World Academy of Science, Engineering and Technology
International Journal of Medical and Health Sciences
Vol:7, No:1, 2013

Effect of Abdominal Exercises versus Abdominal Supporting Belt on Post-Partum Abdominal Efficiency and Rectus Separation

Hanan S. El-Mekawy, Abeer M. Eldeeb, Marzouk A. El- Lythy, and Adel F. El-Begawy

Abstract**—**This study was conducted to determine the effect of abdominal exercises versus abdominal supporting belt on abdominal efficiency and inter-recti separation following vaginal delivery.30 primiparous post-natal women participated in this study. Their age ranged from (25 - 35) years and their BMI < 30 Kg/m^2. Participants were assigned randomly into 2groups, participants of group (A) used abdominal belt from the 2nd day following delivery, till the end of puerperium (6 weeks), while participants of group (B) engaged into abdominal exercises program from the 2nd day following delivery for 6 weeks. The results of the present study revealed that although there was no statistical difference in waist circumference between both groups, participation in abdominal exercise program produced a pronounced reduction in waist/hip ratio, and inter-recti separation and also caused significant increase in abdominal muscles strength (peak torque, maximum repetition total work and average power) higher than the use of abdominal belt.

Keywords**—**Abdominal exercise, Abdominal supporting belt, Postnatal abdominal weakness, Rectus Diastases.

I. Introduction

THE abdominal muscles are actually four layers of the muscles which span from the breastbone and ribs to the pelvis. Working together, these muscles function as a corset to support the spine and pelvis. In addition to flexing and rotating the trunk, the abdominal muscles are known as primary “core muscles”, because they stabilize the lower back during all movements [1].

During pregnancy, hormonal changes caused by relaxin, progesterone and estrogen combined with uterine growth cause stretching of the abdominal muscles, affecting mainly the rectus abdominis. Also, anterior pelvic tilting with or without lumbar hyperlordosis, affects the insertion angle of pelvic and abdominal muscles and influences postural biomechanics generating a deficit in the support of the pelvic-abdominal organs. Furthermore, as pregnancy progresses and the abdominal muscles stretch, a loss in the force vector and a decrease in contraction strength of rectus abdominis muscles occur [2].

H. S. El-Mekawy, Assistant Prof., is with Department of Physical Therapy for Obstetrics & Gynecology, Faculty of Physical Therapy, Cairo University, Egypt (phone: 202010066268722; e-mail: hanan_mekawy@yahoo.com).

A. M. ElDeeb, Lecturer of Physical Therapy for Obstetrics & Gynecology, is with Faculty of Physical Therapy, Cairo University, Egypt.

M. A. EL-Lythy, Lecturer of Basic Science, is with Faculty of Physical Therapy, Cairo University.

A. F. El-Begawy, Professor of Obstetrics & Gynecology, is with Faculty of Medicine, Cairo University, Egypt.

Two out of three women experience a separation of the rectus abdominis muscles, the long muscle located in the middle of the abdomen, during their pregnancy. The combination of abdominal weakness, hormonal changes, weight gain and great amount of tension on already weakened structure produces a predisposition to separation [3].

Separation can occur anytime in the last half of pregnancy but is most problematic after pregnancy when the abdominal wall is weak. Abdominal separation or diastases recti reduces the integrity and functional strength of the abdominal wall and aggravates lower back pain and pelvic instability. Separation in a previous pregnancy significantly increases the probability and severity of the condition in subsequent pregnancies[4].

The abdominal muscles usually take some time to regain their tone and strength. As after delivery, although the uterus immediately begins to shrink back to its pre-pregnancy size, the abdominal muscles remain in their over lengthened state. This often makes the belly feel 'soft and flabby' from muscle weakness, making it look 'enlarged' with the pressure of the intestines and abdominal organs distending the flexible muscles. In 66 % of women, the vertical abdominal muscles have separated and take at least six weeks to heal [5].

