Investigating Kinesiotaping effect on postnatal rectus abdominis diastasis recovery and back function: A randomized clinical trial

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ABSTRACT

Purpose: Investigate the effect of Kinesio Taping on the recovery of abdominal muscle strength and back function in postnatal women. **Methods:** Forty-eight post-partum women participated in this study. They were separated into two equal groups at random. The first group, A, received KT as well as abdominal exercises, whereas the second group, B, received only abdominal exercises. The intervention lasted 8 weeks in both groups and consisted of two sessions each week. The outcome measures were evaluating pre and post treatment via determining the inter recti distance at 5 and 10 centimeters above the umbilicus; 2.5 and 5 centimeters below the umbilicus and back function by using abdominal caliper and Oswestry Low Back Pain Disability Index (ODI). **Results:** Within group comparison showed in both the study and control groups, there was a substantial decrease in the inter-recti distance at all levels after therapy compared to before treatment ($p = 0.001$). Between groups comparison, Pre-treatment, there was no significant difference between groups ($p > 0.05$). While post-treatment between-groups analyses indicated a substantial decrease in the inter-recti distance in the study group compared to the control group at all evaluated levels ($p = 0.001$). There was a moderate to strong positive significant connection between ODI and inter-recti distance variations ($p <0.01$). **Conclusion:** Kinesio Taping (KT) when combined with the abdominal strengthening exercises boosted the recovery of the inter-Recti diastasis and improved the back function in postnatal females.

Keywords: Abdominal muscles, Diastasis recti, Postnatal, Kinesiotaping, Exercise.

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INTRODUCTION

Diastasis recti abdominis (DRA) is a widening more than 3 cm in the space between the two rectus muscles on either side of the Linea Alba (LA). DRA can occur for a variety of reasons, the most prevalent of which being pregnancy. Other factors include genetic changes in collagen composition, massive weight reduction, and past abdominal surgery. **Emanuelsson et al. [1].**

The expanding uterus increases abdominal pressure during pregnancy, which can cause the rectus abdominis muscles to split along the linea alba. **Thabah & Ravindran [2].** Progesterone, estrogen and relaxin hormones, in conjunction with displaced organs in the abdominal cavity. This may cause alterations in connective tissue, and may be linked to developing the DRA, low back pain, pelvic pain and pelvic floor muscles weakness. **Thabah & Ravindran; Thabet & Alshehri [2-3]**

Abdominal muscles groups support the trunk insituations such as coughing and sneezing, help in defecation, moving in different directions. furthermore, abdominal muscles manage the angle of insertion to stabilize the lower back and pelvic muscles. **Neumann & Gill [4].**

The most prevalent causes of pregnancy-related factors to DRA, such as the number of pregnancies, the fetus's large size for gestational age, an excess of amniotic fluid, or being pregnant with multiples. In addition to obesity, constipation-induced increased intra-abdominal pressure, or a poor breathing pattern can all contribute to DRA. **Thabet & Alshehri; Himani & AratiMahishale [3-5].**

DRA was found in 33% of women at week 21 of pregnancy and 60.0 percent of women six weeks after delivery. It was also 45.5 percent six months after giving birth and 32.6 percent a year later. Throughout the study, the umbilicus was the region with the highest frequency of DRA. **Sperstad et al. [6].**

DRA will cause anterior shift of the abdominal contents which may lead to changes in body statics, and 2 cm forward shift of the center of gravity (COG). Correctly tensed abdominal muscles maintain the viscera in place and prevent them from exerting too much strain on the lumbar spine. It's also connected to healthy body posture and avoiding lumbar lordosis and pelvic anteversion. As a result, functional abnormalities in the abdominal muscles may cause spinal discomfort and dysfunction. **Emanuelsson et al. [1].**

Therefore, DRA causes a high degree of abdominal or pelvic region pain, which may also lead to LBP pain, disruption of trunk stability and movement, pelvic pain, disturbed posture, and pelvic floor dysfunction. These pains and distributions are thought to have a severe effect on ADL in these females, resulting in restricted social life and travel. **Benjamin et al.; Parker et al. [7-8].**

Abdominal exercises, postural training, education, and training on appropriate mobility and lifting techniques, the Noble Technique, manual therapy that includes soft tissue mobilization, myofascial release, abdominal bracing and taping, the tub grip, or a corset are all options for conservative management of DRA. **Benjamin et al.; Keeler et al. [9-10].**

