Is There A Radiological Evidence Support Functional Improvement of Pelvic Floor Muscle Following Kegel Exercise?

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ABSTRACT

This study is carried out to determine the impact of Kegel exercises on the pelvic floor muscles' thickness measured by ultrasonography during relaxation as well as during contraction. For this reason, thirty continent primiparae in the first month following vaginal delivery were participated in this study. The participants were engaged into biofeedback assisted Kegel exercises for 45 minute twice weekly in addition to daily home program for six months. Assessment of the pelvic floor muscles' strength for all participants was performed by using digital vaginal palpation in the form of Modified Oxford Grading Scale and vaginal pressure measured by perineometer while, the assessment of the pelvic floor muscles' thickness was performed by using perineal ultrasound at relaxation and during contraction at the beginning and after the course of the study (6 months).The results of this study revealed a significant improvement of the pelvic floor muscle strength measured by Modified Oxford Grading Scale and perineometer as the P- values were (0.001) and (0.01) respectively this improvement is supported by increase in pelvic floor muscle thickness measured by perineal ultrasound both at relaxation and during contraction as the P- values for both of them were (0.001). So, it could be concluded that participation in Kegel exercises program not only help in increasing the pelvic floor muscles' strength but also has an evidence on increasing pelvic floor muscles' thickness both at rest as well as during contraction.

Key words: *Kegel exercises, pelvic floor muscles' strength, pelvic floor muscles' thickness- perineal ultrasound.*

INTRODUCTION

Pregnancy and vaginal delivery affect the pelvic floor structure by increased intra-abdominal pressure, direct muscle trauma, nerve injury and connective tissue damage. Pelvic floor muscle training during pregnancy or after delivery may reduce the incidence of fecal and urinary incontinence after delivery, but data about long-term effects is scarce[2].

PFMs strength is significantly reduced after vaginal delivery, both normal and instrumental, 6 to 12 weeks postpartum. While, cesarean section resulted in significantly less muscle strength reduction[18].

Pregnancy has a large etiological role and up to 42% of women report episodes of stress urinary incontinence during their pregnancy. Even in women during their first pregnancy, the incidence of urinary symptoms can be as high as 35%. In the postpartum period, up to 38% of women will suffer from stress urinary incontinence; the majority of them have developed symptoms before delivery and not postpartum[9].

Delivery may impact the pelvic floor and result in detrimental effects on urinary and bowel symptoms, specifically urinary urgency, stress incontinence, obstructive voiding and fecal incontinence. Stress urinary incontinence and urinary urgency and frequency are common following delivery, with previous studies documenting a frequency of incontinence in 25– 75% of postnatal women[16].

The pelvic floor muscles (PFMs) play an important role in maintaining adequate pelvic support, mainly the position and function of the urinary bladder, urethra, uterus, vagina and rectum, as well as enabling urinary continence[14].

Interest has increased over the last few years in antenatal pelvic floor muscle training (PFMT) programs. It was found that pelvic floor exercises (PFE), when done daily, were associated with a reduction in the incidence of occurrence of stress urinary incontinence[9].

As early as in 1948, the American gynecologist Kegel emphasized the value of pelvic floor muscle exercise in restoring function after childbirth. He claimed that genital relaxation after delivery was due to nerve injury, over stretching of muscles and tearing of fascia also, he mentioned that the method of restoring the condition was "tightening" of the pelvic floor muscles[14].

Pelvic floor exercises are safe and highly effective measure in the prevention of occurrence and treatment of stress urinary incontinence, both antepartum and postpartum. Their performance in the inpatient setting during early puerperium can allow proper physiotherapeutic instruction and supervision without additional admission and costs[11].

With increasing load, recruitment of more and increasingly larger motor units takes place. There seems to be a higher potential for hypertrophy in fast-twitch fibers. When additional force is demanded, both slow-twitch and fast-twitch fibers are recruited. Intensity rather than frequency of work is important, and high tension must be created to increase strength. A contraction as close to maximum as possible is required to create high tension[3].

As a consequence of Kegel's studies, women in most industrialized countries have been encouraged to exercise their pelvic floor muscles during pregnancy and after delivery to strengthen the pelvic floor and to prevent and treat urinary incontinence. Although more than 60 years have passed since this practice was introduced, the effects of such exercises have until recently been only sparsely documented[14].

