

**PRONE PLANK EXERCISES VERSUS ELECTRICAL STIMULATION FOR THE TREATMENT OF DIASTASIS RECTUS ABDOMINIS IN POSTPARTUM WOMEN**Doaa S. Darwish<sup>1\*</sup>, Nermeen K. Bleedy<sup>2</sup>, Eman A. Elhosary<sup>3</sup>, Ahmed I. Ebeed<sup>4</sup>, Shaimaa E. Salem<sup>5,6</sup>, Fayiz F. Elshamy<sup>3</sup><sup>1</sup>Outpatient Clinics, Faculty of Physical Therapy, Kafrelsheikh University, Egypt; <sup>2</sup>Department of Physical Therapy for Woman's Health, Physical Therapy Department, College of Allied Health Sciences, Jerash University, Jerash, Jordan; <sup>3</sup>Department of Physical Therapy for Woman's Health, Faculty of Physical Therapy, Kafrelsheikh University, Egypt; <sup>4</sup>Department of Diagnostic Radiology, Faculty of Medicine, Kafrelsheikh University, Egypt; <sup>5</sup>Department of Basic Science, Faculty of Physical Therapy, Cairo University, Egypt; <sup>6</sup>Department of Basic Science, Faculty of Physical Therapy, Al Ryada University for Science and Technology, Egypt**Abstract****Objective:** To compare the effectiveness of prone plank exercises with electrical stimulation on improving waist-hip ratio (WHR) and interrectus distance (IRD) in postpartum women.**Design:** Randomized, controlled trial.**Setting:** Outpatient physical therapy clinics at Kafrelsheikh University between March 2023 and February 2024.**Participants:** Forty-two postpartum women, aged 20 to 35 years, were randomly allocated into two groups: prone plank exercises (Group A) and electrical stimulation (Group B).**Interventions:** Group A performed prone plank exercises, while Group B received electrical stimulation. Interventions were administered triweekly for eight weeks.**Main Outcome Measures:** WHR was assessed by measuring tape and IRD was assessed by ultrasonography, evaluated both pre- and post-intervention.**Results:** Both groups showed Significant improvement within each group ( $p \leq 0.05$ ). Comparatively, post-treatment analyses revealed significant improvements in WHR and IRD in Group A over Group B, with no significant pre-treatment differences between groups.**Conclusions:** Prone plank exercises were superior to electrical stimulation in improving waist-hip ratio and interrectus distance in postpartum women. These findings suggest that prone plank exercises could be recommended for postpartum rehabilitation to improve abdominal separation and reduce waist size.Manuscrito recibido: 16/02/2024  
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**Trial Registration:** NCT06259240.**Keywords:** Diastasis Rectus Abdominis. Postpartum. Prone Plank Exercises. Electrical Stimulation**Introduction**

Diastasis rectus abdominis (DRA) is considered an expected result due to the growth of the fetus during pregnancy. It refers to the extensibility of the muscular tissue of the abdomen beyond its normal structure and appearance. It may result in poor outcomes if the interrectus distance (IRD) remains huge and affects the woman's activities of daily living, work, and her life as a whole. The linea alba in DRA becomes thin and very wide as compared to a normal abdomen; this happens due to the elevation of intra-abdominal pressure during the late pregnancy stage for any woman 1.

The main cause of DRA is stretching of the myofascial sheath covering the abdominal viscera rather than the abdominal muscle separation itself. Diastasis greatly affects the function and normal condition of the muscle, which without proper treatment could lead to many complications and decline in the role of the abdominal role 2.

The prevalence rate of DRA is inversely proportional to post-partum time. It was found that approximately 60% of women having DRA were diagnosed at 6 weeks post-partum. On the other hand, approximately 45% and 33% were diagnosed at 6 and 12 months, respectively3.

Despite the high prevalence rate, the main cause and explanation behind DRA is still unknown and requires future research. The average distance between the bilateral bellies of the rectus abdominis (RA) muscle ranges from 1.5 to 2.7 centimetre4.

DRA is considered not only an esthetic disorder but also results in poor clinical outcomes, including weakness of the RA muscle, abdominal-associated painful symptoms after activities, low back pain, pelvic girdle and pelvic floor dysfunction, and sacroiliac joint pain5-7.

The DRA is simply evaluated by measuring the IRD and comparing it with normal values8.

The population of women has insufficient information or culture regarding DRA or the complications associated with it, which represents a critical problem in many societies. The majority of women do not perform any type of exercises or care during pregnancy9.