Post-natal support belts and belly binding have been used for many centuries as methods of supporting a woman's abdomen. It may give the abdomen a slimmer appearance by holding the skin that is stretched during pregnancy. Wearing the belt can allow to fit into pre pregnancy clothes sooner and help in returning to normal activities as early as possible. Regular use of a postpartum support belt may relieve back pain and strain on muscles and ligaments by transferring the weight of the abdomen to the spine where it can be carried naturally and also assist in maintaining proper posture during breastfeeding [6].

Many women continue, or even begin, abdominal exercise programs during their pregnancies. In addition, mothers often are encouraged to resume abdominal exercises shortly after delivery. It is important to begin postnatal abdominal exercises that are graded to the rate of recovery and the pre-delivery level of fitness, as gradual abdominal muscle strengthening is safe and effective. This not only helps with the physical appearance; but it also keeps the back healthy as strong abdominals create a stable core to support the lower back during daily activities. With a good strengthening program, the mother can safely rebuild these core muscles to regain the pre-pregnancy appearance and meet the demands of carrying and lifting her baby [7].

So, this study was conducted to compare between the effect of abdominal exercises and abdominal supporting belt on restoring abdominal efficiency and decreasing abdominal separation following vaginal delivery.

II. Subjects, Materials and Methods

Subjects

This study was carried out on thirty non-obese primiparous lactating women following vaginal delivery. They were selected from the maternity hospital at Kasr Al-Aini University Hospital, their age ranged from 25-35 years and their body mass index (BMI) less than 30kg/m².

Females with abdominal/back operations, low back pain, any disease that interfere with the exercises (asthma) or any skin disease or sensitivity that interfere with the use of abdominal belt were excluded from this study.

All participants were instructed to follow weight maintenance diet (1800 cal/day) and do not participate in any other exercise programs throughout the study period. The participants were divided into 2 equal groups (A& B).

Group A consisted of 15 postpartum women who used abdominal belt from the 2nd day following the delivery, till the end of puerperium (6 weeks).

Group B consisted of 15 postpartum women who performed abdominal exercises program starting on the 2nd day following the delivery, 3 times per week, for 6 weeks, in addition to daily abdominal exercises as a home routine.

Instrumentations

A. Evaluative instruments

1- Height-Weight Scale: A universal height-weight scale was used to determine the subject's height and weight in order to calculate body mass index (BMI) for all participants in both groups (A&B) before starting the treatment, according to the following equation: $BMI = (weight / height^2)$.

2- Tape Measurement: It was used to measure the waist and hip circumferences to calculate waist /hip ratio for both groups (A & B) before and after the study.

*3- Isokinetic Dynamometer***:** (Biodex Medical System Inc. Shirely, New York (11967-4704/1999)), was used for evaluation of the abdominal muscles efficiency for all participants in both groups (A& B) before starting the study and after 6 weeks of treatment. It had the following characteristics: 17flat panel LCD touch screen monitor, multimode operation (isokinetic, isometric, isotonic, eccentric and concentric), speed up to 500 deg/sec, total weight: 1350 pounds, physical dimensions: 27 inches wide, 24 inches deep, 66 inches height & chair: 52 inches wide, 65 inches deep, 60 inches height. The Biodex system offers a high level of performance, accuracy and safety. Biodex equipment marks the highest correlation coefficient for reliability, accuracy, validity and repeatability [8]. It consists of: adjustable seat, thigh & pelvic straps, dynamometer and a control unit consists of personal computer and operator equipment.

*4- Dial up Caliper***:** Mitutoyo dial up caliper instrument, with durable superpolyamide plastic and fiberglass construction, was used to assess the amount of separation between the two recti before and after 6weeks for all women in both groups (A & B).

It can measure a distance between two recti up to 150mm in increments of 0.1mm. It is used as simple as a compass with inward or outward-facing points. The pointer rotates once every inch, tenth of an inch, or 1mm, allowing for a direct reading. The tips of the caliper were adjusted to fit across the points to be measured, the caliper was then removed and the distance was read by measuring between the tips with a ruler.

