



The effect of exercise mat pilates on pain scale, anxiety, heart rate frequency in adolescent principle with primary dismenorhea in surakarta

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ABSTRAK

Latar Belakang: Saat menstruasi maka terjadi ketidakseimbangan hormon progesteron yang mengakibatkan munculnya rasa nyeri atau sering disebut dengan dismenorhea. Persentasi umumnya 50–60% wanita menangani dismenorhea dengan menggunakan obat-obat analgetic. Pilates exercise ditujukan untuk menghasilkan gerak natural, gerak yang benar dan gerak yang efisien. Merupakan latihan penguluran dan penguatan pada daerah core yaitu daerah antara pelvik, perut dan punggung yang mempunyai tujuan meningkatkan kekuatan otot, fleksibilitas, daya tahan otot sehingga kestabilan tubuh dapat terjaga melalui kontrol tubuh, postur dan pernapasan.

Tujuan: Tujuan penelitian dasar ini untuk menguatkan teori hubungan antara pilates exercise dengan gejala dysmenorrhea.

Metode: Desain penelitian adalah eksperimen pre tes post tes kontrol group. Subjek adalah mahasiswa sebanyak 52 orang yang mengalami dysmenorrhea primer, dibagi menjadi dua kelompok. Kelompok pertama mendapat perlakuan pilates exercise dua kali seminggu selama empat minggu. Kelompok kedua hanya mendapat dukungan informasi saja. Variabel yang diukur meliputi nyeri, kecemasan, frekuensi nadi.

Hasil: Hasil penelitian menunjukkan terdapat perbedaan pada skor skala nyeri dan kecemasan dengan mean 4,15 dan 27,7 ($p > 0,05$).

Kesimpulan: Kesimpulan yang didapatkan pilates dapat menjadi alternatif asuhan komplementer pada remaja putri yang mengalami kecemasan.

KATA KUNCI: dismenor primer; pilates; kecemasan; frekuensi nadi; komplementer

ABSTRACT

Background: During menstruation, there is an imbalance in the hormone progesterone which causes pain or is often called dysmenorrhea. A general percentage of 50–60% of women manage dysmenorrhea using analgetic drugs. Pilates exercise is aimed at producing natural, correct, and efficient motion. It is a stretching and strengthening exercise in the core area, namely the area between the pelvic, abdomen, and back which has the aim of increasing muscle strength, flexibility, muscle endurance so that body stability can be maintained through body control, posture and breathing.

Objectives: The purpose of this basic research is to strengthen the theory of the relationship between pilates exercise and dysmenorrhea symptoms.

Methods: The research design was an experimental pre-test post-test control group. Subjects were 52 students who experienced primary dysmenorrhea, divided into two groups. The first group received pilates exercise twice a week for four weeks. The second group only received information support. The variables measured include pain, anxiety, pulse frequency.

Results: The results showed that there were differences in pain and anxiety scale scores with a mean of 4.15 and 27.7 ($p > 0.05$).

Conclusions: The conclusion obtained by Pilates can be alternative complementary care for adolescent girls who experience anxiety.

KEYWORD: primary dysmenorrhea; pilates; anxiety; heart rate; complementer

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INTRODUCTION

The growth and development of puberty are experienced by every teenager. Puberty is the initial period of sexual maturation, which is a period in which a child experiences physical, hormonal and sexual changes and can carry out a reproductive process. Puberty in adolescents generally occurs at the age of 9-15 years which is marked by menstruation. The menstrual cycle refers to the changes that appear in the uterus. The average menstrual cycle in women is about 28 days. Menstruation is a regular process controlled by hormones released by the hypothalamus, pituitary gland and ovaries. Usually, women in the few days before menstruation will experience discomfort (1). During menstruation, there is an imbalance in the hormone progesterone which causes pain or is often called dysmenorrhea. A general percentage of 50–60% of women manage dysmenorrhea using analgesic drugs (2). Adolescence is one of the most important periods of human development. One of the signs of youth that appears biologically in women is menstruation. Menstrual events are periods of bleeding that occur in women routinely every month during their fertile period unless pregnancy occurs. There are many menstrual disorders are usually faced by a woman. Menstrual disorders usually cause physical discomfort for a woman which can interfere with activities. One of the menstrual

disorders that cause physical discomfort is dysmenorrhea (3).

