

The effect of isometric exercise on the intensity and duration of pain among physically inactive young females with primary dysmenorrhea

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Abstract:

Introduction: Primary dysmenorrhea (PD) is defined as recurrent, cramp-like pain occurring with normal ovulatory menses in the absence of any pelvic pathology. Isometric exercise is a subgroup of exercises, during which the muscle length and joint remain constant during contraction. To date, the effectiveness of isometric exercise in reducing the intensity and duration of PD is not yet established. **Objective:** The aim of the study is to investigate the effect of isometric exercise on the intensity and duration of PD among physically inactive young females. **Methods:** In this randomised controlled trial, twenty-four young females with PD were randomly assigned to either exercise or control groups, with twelve participants in each group. While participants in the control group continued with their physically inactive lifestyle, participants in the exercise group were required to perform isometric exercises for eight weeks, five days per week, two sessions per day, and ten minutes per session. Pain intensity and duration of all the participants were measured during menses at pre, mid and post-test. The intensity of pain was measured by using the Visual Analogue Pain Scale (VAPS) and the duration of pain was recorded in hours. The data was analysed by Mixed ANOVA, SPSS version 26.0. **Results:** After eight weeks of isometric exercise intervention, the mean score of pain intensity was significantly reduced in the exercise group (6.08 to 1.92) ($p = 0.002$), while it remained constant in the control group (6.25 to 6.58) ($p = 0.126$). The mean duration of pain (hours) was also significantly reduced in the exercise group (10.00 to 2.00 hours) ($p = 0.000$) but remained constant in the control group (9.25 to 9.42 hours) ($p = 0.691$). **Conclusion:** The mean intensity and duration of menstrual pain were significantly reduced after eight weeks of isometric exercise intervention. It appears that isometric exercise is an effective non-pharmacological method to induce a positive reduction in intensity and duration of pain for primary dysmenorrhea.

Key Words: - Isometric exercise, primary dysmenorrhea, physically inactive female, pain scale.

Introduction

Dysmenorrhea is obtained from the Greek word ‘dys’ which means difficult, painful, or abnormal, while ‘meno’ means month, and ‘rhea’ means flow (Chauhan & Kodnani, 2016). Primary dysmenorrhea (PD) is defined as recurrent, cramp-like pain that occurs with normal ovulatory menses in the absence of any pelvic pathology such as pelvic inflammatory disease, endometriosis, adenomyosis, infertility issues, ovarian cysts, uterine myomas or polyps, intra-uterine adhesions, or cervical stenosis (Unsal *et al.*, 2010). It is the most common type of periodical pelvic discomfort experienced by most women, affecting primarily young women, often those in university or occupational activity (Teherán *et al.*, 2018). In a cross-sectional study of 370 female students, it was reported that 85.7 percent of them had PD, with 12.7 percent having mild, 65.6 percent having moderate, and 8.4 percent having severe dysmenorrhea (Rafique & Alsheikh, 2018). The largest contributing physiological factor in PD is the excessive or imbalanced amount of prostaglandins (PG), particularly PGF_{2α}, released from the endometrium during menstruation. This imbalanced was found to stimulate frequent dysrhythmic myometrial contractions, which reduce uterine blood flow and cause uterine hypoxia. This hypoxia is responsible for the painful cramping in PD (Armour *et al.*, 2019).

PD appears up to 6–12 months after menarche once the ovulatory cycle is established and primarily affects young women, often those in university or occupational activity (Latthe, Champaneria & Khan, 2011). It begins on the first day of menses and lasts from 48 to 72 hours. At least one out of every three young women had to be absent during menstrual bleeding, due to the intensity of the pain, impeding their ability to do daily activities, and it is anticipated that 25-95 percent of women with dysmenorrhea will experience significant psychological, behavioural, social, and physical stress (Gagua *et al.*, 2012; De Sanctis *et al.*, 2015). The high prevalence of PD among adolescents appears in the early years of their reproductive life which affects their daily activities including school absenteeism and thus it makes PD a public health problem (Santina *et al.*, 2012). Even though it is one of the frequent problems endured by most girls from adolescence onwards, it is hardly taken into

consideration when assessing adolescents' health (Kumbhar *et al.*, 2011). In addition, WaLIDD Score is designed to integrate the feature of dysmenorrhea through the specific score ranging from 0 to 12 points (Teherán *et al.*, 2018). In detail, the score is classified as without dysmenorrhea (0), mild dysmenorrhea (1-4), moderate dysmenorrhea (5-7) and severe dysmenorrhea (8-12). In this study, only those who obtained WaLIDD score ≤ 7 (mild and moderate dysmenorrhea) were recruited in accordance with the Primary Dysmenorrhea Consensus Guideline (Teherán *et al.*, 2018).

