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ORIGINAL RESEARCH

Acute neuromuscular fatigue responses to Russian current in Paralympic powerlifting athletes

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Abstract

Background: Paralympic powerlifting (PP) focuses on increasing strength through specific mechanical adaptations. Neuromuscular activations are known to differ between conventional and Paralympic athletes, making it essential to investigate strategies to optimize training and improve performance in the sport. This study investigates the impact of Russian current associated with traditional training on dynamic strength indicators (speed and power) in PP athletes after a single session. **Methods**: This is a randomized crossover clinical trial, conducted over three weeks, in which maximum velocity (MV), mean propulsive velocity (MPV), and power (PO) were analyzed before, during, after, 24 h, and 48 h after the intervention. In the first week, athletes performed initial and familiarization tests. In the following weeks, they underwent conventional training (TT) and training preceded by electrical stimulation (TPE), with protocols reversed between weeks. **Results**: At 45% of 1RM (maximum repetition), there was a significant reduction in power between the time points after 24 h (466.40 W) and before (522.69 W) (p = 0.009), with no differences between the conditions. At 80% of 1RM, MPV differed in series 4 (p = 0.026) and MV in series 1 (p = 0.020) and 4 (p = 0.003). There was no impact on power. **Conclusions**: Acute use of electrostimulation did not improve performance. **Clinical Trial Registration**: https://ensaiosclinicos.gov.br/rg/RBR-8ypr4kj, RBR-8ypr4k (Retrospectively registered).

Keywords

Paralympic powerlifting; Strength training; Electrostimulation; Electrical stimulation; Russian current

1. Introduction

Paralympic Powerlifting is a parasport regulated by the International Paralympic Committee (IPC), featuring a single competitive event: the adapted bench press. In this discipline, athletes with lower limb impairments and/or cerebral palsy compete in body weight categories, aiming to lift the maximum possible load in a valid movement [1].

Evidence suggests that Paralympic powerlifters generally exhibit greater strength than conventional powerlifting [1, 2]. Furthermore, neuromuscular activation and velocity profiles differ from those of non-disabled individuals [3–5]. Consequently, optimizing training methodologies to maximize athletic performance is essential, and numerous studies have explored alternative training approaches for Paralympic powerlifters to enhance their performance [6–9].

Neuromuscular electrical stimulation (NMES) has emerged as a widely utilized and efficacious alternative strength training method, potentially leading to improvements in muscular strength, hypertrophy, movement velocity, and muscular endurance [10–12]. Among NMES modalities, Russian current (RC) is classified as a medium-frequency current (with a carrier frequency of 2500 Hz), modulated by a wave varying from 10 to 200 Hz. It is extensively employed for excitomotor purposes due to its ability to reach deeper tissue structures compared to low-frequency currents. RC stimulates motor nerves, depolarizing membranes and inducing stronger, synchronized muscle contractions, resulting in muscular strengthening with minimal discomfort to the user [13, 14].

Although there is still controversy in the literature regarding the application of Russian current therapy, numerous studies indicate strength gains both after long periods of disuse and in trained individuals [11, 12, 15, 16]. Thus, we investigated the effect of applying Russian electric current in pre-training with fixed resistance on dynamic strength indicators—speed and power—in Paralympic weightlifters during a single training session. We hypothesize that the Russian current will enhance the speed of movement of the bar and the power of these individuals.

2. Materials and methods

2.1 Study design

This study was designed as a randomized crossover clinical trial (Fig. 1). The re-search was conducted over a three-week period (Fig. 2), with participants undergoing measurement of study variables at pre-intervention, post-intervention, 24 hours post-intervention, and 48 hours post-intervention time points. In the first week, participants underwent an initial assessment where body mass wasf measured and a maximum repetition (1RM) test was performed. After a 48-hour interval, a familiarization session was conducted to acquaint participants with the Russian current stimulation, equipment, and study procedures. During weeks 2 and 3, participants were subjected to two intervention protocols: traditional training (TT) and training preceded by electrostimulation (TPE).

2.2 Sample

The sample consisted of 15 male athletes recruited through a university extension group at the Federal University of the Sergipe in July 2024. The characteristics of the participants are presented in Table 1. Of these, 4 had arthrogryposis, 3 were sequelae of spinal cord trauma, 3 were amputees, 2 had congenital malformations, 2 presented sequelae of poliomyelitis, and 1 had myelomeningocele.

2.3 Inclusion/exclusion criteria

Inclusion criteria required participants to have at least 18 months of experience, participation in at least one official Brazilian Paralympic Committee competition, and a ranking within the top 10 in their respective weight categories. Exclusion criteria included pain, intolerance to electrostimulation, injury or need for medical/physiotherapeutic intervention during the study period, use of analgesics, tranquilizers, antidepressants, or any central-acting medication, inability to complete the study, and/or withdrawal.

