Effect of Abdominal crunch exercise versus Tubigrip on Inter-rectus distance and Quality of life among postpartum women with diastasis recti abdominis

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Abstract

Background: Diastasis recti abdominis (DRA) is a prevalent disorder during pregnancy and the immediate postpartum period. It increases the risk of abdominal muscles dysfunction and lowers the quality of life after childbirth. **Study aim:** To evaluate the effect of abdominal crunch exercise versus tubigrip on inter-rectus distance and quality of life among postpartum women with diastasis recti abdominis. **Research design:** A quasi-experimental research design. **Setting:** This research was conducted at the El Shatby Maternity University hospital in Alexandria Governorate, Egypt, both inpatient and outpatient postpartum departments. **Study subjects:** A purposive sample of 90 postpartum women was enrolled in the study. **Tools:** Three tools were utilized to collect the data, tool (I): Basic data structured interview schedule, tool (II): Finger Palpation Method, and tool (III): Persian version of MAPP-QOL. **Results:** A statistically significant narrowing in the inter-recti distance (IRD) in all distances at the umbilicus or 4.5 cm above or below it ($p=<0.001$) after the intervention of both the abdominal crunch and tubigrip group in the favor of abdominal crunch group. In addition, a statistically significant difference was found in the mean quality of life scores among the studied groups after intervention, in the favor of abdominal crunch group ($p=<0.001$). Furthermore, a statistically significant negative correlation was found between quality of life and inter-recti distance of rectus abdominal muscle at rest in the favor of abdominal crunch group in all distances before and after intervention respectively. **Conclusion:** After 6 weeks of intervention, abdominal crunch exercises are more effective than wearing tubigrip on narrowing inter-recti distance in all 3 distances at the umbilicus or 4.5 cm above or below it. In addition, it improves the quality of life among women with diastasis recti abdominis. **Recommendations:** Abdominal crunch exercises are recommended for postnatal women suffering from DRA.

Keywords: Abdominal crunch exercise, Diastasis recti abdominis, Inter-rectus distance, Quality of life, Tubigrip.

Introduction

A woman's life undergoes significant physiological and psychological changes during the postpartum phase. One of the most noticeable acquired conditions that lasts throughout the postpartum period is a separation (or diastasis) of the rectus abdominis muscle, which is caused by the growth of the abdominal wall during pregnancy to accommodate the growing fetus **(Laframboise et al., 2021).** The term diastasis recti abdominis (DRA) describes the midline separation of the two rectus abdominis muscles bellies on either side of the linea alba **(Gluppe et al., 2018).** (Figure 1)

The abdominal wall shields the abdominal viscera while also supporting the stability and motion of the trunk. One of the main vertical muscles of the anterior abdominal wall is the rectus abdominis, a long, broad muscle that resembles a strap. It is thick and broad inferiorly, as well as three times as wide superiorly. The two inferiorly closely spaced rectus muscles are divided by the linea alba **(Dalley & Agur, 2023; F. Gary Cunningham, 2022 ; Reinpold et al., 2019)**.The remaining three major abdominal muscles on each side are the transversus abdominis, external obliques, and internal obliques. These muscles all are inserted into the rectus abdominis at the linea alba, a tendinous central fibrous tissue that connects the two parts of the rectus abdominis muscle and runs from the symphysis pubis to the xiphoid process. The rectus sheaths and its ordered network of connective tissue are essential for preserving the stability of the abdominal wall **(Hernández-Granados et al., 2021; Hills et al., 2018; Laframboise et al., 2021).**

Diastasis recti abdominis is diagnosed based on the existence of one or more points of

separation along the linea alba that are more than 2 cm apart. This includes points at or above and below a 4.5 cm distance from the level of the umbilicus **(Hu et al., 2021; Thabet & Alshehri, 2019).** DRA was also diagnosed in case of a visible protrusion along the linea alba during exertion, regardless of whether the palpated separation was less than two finger widths. Based on the number of finger widths, the results were then divided into four categories: normal (<2), mild (2–3), moderate (3–4), and severe (≥4) **(Gluppe et al., 2018).**

Diastasis recti is a commonly occurring condition during pregnancy **(Dave & Mahishale, 2019)**. This condition typically emerges in the 2nd trimester and reaches its peak in the 3rd trimester of pregnancy. Although the prevalence decreases, it does not completely disappear in the postpartum period. Six weeks and twelve months after giving birth, the prevalence has been observed to be 60% and 32%, respectively **(Gluppe et al., 2021).** Just 11% of them occurred below the umbilicus, and it was always concurrent with events at or above the umbilicus, while just 37% of DRA were found above the umbilicus **(Thabet & Alshehri, 2019)**. Compared to primipara, the occurrence rate in multipara was more than 67% **(Dave & Mahishale, 2019).**

The exact cause of diastasis recti during pregnancy is unknown, but theories suggest that hormonal fluctuations and mechanical strains on the abdominal walls structures are significant contributors to the separation of the rectus muscle **(Laframboise et al., 2021)**. Hormonal changes lead to elevation in the levels of relaxin, progesterone, and estrogen hormones, which weaken the linea alba and soften the connective tissues. Furthermore, the weight of the fetus places mechanical stresses on the weak abdominal muscles and soft tissue structures, which can lead to stretching and, in certain cases, a slit on the linea alba, which can cause the abdominal wall to bulge, the organs to shift, and the inter-rectus distance to increase **(Michalska et al., 2018)**. Additionally, pregnancy is a common time for anterior pelvic tilt, with or without lumbar hyperlordosis. The alterations in posture can impact the pelvic and abdominal muscles' insertion angle; thereby exerting an influence on postural biomechanics **(Saleem et al., 2021).**

Other predisposing factors include advanced maternal age, obesity, multiple pregnancies, macrosomic fetus, weakened abdominal muscles, polyhydramnios, cesarean section delivery, gestational weight gain, multiparity, previous abdominal surgery, high birth weight, and increased intra-abdominal pressure have all been identified **(Gluppe et al., 2021; Thabet & Alshehri, 2019)**. Notably, weightlifting is thought to be the most common factor impacting about 60% of women at six months postpartum. This is because it causes a large increase in intra-abdominal pressure (IAP) and the loading of the already weak abdominal muscles during pregnancy **(Saleem et al., 2021)**.

