INTERNATIONAL JOURNAL OF
PHYSICAL THERAPY RESEARCH & PRACTICE
AN OFFICIAL JOURNAL OF SAUDI PHYSICAL THERAPY ASSOCIATION

Original Article

Effectiveness of Self-administered High Frequency pocket TENS in pain intensity, and workability among university students with Primary Dysmenorrhea – A quasi-experimental study design

Ramya R Sanjeevi[1]; Karthick Balasubramanian[1*]; Muzun AlShahran[1]; Amani Khubrani[1]; Laila J Sairam[1]; Razan Mahnashi[1]; SettingsManar Hamdi[1]

[1.] Department of Physical Therapy, College of Nursing & Health Sciences, Jazan University, Jazan, Saudi Arabia

*Corresponding Author: bkarthick@jazanu.edu.sa

Article info

Received : **Nov. 26, 2024**
Accepted : **Dec. 08, 2024**
Published : **Dec. 31, 2024**

To Cite: Ramasamy Sanjeevi, R. ., Balasubramanian, K. ., Nasser AlShahrani, M. ., Abdullah Khubrani , A. ., Abdullah J Sairam , L., Razan, R. ., & Abdulrahman Abdullah Hamdi , M. . Effectiveness of Self-administered High Frequency pocket TENS in pain intensity, and workability among university students with Primary Dysmenorrhea – A quasi-experimental study design. International Journal of Physical Therapy Research &Amp; Practice, 4(4), 230–236. https://doi.org/10.62464/ijoprp.v4i4.101

Abstract

Background: Primary Dysmenorrhea (PD) is a painful condition affecting women of childbearing age, often hindering daily tasks. In Physical Therapy, Transcutaneous Electrical Nerve Stimulation (TENS) is widely used to relieve pain without side effects. Our study assesses the effectiveness of self-administered high-frequency pocket TENS (HF TENS) in reducing pain and enhancing workability among university students with PD in Jazan, Saudi Arabia. **Methods:** A quasi-experimental study involving 51 female university students was conducted. Participants received HF TENS with a pulse frequency of 100Hz for 30 minutes from day 1 to day 3 of their menstrual cycle. Pain intensity was assessed using the Numerical Pain Rating Scale (NPRS) for lower abdomen pain (LAP) and low back pain (LBP). The Workability, Location, Intensity, Days of Pain, and Dysmenorrhea (WaLIDD) score was used to determine dysmenorrhea severity. Pre-intervention and post-intervention assessments were conducted on day 1 and day 3 of the menstrual cycle, respectively. **Results:** The Wilcoxon signed-rank test revealed a significant reduction in pain intensity for both LAP (Median pre-6; post-1) and LBP (Median pre-5; post-1) following HF TENS application ($p < 0.001$). Similarly, a significant improvement in dysmenorrhea severity was observed ($p < 0.001$). Fisher's exact test indicated a statistically significant association between HF TENS treatment and dysmenorrhea severit. **Conclusion:** Self-administered HF pocket TENS application effectively reduces pain intensity and improves workability among university students with PD in Jazan, Saudi Arabia.

Keywords: Primary Dysmenorrhea, Transcutaneous Electrical Nerve Stimulation (TENS), Menstruation.

Introduction

Primary Dysmenorrhea (PD) is a painful menstrual cycle usually experienced by women during childbearing age. (Itani et al., 2022) The menstrual pain causes many women to struggle with completing their regular tasks, such as work or school. This negative consequence of PD often results in absenteeism from both work and school . (Ferries-Rowe et al., 2020) The prevalence of PD in Saudi Arabia was 80.1% among female medical students (Hashim et al., 2020) and it affects their attendance along with their active participation in the class. A study conducted in Pakistan among university students concluded that about 60.87% of participants had a moderate level of dysmenorrhea and their instrumental activities of daily living were affected. (Adil & Zaigham, 2021)