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) and Oral Contraceptive Pills (OCP) are reported as being the most efficient pharmacological treatments for providing pain and associated PD symptom relief (Wang *et al.*, 2004). However, due to high costs, complications, and some drug therapies contraindications as well as accessibility and public desire to use complementary treatments, extensive studies on complementary and alternative methods are being conducted these days, such as doing exercise (Lee *et al.*, 2006). For almost half of a century, exercise has been thought to relieve PD and in the last 15-20 years, reports on the link between physical activity and menstrual disorder have increased significantly (Shavandi, Taghian & Soltani, 2010; Daley, 2008; Lee *et al.* 2006).

Isometric exercises are a subcategory of exercises in which the length of the muscle and angle of the joint remains constant during contraction (Kubo, Kanehisa & Fukunaga, 2005). It is easy and safe for the sedentary population as the protocol is non-invasive and implemented at low intensity, and it is widely used in rehabilitation settings (Schafer, 2017). In addition, it is inexpensive as special facilities or equipment are not required, and it is not time-consuming. Hence, isometric exercise seems to be an appropriate non-pharmacological method for reducing the pain intensity of PD. Isometric exercises may have the potential mechanism of strengthening pelvic muscles, facilitating bleeding, and excreting waste containing PG, which causes excessive contractions (Shavandi, Taghian & Soltani, 2010). It also stimulates the constant muscles, which are of a δ -type and C fibres, which in turn reduce the pain via pain inhibitory effects (Umeda *et al.*, 2010). In addition, regular exercise relieves stress and further reduces the activity of the sympathetic nervous system, which induces contraction and pain in the uterine muscles (Mahvash *et al.*, 2012).

Though PD is not fatal, these conditions can certainly affect the productivity of many women, negatively impacting their mental health and potentially creating physical and social disability, resulting in school absences, hampered sports participation, and daily activities (Anandha Lakshmi *et al.*, 2011). However, up to now, contradictory, and inconsistent findings about the positive effects of exercises on PD have been reported, contributing to mixed and conflicting evidence. Due to the given prevalence, detrimental symptoms, treatments complications, and inconsistent results from previous studies on the effects of exercises on PD, a clarification is required for further reliable studies in this regard. Hence, the objective of this study is to investigate the effect of isometric exercise on the intensity and duration of pain among inactive young females with primary dysmenorrhea.

Material & methods

Study Design. This study employed randomised control trial (RCT) study design and was performed from October 2020 to January 2021. It involved eight weeks of intervention with pre, mid and post-test measurements. During the recruitment process, potential participants were explained in detail regarding the purpose, objectives, procedures, potential risks, and benefits of this study. The study protocol had been reviewed and granted ethical approval by the Human Research Ethics Committee, Universiti Sains Malaysia (USM/JEPeM/20040216).

Participants. Twenty-four participants volunteered to participate in this study. They were physically inactive, healthy, able to involve in exercise programmes [answer NO to all questions in the Physical Activity Readiness Questionnaire (PAR-Q)], had regular menstrual cycles and had primary dysmenorrhea (WaLIDD Score of ≤ 7). In addition, they were aged between 18-29 years old, never gave birth and did not have lower abdominal pain at any other times than just before or during menstruation. Those who were smokers, currently on oral contraception pills/medications (paracetamol, analgesics etc.) or other non-pharmacological methods (hot water bag/heat massage/TCAM etc.) for pain relief two weeks prior to the study, had an irregular menstrual cycle (more than 35 days per cycle) and had a history of secondary caused of dysmenorrhea (endometriosis, pelvic inflammatory disease etc.) or other gynaecological problems (ovarian cysts, adenomyosis etc.) diagnosed by gynaecologist were excluded from this study.

Study procedures. The participants ($N = 24$) were randomly assigned into either control or exercise groups (12 participants per group, $n = 12$). The data collection (pain intensity and duration) was conducted at pre-test (first menses), mid-test (second menses) and post-test (third menses) during the first 3 days of each menstrual cycle. The intensity of pain was measured by using a Visual Analogue Pain Scale (VAPS), which is a 10 cm continuum line of participants' perception of the degree of pain on which zero represented the lowest pain while 10 represented the highest intensity of pain. The score was classified as mild (1-3 points), moderate (4-7 points) and severe (8-10 points). VAPS measurements of acute pain were valid and reliable, and the instrument's dependability ($r = 0.99$) had been confirmed in several trials (Farrar *et al.*, 2011). The average duration of pain

(in hours) per day was recorded as per self-claimed by the participants. The pre- and mid-test measurements, as well as the mid and post-test measurements, were separated by 4 weeks of the intervention period.