Consequently, the development of abdominal separation or diastasis recti results in a reduction of the mechanical control, functional strength, and the overall integrity of the abdominal wall. Therefore, the lumbar spine and pelvis may become more vulnerable to injury due to altered posture, altered pelvic stability, and changes in trunk mechanics. In the end, this makes pelvic instability and lower back discomfort worse. Furthermore, it may lead to problems in breathing, delivery, defecation, abdominal muscle trunk (rotation, flexion, bending to the side) and pelvic floor functions as well as the support of the abdominal viscera owning to prolapse of abdominal organs and abdominal hernia. As a result, this phenomenon negatively affects the quality of women life throughout the course of pregnancy and in the postpartum period **(Laframboise et al., 2021; Thabet & Alshehri, 2019).**

The term "quality of life" (QOL) refers to a multifaceted concept that influences individuals' performance in their physical, psychological, social, and spiritual contexts. Assessing quality of life during the postpartum period will enable women to evaluate their postpartum circumstances and help healthcare professionals to promote the health of women and their newborns **(Gökşin & Ayaz-Alkaya, 2018)**.

Therefore, numerous strategies for the management of women suffering from postpartum DRA, including both surgical and conservative approaches should be available.

Despite its proven effectiveness in treating DRA, surgical intervention is not considered the best option because of its invasive nature, which may result in complications such as the formation of postoperative scars, wound infection, rejection of surgical patches, postoperative adhesions, and other associated complications **(Kinney & Lozanova, 2019).** Furthermore, the abdominal surgical repair may have an impact if postpartum women ever require additional abdominal surgery. When the condition is more serious, surgical options are advised. Therefore, using numerous conservative management techniques is always advised, including techniques to strengthen the transversus abdominis musculature. Core strength exercises such as abdominal crunch exercises, Glute bridge and modified plank focus on the trunk flexors are frequently recommended for women experiencing postpartum diastasis recti abdominis **(Gluppe et al., 2021).**

Other regularly utilized non-surgical interventions comprise of postural and back training, pilates exercises, exercises using the Tupler's approach, either with or without abdominal splinting, the Noble technique, which involves manually approximating the rectus abdominis muscles during a partial sit-up, and manual therapy, which includes myofascial release as well as soft tissue mobilization. Aerobic exercise, electrical stimulation therapy, traditional Chinese medicine acupuncture abdominal bracing and taping are also used **(Nahabedian, 2018; Weingerl et al., 2022).**

It is important to mention that there has been a dispute regarding the effectiveness of various types of exercises in resolving diastasis recti abdominis **(Emeka et al., 2022)** .Abdominal exercises are frequently recommended for postnatal women suffering from DRA. One example of such exercises is the abdominal crunch, which is a classic core exercise that is most frequently utilized for strengthening the abdominal core muscles **(Gluppe et al., 2021).**

The abdominal crunch exercise is regarded as a fundamental method for engaging the abdominal musculature. It involves flexing the spinal column to approximately 30 degrees from a supine position, while the knees are flexed and the feet are secured in place. Studies have indicated a greater activation of the upper section of the rectus abdominis muscle during exercises that involve flexion of the spinal column **(Ifeyinwa et al., 2021)**. It is believed that additional soft abdominal supports, like the tubigrip, may lessen the diastasis. It is a multifunctional tubular bandage as it offers tissue support that is comfortable and effective in a variety of widths to accommodate most applications as well as reduces pressure on the muscles and ligaments, perhaps alleviating pelvic or back pain. Its composition consists of covered elastic threads that are woven into the fabric in a continuous spiral to conform to the curves of the body and transfer pressure uniformly throughout the surface, preventing stretching along the length of the material and making application and reapplication simple **(Calatayud et al., 2019).**

One example of abdominal braces and tapings is the tubigrip which is typically characterized by its unique construction and arrangement, it helps to optimize bodily support. Tubigrip connects the sacral spine and pelvis to the mid-thoracic spine. This particular belt offers three distinct and advantageous features. First, the tubigrip's adjustability and unique construction enable it to be effectively applied to individuals with various sizes and shapes. Second, because it is made specially to support the back and abdomen. So, it may reduce strain on the muscles and ligaments as well as decrease back or pelvic pain, while also facilitating static contraction of the abdominal muscles. Lastly, the tubigrip boasts a remarkably simple construction, making it relatively easy and cost-effective to manufacture **(Dave & Mahishale, 2019).** Moreover, the current techniques for managing postpartum DRA remain a subject of debate, and there is a deficiency in well-established non-surgical approaches that yield effective results **(Hu et al., 2021)**. Therefore, this study was conducted to evaluate the effect of abdominal crunch exercise versus tubigrip on inter-rectus distance and quality of life among postpartum women with diastasis recti abdominis.

Significance of the study

Throughout the postpartum phase, a parturient experiences significant physical and emotional alterations. Between 30% and 70% of pregnant women may experience DRA, a condition that may persist in up to 60% of women during the first several weeks after giving birth and may not always spontaneously end. This can result in a number of issues that have an adverse effect on a woman's quality of life. Women with DRA encounter limitations when doing trunk flexion, rotation, side bending and low back pain. Moreover, they experience breathing problems and abnormal abdominal visceral support. Numerous studies indicate that a woman's reduced health-related quality of life (HRQoL) following childbirth reduces her daily activities, causes her to struggle in caring for her newborn and herself, makes it more difficult for her to breastfeed and start solid food at a young age, as well as increases the expense of medical care **(Kohler et al., 2018; Özdemir et al., 2018; Tully et al., 2017).** Finding a straightforward and efficient approach of treating DRA is of utmost importance **(Benjamin et al., 2019; Thabet & Alshehri, 2019).**

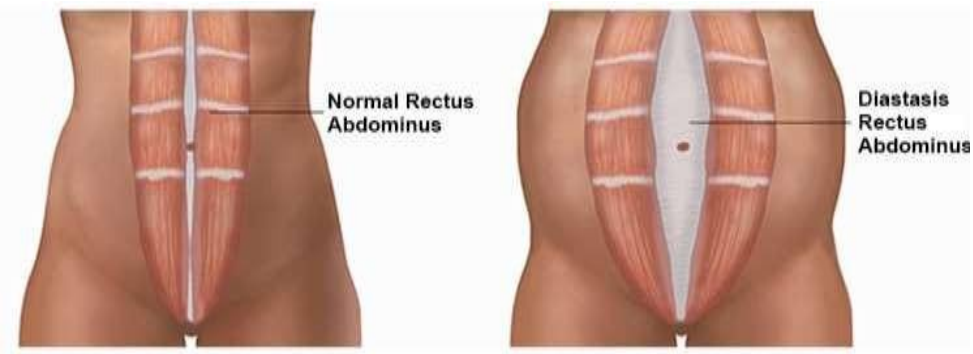

Figure (1) Diastasis Recti Abdominus.
Available online: https://prosurgicare.com/all-you-need-to-know-about-diastasis-recti/

Aim of the study

To evaluate the effect of abdominal crunch exercise versus tubigrip on inter-rectus distance and quality of life among postpartum women with diastasis recti abdominis.

