



## Effect of core muscles strengthening exercises on pelvic pain caused by copper intrauterine device

Sherien K. Mahmoud<sup>1</sup>, Amel M. Yousef<sup>2</sup>, Hossam El- Deen O. El-Shenoufy<sup>3</sup>, Marwa E. Hasanin<sup>2</sup>

<sup>1</sup>Department of Physical Therapy for Woman's Health, El- Sheikh Zayed Al- Nahyan Hospital, Cairo, Egypt.

<sup>2</sup>Department of Woman's Health, Faculty of physical therapy, Cairo University, Egypt.

<sup>3</sup>Department of Obstetrics and Gynecology, Faculty of Medicine, Cairo University, Egypt.

### \*Correspondence to

Sherien K. Mahmoud  
Department of Physical  
Therapy for Woman's  
Health, El- Sheikh Zayed  
Al- Nahyan Hospital,  
Cairo, Egypt.  
Tel:+201120005506  
Email;  
sherine.khaled.712  
@gmail.com

Published online:  
Sept.-2020

### Abstract:

**Purpose:** The purpose of this study was to investigate the effect of core muscles strengthening exercises on the pelvic pain caused by copper intrauterine device (IUD).

**Methods:** 30 women complained of pelvic pain after IUD insertion by at least 6 months were participated in this study. They were divided into two groups, equal in number. The study group (group A) received core muscles strengthening exercises and supportive advice at the painful episodes as heating application on the lower abdominal area, hot cinnamon drinks and diaphragmatic breathing exercise for relaxation and mind distraction. The second group was the control group (group B) received the same supportive advice as group (A) at the painful episodes. Both groups were assessed before and after treatment period (10 weeks) for pain degree by visual analogue scale (VAS) and menstrual pain severity by verbal multidimensional scoring scale (VMSS) to assess pain severity experienced through the activities of daily living.

**Results:** The results of this study revealed that, there was a significant decrease in VAS and VMSS values post treatment in group (A) (study group) compared with that pre treatment values, while there was no significant difference between pre and post treatment values in VAS and VMSS in group (B) (control group). when comparing both groups there was a significant decrease in the post treatment values of VAS and in the median values of VMSS of group (A) compared with that of group (B).

**Conclusion:** Core muscles strengthening exercises is considered as an effective modality in reducing pelvic pain caused by IUD.

**Key words:** Intrauterine device, core muscles, core strengthening exercises, pelvic pain.

### 1. Introduction

Intrauterine device (IUD) is represented as an important method of contraception, due to their high effectiveness in reducing the risk of unintended pregnancies (1). It is the most widely used as a long acting reversible contraceptive (LARC) method in the whole world (2), with protection lasting up to 12 years (3). The prevalence rate of IUD usage as a non-

hormonal contraceptive option ranges from 2 - 80% among the women in different world countries (4). The IUD was nearly one third (33.1%) of the prevalence rate of contraception (57.5%) in Egypt (5).

Pelvic pain was the most frequently IUD associated complication; it was defined as having significant pain and cramping during and / or prior to menstrual cycle

that were not present before IUD was inserted (6). This cramping (menstrual pain) is thought to be due to the presence of increased abnormal uterine contractility and decreased uterine blood flow (7). It was found that according to the analysis of Demographic and Health Survey (DHS) data 38% of women had chosen to discontinue the use of IUD due to its complication as bleeding and pelvic pain (8).

Copper IUDs were recorded to increase the release of prostaglandin and even to cause pain. This pain is one of the cited reasons for cessation of intrauterine contraception or a reason for not using the IUD (3), (7) & (9). Even though these side effects, the cumulative continuation rates for IUDs up to three years have been reported to be among the highest of all modern methods of contraception (10) & (11).

Physical exercise may reduce pelvic pain caused by excessive prostaglandins release as it works by improving blood flow at the pelvic level as well as stimulating the release of endorphins; in fact, it acts as non-specific analgesics (12). Core strengthening exercises can be safely used as a therapy for the relief of increased pain due to increased uterine muscle contraction (13). Core muscles strengthening can increase pelvic stability, improve abdominal muscle tone, improve posture, reduce back pain, and prevent repetition of back injuries (14).