2.4 Procedures and instruments

The study was conducted over three weeks. In the first week, body mass was measured and the 1RM test was applied. After a 48-hour interval, participants underwent a familiarization session with Russian current (limited interval of 5 minutes), followed by randomization to define the order of the disciplines. In weeks 2 and 3, the experimental protocols were applied: traditional training (TT) and training preceded by electrostimulation (TPE).

Both TT and TPE consisted of five sets of five repetitions with an isoinertial load corresponding to 80% of 1RM in the adapted bench press exercise at the maximum possible speed. The protocol was preceded by five minutes of upper limb cycle ergometry, specific stretches for the pectorals, triceps and deltoids, and a specific warm-up consisting of eight repetitions

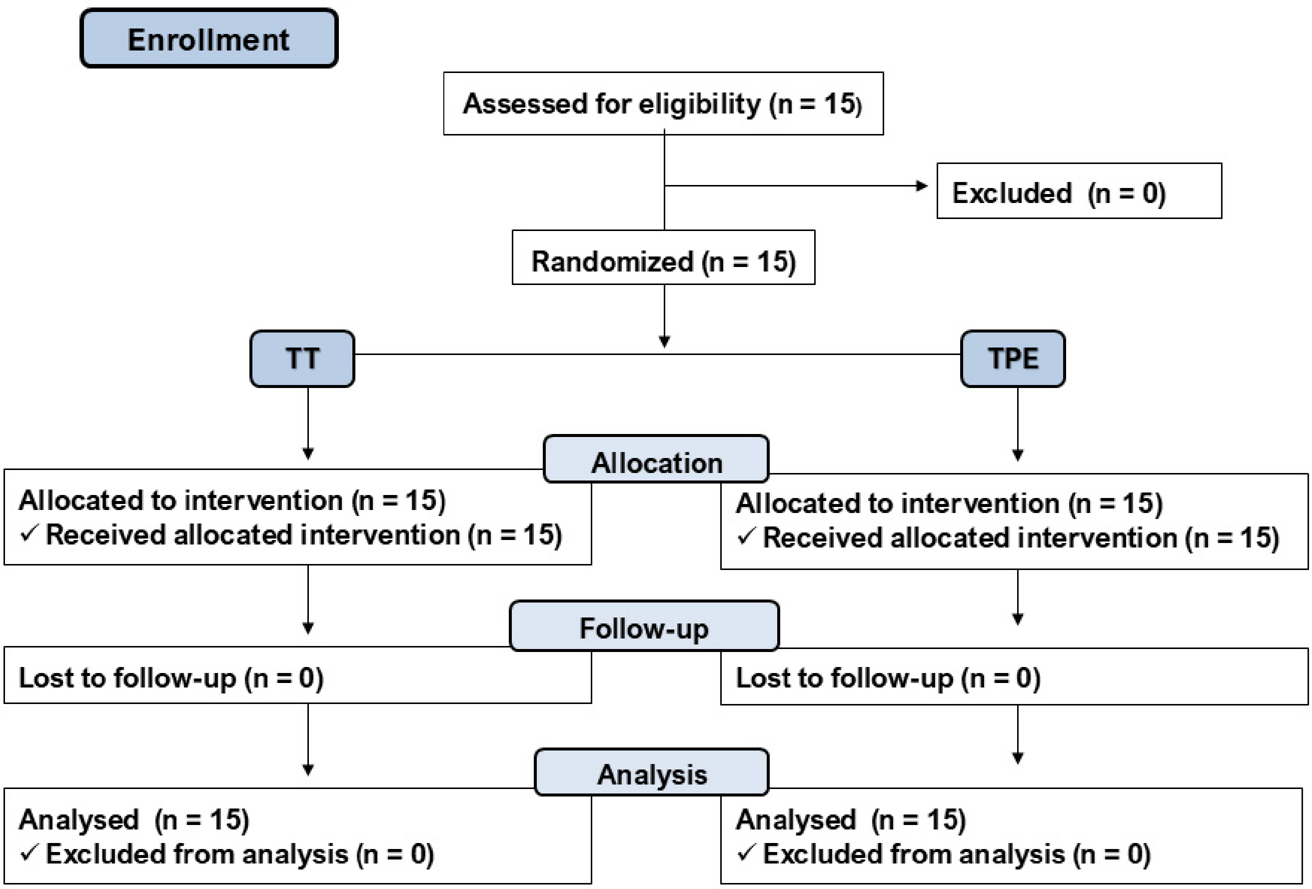

FIGURE 1. CONSORT diagram. TT: Traditional training; TPE: Training preceded by electrostimulation.