There are several methods for this measurement, including palpation, using a caliper, or diagnostic ultrasound. Nevertheless, there is no universally accepted standard method for precisely assessing DRA10.

Regarding the management methods of DRA, it was found that progressive prone plank exercises are effective in reducing and controlling DRA in many women. In addition, the engagement of lumbar stabilization exercises in the physiotherapy programs for DRA helps in preventing complications and improving postpartum partum11. Furthermore, electrical stimulation (ES) for the abdominal musculature combined with strengthening exercises was found to be effective in reducing IRD specifically when ES was applied to internal and external oblique muscles12. In recent years, the transversus abdominis (TrA) muscle has been considered the main muscle that when strengthened and improved, it results in controlling the DRA by reducing the distance between the bilateral muscle bellies and improving the state of the abdominal musculature13. In addition, it was found that the combination of TrA training exercises and the application of elastic taping can greatly influence DRA and help in its management, thereby returning patients into a full pain-free and functional state14.

There are several exercises and therapies found in the literature used for managing DRA in addition to abdominal binders and neuromuscular ES14,15. However, there is no ideal method or treatment program for the management and control of DRA. There is also no evidence of good quality supporting the effectiveness of a technique in reducing IRD in patients suffering from DRA16.

To the best of the authors' knowledge regarding the published clinical trials covering the management methods of DRA, no study was found comparing prone plank exercises versus ES for postpartum women with DRA. Both therapeutic methods had good clinical outcomes; therefore, this study was conducted to examine if there is a significant difference between them. The greater demand for physical therapy for women's health signifies the need for more effective, safer, and evident therapeutic modalities. We hypothesized that prone plank exercises and ES would exhibit no significant between-group differences regarding WHR as well as supraumbilical and infra umbilical IRD at rest and contraction for DRA in postpartum women.

**Methods****Study Design and Setting**

This randomized controlled trial was carried out at the outpatient clinics of

the Faculty of Physical Therapy, Kafrelsheikh University, from March 2023 to February 2024. The study aimed to compare the impact of prone plank exercises versus electrical stimulation on Diastasis Rectus Abdominis (DRA) in postpartum women. Participants were randomly assigned to one of two groups: Group A (prone plank exercises) or Group B (electrical stimulation), utilizing a simple randomization approach. Prior to commencement, approval was secured from the clinic's management. Prior to any study-related procedures, all participants were adequately informed about the study's aims, procedures, potential risks, and benefits. Written informed consent was obtained from each participant, affirming their voluntary participation and understanding of the study's terms. This process was conducted in accordance with the Declaration of Helsinki and local ethical guidelines for research.

### Participants

The study included 42 postpartum women, aged between 20 and 35 years, with a Body Mass Index (BMI) not exceeding 30 kg/m<sup>2</sup>. Inclusion criteria were as follows: diagnosis of DRA 12 weeks to 36 months postpartum, referred for physiotherapy by a gynecologist, and an IRD of more than two cm. Exclusion criteria included ongoing pregnancy, twin pregnancy, preterm birth before 37 weeks of gestation, being beyond 36 months postpartum, having an IRD less than two fingers wide, diagnosed systemic conditions that could interfere with treatment (such as cardiac or pulmonary diseases), recent surgeries with potential for postoperative complications, any disorders affecting RA muscle function, recent engagement in physical activities or rehabilitation, or undergoing treatment for depression.

### Treatment Procedures

Group A included 21 participants who received progressive prone plank exercises, triweekly, for eight weeks, and with moderate hard intensity. During the first four weeks, the exercise session began with a 5-min light walk followed by corrective exercises; this helped in controlling the poor outcomes produced after long weeks of pregnancy. First, women performed prone plank exercises, the stable prone plank, attempting to maintain and hold a neutral alignment. Second, women were asked to apply the unilateral position of the prone plank by extending their dominant lower limb away from the surface on which they were training. Third, using a 65-cm diameter Swiss ball, women were asked to assume the prone bridge position, resting their forearm on the Swiss ball.

During the last four weeks, women were asked to repeat the same program noting that the progressive prone plank exercises should be applied in a dosage of 20 repetitions, three sets, holding the contraction for 1 min, and taking a break for 2 min.

Group B included 21 participants who received electrical stimulation for the RA muscle:

Before applying ES, the RA muscle was cleaned using alcohol and cotton to decrease the resistance of the skin as much as possible. In addition, women were asked to go to the toilet for urination and then lie in the crook lying position and relax at the beginning of the session.

