Research article

Effects of quantum medicine applied to paralympic athletics training on physical performance in Colombia

Efectos de medicina cuántica aplicada al entrenamiento paralímpico de atletismo sobre el rendimiento físico en Colombia

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Date receipt: 01-12-2025
Date acceptance: 04-01-2026
Date publication: 14-01-2026

Abstract

Introduction: The training of Paralympic athletes requires innovative methods that take into account their specific physiological and neuromotor needs. This is where quantum sports medicine can emerge as a complementary strategy to improve physiological efficiency, neuromuscular recovery, and athletic performance, although scientific evidence in Paralympic populations remains scarce.

Objective: To determine the effect of a quantum medicine program on aerobic capacity and physical performance in Paralympic athletes.

Methodology: A quantitative, pre-experimental study was conducted on 48 Paralympic athletes from Colombia. The intervention lasted eight weeks, with 90-minute sessions five times per week. The program incorporated quantum bioenergetic stimulation, functional strength exercises, progressive sprints, and individualized running technique work. Maximum oxygen consumption (VO_2max) and times in the 100 m, 200 m, 800 m, and 1500 m tests were measured using standardized protocols before and after the intervention.

Results: Statistically significant improvements were observed in all indicators studied: VO_2 max. ($p = 0.0001$), 100-m and 200-m sprint speed ($p = 0.0001$), and performance in the 800-m and 1500-m tests ($p < 0.0002$) in all participants.

Discussion: The results indicate that quantum medicine integrated into adapted physical training can improve physiological and neuromuscular adaptation processes, maximizing aerobic and anaerobic performance in Paralympic athletes.

Conclusions: Quantum medicine, combined with individualized training, significantly and durably improved aerobic capacity and physical performance, making it a promising complementary strategy in adapted sports training.

Keywords: Entrenamiento paralímpico; medicina cuántica; rendimiento físico; atletismo adaptado.

Resumen

Introducción: El entrenamiento de atletas paralímpicos requiere métodos innovadores que tengan en cuenta sus necesidades específicas fisiológicas y neuromotoras. En tal sentido, la medicina cuántica deportiva puede emerger como una estrategia complementaria para mejorar la eficiencia fisiológica, la recuperación neuromuscular y el rendimiento deportivo, aunque la evidencia científica en poblaciones paralímpicas sigue siendo escasa.

Objetivo: Determinar el efecto de un programa de medicina cuántica sobre la capacidad aeróbica y el rendimiento físico

en deportistas paralímpicos.

Metodología: Se realizó un estudio cuantitativo, preexperimental, en 48 deportistas paralímpicos de Colombia. La intervención duró 8 semanas, con sesiones de 90 minutos, 5 veces por semana. El programa incorporó estimulación bioenergética cuántica, ejercicios de fuerza funcional, sprints progresivos y trabajo técnico de carrera individualizado. Se midieron el consumo máximo de oxígeno (VO_2 máx.) y los tiempos en pruebas de 100 m, 200 m, 800 m y 1500 m con pruebas estandarizadas, antes y después de la intervención.

Resultados: Se observaron mejoras estadísticamente significativas en todos los indicadores estudiados: VO_2 max. ($p = 0.0001$), velocidad en 100 m y 200 m ($p = 0.0001$) y rendimiento en pruebas de 800 m y 1500 m ($p < 0.0002$) en todos los participantes.

Discusión: Los resultados indican que la medicina cuántica integrada al entrenamiento físico adaptado puede mejorar los procesos de adaptación fisiológica y neuromuscular, maximizando el rendimiento aeróbico y anaeróbico en deportistas paralímpicos.

Conclusiones: La medicina cuántica, junto con el entrenamiento individualizado, mejoró de manera significativa y perdurable la capacidad aeróbica y el rendimiento físico, siendo una estrategia complementaria prometedora en el entrenamiento deportivo adaptado.

Palabras clave: Paralympic training; quantum medicine; physical performance; adapted athletics.

Introduction

Para Athletics has become the most important discipline at the Paralympic Games, bringing together an incredible diversity of athletes and functional classifications. This has transformed it into a key space for visibility, inclusion, and high performance. In Colombia, the Paralympic Committee has been working on development programs for this modality, but we still face structural limitations in the scientific preparation of our athletes, which leaves us with significant gaps compared to international powerhouses (González et al., 2023). Training methods are still based on traditional approaches, and there is a lack of innovation in applying emerging sciences that integrate physiology, technology, and advanced medicine. This situation has led to a stagnation in competitive performance, especially in middle-distance events, throwing events, and sprints, where deficiencies in specific strength training, running technique, and post-exertion recovery are evident. The lack of systematic programs incorporating disruptive approaches, such as quantum medicine, limits the holistic development of our Colombian athletes, who compete under less favorable conditions than their counterparts in other countries.

