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Comparison of the Effect of Transcutaneous Electrical Nerve Stimulation and Hot Pack on Dysmenorrhea amongst Female Interns in A Tertiary Health Facility in Nigeria

[1,2]Bolarinde S.O.[*], [1]Emeana-Chuckwuma R.C., [1]Ogunmilua T.O., [1]Aku-Dania G.A., [1]Nomiye K.T., and [1]Adeniyi O.G.

[1]Department of Physiotherapy, Federal Medical Centre, Owo. Ondo state. Nigeria.

[2]Department of Physiotherapy, Achievers University, Owo, Ondo state, Nigeria.

***Corresponding Author's Email Address:** sobolarinde@yahoo.co.uk

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Abstract

Dysmenorrhea a painful menstrual cramp during menstruation is managed pharmacologically using non-steroidal anti-inflammatory drugs or hormonal contraceptives. However, concerns over side effects have led many to explore alternative therapies such as Transcutaneous Electrical Nerve Stimulation and thermotherapy using Hydrocollator Pack. This study compared the effectiveness of Transcutaneous Electrical Nerve Stimulation and Hydrocollator Pack on dysmenorrhea amongst female interns in Federal Medical Center, Owo. The study recruited 30 female interns into Transcutaneous Electrical Nerve Stimulation (n=15) and Hydrocollator Pack (n=15) using a fish bowl sampling method. Data was collected using Numerical Pain Rating Scale an 11-point scale, from 0 to 10, (0 meaning "no pain" and 10 meaning "worst possible pain") on 3 consecutive days of treatment for a period of 3 months. Statistical analysis was performed using IBM SPSS version 25 with alpha level set at 0.05. Result showed that, both interventions reduced pain, although within-group change across nine treatment days was not statistically significant for either Transcutaneous Electrical Nerve Stimulation or Hydrocollator Pack (Friedman tests, $p \geq .282$). However, Hydrocollator Pack produced greater pain reduction than Transcutaneous Electrical Nerve Stimulation at all timepoints (Holm-adjusted $p \leq .05$). Furthermore, comparative effect revealed that participants in Hydrocollator Pack group exhibited a significantly greater reduction in pain compared to the Transcutaneous Electrical Nerve Stimulation group ($p < .05$). In conclusion, Transcutaneous Electrical Nerve Stimulation and Hydrocollator Pack had a positive effect on dysmenorrhea in terms of pain reduction, however, Hydrocollator Pack demonstrated greater reduction in pain than Transcutaneous Electrical Nerve Stimulation.

Keywords: TENS, Hot pack, Dysmenorrhea, Pain

1.0 Introduction

Dysmenorrhea refers to painful menstrual cramps in the lower abdominal region during menstruation in the absence of any discernible macroscopic pelvic pathology. It frequently involves other symptoms, including sweating, headache, nausea, vomiting, diarrhea, and tremulousness before or during menstruation with its estimated prevalence varying between 45% and 95% of all women of reproductive age (Yu and Wen, 2023). It is a condition affecting a large proportion of young women. The highest prevalence has been reported in adolescent women, where approximately 50–75% suffer from dysmenorrhea (Himani *et al.,* 2021).

According to Gyan *et al.* (2020), dysmenorrhea is classified in relation to intensity as; light, moderate or severe, and to etiology as; primary or functional, and secondary or organic. Primary dysmenorrhea is a very common problem in young women. It is usually often described as cramping pain in the lower abdomen occurring at the onset of menstruation in the absence of any identifiable pelvic disease (Veena, 2021). In a prospective study of college students, based on diaries kept for one year, revealed that 72 percent of monitored periods were painful, most commonly during the first day of menses. Sixty percent of the women studied reported at least one episode of severe pain (Veena, 2021). In another study in USA about 15% adolescent and young women describe their dysmenorrhea as severe, causing regular absenteeism from school and work (Omidvar *et al.,* 2016). Dysmenorrhea, a monthly disability, which interferes with daily work several days each cycle, has been estimated to account for 600 million lost working hours and two billion dollars in lost productivity annually in the USA.

Effective management of dysmenorrhea is beneficial for both the individual and society (Himani *et al.,* 2021). The usual medical treatments for dysmenorrhea are analgesics, generally non-steroidal anti-inflammatory drugs (NSAIDs like ibuprofen), or the oral contraceptive pills. However, preference for treatment has been diverse among young adult due to the effects of chemical drugs, the associated adverse effects such as gastrointestinal discomfort and bleeding; and often times inability to effectively alleviate the pain for everyone hence the preference for alternative and complementary therapies which help to effectively reduce the need for medical treatment (Veena, 2021). The lack of desire of young girls to use hormonal drugs to reduce pain has led to the use of alternative and complementary treatments which has attracted the attention of researchers.