Using 4 electrodes, ES was applied in a bilateral method covering the bilateral bellies of the RA muscle. As a precaution, the therapist used straps for electrode fixation. Regarding the active electrodes of each canal, the therapist applied them with a 3-cm space between each other. Then, the therapist elevated the current intensity gradually to get a visible and well-elicited RA muscle contraction on the condition that it was comfortable for the patient.

The technical procedures of faradic stimulation were applied day after day for 8 weeks. The crook lying position was adopted for patient comfort during ES sessions. The session parameters were 30 min/session with a low-frequency current (50-100Hz).

### Evaluation Procedures

The evaluation procedures for this study were systematically designed to ascertain the efficacy of interventions aimed at addressing Diastasis Rectus Abdominis (DRA), with a clear demarcation between primary and secondary outcomes for comprehensive assessment. The primary outcome, interrectus distance (IRD), crucial for evaluating the rectification of DRA, was measured using both palpation and ultrasound imaging (USI) methods before and after the treatment regimen to ascertain the magnitude of intervention impacts.

In the palpation method, patients assumed the crook lying position, wherein the evaluative process involved manual placement of fingers between the medial sides of the bilateral bellies of the rectus abdominis (RA) muscle. This approach facilitated the determination of IRD by measuring the span that could be bridged by fingers between the muscle bellies above and below the umbilicus, selected for its reliability, practical application, and patient comfort<sup>17,18</sup>.

Concurrently, the ultrasound imaging (USI) modality provided a refined measurement approach. A trained sonographer employed a Toshiba

Xario100 equipped with an 8-12 MHz linear transducer to perform pre- and post-intervention assessments. Utilizing the umbilicus as a focal reference, measurement sites were demarcated 4.5 cm proximal and distal to this point, ensuring precision through skin markings. The quantification of the IRD was achieved by gauging the distance between the inner contours of the bilateral RA muscle bellies, employing the ultrasound system's integrated measuring functionalities<sup>6, 19, 20, 21,22</sup>.

Complementing the primary outcome, the study's secondary outcome encompassed the evaluation of the Waist-Hip Ratio (WHR), a metric indicative of body composition alterations and abdominal reshaping resultant from the treatments. The WHR was derived from the ratios calculated from the circumferences measured at the narrowest segment between the costal arch and the iliac crest after a mild exhalation for the waist, and at the most pronounced segment of the buttocks for the hips. These dimensions were measured using a standard measuring tape, with assessments conducted both prior to and subsequent to the intervention phase to gauge any significant morphological changes imparted by the therapeutic protocols.

### Sample size calculation

Using G-power version 3.1.9.7 for Windows and regarding t-test study, alpha level of 0.05, confidence interval 80%, and effect size of 0.9, calculated from the previous study of Awad et al. [11], and a two-sided alternative hypothesis, the sample size was 42 women (twenty-one in each group).

### Randomization

In this study, block randomization was employed to ensure balanced assignment of participants into two groups, aiming to reduce selection bias and enhance comparability between groups. Allocation concealment was achieved using sequentially numbered, sealed opaque envelopes, safeguarding against potential allocation bias and maintaining the study's integrity. The trial adopted a double-blind approach, wherein both the participants and the outcome assessors were unaware of the group assignments, effectively reducing performance and evaluation biases and thereby strengthening the credibility of the research findings.

### Statistical Methods

In the statistical analysis phase of this study, we first assessed the normality of the data distribution for each variable using the Shapiro-Wilk test, a standard procedure to determine the appropriateness of parametric testing. SPSS version 26 (IBM Corp, Armonk, NY) facilitated these preliminary assessments alongside subsequent comprehensive statistical tests. Following the confirmation of data normality, within-group comparisons were conducted using paired t-tests to identify pre- and post-intervention changes. Conversely, for between-group comparisons, unpaired t-tests were employed to evaluate the differential impacts of the interventions. The threshold for statistical significance was set at  $p \leq 0.05$  across all analysis.

### Results

All 42 randomized participants accounted for the data analysis with no dropouts or harms reported (Figure 1).

#### General Characteristics

Participants in both Group A and Group B exhibited similar baseline characteristics, as evidenced by non-significant differences in age, weight, height, and BMI between the two groups. This parity underscores the comparability of the study cohorts at baseline and enhances the validity of subsequent between-group comparisons.

#### Within-Group Comparison

Both Group A and Group B demonstrated significant pre-post improvements across all outcome measures, as determined by paired t-tests (Table 1).