Despite the fact that numerous studies have been conducted on the effects of various activities on DRA, there are no particular instructions about the exercises aimed at treating the described ailment. The most commonly used exercise methods target the transversus abdominis and rectus abdominis. **Michalska et al. [11].** Adaptive changes in the muscles as their metabolic capacities are increasingly stressed, muscle fiber hypertrophy, and higher activation of their motor units might explain the reported increase in muscular strength following abdominal workouts. **Kisner C, Colby [12].**

Kinesiotaping (KT) has gained popularity in the treatment of a variety of musculoskeletal problems. **Castro-Sánchez et al. [13].** KT works by enabling stimulation of the muscles, improving the circulation of blood and lymph, and reducing pain by suppressing the nervous system. It's also been discovered that KT has the ability to control the tension in the muscles and tissues. **Kisner C, Colby [12].**

One of the theories linked muscular action to mechanoreceptor stimulation when KT was applied to the skin. When skin mechanoreceptors are triggered, they cause local depolarization and nerve impulse transmission through afferent fibers to the central nervous system. **Mady [14].**

In addition, muscle's facilitation or inhibition, depends on the direction of KT application. The application concept for weak muscles is to start at the muscle's origin and ending at the muscle's insertion. During muscle contraction, this causes a concentric pull on the fascia, which enhances the contraction. **Hammer [15].**

Due to the prevalence of back pain caused by DRA after delivery, and the lack of a coordinated and eff ective program for treating DRA, this study aimed to investigate the effect of KT on healing of the DRA and LBP among postnatal women.

MATERIALS AND METHODS

Participants

The subjects were recruited from the gynecologic outpatient clinic at College of Physiotherapy, October 6 University. Inclusion criteria, age range was 25 to 35 years old, had normal vaginal delivery, diastasis recti > 2.5 cm at any point of assessment along the linea alba. participants' body mass index (BMI) was < 30 kg/m^2; and all the participants were after the end of the postpartum period. Exclusion criteria were skin sensitivity to tape; skin diseases especially in abdomen; history of cesarean section; abdominal hernia; parity more than 3 times; other abdominal or back operation. Persistent gestational diabetes, and hypertension; spinal disorders and body deformities which may limit the abdominal exercises.

Using a simple randomization procedure, 48 postpartum mothers were randomly allocated into two groups. Sample size calculation was performed prior to the study using G*POWER statistical software (version 3.1.9.2; Franz Faul, Universitat Kiel, Germany) and revealed that the required sample size for this study was 24 subjects per group considering the 20% of drop out. Calculations were done using α=0.05, β=0.2 and effect size = 0.91 and allocation ratio N2/N1 =1. The first group (Group A) was given KT and abdominal muscle exercises for two sessions /week, and the second group (Group B) was given abdominal muscle exercise for two sessions/week, and the entire program for both groups was applied for eight weeks, **Figure 1.**

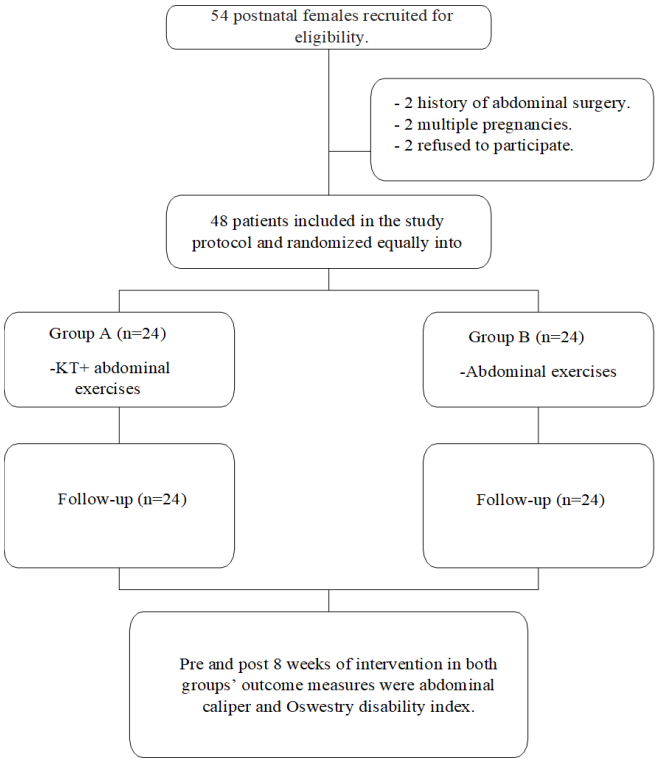

Fig.1. Flow diagram of patients in the study.