SUBJECTS, MATERIALS AND METHODS

Subjects

This study was carried out on thirty volunteer continent primiparae at the first month following vaginal delivery. All of them were non obese and referred from the outpatient clinic of El Mataria teaching hospital after full examination to exclude the presence of diabetes, congenital prolapse or any pelvic floor abnormality that may affect the results of the study.

The age of the participants ranged from 20 to 29 yrs, height ranged from 148 to 168 cms, weight ranged from 60 to 80 kgs and body mass index (BMI) ranged from 25.39 to 29.33 Kg / m^2. They performed biofeedback assisted Kegel exercises twice weekly in addition to daily home program for six months.

Materials

1. Weight - height scale: was used to measure the weight and the height of each participant in order to calculate the BMI before starting the study.
2. Manual muscle testing (Modified Oxford Grading Scale): was used to measure PFMs strength through vaginal palpation.
3. Perineometer: (Periton 9300): Periton 9300 designed by Carido Design, Australia, supplied with vaginal sensor. It was used for pelvic floor muscle training of participants throughout the study and to assess all participants before and after the course of the study for assessment of the pelvic floor muscle strength.

Technical specification of Periton 9300 perineometer:

- Numerical readout 0-300 cm H_2O.
- Resolution 1 cm H_2O.
- Accuracy ± 1 cm H_2O for 95% of reading.
- It has a vaginal sensor connect to the main unit by a connecting tube as follow:

- Vaginal sensor:

It is 28 mm diameter, 30 mm seamless active surface, medical grade silicone rubber sheath. Autoclavable at 125º/15 min. and 137º/3.5 min. It consists of an air-tight seamless silicone rubber sheath over a skeleton that allows the central part of the probe to be pressed in response to a muscular contraction. Silicone rubber is chosen for its high biocompatibility, excellent flexibility, high durability and suitability for autoclaving. The wall thickness of the sheath kept minimum to transmit pressure with high sensitivity unaffected by temperature over the physiological range.

- Connecting tube with end fittings:

Tube Cat 2031 is 80 cm long and has a T connector with one way valve for optimal air inflation.

4. Antiseptic solution: was used for cleaning the vulva.
5. Jell: was used for lubrication of the perineometer probe.
6. Condoms: were used for covering of the probe of the perineometer to avoid cross infection.
7. Ultasound machine: Ultrasound machine no.33001584, 17.NN, designed by Medison FA 6000C, Korea, with a 6.5 MHz transvaginal probe, was used for evaluation of all participants in both groups (A&B) before starting the study and after the end of the study (after 3 months postnatal), with consideration that the same investigator performed all perineal ultrasound assessments. Perineal ultrasound to measure the thickness of the urogenital diaphragm at relaxation and during contraction for all participants at the beginning and after the end of the study. The muscular layer of the pelvic floor situated caudal to the pelvic diaphragm and anterior to the ano-rectum.

Procedure

(A) Evaluative procedures:

1-Personal data:

All data of each participant were recorded in data recording sheet.

2- Measurement of pelvic floor muscle strength:

Pelvic floor muscle strength was measured by using the Modified Oxford Grading Scale and the perineometer before and after the study (6 months).

- Modified Oxford Grading Scale:

It was used to measure pelvic floor muscles (PFMs) strength[4] through vaginal palpation of the PFMs by placing two fingers in the distal one third of the vagina and ask the woman to contract, lift inward and squeeze around the two fingers. This is a 6-point scale: 0=no contraction, 1=flicker, 2=weak, 3=moderate, 4=good (with lift), and 5=strong.

- Perineometer:

Each subject was asked to lie down in crock lying position with slightly abducted hips. The battery of the perineometer was checked out; wires of the vaginal probe were connected to the main unit. After cleaning the vulva with antiseptic solution, the vaginal probe was covered with a condom lubricated by sterile lubricant and inflated with air from T connector, after that it was inserted into the vagina until only 1cm of the lower margin of the pressure area of the probe remains outside. Then the woman was asked to contract her pelvic floor muscles, lift inward and squeeze on the vaginal probe. The mean value of five pelvic floor muscle contractions was recorded and considered the evaluative value. After recording the evaluative value, the main unit of perineometer was switched off, the vaginal probe was extracted from the vagina and the condom was removed then, the probe was returned to the autoclaving while the main unit was saved in its bag till the next use.