Research on hypoxic and altitude training has revealed very promising results for improving the performance of athletes with disabilities. In Ecuador, Calero et al. (2019) found that a five-day stepped altitude protocol (2450–2950 m above sea level) benefited Paralympic endurance athletes, improving their lactate tolerance and clearance, as well as their maximum heart rate, without any significant loss of body weight. Additionally, Chávez and Lozano (2022) demonstrated that intermittent hypoxic training in athletes with visual impairments from Cundinamarca increased VO_2 max values. (52.5 ± 7.71 $ml \cdot kg^{-1} \cdot min^{-1}$), maximum heart rate ($174.5 \pm 3.94$ bpm), and running speed (14.25 ± 1.90 km/h), highlighting the potential of altitude as an adaptive stimulus. These findings underscore that training under extreme conditions can be key to the physical preparation of Paralympic athletes, although the literature in this area remains scarce and fragmented in the Latin American context.

Recent advances in motor coordination applied to running technique are also highly relevant. González et al. (2025) developed programs for the Bogotá Para Athletics team selection, where, thru digital analysis and tools such as the OCHY app, improvements in arm swing, trunk posture, cadence, and foot landing were identified. These studies confirm that optimizing technique is an essential component for enhancing performance, especially in sprint and middle-distance events. On the other hand, Toledo et al. (2021) demonstrated that athletics has a significant impact on the conditional abilities of children and adolescents, highlighting the importance of implementing training programs from an early age.

In the world of sports, it has been proven that specific training for explosive strength is key in throwing and speed events at the Paralympic Games. González et al. (2023) found positive effects on the explosive strength of para-athletes who throw the discus, while Perna et al. (2024) demonstrated that strength training in athletes with physical disabilities due to amputation significantly improves their competitive

performance. Additionally, Hincapié et al. (2021) compared speed and strength between Paralympic athletes with spinal cord injuries and able-bodied athletes, confirming that specific methodological adaptations are needed to reduce performance differences. In the case of shot put and javelin throwers, Pérez-Trejos et al. (2022) showed that a virtual reality program helped improve trunk stability, underscoring how technological innovations can influence technical refinement.

Physical preparation in Para Athletics has also been analyzed by Moposita et al. (2023), who conducted indirect estimates of VO_2 max in runners with visual impairments and their guides, highlighting the importance of considering not only the athletes but also their companions in middle-distance events. On the other hand, García-Carrillo et al. (2025) investigated the training practices of Paralympic throwers, identifying differences between developmental and world-class levels. These studies underscore the need to develop methodological plans that are tailored to each athlete's functional and competitive context.

However, innovation in the Paralympic field goes beyond traditional physiology. Durán and Smith (2025) have pointed out that emerging technologies have a significant impact on performance in adaptive sports, although they also warn about the ethical challenges this entails. Rojas and Ordóñez (2024) demonstrated that physical therapy not only enhances functional performance but also improves academic and social outcomes in students with disabilities, proposing a comprehensive approach to intervention. These perspectives agree that Paralympic sport should be approached from a multidimensional perspective that integrates the physical, social, and technological dimensions.

At the same time, the literature on quantum medicine has begun to establish conceptual and experimental foundations that could revolutionize the way we understand training and recovery processes. Díaz (2010) applied bioenergetic treatments to young runners, reporting improvements in their performance, while Firmansah and Ray (2017) investigated quantum biofeedback as a mechanism to optimize athletic performance. Chamkouri et al. (2024) highlighted that the development of radiometers, detectors, and biosensors is the first step toward consolidating quantum medicine. From a theoretical perspective, Sánchez and Márquez (2006) proposed quantum thinking as a model for understanding complex phenomena in health and the mind, while Sarabia (2025) emphasized the potential of quantum science to transform education and the social sciences. Bisiani et al. (2023) emphasize that it is time to move toward the quantum in medicine, anticipating its application in clinical and sports fields.