Procedures

Evaluative procedures

In both groups, evaluations were done before and after interventions.

(1) Abdominal Caliper: An electronic digital (*Mitutoyo America Corporation, Aurora, IL, Germany*) 6-Inch, 150-millimeter (mm) caliper with LCD screen, Battery powered, Inch/Metric (mm), 0-6-inch range, +/-0.001-inch accuracy, was used to measure diastasis recti in the subjects in millimeter in both active and resting position. It consists of four jaws two large and two small, three buttons on the digital caliper on/off button to turn on or off, and zero prepare to take a measurement and the mm/inch button if you need it in metric or in inches, and a locking screw to keep the reading in place to avoid losing of the reading located on top of the caliper. Caliper is valid tool for inter-recti distance measurement. **Chiarello et al. [16].**

While the female assumed the hook lying position, she was asked to curl up and hold for 3 seconds for DRA measurements. The diastasis was assessed at different locations in reference to the umbilicus; at 5 cm and 10 cm above while below measurement were at 2.5 cm and 5 cm, **Figure 2.**

Fig 2. Application of facilitation technique on rectus abdominus, right and left internal and external oblique abdominal muscles (OAM).

(2) The Oswestry Low Back Pain Disability Questionnaire: also known as The Oswestry Disability Index (ODI), is used to assess a patient's long-term functional disability. ODI is considered as the "golden standard" for low back functional outcome measures. It includes 10 multiple-choice questions regarding the back pain and the subsequent disability in daily activities. The maximal score is 50 which interpreted as maximum disability also a percentage from the total score can be calculated. Each question can be scored on a 0-5 scale, where 5 represents the maximum disability. The ODI score is calculated as the total scored) divided by 50 (total potential score) multiplied by 100. If a section is missing or is not applicable, the denominator i.e., total potential score will be reduced by 5. **Fairbank & Pynsent [17].**

The Oswestry Index for Arabic was translated and modified for use in Saudi women with low back pain. With a similar number of items as in the original version, both the appearance validity and structural validity were good. This study suggests that even if Arabic is the target population's common language, transcultural translation in Arabic necessitates cultural modifications. More research is needed to investigate the questionnaire's response to modification. **Algarni et al. [18].**

Treatment procedures

The two groups received their treatments for two sessions /week for 8 weeks.

(1) Kinesiotaping (KT): Women in group A received KT for 2 sessions/ week for eight weeks i.e. the Kinesiotaping was changed every 3 days.

Technique: Rectus Abdominal Muscles (RAM) and Oblique Abdominal Muscles (OAM) are two of the most important abdominal muscles (OAM). Tape was placed to RAM using the muscles facilitation technique, with a tension of 15-35 percent, from the origin to the insertion of the muscle. The band began with little strain on the symphysis pubis, and then the ladies stretched the abdominal area via deep abdominal inspiration, ending at the xiphoid process. The right and left external oblique muscles were taped, and the procedure began without stress from the bottom and of 6-12 ribs., the hip was then flexed and rotated in the other direction, and the tape was fastened to the pubic bone with a 15-35 % strain. Finally, were performed on the right and left internal oblique muscles the procedure was women position in crock lying position was started without tension from anterior superior iliac spine and then the hip was placed in extension position and the tape was attached to lower 4 ribs and linea alba with tension between 15-35%. **Kase et al. [19], figure 2.**

(2) Abdominal muscles exercise: Women in group B, for eight weeks, the abdominal muscles were exercised twice a week. The ladies followed the same workout plan at home on subsequent days, this program was suggested by **Kamel & Yousif [20].** For DRAM, there is no one-size-fits-all exercise routine. The exercises were taught to the women, as they may do as a home routine. Wrapping a scarf around the participant's waist, was advised while performing the exercises. The recommended exercises were sit ups, reverse sit-ups, reverse trunk twists, and U-seat exercises. Throughout the treatments, each exercise was done 20 times and increased by four repetitions each week. Additionally, respiratory rehabilitation technique in terms of diaphragmatic stretching and thoracic blocking was performed as deep inspiration followed by deep expiration accompanied by isometric abdominal muscle contraction **Kamel & Yousif [20].** The technique repetition was raised by one set each week until the eight-week intervention was completed, starting with a set of five times.

