# Dark chocolate as a non-pharmacological alternative to reduce dysmenorrhea in adolescents

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## Abstract

Dysmenorrhea, menstrual pain often experienced by women of reproductive age, including teenage girls, can cause discomfort and hinder daily activities, necessitating treatment. Chocolate contains copper, which synthesizes neurotransmitters like collagen and endorphins, serving as an analgesic and natural sedative to alleviate pain. This study aimed to assess the effect of dark chocolate on reducing dysmenorrhea in adolescents. This study employed a quasi-experimental research design and was conducted over six months at a polytechnic in Bandung. Pain intensity was measured using a standardized instrument known as the WALIDD score. A total of forty students with primary dysmenorrhea participated in the study, selected through purposive sampling, and were divided into a treatment group and a control group. The independent variables included the administration of dark chocolate, while the dependent variable was the intensity of menstrual pain in students with primary dysmenorrhea. Data were analyzed using an independent t-test. The intervention group, which received education on menstruation and dark chocolate, exhibited a significant reduction in dysmenorrhea pain as early as the second day, with a p-value of <0.001. Administering dark chocolate at a dosage of 35 mg/day from the onset of menstruation helps reduce pain from the first day of menstruation compared to standard therapy, which includes education about menstruation. Chocolate enhances mood due to its copper content, releasing endogenous morphine that inhibits pain impulses. This makes chocolate a non-pharmacological alternative for alleviating dysmenorrhea.

## Introduction

Dysmenorrhea is primarily caused by an imbalance of the hormone progesterone in the blood.[1–3] Studies suggest that 16.8-81% of women may experience dysmenorrhea.[4,5] A preliminary study conducted at a public junior high school in Bandung found that 6 out of 10 female students had encountered menstrual pain (dysmenorrhea), which caused discomfort, abdominal pain radiating to the pelvis, and hindered their school performance.[2] Dysmenorrhea is prevalent globally, with examples such as the UK, where 41-97% of cases were reported, and Sweden, where 72% of respondents aged 19 experienced dysmenorrhea, with 15% of them being unresponsive to analgesics.[1,3] The global prevalence of dysmenorrhea ranges from 20-90%, with 52.4-85.7% in Europe and America and 58.8-84.9% in Asia.[6]

The cause of dysmenorrhea is an imbalance of the hormone

progesterone in the blood.[7] Women with dysmenorrhea produce significantly more prostaglandins than those without, leading to heightened uterine contractions and intestinal activation at excessive levels. Other causes include underlying conditions such as endometriosis, pelvic infections, uterine tumors, appendicitis, gastrointestinal disorders, and kidney issues.[1,8]

To alleviate the painful symptoms of dysmenorrhea, various approaches have been attempted, including the use of pain-relieving medications such as mefenamic acid, ibuprofen, and metamphyron.[9] Nonsteroidal anti-inflammatory drugs (NSAIDs) and combined oral contraceptive pills are common pharmacological treatments. NSAIDs work by inhibiting prostaglandin production and have been found to be significantly more effective in relieving pain than placebos (OR 7.91; 95% CI 5.65-11.09).[1,6] However, long-term use of analgesics can lead to dependence and potentially cause liver damage and hypertension.[10] Hence, there is a need for alternative pain management methods that don't rely on synthetic analgesic drugs.

Non-pharmacological methods can be employed for pain management, such as relaxation, hypnotherapy, warm water compresses, regular exercise, yoga, distraction, massage,[2,11–14] and the consumption of foods that trigger the release of endorphins, such as chocolate.[15–18] Chocolate is rich in vitamins A, B1, C, D, and E, as well as phenol and flavonoid antioxidants. It also contains essential minerals like calcium, potassium, and iron, along with omega-3 and omega-6 fatty acids, and high levels of magnesium, which can alleviate menstrual pain and premenstrual symptoms in women.[15,18] Chocolate has numerous benefits for the body, including mood enhancement and a rich content of vitamins and minerals that stimulate the release of endorphins.[16] Dark chocolate, in particular, is known for its higher cocoa content, which contributes to its anti-inflammatory properties, making it a potential pain reducer.[19] It is favored by many, especially teenagers, for its pleasant taste and its ability to stimulate the release of serotonin, inhibit pain pathways in the spinal cord, and generate endorphins, thereby activating the brain's analgesia system by inhibiting prostaglandins.[17] Chocolate contains copper, which the body uses to synthesize collagen and neurotransmitters, including endorphins. Endorphins are natural analgesics and tranquilizers that can reduce pain intensity, such as menstrual pain.[15–18] The purpose of this study was to evaluate the effect of dark chocolate on reducing dysmenorrhea.