Dysmenorrhea is pain that results from dysrhythmic contractions of the myometrium with one or two symptoms ranging from mild to severe pain in the lower abdomen, buttocks and thighs. Dysmenorrhea can be classified into primary dysmenorrhea and secondary dysmenorrhea. Primary dysmenorrhea is menstrual pain which is closely related to ovarian sex steroid imbalance without any organ abnormalities, while secondary dysmenorrhea is menstrual pain due to abnormalities in the pelvic organs (4). Dysmenorrhea is felt by all women in their life. Dysmenorrhea most often occurs at the age of 17-20 years. But the exact age at the onset of the dysmenorrhea may be difficult to determine because menstrual pain can gradually become progressive. The hallmark of dysmenorrhea is the onset of 3-5 years after menarche, along with the absence of the ovulatory menstrual cycle which is characteristic of normal adult women. (5)

Symptoms that are felt during dysmenorrhea are a pain in the lower abdomen (suprapubic), pain that radiates to the back and along the thighs starting several hours before or during menstruation (generally lasting 2 - 3 days), accompanied by nausea, vomiting, headache and diarrhea. Approximately 70-90% of cases of menstrual pain occur during adolescence and 15% of them with severe dysmenorrhea

which result in having to leave school during menstruation and will be affected by academic, social and sports activities. (6). Not all of the causes of dysmenorrhea are known, but it is mostly found in the ovulatory cycle, however, it is suspected that low progesterone levels at the end of the corpus luteum phase cause menstrual pain. The decrease in progesterone levels causes an increase in prostaglandin synthesis by the enzyme cyclooxygenase (COX-2) which results in hypertonus and vasoconstriction in the myometrium resulting in ischemia and menstrual pain. There is an increase in the lipid peroxidation process which will activate inflammatory mediators in the endometrium (5,7)

Dysmenorrhea is a marker that there is injury (inflammation) in the human endometrium that occurs during the endometrial and menstrual periods. The inflammatory process is thought to be due to the biological effect of the membrane lipid peroxide process which depends on the profile of saturated fatty acids (Poly Unsaturated Fatty Acids) on the cell membrane phospholipid. Lipid peroxidation is a mechanism of cellular injury in humans and is used as an indicator of oxidative stress in cells and tissues. Oxygen free radicals and dysmenorrhea are closely related to arterial contraction of uterine smooth muscle, when the muscles between blood vessels cause compression of the uterus, muscle and endometrial cells experience ischemia to the uterus as ischemic reperfusion and produce more oxygen free radicals in the clearing of the superoxide dismutase enzyme. Lipid peroxides decompose to malondialdehyde (MDA). MDA is a byproduct of prostaglandins. Unsaturated fatty acids are also used for the synthesis of eicosanoids (8–10)

Pilates basic exercises are designed to build posture, improve blood flow, respiratory system, and lymph system. By using a series of movements and controlled breathing, pilates exercises are designed for the inner postural

muscles. A kind of building muscles around the body that can protect the back from possible injuries, aches and pains (11). Pilates exercise is aimed at producing natural, correct and efficient motion. The basics are done in order, sleep on your back with your knees bent and your hips in a neutral position. There are three basic things in the spinal column: the spine is in a neutral position, breathing and the pelvis is arched. (12).