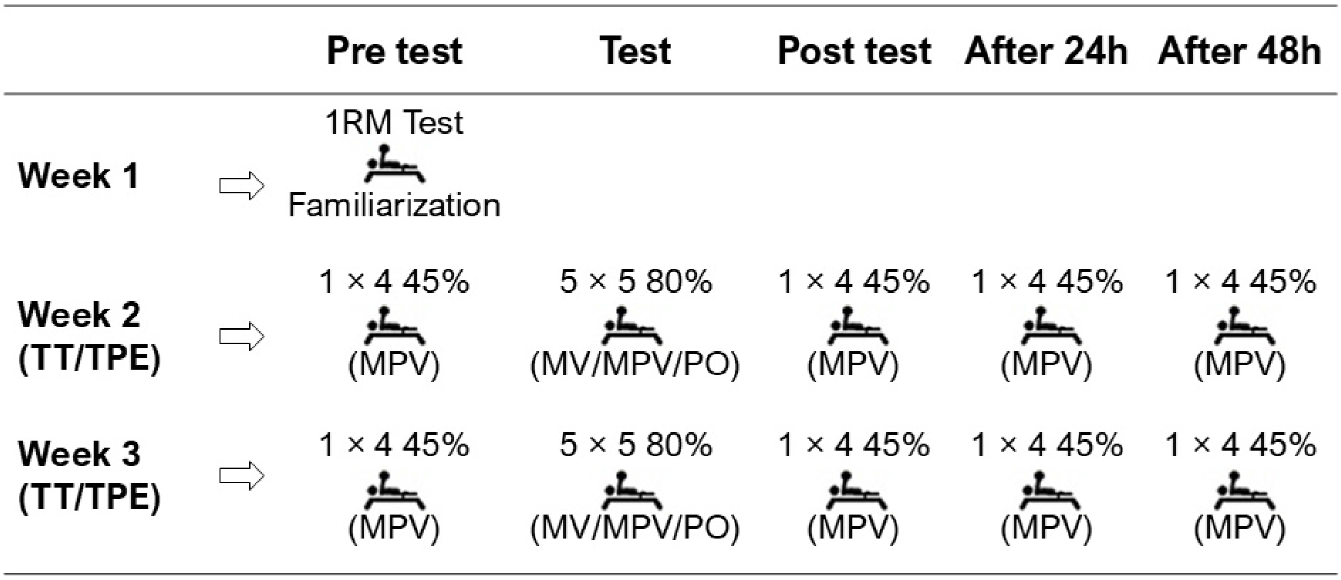

FIGURE 2. Experimental design. TT: Traditional training; TPE: Training preceded by electrostimulation; 1RM: Maximum repetition; MPV: mean propulsive velocity; MV: Maximum velocity; PO: Power.

TABLE 1. Sample characteristics.

Characteristic	Mean ± Standard Deviation
Age (yr)	31.67 ± 8.76
Body Weight (kg)	80.79 ± 22.71
1RM test (bench press) (kg)	135.33 ± 34.47
1RM test/Body Weight	1.72 ± 0.34

1RM: Maximum repetition.

at 50% and three repetitions at 70% of the estimated 1RM. In the TPE condition, after warm-up and before training (5 × 5 at 80% of 1RM), participants received neuromuscular electrical stimulation using Russian current, applied with the Neurodyn 2.0 device (Ibramed, Amparo, SP, Brazil), at 2500 Hz modulated at 50 Hz, for 10 minutes. The protocol used cycles of 3 s "on", 1 s of "rise", 1 s of "decay" and 15 s "off", with intensity adjusted above motor limits and below pain limits. The stimulus was applied using insulated cables connected to self-adhesive electrodes positioned over the muscle belly of the pectoralis major, anterior deltoid and triceps brachii.

Body mass was measured using a digital electronic platform scale, model Mic Welcair (Michetti, São Paulo, SP, Brazil), allowing weighing in a seated position.

The training load was determined using the 1RM test in the bench press exercise. Each participant performed the test with a load that they felt they could lift only once, with the weight being progressively adjusted until the individual maximum load was delivered. In case of failure to perform the exercise, the load was reduced by between 2.4% and 2.5% of the value used. The protocol was limited to a maximum of five attempts, with rest intervals of 3 to 5 minutes between them [7].

Measurements of maximum velocity (MV), mean propulsive velocity (MPV) and power (PO) were obtained using a Speed4Lift linear position transducer (Vitruve, Madrid, Spain) [17], fixed vertically on the left side of the bench press bar using a Velcro strap. The analysis of these sessions was performed at pre-intervention, post-intervention, 24 hours and 48 hours after the training session, using a load corresponding to 45% of 1RM and during an intervention of five sets of five repetitions with 80% of 1RM.