B. Treatment instruments

*1- Post-Natal Abdominal Belt***: (**The ITA- Med postnatal elastic abdominal binder, Frank Stubbs Co., INC, Eastman Avenue / USA, CA 93030 (2010), Weight: 0.02 lbs, Width: 25 centimeter (10 inches), Thickness: 1 millimeter**)** was worn by each woman in group (A). It is made of strong, air permeable, elastic and anti-sweating porous material, 100% cotton lining to prevent allergies and irritations. It covers the area from the pubis to the lower ribs and consists of: Contoured back panel that prevents rolling and shifting; soft elastic side panels to maximize comfort while providing stable compression; easy application contact closure tabs' allowing maximum adjustability and straps by which tightness is adjusted.

Procedures

A. Evaluative Procedures

1-Weight and Height Measurements:

Weight and height were measured while the woman wearing a thin layer of clothes to calculate the BMI according to the following equation: BMI= weight/height² (kg/m²). It was done for all participants in both groups (A&B).

2-Waist and Hip Circumference Measurements:

Waist circumference was measured at the narrowest level between the costal margin and the iliac crest at the end of gentle expiration, and the hip circumference was measured at the widest level over the buttocks with the patient standing. Then, waist/hip ratio was calculated by dividing the waist by the hip circumference before and after treatment in both groups (A and B)

3- Measurement of the Abdominal Muscles Strength:

The abdominal muscles strength was assessed before starting the study and after 6 weeks for all participants in both groups (A&B). A full illustration and explanation about the device and how to perform the test were given to each woman and three training trials were done before the testing procedure.

Procedures of Measuring Abdominal Muscles Strength:
Starting Position of the Subject:

Woman was seated on the isokinetic seat with maintaining her trunk in an angle with the thigh equals 120º and keeping her lower trunk (back) rested and supported on the back of the seat which maintained all through the test by two adjustable straps on the upper third of the chest. Another two straps were

on right and left sides of the anterior chest wall which fixed the chest from above and below the right and left shoulders. Knees were bent 90º, the thighs were fixed to the seat by two adjustable straps one from right to left and the other one from left to right and both feet were supported on the foot support.

Testing Procedures:

The computer was adjusted on the parameters that were needed for evaluating the trunk flexion which included: Isokinetic mode; Pattern: Extension/flexion seated compressed; Protocol: Isokinetic Unilateral; Contraction: Concentric/eccentric; Joint: Lumbar; Range of motion: From sitting position with the trunk in an angle with the thigh equal 120º, till reaching 45°; Angular velocity: extension 60 degree/sec and flexion 60 degree/sec; and Test repetitions: 3-5 times.

After that woman's data was introduced into the computer system and then the test was started. At that time the woman was instructed when she hearing the starting signal, she immediately flexed her trunk towards the thighs as much as she could and then returned to the starting position and repeat the same movement for five successive repetitions. The results were reported on the computer screen and saved into the computer as follow: Peak torque, maximum repetition total work and average power. The best repetition was the one of choice for data analysis of each woman.

4- Measurement of the Intra Recti Distance:

The intra-recti distance was measured before and after the end of study for each woman in both groups (A & B). Each woman was asked to assume crock lying position and the therapist palpated the medial edge of the two recti muscle borders and placed the arms of the dial caliper perpendicular to the recti border just above umbilicus; then the therapist asked the woman to raise her head and shoulders out of the plinth, at this point the distance between the two recti was measured to the nearest centimeters. This point was marked with a soluble marker to ensure standardization with repeated measures. Three trials were taken for each assessment and the mean was recorded.

