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Effectiveness of Red Onion (*Allium cepa L.*) Ointment in Reducing Pain Intensity and Salivary Cortisol Levels Among Adolescent With Primary Dysmenorrhea

Clara Tika Pangesti[1], Sri Sumarni [2], Marsum Marsum[3]
[1]Master of Applied Midwifery, Poltekkes Kemenkes Semarang, Semarang, Indonesia, pangesticlaratika@gmail.com
[2]Midwifery Department, Poltekkes Kemenkes Semarang, Semarang, Indonesia, srissumarnimmid@poltekkes-smg.ac.id
[3]Radiodiagnostic Engineering and Radiotherapy Department, Poltekkes Kemenkes Semarang, Semarang, Indonesia, marsumrahma1963@gmail.com

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ABSTRACT

Primary dysmenorrhea is a common condition among adolescent girls that substantially impairs daily functioning and quality of life, with prevalence reaching 87.8% in Semarang. This study aimed to evaluate the effectiveness of red onion ointment in reducing pain intensity and salivary cortisol levels among adolescents with primary dysmenorrhea. A randomized pretest–posttest-controlled trial group design was conducted involving 36 participants, who were randomly allocated using computer-generated simple randomization into an intervention group (n=18) and a control group (n=18). The intervention group received 2 grams of red onion ointment twice daily during the first three days of menstruation, while the control group received heat cream. Pain intensity was assessed using the Numeric Rating Scale, and salivary cortisol concentration was analyzed in the laboratory. Baseline pain intensity was comparable between groups, whereas baseline salivary cortisol concentration differed significantly. After the intervention, the red onion ointment group showed significantly greater reductions in Δ pain score (3.33±0.49 vs. 0.50±0.51) and cortisol (3.61±2.19 vs. 0.43 ± 3.78) compared with control ($p<0.001$). Effect sizes were very large for pain ($d=5.67$) and large for cortisol ($d=1.03$). These findings demonstrate that red onion ointment effectively reduces primary dysmenorrhea pain and physiological stress. It may serve as a promising complementary therapy although further studies are needed to evaluate long-term safety and broader applicability.

Corresponding Author:

Clara Tika Pangesti
Master of Applied Midwifery, Poltekkes Kemenkes Semarang
Tirto Agung Street, Pedalangan, Banyumanik, Semarang, Central Java, Indonesia. 50268, Phone: (024) 76479189
Email: pangesticlaratika@gmail.com

INTRODUCTION

Dysmenorrhea, defined as menstrual pain occurring during the menstrual phase, commonly presents as cramping pain in the lower abdomen that may radiate to the lower back and thighs.(1) Although often regarded as a normal physiological experience, dysmenorrhea can substantially impair daily functioning, academic performance, and psychological well-being, making it a relevant public health concern. Persistent symptoms may also lead to anxiety, irritability, and emotional exhaustion, particularly among adolescents. Despite its high burden, dysmenorrhea in adolescents remains an underrecognized and undertreated health issue.(2)

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Dysmenorrhea is categorized into primary dysmenorrhea, which occurs without pelvic pathology, and secondary dysmenorrhea, which is associated with gynecological disorders.(3) Primary dysmenorrhea typically emerges within two years after menarche and is driven by excessive prostaglandin production, leading to increased uterine contractions, vasoconstriction, and ischemic pain.(4)

Globally, dysmenorrhea affects 41–94% of reproductive-age women, with 10–16% experiencing severe symptoms.(5) In Indonesia, prevalence reaches 64.25%, including 56% in Central Java and up to 87.8% in Semarang. Various factors such as stress, poor nutrition, sedentary lifestyle, and low social support contribute to symptom severity. Stress activates the hypothalamic–pituitary–adrenal (HPA) axis, increasing cortisol levels, which may further exacerbate primary dysmenorrhea.(6)