2.5 Statistics

Descriptive statistics were calculated, presenting mean ($\bar{x}$) ± standard deviation (SD). The Shapiro-Wilk test was employed to assess the normality of variable distributions, given the sample size. To evaluate mean propulsive velocity, maximum velocity, and power across series, a two-way repeated measures ANOVA (analysis of variance) was conducted. In instances where sphericity was violated, the Greenhouse-Geisser correction procedure was applied. When significant main effects were observed, Bonferroni *post hoc* analyses were performed to identify specific differences.

Effect sizes were quantified using partial eta squared (η^2) values, interpreted as follows: small effect (≤0.05), medium effect (0.05 to 0.25), large effect (0.25 to 0.50), and very large effect (>0.50). All statistical analyses were executed using the Statistical Package for Social Sciences (SPSS) version 22.0 (IBM, Armonk, NY, USA). The threshold for statistical significance was set at $p < 0.05$.

3. Results

At 45% of 1RM, no statistically significant differences were observed in mean propulsive velocity or maximum velocity between traditional training and training preceded by electrostimulation conditions, nor across time points.

Regarding power output, a significant difference ($p = 0.009$) was detected when comparing the 24-hour post-intervention (466.40 W) to pre-intervention (522.69 W) measurements in the TT condition, with a large effect size, as presented in Table 2. This represents a 10.77% decrease in power output 24 hours post-intervention compared to baseline. No significant differences were found between TT and TPE conditions for any of the measured variables.

At 80% of 1RM (Table 3), significant differences were observed in kinematic variables between traditional training and training preceded by electrostimulation conditions. Mean Propulsive Velocity showed a significant difference in set 4 ($p = 0.026$), with a medium effect size. Maximum Velocity exhibited significant differences in set 1 ($p = 0.020$; TT = 0.49 m/s *vs.* TPE = 0.40 m/s) and set 4 ($p = 0.003$; TT = 0.49 m/s *vs.* TPE = 0.41 m/s), both with large effect sizes. No significant differences were observed in power output between time points or conditions.

4. Discussion

The objective of this study was to evaluate the acute effects of pre-exercise Russian current electrostimulation on velocity and power output parameters in Paralympic powerlifters following a single resistance training session. The results revealed significant findings across different load intensities. At 45% of maximum repetition, a statistically significant difference in power output was observed when comparing the 24-hour post-intervention to pre-intervention measurements in the traditional training condition. At 80% of 1RM, mean propulsive velocity exhibited a significant difference between conditions in the fourth set, while maximum velocity showed significant differences between conditions in both the first and fourth sets. The findings of the present study reinforce that the acute application of Russian current may increase neuromuscular fatigue, particularly under higher load conditions. The reduced bar velocity observed in the TPE condition at 80% 1RM suggests that electrical stimulation prior to training may induce non-physiological recruitment patterns, as NMES does not follow the orderly, size-dependent motor unit activation typical of voluntary contractions [18, 19]. Moreover, motor point stimulation may generate antidromic activation and disrupt afferent signaling [20], potentially compromising the efficiency of force production during subsequent voluntary efforts. Given that movement velocity is highly sensitive to acute neuromuscular fatigue [21], the decreases observed in the TPE condition align with mechanisms indicative of increased neural and mechanical stress rather than improved readiness for high-intensity performance.

This interpretation is further supported by evidence showing that Paralympic powerlifters exhibit distinct neuromuscular characteristics, including lower absolute bar velocities and unique fatigue responses [4, 5]. Although the initial hypothesis suggested that Russian current might enhance motor unit recruitment and potentiate bar velocity, the lack of improvements—and the inferior performance in key sets—are consistent with findings that NMES may increase the neuromuscular cost of the task without translating into enhanced mechanical output. Considering that velocity loss is a reliable indicator of neuromuscular fatigue [22], the pattern observed in the present study suggests that acute Russian current stimulation may exacerbate fatigue accumulation, particularly in high-load bench press efforts characteristic of Paralympic

TABLE 2. Mean Propulsive Velocity (MPV), Maximum Velocity (MV), Power (PO) at 45% of 1RM (Mean ± SD; 95% CI) at different times with traditional training and with training preceded by electrostimulation in Paralympic powerlifting.