3- Measurement of pelvic floor muscle thickness by Perineal Ultrasound:

Women were examined in a supine position with 45º hip flexion and slight abduction. The long axis of the transducer was held approximately parallel to the examination bench and was placed in a parasagittal plane on the perineum just to the right of the vaginal introitus. With the transducer in this position, the plane was moved parallel to the left until the vaginal wall was visualized and then, moved about 1 cm to the right. The scanning plane was further secured by visualizing the pubic bone as a landmark to the right on the ultrasound screen; a vertical reference line then was drawn in the middle of the screen. The pelvic floor muscles (urogenital diaphragm) then was identified as a hypoechoic structure beneath the subcutaneous fascia 3–6 mm below the skin surface. Slight movements of the transducer were often necessary to improve the delineation of the muscle towards the surrounding tissues. Further assurance of the examination plane was done by asking the woman to relax her pelvic floor muscles and then perform maximum contraction. Muscle movement during contraction was visualized dynamically and muscle thickness was measured in millimeters both at relaxation and during contraction.

(B) Treatment procedures:

Each subject was asked to lie down in crock lying position with slightly abducted hips. The battery of the perineometer was checked out; wires of the vaginal probe were connected to the main unit. After cleaning the vulva with antiseptic solution, the vaginal probe was covered with a condom lubricated by sterile lubricant and inflated with air from T connector, after that it was inserted into the vagina until only 1cm of the lower margin of the pressure area of the probe remains outside. Then the woman was asked to contract her pelvic floor muscles, lift inward and squeeze on the vaginal probe.

*The patient was asked to continue contraction and relaxation of the pelvic floor muscle against the vaginal electrode (sensory feedback) trying to reach a higher than the number already visible to her on the screen (visible feedback) for 20 minutes and then relax for 5 minutes.

*The patient then was asked to contract the anterior fibers of the pelvic floor muscle (pubo-vaginalis), 15 repetitions consisted of contraction and squeezing for 10 seconds, followed by relaxation for 10 seconds, after 10 repetitions a rest of 1 minute was allowed.

*After 2 minute rest, the patient was asked to contract the posterior fibers of the pelvic floor muscle (pubo-rectalis), 15 repetitions consisted of contraction and squeezing for 10 seconds, followed by relaxation for 10 seconds, after 10 repetitions a rest of 1 minute was allowed.

*After 3 minute rest, the patient was asked to contract both anterior and posterior fibers of the pelvic floor muscle (pubo-vaginalis and pubo-rectalis), 15 repetitions consisted of contraction and squeezing for 10 seconds, followed by relaxation for 10 seconds.

* The duration of exercise session is 20 minutes (the whole duration of training session is 45 minutes.

- Daily home routine:

Each participant started with 3 repetitions of 8 contractions (hold for 10 sec. and relax for 10 sec.) with 2 minutes rest between repetitions, twice daily and the number of contractions was increased to be 12 contraction/ repetition and then increase the number of contractions gradually till performing about 80-100 contractions daily[1].

Statistical Analysis

The collected data was statistically analyzed by using the following methods:

1. Descriptive statistics including mean, standard deviation and percentage.
2. T-test for comparing the data before and after training program.
3. Level of significance, the degree of significance, was selected at 5%, P value > 0.05 indicates non significant results, P value < 0.05 indicates a significant result, and P value < 0.001 indicates a highly significant result[10].

RESULTS

There was a highly statistical significant difference in the paired t-test of Modified Oxford Grading scores between the pelvic floor muscle strength at the beginning of the study (3.06 ± 0.82) while, after the training program it increased to be (3.73 ±1.08), where the t-value and P-value were (3.80) and (0.001) respectively and the percentage of improvement was 21.56 % as shown in table (1).

Table (1) : The Modified Oxford Grading scores before and after the study.

	Modified Oxford Grading scores	
	Before	After
Mean	3.06	3.73
±SD	±0.82	±1.08
Mean difference	0.66	
Percentage of improvement	21.56 % ↑	
DF	29	
t-value	3.80	
P-value	0.001	
Sig.	HS	

Table (2), represents the intravaginal pressure which was measured by the perineometer before and after the training program.

The mean value of intravaginal pressure at the beginning of the study was (8.40 ± 2.20) while, after pelvic floor muscle training it increased to be (9.60 ±2.74), where the t-value and P-value were (2.14) and (0.01) respectively and the percentage of improvement was 14.28 %.