## Matrials and Methods

### Research design

This research is of an analytical nature and aims to analyze the effect of dark chocolate in reducing dysmenorrhea using a quasi-experimental pretest-posttest control group design. The study examines the age characteristics and BMI of the participants who experience dysmenorrhea and investigates the differences in pain intensity reduction among adolescents with dysmenorrhea who receive education alone and those who receive education and dark chocolate. It also analyzes the variations in the number of days required to reduce pain intensity in these two groups.

### Study participants

The subjects of this study were young women aged 17-21 years at the one polytechnic in Bandung, West Java. The target population in this study were all adolescents at the one polytechnic in Bandung who experienced primary dysmenorrhea. Sampling obtains a purposive sampling technique. The sample size in this study was calculated based on formula for unpaired numerical analytical research uses the two-average hypothesis test. The minimum sample size required in this study is ten respondents. To anticipate the loss of follow-up, researchers took a sample size for each group of 20 people. The total respondents who were included in this study were 40 people. The inclusion criteria are defined as follows: students of polytechnics in Bandung who experience dysmenorrhea with a score of > 5 (WaLLID maximum score of 12). The WaLIDD score is an instrument used to measure dysmenorrhea pain by modifying the Wong-Baker Face instrument designed and validated to assess pain in pediatric populations, which has also proven useful in investigations involving adult populations with or without abdominal pain. WaLIDD is a combination of manifestations, subjective (intensity, work ability), and objective (days of pain, location), characteristics that often appear when dysmenorrhea manifests. The WaLIDD score contains three frequently used criteria identified in existing definitions of dysmenorrhea in the literature: pain days (D), work ability (Wa), and anatomic region of pain location (L). Thus, the WaLIDD scores demonstrated acceptable internal consistency (Cronbach's alpha = 0.723).[2,20] The inclusion criteria for this research sample were as follows: Dysmenorrhea is felt every cycle for at least the last three months; regular menstrual cycle 21-35 days, adolescents aged 17-21 years, primary dysmenorrhea, Body Mass Index 18-25 kg/m$^2$, willing to be a respondent. The exclusion criteria are if respondents have other diseases that cause dysmenorrhea or allergy to eat chocolate. The inclusion criteria for this research sample were as follows: Dysmenorrhea is felt every cycle for at least the last three months; regular menstrual cycle 21-35 days, adolescents aged 17-21 years, primary dysmenorrhea, Body Mass Index 18-25 kg/m$^2$, willing to be a respondent. The exclusion criteria are if respondents have other diseases that cause dysmenorrhea or allergy to eat chocolate.

### Variable, instrument and data collection

The independent variable in this study is the pain intensity of dysmenorrhea, while the dependent variables are the consumption of dark chocolate and dysmenorrhea education. Pain intensity was measured using the WALIDD score questionnaire, which has been validated and deemed reliable. The questionnaire employs a scale ranging from 0 to 12.[20]

In the intervention group, participants received education on managing dysmenorrhea pain and were provided with a package of 35 grams of 72% dark chocolate to be consumed during the first 5 days of menstruation. The control group, on the other hand, received only education on managing dysmenorrhea pain.

Data for this study were collected using a Google Form questionnaire, with enumerators assisting in the research process. Enumerators played a role in the research preparation, data tabulation, preparation of educational materials on menstruation and dysmenorrhea, and delivery of these materials. To ensure that participants experiencing menstrual pain only consumed dark chocolate, information about dysmenorrhea and the use of dark chocolate was provided initially. Enumerators maintained contact with participants daily to record dark chocolate consumption and verify the absence of other pain reduction techniques.