Akuthota et al. (2008) described the core muscles as a box in which the abdominal muscles anteriorly, gluteal muscles and paraspinal muscles posteriorly, the diaphragm superiorly, and the hip girdle muscles in addition the pelvic floor muscles inferiorly (15). In a study which was done to assess the effect of eight weeks of core strengthening exercises on pelvic pain, almost 90% of the treated women reported a reduction or complete disappearance of pelvic pain (which was presented by increasing uterine contraction and excessive prostaglandin release) (13).

## 2. Patients and Methods

### 2.1. Participants

This study was carried out on thirty adult females selected from El- Sheikh Zayed Al- Nahyan Hospital in Cairo, Egypt, after the approval of the ethical committee of Faculty of Physical Therapy, Cairo University (No. P. T. REC/012/001908). Each participant was informed about the nature, purpose, and benefits of the study, the right to refuse or withdraw at any time, and the confidentiality of any obtained data. All participants signed an informed consent form before being assigned randomly into

two equal groups (A & B). The participants were blinded to their allocation.

### 2.2. Inclusion and exclusion criteria:

#### 2.2.1. Inclusion criteria:

The inclusion criteria were thirty adult females with regular menstrual cycle they were complaining of pelvic pain after 6 months of IUD insertion, their age ranged from 20 – 30 years, body mass index (BMI) ranged from 20 – 25 kg/m<sup>2</sup>.

#### 2.2.2. Exclusion criteria:

The exclusion criteria were congenital uterine anomalies, any intrinsic pelvic pathology including: endometriosis, acute or chronic pelvic inflammatory disease, cervicitis, benign or malignant gynecologic tumors or uterine pathology including adenomyosis or leiomyoma and postoperative adhesions, irregular or infrequent menstrual cycles, menorrhagia or abnormal vaginal bleeding due to other causes other than IUD, any systemic diseases or diseases in the genital organs.

### 2.3. Assessment:

2.3.1. Detailed medical, obstetric and menstrual histories were taken from each female before starting the study to confirm absence of any contraindications that may interfere with the study.

2.3.2. Ultrasound Assessment: The initial step in assessment before the program had begun was the ultrasound assessment. The stem and arms of the copper IUD are fully echogenic; therefore, easily identified on standard two-dimensional (2D) transvaginal ultrasonography (TVUSG) (16) & (17). It has been done to confirm the correct position of the IUD; in addition, to assess for any associated complications (18).

2.3.3. Visual analogue scale (VAS): It is the most widely scale used in the clinical setting of pain evaluation. It has been detected that VAS is a sensitive and reliable scale (19). By using a 10-cm line, participants' can rate the degree of their pain by marking on it, as 10 represented 'unbearable pain' and zero represented 'no pain at all'. It was assessed for all patients in both groups before and after treatment.

2.3.4. Verbal multidimensional scoring scale (VMSS): It is a scale that assesses the working ability impairment, the appearance of the systemic symptom, and analgesics requirement due to menstrual pain with grades from 0 to 3. It was done

for all patients in both groups before and after treatment (20).

#### 2.4. Interventions:

Group A: (Study group): consisted of 15 patients who received core muscles strengthening exercises and supportive advice at the painful episodes as heating application on the lower abdominal area for 15 minutes, hot cinnamon drinks and diaphragmatic breathing exercise for relaxation and distraction, Group B: (Control group): consisted of 15 patients who received the same supportive advice as group (A) at the painful episodes. All participants in both groups evaluated before and after treatment program which was 10 weeks.

#### 2.5. Treatment Procedures:

##### 2.5.1. Group (A) (study group)

Consisted of fifteen females who received supportive advice (22)-(24) to deal with the painful episodes which were heat application on the lower abdomen for 15 minutes, hot cinnamon drinks and diaphragmatic breathing exercises as a method of relaxation and distraction. In addition, core strengthening exercise program for 10 weeks with frequency of 3 sessions per week.