PD occurs in the absence of any pelvic pathology which is more common among adolescent and adult girls. In contrast, secondary dysmenorrhea occurs due to pelvic pathology like endometriosis. (McKenna & Fogleman, 2021) Some of the risk factors for PD are age less than 30 years, earlier menarche (menarche at the age of 12 or less), heavy menstrual flow, and oral contraceptive use. (Weissman et al., 2004) PD results from an increased prostaglandin and leukotriene secretion which leads to inflammation in the uterus and painful uterine contraction. (Itani et al., 2022; McKenna & Fogleman, 2021) This elevated prostaglandin causes vasoconstriction, and increased uterine contraction, with elevated intra-uterine pressure, uterine hypoxia and ischemic pain. Thus, the treatment of PD focuses on limiting the secretion of prostaglandin by prescribing analgesics and Non-Steroidal anti-Inflammatory Drugs (NSAIDs), which are the first line of treatment and also have side effects. (Dawood, 2006) Henceforth, we are aiming for an easy portable hand-held Physical Therapy modality with no side effects in the treatment of PD with university students. They can carry the modality and use it whenever, and wherever they want, to improve their workability.

In Physical Therapy, various modalities like hot packs, cryotherapy, Interferential Therapy (IFT) and Transcutaneous Electrical Nerve Stimulation (TENS) are commonly used to alleviate PD symptoms and it is a simple, non-invasive, non-pharmacological, self-administered treatment method that does not cause any adverse effects. (Gerzson et al., 2014; Igwea et al., 2016; M. I. Johnson et al., 2015; Tugay et al., 2007) The efficacy of TENS is widely accepted as the management of PD in reducing pain (Bai et al., 2017; Manisha & Anuradha, 2021) The TENS produces vasodilation, alters menstrual fluid prostaglandin and indirectly induces analgesic effects. This analgesic effect is mediated by the inhibition of nociceptors and their responses in the dorsal grey horn of the spinal cord. TENS stimulates the large diameter afferent fibres and controls pain, which is based on the gate-control theory of pain. (Elboim-Gabyzon & Kalichman, 2020; Vance et al., 2014). The aforementioned modalities are readily available in physiotherapy clinics, with prior research primarily conducted in clinical settings. In light of this, we propose the introduction of the pocket TENS—a lightweight, compact, and portable device that can be discreetly worn under clothing. This innovation enables individuals to continue their daily activities, such as work or study, without disruption or absenteeism(Lauretti et al., 2015). Moreover, pocket TENS presents a cost-effective and safe alternative to prolonged drug therapy for pain management. It allows users to self-administer treatment with minimal training, adjusting the intensity to their maximum tolerable level to achieve optimal analgesic effects(M. Johnson,

2007). Previous research has extensively explored the effects of TENS on pain intensity in individuals suffering from PD with in the clinical settings. Building on this foundation, our study specifically focused on evaluating the effectiveness of self-administered pocket-TENS device in non-clinical environment in reducing pain intensity and improving workability of university students experiencing PD.

Methodology

Participants and Study Design

It was a quasi-experimental study design with a single group pre-test and post-test. The study was conducted from June 2023 to December 2023 at the Department of Physical Therapy, College of Nursing & Health Sciences, Jazan University, Saudi Arabia. To recruit participants, a notice detailing the study was displayed on the college notice board. Initially, 72 participants were enrolled and screened for eligibility. Four were excluded for not meeting the inclusion criteria, and 17 withdrew due to unwillingness to continue. Written informed consent was obtained from all participants. Ultimately, 51 university students from various departments participated in the study. Pre-intervention assessment was conducted on the first day of their menstrual cycle, and post-intervention assessment was administered on the third day of their menstrual cycle. The participants were included in this study with the following criteria: women with PD, from the age 18 to 23 years; a history of lower abdominal pain for more than 6 menstrual cycles; numerical Pain Rating Scale score > 4 out of 10; no alternative therapy including TENS within 1 month before enrolment in the study, provision of informed consent before enrolment in the study. The participants were excluded if they were found as follows: breastfeeding women; history of lower abdomen surgery; heart diseases; skin disease; cancer, and severe mental disorders.

Sampling technique and sample size:

Convenient sampling was employed. An a priori power analysis was performed using G*Power version 3.1.9.7 (Faul et al., 2007) to calculate the minimum sample size needed to test the study aim. The analysis revealed that a sample size of N = 35 would be required to achieve 80% power for detecting a medium effect size, with a significance level of $\alpha = .05$, using the Wilcoxon signed-rank test (single group). To account for a 20% dropout rate, the sample size was adjusted to 42.