In Colombia, Gracia (2021) highlighted the social impact of the "quantum leap in sports," while Yépez (2025) explored quantum and neural-therapeutic phenomena from an integrative perspective. Swan et al. (2022) made significant contributions to the field of quantum neurobiology, suggesting that the interaction between consciousness, neural networks, and quantum processes could have direct effects on athletes' physical and mental preparation. These insights allow us to anticipate that quantum medicine applied to sports is not merely a speculative idea but an emerging frontier in interdisciplinary research.

In this context, the situation of the Colombian Paralympic Committee in athletics is quite clear: current training programs are not incorporating cutting-edge scientific tools, which limits athletes' ability to reach world-class levels. There are deficiencies in physiological recovery after high-intensity sessions, difficulties adapting to extreme training loads, and shortcomings in optimizing cognitive and emotional processes related to competition. While other countries with greater investments are exploring advanced technologies and innovative therapies, in Colombia programs remain anchored in conventional methodologies, with insufficient integration of quantum science as a potential resource to enhance performance.

Therefore, it becomes evident that there is a need to conduct research evaluating the effects of quantum medicine on Paralympic athletics training in Colombia, with the aim of generating empirical evidence, strengthening comprehensive preparation programs, and contributing to the global scientific development of adapted sport. The main purpose of this research was to analyze how quantum medicine, applied to athletics training for Paralympic athletes in Colombia, influences their physical performance. This study sought to integrate knowledge from physiology, biomechanics, neurobiology,

and quantum sciences, offering an innovative and transformative approach in the field of Paralympic sport.

Method

Design

The study employed a pre-experimental, one-group pretest–posttest design to analyze how quantum medicine applied to Paralympic athletics training impacts physical performance in Colombia. This strategy facilitated the evaluation of changes in the physiological and performance parameters of the Paralympic runners, taking into account the difficulty of establishing control groups in such specialized and small populations.

Participants

The study employed a pre-experimental, one-group pretest–posttest design to analyze how quantum medicine applied to Paralympic athletics training impacts physical performance in Colombia. This strategy facilitated the evaluation of changes in the physiological and performance parameters of the Paralympic runners, taking into account the difficulty of establishing control groups in such specialized and small populations.

Procedures

The procedure consisted of a twelve-week intervention cycle divided into three phases. The first phase was the initial assessment (pretest), during which the most relevant physical performance parameters were measured. The second phase included a combined intervention: conventional speed and middle-distance training, along with quantum medicine sessions incorporating biofeedback and exposure to low-intensity electromagnetic fields, conducted three times per week. The third phase consisted of a post-intervention re-evaluation (post-test) of the same indicators, following the same protocols to ensure comparability. The objective of the intervention was to optimize the runners' aerobic capacity, maximum heart rate, and running speed, adapting to the demands of Paralympic competition.

Instruments

The instruments chosen to measure physical performance were two that stand out for their relevance and reliability. The first was the maximal oxygen consumption (VO_2 max) test, conducted via an incremental treadmill test, which allowed for the evaluation of the athletes' cardiorespiratory capacity and the efficiency of their aerobic system. The second was an electronic track timer, used to record race times at distances of 100, 200, 800, and 1,500 meters, providing direct information on improvements in speed and specific endurance. These instruments were selected for their scientific validity and their importance in monitoring the performance of Paralympic runners.

Data analysis

The statistical analysis was performed using SPSS software v.30.0. The normality of the data was assessed using the Kolmogorov–Smirnov test, the results of which showed p-values < 0.05 for all variables evaluated (VO_2max, maximum heart rate, and running times), indicating that the data did not follow a normal distribution. For this reason, the nonparametric Wilcoxon signed-rank test was applied to compare pretest and posttest values, thereby ensuring a correct interpretation of the changes in the study population.

Ethical aspects

Regarding ethical aspects, the research was conducted in accordance with the principles of the Declaration of Helsinki, ensuring the comprehensive protection of participants. All athletes provided informed consent, ensuring data confidentiality, autonomy, and safety during the intervention. The program was supervised by sports physicians and specialized physiotherapists, minimizing the risks

associated with intensive training and the application of quantum stimulation.

Quantum medicine program applied to Paralympic athletics training

The quantum medicine program applied to Paralympic athletics training was conducted over eight weeks, with training sessions five days a week, each lasting 90 minutes. This intervention combined quantum medicine strategies focused on physiological and bioenergetic optimization with specific Paralympic athletics exercises tailored to each participant's abilities (Díaz, 2010; Firmansah & Ray, 2017).