Statistical analysis

The Shapiro-Wilk test was used to assess the normal distribution of data. Levene's test was used for homogeneity of variances assessment. Unpaired and paired t-tests were conducted for between and intra-groups comparisons of outcome measures, respectively. Mann Whitney U test was conducted for comparison of number of deliveries and years since delivery between groups. Pearson correlation coefficient was used to investigate the correlation between ODI and inter-recti distance. Regression analysis was conducted for prediction of ODI from subjects' characteristics and inter-recti distance. For all statistical tests, the significance threshold was set at $p< 0.05$. The statistical package for social studies (SPSS) version 25 for Windows was used for all statistical analysis (IBM SPSS, Chicago, IL, USA).

Ethical approval

This study was a randomized control study, approved by the Institutional Ethical Committee of the Faculty of Physical Therapy, Cairo University, granted the authors the approval to conduct the trial under the agreement code of P.T.REC/012/003222. This trial was documented in clinicaltrials.gov with an identifier number (NCT04932772).

Informed consent

After full explanation of the study aim and procedures, each participant was requested to sign a consent form as an approval to take part in the study. To withdraw from the study at any time was granted to all participants without any consequences. The rules of Helsinki's declaration were taken into consideration during the application of this trial.

Results

The Shapiro-Wilk test of data normality for each dependent variable showed normal distribution in both groups ($p > 0.05$). Also, Levene's test revealed that there was equality of variances between groups ($p > 0.05$). All subjects in study and control groups showed no significant difference ($p > 0.05$) in the demographic characteristics, **table 1.**

Table 1. Demographic characteristics of participants.

Variables	Study group (n= 24) mean ± SD	Control group (n=24) mean ± SD	t- value	p-value
Age (years)	29.71 ± 2.34	29.75 ± 2.04	-0.06	0.94
Weight (kg)	73.6 ± 6.76	74.75 ± 5.44	-0.64	0.52
Height (cm)	165.12 ± 7.51	167.41 ± 6.42	-0.84	0.26
BMI (kg/m²)	26.95 ± 1.13	26.65 ± 0.95	0.26	0.31
Number of deliveries, median (IQR)	2 (2-1)	2 (2-2)	U- value = 256.5	0.45
Years since delivery, median (IQR)	4 (5-4)	4 (5-4)	U- value = 241.5	0.3

SD, standard deviation; IQR, interquartile range; U- value, Mann Whitney U test value; p-value, level of significance

Within group comparison, both the study and control groups showed significant decrease in the inter-recti distance after treatment as compared to pretreatment (p = 0.001). The highest change occurred at 10 cm above umbilicus by 69.02% in study group and 48.27% in the control group. The percent of change in inter-recti distance of the study group at 5 cm below umbilicus, 2.5 cm below umbilicus and 5 cm above umbilicus was 34.83, 22.33 and 32.65% respectively while that in the control group was 23.83, 13.19 and 24.5% respectively, **table 2.**

Table 2. Mean of inter-recti distance pre and post treatment of the study and control groups.

	Study group mean ± SD	Control group mean ± SD	MD	t- value	p value
Inter-recti distance (mm)					
5 cm below umbilicus					
Pre treatment	24.2 ± 0.61	24.42 ± 0.76	-0.22	-1.11	0.27
Post treatment	15.77 ± 0.39	18.6 ± 0.52	-2.83	-21.07	0.001
MD	8.43	5.82			
% of change	34.83	23.83			
t- value	46.69	42.53			
p value	*p = 0.001*	*p = 0.001*			
2.5 cm below umbilicus					
Pre treatment	29.96 ± 2.23	30.26 ± 0.97	-0.3	-0.61	0.54
Post treatment	23.27 ± 0.35	26.27 ± 0.42	-3	-26.61	0.001
MD	6.69	3.99			
% of change	22.33	13.19			
t- value	14.14	28.93			
p value	*p = 0.001*	*p = 0.001*			
5 cm above umbilicus					
Pre treatment	32.31 ± 0.77	32.37 ± 1.04	-0.06	-0.22	0.82
Post treatment	21.76 ± 0.22	24.44 ± 0.65	-2.68	-19.06	0.001
MD	10.*55*	7.93			
% of change	32.*65*	24.5			
t- value	59.62	61.89			
p value	*p = 0.001*	*p = 0.001*			
10 cm above umbilicus					
Pre treatment	12.49 ± 0.81	12.45 ± 0.72	0.04	0.21	0.83
Post treatment	3.87 ± 0.51	6.44 ± 0.22	-2.57	-22.43	0.001
MD	8.62	6.01			
% of change	69.02	48.27			
t- value	39.26	49.42			
p value	*p = 0.001*	*p = 0.001*			

SD, standard deviation; MD, mean difference; p-value, level of significance

Furthermore, both groups had a substantial drop in ODI post-treatment compared to pre-treatment (p = 0.001). The study group had a change of 63.56 %, whereas the control group had a change of 51.5%, table 3.