### Data analysis

Data were analyzed using SPSS for Windows version 26. Bivariate analysis was conducted to assess the impact of the independent variables on the dependent variables. An unpaired parametric test, the independent t-test, was employed if the data followed a normal distribution. If normal distribution assumptions

were not met, the Mann-Whitney test was used. The researchers made statistical decisions with a significance level (α) of 0.05.

### Ethical clearance

The research received ethical approval from the Health Research Ethics Committee at the Health Polytechnic of the Ministry of Health in Bandung, as evidenced by ethical certificate 21/KEPK/IX/2020. Throughout the study, the researchers adhered to ethical principles, including informed consent, respect for human rights, beneficence, and non-maleficence.

## Results

An overview of the characteristics of adolescents who experience dysmenorrhea based on age, age at menarche, and BMI at the Poltekkes Kemenkes Bandung can be seen in Table 1.

Table 1 presents the results of the statistical tests conducted using the Mann-Whitney Test at a 95% confidence level. The analysis indicates that there is no significant difference in the characteristics of the research subjects based on age between the group administered dark chocolate in the morning (AM) and the control group. The p-value obtained is 0.675, which is greater than the 0.05 significance level (p>0.05). Similarly, there is no significant difference in the characteristics of research subjects based on BMI between the group given dark chocolate and the control group, with a p-value of 0.675 (p>0.05).

These results indicate that the research subjects in both groups, the one administered dark chocolate in the morning and the control group, exhibited similar age and BMI characteristics. The characteristics based on age and BMI were found to be homogeneous between these two groups, as the p-values were greater than 0.05. This homogeneity in subject characteristics allows for further analysis to determine the effectiveness of providing dark chocolate in reducing pain intensity in adolescents with dysmenorrhea.

Table 2 displays the results of the statistical tests conducted using the Wilcoxon Sign Rank Test at a 95% confidence level. The analysis reveals a significant difference in pain intensity among dysmenorrhea adolescents before and after they were administered dark chocolate. The p-value obtained is less than 0.001 (p<0.001), which is less than or equal to the 0.05 significance level (p≤0.05).

This significant difference in pain intensity before and after the administration of dark chocolate suggests that dark chocolate had a noticeable impact on reducing pain intensity in dysmenorrhea adolescents. The results indicate that the intervention with dark chocolate effectively led to a decrease in pain intensity.

Table 3 shows that the results of the statistical tests using the Wilcoxon Sign Rank Test at a 95% confidence level indicate a significant difference in pain intensity in the control group of dysmenorrhea adolescents before and after the intervention. The p-value obtained is less than 0.001 (p<0.001), which is less than or equal to the 0.05 significance level (p≤0.05). This significant difference suggests that there was a noticeable impact on reducing pain intensity in dysmenorrhea adolescents in the control group after the intervention.

Table 4 shows that the results of the statistical tests using the Friedman Test at a 95% confidence level show a significant difference in pain intensity among dysmenorrhea adolescents who were administered dark chocolate from the beginning of the intervention through day 5. The p-value is less than 0.001 (p<0.001), indicating that the pain intensity changed significantly over the five-day period (p≤0.05).

Table 5 shows that the results of the statistical tests using the Friedman Test at a 95% confidence level reveal a significant difference in pain intensity among dysmenorrhea adolescents who did not receive dark chocolate from the beginning, through day 1, and



**Table 1.** Characteristics of research subjects between the group given dark chocolate and the control group in adolescents with dysmenorrhea.

| Variable | Intervention dark chocolate (n=20) | | | | Control (n=20) | | | | p |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Md | Min-Max | Mean | SD | Md | Min-Max | |
| Age | 19.75 | 0.71 | 20 | 19-21 | 19.60 | 0.59 | 20.00 | 19-21 | 0.675 |
| BMI | 20.58 | 1.97 | 20 | 18.00-24.97 | 20.87 | 1.99 | 20.78 | 18.00-24.98 | 0.675 |

*Mann Whitney test.

