Review article

Electrostimulation in the treatment of erectile dysfunction: a scoping review

Eletroestimulação no tratamento da disfunção erétil: uma revisão de escopo

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ABSTRACT

This study aimed to evaluate the effects of electrostimulation in the treatment of erectile dysfunction in adult men. It is a scoping review conducted according to PRISMA-ScR guidelines. Intervention studies using electrostimulation for the treatment of erectile dysfunction in adult men (≥ 19 years) were included, sourced from PubMed, with no restriction on publication year. The search was conducted using the English descriptors: "Erectile Dysfunction," "Impotence," "Electrotherapy," "Electrical Stimulation," "Electro-stimulation," "Experimental Study," "Randomized Controlled Trial," "RCT," and "Clinical Trial," with boolean operators AND and OR. Two studies used the Erect Fit Stimulation System, one employed the FES technique, and the other used Quadrangular Electric Stimulation. Regarding the stimulation frequency, there was a variation from 2 Hz to 50 Hz, with 50% of the studies using frequencies between 2 Hz and 5 Hz and the remaining 50% using frequencies between 30 Hz and 50 Hz. FES was shown to be an effective and beneficial therapy for erectile function and patient quality of life, demonstrating greater efficacy compared to aerobic exercises in managing erectile dysfunction. Transcutaneous electrostimulation of the ischiocavernosus region emerges as a promising and non-invasive approach, improving penile rigidity by acting on relevant striated muscles.

Descriptors: electrical stimulation, erectile dysfunction, therapies

RESUMO

Este estudo teve como objetivo avaliar os efeitos da eletroestimulação no tratamento da disfunção erétil em homens adultos. Trata-se de uma revisão abrangente realizada de acordo com as diretrizes PRISMA-ScR. Foram incluídos estudos de intervenção que utilizaram eletroestimulação para o tratamento da disfunção erétil em homens adultos (≥ 19 anos), obtidos a partir do PubMed, sem restrição de ano de publicação. A busca foi realizada utilizando os descritores em inglês: "Erectile Dysfunction," "Impotence," "Electrotherapy," "Electrical Stimulation," "Electro-stimulation," "Experimental Study," "Randomized Controlled Trial," "RCT," e "Clinical Trial," com operadores booleanos AND e OR. Dois estudos utilizaram o Sistema de Estimulação Erect Fit, um empregou a técnica de FES, e o outro usou Estimulação Elétrica Quadrangular. Em relação à frequência de estimulação, houve uma variação de 2 Hz a 50 Hz, sendo que 50% dos estudos utilizaram frequências entre 2 Hz e 5 Hz, e os 50% restantes utilizaram frequências entre 30 Hz e 50 Hz. A FES demonstrou ser uma terapia eficaz e benéfica para a função erétil e a qualidade de vida dos pacientes, apresentando maior eficácia em comparação aos exercícios aeróbicos no manejo da disfunção erétil. A eletroestimulação transcutânea da região isquiocavernosa surge como uma abordagem promissora e não invasiva, melhorando a rigidez penile ao agir sobre os músculos estriados relevantes.

Descritores: eletroestimulação, disfunção erétil, terapias

INTRODUCTION

Erectile dysfunction (ED) is defined as the difficulty an individual faces in achieving or maintaining an adequate erection for desired sexual activity[1]. Brazilian epidemiological data estimate that approximately 45% of men aged 40 to 70 experience some degree of ED. Among these, the majority are classified with minimal ED (31.5%), while the remainder are categorized as moderate (12.1%) and severe (2.6%)[2].

ED can have various causes and may manifest at different stages of life. The etiologies are classified according to the chronology reported by the patient. Primary dysfunction is often associated with psychological factors, such as anxiety and depression, or social influences the individual may have experienced[3]. However, there may also be an organic component, with the patient reporting persistent ED over time[4]. Secondary dysfunction, which is more prevalent, occurs after a period of normal erections, when the individual begins to have difficulty maintaining an erection at a specific moment, usually associated with periods of stress and fatigue[5].

Another way to classify ED is based on the phenomenology of erection. Absolute ED is characterized by the complete absence of erection, regardless of the circumstances. In contrast, specific or situational ED occurs only in specific situations or with certain partners[6].