	MPV (m/s)	MV (m/s)	PO (W)
Before Traditional[a]	0.89 ± 0.17 (0.80–0.99)	1.26 ± 0.19 (1.15–1.37)	522.69 ± 140.98 (444.62–600.76)
Before Electrostimulation[b]	0.89 ± 0.19 (0.78–1.00)	1.26 ± 0.25 (1.12–1.39)	516.22 ± 154.51 (430.65–601.79)
After Traditional[c]	0.94 ± 0.18 (0.84–1.04)	1.34 ± 0.25 (1.20–1.47)	536.60 ± 190.09 (431.33–641.87)
After Electrostimulation[d]	0.88 ± 0.19 (0.78–0.99)	1.20 ± 0.20 (1.09–1.31)	515.89 ± 159.89 (427.34–604.43)
24 h Traditional[e]	0.85 ± 0.11 (0.79–0.91)	1.19 ± 0.13 (1.12–1.26)	**466.40 ± 114.34[a] (403.08–529.72)**
24 h Electrostimulation[f]	0.83 ± 0.12 (0.77–0.90)	1.18 ± 0.13 (1.11–1.25)	491.60 ± 136.62 (415.94–567.25)
48 h Traditional[g]	0.87 ± 0.11 (0.81–0.93)	1.19 ± 0.12 (1.12–1.26)	487.20 ± 119.31 (421.13–553.27)
48 h Electrostimulation[h]	0.87 ± 0.18 (0.77–0.97)	1.19 ± 0.19 (1.08–1.29)	506.71 ± 148.66 (424.39–589.03)
p	$p = 0.233$	$p = 0.089$	$p = 0.009$*,[a]
F			6.991*
η_p^2			0.333*

*$p \leq 0.05$ (ANOVA two way and Post Hoc Bonferroni). η_p^2 = partial eta square (small effect ≤0.05, medium effect 0.05 to 0.25, high effect 0.25 to 0.50, and very high effect (>0.50). *Intraclass. Superscript letters ("a–h") identify specific time points and are used to facilitate pairwise comparisons. Bold text was used to indicate where the statistical difference was observed.*

TABLE 3. Mean Propulsive Velocity (MPV), Maximum Velocity (MV), Power (PO) at 80% of 1RM (Mean ± SD; 95% CI) at different times with traditional training and with training preceded by electrostimulation in Paralympic powerlifting.

	MPV (m/s)	MV (m/s)	PO (W)
S1 Traditional[a]	0.33 ± 0.09 (0.28–0.38)	0.49 ± 0.14 (0.41–0.57)	325.77 ± 95.06 (273.12–378.41)
S1 Electrostimulation[b]	0.29 ± 0.08 (0.24–0.33)	**0.40 ± 0.10[a] (0.35–0.46)**	297.10 ± 102.93 (240.10–354.10)
S2 Traditional[c]	0.34 ± 0.12 (0.27–0.40)	0.48 ± 0.16 (0.40–0.57)	325.23 ± 114.77 (261.67–388.79)
S2 Electrostimulation[d]	0.31 ± 0.10 (0.25–0.36)	0.42 ± 0.13 (0.35–0.49)	314.13 ± 112.83 (251.65–376.62)
S3 Traditional[e]	0.30 ± 0.08 (0.26–0.35)	0.44 ± 0.10 (0.38–0.50)	303.20 ± 102.48 (246.45–359.95)
S3 Electrostimulation[f]	0.31 ± 0.12 (0.24–0.37)	0.44 ± 0.16 (0.35–0.53)	313.58 ± 131.72 (240.64–386.53)
S4 Traditional[g]	0.33 ± 0.09 (0.28–0.38)	0.49 ± 0.12 (0.43–0.56)	339.18 ± 132.99 (239.01–361.19)
S4 Electrostimulation[h]	**0.29 ± 0.10[g] (0.23–0.34)**	**0.41 ± 0.13[g] (0.34–0.48)**	300.10 ± 110.32 (239.01–361.19)
S5 Traditional[i]	0.29 ± 0.13 (0.22–0.36)	0.45 ± 0.16 (0.36–0.54)	279.43 ± 127.98 (208.56–350.31)
S5 Electrostimulation[j]	0.31 ± 0.09 (0.26–0.36)	0.44 ± 0.13 (0.37–0.52)	322.90 ± 127.77 (252.14–393.66)
p	$p = 0.026^{\#,g}$	$p = 0.020^{\#,a}$, $p = 0.003^{\#,g}$	$p = 0.087$
F	$1.826^{\#}$	$6.434^{\#}$	
$\eta_p{}^2$	$0.115^{\#}$	$0.315^{\#}$	

$p \leq 0.05$ (ANOVA two way and Post Hoc Bonferroni). $\eta_p{}^2$ = partial eta square (small effect ≤0.05, medium effect 0.05 to 0.25, high effect 0.25 to 0.50, and very high effect (>0.50). #Interclass. Superscript letters ("a–j") identify specific time points and are used to facilitate pairwise comparisons. Bold text was used to indicate where the statistical difference was observed.

powerlifting.