The benefits of Pilates exercise according to (13) for weight loss, increasing strength of the back and abdominal muscles, preventing trauma, increasing flexibility, improving posture and improving cardiovascular conditions, is also used to treat conditions such as epilepsy, obesity, multiple sclerosis, diabetes mellitus, osteoporosis, osteoarthritis, hypertension, asthma, neck pain and low back pain. Muscles that are not flexible result in a decrease in the range of motion of the joints, thereby reducing basic human daily movement activities such as sitting to standing, walking, bending, reaching forward and lifting weights (14). Flexibility is the ability to use muscles and joints to move as widely as possible without discomfort or pain. (15) Moreover, (16) said that flexibility is the ability of muscles and tendons to extend without joint limitations. General body flexibility involves the ligaments, muscles, joints and intervertebral discs of the lower back. A body that has flexibility will minimize the risk of injury to the back considering that the back as the core of the body is a body component that has a fairly high level of activity. Back flexibility works when bending and lifting weights (17).

Mat Pilates Exercise, which consists of: (1) Warm-up exercises, in this warm-up exercise stretching movements are carried out in each joint throughout the body including the head, neck, arms, back to legs to prepare the body's tissues to move without injury during exercise. Warm up is done for 5 minutes at each training session. (2) Core exercises in the form of lumbar

stretch, spine stretch I, spine stretch II, spine twist, Child pose, the wind mill, the saw, half curl, the hundred I, rolling like a ball, single leg circle, single leg stretch, double leg stretch. (3) cooling exercises, in this exercise, light stretching movements are carried out in each joint such as the head, neck, arms, back accompanied by deep breathing to restore the body to relax again. (18)

a) Waist stretch

The purpose of this movement is to stretch the quadratus lumborum, obliquus externus, erector spine. Early sleep position on your back, legs and feet together, knees bent. The implementation is moved to the right and left side until the joints and knees are monitoring on the floor.



Figure 1. Waist stretch(18)

b) Spine stretch I

The purpose of this movement is to stretch the vastus lateralis muscle, iliotibial band, tensor fasciae latae. The initial position of sleeping on your back, one leg straight and the other bent. The right leg is placed on the lower left leg. Both arms are perpendicular to the body. The implementation is the bent leg is brought to the side of the body on the opposite side until the lower back feels stretched out. During the movement both arms remain flat on the floor.



Figure 2. Spine stretch I (18)

c) Spine stretch II

The purpose of this movement is to stretch the hamstring muscles. Starting position sitting on the mat, legs straightened, arms straight out

in front of you. The practice is to inhale, arms extended forward and perpendicular to the floor. Next, exhale, bending your back towards your knees in a kissing motion. After that exhale while straightening your back again.



Figure 3. Spine stretch II (18)

d) Spine twist

The purpose of this movement is to stretch the transverse abdominis and obliquus externus muscles. Initial position sitting on the mat, legs straight. The implementation is to inhale, then exhale, the body is rotated to the left, the hip joint remains in touch with the mat. Then inhale and return to the starting position, and exhale while repeating the movement to the right side, then inhale and return to the starting position.



Figure 4. Spine twist (18)

e) Child pose

The purpose of this movement is to stretch the muscles of the lower back. The starting position is kneeling on the mat, the hip joints are sitting on the heels, the chest is lowered between the thighs. The practice is that the head is lowered, the arms are stretched out in front of the head and extended.



Figure 5. Child pose (Ellsworth, 2009)

f) The wind mill

The purpose of this movement is to stretch the back muscles, hamstring muscles and gluteus maximus muscles. The starting position is standing straight. The practice is to exhale, the neck is bent down towards the chest, the spine is bent one by one, hold the knees and hold the position, then the arms go down and grab the toes and hold the position. Weight is moved forward. After that, inhale and slowly straighten your spine one by one until you return to a straight up position.



Figure 6. The windmill (18)

g) The saw

The purpose of this movement is to stretch the muscles in the spine. Starting position sitting on the mat, legs straight forward with the width between the legs wider than the distance between the hip joints. Arms extended to the side in a T-shape and palms facing forward. The practice is to inhale, then exhale while bending your back and grabbing the outside of your left heel with your right hand. Then inhale again, then exhale, hands stretched forward, head lowered and left shoulder away from the left ear. Then inhale, return to the starting position, continue with an exhalation, and do the opposite direction.