Research hypotheses

H (1): Post-partum women who practice abdominal crunch exercise exhibit less inter-rectus distance and a higher quality of life than those who don't.

H (2): Post-partum women who wear tubigrip exhibit less inter-rectus distance and a higher quality of life than those who don't.

Material and Methods

Materials

Research design:

The study used a quasi-experimental research design to assess the effect of the independent variables (tubigrip and abdominal crunch exercise) on the dependent variables (Inter-rectus distance and Quality of life among postpartum women with diastasis recti abdominis).

II- Study setting:

This research was conducted at El Shatby Maternity University hospital in Alexandria Governorate, Egypt, both inpatient and outpatient postpartum departments. This hospital was selected because it is a major hospital in Alexandria governorate as it receives women from rural and urban areas and provides care for women in their whole life cycles.

III- Subjects:

A purposive sample of 90 postpartum women were enrolled in the study and distributed equally between the three groups: **Abdominal crunch group (1)** included "30" women who practiced abdominal crunch exercise, **Tubigrip group (2)** included "30" women who wore tubigrip and **Control group (3)** included "30" women who received routine hospital care.

Women in each group were selected according to the inclusion criteria:

- Primipara, undergone normal vaginal delivery and aged between 20 - 35 years. Had an inter-rectus distance with mild (2–3), moderate (3–4), and severe (≥4) in all distances at the umbilicus or 4.5 cm above or below it were involved into the study.
- Women with musculoskeletal issues as disc prolapse or bulge, spinal surgeries, previous abdominal surgery or hernia, lower segment Caesarean section, heart disease, respiratory disorders, including persistent coughing or sneezing, antenatal and postnatal complications, as well as performing abdominal strengthening exercises during pregnancy were not allowed to participate in the abdominal crunch exercise group.
- Women who have latex allergy were also excluded from tubigrip group.

The Epi info 7 statistical tool was used to calculate the population sample size using the following parameters:

- The population size is 345 women in 3 months.
- Expected frequency of 50 %.
- Acceptable error of 5%
- Confidence coefficient of 95%.
- The minimal sample size is 89.
- 90 was the final sample size for a potential normal response.

IV- The study tools:

Data was gathered using three tools.

Tool I*:* Basic data structured interview schedule: This was constructed by the researchers following a search and evaluation of relevant literature, and it consisted of two sections:

Section one: Socio-demographic data (age, educational level, employment, marital status, place of residence, family type and income).

Section two: Reproductive history such as (number of pregnancies, deliveries, stillbirths and living children).

Tool II: Finger Palpation Method:

Based on the literature review, the inter-recti distance was measured using this tool **(Benjamin et al., 2020; Depledge et al., 2021)** both before and after the six-week intervention for the women in the three groups. The participants were instructed to lie in a crook lying manner, with a cushion placed underneath and their head as well as their feet resting on the plinth. In order to clear the surface with their scapular spine, the individuals were instructed to simultaneously elevate their head and shoulder off the plinth and touch their knees with outstretched arms. The participant's linea alba was then horizontally palpated by the researcher using her fingers. The space between the interior borders of two abdominal rectus muscles was measured using a finger-width fit **(Saleem et al., 2021)** .

The outcome was measured as the number of fingers then the outcome was expressed in millimeters after the number of fingers that could be inserted between the muscular bellies was recorded. Measurements were obtained 4.5 cm above, at, or below the umbilicus, using the umbilicus as a reference point.

Tool III: Persian version of MAPP-QOL

Persian version of MAPP-QOL (MAPP-QOL) was adapted from **(Mokhtaryan-Gilani et al., 2021)** by the researchers to include four subdivisions totaling 22 items. These subdivisions comprise:

- ***Psychological*** (8 items) such as woman's happiness in general and woman's peace of mind
- ***Relational/spouse-partner*** (3 items) such as the husband/partner's emotional support and relationship with her.
- ***Relational/family-friends*** (4 items) such as the family emotional support and the time for friends/relatives.
- ***Health and functioning*** (7 items) such as woman's energy level for daily tasks and her capacity to care for herself on her own.

This scale evaluates the quality of life during postpartum period. MAPP-QOL items were scored using a five-point Likert scale, which is as follows: 1: "None"; 2: "Little"; 3: "Moderate"; 4: "Much" and 5: "Very much." The scale can have a maximum score of 22–110. Lower scores imply a lower quality of life after birth; higher scores suggest a higher quality of life after birth. Quality

of women's life is classified into three categories as follows:

1. Scores of 22- 51 indicate poor quality of life.
2. Scores of 52- 80 indicate fair quality of life.
3. Scores of 81-110 indicate good quality of life.

Field work

The researchers attended the study setting twice per week, from 10 am to 2 pm until obtaining the calculated sample. There were three stages to the study's completion: preparation, application and evaluation stage.

The following procedures were followed in conducting the study:

Preparation stage:

- Prior to starting the research, ethical approval was received from Alexandria University, Faculty of Nursing, Research Ethics Committee.
- Following an explanation of the study's objectives, written official approval to gather data was gotten from the relevant study setting authorities.
- Tool one was developed by the researchers based on an in-depth review of current and relevant literature. Tool two was adopted and tool three was adapted to fit Egyptian women.
- Three highly qualified professors in the field of obstetrics and gynecologic nursing evaluated the tools for content validity.
- Tools were checked for reliability for tool two and three by Cronbach's alpha test & it was reliable for tool two (0.81) and tool three (0.74).
- A pilot study was conducted on nine postpartum women who were not included in the study population. To ensure that the study was feasible, and the tools were clear as well as applicable throughout time. The tools were redesigned and revised after the pilot study to ensure their usability.