According to French, Kraemer and Cooke [18], the recruitment of motor units induced by electrostimulation differs from that of voluntary contraction. During electrostimulation, both slow-twitch and fast-twitch fibers are recruited simultaneously, whereas voluntary contraction follows an orderly recruitment pattern, with slow-twitch fibers initially activated.

Given this information, our findings present intriguing questions. When comparing the 45% 1RM load, a significant difference in power output was observed only in the traditional training condition, contrary to our expectations that electrostimulation would enable athletes to generate greater power under the same load. Mocaluso and De Vito [23], defines muscle power as the product of force and velocity. Based on this concept, electrostimulation's primary advantage should be the simultaneous activation of both type I and type II muscle fibers, theoretically resulting in higher power outputs at the same workload compared to traditional training. However, this phenomenon was not observed in our study.

Sale [19] described the recruitment of motor units in order of increasing size and effort, with smaller units being activated before larger ones, which is essential for efficient activation. Considering that we used loads below 50% of 1RM, and according to French, Kraemer and Cooke [18], electrical stimulation could promote synchronous activation of motor units, theoretically the power should be increased compared to conventional training. However, the findings of Nakagawa *et al.* [21] suggest that electrical stimulation at the motor point may not adequately activate the IA sensory nerves (primary afferents), which would result in antidromic activation (where the impulses do not follow the natural route and return to the cell body). This may alter the pattern of force and power production, not enhancing the expected effects of electrical stimulation. Although it was not possible to test these hypotheses in our study, this theory may explain the absence of the expected results, given that electrostimulation should activate all motor units at lower loads, while traditional training follows the progressive activation of motor units.

Regarding the data analysis, only the traditional training group exhibited significant power output differences between pre-intervention and 24-hour post-intervention measurements, indicating impaired rapid force production capacity in the athletes. The literature describes movement velocity-based training control as the gold standard for non-invasive analysis [21]. However, our research group has been debating the application of this method for strength training, particularly in Paralympic Powerlifting (PP) [5]. Our studies have shown that velocity does not consistently yield unanimous results for this group in dynamic conditions. In a more recent study, Filho *et al.* [9] did not identify significant power differences for traditional training, but did observe differences in thermal variables. In our results, despite mean propulsive velocity showing different absolute values between pre-intervention (0.89 m/s) and 24-hour post-intervention (0.85 m/s) in traditional training, these differences were not statistically significant. However, power out-put values demonstrated significance (522.69 W versus 466.40 W), exhibiting the expected behavior of capacity loss following a training session. Contrary to expectations, this significant difference was observed in power output rather than MPV, despite MPV being considered more reliable for neuromuscular assessments according to Sanchez-Medina, Perez [22]. Analysis of raw data indicates that training preceded by electrostimulation shows a slight performance decrease when comparing pre-intervention (0.89 m/s) to post-intervention (0.88 m/s) measurements, suggesting a greater tendency towards fatigue with this training method compared to traditional training.

These findings suggest that the application of electrostimulation prior to resistance training did not confer any acute performance benefits in terms of velocity or power out-put compared to traditional training alone. The observed decrease in power output 24 hours post-intervention in the TT condition may be indicative of residual fatigue or delayed onset muscle soreness (DOMS) following the training session.

Another intriguing finding is that, due to the simultaneous contraction induced by electrostimulation, we anticipated superior bench press velocity responses in the electrostimulation preceded training condition compared to the traditional training condition, either across all sets or at least in the initial sets. However, when analyzing the 80% 1RM load, significant differences in mean propulsive velocity between conditions were observed only in set 4, and in maximum velocity only in sets 1 and 4. In both instances, the TT condition exhibited superior velocity responses. As previously mentioned, the inter-set velocity behavior did not align with our expectations across conditions. The mean values for TT were higher than those for TPE, and even within the TT condition, the velocity differences were minimal, even in raw data. We posit that MPV may not be sufficiently sensitive for this training modality. The majority of studies reporting optimal results with movement velocity are characteristic of hypertrophy or endurance-oriented training [24–28]. In Paralympic Powerlifting, certain factors are known to be specific, such as lower velocities compared to non-disabled athletes [29], and non-significant levels of oxidative stress for this training profile [30].

These findings indicate that the application of electrostimulation prior to resistance training may have a detrimental effect on velocity parameters, particularly in later sets of the exercise. The absence of significant differences in power output suggests that the observed velocity decrements did not translate into meaningful changes in overall power production.

Despite the relevance of the results obtained, this study has some limitations. This study employed electrostimulation before traditional training, and perhaps this cumulative stimulation generated greater fatigue, resulting in more pronounced results for traditional training. If we had analyzed the isolated effect of electrostimulation, we might have observed different responses. Other relevant limitations concern the acute nature of the assessment, performed in a single training session, and the limited number of participants in the participants [15]; however, this small participant size is justified by the fact that they are elite athletes in the sport at the national level.