Before starting the exercise session the patient is asked to walk slowly for 10 minutes as a warming up with their normal speed and repeat it at the end of exercise session as a cooling down.

##### 2.5.1.1. Core strengthening exercises:

Firstly: "cat" and "camel" motions:

The participants asked to assume prone kneeling position. The program initially started by recognizing the neutral spine position (midrange between lumbar flexion and extension), the participants took a deep breath from the nose while making hump in the back "camel motion" and breathed out from mouth while curving the spine in "cat motions". This exercise is started from the 1<sup>st</sup> week till the end of the 10<sup>th</sup> week of the exercise program as a form of flexibility exercise for the lumbopelvic region. It was repeated for 5 times in each session.

Then: The "big 3" of the core strengthening exercises program:

The participants joined in the three main exercises "big 3" exercises as described by McGill (21). These exercises include the curl-up, side bridge and bird dog (quadruped position with alternate arm/leg raising); it was done from the 1<sup>st</sup> till the end of the 10<sup>th</sup> week of the exercise program on the following criteria.

##### A- Curl – up exercise:

Participants were instructed to raise the head and lift the shoulder blades off away from the mat while maintain neutral cervical and lumbar position.

from the 1<sup>st</sup> week till the end of the 5<sup>th</sup> week the exercises has been repeated for 5 times with 5 seconds holding while breathing deeply, Then from the 5<sup>th</sup> week till the end of the 10<sup>th</sup> week the repetitions was increased gradually to be 10 times and the hold time to 8 seconds while breathing deeply, time of hold was equal to the time of relaxation.

##### B- Side bridge exercise:

Level (1): side lying position on the right side supported by the right hip flexed 90 degrees and elbow flexed 90 degrees. It was started from the 1<sup>st</sup> week by 2 repetitions on each side and hold for 5 seconds till the end of the 3<sup>rd</sup> week. From the 3<sup>rd</sup> to the end of the 5<sup>th</sup> week, 5 times has been done on each side with 8 seconds hold time while breathing deeply, time of hold was equal to the time of relaxation.

Level (2): the full side bridge, legs were extended and the top foot was placed in front of the lower foot for support. It was started at the 6<sup>th</sup> week of the exercise program by 2 repetitions on each side and 5 seconds hold while breathing deeply, the repetitions are increased gradually and at the 8<sup>th</sup> week the repetitions reached 5 times on each side and 8 seconds hold till the end of the treatment period (10 weeks), time of hold was equal to the time of relaxation.

##### C- Bird – dog exercise:

From quadruped position, the patient is asked to raise the right arm only and hold this position for 5 seconds, then relax and raise the left leg only for 5 seconds then relax. Afterwards, she asked to raise both right arm and left leg simultaneously and hold the position for 5 seconds. The same steps were repeated on the other side with the same sequence. from the 1<sup>st</sup> week till the end of the 5<sup>th</sup> week each step is repeated for 2 times on each side and maintained for 5 seconds while breathing deeply, afterwards, from the 6<sup>th</sup> week till the end of the 10<sup>th</sup> week the repetitions was increased gradually to be 5 times on each side and the hold time to 8 seconds while breathing deeply. Time of hold was equal to the time of relaxation.

Finally: The last progression of the core strengthening exercises program:

As a progression, pelvic bridging and prone plank was added from the 6<sup>th</sup> week till the end of the 10<sup>th</sup> week of the exercise program.

##### A- Pelvic bridging exercise:

The participants were instructed to lie supine with knees flexed (crock lying) then raise the pelvis upward till be comfortable. from the 6<sup>th</sup> week till the end 7<sup>th</sup> week, the exercises has been done with 5 repetitions and 5 seconds holding while breathing deeply, then from the 8<sup>th</sup> week till the end of the 10<sup>th</sup> week the repetitions was increased gradually to be 10 times and the hold time to 8 seconds while breathing deeply, time of hold was equal to the time of relaxation.

