

## Effectiveness of Lemongrass Gel on Pain Intensity and Salivary Cortisol Levels in Adolescent Girls with Primary Dysmenorrhea

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### ABSTRACT

**Background:** Primary dysmenorrhea is menstrual pain caused by increased prostaglandins, which cause excessive uterine contractions. This condition is often experienced by adolescent girls and can cause stress and increased cortisol levels. One safe and easy-to-use non-pharmacological treatment is lemongrass gel (*Cymbopogon citratus*), which contains essential oils such as citral and geraniol, which have analgesic, anti-inflammatory, and antispasmodic properties. The purpose of this study was to determine the effectiveness of lemongrass gel on pain intensity and salivary cortisol levels in adolescent girls with primary dysmenorrhea.

**Subjects and Method:** This was a randomized controlled trial. The study location was State Vocational High School 11 of Semarang. Data collection was conducted from June to July 2025. The intervention group was given 2 grams of 5% lemongrass gel twice daily for 3 days, and the control group was given hot cream. The dependent variables studied were pain intensity and salivary cortisol levels, while the independent variables were lemongrass gel and analgesic cream (Hot Cream®). The analysis technique used a paired sample t-test.

**Results:** The mean pain intensity in the intervention group after being given lemongrass gel was lower (Mean= 2.55; SD= 1.15) compared to before the intervention (Mean= 8.30; SD= 1.13) and was statistically significant ( $p < 0.001$ ). The average salivary cortisol level in the intervention group after being given lemongrass gel was lower (Mean= 12.15; SD= 3.30) compared to before the intervention (Mean= 21.91; SD= 8.05) and was statistically significant ( $p=0.008$ ).

**Conclusion:** The application of 5% lemongrass gel was proven to be effective in reducing pain intensity and salivary cortisol levels in adolescent girls with primary dysmenorrhea, making it a safe and practical non-pharmacological therapy alternative.

**Keywords:** Lemongrass gel, menstrual pain, salivary cortisol levels, female adolescent

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## BACKGROUND

Adolescence, characterized by accelerated physical, emotional, mental, and social development, is a period of transition from childhood to adulthood. Adolescents experience significant physical changes, including growth spurts such as increases in height and length, which significantly impact their mental development. In adolescents, menstruation is a secondary sexual characteristic after the reproductive organs begin to function (marked by menstruation in girls), and some adolescents experience menstrual problems, such as dysmenorrhea or painful menstruation (Idaningsih and Oktarini, 2020).

Dysmenorrhea is pain that occurs during menstruation, with severity varying from woman to woman. Some women experience only mild discomfort, while others experience severe pain that interferes with daily activities. This pain is generally cramp-like and centered in the lower abdomen. Furthermore, dysmenorrhea is often accompanied by other symptoms such as nausea, vomiting, headaches, dizziness, and even fainting (Wildayani et al., 2023).

Dysmenorrhea in adolescents is generally caused by hormonal imbalances as they adjust to the new menstrual cycle. Besides causing physical pain, this condition can also interfere with daily activities, trigger physical and emotional stress, and increase cortisol levels. Beyond hormonal factors, dysmenorrhea can also be influenced by stress levels, an unhealthy lifestyle, and medical conditions such as endometriosis, which can worsen pain and increase psychological distress in adolescents (Pujiati, 2024).

According to the World Health Organization (WHO), in 2022, the incidence of dysmenorrhea worldwide was 1,769,425 (90%), with 10-15% of adolescents experiencing severe dysmenorrhea. Adolescents most

frequently experience dysmenorrhea in European countries, with an average prevalence of 45-97% of women, with the lowest prevalence in Bulgaria (8.8%) and the highest, reaching 94% in Finland (Fauziah et al., 2024).

In Indonesia, the incidence of dysmenorrhea is quite high, namely around 64.25% of women in Indonesia experience dysmenorrhea (Kementerian Kesehatan Republik Indonesia, 2024). In Central Java, according to the report of the Provincial Health Office, the incidence of dysmenorrhea is quite high, namely 56% (Dinas Kesehatan Provinsi Jawa Barat, 2023).