Outcome measure:

Numerical Pain Rating Scale (NPRS)

The Numerical Pain Rating Scale (NPRS) stands as a pivotal tool for evaluating pain intensity. This unidimensional measurement facilitates the quantification of pain using an 11-point ordinal scale. On this scale, '0' indicates the absence of pain ("no pain"), while '10' signifies the most extreme pain imaginable ("pain as bad as you can imagine" or "worst pain imaginable"). The NPRS can be regarded as a trustworthy and dependable patient-reported outcome measure for evaluating the intensity of pain associated with dysmenorrhea. NPRS has high reliability and validity in measuring dysmenorrhea-related pain, with a reliability coefficient (r) of 0.97 and validity over 0.90. (De Arruda et al., 2022)

Workability, Location, Intensity, Days of pain, Dysmenorrhea (WaLIDD) score

The WaLIDD score, developed by Teherán et al. (Teherán et al., 2018) in 2018, is designed to diagnose dysmenorrhea, predict activity

limitations, and forecast medical leave for university students. WaLIDD stands for Working ability, Location, Intensity, Days of Pain, and Dysmenorrhea. Each category is scored from 0 to 3, with a total possible score ranging from 0 to 12. Dysmenorrhea severity is classified based on the total WaLIDD score as follows: 0 indicates no dysmenorrhea, 1 to 4 indicates mild dysmenorrhea, 5 to 7 indicates moderate dysmenorrhea, and 8 to 12 indicates severe dysmenorrhea. The WaLIDD score is user-friendly, has minimal application delay, and does not require specialist intervention. (Teherán et al., 2018)

Study Intervention

Participants underwent High-Frequency Transcutaneous Electrical Nerve Stimulation (HF TENS) using the Classic TENS device (Body Clock Health Care Ltd, UK) (Figure 1). The device was programmed with a pulse frequency of 100Hz, administered for 30 minutes twice daily over the first three days of the menstrual cycle, totaling six sessions. Devices were distributed to participants before their menstrual cycles, as per their requests.

Figure 1: Classic TENS device (Body Clock Health Care Ltd, UK)

Each participant received detailed instructions on using the device, including electrode placement, gradually increasing intensity, and stopping the machine after use. To support proper usage, participants were provided with an informational booklet. Additionally, a WhatsApp group was created to address any questions and facilitate the booking of devices prior to the expected start of menstruation.

The TENS device was applied to alleviate abdominal and/or back pain associated with primary dysmenorrhea (PD). Each device included four self-adhesive gel pads, which were adhered to the skin. Two electrodes (E1, E2) were positioned on the lower abdominal area, while the other two electrodes (E3, E4) were placed on the lower back region. The electrode placements were showed in the figure 2. Participants adjusted the intensity to their maximum tolerable level. In cases of discomfort, participants were allowed to withdraw from the session; however, no participants reported any discomfort or adverse effects during the application of TENS. Treatment was limited to the first three days of menstruation, as participants reported PD symptoms primarily within this timeframe. Treatment was discontinued after the third day, either upon cessation of menstruation or when pain subsided.

Pre-intervention pain intensity scores, including the Numeric Pain Rating Scale (NPRS) for lower abdomen (LAP) and lower back (LBP) pain, as well as WaLIDD scores, were documented by a research assistant on the first day (prior to TENS application). Post-intervention scores were recorded on the third day. No participant underwent treatment for more than three days per month, with the intervention

spanning a single menstrual cycle.

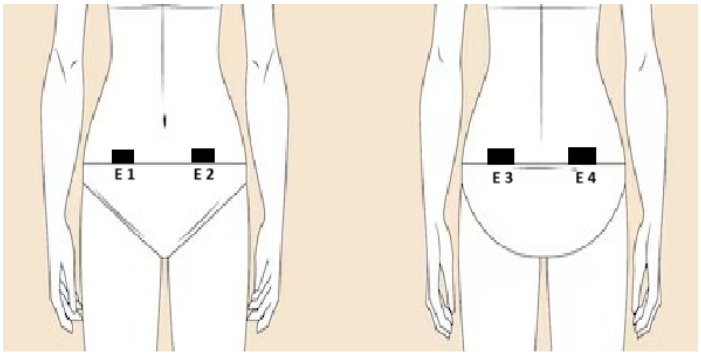

Figure 2: Electrode placements

Statistical analysis

The data was analysed using SPSS version 25.0 (SPSS Inc. Chicago, IL, USA). The distribution of data was examined before analysis using Kolmogorov-Smirnov test. Data are presented as mean ± standard deviations (SD) of the normal distributed quantitative variables, median and interquartile range (IQR) of non-normal distributed quantitative variables, and frequency and percentages of the qualitative variables. A Wilcoxon signed-rank test was used to check the effectiveness of HF TENS in the treatment of PD and Fisher's Exact Test was used to compare the dysmenorrhea severity before and after treatment. A $p < 0.05$ was considered significant for all statistical tests.