The integration of electrical stimulation into training may increase neuromuscular fatigue and should be approached with caution, especially during competitive periods. For a better understanding of the observed phenomena, further studies are needed, ad-dressing these issues more comprehensively.

5. Conclusions

Acute Russian current stimulation failed to elicit any performance enhancing effect in Paralympic powerlifters and, instead, promoted responses indicative of heightened neuromuscular fatigue, particularly under high-load conditions. These findings challenge the assumption that pre-activation with electrical stimulation can acutely potentiate strength-related tasks in this population. From a practical standpoint, coaches and practitioners should consider that Russian current may transiently impair, rather than facilitate, the mechanical output required in maximal or near-maximal bench press efforts. Future investigations should evaluate alternative stimulation strategies and determine whether chronic adaptation differs from the acute responses documented here.

AVAILABILITY OF DATA AND MATERIALS

The data that support this study will be made available on request.

AUTHOR CONTRIBUTIONS

TPS, FJA—conceptualization; methodology; investigation. MGM—software; validation. DRG—formal analysis. FJA—resources; project administration; funding acquisition. TPS—data curation. TPS, FJA, MT, GB—writing–original draft preparation. GB, MT, LPA—writing–review and editing. MGM, MT, GB, DRG, PSP—visualization. LPA, TPS—supervision. All authors have read and agreed to the published version of the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study adhered to ethical guidelines for human research as outlined in Resolution No. 466 of 12 December 2012, by the National Health Council, and the ethical principles of the Declaration of Helsinki (1964, revised in 1975, 1983, 1989, 1996, 2000, 2008, and 2013) by the World Medical Association. The research was approved by the Ethics Committee of the Federal University of Sergipe (CAAE: 67953622.7.0000.5546/Opinion 6.523.247/23). All athletes voluntarily participated in this study and provided written informed consent.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest. Georgian Badicu is serving as one of the Editorial Board members of this journal.

We declare that Georgian Badicu had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to PMF.

REFERENCES

[1] International Paralympic Committee. History of para powerlifting. 2024. Available at: https://www.paralympic.org/powerlifting/about (Accessed: 26 December 2024).

[2] van den Hoek D, Garrett J, Howells R, Latella C. Paralympians are stronger than you know: a comparison of para and nondisabled powerlifting bench press world records. The Journal of Strength & Conditioning Research. 2023; 37: 452–456.

[3] Ribeiro Neto F, Dorneles JR, Costa RRG. Are the flat and arched bench press really similar? Sports Biomechanics. 2023; 22: 784–785.

[4] Loturco I, Pereira LA, Winckler C, Santos WL, Kobal R, McGuigan M. Load-velocity relationship in national Paralympic powerlifters: a case study. International Journal of Sports Physiology and Performance. 2019; 14: 531–535.

[5] Getirana-Mota M, Aidar FJ, Ribeiro Neto F, Santos TP, Almeida-Neto PF, Cabral BGAT, *et al*. Comparison of neuromuscular fatigue in powerlifting Paralympics in different training methods. Sports Medicine International Open. 2024; 8: a22077922.

[6] Mendonça TP, Aidar FJ, Matos DG, Souza RF, Marçal AC, Almeida-Neto PF, *et al.* Force production and muscle activation during partial *vs.* full range of motion in Paralympic powerlifting. PLOS ONE. 2021; 16: e0257810.

[7] Aidar FJ, Clemente FM, de Lima LF, de Matos DG, Ferreira ARP, Marçal AC, *et al*. Evaluation of training with elastic bands on strength and fatigue indicators in Paralympic powerlifting. Sports. 2021; 9: 142.

[8] Shi L, Cai Z, Chen S, Han D. Acute effects of variable resistance training on force, velocity, and power measures: a systematic review and meta-analysis. PeerJ. 2022; 10: e13870.

[9] Filho GFDS, Aidar FJ, Getirana-Mota M, Brito CJ, Aedo-Muñoz E, de Almeida Paz Â, *et al.* Analysis of velocity, power and skin temperature in Paralympic powerlifting athletes with fixed and variable resistance. Sports. 2024; 12: 250.

[10] Lee MC, Ho CS, Hsu YJ, Wu MF, Huang CC. Effect of 8-week frequency-specific electrical muscle stimulation combined with resistance exercise training on muscle mass, strength, and body composition in men and women: a feasibility and safety study. PeerJ. 2023; 11: e16303.

[11] Akagi R, Miyokawa Y, Shiozaki D, Yajima Y, Yamada K, Kano K, *et al*. Eight-week neuromuscular electrical stimulation training produces muscle strength gains and hypertrophy, and partial muscle quality improvement in the knee extensors. Journal of Sports Sciences. 2023; 41: 2209–2228.