#### B- Plank exercise:

The participants lie in prone position and put the weight of their body on the elbows & toes; then they lifted the body upward. From the 6<sup>th</sup> week till the end of 7<sup>th</sup> week the exercises has been done with 2 times repetitions and 5 seconds holding while breathing deeply, then from the 8<sup>th</sup> week till the end of the 10<sup>th</sup> week the repetitions was increased gradually to be 5 times and holding for 5 seconds while breathing deeply. Time of hold was equal to the time of relaxation.

#### 2.5.1.2. Supportive advice at the painful episodes:

##### A- Heating application:

Heat increases the blood flow via vasodilatation, leading to relaxation of smooth muscle and decrease in the perception of pain. It is done on the lower abdominal area for 15 minutes (22).

##### B- Hot cinnamon drinks:

Cinnamon are consisted of: Cinnamaldehyde 90% and eugenol is 5-18%. Cinnamaldehyde has been reported to have an antispasmodic effect. Also, eugenol can prevent biosynthesis of prostaglandins and reduce inflammation, in addition, traditional chinese culture suggests that hot drinks are good for menstrual pain (23).

##### C- Diaphragmatic breathing exercise:

It was used as a method of relaxation and mind distraction technique for minimizing pelvic pain prior to / or during menstruation (24). Participants assumed the supine position with a pillow under their knees for support. One hand is placed below the rib cage and the other on the upper chest, then they took a deep breath through the nose slowly to raise the abdomen like a balloon, therefore, the hand over the abdomen raised and the other moved a little; then, the participants let the air escape through the mouth with a 'sigh'. The participants breathed slowly and deeply without moving shoulder. It was repeated for not more than 3-5 times (24).

#### 2.5.2. Group (B) (Control Group):

Fifteen females received the same supportive advice as group (A) at the painful episodes which were: heat application on the lower abdominal area, hot cinnamon drinks and diaphragmatic breathing exercises as a method of relaxation and mind distraction (22)-(24).

### Data analysis

Descriptive statistics and unpaired t-test were conducted for comparison of subject characteristics between both groups. Normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Unpaired t-test was conducted to compare the mean values of VAS between the study and control groups and paired t-test was conducted for comparison between pre and post treatment in each group. VMSS were compared between groups by Mann-Whitney U test and between pre and post treatment in each group by Wilcoxon Signed Ranks. The level of significance for all statistical tests was set at  $p < 0.05$ . All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

## 3. Results

### 3.1. Subject characteristics:

Table (1) showed the subject characteristics of the study and control groups. There was no significant difference between both groups in the mean age, BMI, number of labour and duration of IUD placement ( $p > 0.05$ ).

**Table (1) Comparison of subject characteristics between study and control groups:**

	$\bar{x} \pm SD$		MD	t- value	p- value
	Study group	Control group			
Age (years)	28.86 $\pm$ 1.06	28.46 $\pm$ 1.64	0.4	0.79	0.43
BMI (kg/m <sup>2</sup> )	23.8 $\pm$ 1.74	24.58 $\pm$ 1.03	-0.78	-1.51	0.14
Number of labour	1.66 $\pm$ 0.48	1.93 $\pm$ 0.7	-0.4	-1.57	0.12
Duration of IUD placement (years)	2.46 $\pm$ 1.5	2.8 $\pm$ 1.9	-0.34	-0.53	0.59

$\bar{x}$ , Mean; SD, Standard deviation; MD, Mean difference; p value, Probability value

### 3.2. Effect of treatment on VAS and VMSS:

#### 3.2.1. Within group comparison:

There was a significant decrease in VAS and VMSS values post treatment in group (A) (study group)

compared with that pre treatment values ( $p < 0.001$ ), while there was no significant difference in VAS and VMSS values in group (B) (control group) between pre and post treatment values ( $p > 0.05$ ). (Table 2, 3).

### 3.2.2. Between groups comparison:

There was no significant difference in VAS and VMSS values between both groups at the pre-treatment measures ( $p > 0.05$ ). While comparison between the group (A) and group (B) at post treatment evaluation revealed a significant decrease in VAS ( $p = 0.002$ ) and VMSS ( $p = 0.005$ ) of the group (A) compared with that of group (B) (Table 2, 3).