**Table 2.** Comparison of pain intensity before and after giving dark chocolate to dysmenorrhea adolescents.

| Variable | Intervention dark chocolate group | | | | | | | | p* |
|---|---|---|---|---|---|---|---|---|---|
| | Before | | | | After | | | | |
| | Mean | SD | Md | Min-Max | Rerata | SD | Md | Min-Max | |
| Pain intensity | 6.50 | 0.60 | 6 | 6-8 | 0.45 | 0.94 | 0 | 0-4 | <0.001 |

* Wilcoxon sign rank test.

**Table 3.** Comparison of pain intensity before and after giving dark chocolate in adolescents with dysmenorrhea.

| Variable | Control group without dark chocolate | | | | | | | | p* |
|---|---|---|---|---|---|---|---|---|---|
| | Before | | | | After | | | | |
| | Mean | SD | Md | Min-Max | Rerata | SD | Md | Min-Max | |
| Pain intensity | 6.50 | 0.68 | 6 | 6-8 | 0.45 | 1.09 | 0 | 0-4 | <0.001 |

* Wilcoxon sign rank test.

up to day 5. The p-value obtained is less than 0.001 ($p<0.001$), indicating that the pain intensity changed significantly over the five-day period ($p\leq0.05$).

Table 6 presents the results of the statistical tests conducted using the Mann-Whitney Test at a 95% confidence level. The analysis indicates that there is no significant difference in initial pain intensity in dysmenorrhea adolescents between the group administered dark chocolate and the control group. The p-value obtained is 0.877, which is greater than the 0.05 significance level ($p>0.05$). However, it's worth noting that significant differences emerged after specific time intervals in the intervention and control groups. After the second day in the intervention group and after the third day in the control group, significant differences in pain intensity were observed. This suggests that in the intervention group, which received education and consumed dark chocolate, a quicker reduction in pain intensity was experienced compared to the control group, where pain reduction became significant after the third day.

## Discussion

The primary finding of this study suggests that the consumption of dark chocolate containing 72% cocoa led to a significant reduction in experimentally induced pain among adolescent girls with dysmenorrhea. The study initially selected respondents with moderate and severe pain intensity using the WaLLID score instrument and divided them into an intervention group, which received education about dysmenorrhea and consumed 72% dark chocolate daily for five days, and a control group, which only received education about dysmenorrhea. The analysis of age, body mass index (BMI), and initial pain intensity (Table 1) revealed no significant differences between the two groups, indicating the homogeneity of their characteristics.

The results demonstrated that the intervention group, which received both education and dark chocolate, experienced a significant reduction in pain intensity more rapidly than the control

**Table 4.** Comparison of pain intensity from baseline, day 1 to day 5 with dark chocolate given to dysmenorrhea adolescents.

| Variable | Pain intensity | | | | p* |
|---|---|---|---|---|---|
| | Mean | SD | Md | Min-Max | |
| LMP | 6.50 | 0.60 | 6 | 6-8 | <0.001 |
| Days 1 | 4.70 | 1.34 | 5 | 2-7 | <0.001 |
| Days 2 | 2.45 | 1.87 | 3 | 0-5 | <0.001 |
| Days 3 | 1.10 | 1.58 | 0.5 | 0-5 | <0.001 |
| Days 4 | 0.75 | 1.29 | 0 | 0-5 | <0.001 |
| Days 5 | 0.45 | 0.94 | 0 | 0-4 | <0.001 |

* Friedman test.

**Table 5.** Comparison of pain intensity from baseline, day 1 to day 5 without giving dark chocolate to dysmenorrhea adolescents.

| Variable | Pain intensity | | | | p* |
|---|---|---|---|---|---|
| | Mean | SD | Md | Min-Max | |
| LMP | 6.50 | 0.68 | 6 | 6-8 | <0.001 |
| Days 1 | 4.40 | 1.14 | 4 | 1-6 | <0.001 |
| Days 2 | 3.40 | 2.06 | 4 | 0-6 | <0.001 |
| Days 3 | 1.80 | 2.01 | 0.5 | 0-5 | <0.001 |
| Days 4 | 0.65 | 1.34 | 0 | 0-4 | <0.001 |
| Days 5 | 0.45 | 1.09 | 0 | 0-4 | <0.001 |

* Friedman test.