Ethical consideration

This study has been reviewed and approved by the standing committee for scientific research at the Jazan University (HAPO-10-Z-001), Jazan, Saudi Arabia with the reference number: REC-44/10/640.

Results

Fifty-one (51) participants were included in the study and their data was used for statistical analysis. The Socio-demographic and anthropometric characteristics of study participants are given in Table 1. The median (IQR) age of participants was 21 (20,22) years and BMI was 21.41 (17.5, 25.4) kg/m^2. Forty-seven (92.2%) participants were unmarried and four (7.8%) were married.

Table 1: Socio-demographic and anthropometric characteristics of participants.

Variables	Median (IQR)/ n (%)
Age	21 (20,22)
BMI	21.41 (17.5, 25.4)
Marital status Unmarried Married	 47 (92.8%) 4 (7.8%)

IQR- Interquartile range; BMI- Body Mass Index

The Wilcoxon signed-rank test was employed to compare the average pre-intervention and post-intervention values of NPRS LAP and NPRS LBP, given the non-normal distribution of the data. The test indicated a significant reduction in LAP pain among participants following HF TENS intervention (Z = -6.27; p = 0.000). The median value of LAP pain decreased to 1 post- intervention from a median value of 6 pre- intervention. The effect size was -0.878, indicating a large effect (Table 2). The pre-intervention and post-intervention values of NPRS LBP were analyzed using the Wilcoxon signed-rank test, revealing a significant reduction in LBP following HF TENS intervention (Z = -6.306; p = 0.000). The median value of NPRS LBP decreased to 1 post- intervention from a median value of 5 pre-

intervention. The effect size was -0.883, indicating a large effect (Table 2).

Table 2: Comparison of pre- and post- intervention values of NPRS LAP and NPRS LBP using Wilcoxon signed-rank test.

Outcome measure	Median (IQR)	Z value	P value	Effect size
NPRS LAP Pre-intervention Post- intervention	 6 (5,7) 1 (0,2)	-6.27	*p<0.001*	-0.878
NPRS LBP Pre- intervention Post- intervention	 5 (5,6) 1 (1,2)	-6.306	*p<0.001*	-0.883

IQR- Interquartile range; NPRS – Numerical Pain Rating Scale; LAP – Lower Abdominal Pain; LBP – Lower Back Pain

The Wilcoxon signed-rank test revealed a highly significant statistical difference between pre-and post- intervention values across WaLIDD score sub-categories: workability (Z = -6.225, p = 0.000), location (Z = -4.75, p = 0.000), intensity (Z = -6.233, p = 0.000), and days of pain (Z = -5.915, p = 0.000), with a large effect size observed in each subscale (Table 3).

Table 4 presents the frequency and percentage of participants' dysmenorrhea severity before and after treatment, based on the total scores of the WaLIDD score. Fisher's exact test indicated a statistically significant association between HF TENS treatment and grades of dysmenorrhea severity as determined by the WaLIDD scale (p < 0.001).

Table 3: Comparison of pre- and post- intervention values of WaLIDD score sub-categories using Wilcoxon signed-rank test.

Outcome measure	Median (IQR)	Z value	P value	Effect size
WaLIDD – Work Ability Pre- intervention Post- intervention	 2 (2,3) 1 (1.1)	-6.225	p<0.001	-0.872
WaLIDD – Location Pre- intervention Post- intervention	 1 (1,2) 1 (1,1)	-4.75	p<0.001	-0.665
WaLIDD – Intensity Pre- intervention Post- intervention	 2 (2,3) 1 (1,1)	-6.233	p<0.001	-0.873
WaLIDD – Days of pain Pre- intervention Post- intervention	 2 (2,3) 0 (0,1)	-5.915	p<0.001	-0.828

IQR- Interquartile range

Table 4: Comparison of pre- and post- intervention dysmenorrhea severity by WaLIDD score using Fisher's Exact Test.