**Table (2) Mean VAS pre and post treatment of the study and control groups:**

VAS	Study group	Control group	MD	t-value	p value
	$\bar{x} \pm SD$	$\bar{x} \pm SD$			
Pre treatment	5.8 $\pm$ 1.32	5.6 $\pm$ 1.84	0.2	0.34	0.73
Post treatment	2.86 $\pm$ 1.18	4.93 $\pm$ 1.94	-2.07	3.51	0.002
MD	2.94	0.67			
% of change	50.68	11.96			
t- value	9.76	1.62			
	$p = 0.001$	$p = 0.12$			

$\bar{x}$ , Mean; SD, standard deviation; MD, Mean difference; p-value, level of significance

**Table (3) Median values of VMSS pre and post treatment of the study and control groups:**

VMSS	Study group	Control group	U- value	p-value
	Median (IQR)	Median (IQR)		
Pre treatment	2 (2.2)	2(2.1)	80.5	0.13
Post treatment	1 (1.1)	2(2.1)	56.5	0.005
Z- value	3.27	0.57		
	$p = 0.001$	$p = 0.56$		

IQR, inter quartile range; U- value, Mann-Whitney test value; Z- value, Wilcoxon signed ranks test value; p-value, level of significance

## 4. Discussion

Pelvic pain is the reason that more than 50% of women discontinue using IUDs by five years (25). This study investigated the effect of core muscles strengthening exercises on the pelvic pain caused by IUD. The results revealed that, there was a significant decrease in VAS and VMSS values post treatment in group (A) (study group) compared with that pre treatment values, while there was no significant difference between pre and post treatment values in

VAS and VMSS in group (B) (control group). when comparing both groups there was a significant decrease in the post treatment values of VAS and in the median values of VMSS of group (A) compared with that of group (B).

Shahr-Jerdy et al. (2012) explained that pelvic pain is possibly the result of increased uterine muscle contraction, which is mediated by the sympathetic nervous system. Exercises decrease sympathetic activity by release of endorphins substances produced by the brain that raise the pain threshold, relieving stress and reducing symptoms (26).

Kumar et al. (2015) reported that core strengthening exercises have the ability to properly strengthen all trunk muscles responsible for maintaining a strong and stable spine, without exceeding compressive and shear loading cautious injury thresholds. Therefore, core strengthening exercises help in stimulating the deep abdominal muscles, restoring the function of weakened muscles and increasing the capacity to support the spine and pelvis, which help to relieve mechanical discomfort and pain (27). This might explain the significant rise in the pain threshold and reduced pain intensity in group (A) in comparison to group (B) in the current study.

In addition, the significant decline in pain intensity in group (A) may be explained by the effect of core strengthening exercises in improving tissue blood flow to the pelvic region, which can help in alleviating pain by providing more oxygen and nutrients to the painful area, and by extracting waste products and irritants from sensitive tissues. This explanation is in line with the study of Paungmali et al. (2016) & Saleh et al. (2019) (28) & (29).

Prabhu et al. (2019) stated that core exercises were used in reducing pain and improving women's quality of life. During menstruation weak core musculature leads to improper biomechanical function of structures adjacent to the lumbar spine and inability to handle forces required for normal movement and function. Therefore, it results in pain throughout the abdomen, low back and thighs (30).

The result of the current study is also come in agree with Koohestani et al. (2020) who stated that core muscle exercises are associated with increasing core muscle fitness indices by increasing the endurance and flexibility of abdominal muscles. Thus, it can be used as a treatment for reducing the severity of pelvic pain (31). Also, Gim and Choi (2018) showed the result of short-term swiss ball training 'core strengthening exercises' significantly decreases pain and should be considered as an effective form of treatment (32).

Armour et al. (2019) reported that exercises done for approximately 45 to 60 minutes, three days a week or more, regardless of intensity, can result in a clinically meaningful reduction in pelvic pain intensity of approximately 25 mm out of 100 mm VAS. All the studies used routine exercise during the month, although some researches warned women not to work out during menstruation (33).

Based on the results of this study, we recommend evaluating the long term effect of core strengthening exercises on pelvic pain caused by IUD by using the doppler ultrasound on the uterine arteries.