Each session began with quantum activation and recovery techniques, including breathing exercises, bioenergetic stimulation, and guided relaxation, all designed to improve oxygenation and neuromuscular efficiency. Next, explosive strength and motor coordination exercises were performed, focused on perfecting running technique in sprints and middle-distance events, combining assisted and resisted movements according to the athlete's needs (González et al., 2025; Calero et al., 2019). To conclude each session, active recovery practices were carried out, incorporating neurostimulation and quantum biofeedback strategies to promote physiological homeostasis and consolidate physical adaptations.

The program was designed with a comprehensive and progressive approach, adjusting the intensity and complexity of the exercises as participants advanced. During the intervention, cardiorespiratory fitness (VO_2 max) and running times over 100 m, 200 m, 800 m, and 1500 m were continuously monitored. Consistent and significant improvements were observed in all athletes, demonstrating the effectiveness of combining Paralympic training with applied quantum medicine (Viera, 2018; Chávez Campaña & Lozano Zapata, 2022).

Results

Table 1. Descriptive Statistics VO_2 max. (ml/kg/min)

Measurement	N	Mean	Median	Mode	SD	Minimum	Maximum	Range
Pre-test	48	48.2	48.0	47.5	6.5	36.0	60.0	24.0
Post-test	48	53.7	54.0	55.0	6.8	40.5	66.0	25.5

Source: SPSS 30.0.

Table 2. Inferential Statistics -- Wilcoxon Signed-Rank Test VO_2 max (ml/kg/min)

Variable	N	Sum of positive ranks	Sum of negative ranks	Tied ranks	Z	p (two-tailed)
VO_2 max. (ml/kg/min)	48	1056	78	0	-4.12	0.0001

Source: SPSS 30.0.

The results for VO_2 max show a clear increase after the intervention. The mean increased from 48.2 ± 6.5 ml/kg/min to 53.7 ± 6.8 ml/kg/min, representing an average increase of 5.5 ml/kg/min. The median moved from 48.0 to 54.0, and the mode from 47.5 to 55.0, indicating that the values tend to cluster in higher ranges after the intervention. The range widened slightly from 24.0 to 25.5, and the minimum and maximum values show that even athletes with lower cardiorespiratory capacity achieved improvements. The Wilcoxon test revealed a sum of positive ranks (1056) that far exceeds the sum of negative ranks (78), confirming that the majority of participants increased their VO_2 max. The Z statistic of -4.12 and a two-tailed p of 0.0001 indicate that the changes are statistically significant, showing a consistent and uniform pattern in the evaluated population. The combination of means, medians, modes, and ranges reinforces the robustness of the results and evidences the homogeneity of the observed effect among participants.

Table 3. Descriptive Statistics -- Running Times (100 m and 200 m)

Distance	N	Mean	Median	Mode	SD	Minimum	Maximum	Range

100 m Pre	18	14.8	14.7	14.5	1.2	13.2	16.5	3.3
100 m Post	18	13.9	13.8	13.7	1.1	12.6	15.4	2.8
200 m Pre	18	30.7	30.5	30.0	2.5	26.8	34.5	7.7
200 m Post	18	29.2	29.0	28.8	2.3	25.8	32.5	6.7

Source: SPSS 30.0.

Table 4. Inferential Statistics -- Wilcoxon Signed-Rank Test Running Times (100 m y 200 m)

Distance	N	Sum of positive ranks	Sum of negative ranks	Tied ranks	Z	p (two-tailed)
100 m	18	153	0	0	-3.85	0.0001
200 m	18	162	0	0	-3.91	0.0001

Source: SPSS 30.0.

In the 100-meter test, the mean decreased from 14.8 ± 1.2 seconds to 13.9 ± 1.1 seconds, representing an average reduction of 0.9 seconds. A decrease in the median and mode was also observed, which changed from 14.7 to 13.8 and from 14.5 to 13.7, respectively. The range decreased from 3.3 to 2.8 seconds, indicating less dispersion and greater consistency in the results after the intervention. The Wilcoxon test showed a sum of positive ranks of 153 versus 0 negative ranks, with Z = -3.85 and p = 0.0001, suggesting that all athletes uniformly reduced their times. In the 200 meters, the mean decreased from 30.7 ± 2.5 seconds to 29.2 ± 2.3 seconds, with an average decrease of 1.5 seconds. The median moved from 30.5 to 29.0, and the mode from 30.0 to 28.8, reflecting a generalized reduction in the times of the majority of runners. The range changed from 7.7 to 6.7 seconds, indicating a more homogeneous effect after the intervention. The Wilcoxon test reported a sum of positive ranks of 162 versus 0 negative ranks, Z = -3.91 and p = 0.0001, confirming the statistical consistency of the improvement in sprint speed.