During the intervention period, the participants in the control group were not involved in the exercise programme and continued with their regular daily activities. Meanwhile, the participants in the exercise group performed 10 repetitions of isometric exercise per session, 2 sessions per day for 5 days per week. The exercise was started on the third day of their menstrual cycle. Each exercise session lasted about 10 minutes. Participants were trained and were provided with video guidelines and verbal-audio instruction to ensure they understood and performed the correct exercise technique. An exercise adherence log was given to each participant to record their adherence to the exercise programme. The steps of isometric exercise protocols were revised and verified by a specialised rehabilitation professional (Azima *et al.*, 2015). The following are the instructions given to the participants during the exercise session:

1. Lie down in the supine position. Extend your feet next to each other and press them against each other. Hold for five seconds and relax.
2. In the supine position, put your feet crossed and press them against each other. Hold for five seconds and relax.
3. In the supine position, bend your knees and thighs. Put a pillow between two knees and press the knees to each other. Hold for five seconds and relax.
4. Going back to the first position, put your hands below the waist, and press the waist to the ground. Hold for five seconds and relax.
5. Going back to the third position, try to raise your head and neck above ground level. Hold for five seconds and relax.
6. Going back to the third position, try to move your head and neck toward the right thigh. Hold for five seconds and relax.
7. Repeating step six toward the left thigh.
8. Take one deep abdominal breath among the above-mentioned movements. Breathe through the nose in a way that the abdomen expands. Then, exhale from the mouth in such a way that abdominal muscles stick to the waist. You can also place your hand on the abdomen to ensure abdominal breath.

Statistical analysis. The statistical software IBM SPSS version 25.0 were used to perform all statistical analyses. Statistical analyses were tested using mixed Analysis of Variance (ANOVA) and pairwise Bonferroni post hoc test. The 95% confidence interval was computed to allow comparison between scales. The level of statistical significance was set at $p \leq 0.05$. All the data were reported as mean $\pm$ standard deviation (SD).

Results

This study was conducted on twenty-four physically inactive young females, and no dropout was recorded as all participants completed the pre-test, mid-test, and post-test measurements. Before intervention, no statistically significant mean differences in age ($p = 1.00$), BMI ($p = 0.12$), menarche age ($p = 0.84$), duration of menstrual cycle ($p = 0.45$) and duration of bleeding ($p = 0.63$) between the exercise and control groups (Table 1).

Analysis with mixed ANOVA (Table 2) revealed a significant main effect of time ($F = 9.182$; $df = 1$; $p = 0.006$), a significant interaction effect ($F = 12.726$; $df = 1$; $p = 0.002$), and a significant group effect ($F = 0.367$; $df = 22$; $p = 0.037$) for means of VAPS. Further analysis of pairwise comparison showed that the mean of VAPS was significantly reduced at mid-test ($p = 0.037$) and post-test ($p < 0.001$) compared to pre-test in exercise but not in the control group ($p = 0.126$). There was also a significant reduction in pain intensity at post-test compared to mid-test ($p = 0.037$). For the between-group effect, there was no statistically significant mean difference ($F = 1.978$; $df = 22$; $p = 0.841$) at the pre-test between exercise and control groups with a mean difference of -0.167 (95% CI of mean difference: -1.871, 1.538). However, there was a statistically significant mean difference ($F = 0.367$; $df = 22$; $p = 0.037$) at mid-test between the exercise and control groups with a mean difference of -2.000 (95% CI of mean difference: -3.870, -0.130). Similarly, there was a statistically significant mean difference ($F = 7.055$; $DF = 22$; $p = 0.001$) at post-test between the exercise and control groups with a mean difference of -4.667 (95% CI of mean difference: -6.470, -2.863).