Application stage:

- Data was gathered over a three-month period, commencing in February 2023 and ending in April 2023.
- Each postpartum woman who met the inclusion criteria and accepted the participation in the research was randomly assigned into abdominal crunch, tubigrip and control groups.
- Upon admission to the postpartum ward, data of tool I was collected from three groups through an interview schedule for 10 – 15 minutes, it was conducted individually and in a total privacy.
- The data of tools II and III were collected from the three groups to assess the inter recti distance and quality of life before intervention
- The researcher was started by the control group before the intervention groups to prevent contamination of the study.

For group (1) abdominal crunch group:

- Before starting the procedure, the postpartum women were verbally instructed about the correct performance of the exercise as to begin the abdominal crunch exercise in the second day after delivery and continued on 3 alternate days per week for 6 weeks.
- She was told to lie on her back, bend her knees to a 90-degree angle, and plant her feet flat on the floor, slightly apart from her hips, while she was still in the resting posture. Preferably, crosses her arms in front of her chest with her hands just below her shoulders. Exhaling, raises her head and shoulders high enough for their shoulder blades to clear the table. Contract her abdomen to bring her chest towards her knees with a smooth, controlled motion. Hold this position for 1–2 seconds, then return to the starting position while inhaling. For every repetition, 10 seconds of relaxation were added in between. Women in this group were asked to repeat the exercise 10 to 12 times for 5 rounds in each repetition **(Kristeen Cherney, 2018; P. Mota et al., 2015)**. (Figure 2)

Figure (2) Abdominal Crunch Exercise. Available at: https://blog.fizzup.com/tips-from-the-pros/work-your-abs-without-equipment-all-about-the-crunch/

For group (2) Tubigrip group:

- Women in this group were asked to wear the tubigrip from the 2nd postpartum day.
- Woman was instructed how to wear tubigrip by Sitting down and stepping into the tubigrip like stepping into a miniskirt. Once both feet are through, stand up and pull the tubigrip gently up toward her abdomen. The Tubigrip should sit roughly from bra strap level down to the widest part of the hips and over the underwear, but under the clothing. Woman should also inform not wear the tubigrip overnight or if she are sleeping during the day as it may end up exerting too high a pressure on the area, reducing circulation **(Depledge et al., 2021).**
- It was recommended that postpartum mothers keep the tubigrip on their abdomens for six weeks before getting reevaluated. They were instructed to wear tubigrip over a layer of clothing and discontinue use it, if she develop a rash or itching under it**.** She should also inform to remove it during shower **(Depledge et al., 2023)**. (Figure 3)

Figure (3): Abdominal Tubigrip

For group (3) control group:

Women received only the routine hospital care such as postpartum health education about prevention of carrying heavy objects and performing vigorous activities.

Evaluation stage:

- The distance between each of the three groups' women's rectus abdominis muscle blocks at the umbilicus, 4.5 cm above and below the umbilicus was measured using tool II before and after six weeks of intervention while the women were at rest.
- Quality of life was also measured using tool (III) before and after 6 weeks of intervention for each woman in the three groups.
- The three groups' quality of life and inter-recti distance were compared in order to ascertain which intervention was more effective.

The researchers performed the following statistical analysis:

Statistical package for social sciences (SPSS) version 23.0 was used for statistical analysis following data collection. In order to describe sociodemographic data, reproductive history, inter-recti distance at rest of the rectus abdominis muscle, and postpartum women's quality of life, descriptive statistics were used. These included numbers, percentages, means, and standard deviation. The distribution of the study variables was examined for normality using the Shapiro-Wilk test. To compare quantitative variables that were abnormally distributed among the three groups, the Kruskal Wallis Test was employed. Comparison between the inter-recti distance at rest of rectus abdominis muscle in the studied groups regarding to distance at umbilicus and 4.5 mm above and below it. Wilcoxon Signed Ranks Test was used to compare each group's pre- and post-intervention results. The statistical analyses in all tables were measured significant at $P < 0.05$.

The ethical considerations:

In order to conduct this study, each woman who agreed to participate in the study were completed a written consent form after being told of its purpose and methodology. Particular emphasis was placed on ensuring safety, privacy, anonymity of each participant, and strict confidentiality of their collected data, in addition, the participants' right to withdraw from the study at any point in time.

The study results:

Table (1) indicates that there were no statistically significant differences in the sociodemographic data among the studied groups. Where, the abdominal crunch (66.7%), tubigrip (76.7%) and control group (73.3%) aged from 20-25 years old. The mean ages of them were 25.47 ± 5.15, 24.73±4.66 and 24.57±4.61 years respectively. Substantial proportions (66.7%, 70% & 73.3%) of them can read and write. Moreover, (66.7%, 73.3% & 70%) of them had extended families. The majority of the abdominal

crunch (83.3%), tubigrip (73.3%) and control (80%) groups were housewives. The majority of them 86.7%, 83.3% & 90% also were rural residents respectively. Most of subjects (90%, 93.3% & 86.7%) and (93.3%, 90% & 86.7%) were married and had not enough income respectively.

Table (2) shows that there were no statistically significant differences in the reproductive history among study participants. A sizeable proportion of the abdominal crunch (76.7%), tubigrip (73.3%) and control (83.3%) groups had one to three pregnancies. In addition, the abdominal crunch (76.7%), tubigrip (66.7%) and control (70%) groups had 1-2 deliveries. Most of them (90%, 93.3% & 83.3%) had no stillbirth respectively. Moreover, abdominal crunch (83.3%), tubigrip (80%) and control groups (90%) had 1-3 living children.

Table (3) manifests that there was no statistically significant difference in baseline mean scores of inter-recti distance (IRD) between the studied groups before intervention (p= 0.535, p=0.263 & p=0.087). ***After 6 weeks of intervention***, it was noticed that there was an obvious decline in the mean scores of IRD among the studied groups, in the favor of abdominal crunch group. Where, the mean score in abdominal crunch group above, at level and below umbilicus was (2.67±0.48, 2.50±0.51 & 2.67±0.48), compared to (3.30±0.92, 3.27±0.45& 3.17±0.38) in the tubigrip group and (4.33±0.48, 4.30±0.47& 3.93±0.25) in the control group respectively. There was statistically significant narrowing in the IRD (p= <0.001) in all studied groups in favor of abdominal crunch group, compared to the tubigrip and control group respectively after 6 weeks of intervention.