The organic component of ED is often associated with vascular changes, such as the narrowing of the arteries that supply blood to the cavernous and spongy bodies of the penis. This narrowing reduces the hypogastric-cavernous bed, decreasing perfusion pressure and, consequently, the blood flow needed to maintain an erection[7]. Additionally, with aging, some individuals may develop atherosclerotic diseases, diabetes, hypercholesterolemia, and sedentary lifestyles, which can worsen ED[8]. Other etiologies include neurogenic, endocrine, medication-related, and surgical causes[9].

In addition to physiological causes, ED can be triggered by surgical procedures, with radical prostatectomy (complete removal of the prostate and seminal vesicles) being one of the main reported interventions[10]. This surgery is often chosen as a definitive treatment for prostate cancer[11]. However, prostatectomy can compromise the functionality of the autonomic cavernous nerves located in the neurovascular bundles, resulting in erectile dysfunction in the patient[4].

The consequences of ED have profound impacts on the lives of affected individuals, significantly reducing their quality of life[12]. The stigma associated with aging intensifies when combined with ED, exacerbating feelings of distress and insecurity[13]. Over time, men may face not only a pathological condition but also a clinical scenario that can lead to social isolation

and, subsequently, depression. This morbid cycle can result in increased shame and fear of seeking treatment, worsening the situation and perpetuating these comorbidities[14]. As a result, many individuals withdraw from social life and interact less with their community[15].

Therapeutic options for treating ED are limited, but they still contribute to a relative improvement of the condition. Among the available alternatives, intracavernous injection stands out, offering some benefits but is limited by adherence difficulties and side effects, such as priapism[16]. Oral phosphodiesterase type 5 inhibitors, such as Tadalafil and Sildenafil, are widely used, but their side effects can compromise treatment adherence despite their accessibility[17]. Other options include surgeries with penile prostheses combined with psychotherapy, which, while effective, are less accessible and complicate the implementation of their benefits[4].

In addition to these approaches, ES emerges as a promising alternative, used in various clinical contexts, from medicine to physical therapy, expanding its potential applications[18]. Based on the induction of low-intensity electrical waves, ES can stimulate increased blood flow in the penile chambers, helping to maintain an erection, and thus may be beneficial for cases of ED[19]. However, there are gaps in knowledge about this therapeutic approach due to the limited number of studies and the lack of specific evaluations regarding the concerns of patients with ED, both before and after the intervention, to observe the impact of therapy on their lives. Therefore, this study aimed to evaluate ES's effects in treating ED in adult men through a scoping review.

METHODS

This scoping review was planned and developed according to the PRISMA extension for scoping reviews—PRISMA-ScR—following the methodology outlined in the Joanna Briggs Institute (JBI Manual) scoping review manual. The research question for the review was: What are the effects of ES in adult men with ED?

Eligibility criteria, inclusion, and exclusion

To be eligible, studies involved interventions with ES for ED and included adult men (≥ 19 years) in the sample. The inclusion criteria for the review were intervention studies conducted with individuals aged 19 years or older, available in full text for free, in Portuguese, English, or Spanish, with no specific publication date. Policy documents, technical reports, review studies,

observational studies, case studies, and articles for which the full text could not be obtained, even after attempts to contact the authors, were excluded

Sources of Evidence and Search Strategy

The searches were conducted on PubMed to identify relevant studies on the topic and to define the descriptors for the search strategy. The terms and Boolean operators used were: ("Erectile Dysfunction" OR "Impotence") AND ("Electrotherapy" OR "Electrical Stimulation" OR "Electro-stimulation") AND ("Experimental Study" OR "Randomized Controlled Trial" OR "RCT" OR "Clinical Trial"). The process involved a sequential review of titles, abstracts, and full texts.

Data extraction

Data from the included studies were extracted using a form developed by the authors. This form contained detailed information about the study characteristics, such as title, objective, year of publication, study location, and participant characteristics, including number and age. Additionally, the form recorded details about the electrotherapy intervention, such as the type of electrical current, equipment used, frequency, duration, and other relevant aspects.

To ensure accuracy, two reviewers tested the extraction form on two preliminary studies to verify that all relevant information was appropriately extracted.