Dysmenorrhea is divided into two types: primary dysmenorrhea and secondary dysmenorrhea. Primary dysmenorrhea is menstrual pain without any associated pelvic pathology. It usually occurs 6-12 months after menarche (the first menstrual period). Secondary dysmenorrhea is menstrual pain associated with various pathological conditions in the genital organs, such as endometriosis, adenomyosis, cervical stenosis, uterine fibroids, irritable bowel syndrome, pelvic inflammatory disease, or pelvic adhesions. Secondary dysmenorrhea can occur at any time during a woman's reproductive years, but most often occurs more than two years after menarche (Swandari, 2023). In Indonesia, there is a high incidence of dysmenorrhea, 54.89% of which is primary dysmenorrhea and 9.36% of which is secondary dysmenorrhea (Maulani et al., 2025). Meanwhile, according to research (Dwimisti et al., 2024) there were 164 (75.2%) female students who experienced primary dysmenorrhea.

Primary dysmenorrhea occurs due to excessive contractions of the uterine muscles triggered by increased levels of prostaglandins, particularly prostaglandin F2 $\alpha$ . Prostaglandin F2 $\alpha$  stimulates uterine contractions, while prostaglandin E inhibits

them. Increased prostaglandin levels occur during the transition from the proliferative phase to the secretory phase, particularly in the first 48 hours of menstruation, resulting in increased menstrual pain. Prostaglandin F<sub>2α</sub> is a major factor in primary dysmenorrhea because it triggers longer and more intense uterine contractions while reducing blood flow to the uterine muscles, which exacerbates menstrual pain (Sumiati and Sakti, 2022).

The factors that cause dysmenorrhea are not all known, but there is research that states that there are several factors that cause dysmenorrhea, namely according to research (Saragih et al., 2024) factors that cause dysmenorrhea include age, menstrual cycle, length of menstruation, family history, exercise or physical activity habits, stress levels and nutritional status.

Untreated dysmenorrhea can lead to pathological conditions, increase mortality, and affect fertility. Furthermore, dysmenorrhea can cause anxiety, discomfort, and feelings of sensitivity in adolescent girls. Untreated dysmenorrhea can lead to decreased enthusiasm for school, difficulty sleeping, and disruption to activities due to pain (Aisyaroh et al., 2022). Meanwhile, according to research from (Wahyuni and Zulfahmi, 2021) Prolonged pain can also trigger chronic stress and increase cortisol hormone levels.

The hormone cortisol plays a role in regulating bodily systems, including the heart, lungs, circulation, metabolism, and immunity, when faced with stress. Cortisol levels are often used as an indicator of stress levels, with higher stress levels leading to higher cortisol levels. If this increase persists, it can disrupt hormonal balance, trigger sleep disturbances, mood swings, and increase the risk of anxiety and depression. Left untreated, primary dysmenorrhea can also increase pain sensitivity

due to changes in the central nervous system, making the body more susceptible to pain later in life. This condition can worsen dysmenorrhea symptoms and negatively impact both physical and psychological health. Therefore, appropriate treatment is necessary to relieve pain and prevent long-term effects (Larasati, 2023).

Dysmenorrhea management typically involves pharmacological and non-pharmacological techniques. Pharmacological methods are the first line of treatment for menstrual pain/ dysmenorrhea, aiming to relieve pain. The use of prostaglandin inhibitors reduces menstrual pain/ dysmenorrhea in 80% of patients. Pharmacological therapy is typically used to treat dysmenorrhea because it can act as an analgesic. These include medications such as paracetamol, mefenamic acid, aspirin, and ibuprofen. Side effects of pharmacological therapy typically include gastrointestinal problems such as nausea, vomiting, dyspepsia, diarrhea, and other symptoms that cause irritation of the gastric mucosa, as well as skin erythema and headache. Therefore, non-pharmacological therapy is safer to use because it does not have the side effects of pharmacological therapy (drugs) (Maulani et al., 2025).