Figure 7. The saw (18)

h) The mermaid

The purpose of this movement is to stretch the spinal muscles and open the chest cavity. Starting position is sitting with knees bent and right lower leg overlapping the left leg, right hand holding the ankle. The implementation is to inhale, lift the left arm up as high as possible. Then exhale, the left arm is brought to the right side of the body while tightening the stomach. Next inhale, and return to the starting position.



Figure 8. The mermaid (18)

i) Half curl

The purpose of this movement is to strengthen core muscles, increase the endurance of the abdominal muscles. Starting position on your back on the mat, knees bent and arms straight at your sides. Both feet are together and the surface of the feet is flat on the floor. The practice is to bend your upper back and lift your shoulders off the floor using your upper abdominal muscles, your arms parallel to the floor and keep your lower back touching the floor.



Figure 9. Half Curl (18)

j) Tiny step

The purpose of this movement is to develop stability of the abdominal muscles, protecting the hip joint and lower back. The main target of the movement is the lower abdominal muscles. Starting position on your back on the mat, knees bent and feet tiptoeing, both hands on the hip joint to feel leg movement. The practice is to exhale, then raise the right knee towards the

chest while tightening the stomach. Followed by inhaling and holding the position, then exhaling again while tightening the stomach. The legs are lowered slowly. Then do the same movement on the left leg.



Figure 10. Tiny step (18)

k) The hundred I

The purpose of this movement is to strengthen the abdominal muscles. The starting position is supine on the knee mat, bent with the surface of the feet against the floor and tightening the thighs. The practice is to inhale, hands extended forward with palms pointing downwards. Then the breath is exhaled, the arms are raised so that the neck muscles are extended by raising the head. Gently push your hands up while inhaling and down while exhaling in small movements like tapping water. Next is to inhale while moving your hands, slowly exhaling forcibly using your abdominal muscles.



Figure 11. The hundred I (18)

l) Rolling like a ball

The purpose of this movement is to improve abdominal muscle control. Starting position is sitting with knees bent, feet raised off the floor, after a balanced position, hands placed under the folds of the knees. The practice is to inhale, then the hip joint is lifted by contracting the abdominal muscles while slowly rolling backwards until the shoulders rest on the floor. Then the breath is exhaled using the abdominal muscles to roll forward keeping balance. The shoulders remain relaxed during the movement.



Figure 12. Rolling like a ball (18)

m) Rolling down

The purpose of this movement is to increase the strength of the deep abdominal muscles, stretch the back muscles, develop the control core. The starting position is sitting upright on the mat, with your knees bent and your feet resting on the floor. The implementation is inhaling while straightening the body as high as possible, then exhale and roll your back towards the mat, keeping your feet flat on the floor. Movement is carried out until the back is against the mat, then return to the starting position.



Figure 13. Rolling down (18)

n) Single leg circle

The purpose of this movement is to stretch the leg muscles, strengthen the deep abdominal muscles, and stabilize the pelvic and abdominal muscles. The starting position is supine on the mat, both legs straight. The practice is to inhale and exhale a circle with the knee clockwise with the knee bent. Followed by inhaling again, then exhaling, the left leg forms a circle in the opposite direction to the previous one.



Figure 14. Single leg circle (19)

o) Single leg stretch

The purpose of this movement is to stabilize the core when the lower limb is moved, and to strengthen the abdominal muscles. The initial position of sleeping on your back on the mat.

The implementation is the right leg is raised towards the chest. The right hand touches the right ankle and the left hand touches the right knee while raising the head and then the left leg is straightened and raised at ear level from the mat.



Figure 15. Single leg stretch (18)

p) Double leg stretch

The purpose of this movement is to stretch the leg muscles, strengthening the abdominal muscles. The main target of this movement is the abdominal muscles. The starting position is supine on the mat, then the knees are pushed towards the chest, the head and upper back are raised, both hands holding the ankles. In practice, inhale, then raise your arms and stretch out parallel to the mat and straighten your legs upwards, then exhale while hugging your knees back towards your chest. Make sure your upper back is lifted off the mat.