#### Between Groups Comparison

Unpaired t-tests conducted at baseline revealed no significant between-group differences in any outcome measures, indicating comparable baseline characteristics between the two groups (Table 1). However, post-treatment analysis revealed significantly greater improvements in all outcome measures for Group A compared to Group B (Table 1).

To quantify the observed differences, effect sizes were calculated for each outcome measure. The supraumbilical interrectus distance at rest exhibited a large effect size (Cohen's  $d = 6.65$ ) with a 95% confidence interval (CI) of (2.718, 3.922). Similarly, the infraumbilical interrectus distance at rest showed a large effect size (Cohen's  $d = 2.8$ ) with a 95% CI of (0.848, 2.052). The supraumbilical interrectus distance during contraction demonstrated a large effect size (Cohen's  $d = 3.95$ ) with a 95% CI of (2.348, 3.552). Also, the infraumbilical interrectus distance during contraction revealed a large effect size (Cohen's

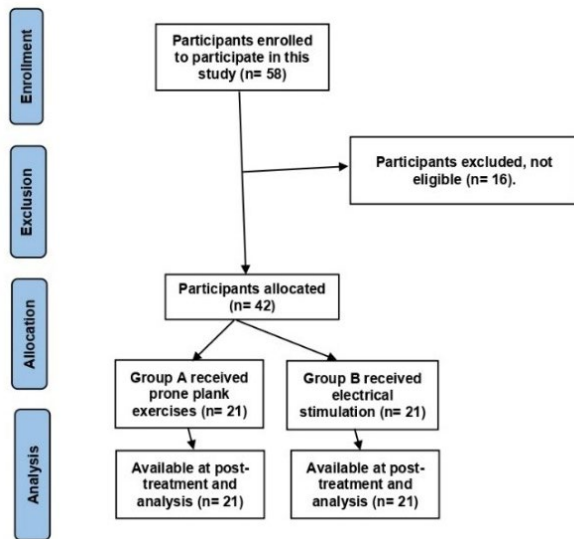


Figure 1. Study flow chart.

Table 1. Within- and between-group comparisons of the mean values of all variables for all participants in both groups.

Items	Mean ± SD		P-Value
	Group A	Group B	
Waist -hip ratio			
Pre-treatment	0.91 ± 0.04	0.91 ± 0.05	0.67
Post-treatment	0.84 ± 0.02	0.87 ± 0.04	0.04*
P-Value	0.0001*	0.0001*	
Supraumbilical interrectus distance at rest			
Pre-treatment	29.05 ± 1.54	29.25 ± 1.48	0.68
Post-treatment	19.7 ± 2.16	26.35 ± 1.57	0.0001*
P-Value	0.0001*	0.0001*	
Infraumbilical interrectus distance at rest			
Pre-treatment	23.5 ± 1.5	23.1 ± 1.77	0.45
Post-treatment	16.65 ± 2.13	19.45 ± 1.7	0.0001*
P-Value	0.0001*	0.0001*	
Supraumbilical interrectus distance during contraction			
Pre-treatment	32.2 ± 1.15	32.15 ± 1.18	0.89
Post-treatment	24.3 ± 1.46	28.25 ± 1.21	0.0001*
P-Value	0.0001*	0.0001*	
Infraumbilical interrectus distance during contraction			
Pre-treatment	27.65 ± 1.9	27.25 ± 1.89	0.51
Post-treatment	22.65 ± 2.16	24 ± 1.49	0.02*
P-Value	0.0001*	0.0001*	

SD = standard deviation, P-value = probability

d = 1.35) with a 95% CI of (0.118, 1.322). These results underscore the notable impacts of the interventions on the measured outcomes, particularly in the case of supraumbilical interrectus distance at rest and during contraction.

Discussion

The goal of this study was to compare the outcomes of prone plank exercises and ES for DRA in postpartum women. The findings could offer guidance for many physiotherapists working with women complaining of DRA to help them in planning and executing rehabilitation programs to control IRD, prevent complications, and enhance the quality of life for patients post-partum.

The results of this study demonstrated the superior effectiveness of prone plank exercises compared with ES in improving WHR, as well as supraumbilical and infraumbilical IRD for DRA in postpartum women. They greatly helped the participants improve and return to normal musculature pre-pregnancy and labor.

The findings of this study align with those of Kamel and Yousif23 who combined ES with abdominal exercises on 60 postnatal women. He found that WHR can be improved and normalized after weight reduction and muscle recovery.

Another study by El-Mekawy et al.24 found that women should participate in a rehabilitation program postpartum as it has a considerable impact on reducing WHR and fostering a peaceful lifestyle.