Table (4) demonstrates that there was no statistically significant difference in the overall mean quality of life scores among the studied groups ***prior to intervention*** (p= 0.970). ***After 6 weeks of intervention***, it was noticed that there was an obvious improvement in the overall mean quality of life scores among the studied groups, in favor of abdominal crunch group. Where, the mean score of abdominal crunch, tubigrip and control groups before intervention was (16.73±7.09, 16.43±7.16 &16.77±7.12) compared to (25.17±6.41, 18.13±7.65 &16.83±6.29) after 6 weeks of intervention respectively. There was a statistically significant difference (p= <0.001) in all studied groups in favor of abdominal crunch group, compared to tubigrip and control groups respectively after 6 weeks of intervention.

Figure 4: exhibits that the same percentage (66.7%) of the abdominal crunch and the tubigrip groups as well as (63.3%) of the control group had poor quality of life **before the intervention**. On the other hand, **after 6 weeks of intervention**, around two thirds of the abdominal crunch group (63.3%) had good quality of life, compared to only 23.3% in the tubigrip group and 10 % in the control group.

Table (5) portrays the presence of a statistically significant negative correlation between quality of life and inter-recti distance at rest before and after intervention at umbilicus, 4.5 cm above and below it in the favor of abdominal crunch.

Table (1): Number and percent distribution of postpartum women according to their socio - demographic data (n=90)

Socio demographic data	Abdominal crunch group (n = 30)		Tubigrip group (n = 30)		Control group (n = 30)		Test of sig.(P)
	No.	%	No.	%	No.	%	
Age							
20 -25	20	66.7%	23	76.7%	22	73.3%	χ^2= 1.098
25 – < 30	7	23.3%	5	16.7%	5	16.7%	^{MC}p=0.944
30-35	3	10.0%	2	6.7%	3	10.0%	
Mean + SD.	25.47 ± 5.15		24.73±4.66		24.57±4.61		F = 0.297 (0.744)
Educational level							χ^2= 1.461
Read and write	20	66.7%	21	70.0%	22	73.3%	
Primary	8	26.7%	6	20.0%	7	23.3%	^{MC}p=0.886
Secondary	2	6.7%	3	10.0%	1	3.3%	
Employment							χ^2= 0.934
House wife	25	83.3%	22	73.3%	24	80.0%	(0.627)
Worker	5	16.7%	8	26.7%	6	20.0%	
Marital status							χ^2= 0.741
Married	27	90.0%	28	93.3%	26	86.7%	^{MC}p=0.905
Divorced	3	10.0%	2	6.7%	4	13.3%	
Place of residence							χ^2= 0.635
Urban	4	13.3%	5	16.7%	3	10.0%	^{MC}p=0.926
Rural	26	86.7%	25	83.3%	27	90.0%	
Family Type							χ^2= 0.317
Nuclear	10	33.3%	8	26.7%	9	30.0%	(0.853)
Extended	20	66.7%	22	73.3%	21	70.0%	
Family income							χ^2= 0.797
Enough	2	6.7%	3	10.0%	4	13.3%	^{MC}p=0.905
Not enough	28	93.3%	27	90.0%	26	86.7%	

χ^2: **Chi square test** MC: **Monte Carlo**
t: Student t-test
F (P): **Fisher Exact test &P for F Test** *: **Significant at P ≤0.05**
SD: **Standard deviation**

Table (2): Number and percent distribution of postpartum women according to their reproductive history(n=90)

Reproductive history	Abdominal crunch group (n = 30)		Tubigrip group (n = 30)		Control group (n = 30)		t-test (P) F/ χ 2 (P)
	No.	%	No.	%	No.	%	
No of pregnancy							
1-3	23	76.7%	22	73.3%	25	83.3%	χ^2= 0.900
4-7	7	23.3%	8	26.7%	5	16.7%	(0.638)
No of delivery							
1-2	23	76.7%	20	66.7%	21	70.0%	χ^2= 0.757
3-4	7	23.3%	10	33.3%	9	30.0%	(0.685)
No of stillbirth							
0	27	90.0%	28	93.3%	25	83.3%	χ^2= 1.575
1	3	10.0%	2	6.7%	5	16.7%	(0.592)
No of living children							
1-3	25	83.3%	24	80.0%	27	90.0%	χ^2= 1.184
4 and more	5	16.7%	6	20.0%	3	10.0%	(0.553)

χ^2: **Chi square test**
F (P): **Fisher Exact test &P for F Test** *: **Significant at P ≤0.05**

Table (3): Distribution of postpartum women according to their inter-recti distance at rest using finger palpation method before and after 6 weeks of intervention (n=90)