Although pharmacological therapies such as NSAIDs and hormonal contraceptives are effective, they may cause adverse effects and are not always suitable for long-term use.(7) Consequently, non-pharmacological therapies are increasingly being explored as alternative pain-management options, including topical agents with physiological effects. However, scientific evidence on the effectiveness of red onion (*Allium cepa L.*)–based topical preparations remains insufficient. To our knowledge, no previous randomized controlled study has simultaneously evaluated the effects of topical *Allium cepa* ointment on both pain intensity and salivary cortisol concentration among adolescents with primary dysmenorrhea. Existing studies are scarce, mostly small-scale, and focus primarily on subjective pain outcomes, with almost no research evaluating objective physiological biomarkers such as salivary cortisol concentration. This gap highlights the need for more rigorous experimental studies to assess the potential of red onion ointment as a safe, effective, and evidence-based non-pharmacological intervention for primary dysmenorrhea.(8)

Among non-pharmacological options, topical herbal therapies are increasingly explored; however, most existing interventions such as heat packs, massage, and aromatherapy, provide only temporary symptomatic relief and do not sufficiently address the underlying physiological mechanisms of dysmenorrhea.(9) These approaches generally rely on subjective pain assessments and rarely target the neuroendocrine component of stress, even though dysmenorrhea is closely influenced by elevated prostaglandin activity and heightened cortisol levels triggered by psychological stress. Because these pathways contribute to uterine hypercontractility, vasoconstriction, and amplified pain perception, therapies capable of modulating both inflammatory and stress responses may offer more comprehensive clinical benefits.(10,11)

Despite this pharmacological potential, scientific evidence on red onion ointment remains very limited, particularly regarding its efficacy in modulating both subjective pain and objective stress-related biomarkers such as salivary cortisol concentration. Existing studies are scarce, small-scale, and predominantly descriptive, leaving a significant research gap. Thus, evaluating onion ointment in an experimental design represents an important contribution in identifying safe, accessible, and physiologically targeted interventions for primary dysmenorrhea.

Given these properties, this study aims to evaluate the effectiveness of red onion ointment in reducing pain intensity and salivary cortisol concentration among adolescent girls with primary dysmenorrhea, as a potential safe, natural, and accessible non-pharmacological therapy.

METHOD

This study employed a randomized pretest–posttest control group design and was conducted at Mardisiswa Senior High School, Semarang City, Indonesia, in June 2025. The minimum sample size was determined using the Lemeshow formula for experimental studies, resulting in a required sample of 36 participants. A total of 60 adolescent girls

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constituted the target population, of whom 40 met the initial eligibility criteria. After applying the inclusion and exclusion criteria and accounting for voluntary withdrawals, 36 participants were enrolled and randomly assigned to the intervention and control groups using a computer-generated simple randomization sequence in a 1:1 ratio. Inclusion criteria included adolescent girls aged 14–17 years with clinically diagnosed primary dysmenorrhea during the previous three menstrual cycles, regular menstrual cycles, and willingness to participate. Exclusion criteria included a history of pelvic disorders or endometriosis. The study used a single-blind procedure, in which participants were unaware of their group allocation, while the investigators administering the intervention were informed due to the distinguishable characteristics of the ointments.

The intervention group received 2 grams of a standardized red onion ointment formulated at a 5% w/w concentration, prepared through maceration of fresh red onion bulbs in a neutral hydrophilic ointment base (consisting of white petrolatum, emulsifying wax, and purified water). The red onion (*Allium cepa L.*) ointment was formulated and prepared by the research team following a standardized formulation protocol to ensure consistency across all batches. The preparation underwent basic quality control, including organoleptic evaluation (colour, odor, and texture), pH measurement, homogeneity assessment, and microbial limit testing before use. However, no quantitative phytochemical analysis or standardization of active constituents, such as total flavonoids or quercetin, was performed. The ointment was applied topically to the lower abdomen (approximately a 5 × 10 cm suprapubic area) twice daily (every 12 hours) for three consecutive days during menstruation, accompanied by gentle circular massage for 3–5 minutes to enhance absorption. A 24-hour occlusive skin patch test was performed on the volar forearm before treatment to assess individual tolerance and exclude hypersensitivity reactions. The control group received a placebo cream with a similar colour, texture, and application procedure to minimize expectancy bias.