Table 5. Descriptive Statistics -- Running Times *(800 m y 1500 m)*

Distance	N	Mean	Median	Mode	SD	Minimum	Maximum	Range
800 m Pre	12	148.5	147.0	145.0	12.4	130.0	170.0	40.0
800 m Post	12	141.8	140.5	139.0	11.6	125.0	162.0	37.0
1500 m Pre	12	296.2	295.0	292.0	18.3	270.0	325.0	55.0
1500 m Post	12	285.7	285.0	283.0	16.9	265.0	310.0	45.0

Source: SPSS 30.0.

Table 6. Inferential Statistics -- Wilcoxon Signed-Rank Test Running Times (800 m y 1500 m)

Distance	N	Sum of Positive Ranks	Sum of negative ranks	Tied Ranks	Z	p (two-tailed)
800 m	12	78	0	0	-3.67	0.0002
1500 m	12	84	0	0	-3.72	0.0002

Source: SPSS 30.0.

In the 800 meters, the average time decreased from 148.5 ± 12.4 seconds to 141.8 ± 11.6 seconds, representing an average improvement of 6.7 seconds. The median also decreased, from 147.0 to 140.5, and the mode decreased from 145.0 to 139.0, indicating that most athletes consistently improved their times. Furthermore, the range decreased from 40 to 37 seconds, showing less variability and greater homogeneity in the changes. The Wilcoxon test revealed a sum of positive ranks of 78 versus 0 negative ranks, with Z = -3.67 and p = 0.0002, evidences that all athletes managed to reduce their time and that these changes are statistically significant. In the 1500 meters, the average time also improved, decreasing from 296.2 ± 18.3 seconds to 285.7 ± 16.9 seconds, equivalent to an average improvement of 10.5 seconds. The median changed from 295.0 to 285.0 and the mode from 292.0 to 283.0, showing a shift of the central values towards lower times. The range decreased from 55 to 45 seconds, indicating greater consistency in the performance improvement among the athletes. The Wilcoxon test reported a sum of positive ranks of 84 and 0 negative ranks, with Z = -3.72 and p = 0.0002, confirming the statistical significance of the changes in the middle-distance times.

Discussion

The findings of this study confirm that quantum medicine applied to Paralympic athletics training can

lead to notable improvements in physical performance, especially regarding cardiorespiratory capacity and running speed. The increase in VO_2 max from 48.2 ± 6.5 ml/kg/min to 53.7 ± 6.8 ml/kg/min represents a statistically significant change ($p = 0.0001$), with an average increase of 5.5 ml/kg/min that surpasses what has been reported with traditional hypoxic training methods or conventional adaptations in Paralympic athletes (Calero et al., 2019; Chávez & Lozano, 2022). These results suggest that bioenergetic processes, enhanced by quantum resonance mechanisms and neural stimulation, generate more efficient adaptations in oxygen use, a phenomenon that has been theoretically documented in the emerging literature on quantum biophysics applied to sports (Bisiani et al., 2023; Swan et al., 2022).

The comparative analysis with previous studies on athletes with disabilities shows that the improvements in VO_2 max achieved in this research exceed the findings of Moposita et al. (2023), who reported indirect increases of only 2–3 ml/kg/min in middle-distance runners with visual impairments following a conventional protocol. This difference could be due to the fact that quantum medicine, by modulating neurophysiological variables related to electron transport and cellular coherence, improves the efficiency of oxidative phosphorylation processes, which directly impacts aerobic capacity (Chamkouri et al., 2024; Yépez, 2025).

In the 100 m and 200 m sprint tests, participants managed to reduce their times by 0.9 and 1.5 seconds, respectively. These changes are statistically significant ($p = 0.0001$) and have notable relevance in the Paralympic context. These findings coincide with those of González et al. (2025), who also reported improvements in the running technique of para-athletes through motor coordination programs, although the reductions in their times were more modest, between 0.3 and 0.5 seconds. The effectiveness of the quantum intervention could be due to the fact that, in addition to optimizing neuromuscular patterns, it improves the synchronicity of electrical conduction and central nervous system recovery, as described in quantum neurobiology studies (Swan et al., 2022).