Table (2): The intravaginal pressure before and after the study.

	Intravaginal pressure (cm H_2O)	
	Before	After
Mean	8.4	9.6
±SD	±2.2	±2.74
Mean difference	1.2	
Percentage of improvement	14.28 % ↑	
DF	29	
t-value	2.14	
P-value	0.01	
Sig.	HS	

Tables (3 and 4), represent the pelvic floor muscles thickness which was measured by perineal ultrasound at relaxation and during contraction before starting and after 6 months of pelvic floor muscle training . (Fig.1 and 2).

The pelvic floor muscles thickness at relaxation at the beginning of study was (8.83± 1.19) while, after 6 months of training it increased to be (9.41±1.38), where the t-value and P-value were (3.75) and (0.001) respectively and the percentage of improvement was 6.56 %.

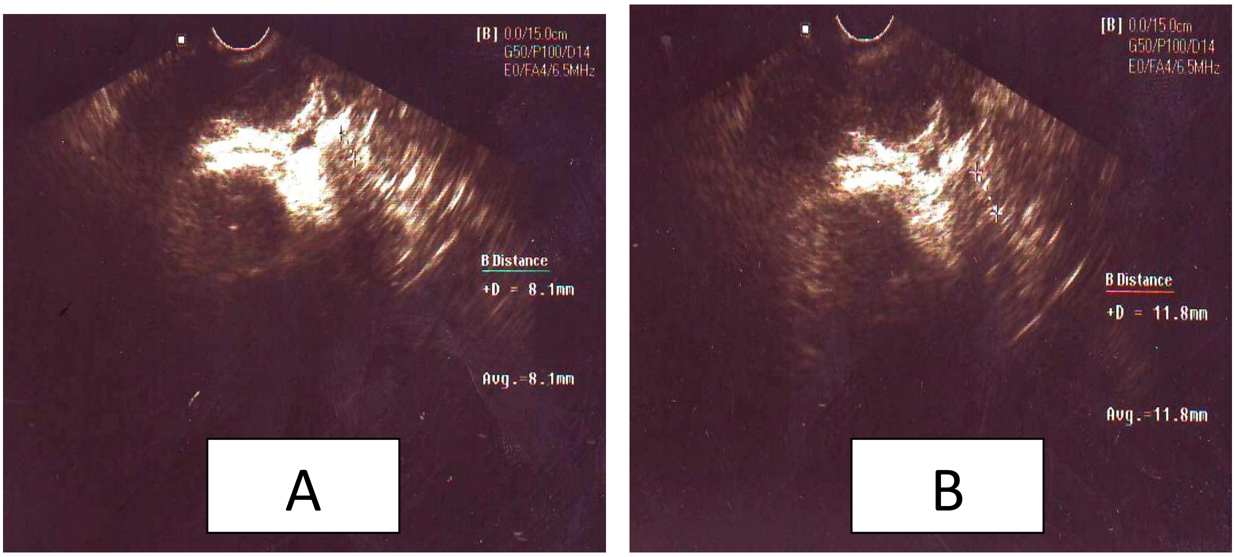
The pelvic floor muscles thickness during contraction at the beginning of the study was (10.33± 1.09) while, after 6 months of training it increased to be (10.99±1.50), where the t-value and P-value were (3.85) and (0.001) respectively and the percentage of improvement was 6.38 %.

Table (3): The pelvic floor muscles thickness at relaxation before and after the training program.