Inter-recti distance at rest (mm) IRD	Abdominal crunch group (n = 30)				Tubigrip group (n = 30)				Control group (n = 30)				Test of sig.(P)	
	Before intervention		After 6 weeks		Before intervention		After 6 weeks		Before intervention		After 6 weeks		Before intervention	After 6 weeks
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
4.5 cm above umbilicus at rest (mm)														
- Normal < 2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%		
- Mild 2- <3	0	0.0%	10	33.3%	0	0.0%	8	26.7%	0	0.0%	0	0.0%	χ^2 =1.886	χ^2 = 63.032*
- Moderate 3- <4	2	6.7%	20	66.7%	3	10.0%	6	20.0%	1	3.3%	2	6.7%	MCp=0.770	MCp<0.001*
- Severe 4 & more	28	93.3%	0	0.0%	27	90.0%	16	53.3%	29	96.6%	28	93.3%		
Mean ± SD	**5.47±1.07**		2.67±0.48		**5.37±1.30**		3.30±0.92		**5.70±1.26**		4.33±0.48		**H = 1.251, p = 0.535**	**H = 50.729* p <0.001***
At umbilicus at rest (mm)														
- Normal < 2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%		
- Mild 2- <3	0	0.0%	15	50.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	χ^2 = 2.944	χ^2 = 88.592*
- Moderate 3- <4	2	6.7%	15	50.0%	3	10.0%	22	73.3%	0	0.0%	2	6.7%	MCp=0.360	MCp<0.001*
- Severe 4 & more	28	93.3%	0	0.0%	27	90.0%	8	26.7%	30	100%	28	93.3%		
Mean ± SD	**5.20±1.16**		2.50±0.51		**5.23±1.14**		3.27±0.45		**5.67±1.18**		4.30±0.47		**H = 2.668, p = 0.263**	**H = 66.430* p <0.001***
4.5 cm below umbilicus at rest (mm)														
- Normal < 2	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%		
- Mild 2- <3	0	0.0%	10	33.3%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	χ^2 =5.474	χ^2 = 79.226*
- Moderate 3- <4	2	6.7%	20	66.7%	3	10.0%	25	83.3%	0	0.0%	2	6.7%	MCp=0.065	MCp<0.001*
- Severe 4 & more	28	93.3%	0	0.0%	27	90.0%	5	16.7%	30	100%	28	93.3%		
Mean ± SD	**5.60±1.04**		2.67±0.48		**4.90±1.06**		3.17±0.38		**5.57±1.10**		3.93±0.25		**H = 5.357, p = 0.087**	**H = 61.642* p <0.001***
Fr	**123.974***				**80.539***				**90.296***					
P0	<0.001*				<0.001*				<0.001*					

χ^2: **Chi square test**
MC: **Monte Carlo**
Fr: **Friedman test**
H: **Kruskal Wallis Test**
F (P): **Fisher Exact test &P for F Test *: Significant at P ≤0.05**
p_0: **p value for comparing between the different periods**

Table (4): Mean distribution of the postpartum women with diastasis recti abdominis according to their quality of life before and after 6 weeks of intervention(n=90)

Quality of life	Abdominal crunch group (n = 30)		Tubigrip group (n = 30)		Control group (n = 30)		Test of sig. H (p)	
	Before intervention	After 6 weeks	Before intervention	After 6 weeks	Before intervention	After 6 weeks	Before Intervention	After 6 weeks
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
Health and functioning	8.37±3.54	12.57±3.37	8.17±3.59	9.03±3.85	8.37±3.52	8.30±3.11	0.116 (0.944)	21.872* (<0.001*)
Psychological status	1.63±0.76	2.37±0.85	1.60±0.77	1.77±0.82	1.67±0.76	1.67±0.71	0.168 (0.919)	11.629* (<0.001*)
Relational family-friends	2.87±1.22	4.60±1.54	2.83±1.23	3.23±1.41	2.97±1.25	3.07±1.23	0.259 (0.879)	16.786* (<0.001*)
Relational spouse-partner	3.90±1.75	5.63±0.93	3.90±1.79	4.10±1.75	3.80±1.79	3.87±1.63	0.069 (0.966)	21.001* (<0.001*)
Overall score	**16.73±7.09**	**25.17±6.41**	**16.43±7.16**	**18.13±7.65**	**16.77±7.12**	**16.83±6.29**	0.060 (0.970)	21.466* (<0.001*)
P	<0.001*		<0.001*		**0.282**			

H: Kruskal Wallis Test for comparing between the studied groups
Z: Wilcoxon Signed Ranks Test for comparing before and after
*: Statistically significant at p ≤ 0.05

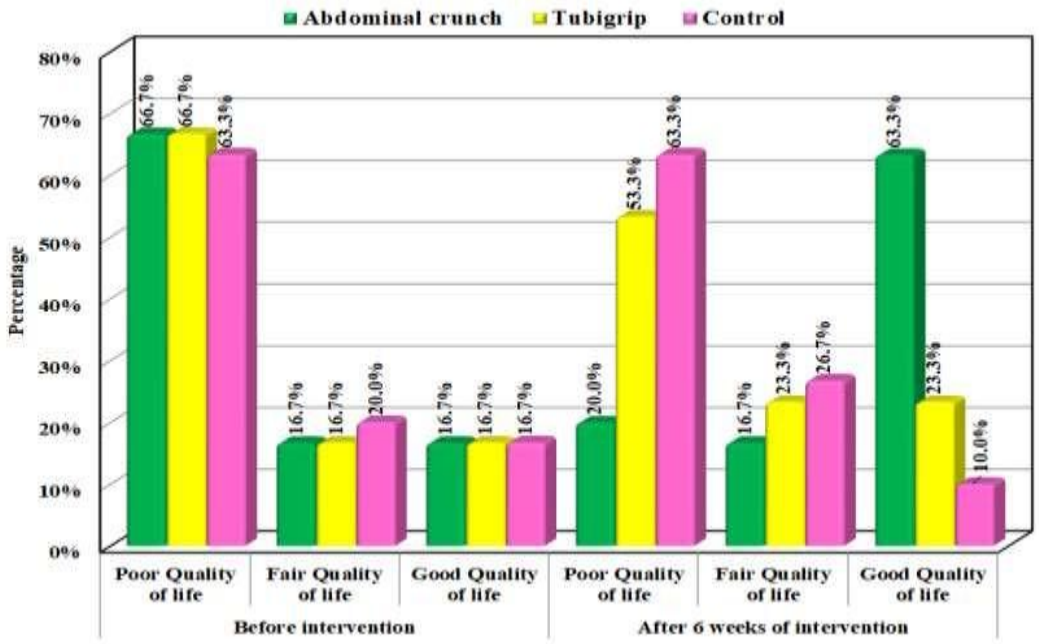

Figure 4: Quality of life among postpartum women with diastasis recti abdominis in the three studied groups (n=90)

Table (5): Correlation between Quality of life and IRD at rest of rectus abdominal muscle among three studied groups before and after intervention (n=90)