Pain intensity was measured using the 11-point Numeric Rating Scale (0–10), an instrument widely validated for clinical and adolescent populations, with strong construct validity and high test–retest reliability *(r = 0.83; Hawker et al., 2011)*. Salivary cortisol concentrations (µg/dL) were measured using a commercially available Cortisol Saliva enzyme-linked immunosorbent assay (ELISA) kit (Diagnostics Biochem Canada Inc., London, Ontario, Canada; REF CAN-C-240; Lot No. 250160) according to the manufacturer's instructions. Saliva samples were collected on day one (pretest) and day three (posttest) of menstruation between 07:00 and 10:00 a.m. to minimize the effects of diurnal variation. Following collection, samples were immediately stored at −20°C for a maximum of 7 days before analysis. During transportation, all samples were maintained at ≤4°C in a temperature-controlled cold box to preserve sample integrity. Laboratory analysis was performed within 24 hours after thawing in accordance with the manufacturer's protocol. This study was reported in accordance with the CONSORT 2010 Statement.

Data were analysed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA Normality was assessed using the Shapiro–Wilk test, which indicated that both pain intensity and salivary cortisol concentration data were not normally distributed. Therefore, nonparametric statistical tests were applied. Within-group comparisons (pretest vs. posttest) were performed using the Wilcoxon signed-rank test, while between-group comparisons were conducted using the Mann–Whitney U test. A p-value < 0.05 was considered statistically significant. Effect sizes were calculated using Cohen’s d. Cohen's d was calculated based on standardized mean differences of change scores.

This study obtained ethical clearance from the Research Ethics Committee of Poltekkes Kemenkes Semarang (No. 916/EA/F.XXIII.38/2025). Written informed consent was obtained from all participants, accompanied by parental or guardian consent due to the adolescent status of the participants. In addition, formal permission was secured from the school authorities before data collection. All procedures adhered to the ethical principles of

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beneficence, respect for persons, and justice, ensuring voluntary participation, participant safety, and confidentiality.

RESULTS

Participant Characteristics

A total of 60 adolescent girls were screened for eligibility. Of these, 40 met the inclusion criteria, and 36 participants completed the study and were included in the final analysis, with 18 participants allocated to the intervention group and 18 to the control group.

Baseline Characteristics

Baseline characteristics of the participants and confounding variables included respondent characteristics such as age, BMI (body mass index), menstrual duration, history of dysmenorrhea, physical activity, and sleep quality. A descriptive analysis of these characteristics was conducted, and the results are presented in Table 1.

Table 1. Baseline characteristics of adolescent girls with primary dysmenorrhea in the intervention and control groups

Characteristics	Group				*p-value*
	Intervention		Control		
	n	%	n	%	
BMI					1.000*
Normal: 18.5 – 25 kg/m^2	14	77.8	15	83.3	
Abnormal: <18.5 or > 25 kg/m^2	3	16.7	3	16.7	
Menstrual duration					1.000*
Normal: 3-7 days	14	77.8	14	77.8	
Abnormal: <3 days or > 7 days	4	22.2	4	22.2	
Menstrual Cycle Length					0.088*
Normal: 21-35 days	11	61.1	8	44.4	
Abnormal: <21 or > 35 days	7	38.9	10	55.6	
History of dysmenorrhea					1.000*
Yes	11	61.1	11	61.1	
No	7	38.9	7	38.9	
Physical activity					0.717*
Light: < 600 METs-min/week	4	22.2	2	11.1	
Moderate: 600 – 3000 METs-min/week	10	55.6	15	83.3	
Vigorous: > 3000 METs –min/weeks	4	22.2	1	5.6	

**Chi Square Test*

Table 1 shows that the intervention and control groups were comparable across all baseline characteristics, with no statistically significant differences between groups (all $p > 0.05$). Most participants in both groups had a normal BMI (77.8% in the intervention group and 83.3% in the control group) and reported a normal menstrual duration of 3–7 days (77.8% in each group). Similarly, menstrual cycle length, history of dysmenorrhea, and physical activity levels were comparable between groups, indicating good baseline homogeneity.