RESULTS

A total of seven studies were identified in PubMed. However, three of these (42.8%) were excluded from the analysis. Among the excluded studies, 33.3% involved research with rodents rather than humans. Additionally, these studies used Trazodone as a therapy for ED instead of ES. Another study, although conducted with humans, did not investigate the effects of ES; its primary aim was to assess patients' perineal sensation and diagnose the types of impotence present in the group. Furthermore, another excluded study aimed to evaluate the combined effect of ES and Tadalafil. Although it showed satisfactory results for both therapies and demonstrated the benefit of ES in conjunction with Tadalafil, it could not be fully assessed due to its availability only as an abstract, not as a complete article, which prevented a detailed understanding of the materials and methods used. Therefore, four studies were included in the final analysis.

The search identified studies published between 1997 and 2020, with half (50%) published from 2018 onwards. The four included articles were conducted in four different countries: Brazil (25%), Nigeria (25%), Germany (25%), and Spain (25%). Additional information is detailed in Table 1.

Table 1. Information about the studies included in the research.

Authors	Title	Objective	Year of publication	Information on Electrotherapy	Conclusions
Carboni et al.[20]	An initial study on the effect of functional electrical stimulation in erectile dysfunction: a randomized controlled trial.	Evaluate the impact of Functional Electrical Stimulation (FES) on erectile function in men with erectile dysfunction.	2018	The therapy was conducted with parameters of 50 Hz and 500 µs. The treatment was administered over four weeks, with two weekly sessions, each lasting 15 minutes. The electrode configuration involved placing one electrode at the base of the penis and another 2 cm below the first. Erectile function was assessed using the International Index of Erectile Function (IIEF-5) and the Erection Hardness Score. Quality of life was evaluated using the WHOQOL-BREF.	Functional electrical stimulation (FES) has proven effective and beneficial for erectile function and patients' quality of life.

Rislanu et al.[21]	Comparative Effectiveness of Electrical Stimulation and Aerobic Exercise in the Management of Erectile Dysfunction: A Randomized Clinical Trial.	Investigate the effects of Electrostimulation compared to aerobic exercise in the management of individuals with erectile dysfunction.	2020	The treatment was conducted using the Erect-fit device at a frequency of 5 Hz with a pulse width of 150 µs. The protocol involved six weeks of treatment, with two weekly sessions, each lasting 30 minutes. During the sessions, one electrode was placed in a circular pattern around the penis, and the other on the lumbosacral region, aiming to target the deeper muscles. Erectile function was assessed using the IIEF-5 questionnaire.	She indicated that electrical stimulation is more effective than aerobic exercise in managing individuals with erectile dysfunction.
Derouet et al.[22]	Treatment of Erectile Dysfunction by an External Ischiocavernosus Muscle Stimulator.	Evaluate the therapeutic efficacy of electrostimulation of the striated ischiocavernosus	1998	The treatment was conducted using the Erect-fit device set to 30 Hz. Sessions were held daily over three months, each	Transcutaneous electrical stimulation of the ischiocavernous region is a promising and non-invasive therapy for

		muscles in patients with erectile dysfunction.		lasting 20 minutes. Erectile function was assessed solely through clinical observation.	improving penile rigidity. The importance of the striated muscles in this region for penile rigidity is emphasized.
Casado et al.[23]	Valoración de los umbrales sensoriales del nervio dorsal del pene como técnica de Screening de lesión neurológica en la impotencia.	Determine the utility of sensory thresholds and dorsal nerve stimulation of the penis in the diagnosis of neurogenic impotence.	1997	Electrical stimulation was applied for 0.2 milliseconds at a frequency of 2 Hz. The total duration of the therapy and the number of sessions performed were not specified. Action potentials were recorded using selective electromyography of the bulbocavernosus muscles.	Sensory thresholds of electrical stimulation of the dorsal penile nerve and the examination of perineal sensitivity did not help diagnose impotence. However, they were valuable in identifying the target of the electrical stimulation and demonstrating the therapy's benefits in the patients who underwent it.

Regarding the study characteristics, 100% of the studies employed a Randomized Clinical Trial design, including a simple parallel-blind layout. The number of participants varied from 22 to 130, with 222 individuals; most studies included participants aged 22 to 40 years (75%), while the remaining studies included 130 individuals (25%) outside this age range.

Three studies reported a range from 25 to 68 years in terms of patient age. Only one study did not specify this age range, providing only the overall average age of participants, which was 55.49 years. Although three studies provided the age range, they did not report the average age of participants eligible for the intervention.