Inter-recti distance at rest (mm) IRD		Abdominal crunch group (n = 30)		Tubigrip group (n = 30)		Control Group (n = 30)	
		R	P	r	P	R	P
- 4.5 cm above umbilicus	Before (baseline)	-0.748*	<0.001*	-0.706*	<0.001*	0.224	0.235
	After 6weeks	-0.509*	0.004*	-0.370*	0.044*	0.168	0.375
- At umbilicus	Before (baseline)	-0.563*	0.001*	-0.681*	<0.001*	0.106	0.974
	After 6weeks	-0.397*	0.030*	-0.422*	0.020*	0.118	0.926
- 4.5 cm below umbilicus	Before (baseline)	-0.677*	<0.001*	-0.264	0.015*	-0.103	0.586
	After 6weeks	-0.341	0.066	-0.112	0.045*	-0.295	0.113

r: Pearson coefficient

*: Statistically significant at $p \leq 0.05$

Discussion

Globally, DRA is one of the main health concerns that affects around fifty percent of the females in their third trimester and the first few months after giving birth **(Saleem et al., 2021)**. This phenomenon may result in potential health concerns such as the manifestation of core instability, reduced functional capacity, diminished trunk muscle strength, depression, and lower back pain. Diastasis recti is often not painful hence many times is unnoticed and untreated **(Lalingkar et al., 2019).** The management of DRA is a complex issue that has historically been poorly understood, resulting in delayed and inadequate diagnosis and treatment for patients. This has led to worsening symptoms in postpartum women and negatively impacting their quality of life **(Nahabedian, 2018).**

Diastasis recti abdominis (DRA) can be diagnosed and treated early to lessen the onset and severity of problems, as well as negate the requirement for surgical intervention. The management approaches for this condition encompass both conservative and surgical methods **Nahabedian (2018)**. Nevertheless,

there is still a lack of clarity about which types of conservative interventions are effective in preventing and/or reducing diastasis recti abdominis (DRA) during the postpartum period. Therefore, the aim of this study was to determine the effect of abdominal crunch exercise versus tubigrip on inter-rectus distance and quality of life among postpartum women with diastasis recti abdominis

After six weeks of crunch abdominal core strength exercises and wearing tubigrip, the present study's results demonstrated a significant decrease in IRD at all three levels above, below, and in the center of the umbilicus as measured by finger palpation. However, the results of crunch abdominal exercise were much better than wearing tubigrip, despite the fact that there was no statistically significant difference. This can be explained by activating the transversus abdominis muscle, which connects the bellies of the rectus abdominis muscle, that increases the tone, strength, and control of the abdominal muscles. This process increases fascial tension and preserves the integrity of the linea alba, leading to a reduction in diastasis recti abdominis ((**M. J. Mota et al., 2015; Weingerl et al., 2023).**

However, wearing tubigrip is effective in decreasing IDR through external support that has the potential to imitate the fascial tension and provide a continuous state of static contraction demonstrated by the transversus abdominis muscle **(Dave & Mahishale, 2019).** This support contributes to the compression and maintenance of the abdominal region, which may improve the transversus abdominis muscle's activation through biofeedback. Developing a muscular "corset" is additionally beneficial as it imparts support to the back and spine, diminishes abdominal separation, combines toning, and mitigates muscular stress induced by consistent physical activity **Patwardhan et al. (2021)**

The results of this study are consistent with a study conducted by **Benjamin et al. (2023),** who revealed that postpartum females who performed abdominal exercises experienced a slight reduction in inter-recti distance in comparison to standard care. It is also partially in line with a study of **Weingerl et al. (2022),** who found that abdominal exercises are currently considered to be among the most effective protocols for reducing the inter-recti distance of muscle bellies in postpartum women. In addition, it is partially consistent with a study of **Kim et al. (2022),** who discovered that the implementation of core exercise interventions using a videoconferencing platform in real-time has proven to be efficacious in enhancing inter-recti distance, trunk stability among women during postpartum. Moreover, the current result is consistent with a study carried out by **Oktaviyani et al. (2022),** who found that core stability exercises have recognized to be effective in decreasing diastasis recti abdominis among postpartum mothers who had a normal delivery.

Furthermore the current study's findings partially matches with **Naseem et al. (2022)** study, which proposed that the exercise program that focuses on enhancing core stability has proven to be effective in managing lumbopelvic pain, primarily by decreasing the gap between the recti muscle bellies in postpartum women. A study of **Situt and Kanase (2021)** relatively conforms with the result of current study, which found that rehabilitation of diastasis recti and an increase in abdominal muscle strength can be achieved through the use of Neuro-Muscular Electrical Stimulation (NMES) in conjunction with core stabilization exercises.

The results of the present study are comparatively in line with a study by **Patwardhan et al. (2021)**, who explained that core strengthening exercises not only yield a reduction in abdominal girth, but also serve to enhance the fortitude of the core musculature, ultimately leading to a decrease in DRA. Another supporting study of **Saleem et al. (2021)** reveals that a six-week exercise protocol was observed to have positive outcomes in the treatment of DRA. Evidently, the performance of abdominal crunch exercises exhibited potential in the reduction of inter-recti distance. In addition, the current result is partially consistent with a study performed by **Igwe and Okoye (2020) ,** which demonstrated that abdominal training may improve abdominal muscular strength and encourage healing of inter-recti diastasis. Moreover, the

current finding corresponds with a research of **Yalfani et al. (2020)**, which suggests that abdominal muscle strengthening activities are a useful therapy option for diastasis recti in the postpartum period.

In this regard, **Gruszczyńska and Truszczyńska-Baszak (2018)** spotlighted that performing abdominal exercises has the potential to mitigate or prevent diastasis recti abdominis. A study of **Tuttle et al. (2018)** also consistent with the present findings , who concluded that targeting the transverse abdominis through exercise has the potential to be an effective treatment for improving IRD.

In contrast , a study of **Charpot (2021)** illustrated that abdominal strengthening exercises have demonstrated limited efficacy in alleviating the severity of diastasis recti during the postpartum period. In addition, a study of **Da Cuña-Carrera et al. (2021)** is incongruent with the present study, who came to the conclusion that, the application of the abdominal crunch with pre-activation of the transversus abdominis muscle yields a remarkable augmentation in the inter-rectus gap when contrasted with both rest and the abdominal crunch executed in the U point. Furthermore, a study by **Theodorsen et al. (2019)** partially contradicts the findings of the current study, which indicated that both pelvic floor and transversus abdominis muscle contractions were found to increase inter-rectus distance in postpartum women with DRA. Additionally, **Gluppe et al. (2018)** found no statistically significant differences in DRA reduction between the abdominal exercise and control group.