B. Treatment Procedures

I- Post-Natal Abdominal Belt:

It was used from the 2nd day after delivery; each participant in group (A) was instructed to wear it on the abdominal area from morning till go to sleep (at night); remove it during sleep and bathing, till the end of puerperium (for 6 weeks). The participants were instructed to wear the belt according to the following steps:

1- The belt was placed underneath the participant while she was lying down, as it was easier to get a more secure fit. The belt can be applied next to the skin or over a thin shirt.

2- The side of the belt without the velcro or fasteners was pulled over the participant's stomach with one hand and hold firmly.

3- The other side of the belt was stretched across the participant's stomach, over the first side and pulled, so the fit was snug but not too tight.

4- Then, it was easily adjusted by straps according to the waist circumference of the participant.

The mother was instructed to avoid over tight the belt as it can produce discomfort and itches and inspect the skin for any redness or any signs of sensitivity.

II-Abdominal Exercise Program:

All women in group (B) were participated in an exercise program for 30 minutes, three sessions per week (one every other day for 6 weeks). The exercise program consists of Static abdominal contraction, Posterior pelvic tilt, Reverse Sit-Up exercise, Trunk Twist and Reverse Trunk Twist exercise **[9].** The woman was asked to hold contraction for 5 seconds then relax 10 seconds, 20 repetitions for each exercise [10].

Also, the participants were instructed to repeat the same exercise program at the other days as a home routine program.

Statistical Analysis:

The collected data was statistically analyzed by using paired T-test to determine differences within the same group and unpaired T-test to compare between the two groups. Data were represented as means and standard deviations and percentage of change was calculated. It was considered significant at P-value<0.05 and highly significant at P-value<0.001.

III. Results

The collected data from participants of group (A) who used abdominal supporting belt immediately following delivery for 6 weeks revealed statistically significant decrease (P<0.01) in waist circumference, waist /hip ratio with highly significant (P<0.001) decrease in inter-recti distance. There was also a statistically significant increase (P<0.01) in abdominal muscle efficiency including increase in peak torque, increase in maximum repetition total work and increase in average power (TABLE I).

TABLE I
COMPARISON BETWEEN THE MEAN VALUES OF DIFFERENT PARAMETERS MEASURED BEFORE AND AFTER STUDY FOR GROUP A

Group A	Before	After	Mean Dif.	%	P-value
Waist circumference (cm)	105.13 ± 5.64	99.47 ± 4.98	5.66± 0.66	5.4	0.01*
Waist/hip ratio	0.92 ± 0.02	0.87 ± 0.03	0.05± 0.01	5.4	0.01*
Intra recti distance (cm)	3.01 ± 0.14	2.45 ± 0.12	0.56± 0.02	18.6	0.001**
Peak torque (N/M)	34.48 ± 4.31	35.27 ± 4.34	0.79± 0.03	2.3	0.01*
Maximum repetition total work (J)	28.01 ± 3.79	28.72 ± 3.83	0.71± 0.04	2.5	0.01*
Average power (watt)	24.41 ± 2.94	25.23 ± 2.91	0.82± 0.03	3.4	0.01*

NS= P>0.05= Not significant, * P< 0.05= significant, **P< 0.001= highly significant.

As shown in Table II, women of group (B) who engaged into abdominal exercises program starting from the 2nd day following delivery, 3 times per week, for 6 weeks, in addition to daily home routine revealed statistically highly significant decrease (P<0.001) in waist circumference, waist /hip ratio and inter-recti distance. There was also a statistically highly significant increase (P<0.001) in abdominal muscle efficiency including increase in peak torque, maximum repetition total work and average power.