Figure 16. Double leg stretch (18)

This study aims to increase the theoretical evidence of the effect of mat pilates exercise on pain scales, anxiety scores, and pulse frequency for girls with dysmenorrhea.

MATERIALS AND METHODS

This study used a research design with an experimental one group pretest and posttest design. Where the researchers conducted the research by providing preliminary observations (pretest) of a group of young women who experienced dysmenorrhea pain, after that pilates exercise was carried out twice a week for four weeks with the time it took every 25-30 minutes of pilates exercise, then carried out back to the final observation of the level of the

pain scale in young women. The number of population in this study was 52 respondents, with total sampling using 26 subjects per group of control and intervention. The sample taken must have the following inclusion criteria: young women who have dysmenorrhea, do not experience physical disabilities such as paralysis, and are willing to be respondents. While the exclusion criteria were: adolescents who did not experience menstrual pain, adolescents who used pharmacological and complementary therapies in treating dysmenorrhea pain and refused to become respondents. Subjects will drop out if: (1) the subject is absent from the exercise more than 2 times in a row. The analysis in this study was univariate and bivariate, where the univariate analysis was used to determine the characteristics of respondents with mean and standard deviation values, as well as to determine the level of pain before and after being given pilates exercise with tendency values, namely the maximum value, minimum value and median value. In the bivariate analysis, the statistical test used to determine the effect of the independent and dependent variables was using statistical analysis.

RESULTS AND DISCUSSION

Table 1 note that the average dysmenorrhoea pain intensity in the group experiment before being given treatment is 4,61 and control group is 4,46.

Table 1. Average pain intensity dysmenorrhoea before intervention in the experimental group and group control

Pain Intensity Dysmenorrhoea before Intervention	Mean	p
Experiment Group	4,61	0,424
Control Group	4,46	

Table 2 note that the average Anxiety Score in the group experiment before being given treatment is 33,3 and control group is 34,6

Table 2. Average score of anxiety before intervention in the experimental group and group control

Anxiety Score before Intervention	Mean	p
Experiment Group	33,3	0,34
Control Group	34,6	

Table 3 note that the average heart rate in the group experiment before being given treatment is 76 and control group is 76

Table 3. Average score of heart rate before intervention in the experimental group and group control

Heart Rate before Intervention	Mean	p
Experiment Group	76	0,285
Control Group	76	

Table 4 shows the decline after given pilates. The results obtained are p value = 0.000 $p < \alpha$ (0.05), then it can concluded that there is a difference in pain intensity dysmenorrhea after being given Pilates

Table 4. Decreased dysmenorrhoea pain intensity after being given intervention in the group experimental and control groups

Pain Intensity Dysmenorrhoea after Intervention	Mean	p
Experiment Group	4,15	0,01
Control Group	5,07	

Table 5 shows the decline after given pilates. The results obtained are p value = 0.000 $p < \alpha$ (0.05), then it can concluded that there is a difference in anxiety score after being given Pilates

Table 5. Decreased anxiety score after being given intervention in the group experimental and control groups

Anxiety score after Intervention	Mean	p
Experiment Group	27,7	0,008
Control Group	35,7	

Table 6 shows the decline after given pilates. The results obtained are p value = 0,139, then it can concluded that there is no difference in anxiety score after being given Pilates

Table 6. Heart rate after being given intervention in the group experimental and control groups

Heart rate after Intervention	Mean	p
Experiment Group	84	0,139
Control Group	79	

DISCUSSION

Dysmenorrhoea generally occurs 2-3 years after menarche the ideal is 12-15 years so that the dysmenorrhoea is more occurs at the age of 17-18 years. At age there is secondary sexual development and the body's hormones are unstable so it can stimulate the prostaglandin hormone causing increased uterine contractions and dysmenorrhoea occurs. (12). This process can not occurs when doing pilates as routine activity. This is because by doing pilates, the b-endorphin level in the blood will increase four to five times. The b-endorphin that comes out will be captured by the receptors in the hypothalamus and limbic system which functions to regulate emotions. In addition, increasing b-endorphins can reduce pain. The endorphins produced by the pituitary gland can function as an analgesic by binding to opioid receptors at both pre and post nerve terminal synapses. When it binds, there is a cascade of interactions that can inhibit the release of takikinin, especially substance P, which is involved in pain transmission. (20)