On investigating the effect of wearing tubigrip on inter-recti distance, the current study's findings reveal a significant reduction in inter-rectus distance; nevertheless it was not as pronounced the way that achieved through the execution of crunch abdominal exercise. Likewise, the current study findings are in a harmony with a study of **Kaya and Menek (2023)** who revealed that the incorporation of the abdominal corset may lead to positive impacts on the inter-rectus distance, muscular strength, endurance related to trunk flexion, balance, and disability in the treatment of diastasis recti abdominis.

Patil (2022) found relatively the same finding with the current study that postpartum woman, who utilize binder support and engage in an abdominal exercise program, demonstrate a significantly greater reduction in inter-recti distance compared to those who solely perform exercise without the aid of a binder, beginning from the second day post-delivery and continuing for duration of six weeks. It also aligns with a research conducted by **Depledge et al. (2021),** who demonstrated a notable and significant decrease in DRA following the use of traditional abdominal binder and exercises. While before intervention, mean and standard deviation values for the areas at, above, and below the umbilicus were 59.39 ± 14.24, 51.87 ± 12.37, and 38.15 ± 12.13, respectively. Following a period of three months of employing the conventional binder in conjunction with exercises, these values were observed to have decreased to 41.19 ± 12.21, 37.76 ± 12.98, and 30.76 ± 8.94, respectively.

A study of **Keshwani et al. (2021)** revealed that the implementation of exercise therapy and abdominal binding intervention have been found to yield a favorable outcome in addressing the condition of inter-rectus distance (IRD) among women. Also, this is somewhat aligned with a study of **Patwardhan et al. (2021),** who found that the utilization of an abdominal binder entails a decrease in the mean value of diastasis rectus abdominis. It serves to diminish abdominal girth and offer post-partum support. However, using an abdominal binder in conjunction with core strengthening exercises not only reduces circumference but also strengthens core muscles, which in turn reduces diastasis rectus abdominis. It is noteworthy that a favorable link between the girth of the abdominal area and the strength of the abdominal muscles. As a result, it has been discovered that a program of focused abdominal exercises combined with an abdominal corset greatly increases the reduction of diastasis recti in postpartum women **Dave and Mahishale (2019)**. In this respect, the current results are in agreement with a study conducted **by Abdel-aziz et al. (2018)** , who came to the conclusion that people with postnatal diastasis recti can benefit from using an intermittent pneumatic compression belt to reduce the thickness of

their abdominal fat and mitigate inter-recti separation.

Women's quality of life during the postpartum period may be adversely affected by the width of DRA muscle, which may result in considerable functional impairment **Benjamin et al. (2019)** . This phenomenon may potentially arise as a result of pregnancy, whereby the abdominal musculature is subjected to stretching, leading to an attenuation of its strength and even the possibility of rectus muscle separation. If this condition is left unaddressed, the supportive structures of the trunk may become compromised, culminating in the manifestation of back pain and consequent limitations in the ability of females to engage in varied activities, ultimately affecting their quality of life postpartum **Gandhi et al. (2021).** Therefore, mitigating the severity of diastasis recti abdominis separation may result in enhancement in abdominal muscle strength and endurance. These enhancements may have a direct influence on a woman's capacity to execute repetitive functional movements that are essential for both maternal and fetal well-being in everyday life activities **Laframboise et al. (2021).**

On evaluating the effect of abdominal crunch exercises on quality of life among women with diastasis recti, the results of the present study revealed that the mean values of quality of life of DRA patients have been significantly improved after 6 weeks of abdominal crunch core strength exercises. The current findings are partially in harmony with a study by **Kim et al. (2022)** ,which showed that implementation of core exercise interventions through a real-time videoconferencing platform has been demonstrated to effectively enhance life quality among females after delivery. It helps to provide further evidence from the previously supportive study of **Igwe and Okoye (2020),** who showed that the implementation of exercise regimens may have the potential to improve the functional activities of daily living among women during the postpartum period.

A study of **Yalfani et al. (2020)** showed similar findings that abdominal strengthening exercises has proven to be efficacious in mitigating occurrences of low back pain. In addition, these exercises have led to a reduction in functional and postural instability, as well as muscle weakness. Consequently, these results have contributed to an enhancement in the general quality of life. In addition , the present result is partially in accordance with a study of **Thabet and Alshehri (2019)**, who found that a deep core stability training program after six weeks is beneficial in alleviating diastasis recti and enhancing the quality of life for postpartum women.

Moreover, the results of this research align with a study conducted by **Kaya and Menek (2023)**, which found that the use of an abdominal corset may have a positive effect on trunk flexion muscular strength and endurance. Furthermore, it may contribute to an improved sense of balance and a reduction in disability when managing diastasis recti abdominis. Consequently, its use may lead to an enhancement in overall quality of life. Similar finding was reported by **Keshwani et al. (2021)**, they revealed that abdominal binding has the potential to exert a positive influence on both body image and trunk flexion strength, thereby enhancing the quality of life for women.

Conclusion:

After 6 weeks of intervention, abdominal crunch exercise is more effective than wearing tubigrip on narrowing inter-recti distance in all the 3 distances at the umbilicus or 4.5 cm above or below it. In addition, it improves quality of life among women with diastasis recti abdominis.

Recommendations:

The following recommendations are made in light of the study's findings:

1. Increase woman’s awareness about the importance of wearing tubigrip and/or performing abdominal crunch exercise for the first 6 weeks postpartum as it's a great feedback garment to engage the core.
2. Utilize the abdominal crunch exercises and tubigrip as a highly successful non-pharmacologic measure for women with diastasis recti abdominis in clinical practice ,

that also, improving fitness and enhancing core muscle function

3. Maternity nurses should receive in-service training programs related to abdominal crunch exercise to improve IRD and quality of life among postpartum women.

Further studies are needed to:

1. Replicate the study on a larger sample size for better generalization.
2. Evaluate the effect of tubigrip in conjunction with abdominal exercises to help assist in the natural 'recoil' of the abdominal muscles and connective tissue among women with DRA.
3. Assess the effectiveness of tubigrip as a treatment option for pregnant women who complain of posterior pelvic pain or low back pain.
4. Employing high-quality randomized controlled trials assessing the impact of various abdominal exercises on DRA.
5. Evaluate the long term effects of applying abdominal exercises in postnatal women with DRA.

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Conflict of interest:

The authors declare that there is no conflict of interest.

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