[12] Hasan S, Kandasamy G, Alyahya D, Alonazi A, Jamal A, Iqbal A, *et al*. Effect of plyometric training and neuromuscular electrical stimulation assisted strength training on muscular, sprint, and functional performances in collegiate male football players. PeerJ. 2022; 10: e13588.

[13] Montenegro EJN, Santos KV dos, Alencar GG de, Siqueira GR de, Maia JN, Andrade M do A. Use of Russian and Aussie current in isometric tetanization of the quadriceps femoris. Revista Brasileira de Medicina do Esporte. 2019; 25: 142–146.

[14] Oliveira P, Modesto KAG, Bottaro M, Babault N, Durigan JLQ. Training effects of alternated and pulsed currents on the quadriceps muscles of athletes. International Journal of Sports Medicine. 2018; 39: 535–540.

[15] Maffiuletti NA. Physiological and methodological considerations for the use of neuromuscular electrical stimulation. European Journal of Applied Physiology. 2010; 110: 223–234.

[16] Adams V. Electromyostimulation to fight atrophy and to build muscle: facts and numbers. Journal of Cachexia, Sarcopenia and Muscle. 2018; 9: 631–634.

[17] Pérez-Castilla A, Piepoli A, Delgado-García G, Garrido-Blanca G, García-Ramos A. Reliability and concurrent validity of seven commercially available devices for the assessment of movement velocity at different intensities during the bench press. The Journal of Strength & Conditioning Research. 2019; 33: 1258–1265.

[18] French DN, Kraemer WJ, Cooke CB. Changes in dynamic exercise performance following a sequence of preconditioning isometric muscle actions. The Journal of Strength & Conditioning Research. 2003; 17: 678–685.

[19] Sale DG. Influence of exercise and training on motor unit activation. Exercise and Sport Sciences Reviews. 1987; 15: 95–151.

[20] Nakagawa K, Bergquist AJ, Yamashita T, Yoshida T, Masani K. Motor point stimulation primarily activates motor nerve. Neuroscience Letters. 2020; 736: 135246.

[21] Sánchez-Medina L, González-Badillo JJ. Velocity loss as an indicator of neuromuscular fatigue during resistance training. Medicine & Science in Sports & Exercise. 2011; 43: 1725–1734.

[22] Sanchez-Medina L, Perez CE, Gonzalez-Badillo JJ. Importance of the propulsive phase in strength assessment. International Journal of Sports Medicine. 2010; 31: 123–129.

[23] Macaluso A, De Vito G. Muscle strength, power and adaptations to resistance training in older people. European Journal of Applied Physiology. 2004; 91: 450–472.

[24] Alcazar J, Cornejo-Daza PJ, Sánchez-Valdepeñas J, Alegre LM, Pareja-Blanco F. Dose-response relationship between velocity loss during resistance training and changes in the squat force-velocity relationship. International Journal of Sports Physiology and Performance. 2021; 16: 1736–1745.

[25] Pareja-Blanco F, Alcazar J, Sánchez-Valdepeñas J, Cornejo-Daza PJ, Piqueras-Sanchiz F, Mora-Vela R, *et al*. Velocity loss as a critical variable determining the adaptations to strength training. Medicine & Science in Sports & Exercise. 2020; 52: 1752–1762.

[26] Jukic I, Castilla AP, Ramos AG, Van Hooren B, McGuigan MR, Helms ER. The acute and chronic effects of implementing velocity loss thresholds during resistance training: a systematic review, meta-analysis, and critical evaluation of the literature. Sports Medicine. 2023; 53: 177–214.

[27] Rissanen J, Walker S, Pareja-Blanco F, Häkkinen K. Velocity-based resistance training: do women need greater velocity loss to maximize adaptations? European Journal of Applied Physiology. 2022; 122: 1269–1280.

[28] Izquierdo M, González-Badillo JJ, Häkkinen K, Ibáñez J, Kraemer WJ, Altadill A, *et al*. Effect of loading on unintentional lifting velocity declines during single sets of repetitions to failure during upper and lower extremity muscle actions. International Journal of Sports Medicine. 2006; 27: 718–724.

[29] Mesquita Souza RL, Aidar FJ, Villar R, Greco G, Santos L dos, Poli L, *et al*. Assessment of asymmetry at different intensities between conventional and Paralympic powerlifting athletes. Heliyon. 2023; 9: e16211.

[30] Aidar FJ, Fraga GS, Getirana-Mota M, Marçal AC, Santos JL, de Souza RF, *et al.* Effects of ibuprofen use on lymphocyte count and oxidative stress in elite Paralympic powerlifting. Biology. 2021; 10: 986.

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