Endorphins in the central nervous system direct their primary action at presynaptic nerve terminals. Endorphins do not inhibit the release of substance P, but inhibit the release of gamma-aminobutyric acid (GABA). This inhibition can increase the production of dopamine, which is associated with pleasure. The endorphins produced during exercise will be circulated throughout the body and control the condition of blood vessels to return to normal and keep blood flow flowing unhindered. Increased metabolism of blood flow to the pelvis that occurs during exercise can reduce ischemic pain during menstruation (20)

Pilates is one way involve physical activity that can improve pelvic organ function by adjusting metabolism, hydropower balance, conditions hemodynamics and blood flow as analgesia or pain relief. Doing physical exercise as a way pain relief by increasing mechanism of action of opioids so will reduce pain. In research conducted by (1) shows the results in the treatment group, namely the p value value $0.001 < \alpha 0.05$ which means there is Pilates effect on reduction primary pain intensity dysmenorrhea. The influence of pilates exercise against dysmenorrhea also pay attention to the age factor so more controlled, with characteristics the same age, namely in the adolescent category. Pilates exercise is very stressful on breathing, visualization, and the mind-body relationship. Besides the benefits of the pilates exercise for flexes and strengthens muscles and helps relieve stress, taste anger and depression because of it production of endorphin hormones as the tranquility hormone that gives sense of comfort. Furthermore, it also led to a reduced anxiety score in the intervention group (1) Although the research results were good for anxiety and pain, they did not make a significant difference in heart rate.

In a study conducted by (21) also showed the pretest results with a mean value of 7.92. The occurrence of dysmenorrhea on a scale high pain can be caused by contraction of the muscles so the need for exercise / sports to be able reduce it. According to (22) low BMI, smoking, early menarche age (< 12 years explains that teens who experience menstrual pain will experience muscle cramps especially in the lower abdomen caused.

by long and strong contractions on uterine wall thus resulting muscle fatigue and physical inactivity therefore it requires exercise. On elasticity of the abdominal muscles will be affected by the oxygen level supply the organs so that will happen decreased pain if the organ especially the abdomen is adequately leveled oxygen to the maximum. And secretion of

prostaglandin hormones when menstruation will also reduce pain. (20)

There are no definite rules for the timing and frequency of pilates. However, by doing exercise regularly and regularly, the pain intensity will decrease because the number and size of blood vessels will increase and circulate blood throughout the body, including to the reproductive organs, so that menstrual pain can be reduced. In this study, doing gymnastics twice a week in the morning or evening. Pilates exercise is more recommended to be done in the afternoon because the highest concentration of endorphins is found in the morning and the lowest at night so that in the afternoon the hormone levels are more stable. (23)

CONCLUSIONS AND RECOMMENDATIONS

Based on theory and results previous research that has been delivered in the discussion above, It is proven that there is a Pilates effect exercise to reduce the pain scale of dysmenorrhea and anxiety on female adolescents in Surakarta but has no effect on heart rate. It can be recommended that Pilates can be an alternative exercises to reduce dysmenorrhea and anxiety for youth people.

REFERENCES

1. Handayani L. Skripsi Pengaruh Pilates Terhadap Intensitas Nyeri Pada Primary Dysmenorrhea. 2014.
2. Rahayu, Suryani, Marlina. Efektifitas Senam Dismenore Dalam Mengurangi Dismenore Pada Mahasiswa Program Studi D III Kebidanan Karawang Tahun 2013. Jurnal Ilmu Solusi. 2014;1.
3. Najmi L. Buku pintar menstruasi & solusi mengatasi segala keluhannya. Yogyakarta: Buku Biru; 2011.
4. Proverawati A, Misaroh S. Menarche menstruasi pertama penuh makna. Yogyakarta: Nuha Medika; 2009.