**Table 6.** Comparison of pain intensity in dysmenorrhea adolescents between the group given dark chocolate and the control group.

| Group | Median | | | | p* |
|---|---|---|---|---|---|
| | Days (n=20) | Min-Max | Days (n=20) | Min-Max | |
| Start LMP | 6 | 6-8 | 6 | 6-8 | 0.877 |
| Control | (1) 4 | | (2) 4 | 1-6 | 0.110 |
| Intervention | (1) 5 | 2-7 | (2) 3 | | 0.001* |
| Control | (2) 4 | | (3) 0.5 | 0-6 | 0.02 |
| Intervention Control | (2) 3 | 0-5 | (3) 0.5 | | 0.028 |
| | (3) 0.5 | | (4) 0 | 0-5 | 0.056 |
| Intervention | (3) 0.5 | 0-5 | (4) 0 | | 0.490 |
| Control | (4) 0 | | (5) 0 | 0-4 | 0.67 |
| Intervention | (4) 0 | 0-4 | (5) 0 | | 0.432 |

*Mann whitney test.

group. The pain intensity in the intervention group decreased significantly on the second day, whereas the control group experienced a significant reduction in pain intensity after the third day. These findings align with previous research, which also found that dark chocolate could significantly reduce dysmenorrhea pain.[15,16,18,21–22]

Adolescence in girls is a period marked by the onset of menarche, often associated with irregular menstrual problems, excessive bleeding, and dysmenorrhea.[18] Severe dysmenorrhea can impact physical,[23] psychological, and social aspects of life, leading to depression, moodiness, and missed school or work.[24–26]

Some evidence supports the role of dietary supplements and specific nutrients, such as Omega-3 fatty acids, vitamins, and minerals, in relieving menstrual pain.[18] Additionally, chocolate is rich in vitamins A, B1, C, D, and vitamin E. Furthermore, chocolate contains phenol and flavonoid antioxidants, along with minerals such as calcium, potassium, iron, and a small amount of omega 3 and 6. Additionally, it is high in magnesium, which can help reduce menstrual pain and premenstrual syndrome in women.[18] Magnesium serves as a cofactor in protein synthesis, muscle relaxation, and energy production. It also has antiarrhythmic and hypotensive properties.[21,27] The consumption of dark chocolate increases serotonin secretion, resulting in the transmission of signals to the dorsal horn, where peripheral pain sensory fibers terminate, inhibiting pain transmission. Serotonin also keeps pain gates closed. A deficiency of serotonin can heighten pain sensitivity, and various methods can stimulate the body to increase serotonin levels. Dark chocolate consumption triggers the release of endorphins, which act as substances that carry the signals of the brain's analgesia system. Endorphins inhibit the cyclooxygenase enzyme, preventing the formation of PGG2, which is a pain mediator substance.[21] The study's results indicate a change in dysmenorrhea levels in adolescents who consume 72% dark chocolate daily for five days. This aligns with the findings of Arfailasufandi's research (2018), which suggested that dark chocolate significantly reduces menstrual pain in students at the University of Malang.[16]

Chocolate is rich in vitamins, minerals, fiber, and polyphenols that support both physical and psychological health. In addition to its various physical effects, chocolate has also been associated with potential psychological effects on mood, cravings, and cognitive function.[28] Most research on the effects of cocoa on psychological variables has focused on explaining chocolate cravings, likely because chocolate is highly craved. For example, in one study, chocolate accounted for 49% of all food cravings reported by a sample of 25 healthy women.[27] Two studies by Macht also support the idea that the psychoactive properties of chocolate are primarily related to taste. These studies suggest that while chocolate consumption may temporarily increase negative moods, this effect is likely due to the palatability of chocolate. In Macht's 2007 study, the consumption of enjoyable chocolate significantly improved mood more than unpalatable chocolate, with no significant difference from the control group (chocolate non-sufferers). In a 2006 study by Macht, a bar of chocolate uplifted mood and elicited greater excitement than an apple, especially within 5 and 30 minutes after consumption. This suggests that the sensory experience of eating chocolate improves mood rather than immediate neurochemical effects.[27] These findings are in line with the responses from the study's participants who mentioned that they enjoy eating dark chocolate because of its taste and its ability to quickly alleviate dysmenorrhea pain.