The findings of this study agree with those of Chiarello et al.25 and Litos,26 who found that the IRD in women with DRA can be reduced up to 2 cm by training these patients with a core stability training program combined with an abdominal brace; this combination was very effective and worthwhile, especially due to the improvement in endurance levels. The findings of the current study may be attributed to the great effects therapeutic exercises result in when applied properly for women with DRA. The exercises can recruit motor units found along the abdominal muscle fibers not only the slow twitch type but also the fast twitch noting that strength of the muscle is simply represented due to the high content and activation of the fast twitch type. Furthermore, the exercises also affect the metabolic demand, which finally results in the improvement of muscle power and endurance 27.

Prone plank exercises, when applied isometrically, can reduce back dysfunction and pain associated with DRA. Many studies have found that these exercises are successful in decreasing IRD among postnatal women suffering from DRA25,28,29. In addition, it was found that prone plank exercise, when applied unilaterally, can greatly activate muscle and increase its action as compared to the bilateral performance. As a progression, when the therapist uses tools to increase the difficulty of prone plank exercises, it results in more muscle activation, balance and proprioception improvement, and strength24,30,31.

Lisnaini32 also showed 68% improvement in infraumbilical IRD with planks versus 24% in controls, supporting this study's findings that planks successfully control infraumbilical separation in postpartum DRA.

The findings of the current work also agree with the recent cohort study of Leopold33, who concluded that the online method may have a great effect in training the core muscles, especially the TrA muscle, for 12 weeks of isometric strengthening exercises. IRD was significantly reduced in both sites, above and below the umbilicus. Furthermore, the women who participated in the program were greatly satisfied and shared it with their colleagues and friends. In this program, the online method had a double benefit regarding the time and cost. The benefits were very high and effective. There was no need for critical observation or guidance from a therapist as in many health facilities. The online method was worthwhile, especially because it included videos explaining and interpreting the sequence and dosage for each position or exercise. Therefore, isometric training of core muscles for DRA in postpartum women is considered a very effective and promising future for the management of this disorder and its associated dysfunctions.

Despite the intergroup superior effect for the prone plank exercise groups, the ES group also showed significant improvement in all outcome measures. The results in the present study agree with the earlier research conducted by Kamel and Yousif23, who found that the IRC above the umbilicus, in the middle between the umbilicus and the xiphoid process, can be improved, decreased, and returns the muscle into a well-developed state after ES combined with abdominal exercises for post-natal women.

It was also reported that ES, when applied in variable procedures, can lead to good clinical outcomes regarding the functional state of the RA muscle, including both strength and endurance34.

Awad et al.11 Also found that progressive prone plank training protocol combined with diastasis recti advice and abdominal binding effectively reduced supraumbilical and infraumbilical IRD in postnatal women with DRA.

In contrast, the current finding conflict with two recent studies showing immediate increases in IRD and poorer clinical outcomes after drawing-in exercises versus crunches30,35.

The current study's findings indicated that combining prone plank exercise with ES in physical therapy protocols can optimize DRA treatment in postpartum women with a greater superiority for prone plank exercises. These findings will assist therapists and patients in saving time and effort while achieving the optimum outcomes as soon as possible.

Study limitations

The current study represents a simple line in getting the best management guidelines and evidence for the DRA treatment and improvement of women complaining of it, but it had some limitations; it did not study the long-term effects and the follow-up of prone plank exercises and ES. In addition, the program delimitation to only specific exercises or a single ES made some patients not participate and other eligible patients replaced them. Furthermore, the patients' commitment was affected, and some of them were replaced if they did not complete the whole program.

In conclusion, prone plank exercises and ES had significant effects in improving WHR as well as supraumbilical and infraumbilical IRD for DRA in postpartum

women, with greater effects for prone plank exercises.

### Recommendations

There are some suggested recommendations for further research; first, the long-term follow-up needs to be studied. In addition, further work is required to examine patients of different ages. Furthermore, replication of this study mixing prone plank exercises and ES as treatment programs for DRA in postpartum women should be applied.

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None.

### Ethics approval and consent to participate

The study protocol was thoroughly reviewed and received approval from the Research Ethics Committee of the Faculty of Physical Therapy, Kafrelsheikh University (Reference: P.T/ WH /1/2023/25). This approval ensured that all research activities adhered to international ethical standards and local regulations concerning human research. Also, the study was registered with ClinicalTrials.gov, (Registration Number: NCT06259240).

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