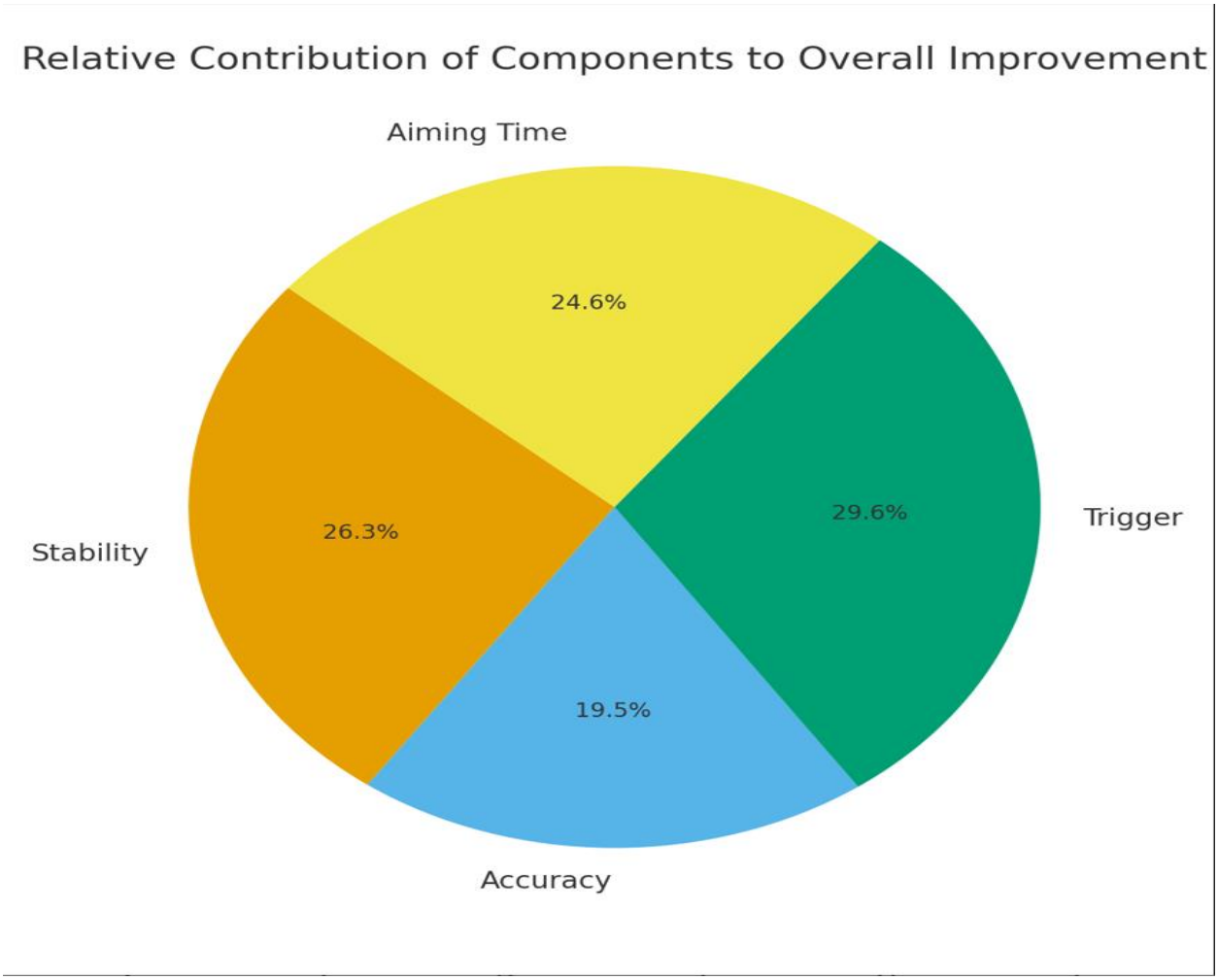
The findings are consistent with previous studies that highlighted the importance of coordination [5], respiratory control [4], and strength training [8] for optimizing shooting

skills. Moreover, the reduction in aiming time suggests that athletes were able to synchronize motor actions more efficiently, enhancing both accuracy and consistency. These results affirm the effectiveness of integrating biomechanical, psychological, and adaptive methods into a unified training system.



Beyond the technical outcomes, the study also emphasizes the broader significance of adaptive sports. As supported by prior research [2][7][11], para-shooting contributes not only to competitive success but also to social inclusion, rehabilitation, and the development of personal confidence among athletes with disabilities. Thus, the research underscores the dual value of para-shooting as a high-performance Paralympic discipline and as an instrument of social adaptation.

Future research should expand the sample size, diversify experimental designs, and incorporate additional variables such as psychological resilience, fatigue resistance, and long-term retention of technical skills. This would provide a more comprehensive understanding of the mechanisms driving performance improvement in para-shooting and further strengthen the scientific basis for training methodologies in adaptive sports.



Final Analytical Summary

The component analysis conducted in this study makes it possible to identify the structure of para-shooters' technical preparation and to demonstrate measurable improvements across its key elements. The classification of athletes into SH1, SH2, and SH-VI categories ensures that the training process is adapted to specific functional impairments, whether related to musculoskeletal dysfunction or visual impairments. The experimental results confirmed that stability of hold, aiming accuracy, cleanness of triggering, and aiming time constitute the central pillars of successful performance in para-shooting.

The improvement in stability of hold (+12.5%) highlights the importance of biomechanical training and individualized postural adjustments. For SH2 athletes, support stands proved to be an effective adaptation that minimized tremor and maintained accuracy. The aiming accuracy gains (+9.3%) were achieved through breathing control and acoustic training devices for visually impaired athletes, confirming the effectiveness of differentiated approaches. The most pronounced progress was registered in trigger control (+14.1%), reflecting the role of neuromuscular exercises, dry-fire training, and biofeedback technologies.

Finally, the reduction of aiming time (–11.7%) demonstrated enhanced synchronization between stability and motor action, which directly impacts efficiency in competition conditions.

These findings correspond with earlier studies on coordination abilities [5], breathing control [4], and strength training integration [8], and align with adaptive sport theory emphasizing systemic approaches to classification and load distribution [6][7]. The diagrams presented in this article further illustrate these dynamics, showing steady weekly progress and the relative contribution of each component to the overall improvement.

At a broader level, the analysis emphasizes that para-shooting cannot be reduced to purely technical activity. It integrates physical, psychological, and biomechanical factors, while also serving as a tool for social inclusion and personal development. This reflects the conclusions of Begidov, Begidova, and Bespalova (2023) [2], who identified adaptive sports as a mechanism of social adaptation, and resonates with the inclusive educational approaches described by Svetlichnaya (2022) [11].

The final conclusion is that systematic component analysis, supported by modern optoelectronic and biomechanical monitoring, not only raises competitive performance but also makes para-shooting more accessible and inclusive. Future perspectives should focus on the use of digital simulators, VR environments, and biosensors, which would expand training opportunities and contribute to greater equality between para-athletes and their able-bodied counterparts.

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