On the other hand, there is some evidence supporting the psychoactive effects of flavanols or the methylxanthine compounds in cocoa, which can extend beyond affecting mood to cognitive function. A study conducted by Scholey and colleagues involved a randomized, controlled, double-blind cross-sectional trial with 30 healthy adults. This study investigated the effects of cocoa flavanol consumption on cognitive performance, anxiety status, and mental fatigue. Three treatments were tested: cocoa drinks containing 46 mg (control), 520 mg, and 994 mg of total flavanols. Both flavanol-rich preparations significantly improved cognitive performance and reduced mental fatigue compared to the control group. Smith *et al.* examined cocoa's methylxanthine compounds, caffeine, and theobromine, as potential mood-altering agents.[27]

Therefore, it can be expected that the consumption of dark chocolate can affect adolescent primary dysmenorrhea. The intervention group that received dark chocolate experienced a decrease in dysmenorrhea pain from the first day of consuming dark chocolate, compared to the control group that did not receive dark chocolate. This rapid reduction in pain is highly beneficial for adolescents in their daily lives, as somatic complaints often disrupt their activities. These results suggest that teenagers can use dark chocolate as an alternative non-pharmacological therapy to alleviate primary dysmenorrhea pain, as dark chocolate has very few side effects. This allows teenagers to comfortably engage in activities during their menstrual period. These findings align with research that indicates a significant effect of pain intensity before dark chocolate therapy on pain after consuming dark chocolate. These results are consistent with another study that found an effect of dark chocolate therapy in reducing menstrual pain among adolescents in Natar South Lampung.[21]

Dark chocolate is rich in complex carbohydrates, antioxidants (polyphenolic flavonoids), vitamin B6, unsaturated fatty acids (omega 3 and omega 6),[29] and essential minerals (magnesium, calcium, iron) that play a crucial role in regulating the menstrual cycle by maintaining a balance of sex hormones in the bloodstream during menstruation. Dark chocolate, distinguished by its higher cocoa bean content compared to other chocolate types, is particularly abundant in polyphenolic compounds, contributing to its distinct bitter taste and deep black color. Dark chocolate stands out as an optimal choice for promoting various health benefits. Its advantages extend to combating infectious diseases, cancer, cardiovascular issues, metabolic disorders, and psychological ailments.[27]

Furthermore, dark chocolate contains significant levels of magnesium, which directly influences vascular pressure and has the ability to modulate the influx of calcium into the uterine smooth muscle cells. This modulation by magnesium affects the contraction and relaxation of the uterine muscles. Additionally, magnesium exhibits anti-inflammatory properties by inhibiting the formation of prostaglandins. As the fourth most abundant mineral in the human body, magnesium found in dark chocolate has the potential to enhance one's mood. This aligns with research that demonstrates a reduction in primary dysmenorrhea pain by 2.46 in a group of students in Malang Regency before and after consuming dark chocolate.[30] Another study has shown a significant difference between groups of female adolescents who were provided with dark chocolate, milk chocolate, and milk without chocolate. The group that consumed dark chocolate experienced a significant reduction in premenstrual and menstrual pain.[18]

However, it is noteworthy that the intervention in the study involved not only dark chocolate but also education for both the control and intervention groups to address dysmenorrhea pain. Statistically, this intervention in both groups resulted in a non-significant difference in reducing dysmenorrhea pain. This suggests that education on reducing dysmenorrhea pain, in addition to the consumption of dark chocolate, had a significant effect on pain reduction. A considerable reduction in dysmenorrhea pain can be

achieved through various means, such as physical exercise, relaxation techniques, and mood-enhancing activities. Consuming chocolate can be a part of these strategies to alleviate dysmenorrhea pain.[18]

## Conclusions

The utilization of dark chocolate as a non-pharmacological alternative therapy shows promise in expediting pain reduction in adolescents with dysmenorrhea. However, additional research and larger-scale studies are essential to delve into the long-term effects and determine the optimal dosage of dark chocolate for effectively managing dysmenorrhea. Dark chocolate can serve as a more enjoyable non-pharmacological alternative for alleviating pain associated with dysmenorrhea in adolescents.

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