Regarding the techniques used in the studies, all employed ES as the primary intervention method, varying only in the devices and application methods. Two studies (50%) used the Erect Fit Stimulation System, a portable device with a battery and self-adhesive electrodes. In these studies, the electrodes were placed around the proximal base of the penis and on the dorsal side of the penis near the glans to deliver the electrical stimulation. Additionally, one study described the use of a circular electrode installed around the base of the penis. Another study (25%) utilized Functional Electrical Stimulation (FES), while another employed square-shaped electrical stimulation, with no details about the devices used for these interventions.

The frequency used for the ES parameters varied, ranging from 2 Hz to 50 Hz. Half of the studies used frequencies between 2 Hz and 5 Hz, while the other half used 30 Hz and 50 Hz. The average duration of each intervention session was reported to be 21.6 minutes, with only one study not providing information about the duration.

Additionally, two studies reported the duration in weeks ES was applied, with an average of 5 weeks and two sessions per week. In contrast, one study mentioned the daily application of the therapy but did not specify the duration of the intervals. Only one study did not detail the application time, focusing solely on the techniques used.

Half of the studies used the International Index of Erectile Function (IIEF-5) to evaluate interventions, with one of these also including the Erectile Hardness Score (EHS) and the WHOQOL-BREF quality of life questionnaire. Another study assessed the intervention using Selective Electromyography of the Bulbocavernosus Muscles (SPACE) and Provoked Genital Sympathetic Potential (PGSP). However, one study did not describe a validated method for evaluating the effectiveness of ES, only providing a clinical observation of the technique used.

DISCUSSION

This scoping review covers four studies that provide insights into using ES as an adjunct and treatment for ED. The interventions typically involved groups of participants ranging from 22 to 130 individuals aged between 34 and 68 years. These interventions usually spanned five weeks, with an average of two sessions per week; however, one study was conducted with daily sessions. For the studies that applied the therapy weekly, the average duration of the sessions was 21.6 minutes.

Additionally, all studies used ES as a tool, varying only in the type of device used, the methods of applying the stimulus, and the frequencies employed. Half of the studies used the IIEF-5 to evaluate the effectiveness of the therapy, with one of these also including the Erectile Hardness Score (EHS) and the WHOQOL-BREF questionnaire, as demonstrated in the study by Carboni et al.[20].

The issue investigated is predominantly relevant to men over 50 years old. Thus, it is possible to understand that the prevalence of ED is directly proportional to age[24]. Additionally, it is essential to highlight that the severity of ED tends to increase with age, with one explanation being gradual endothelial dysfunction, which becomes more pronounced in older individuals[25]. On the other hand, in addition to organic factors, Laumann et al.[26] suggest that psychological factors, such as anxiety and depression, can play a significant and persistent role, contributing to the development of ED over a lifetime.

In terms of the devices used for the intervention, the studies "Treatment of Erectile Dysfunction by an External Ischiocavernosus Muscle Stimulator" and "Comparative Effectiveness of Electrical Stimulation and Aerobic Exercise in the Management of Erectile Dysfunction: A Randomized Clinical Trial" utilized the Erect Fit Stimulation System, which consists of a battery-operated portable device and self-adhesive skin electrodes. These electrodes are wrapped around the penis, with one placed at the base and another behind the glans. Additionally, a circular electrode is placed around the base of the penis and another in the perineal area. The authors concluded that this method of applying ES is mainly responsible for altering the hemodynamics of the cavernous bodies of the penis.

For the induction and maintenance of an erection, arterial influx must be balanced with venous outflow resistance. This is aided by the contraction of the ischiocavernosus and bulbospongiosus muscles that surround the cavernous bodies, promoting a phase of

rigid erection, during which patients often report their main issues. Additionally, Derouet et al.[22] and Rislanu et al.[21] concluded that increasing intracavernous pressure also requires enhanced contractions of the pelvic floor muscles. Furthermore, the need for a circular-shaped electrode at the base was noted, as the proximal coverage of the ischiocavernosus muscles helps reduce venous blood return, and the electrostimulation applied in this area ensures efficacy in the target muscles for maintaining the erection.

The study by Rislanu et al.[21], which also utilized the Erect Fit Stimulation System with the same electrode placements on the penis, described the necessity of installing a negative pole electrode in the sacral region to target internal muscles. This confirmed the benefits shown in the study by Sturn et al.[27], where low-intensity, long-duration electrostimulation of the injured cavernous nerve improved erectile function recovery in a rat model of post-prostatectomy ED. The electrostimulation promoted cavernous nerve regeneration and subsequently restored erectile function.