Non-pharmacological therapies that are often used include treatments that provide a hot or warm effect on the lower abdomen, which has been proven to be effective in reducing stomach cramps (Nuryanti et al., 2023). A warm compress will provide a warming effect and can increase blood circulation and capillary pressure. This can also relax the uterine muscles and reduce spasms (Khotimah and Lintang, 2022).. According to research (Novitaningsih et al., 2024) warm compresses are given to meet the need for comfort, reduce or eliminate pain, reduce or prevent muscle spasms, and provide

warmth to certain areas (such as the stomach).

One alternative to warm compresses is a lemongrass compress, a traditional non-pharmacological treatment. Lemongrass, scientifically known as *Cymbopogon citratus*, contains essential oils with citral as the main component, a combination of geranial and neral compounds, which gives it its distinctive lemony aroma. In addition to citral, lemongrass essential oil also contains other compounds such as myrcene, limonene, geraniol, and linalool. These compounds have antioxidant properties that can reduce the production of prostaglandins, pain mediators formed through the metabolism of arachidonic acid. Arachidonic acid itself is stored in the phospholipid membranes of cells and is released when inflammatory stimuli occur, thereby triggering prostaglandin synthesis. Because antioxidants play a role in inhibiting prostaglandin biosynthesis, which contributes to pain, the active compounds in lemongrass essential oil have the potential to help relieve menstrual pain and improve blood circulation (Harahap et al., 2024).

According to research (Nurhalimah et al., 2020) Lemongrass compresses have a significant effect on menstrual pain (dysmenorrhea) in female students at the An Nuur University Purwodadi Dormitory. The effect of lemongrass compresses can reduce pain because lemongrass contains essential oils with chemical and pharmacological properties, namely a spicy and warm taste, which can relieve pain or aches with analgesic properties and improve blood circulation. However, the lemongrass compress method has several drawbacks. The compress must be applied immediately after boiling to prevent the essential oils from evaporating, and the process is quite long. This makes this method less practical, especially for adolescents. As an easier

alternative for adolescent girls, namely using lemongrass gel to treat dysmenorrhea.

A gel is a semi-solid system consisting of a suspension made of small inorganic particles or large organic molecules, penetrated by a liquid. Lemongrass gel is intended for topical use. The advantages of gels over other topical preparations are high adhesiveness and non-blocking of pores, thus maintaining pore respiration, easy washing with water, good drug release, and good skin spreadability. Furthermore, lemongrass gel also provides a warm and soothing sensation typical of lemongrass essential oil, which contains compounds such as citral and geraniol that have analgesic, anti-inflammatory, and antispasmodic properties, thus helping to relieve dysmenorrhea pain by reducing muscle contractions and increasing local relaxation in the lower abdominal area (Rinaldi et al., 2021).

Based on the data found, the researcher was interested in conducting a study entitled "effectiveness of lemongrass gel on pain intensity and salivary cortisol hormone levels in adolescent girls with primary dysmenorrhea".

## SUBJECTS AND METHOD

### 1. Study Design

This study used a true experiment and a pretest-posttest with control group design. The research location was State Vocational High School 11 Semarang. Data collection was conducted in June-July 2025.

### 2. Population and Sample

The target population was female students at State Vocational High School 11 Semarang. The total sample size was 40 female students.

### 3. Study Variable

The dependent variables studied were pain intensity and salivary cortisol hormone levels, and the independent variables were

lemongrass gel and analgesic cream (Hot Cream).

#### 4. Operational Definition of Variable

Lemongrass gel, a 5% lemongrass gel made from lemongrass oil emulsion and gel, was administered at 2 grams twice daily for 3 days at the point of pain (suprapubic). Analgesic cream, a hot cream containing methyl salicylate, menthol, and camphor, acts as a counterirritant to produce a warm sensation on the skin and help relieve pain. 2 grams was administered at 2 grams twice daily for 3 days at the point of pain (suprapubic). Pain intensity was measured before and after the intervention to see changes in pain levels. Salivary cortisol levels, a hormone produced by the adrenal glands in response to stress, were measured before and after the intervention.

#### 5. Study Instrument

Pain intensity was measured using the Numeric Rating Scale (NRS) pain scale from 0-10. Salivary cortisol hormone levels were measured using an ELISA KIT.

#### 6. Data Analysis

The data analysis used is Excel and with the help of the SPSS program. The average difference between paired groups was tested using the Paired Sample T-Test.