Between groups comparison, Pre-treatment comparisons showed no significant difference

between groups (p > 0.05). While post-treatment comparisons demonstrated a substantial decrease in the inter-recti distance at all observed levels in the study group compared to the control group (p = 0.001), **table 2**. Same observation was noted for ODI significant improvement in favor of the study group (p = 0.001), **table 3.**

Table 3. Mean ODI pre and post treatment of the study and control groups

	Study group	Control group	MD	t- value	p value
	mean ± SD	mean ± SD			
ODI (%)					
Pre treatment	17.37 ± 2.24	16.66 ± 2.86	0.71	0.95	0.34
Post treatment	6.33 ± 2.09	8.08 ± 2.79	-1.75	-2.45	0.01
MD	11.04	8.58			
% of change	63.56	51.5			
t- value	31.7	33.68			
p value	***p = 0.001***	***p = 0.001***			

SD, standard deviation; MD, mean difference; p-value, level of significance

ODI and inter-recti distance showed moderate to strong positive significant correlation (p < 0.01) with r value ranged from 0.377 to 0.814, **table 4.**

Table 4. Correlation between ODI and inter-recti distance:

Inter-recti distance (mm)	ODI (%)	
	r – value	p- value
5 cm below umbilicus	0.676	0.001
2.5 cm below umbilicus	0.377	0.008
5 cm above umbilicus	0.692	0.001
10 cm above umbilicus	0.814	0.001

r value: Pearson correlation coefficient; p-value, level of significance

Multiple linear regression was conducted to predict ODI from subjects' characteristics and inter-recti distance. The model was significantly fit the data (F = 11.38, p = 0.001). The adjusted R^2 was 0.68 so 68% of the variation in ODI can be explained by the model including age, weight, height, BMI, number of deliveries, years since last delivery and inter-recti distance at different levels in reference to the umbilicus. There was a significant association between ODI with years since delivery (p = 0.01) and inter-recti distance 10 cm above umbilicus (p = 0.001), **table 5.**

Table 5. Regression model of ODI, subjects' characteristics and inter-recti distance:

Regression model							
Model	**Unstandardized Coefficients**		**Standardized Coefficients**	**t-value**	**p value**	**95% CI for B**	
	B	**Std. Error**	**Beta**			Lower Bound	Upper Bound
Constant	48.76	81.05		0.602	0.55	-115.47	212.99
Age	0.00	0.17	0.002	0.012	0.99	-0.35	0.35
Weight	0.45	0.56	1.07	0.808	0.42	-0.68	1.59
Height	-0.39	0.50	-1.16	-0.782	0.44	-1.39	0.62
BMI	-1.34	1.42	-0.77	-0.940	0.35	-4.21	1.54
Number of deliveries	0.94	0.69	0.23	1.367	0.18	-0.45	2.33
Years since delivery	-1.01	0.37	-0.29	-2.751	**0.01***	-1.75	-0.27
5 cm below umbilicus	1.18	0.63	0.32	1.865	0.07	-0.10	2.47
2.5 cm below umbilicus	-0.01	0.15	-0.01	-0.064	0.95	-0.31	0.29
5 cm above umbilicus	-0.61	0.56	-0.23	-1.092	0.28	-1.73	0.52
10 cm above umbilicus	2.29	0.55	0.68	4.150	**0.001***	1.17	3.40

B, Regression coefficient; CI, confidence interval; p-value, level of significance; *, significance

DISCUSSION

In present study, the KT application for 8 weeks on postnatal rectus abdominal diastasis recovery and back function was investigated. The outcome measures were inter-recti distance (IRD) measured by a nylon numerical caliper, and patients' functional disability by the ODI.