Grades of Dysmenorrhea	Pre- intervention n (%)	Post- intervention n (%)	*p*-value
No Dysmenorrhea (WaLIDD score:0)	0 (0)	0 (0)	<0.001
Mild Dysmenorrhea (WaLIDD score: 1 to 4)	0 (0)	7 (13.7)	
Moderate Dysmenorrhea (WaLIDD score: 5 to 7)	19 (37.3)	31(60.8)	
Severe Dysmenorrhea (WaLIDD score: 8 to 12)	32 (62.7)	13 (25.5)	

Discussion

The study aimed to evaluate the effectiveness of self-administered HF pocket TENS in non-clinical environment on pain intensity and workability among university students. The results revealed that self-administered HF TENS effectively reduces pain intensity, and improves the workability among university students with PD. Our findings align with previous studies conducted on similar populations in China (Bai et al., 2017), Korea (Lee et al., 2015), India (Muragod et al., 2017), Brazil (Lauretti et al., 2015), and Turkey (Tugay et al., 2007).

Pain Intensity

In our study, both Lower Abdominal Pain (LAP) and Low Back Pain (LBP) showed significant reduction after HF pocket TENS application, with a larger effect size. A systematic review on the effectiveness of TENS for PD pain reported that TENS is a safe, non-pharmacological, well-tolerated physical therapy modality for reducing pain intensity in PD. They concluded that using biphasic, high-frequency TENS significantly reduces pain intensity in PD. (Arik et al., 2022) Elboim-Gabyzon & Kalichman's (Elboim-Gabyzon & Kalichman, 2020). A review explained that TENS achieves pain reduction by pain-gate mechanism, increasing endogenous inhibition and decreasing central excitability. They mentioned that HF TENS applied at maximum tolerable intensity provides stronger pain relief than analgesics. HF TENS produces pain relief more effectively than verapamil and the same amount of relief as naproxen in PD. Vance et al. (Vance et al., 2014) found that TENS at strong intensities produces analgesia more effective than opioids, with greater benefits when applied during movement or activity. This supports our findings, as participants were encouraged to use HF pocket TENS application at their maximum tolerable intensity while engaging in functional activities, rather than during periods of rest. This approach was particularly emphasized during routine activities, such as attending work or school.

The minimum clinically important difference (MCID) of the NPRS for dysmenorrhea was reported as 2 points on an 11-point scale (Li et al., 2024). In our study, NPRS LAP showed a 5-point reduction, and NPRS LBP showed a 4-point reduction, indicating that HF pocket TENS application is effective in reducing pain associated with PD.

Workability

The WaLIDD score showed significant improvement following the HF pocket TENS application across all categories in our study. A study conducted by Abd Elaziz et al. (Abd Elaziz et al., 2022) found that TENS significantly reduces menstrual distress of primary dysmenorrhea, with a 48.03% change in WaLIDD score, associated with a significant reduction in prostaglandin level. Prostaglandins are inflammatory mediators that increase uterine muscle contractions, reducing blood supply and causing ischemic pain. (Ricciotti & FitzGerald, 2011) TENS application decreases prostaglandin levels, causes vasodilation, increases blood flow, and reduces muscle ischemia. (Abd Elaziz et al., 2022; Desai, 2022) Moreover, the WaLIDD score is an excellent tool with high detection power and low rates of false negatives for detecting dysmenorrhea. These properties make the WaLIDD score suitable and reliable for assessing PD and its treatment effects (Teherán et al., 2018). Our study demonstrated a significant reduction in the severity of dysmenorrhea following the application of HF pocket TENS. These findings indicate that HF pocket TENS is effective in alleviating the distress associated with PD and enhancing participants' ability to carry out their routine activities and maintain work productivity.

The WaLIDD score not only measures pain in PD but also includes working ability, pain location, pain intensity and pain duration. This makes it a highly specific scale for assessing PD and detecting any prognosis after treatment. (Rashidi Fakari et al., 2021; Teherán et al., 2018) Therefore, the changes in the WaLIDD score in our study reflect not only the reduction in participants' pain relief but also a decrease in the pain location, as well as an improvement in their workability.