#### 7. Research Ethics

Research ethics issues, including informed consent, anonymity, and confidentiality,

were carefully addressed throughout the research process. A research ethics approval letter was obtained from the Research Ethics Committee of the Ministry of Health Polytechnic of Semarang, Indonesia, No. 855/EA/F.XXIII.38/2025, on June 18, 2025.

### RESULTS

Table 1. shows the characteristics of respondents, in the age characteristics of both groups all (100%) were 16-19 years old, in the BMI characteristics, most had a thin BMI (60%) in the intervention group and half (50%) had a thin BMI in the control group, the characteristics of the duration of menstruation in both groups were mostly (85%) had a normal duration of menstruation, the characteristics of the menstrual cycle were mostly had a normal menstrual cycle (60%) in the intervention group and (70%) in the control group, the characteristics of the physical activity of both groups showed that half of the respondents had moderate physical activity (50%), and in the characteristics of the family history of both groups showed that half of the respondents had a family history (50%).

**Table 1. Response Characteristics**

Characteristics	Intervention		Control		p
	N	%	N	%	
Age (years)					-
16-19	20	100.0	20	100.0	
BMI					0.089
Severe underweight	3	15.0	9	45.0	
Underweight	12	60.0	10	50.0	
Normal	3	15.0	0	0.0	
Overweight	2	10.0	1	5.0	
Menstrual period					1.000
Normal	17	85.0	17	85.0	
Abnormal	3	15.0	3	15.0	
Menstrual Cycle					0.784
Short	7	35.0	5	25.0	
Normal	12	60.0	14	70.0	
Long	1	5.0	1	5.0	
Physical activity					1.000



Characteristics	Intervention		Control		p
	N	%	N	%	
Light	5	25.0	5	25.0	1.000
Medium	10	50.0	10	50.0	
Heavy	5	25.0	5	25.0	
Family History					
Yes	10	50.0	10	50.0	
No	10	50.0	10	50.0	

Table 2. shows the analysis of the effect of lemongrass gel on pain intensity. After the intervention, the difference in mean pain intensity reduction in the intervention group (Mean = 5.75; SD = 1.15) was greater than that in the control group (Mean = 1.55; SD = 1.05) and was statistically significant ( $p < 0.001$ ).

Table 3. shows the effect of lemongrass gel on salivary cortisol levels. The difference in mean salivary cortisol levels in the intervention group (Mean = 9.76; SD = 5.92) was greater than that in the control group (Mean = -1.85; SD = 5.76) and was statistically significant ( $p < 0.001$ ).

**Table 2. Analysis of the effect of lemongrass gel on pain intensity in adolescent girls with primary dysmenorrhea**

Pain Intensity	Mean	SD	P	Difference	
				Mean	SD
<b>Intervention</b>					
Pre	8.30	1.13	<0.001	5.75	1.15
Post	2.55	1.15			
<b>Control</b>					
Pre	6.20	1.11	<0.001	1.55	1.05
Post	4.65	1.04			

**Table 3. Analysis of the effect of lemongrass gel on salivary cortisol hormone levels in adolescent girls with primary dysmenorrhea**

Salivary Cortisol Hormone	Mean	SD	p	Difference	
				Mean	SD
<b>Intervention</b>					
Pre	21.91	8.05	0.008	9.76	5.92
Post	12.15	3.30			
<b>Control</b>					
Pre	16.03	4.78	<0.001	-1.85	5.76
Post	17.88	4.75			

## DISCUSSION

### 1. The Effect of Lemongrass Gel on Pain Intensity in Adolescent Girls with Primary Dysmenorrhea

The analysis results showed a significance value of  $p < 0.001$  in both groups, indicating a decrease in pain intensity after treatment. This indicates a difference in pain intensity

reduction between the two groups, thus concluding that lemongrass gel administration is more effective in reducing the pain intensity of primary dysmenorrhea in adolescent girls.