## 5. Conclusion

Core muscles strengthening exercises is considered as an effective modality in reducing pelvic pain caused by IUD.

## Conflict of Interests

The authors state no conflict of interest or any financial interest or benefit from this research.

## Acknowledgement

We would like to thank all the participants of this study without whom this study would have been impossible.

## References

1. Winner B, Peipert JF, Zhao Q, Buckel C, Madden T, Allsworth JE, Secura GM. Effectiveness of long-acting reversible contraception. *New England Journal of Medicine*. 2012 May 24; 366(21):1998-2007.
2. Joshi R, Khadilkar S, Patel M. Global trends in use of long-acting reversible and permanent methods of contraception: seeking a balance. *International Journal of Gynecology & Obstetrics*. 2015 Oct; 131(S1):S60-S63.
3. Grimes DA, Lopez LM, Manion C, Schulz KF. Cochrane systematic reviews of IUD trials: lessons learned. *Contraception*. 2007 Jun 1; 75(6):S55-S59.
4. The ESHRE Capri Workshop Group. Intrauterine devices and intrauterine systems. *Human Reproduction Update*. 2008 May 1; 14(3):197-208.
5. Awadalla HI. Contraception use among Egyptian women: results from Egypt demographic and health survey in 2005. *Journal of reproduction & infertility*. 2012 Jul; 13(3):167-173.
6. Fadiloglu S, Dilbaz B, Fadiloglu E, Dilbaz S. Relationship between copper IUD complications and ultrasonographic findings. *Archives of gynecology and obstetrics*. 2018 Apr 1; 297(4):989-996.
7. Mutlu I, Demir A, Mutlu MF. Can uterine artery Doppler parameters predict copper intrauterine device-induced side effects?. *The European Journal of Contraception & Reproductive Health Care*. 2014 Feb 1; 19(1):51-56.
8. Robabi H, Arbabisarjou A, Navidian A, Gourkani H. Analysis of the continuation rates of Intrauterine Device (IUD) and three-month injectable Depot Medroxy-progesterone Acetate (DMPA) uses and reasons for their discontinuation in women referred to health centers. *Der Pharmacia Lettre*. 2016; 8(4):233-238.
9. Yilmazer M, Yucel A, Cevrioglu S. The effect of using copper intrauterine device for various periods of time on uterine artery blood flow *Turkiye Klinikleri Journal of Gynecology and Obstetrics*. 2003; 13(6):450-453.
10. O'Neil ME, Peipert JF, Zhao Q, Madden T, Secura G. Twenty-four-month continuation of reversible contraception. *Obstetrics and gynecology*. 2013 Nov; 122(5):1083-1091.
11. Diedrich JT, Zhao Q, Madden T, Secura GM, Peipert JF. Three-year continuation of reversible contraception. *American journal of obstetrics and gynecology*. 2015 Nov 1; 213(5):662:e1-e8.
12. Cheng HF, Lin YH. Selection and efficacy of self-management strategies for dysmenorrhea in young Taiwanese women. *Journal of clinical nursing*. 2011 Apr; 20(7-8):1018-1025.
13. Kaur S, Kaur P, Shanmugam S, Kang MK. To compare the effect of stretching and core strengthening exercises on Primary Dysmenorrhea in Young females. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*. 2014; 13(6):22-32.
14. Akuthota V, Nadler SF. Core strengthening. *Archives of physical medicine and rehabilitation*. 2004 Mar 1; 85(1):86-92.
15. Akuthota V, Ferreiro A, Moore T, Fredericson M. Core stability exercise principles. *Current sports medicine reports*. 2008 Jan 1; 7(1):39-44.
16. Boortz HE, Margolis DJ, Ragavendra N, Patel MK, Kadell BM. Migration of intrauterine devices: radiologic findings and implications for patient care. *Radiographics*. 2012 Mar; 32(2):335-352.
17. Nowitzki KM, Hoimes ML, Chen B, Zheng LZ, Kim YH. Ultrasonography of intrauterine devices. *Ultrasonography*. 2015 Jul; 34(3):183-194.
18. Peri N, Graham D, Levine D. Imaging of intrauterine contraceptive devices. *Journal of*