Similarly, the study by Gandaglia et al.[28] involving patients with post-prostatectomy ED due to cavernous nerve injury determined the effectiveness of electrostimulation in improving erectile function. Comparable findings supporting the exact purpose of electrostimulation were reported in the studies by Kayigil et al.[29] and Van Kampen et al.[30], concluding that electrostimulation plays a crucial role in the rehabilitation of ED.

The study by Carboni et al.[20] utilized an FES machine and confirmed ES as a tool and treatment for erectile dysfunction ED, demonstrating its potential for muscle regeneration. However, this study primarily aimed to analyze the impacts of ED before and after treatment with ES through indicators that will be discussed later.

Casado et al.[23] reported in their study that based on measuring the threshold of perception for the stimulation generated by ES, the purpose of diagnosing types of ED and understanding which innervations are involved in the technique’s success. This led to the conclusion that ES has therapeutic potential for various causes of ED, highlighting that neurogenic etiologies are significant contributors to ED and should be a key focus for treatment.

Moreover, there is discussion regarding the types of muscle involved, whether striated or smooth, and where ES should be applied. However, the study by Derouet et al.[22] noted that using parameters from neuromuscular disease guidelines, which describe the ES pulse protocol for striated muscles, was the primary target for treatment, as benefits were observed there. Nevertheless, they indicated that new protocols and parameters would

be needed to stimulate smooth muscle, which was not conducted. Therefore, it concludes that the target of ES is striated muscles rather than smooth muscles, based on the observed benefits, the etiologies involved in ED, and pre-established protocols for applying the technique.

Furthermore, regarding the frequency used, it was noted that values ranged from 2 to 50 Hz, covering a considerable variation across all analyzed studies. However, no correlation could be established between the frequency value used in each study and its benefits. Thus, it is not possible to determine a minimum value that guarantees good results.

Moreover, it is essential to highlight the criteria for the duration of each session and the overall treatment. The average time for each session (among the studies that provided this data) was nearly 22 minutes, with electrical stimulation and rest intervals to ensure adequate muscle relaxation. Additionally, sessions averaged two per week, with the entire treatment lasting about five weeks. The benefits observed during this timeframe were significant, supporting the premise that the therapeutic use of electrostimulation for ED is advantageous when conducted at the intervals above.

Regarding the effectiveness of ES as a therapy for ED, there are analytical tools that reinforce its validity. Among these are the IIEF-5, the Erectile Hardness Score (EHS), and the WHOQOL-BREF questionnaire, which allow for assessing outcomes perceived by study participants. These tools showed a significant difference when comparing the Control and Intervention groups. This highlights the positive impact of the therapeutic approach with ES, reflecting favorable outcomes in the biopsychological aspects of the individuals involved. According to Laumann et al.[26], several factors are correlated with ED, including overall health status, emotions, mental well-being, stress, and social relationships. Therefore, intervening with ES and achieving even partial improvement leads to significant results that resonate across all mentioned areas, underscoring its importance.

The study's main limitations include the heterogeneity of the electrostimulation protocols used in the analyzed research, which complicates the comparison and generalization of results. Additionally, many studies included a small number of participants, limiting the robustness of the conclusions. The lack of standardization in the evaluation criteria for outcomes and the duration of treatment also represents a significant limitation. Finally, the scarcity of investigations focused on the long-term efficacy of electrostimulation

makes it challenging to determine its viability as a sustainable solution for erectile dysfunction.

CONCLUSION

The attributes of the analyzed studies varied in terms of intervention techniques, frequency, duration, and application intervals. This research has reinforced the potential of ES as a promising approach in the treatment of ED, highlighting its positive effects and clinical applicability. By contributing to the growing body of evidence in this field, the study fosters discussions on the integration of ES into standard therapeutic protocols and its broader implications for healthcare.

Despite the encouraging results, significant knowledge gaps remain, particularly concerning the standardization of application protocols, long-term efficacy, and patient-specific responses. Future clinical studies with larger and more diverse populations, along with comprehensive outcome assessments, are crucial to establishing evidence-based guidelines and optimizing the use of ES as a viable, non-invasive alternative for ED treatment. Additionally, interdisciplinary collaboration between healthcare professionals, researchers, and technology developers may enhance the refinement of ES techniques, ensuring its effectiveness and accessibility in clinical practice.

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CONTATO

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