A variety of alternative and complementary treatments such as rest, exercise, acupuncture, chiropractic, Transcutaneous Electrical Nerve Stimulation (TENS), hydrocollator pack, herbs, and dietary supplements, are used to treat dysmenorrhea. However, diligently integrating of an alternative non pharmacological and non-invasive analgesia has been recommended (Yu and Wen, 2023).

TENS involves stimulation of the skin by using different electrical currents and frequencies, to provide pain relief for patients with primary dysmenorrhea. It is a non-invasive device which involves the application of a pulsed rectangular wave current via surface electrodes on the patient's skin in a repetitive manner. It is a drug free and efficient pain relief method without any significant side effects. TENS include the parameters of pulse width ranges between 50 and 300 μs, frequency in the range of 2 Hz–600 Hz, pulse patterns in the form of continuous and burst, and intensity is between 1 and 60 mA (average intensity till tingling sensation) (Uttam and Lehri, 2021). High Frequency and Low frequency TENS are two main sub-types of TENS. High Frequency TENS consist of frequency range between 75 and 100 Hz with low intensity and pulse width less than 300μsec whereas Low frequency TENS consist of frequency range between 1 and 4 Hz with high intensity and pulse width between 200 and 300μsec (Uttam and Lehri, 2021). High Frequency TENS involves the mechanism of pain gate theory in which pain is stimulated when gate opens by activity in small diameter pain carrying fibers and it is inhibited by closing the gate with the activity of large diameter fibers. Thus, when High Frequency TENS is applied, large diameter fibers in skin get activated and inhibit the small pain carrying fibers input at spinal cord level thereby preventing the pain impulses from transmitting up to brain level (Uttam and Lehri, 2021). TENS

has beneficial effects in controlling post operative low back pain, labor pain and primary dysmenorrhea (Uttam and Lehri, 2021).

Another non-pharmacologic remedy for dysmenorrhea includes heat therapy. A systematic review found that heat therapy consistently decreases menstrual pain in women with primary dysmenorrhea compared to placebo therapy (Kirsch *et al.,* 2024). A study by Machado *et al.* (2019) that compared the effects of microwave diathermy (a deep heating modality) with TENS found that deep heating modality improved pain scores compared to TENS, they however, concluded that due to risks of skin burns, risk of excessive heat in subcutaneous fat layer and contraindications to use in patients with metal implants associated with deep heating modality, superficial heat should be considered first but if no relief is found, shared decision-making should occur in discussing deep heat therapy.

Hydrocollator Pack (superficial heating modality) is the conventional method used for relieving menstrual pain (Revati and Shweta, 2021). The menstrual pain is reduced by dilation of small blood vessels, increase in the local blood flow and activation of pain gate mechanism. Traditionally, superficial heating has been used in different forms (e.g., hot water bags, towels or bottles) to ease menstrual pain. For women with dysmenorrhea, the application of superficial heat can reduce muscle tension and relax abdominal muscles to reduce pain caused by muscle spasms (Revati and Shweta, 2021). Superficial heat that ranges from 40-45°C treats the application site to a depth of about 1cm. Studies have found that heat is a common (36.5-50%) method for coping with dysmenorrhea (Dixon *et al.,* 2024). Heating modalities has been found to increase pelvic blood circulation to eliminate local blood and body fluid retention and diminish congestion and swelling, thereby enabling a reduction in pain caused by nerve compression (Kirsch *et al.,* 2024; Machado *et al.,* 2019).

Consequentially, the introduction and application of Transcutaneous Electrical Nerve Stimulation (TENS) and Hydrocollator Pack as a non-pharmacological management of dysmenorrhea have been shown to significantly relieve menstrual pain and hence, improve quality of life and functionality in individuals with primary dysmenorrhea (Joo *et al.,* 2024). However, despite many published research, uncertainty about the clinical efficacy of TENS remains (Johnson, 2021). Furthermore, there seems to be paucity of studies that compare the effects of TENS and Hydrocollator Pack-a superficial heating modality on dysmenorrhea.