- Ultrasound in Medicine. 2007 Oct; 26(10):1389-1401.
19. Odole AC, Akinpelu AO. Translation and alternate forms reliability of the visual analogue scale in the three major Nigerian languages. *Internet Journal of Allied Health Sciences and Practice*. 2009; 7(3):13.
  20. Moghadam A, Khosravi A. Evaluating Shirazi (*Thymus vulgaris*) on menstrual pain using verbal multidimensional scoring system (VMS). *African Journal of Pharmacy and Pharmacology*. 2012 Oct 31; 6(39):2761-2766.
  21. McGill, S. *Low Back Disorders: Evidence Based Prevention and Rehabilitation*. 2<sup>nd</sup> Ed., Champaign, IL: Human Kinetics Publishers. 2007; 221 – 234.
  22. Potur DC, Kömürçü N. The effects of local low-dose heat application on dysmenorrhea. *Journal of pediatric and adolescent gynecology*. 2014 Aug 1; 27(4):216-221.
  23. Jaafarpour M, Hatefi M, Khani A, Khajavikhan J. Comparative effect of cinnamon and Ibuprofen for treatment of primary dysmenorrhea: a randomized double-blind clinical trial. *Journal of clinical and diagnostic research: JCDR*. 2015 Apr; 9(4):QC04- QC07.
  24. Ortiz MI, Cortés-Márquez SK, Romero-Quezada LC, Murguía-Cánovas G, Jaramillo-Díaz AP. Effect of a physiotherapy program in women with primary dysmenorrhea. *European Journal of Obstetrics & Gynecology and Reproductive Biology*. 2015 Nov 1; 194(1):24-29.
  25. Mavranzouli I. The cost-effectiveness of long-acting reversible contraceptive methods in the UK: analysis based on a decision-analytic model developed for a National Institute for Health and Clinical Excellence (NICE) clinical practice guideline. *Human Reproduction*. 2008 Jun 1; 23(6):1338-1345.
  26. Shahr-Jerdy S, Hosseini RS, Gh ME. Effects of stretching exercises on primary dysmenorrhea in adolescent girls. *Biomedical Human Kinetics*. 2012 Dec 28; 4(1):127-132.
  27. Kumar T, Kumar S, Nezamuddin M, Sharma VP. Efficacy of core muscle strengthening exercise in chronic low back pain patients. *Journal of back and musculoskeletal rehabilitation*. 2015 Jan 1; 28(4):699-707.
  28. Paungmali A, Henry LJ, Sitalertpisan P, Pirunsan U, Uthaikhup S. Improvements in tissue blood flow and lumbopelvic stability after lumbopelvic core stabilization training in patients with chronic non-specific low back pain. *Journal of physical therapy science*. 2016; 28(2):635-640.
  29. Saleh MS, Botla AM, Elbehary NA. Effect of core stability exercises on postpartum lumbopelvic pain: A randomized controlled trial. *Journal of back and musculoskeletal rehabilitation*. 2019 Jan 1; 32(2):205-213.
  30. Prabhu S, Nagrale S, Shyam A, Sancheti P. Effect of yogasanas on menstrual cramps in young adult females with primary dysmenorrhea. *Int J Physiother Res*. 2019; 7(4):3109-3112.
  31. Koohestani Z, Koushkie Jahromi M, Nemati J. Effect of Core Stability Exercises on Primary Dysmenorrhea and Muscular Fitness Indices in Teenage Girls. *Journal of Paramedical Sciences & Rehabilitation*. 2020; 9(1):100-110.
  32. Gim M, Choi JH. Effect of Gym Ball Exercise and Music Therapy on Menstrual Discomfort. *Indian Journal of Public Health Research & Development*. 2018; 9(3):700-706.
  33. Armour M, Ee CC, Naidoo D, Ayati Z, Chalmers KJ, Steel KA, de Manincor MJ, Delshad E. Exercise for dysmenorrhoea. *Cochrane Database of Systematic Reviews*. 2019 (9). CD004142.