5. Baziad A. Endokrinologi ginekologi. Edisi ke-1. : Jakarta: Media Aesculapius dan Kelompok Studi Endokrinologi Reproduksi Indonesia Ginekologi KSERI; 1993.
6. Dawood M. Primary dysmenorrhea advances in pathogenesis and management. *Am Coll Obstet Gynaecol*. 2006;108(2):428–41.
7. Singh A, Kiran D, Singh H, Nel B, Singh P, Tiwari P. Prevalence And Severity Of Dysmenorrhea: A problem related to menstruation, among first and second year female medical students. *Indian Jurnal Physiol Pharmacol*. 2008;389–97.
8. Lefebvre G, Pinsonneault O, Antao V, Black A, Burnett M, Feldman K. Primary dysmenorrhea consensus guideline. *Obstet Gynaecol Canada*. 2005;1117–30.
9. Nielsen F, Mikkelsen B, Nielsen J, Andersen H, Grandjean P. Plasma malondialdehyde as biomarker for oxidative stress: reference interval and effects of life-style factors. *Clin Chem*. 1997;43(7):1209–14.
10. Rao V, Kiran R VM. Oxidative stress and antioxidant status in primary dysmenorrhea. *Jurnal Clin Diagnostic Res*. 2011;5(3):509–11.
11. Kelly T. 50 rahasia alami meringankan sindrom pramenstruasi. Jakarta: Erlangga; 2005.
12. Susy N, Manurung A. Latihan Metode Neurac Lebih Efektif Daripada Senam Pilates Terhadap Peningkatan Stabilitas LumbopelviC. Universitas Kristen Indonesia. 2012;1–19.
13. Paterson J. Teaching Pilates for Postural Faults, Illness & Injury: a Practical Guide. Philadelphia: Butterworth Heinemann Elsevier; 2009.
14. Walker B. Ultimate Guide to Stretching and Flexibility, 3th ed. United State.: Injury Fix and Stretching Institute; 2007.
15. Sudarsono NC. Kebugaran. 2008.
16. Birocco N, Guillame C, Storto S, Ritorto G, Catino C, Gir N, et al. The Effects of Reiki Therapy on Pain and Anxiety in Patients Attending a Day Oncology and Infusion Services Unit. *Am Journal Hosp Palliat Med*. 2012;
17. Muzamil MA. Perbandingan Efek Pengobatan Parasetamol dan Diasepam dengan Natrium Diklofenak terhadap Derajat Nyeri dan Fleksibilitas Otot pada Nyeri Pinggang Non Spesifik Akut. Universitas Diponegoro Semarang; 2006.
18. Ellsworth A. Pilates Anatomy : a Comprehensive Guide. California: Thunder Bay Press; 2009.
19. Brignell R. The Pilates Handbook. New York: Rosen Publishing; 2004.
20. Destyaningrum A, Puspitasari I, Rumini, Mukarromah S, Kumalasari MLF, ا موهلد, et al. Pengaruh Exercise Pilates Terhadap Penurunan Nyeri Haid Primer Pada Mahasiswa DII kebidanan Stikes Yarsi Sumbar Bukittinggi. *Journal Heal Science Prev*. 2017;10(2):1–31.
21. Silva MJL, Freitas CD, Civile VT, Nardini AG. Effect of the Pilates Ball Method in Women with primary dysmenorrhea. *Heal Sci Inst*. 2014;32(1):78–81.
22. Anisa MV. The Effect of Exercises on Primary Dysmenorrhea J Majority | Volume 4 Nomor 2 | Januari 2015 | 60 The Effect Of Exercises On Primary Dysmenorrhea. *Journal Major*. 2015;4(2):60–5.
23. Rahayu MA, Suryani L, Marlina R. Efektifitas Senam Dismenore Dalam Mengurangi Dismenore Pada Mahasiswa Program Studi D III Kebidanan Karawang Tahun 2013. *Jurnal Ilmu Solusi*. 2014;1(2):56–61.