A cross-sectional study conducted in 2020 by Hashim et al. in Saudi Arabia (Hashim et al., 2020) found that 67% of university students experienced significant disruptions in their academic duties due to PD which include increased absenteeism, reduced participation in classroom activities, and a decline in the time spent studying. Teherán et al. (2018) further highlighted the predictive value of the WaLIDD score in determining absenteeism among students suffering from PD (Teherán et al., 2018). Drawing from these results, it can be inferred that interventions aimed at reducing the severity of PD alongside the WaLIDD score, may result in notable improvements in students' overall functionality. Specifically, effective management of PD could lead to decreased absenteeism, greater participation in academic and extracurricular activities, and enhanced workability, ultimately improving their quality of life and educational outcomes.

Clinical Significance and Application

Pharmacological interventions, including analgesics, NSAIDs, and oral contraceptives, are commonly the first-line treatments for PD. However, prolonged use of these medications can lead to mild to moderate side effects such as headaches, constipation, abdominal pain, nausea, vomiting, liver damage, blood pressure fluctuations, and glucose intolerance (Manisha & Anuradha, 2021). Being a non-pharmacological management, the application of TENS effectively alleviates pain in the targeted area without causing any side effects. It provides rapid pain relief, reducing pain by 54% to 62%, with the effects lasting for more than seven hours after application. Additionally, TENS significantly decreases the use of analgesics, with a reduction of up to 93%.(Guy et al., 2022).

The HF pocket TENS is a lightweight and portable device that allows patients to discreetly manage their pain during work or daily activities, eliminating the need to visit clinical settings. It offers a cost-effective alternative to long-term pharmacological treatments. By enabling self-administration, this device provides subjective pain relief while empowering patients to independently manage their condition(Dawood & Ramos, 1990; Igwea et al., 2016). These advantages underscore HF pocket TENS as a rapid, safe, and efficient solution for pain management in PD, potentially replacing or significantly reducing reliance on pharmacological interventions.

This study has few limitations. HF pocket TENS was administered during a single menstrual cycle. application reduces pain intensity, and improves workability among university students with PD.

Future Research

Future studies could broaden the scope by including working women to gain more comprehensive insights.

Author Contributions

All authors significantly contributed to the work reported, including conception, study design, execution, data acquisition, analysis, and interpretation. They actively participated in drafting, revising, or critically reviewing the manuscript, provided final approval of the version to be published, agreed on the journal submission, and accepted accountabilities for all aspects of the work.

Future research could investigate the effects of HF pocket TENS over multiple cycles. Additionally, the long-term effects of HF pocket TENS application on PD were not examined in this study. Our research was limited to university students in Jazan, Saudi Arabia, and the findings are specific to this group; hence, they cannot be generalized to the broader population across Saudi Arabia. Future studies could broaden the scope by including working women to gain more comprehensive insights.

Conclusion

Based on our findings we can conclude that self-administered HF pocket TENS is a rapid, safe, and efficient solution for pain management in PD. Its

Data Availability Statement

The authors will transparently provide the primary data underpinning the findings or conclusions of this article, without any unjustified reluctance. If need from editorial team.

Funding

The author/s have not received any funding for. This study.

Conflicts of Interest

The authors declare no potential conflicts of interest related to the research, writing, or publication of this work

Reference

Abd Elaziz, K. S. A. E., Ph. D., Mohammed, R. E., Kamel, H. A.-D. H., & Mohamed, A. S. (2022). Effect of Pulsed Electro Magnetic Field versus Transcutaneous Electrical Nerve Stimulation on Menstrual

Distress of Primary Dysmenorrhea. The Medical Journal of Cairo University, 90(6), 681–688. https://doi.org/10.21608/mjcu.2022.253117

Adil, R., & Zaigham, U. (2021). Prevalence of primary dysmenorrhoea and its effect on instrumental activities of daily living among females from Pakistan. Physiotherapy Quarterly, 29(4), 65–69. https://doi.org/10.5114/pq.2021.105754

Arik, M. I., Kiloatar, H., Aslan, B., & Icelli, M. (2022). The effect of TENS for pain relief in women with primary dysmenorrhea: A systematic review and meta-analysis. EXPLORE, 18(1), 108–113. https://doi.org/10.1016/j.explore.2020.08.005