To evaluate the effectiveness of the 5% red onion (*Allium cepa L.)* ointment intervention, both descriptive and inferential statistical analyses were performed. Normality testing using the Shapiro–Wilk test showed that the data were not normally distributed ($p < 0.05$); therefore, nonparametric statistical methods were applied. The Wilcoxon signed-rank test was used to assess within-group changes in pain intensity and salivary cortisol concentration, while between-group comparisons were analysed using the Mann–Whitney U test. A significance threshold of $p < 0.05$ with a 95% confidence interval (CI) was applied.

To enhance interpretability of the findings, effect sizes (r) were calculated for both within-group and between-group differences. Mean change scores (Δ) with corresponding

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95% confidence intervals were also reported to provide insight into the magnitude and clinical relevance of the intervention effects.

Pain Intensity

Changes in pain intensity following the intervention are presented in Table 2 and Figure 1.

Table 2. Comparison of Pain Intensity between the Intervention and Control Groups

Variable	Data	Group		*p-value*
		Intervention (n: 18)	Control (n: 18)	
		Mean ± SD	Mean ± SD	
Pain intensity	Pretest	4.28 ± 1,074	3.67±0.767	0.079**
	Post test	0.94 ± 0,725	3.17 ± 0.707	0.000**
p-value		0.000*	0.000*	
	Δ	3.33±0.485	0.50±0.514	0.000**

** Wilcoxon Signed-Rank Test **Mann-Whitney U Test*

At baseline, there was no statistically significant difference in pain intensity between the intervention and control groups (4.28 ± 1.07 vs. 3.67 ± 0.77; $p = 0.079$). Following the intervention, the mean pain score decreased to 0.94 ± 0.73 in the intervention group, whereas the control group showed a posttest mean score of 3.17 ± 0.71, resulting in a significant between-group difference ($p < 0.001$). Within-group analysis using the Wilcoxon signed-rank test demonstrated significant reductions in pain intensity from pretest to posttest in both groups (both $p < 0.001$). However, the mean reduction was substantially greater in the intervention group than in the control group (Δ = 3.33 ± 0.49 vs. 0.50 ± 0.51; $p < 0.001$).

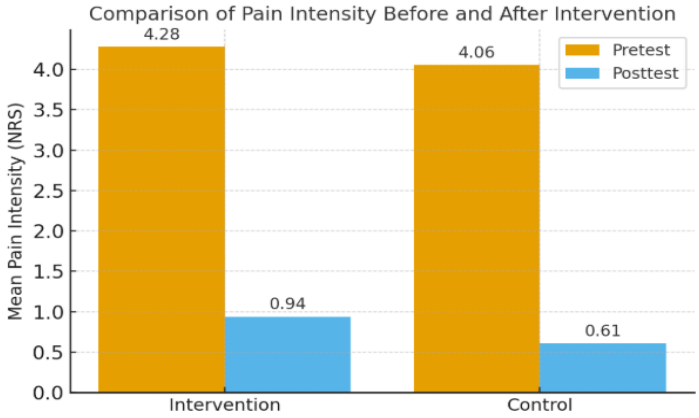

Figure 1. Changes in Mean Pain Intensity Before and After the Intervention in the Intervention and Control Groups.

Figure 1 illustrates the changes in mean pain intensity before and after treatment. The intervention group showed a marked decline in pain scores, whereas only a slight reduction was observed in the control group.