Lemongrass is an effective herb for treating menstrual problems, including abdominal cramps. The essential oils in

lemongrass have chemical and pharmacological properties, including a spicy and warm taste, which act as anti-inflammatory and pain relievers (Sidiq et al., 2025). Women who experience dysmenorrhea typically experience pain that radiates to the lower back, lower back, and thighs, creating challenges in treatment and disrupting daily activities, including school. This menstrual pain causes discomfort that can hinder women's routine activities (Putri et al., 2025).

Topical application of lemongrass gel has been shown to reduce the intensity of menstrual pain through antispasmodic and anti-inflammatory mechanisms. Lemongrass gel works by relaxing uterine muscle contractions and reducing local inflammation, thereby reducing the perception of pain. Previous research has shown that administering lemongrass oil to adolescent girls experiencing dysmenorrhea has been shown to reduce menstrual pain. This is because various chemical compounds contained in lemongrass can provide a warming effect on the stomach, thereby helping reduce blood clots in the uterus, improving blood flow, and reducing pain intensity. After using lemongrass oil, some respondents reported no further dysmenorrhea, which may also be influenced by the initial mild severity of their dysmenorrhea (Khotimah et al., 2021).

Thus, lemongrass gel not only functions as a physical pain reliever, but also provides a psychologically calming effect, making it a safe and effective non-pharmacological alternative for managing primary dysmenorrhea in adolescents.

## **2. The Effect of Lemongrass Gel on Salivary Cortisol Hormone Levels in Adolescent Girls with Primary Dysmenorrhea**

Based on the analysis results,  $p < 0.001$  was obtained in both the intervention and

control groups. This indicates a significant effect before and after administration of lemongrass gel on salivary cortisol levels. Results in the intervention group showed greater changes.

Primary dysmenorrhea is characterized by lower abdominal cramps and pain during menstruation in women with normal pelvic anatomy (Hawari and Triyanti, 2023). Dysmenorrhea can trigger stress and worsen psychological conditions, such as depression and anxiety. Research suggests a possible link between psychological stress and the onset of dysmenorrhea (Sidiq et al., 2025). Stress, anxiety, and depression can directly affect the regulation of the hypothalamus, which plays a role in regulating menstrual function. Disruptions in this regulation can lead to menstrual disorders, including dysmenorrhea (Mivanda et al., 2023).

When an individual experiences stress, cortisol levels increase to help the body adapt to the pressure. The primary function of cortisol is to increase glucose availability to body tissues, particularly the brain and heart. This hormone plays a major role in the body's response to stress (Nuralita et al., 2023). Increased cortisol levels also have the potential to amplify pain perception by influencing the inflammatory response and uterine contractions, making menstrual pain more intense. Previous research has also shown that increased cortisol production leads to a decrease in the number of CD4+ T cells, CD45+ T cells, CD3+ Helper T cells, CD3+ cytotoxic T cells, and CD8+ T cells. This suggests that the level of anxiety experienced by the dysmenorrhea group impacts their immune. Other research by (Fathiyyah et al., 2024) showed that groups with a history of anxiety or other psychological factors tended to produce higher cortisol levels than groups without these factors. This increase in cortisol levels can be considered a manifestation of the

anxiety mechanism in individuals with primary dysmenorrhea.

Lemongrass gel can help reduce menstrual pain through its antispasmodic and anti-inflammatory effects. By reducing uterine contractions and local inflammation, pain perception is reduced, which indirectly lowers the body's stress response and cortisol levels. Therefore, lemongrass gel not only has the potential to reduce physical pain but also helps reduce the psychological burden associated with dysmenorrhea, thus providing a dual effect on both the physiological and psychological aspects of adolescents. This reduction in salivary cortisol levels provides a calming effect on adolescent girls, ensuring their daily activities are not disrupted (Sidiq et al., 2025).

#### **AUTHORS CONTRIBUTION**

In compiling this journal, Nabila Febriana Hadibrata, Sri Sumarni, and Lanny Sunarjo collaborated on the development of the manuscript. Nabila Febriana Hadibrata prepared all research administrative documents (research permits) and data collection. Nabila Febriana Hadibrata, Sri Sumarni, and Lanny Sunarjo analyzed, interpreted, and published the data.

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#### **CONFLICT OF INTEREST**

There was no conflict of interest.

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