TABLE II
COMPARISON BETWEEN THE MEAN VALUES OF DIFFERENT PARAMETERS MEASURED BEFORE- AND AFTER STUDY FOR GROUP B

Group B	Before	After	Mean Dif.	%	P-value
Waist circumference (cm)	106.27 ± 5.16	97.87 ± 3.62	8.4±1.54	7.9	0.001**
Waist/hip ratio	0.91 ± 0.02	0.84 ± 0.02	0.07± 0.0	7.7	0.001**
Intra recti distance (cm)	3.10 ± 0.26	2.05 ± 0.30	1.05± 0.04	33.9	0.001**
Peak torque (N/M)	33.77 ± 4.01	49.65 ± 4.68	15.88 ±0.67	32.0	0.001**
Maximum repetition total work (J)	26.46 ± 3.74	37.12 ± 4.72	10.66 ±0.98	28.7	0.001**
Average power (watt)	23.41 ± 2.77	31.89 ± 3.78	8.48± 1.01	26.6	0.001**

NS= P>0.05= Not significant, * P< 0.05= significant, **P< 0.001= highly significant**.**

Comparison between both groups after treatment revealed non-significant difference in waist circumference, while there was a statistically significant decrease (P<0.01) in waist /hip ratio with highly significant (P<0.001) decrease in inter-recti distance in favor of group (B). There was also a statistically highly significant increase (P<0.001) in abdominal muscle efficiency including increase in peak torque, maximum repetition total work and average power in favor of group (B), Table III.

TABLE III
COMPARISON BETWEEN THE MEAN VALUES OF DIFFERENT PARAMETERS OF THE TWO STUDIED GROUPS (A&B) MEASURED AFTER 6 WEEKS

	Group A (n= 15)	Group B (n= 15)	Mean Dif.	%	P-value
Waist circumference (cm)	99.47 ± 4.98	97.87 ± 3.62	1.87± 1.36	1.8	0.323 NS
Waist/hip ratio	0.87 ± 0.03	0.84 ± 0.02	0.03± 0.01	3.4	0.01*
Intra recti distance (cm)	2.45 ± 0.12	2.05 ± 0.30	0.40± 0.18	16.3	0.001**
Peak torque (N/M)	35.27 ± 4.34	49.65 ± 4.68	14.38 ±0.34	28.9	0.001 **
Maximum repetition total work (J)	28.72 ± 3.83	37.12 ± 4.72	8.4±0.89	22.6	0.001**
Average power (watt)	25.23 ± 2.91	31.89 ± 3.78	6.66± 0.87	20.9	0.001**

NS= P>0.05= Not significant, * P< 0.05= significant, **P< 0.001= highly significant**.**

IV. DISCUSSION

During the childbearing period, an increase in inter recti distance is postulated to be caused by hormonal influences, biomechanical and structural changes mainly of the rectus abdominis and linea alba combined with uterine growth, which cause stretch and weakness of the abdominal muscles [11].

Accordingly, strengthening the core control muscles of the lower abdominal region in the post-natal period is very important as it help in creating a muscular "corset" to support the spine and the back, decreasing abdominal separation as well as, blends toning and alleviate muscle tension arising from repetitive physical movement (bending over, carrying, nursing, or any physical activities). Therefore, it is important to exercise these muscles regularly, after having a baby, to regain strength and pre-pregnancy shape. Static abdominal contractions, pelvic rocking, sit-up and leg slide exercises are good for stubborn and protruding abdominal wall [12].

The obtained improvement of muscle strength (statistically significant increase in peak torque, maximum repetition total work and average power) following abdominal exercise in the current study could be explained via the adaptive changes in the muscles caused by exercise as the metabolic capabilities of the muscles are progressively overloaded. Muscle, which is a contractile tissue, becomes stronger as a result of hypertrophy of the muscle fibers and increase the recruitment of its motor units. Also, it has a profound influence on the metabolic demand associated with producing a given muscle force causing increase in muscular endurance and power [13] .

Also, Snijders et al., [14] reported that therapeutic exercises activates both slow twitch (ST) and fast twitch (FT) fibers of skeletal muscles, with increased fiber ATPase and cross-bridge cycling speed might be attributable to an increased expression of fast MLCs in the slow fibers. As the high content of FT fibers is responsible for the improvement of muscle strength.