Salivary Cortisol Levels

Changes in salivary cortisol concentrations are presented in Table 3 and Figure 2.

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Table 3. Comparison of Salivary Cortisol Concentration Between the Intervention and Control Groups

Variable	Data	Group		P-value
		Intervention (n: 18)	Control (n: 18)	
		Mean ± SD	Mean ± SD	
Salivary Cortisol Concentration	Pretest	16 ± 7.56	10.01 ± 5.7	0.012**
	Post test	12.38±6.06	10.4 ± 4.71	0.402**
P-value		0.000*	0.795*	
	Δ	3.61±2.19	0.433±3.78	0.000**

** Wilcoxon Signed-Rank Test **Mann-Whitney U Test*

Baseline salivary cortisol concentrations differed significantly between groups, with higher values observed in the intervention group than in the control group (16.00 ± 7.56 vs. 10.01 ± 5.70 µg/dL; p = 0.012). Following the intervention, mean salivary cortisol levels decreased to 12.38 ± 6.06 µg/dL in the intervention group, representing a significant within-group reduction (p < 0.001). In contrast, no statistically significant change was observed in the control group, whose cortisol levels changed from 10.01 ± 5.70 µg/dL to 10.40 ± 4.71 µg/dL (p = 0.795). Comparison of the mean changes demonstrated a significantly greater reduction in salivary cortisol levels in the intervention group than in the control group (Δ = 3.61 ± 2.19 vs. 0.43 ± 3.78; p < 0.001).

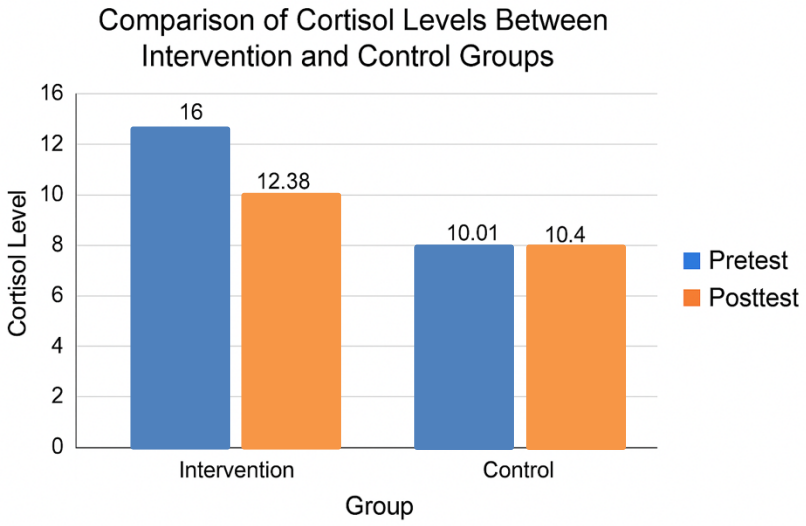

Figure 2. Changes in Mean Salivary Cortisol Levels Before and After the Intervention in the Intervention and Control Groups.

Figure 2 presents the changes in salivary cortisol concentrations before and after treatment. A marked decline was observed in the intervention group, whereas cortisol levels remained relatively unchanged in the control group.

Effect Size Analysis

The magnitude of the intervention effect is summarized in Table 4.

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Table 4. Effect Size Analysis of Pain Intensity and Salivary Cortisol Concentration between the Intervention and Control Groups

Variable	Intervention	Control	Cohen's d	Interpretation
	Δ Mean ± SD			
Pain Intensity	3.33±0.485	0.50±0.514	5.67	Very Large Effect
Salivary Cortisol Concentration	3.61±2.19	0.433±3.78	1.03	Large Effect

The results in Table 4 show based on Cohen's *d*, the intervention demonstrated a very large effect on pain intensity (Cohen's *d* = 5.67). For salivary cortisol, the intervention produced a large effect size (Cohen's *d* = 1.03). These findings indicate substantial differences in outcome changes between the intervention and control groups.