Similarly, analysis with mixed ANOVA (Table 3) revealed a significant main effect of time ($F = 25.128$; $df = 1$; $p = 0.001$), a significant interaction effect ($F = 29.207$; $df = 1$; $p < 0.001$) and a significant group effect ($F = 13.15$; $df = 1$; $p = 0.001$) for means of pain duration. Further analysis of pairwise comparison showed that the mean pain duration was significantly reduced at mid-test ($p = 0.001$) and post-test ($p < 0.001$) compared to pre-test in the exercise group but not in the control group ($p = 0.691$). There was also a significant reduction in pain duration at post-test compared to mid-test ($p = 0.013$) in the exercise group. For the between-group effect, the means of pain duration at pre-test was not significant ($F = 0.746$; $df = 22$; $p = 0.545$) with a mean difference of 0.750 (95% CI of mean difference: -1.779, 3.279) between both groups. However, mid-test ($p = 0.001$) and

post-test ($p < 0.001$) values were significantly lower in the exercise group compared to control group with a mean difference of -5.25 (95% CI of mean difference: -8.252, -2.248).

Table 1. Demographic Characteristics

Demographics Characteristics	Control ($n = 12$)	Exercise ($n = 12$)	p -value
Age (years)	22.58 $\pm$ 0.90	22.58 $\pm$ 0.79	1.00
BMI (kg/m ²)	21.78 $\pm$ 2.42	24.76 $\pm$ 5.91	0.12
Age of Menarche (years)	11.92 $\pm$ 1.00	12.00 $\pm$ 0.95	0.84
Duration of menstrual cycle (days)	32.5 $\pm$ 2.54	31.67 $\pm$ 2.81	0.45
Duration of bleeding (days)	6.92 $\pm$ 1.24	6.67 $\pm$ 1.23	0.63

Table 2. Comparison of Mean Scores of Pain Intensity (VAPS)

Pain intensity	Control ($n = 12$)	Exercise ($n = 12$)
Pre-test	6.25 $\pm$ 2.26	6.08 $\pm$ 1.73
Mid-test	6.33 $\pm$ 1.83	4.33 $\pm$ 2.54 ^{*#}
Post-test	6.58 $\pm$ 2.64	1.92 $\pm$ 1.44 ^{*#a}

*Significantly different ($p < 0.05$) from control group

#Significantly different ($p < 0.05$) compared to pre-test value

^aSignificantly different ($p < 0.05$) compared to mid-test value

Table 3. Comparison of Mean Duration of Pain (hours)

Duration of pain	Control ($n = 12$)	Exercise ($n = 12$)
Pre-test	9.25 $\pm$ 3.28	10.00 $\pm$ 2.66
Mid-test	10.08 $\pm$ 3.09	4.83 $\pm$ 3.95 ^{*#}
Post-test	9.42 $\pm$ 3.20	2.00 $\pm$ 2.09 ^{*#a}

*Significantly different ($p < 0.05$) from control group

#Significantly different ($p < 0.05$) compared to pre-test value

^aSignificantly different ($p < 0.05$) compared to mid-test value

Discussion

The nervous system derivation innervated by sympathetic nerve increased menstrual pain by contracting uterine muscle. Consequently, stress through sympathetic nervous system hyperactivity via the increased uterine muscle contractibility may possibly lead to menstruation symptoms. According to Shah-Jerdy *et al.* (2014), physical compression of nerve pathways and discomfort was caused by contracted ligamentous bands in the abdomen area (Shahr-jerdy *et al.*, 2012).

The first objective of this study was to investigate the effect of isometric exercise on the intensity of pain among inactive young females with primary dysmenorrhea. Results showed a significant difference after eight weeks of intervention between exercise and control groups regarding the intensity and duration of menstrual pain. The notion that countless types of active or passive exercise have the potential to help lessen the intensity of pain in primary dysmenorrhea is not a new matter. A systematic review and meta-analysis study of 23 clinical trials performed in Iran, Taiwan, USA, Turkey, Hong Kong, and Korea found that the exercise group (stretching and yoga) showed the largest effect size in the reduction of menstrual pain symptoms compared to the heat and acupressure groups in females who experienced dysmenorrhea (Armour *et al.*, 2019). In a study conducted by Wood *et al.* (2018), performing abdominal stretching exercises for 15 minutes, 2 times per week for 3 weeks in 46 nursing students who experienced dysmenorrhea in the menstrual cycle in the last 6 months was found to be statistically significant in pain difference between the pre-test and post-test interventions group while the control group pain was not significant (Nadjib, Seweng & Ernawati, 2018). The present study findings were in parallel with these studies. Generally, discomfort associated with dysmenorrhea may be alleviated by exercise therapy.