Bai, H.-Y., Bai, H.-Y., & Yang, Z.-Q. (2017). Effect of transcutaneous electrical nerve stimulation therapy for the treatment of primary dysmenorrheal. Medicine, 96(36), e7959. https://doi.org/10.1097/MD.0000000000007959

Dawood, M. Y. (2006). Primary Dysmenorrhea: Advances in Pathogenesis and Management. Obstetrics & Gynecology, 108(2), 428. https://doi.org/10.1097/01.AOG.0000230214.26638.0c

Dawood, M. Y., & Ramos, J. (1990). Transcutaneous electrical nerve stimulation (TENS) for the treatment of primary dysmenorrhea: A randomized crossover comparison with placebo TENS and ibuprofen. Obstetrics and Gynecology, 75(4), 656–660.

De Arruda, G. T., Driusso, P., Rodrigues, J. C., de Godoy, A. G., & Avila, M. A. (2022). Numerical rating scale for dysmenorrhea-related pain: A clinimetric study. Gynecological Endocrinology, 38(8), 661–665. https://doi.org/10.1080/09513590.2022.2099831

Desai, R. G. (2022). Physiotherapy Intervention for Primary Dysmenorrhea – A Narrative Review. International Journal of Research and Review, 9(3), 441–449. https://doi.org/10.52403/ijrr.20220349

Elboim-Gabyzon, M., & Kalichman, L. (2020). Transcutaneous Electrical Nerve Stimulation (TENS) for Primary Dysmenorrhea: An Overview. International Journal of Women's Health, 12, 1–10. https://doi.org/10.2147/IJWH.S220523

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behavior Research Methods, 39(2), 175–191. https://doi.org/10.3758/BF03193146

Ferries-Rowe, E., Corey, E., & Archer, J. S. (2020). Primary Dysmenorrhea: Diagnosis and Therapy. Obstetrics & Gynecology, 136(5), 1047. https://doi.org/10.1097/AOG.0000000000004096

Gerzson, L. R., Padilha, J. F., Braz, M. M., & Gasparetto, A. (2014). Physiotherapy in primary dysmenorrhea: Literature review. Revista Dor, 15, 290–295. https://doi.org/10.5935/1806-0013.20140063

Guy, M., Foucher, C., Juhel, C., Rigaudier, F., Mayeux, G., & Levesque, A. (2022). Transcutaneous electrical neurostimulation relieves primary dysmenorrhea: A randomized, double-blind clinical study versus placebo. Progrès En Urologie, 32(7), 487–497. https://doi.org/10.1016/j.purol.2022.01.005

Hashim, R. T., Alkhalifah, S. S., Alsalman, A. A., Alfaris, D. M., Alhussaini, M. A., Qasim, R. S., & Shaik, S. A. (2020). Prevalence of primary dysmenorrhea and its effect on the quality of life amongst female medical students at King Saud University, Riyadh, Saudi Arabia. Saudi Medical Journal, 41(3), 283–289. https://doi.org/10.15537/smj.2020.3.24988

Igwea, S. E., Tabansi-Ochuogu, C. S., & Abaraogu, U. O. (2016). TENS and heat therapy for pain relief and quality of life improvement in individuals with primary dysmenorrhea: A systematic review. Complementary Therapies in Clinical Practice, 24, 86–91. https://doi.org/10.1016/j.ctcp.2016.05.001

Itani, R., Soubra, L., Karout, S., Rahme, D., Karout, L., & Khojah, H. M. J. (2022). Primary Dysmenorrhea: Pathophysiology, Diagnosis, and Treatment Updates. Korean Journal of Family Medicine, 43(2), 101–108. https://doi.org/10.4082/kjfm.21.0103

Johnson, M. (2007). Transcutaneous Electrical Nerve Stimulation: Mechanisms, Clinical Application and Evidence. Reviews in Pain, 1(1), 7–11. https://doi.org/10.1177/204946370700100103

Johnson, M. I., Paley, C. A., Howe, T. E., & Sluka, K. A. (2015). Transcutaneous electrical nerve stimulation for acute pain. The Cochrane Database of Systematic Reviews, 2015(6), CD006142. https://doi.org/10.1002/14651858.CD006142.pub3