DISCUSSION

This study demonstrated that 5% red onion (*Allium cepa L.*) ointment was more effective than hot cream in reducing pain intensity among adolescents with primary dysmenorrhea. Participant in the intervention group experienced a significantly greater reduction in pain scores than those in the control group, with a very large clinical effect (Cohen's d = 5.67), indicating that the observed difference was not only statistically significant but also clinically meaningful. These findings suggest that topical red onion ointment has considerable potential as a complementary non-pharmacological intervention for managing primary dysmenorrhea.

The analgesic effect observed in this study of red onion ointment may be associated with its bioactive compounds, including allyl propyl disulfide, diallyl disulfide, cycloallyl disulfide, and quercetin, which function as natural analgesics and anti-inflammatory agents. Previous experimental studies have shown that these compounds possess anti-inflammatory and antioxidant properties and may reduce cyclooxygenase (COX) activity and prostaglandin synthesis, thereby decreasing uterine hypercontractility and pain perception.(9) Although these biological pathways were not directly measured in the present study, they provide a plausible explanation for the greater reduction in pain observed in the intervention group.

In addition to its anti-inflammatory action, topical red onion ointment may enhances local microcirculation through mild vasodilation, reduces uterine smooth muscle spasms, and alleviates myometrial ischemia caused by excessive contractions.(12) Activation of thermal receptors (TRPV1) by its essential oil components produces a warming sensation that increases tissue perfusion and oxygenation, thereby reducing the accumulation of pain mediators such as bradykinin and prostaglandins.(13) This mechanism are consistent with previous reports demonstrating that topical warming therapies can effectively reduce primary dysmenorrhea by improving blood flow and decreasing nociceptive stimulation. (14)

Beyond pain reduction, the present intervention in this study also demonstrated a significant decrease in salivary cortisol levels (p = 0.000) following treatment with red onion ointment, indicating modulation of physiological stress associated with menstrual pain. The cortisol-lowering effect may be attributed to decreased sympathetic nervous system activation and downregulation of the hypothalamic–pituitary–adrenal (HPA) axis, along with sedative and relaxation effects from volatile onion compounds that promote parasympathetic dominance.(15) The aromatic properties of the essential oils engage the limbic system, contributing to emotional relaxation and reduced systemic stress responses. (9)

The findings of this study demonstrate a mean pain reduction of 3.33 points in the intervention group, which is greater than reductions reported in several previous non-pharmacological studies. For example, a study using aromatherapy among adolescents reported an average decrease of 2.4–2.9 points, whereas the current intervention achieved

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a higher reduction, suggesting that red onion ointment may provide a stronger analgesic effect.(16) Similarly, a trial involving heat-based topical therapy among 60 adolescent girls in India showed a mean decrease of 4.5 points, slightly higher than the reduction observed in this study; however, that intervention produced only short-term relief (15–30 minutes), whereas the red onion ointment demonstrated sustained improvement over three days, indicating a longer therapeutic duration.(17)

Compared with studies evaluating plant-based topical agents, the superior effect in this study may be attributed to the combined anti-inflammatory and circulatory-enhancing properties of quercetin, kaempferol, and sulfur compounds, which directly inhibit prostaglandin synthesis while improving local blood flow.(14) These mechanisms provide a plausible explanation for the more substantial and consistent reduction in pain scores observed here.(18) However, because inflammatory mediators such as prostaglandins, cytokines, or oxidative stress biomarkers were not measured, the proposed mechanisms remain hypothetical and require confirmation in future mechanistic studies.