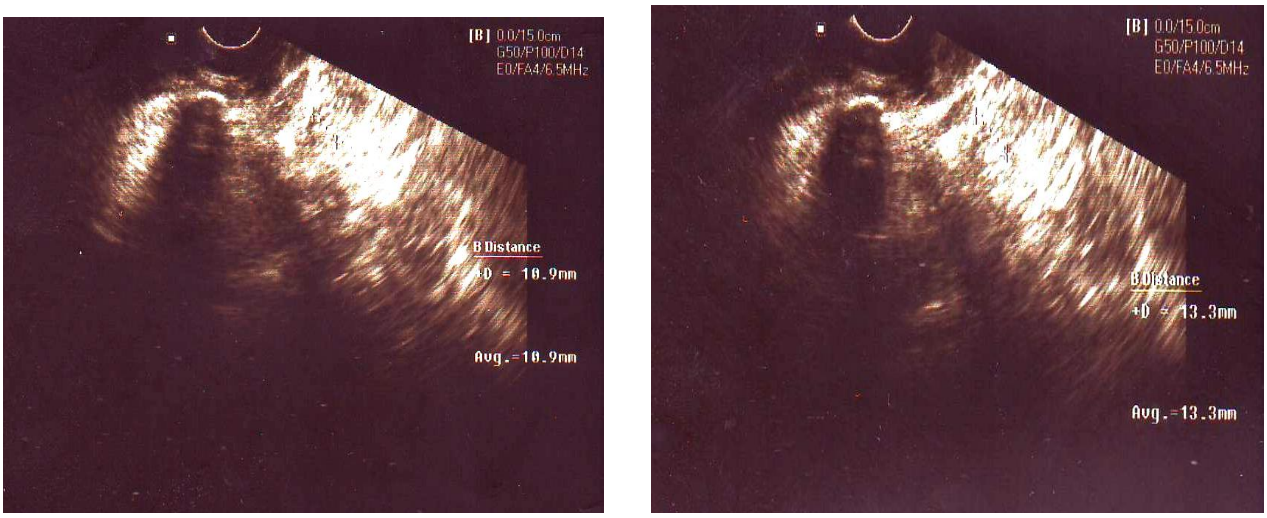
	Pelvic floor muscles thickness (mm) (at relaxation)	
	Before	After
Mean	8.83	9.41
±SD	±1.19	±1.38
Mean difference	0.58	
Percentage of improvement	6.56 %↑	
DF	29	
t-value	3.75	
P-value	0.001	
Sig.	HS	

Table (4): The pelvic floor muscles thickness during contraction before and after the training program.

	Pelvic floor muscles thickness (mm) (during contraction)	
	Before	After
Mean	10.33	10.99
±SD	±1.09	±1.50
Mean difference	0.66	
Percentage of improvement	6.38 % ↑	
DF	29	
t-value	3.85	
P-value	0.001	
Sig.	HS	



Figs. (1): Pelvic floor muscle thickness before the study at relaxation (A) and during contraction (B).



Figs. (2): Pelvic floor muscle thickness after the study at relaxation (A) and during contraction (B).

DISCUSSION

For many women, childbirth brings the embarrassment of urinary incontinence, they wet themselves each time they cough, laugh, sneeze, or try to exercise. Urinary incontinence has a significant impact on quality of life, affecting the social, psychological, physical and financial aspects of life[6].

The pelvic floor muscles (PFMs) may be exposed to alterations during different phases of a woman's life, such as pregnancy, the postpartum period, and physiological aging (menopause). These factors can impair the integrity of the PFMs and lead to pelvic floor dysfunction[8].

Urinary incontinence is common in young women, often manifesting itself following vaginal delivery with its concomitant damage to pelvic floor muscles and other supporting structures. A well-designed PFMs exercise program based on proven exercise protocols can be very effective in improving PFMs function. Since new mothers and busy, working pregnant women have enormous constraints on their time, such programs should be able to be incorporated into every day activities. They are also easily incorporated into any general exercise or fitness class, as well as being used in specific pre- and postnatal exercise classes[6].

Belvic floor dysfunction is believed to be primarily due to structural defects of the neuromuscular and connective tissues supporting the bladder neck and urethra, with the impact of the first vaginal delivery as the key etiological factor. However, ante-partum incontinence in young age women at the first pregnancy and first delivery are also significant predictors of the later development of SUI, indicating that the inherent qualities of the supportive tissues could be independent risk factors[5].

Pelvic floor muscle training (PFMT) given by skilled physiotherapists is an effective method to treat SUI. Furthermore, in women not especially selected for incontinence, PFMT performed during pregnancy and after delivery can also have a positive preventive effect[19].

The results of the current study are consistent with that of Ko et al. (2011)[12], who evaluated the effect of l pelvic floor muscle exercise (PFME) in the prevention and treatment of urinary incontinence during pregnancy and postpartum and they found that PFME is effective in the treatment and prevention of urinary incontinence during pregnancy, and this effect may persist to postpartum period.