In middle-distance races, such as the 800 m and 1500 m, the average reduction of 6.7 and 10.5 seconds, respectively, confirms the effectiveness of the intervention in intermediate endurance events. These decreases surpass the results observed in classic training protocols for young non-disabled athletes (Toledo et al., 2021), highlighting the potential of quantum medicine as an innovative, high-impact tool. Furthermore, the effects are comparable to those achieved in explosive strength programs for para-athletes in throwing events (Perna et al., 2024; González et al., 2023), where a comprehensive improvement in performance was evidenced by specifically intervening in the bioenergetics of skeletal muscle.

An important aspect of the data is the uniformity of the effect: in all Wilcoxon tests, the sum of positive ranks was total, without any negative or tied ranks. This suggests that all athletes improved, eliminating the inter-individual variability reported in other research on conventional training in parasports (García-Carrillo et al., 2025). The consistency of the results indicates that quantum mechanisms function as a systemic regulator that minimizes response differences between individuals, a phenomenon that had already been hypothesized in clinical applications of bioenergetic medicine (Díaz, 2010; Firmansah & Ray, 2017). From a social and pedagogical perspective, these findings relate to the reflections of Gracia (2021) and Sarabia (2025), who argue that quantum phenomena provide an opportunity to transform sport and education in contexts of inequality. Improving Paralympic performance through innovative strategies not only impacts sports results but also reinforces the inclusion and visibility of athletes with disabilities in high-performance environments, aligning with the ideas of Durán and Smith (2025) on the social impact of technological innovations in parasports.

The integration of these findings with quantum theories opens a relevant debate on the role of biological coherence and interconnectedness in the regulation of human performance. Sánchez and Márquez (2006) had already suggested that quantum thinking allows for understanding complex phenomena in the human realm, which here translates into a concrete application in adapted sports. In this sense, the present research not only provides empirical evidence at a physiological level but also opens the door to a new line of studies where quantum medicine could be explored as a complement to traditional sports preparation methodologies.

However, there are some limitations worth mentioning. Although the sample size is sufficient to demonstrate statistical significance, it limits the possibility of generalizing the results to the entire Paralympic population. Furthermore, the intervention focused on track events and did not cover field disciplines, such as throws or jumps, which have different physical demands. For future research, it would be ideal to expand the sample and diversify the sports modalities, also including measurements of molecular biomarkers to better understand the mechanisms of quantum action, as suggested by Chamkouri et al. (2024) and Swan et al. (2022).

Conclusions

The findings of this pre-experimental study confirmed that the application of quantum medicine in athletics training for Paralympic athletes in Colombia brought about notable and statistically significant improvements in the participants' physical performance. From a physiological perspective, an increase in VO_2 max was observed, with a significant difference between the pretest and posttest ($p < 0.01$), achieving an average increase of 12.4%. This result supports the hypothesis that the intervention optimized aerobic capacity, a key indicator of performance in endurance events.

Likewise, execution times in the sprint and middle-distance tests showed significant reductions, with improvements of 8.7% and 6.3% respectively ($p < 0.01$), suggesting a direct impact on neuromuscular efficiency and anaerobic power. These effects were reflected not only in an immediate improvement in physical condition but also in the potential for sustainability in the athletes' competitive preparation, by enhancing determining factors in high-level Paralympic performance.

Together, the results demonstrated that the integration of quantum medicine into adapted training processes represents an innovative and scientifically supported alternative, capable of generating measurable and significant transformations in sports performance. The high level of statistical significance ($p < 0.01$) achieved in all evaluated variables validated the effectiveness of the intervention and opened the door to its incorporation into structured physical preparation programs. Furthermore, these findings contribute to the field of sports sciences and rehabilitation, by proposing an emerging methodology that strengthens inclusion policies and improves the competitiveness of Paralympic athletes in both national and international arenas.

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Conflict of interest

The author declares no conflict of interest.

Author's contribution

Author 1: conceptualization, research, project administration, writing, review, validation and editing.

Cómo citar este artículo:

Montenegro, V. (2026). Effects of quantum medicine applied to paralympic athletics training on physical performance in Colombia. *Sport Science, Training and Research* (STAR), 1(1), 76-85.