In contrast, participant receiving hot cream experienced only a modest reduction and no significant change in salivary cortisol levels. These findings are consistent with previous evidence that capsaicin or menthol-based creams produce primarily peripheral analgesia through vasodilation, TRPV1 activation, and gate-control pathways.(19) Importantly, the current study revealed no significant reduction in cortisol levels in the control group ($p = 0.795$), in agreement with prior studies reporting that hot creams do not modulate neuroendocrine stress responses.(20) The absence of a significant cortisol reduction in the control group further supports the possibility that the intervention may exert broader physiological effects beyond localized pain relief, although this interpretation should be confirmed in future studies using more comprehensive biomarker assessments.

From a clinical perspective, these study demonstrates that red onion (*Allium cepa L.*) ointment may be considered as a complementary intervention for primary dysmenorrhea in adolescents. Its dual effect on reducing menstrual pain and lowering salivary cortisol suggests benefits on both inflammatory and neuroendocrine pathways. This makes it applicable for integration into midwifery practice, school health programs, and primary care as a low-cost, accessible intervention that supports adolescent menstrual health. Nevertheless, its clinical implementation should await confirmation from larger randomized controlled trials evaluating both efficacy and safety.

This study has several limitations. First, the relatively small sample size and single-center design limit the generalizability of the findings. Second, the short intervention period precludes conclusions regarding long-term effectiveness or recurrence of dysmenorrhea symptoms. Third, pain intensity was assessed using self-reported measures, which are inherently subjective and susceptible to response bias. Fourth, inflammatory mediators such as prostaglandins, cytokines, and oxidative stress biomarkers were not evaluated, preventing direct confirmation of the proposed biological mechanisms. Fifth, the absence of a placebo ointment made complete participant blinding difficult because of the characteristic odor of red onion, potentially introducing expectancy effects. Importantly, baseline salivary cortisol levels differed significantly between the intervention and control groups before treatment. Although the analysis of change scores demonstrated a significantly greater reduction following the intervention, this baseline imbalance may have influenced the interpretation of treatment effects. Therefore, these findings should be interpreted with caution and confirmed in future randomized trials with better baseline equivalence and larger sample sizes.

Future research should employ multicenter, double-blind, placebo-controlled randomized controlled trials involving larger and more diverse populations. Additional studies should investigate optimal dosage, treatment duration, long-term safety, recurrence of symptoms, quality of life, and comparisons with standard pharmacological therapies such as nonsteroidal anti-inflammatory drugs (NSAIDs). Furthermore, incorporating objective

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biomarkers, including prostaglandins, inflammatory cytokines, heart rate variability, and oxidative stress markers, would help clarify the biological mechanisms underlying the therapeutic effects of red onion ointment.

To our knowledge, this study is among the first to evaluate topical red onion (*Allium cepa* L.) ointment using both subjective pain assessment and an objective physiological stress biomarker. By simultaneously evaluating pain intensity and salivary cortisol, this study provides a broader understanding of the potential therapeutic effects of red onion ointment than previous studies focusing solely on subjective pain outcomes. These findings contribute preliminary evidence supporting the development of red onion ointment as a complementary therapy for primary dysmenorrhea and provide a rationale for future clinical investigations.

CONCLUSION

Red onion (*Allium cepa L.*) ointment was more effective than topical heat cream in reducing both pain intensity and salivary cortisol levels among adolescents with primary dysmenorrhea. The intervention demonstrated a very large effect on pain reduction and a large effect on lowering salivary cortisol, suggesting potential benefits for both symptom relief and physiological stress modulation. During the intervention period, the ointment appeared to be well tolerated and may represent a promising complementary non-pharmacological option for managing primary dysmenorrhea in adolescents. Nevertheless, given the relatively small sample size and short follow-up period, larger multicenter randomized controlled trials with longer observation periods are required to confirm its safety, optimal dosage, long-term effectiveness, and comparative efficacy against other established non-pharmacological and pharmacological interventions.

AUTHOR CREDIT STATEMENT

CTP is responsible for the idea, design, and writing. **SS** was involved in methodology, analysis, and manuscript editing. **MM** handles project administration, data validation, supervision.

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DECLARATION OF COMPETING INTEREST

There is no conflict of interest.

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