These results are supported by De Oliveira et al. (2007)[7] who conducted a study to evaluate the effect of pelvic floor muscle training in 46 nulliparous pregnant women. Functional evaluation of the pelvic floor muscle was performed by digital vaginal palpation using the strength scale described by Ortiz and Coya, (1996)[15] and by a perineometer (with and without biofeedback). They stated that the functional evaluation of the pelvic floor muscles showed a significant increase in pelvic floor muscle strength in the exercise group more than the control group.

These results come also in agreement with the study of Sampselle et al. (1998)[17] who investigated the effect of pelvic floor muscle exercise on postpartum symptoms of stress urinary incontinence and pelvic floor muscle strength in primigravidas during pregnancy. They found that the PFMT group was approximately 30% less likely to experience urinary incontinence at 36 weeks gestation and approximately 40% less likely to be incontinent at 3 months postnatal.

The increase in muscle thickness may be attributed to Komi, (1992)[13] who stated that strength of a muscle or muscle groups is defined as the maximal force generated at a specified or determined velocity. Muscle strength development is achieved by a combination of recruitment of more motor units, higher frequency of excitation, and muscle hypertrophy. With increasing load, recruitment of more and increasingly larger motor units takes place. There seems to be a higher potential for hypertrophy in fast-twitch fibers. When additional force is demanded, both slow-twitch and fast-twitch fibers are recruited. Intensity rather than frequency of work is important, and high tension must be created to increase strength. A contraction as close to maximum as possible is required to create high tension.

It may also supported by the study of Bo, 1994[3] who concluded that development of strength during the first 6–8 weeks of training is due to a more effective recruitment of motor units and increased frequency of excitation, while the further increase in strength is attributed to hypertrophy, which is a slower process. It is likely that a further gain can be achieved with training periods of 6 months or more.

This results are come in agreement with De Oliveira et al., 2007[7] who reported that various PFMT protocols in non pregnant women have been reported in literature; however, the recommended frequency of PFMT ranges from 2 to 3 times a week for not less than 3-month period, is the amount of time necessary to obtain minimum hypertrophy.

Although no data are available about the measurement of pelvic floor muscle thickness following Kegel exercise program, this study adds an evidence that pelvic floor muscle training not only cause improvement of muscle function but also cause a radiologically proved anatomical change presented as increase in muscle thickness both at rest and during contraction.

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الملخص العربي

هل توفر الاشعة بالموجات فوق الصوتية دليل على التحسن الوظيفي لعضلات قاع الحوض بعد برنامج تمرينات كيجل

أجريت هذه الدراسة لتحديد تأثير تمارين كيجل على سمك عضلات قاع الحوض المقاسة أثناء الاسترخاء وكذلك أثناء الانقباض بواسطة الموجات فوق الصوتية - وقد شارك في هذه الدراسة ثلاثون سيدة في الشهر الأول بعد الولادة الطبيعية قامت كل منهن ببرنامج لتمرينات كيجل المحفزة بواسطة التغذية الرجعية الحيوية لمدة 45 دقيقة مرتين أسبوعيا بالإضافة إلى ممارسة تمرينات كيجل بصفة يومية كبرنامج منزلي وذلك لمدة 6 شهور . وقد تم تقييم جميع المشاركات قبل وبعد البرنامج العلاج ي عن طريق قياس قوة عضلات الحوض الرافعة بواسطة مقياس درجات أوكسفورد المعدلة و قياس الضغط المهبلي بواسطة البرنيوميتر كما تم تقييم سُمك عضلات الحوض الرافعة بواسطة الموجات فوق الصوتية أثناء الاسترخاء و الانقباض . وقد أظهرت نتائج الدراسة تحسن ملحوظ فـي قوة عضلات الحوض الرافعة الت ي تم قياسها بواسطة مقياس درجات أوكسفورد المعدلة و البرنيوميترو كما أظهرت أيضاً تحسن ملحوظ في سُمك عضلات الحوض الرافعة التـي تم قياسها أثناء الاسترخاء والانقباض بواسطة الموجات فوق الصوتية . من هذه النتائج يمكن أن نستخلص إن المشاركة في برنامج لممارسة تمرينات كيجل بعد الولادة تؤدى ليس فقط إلى زيادة قوة عضلات الحوض الرافعة و لكن أيضاً إلى زيادة سُمك هذه العضلات أثناء الانقباض و الاسترخاء.

كلمات البحث: تمارين كيجل- قياس قوة عضلات قاع الحوض - سمك عضلات قاع الحوض، الموجات فوق الصوتية .