To our knowledge, there are still glaring gaps to clarify the mechanism of action in reducing the discomfort associated with dysmenorrhea. Women who regularly exercise may experience fewer dysmenorrhea episodes because of the intensified circulating endorphin levels or hormonal alterations on uterine epithelial tissues (Shahr-jerdy *et al.*, 2012). Exercise alters the reproduction of hormone secretion, which promotes the release of certain neurotransmitters, which include natural endorphins, estrogen, progesterone, dopamine, and endogenous opiate peptides (Awad *et al.*, 2020). This physiological alteration inhibits prostaglandin from being released and elevates the estrone-estradiol ratio, which suppresses endometrial proliferation and improves uterine blood flow. Increased secretion of endorphins from the brain due to exercise inhibits the pain pathways and may further raise the body pain threshold. Contrary to the above results, some published articles (Gordley *et al.*, 2000; Harlow & Park, 1996; Israel, Sutton & O'Brien, 1985) reported no association between physical activity and dysmenorrhea. Meanwhile, Metheny and Smith (2012) reported that regular exercise in dysmenorrhea girls caused higher levels of pain and negative moods. which were in contrast with the present findings.

The second objective of this study was to investigate the effect of isometric exercise on the duration of pain among inactive young females with primary dysmenorrhea. Results showed a significant difference after 8 weeks of intervention between exercise and control groups regarding the intensity and duration of menstrual pain, which is in line with several studies. Rakhshee *et al.* (2011) and Yang *et al.* (2016) reported a decrease in both the severity and duration of pain from baseline in 120 students majoring in nonmedical fields, in the yoga group that performed cobra, cat and fish postures for 15-20 minutes per day for 12 weeks, while no change was observed in the no-treatment group (Rakhshae, 2011; Yang & Kim, 2016). However, to date, reports on the effect of exercise on primary dysmenorrhea among the physically inactive population are limited. Shah-Jerdy *et al.* (2014) and Abbaspour *et al.* (2006) reported in a study of non-athlete female students that static stretching exercise, which is a type of isometric exercise, significantly decreased intensity, duration, and analgesic usage from baseline in the stretching group, but no change was observed in the control group during two-menstrual cycles (eight weeks) (Shahr-jerdy *et al.*, 2012; Abbaspour, Rostami & Najjar, 2006). In addition, the results of myriads of studies have shown that the symptoms and pain intensity have decreased with sports activity. For instance, Shah-Jerdy *et al.* (2014) reported less frequency of dysmenorrhea in high school girls who were actively involved in sports activities compared to the less-active group (Shahr-jerdy *et al.*, 2012). The present study findings were in agreement with these studies. The potential mechanism of reduced intensity and duration of pain persists as exercise promotes better functioning of the organs by adjusting metabolism and electrolyte balance, and improving hemodynamic conditions and blood flow, including in the pelvic region, which influences the reduction of dysmenorrhea (Samara *et al.*, (2012). Increased blood flow and uterus metabolism during exercise could be effective in reducing the dysmenorrhea symptoms.

There were a few limitations found in the present study. This study used self-reported measures of pain intensity and duration. Thus, it required participants to be honest and truthful during data collection. Besides, the adherence to exercise intervention was based on trust as the participants were allowed to practise the exercise programme at home/hostel. Next, the study did not involve the blood analysis of participants. Hence, the plasma levels of progesterone, prostaglandin, and endorphins were not measured to present extensive evidence of physiological adaptation. Another limitation was that the study was conducted on a small sample size; therefore, generalising the findings to a broader female population should be done with caution.

Conclusions

In the present study, the overall effect of isometric exercise showed a large reduction in overall menstrual pain. The mean intensity and duration of menstrual pain were significantly reduced in the exercise group compared to the control group after eight weeks of isometric exercise intervention. Our results further highlighted the benefits of exercise induced hormonal changes and physiological alteration as has been reported previously. Consequently, women who consistently involve in physical activity might encounter less episodes of dysmenorrhea due to the effects of the hormonal changes on uterine epithelial tissues. Hence, it can be concluded that isometric exercise appears to be an effective non-pharmacological method and provides a significant positive reduction in the intensity and duration of pain of primary dysmenorrhea.

Therefore, participants are recommended to continue performing isometric exercise after the intervention to reduce the negative impact of dysmenorrhea. The authors believe the practical implications of the results have provided a major contribution to overcoming the deficiency of data on the management of PD and physical-related activity. A well-designed and well-executed menstrual health education programme could greatly benefit university students who are already under considerable academic related stress from having proper PD management by practising these exercise protocols. Hence, this would contribute more achievements in the university context.

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Conflicts of interest - The authors declare no conflict of interest.

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