The reduction which occurs in waist circumference and accordingly in waist hip ratio after performing the abdominal exercise program could be explained by Boutcher, [15] who mentioned that therapeutic exercise burns glycogen, fat and other nutrients stored in the muscle. Also, it enhances energy consumption, resulting in enhanced skeletal muscle fat and carbohydrate oxidation and whole body glucose uptake so, decrease body circumference. Also, Irving et al., [16] reported that abdominal exercises provides high boosting intensity workouts which induce acceleration of fat burning, especially abdominal fats, resulting in significant reduction of waist circumference.

Also, according to Despres et al., [17] exercises induces loss of body fatness, especially the intra abdominal fat, associated with reduced glucose tolerance, LDL cholesterol

and increased HDL cholesterol.

In the current study the use of post-natal belt in group (A) also produces a statistically significant increase in abdominal muscles strength (Peak torque, maximum repetition total work and average power) and a statistical significant decrease in waist circumference and waist hip ratio which could be explained by Pela et al., [18] who concluded that wearing the binder immediately after the vaginal delivery provides greater stability to the woman's body as it provides support to the stretched ligaments and muscles, as well as supports the spine and improves posture. Subsequently, reducing strain on lower back and pelvic ligaments and joints help in alleviating back and pelvic pain through taking the pressure off these regions. Reducing stress in these areas enhances the body's ability to return to its pre-pregnancy alignment and shape and helps the woman to return to her normal activities and wardrobe sooner.

Also, Mokhtar, [19] reported that the postpartum body garments provide support to abdominal wall, assist in abdominal muscles retraction, improve posture, stabilize loosened ligaments and provide support to the torso while vital organs returned to their pre-pregnancy position. So, many women reported returning to their pre-pregnancy sizes faster while using it.

The improvement of muscle strength and decrease in rectus separation in group (A) could be explained via Warren et al., [20] and Ivancic et al., [21] in which they reported that the abdominal belt improves the strength of abdomen, thereby increases the intra abdominal pressure that contributes to mechanical spine stability through co activation of trunk flexors and extensors musculature. As the abdominals contract, intra abdominal pressure increases and converts the abdomen into a rigid cylinder that greatly increases the stability of the spine, improves abdominal strength and decreases abdominal separation so the abdominal belt play an important role in the stabilization of the lumbar region during lifting, produces significant improvement of the lifting ability with decreased muscular fatigue and strain and improves the ability to perform the ADL activities.

The abdominal binder achieved immediate waist reduction as the soft fleshy tissue compressed, squeezed and redistributed above and below the waistline. Also, it holds the abdominal muscles in at the right tension and prevents them from becoming flaccid and expanding. The binder has to apply the right pressure without strangulating and at the same time exerting a necessary pressure on the abdominal muscles [22].

V. Conclusion

This study concluded that postpartum women after performing abdominal exercises program starting from the 2nd day following delivery for 6 weeks, resulting in a greater increase in abdominal muscles strength and greater decrease in inter-recti distance than those who used post-natal supporting belt from the 2nd day following delivery till the end of puerperium. So, abdominal exercises starting from the 2nd day after delivery could advised as a very effective method in restoring postpartum abdominal efficiency.

Acknowledgment

Deep thanks and gratitude for Dr. Tarek Diab, bio statistician, who helped me in analysis of results.

References

[1] S. Plowman, and D. Smith, "Exercise Physiology for Health, Fitness and Performance", 2nd Ed., Lippincott Williams & Wilkins company, Philadelphia, pp. 522-527, 2008.

[2] J. Rankin,.: "Effect of antenatal exercise on psychological well being, pregnancy and birth outcome", 1st Ed., Athenaeum press, England, Philadelphia, London, pp. 14-16, 2002.

[3] R. Stephenson, and L. O'connor,: "Obstetric and gynecologic care in physical therapy", 2nd Ed., Slack incorporated press, USA, New York, pp. 267-270, 2000.