Lauretti, G. R., Oliveira, R., Parada, F., & Mattos, A. L. (2015). The New Portable Transcutaneous Electrical Nerve Stimulation Device Was Efficacious in the Control of Primary Dysmenorrhea Cramp Pain. Neuromodulation: Technology at the Neural Interface, 18(6), 522–527. https://doi.org/10.1111/ner.12269

Lee, B., Hong, S. H., Kim, K., Kang, W. C., No, J. H., Lee, J. R., Jee, B. C., Yang, E. J., Cha, E.-J., & Kim, Y. B. (2015). Efficacy of the device combining high-frequency transcutaneous electrical nerve

stimulation and thermotherapy for relieving primary dysmenorrhea: A randomized, single-blind, placebo-controlled trial. European Journal of Obstetrics, Gynecology, and Reproductive Biology, 194, 58–63. https://doi.org/10.1016/j.ejogrb.2015.08.020

Li, X., Sun, Y., Wang, Y., Wang, X., & Yu, C. (2024). Manual Therapy in Primary Dysmenorrhea: A Systematic Review and Meta-Analysis. Journal of Pain Research, 17, 1663. https://doi.org/10.2147/JPR.S457381

Manisha, U., & Anuradha, L. (2021). Effect of high frequency transcutaneous electrical nerve stimulation at root level menstrual pain in primary dysmenorrhea. Journal of Bodywork and Movement Therapies, 26, 108–112. https://doi.org/10.1016/j.jbmt.2020.12.025

McKenna, K. A., & Fogleman, C. D. (2021). Dysmenorrhea. American Family Physician, 104(2), 164–170. https://www.aafp.org/pubs/afp/issues/2021/0800/p164.html

Muragod, A., Mathias, O., & Bhoir, P. (2017). Effectivenesss of Transcutaneous Electrical Nerve Stimulation and Diadynamic Current on Primary Dysmenorrhea: A Randomized Clinical Trial. Journal of Medical Science and Clinical Research, 05(03), 18557–18562. https://doi.org/10.18535/jmscr/v5i3.48

Rashidi Fakari, F., Simbar, M., Tahmasebi, G., Ebadi, A., Rashidi Fakari, F., Nasiri, M., & Ghazanfarpour, M. (2021). Efficacy of Working Ability, Location, Intensity, Days of Pain, Dysmenorrhea (WaLIDD) and Verbal Rating Scale (Pain and Drug) in Diagnosing and Predicting Severity of Dysmenorrhea among Adolescents: A Comparative Study. Journal of Obstetrics, Gynecology and Cancer Research, 6(2), 81–86. https://doi.org/10.30699/jogcr.6.2.81

Ricciotti, E., & FitzGerald, G. A. (2011). Prostaglandins and Inflammation. Arteriosclerosis, Thrombosis, and Vascular Biology, 31(5), 986–1000. https://doi.org/10.1161/ATVBAHA.110.207449

Teherán, A. A., Piñeros, L. G., Pulido, F., & Mejía Guatibonza, M. C. (2018). WaLIDD score, a new tool to diagnose dysmenorrhea and predict medical leave in university students. International Journal of Women's Health, 10, 35–45. https://doi.org/10.2147/IJWH.S143510

Tugay, N., Akbayrak, T., Demirtürk, F., Karakaya, I. C., Kocaacar, O., Tugay, U., Karakaya, M. G., & Demirtürk, F. (2007). Effectiveness of transcutaneous electrical nerve stimulation and interferential current in primary dysmenorrhea. Pain Medicine (Malden, Mass.), 8(4), 295–300. https://doi.org/10.1111/j.1526-4637.2007.00308.x

Vance, C. G., Dailey, D. L., Rakel, B. A., & Sluka, K. A. (2014). Using TENS for pain control: The state of the evidence. Pain Management, 4(3), 197–209. https://doi.org/10.2217/pmt.14.13

Weissman, A. M., Hartz, A. J., Hansen, M. D., & Johnson, S. R. (2004). The natural history of primary dysmenorrhoea: A longitudinal study. BJOG: An International Journal of Obstetrics and Gynaecology, 111(4), 345–352. https://doi.org/10.1111/j.1471-0528.2004.00090.x.