Group B (control group), who underwent abdominal exercises twice a week for eight weeks demonstrated within group substantial improvement in the evaluated parameters. This can be linked to abdominal workouts, which assist to strengthen and manage abdominal muscles as well as enhance their tone, reducing tension on the linea alba and therefore facilitating IRD decrease. **Kamel & Yousif [20]**. Furthermore, the transversus abdominis (TrA) muscle, when activated and exercised, this will make the two rectus abdominus muscle close together, improves the linea alba integrity, and increases the fascial tension, all of which contribute to effective load transfer and torque production. TrA muscle stimulation may preserve the linea alba and aid in the prevention or reduction of DRAM, as also grants speedy recovery, allowing sooner return to their physical and social normal activities. **Benjamin et al. [9].**

The changes noted in IRD at 6 months in comparison to 7 weeks postnatal can be attributed to the improvement in trunk flexion strength. **Liaw et al. [21].** Therapeutic activity triggers both slow twitch (ST) and fast twitch (FT) skeletal muscle fibers, resulting in an increase in fiber content, since the high amount of FT fibers improves muscular strength; this explains the reduction in IDR owing to abdominal muscle strengthening exercises. **Thabet & Alshehri [3].**

The current literature showed scarce evidences about recommended exercises to treat the DRA. that is why a proposed abdominal strengthening program was selected in the current research **Kamel & Yousif [20].** Evidences about IRD reduction by performing head lifts and twisted curl-up exercises. **Gluppe et al. [22],** traditional abdominal strengthening program. **Walton et al. [23]** and a proposed abdominal strengthening program. **Kamel & Yousif [20].** all formed the concept to develop the exercise program used in the current study.

Group A, who received Kinesiotaping combined with abdominal workouts resulted in substantial intragroup and intergroup improvements in all evaluated parameters.

KT is a simple approach used to regulate muscle and fascia tension as well as muscle activation. KT can activate the mechanoreceptors on the skin is the concept on how KT application activates muscle action. This results in local depolarization and afferent fiber transfers the nerve impulses to the central nervous system. **Ptak et al. [24].** On other hand, Fascia may indirectly alter muscle tension and the musculoskeletal system dynamics. So, Fascia may contribute to the forces transfer, motion regulation and body protection by proper biomechanics, through its connection with muscular system. **Vithoulka et al.; Kuo, Y. L., & Huang [25-26].**

More to the point, the significant improvement in group A in relation to group B in present study was clarified by the irradiation phenomenon of taping therapy, as it improves the intensity and frequency of stimulation to the muscles, resulting in the increase of contraction force. **Kim & Lee; Ptaszkowska et al. [27-28].**

The existence of an IDR is linked to a lower back pain intensity, as well as a lower health-related quality of life. **Benjamin et al.; Eriksson Crommert et al. [7-29].** This explains the current improvement in Modified Oswestry Questionnaire as improved abdominal strength, function, and decrease of IDR which was more significant in group A in comparison to group B.

The findings of this study are supported by previous literatures **Castro-Sánchez et al.; Lins et al; Gürşen et al. [13-30-31]**, all concluded that taping should be included in a patient's rehabilitation program or used in conjunction with exercise. As it enhances the impact of exercise by promoting muscular facilitation, as seen in group A's results in our study.

However, there was contradictory results reported **Csapo & Alegre [32]** as KT had no effect on muscular strength. This inconsistency can be attributed to two factors: firstly, not defining facilitatory and inhibitory KT application, as each application may have distinct physiological process. Furthermore, different tape directions may affect the result metrics **Lim & Tay [33].** Second, non-randomized controlled studies, which give less evidence than randomized controlled trials, were included in Csapo and Alegre's analysis **Csapo & Alegre [32].**

In conclusion, KT intervention augmented with strengthening abdominal muscles protocol boosts the recovery results of IDR and back function among postnatal women with diastasis recti.

The current study has a limitation of no follow-up on the KT long-term effect was done, so the therapeutic effect's longevity is unknown. Further studies are needed into the best effective physical therapy and supportive treatment modalities for IDR in postpartum women.

AUTHOR CONTRIBUTION

Conceptualization: Elarabi MK, Kamel DM. Methodology: Elarabi MK, Ahmed SM. Formal analysis: Elarabi MK, Kamel DM, Ahmed SM. Project administration: all authors. Visualization: all authors. Writing – original draft: Elarabi MK, Ahmed SM, Samir SH. Writing - review and editing: Elarabi MK, Kamel DM, Ahmed SM. Approval of final manuscript: all authors.

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