[4] J. Tupler, and J.Gould,: "Lose your mummy tummy flatten your stomach now", J. Can. Chiropr. Assoc. 55(7): 63, 2005.

[5] L. Gilleard,; Brown, J. and Brown, M.:" Structure and function of the abdominal muscles in primigravid subjects during pregnancy and the immediate post birth period", Phys. Ther. J., 78(7): 751-762, 1996.

[6] D. O'Donovan,: "Help you get back in shape? Corset will", Sunday Mirror, 5(7):11-13, 2006.

[7] R. Artal, and M. O'Toole,: "Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period", Br. J. Sports Med., 37(10): 116-120, 2003.

[8] J . Zawadzki, .; T .Bober, and A . Siemienski, .: "Validity analysis of the Biodex System 3 dynamometer under static and isokinetic conditions", Acta. Bioeng. Biomech., 12(4):25-32, 2010.

[9] J. Keller,: "Body after baby: the simple 30-day plan to lose your body weight, Penguin group", 2nd Ed., New York, USA, Canada, Australia , England, London, 2006.

[10] A., Eden, and E , Eden.: "How diastasis works" in "Health: How stuff works", 1st Ed., International ltd Publication, USA, 2010.

[11] G.Brook,; Y.Coldron,; G.Evans,; G.Gulliford,; J..Haslam, and A. Lewis,.: "Physiotherapy in women's health" in Porter, B. and Tidy, M.(eds): "Tidy's physiotherapy", 14th Ed., Churchill Livingstone, London, pp.117-118, 2008.

[12] K. Carlson; S. Eisenstat, and N. Zipory,.: "The new Harvard guide to women's health", 1st Ed., Harvard university press, USA, pp. 230-233, 2004.

[13] C. Kisner, and L.Colby,: "Therapeutic exercise foundations and techniques", 5th Ed., F.A. Davis, Philadelphia, pp. 35-39, 2007.

[14] T. Snijders, .; L Verdijk, .; M. Beelen, .; B. McKay, .; G .Parise, ; F. Kadi and L. Van Loon, : "A single bout of exercise activates skeletal muscle satellite cells during subsequent overnight recovery", Exer. Physiol. J., 10(2): 11-14, 2012

[15] S .Boutcher, : "High-intensity intermittent exercise and fat loss", J. Obesity, 11(24):37-40, 2010.

[16] B..Irving; C. Davis; D.Brock; J. Weltman,; D. Swift; J..ugene; and A .Weltman,.: "Effect of exercise training intensity on abdominal visceral fat and body composition", Med. Sci. Sports Ex., 40(11): 1863–1872, 2008.

[17] J. Despres; , M .Powliot ; S. Moorjani,; A .Nadeau,; A .Tremblay.; and C.Bouchard.: "loss of abdominal fat and metabolic response to exercise training in obese women", Am. J. physiol. Endocrinol. Metab., 261(2): 156-167, 1991.

[18] M .Pela.; W. Spoora; R. Goossensb, and A.Pool-Goudzwaardabg.: "Biomechanical model study of pelvic belt influence on muscle and ligament forces", J. Biomech.,41(9): 1878-1884, 2008.

[19] A. Mokhtar,: "A Belly Good Wrap", Postpartum Wellness Assoc., 10(3):8-13, 2010.

[20] L. Warren; S. Appling, ; A. Oladehin, and J. Griffin : "Effect of soft lumbar support belt on abdominal oblique muscle activity in nonimpaired adults during squat lifting", Orthop. Sports J., 31(6):316-323, 2001.

[21] P. Ivancic; J. Cholewicki, and A .Radebold: "Effects of the abdominal belt on muscle-generated spinal stability and L4/L5 joint compression force", Ergonomics, 45(7): 501-513 , 2002.

[22] S. Kunzle and A David: "Fashion and Fetishism", 1st Ed., Sutton Publishing, Philadelphia, pp. 38-39, 2004.