This study, is therefore designed to compare the effectiveness of TENS and Hydrocollator Pack in the management of dysmenorrhea amongst female interns in Federal Medical Center, Owo.

2.0 Materials and methods

Ethical clearance was gotten from the Health Research Committee of Federal Medical Center, Owo, Ondo State (FMCOWO/HREC/2025/10). Participants were nulliparous female interns aged 18–30 years with regular menstrual cycles and no underlying gynecological conditions. Individuals with irregular menstrual cycles, diagnosed gynecological disorders, or those who declined to provide informed consent were excluded from the study.

Informed consent was obtained from the respondents before recruiting them for the study and after thorough explanation of the research was done. The sample size was determined using the Cohen's table at power of 80%, effect size of 0.8 and alpha level of 0.05. The minimum sample size (n) is 26. Using an attrition rate of 10%, the study focused on a total of 29 participants for the study but for equal distribution of participants, the total number of participants was 30, of which 15 participants were on TENS and 15 participants were on hot packs. Participants were randomly assigned to either the TENS group or the Hydrocollator Pack group using the fishbowl method. To ensure allocation concealment, group assignments were written on identical folded slips of paper and placed in an opaque container. A third party, not involved in participant recruitment or data collection, drew the slips to assign participants to groups, thereby minimizing selection bias.

Data on pain rating was collected using Numerical Pain Rating Scale (NPRS) which is an 11-point scale, from 0 to 10, used by participants to rate their pain intensity, with 0 meaning "no pain" and 10 meaning "worst possible pain". Collection of data spanned for three months (beginning of April to June ending) covering three complete menstrual cycles for the participants. The pain assessment was done on 3 consecutive days of treatment each month for a period of 3 months.

2.1 Group A: TENS

The pain intensity was taken prior to the intervention by Numerical Pain Rating Scale (NPRS) which is an 11-point scale, from 0 to 10, used by participants to rate their pain intensity, with 0 meaning "no pain" and 10 meaning "worst possible pain". TENS electrode gel pads were placed at the right and left iliac regions using the TENS device (MH6000P, Medihightec medical co., Ltd). Each device had 2 inches by 2 inches square electrode gel pads. The electrode gel pads (total of 4) were attached to the right (2 gel pads) and left illiac (2 gel pads) regions of the participants while in supine position using the following treatment parameters:

Frequency: 100Hz
Pulse width: 90-100ųs
Time: 15 minutes

Intensity: Intensity on TENS MH6000 model ranges from 0-8, however intensity for each participant was set to a tolerable level of perception of tingling sensation. Pain intensity was noted immediately after the intervention using the NPRS.

2.2 Group B: Hydrocollator Pack (HCP)

Participants were comfortably positioned in supine lying while the HCP (Temp: 40°C – 45°C) were wrapped in a double layer towel and placed on the right and left iliac and the hypogastric regions for 15 minutes while in supine position on a couch, participants were monitored routinely every 5 minutes to avoid any adverse effect like burns, pain level were noted immediately the hot pack is taken off using the NPRS. These procedures were repeated on the first, second, and third days of menstrual flow for three months

Data analyses were conducted using IBM SPSS Statistics (version 25). Descriptive statistics (means, standard deviations, and frequencies) were used to summarize participants' demographic and menstrual characteristics. Pain reduction was calculated as the difference between pre- and post-treatment NPRS scores across nine time-points. Normality was assessed using the Shapiro-Wilk test. Due to violations of normality ($p < .05$), non-parametric tests were applied. Between-group differences (TENS vs. HCP) were assessed using the Mann–Whitney U tests with Hodges–Lehmann median differences and 95% confidence intervals; familywise error across nine timepoints was controlled using Holm–Bonferroni. Effect sizes (r) were calculated as:

$$r = \frac{|Z|}{\sqrt{N}}$$

Where:

r = effect size

Z = Z statistics

N= total sample size (Rosenthal *et al.,* 1994)

A Friedman test was used to evaluate changes in pain reduction across time. Associations between average pain reduction and participant characteristics (flow type, days of flow relief method) were analyzed using Mann–Whitney U tests. Statistical significance was set at $\alpha = 0.05$.

3.0 Results

This study included 30 female interns between the ages of 22 and 27 years (M = 24.73, SD = 1.48). Departments represented included Physiotherapy (33.3%), Nursing (23.3%), Medical Laboratory Science (30.0%), and Radiology (13.3%). The average menstrual cycle duration was 27.53 days (SD = 2.29). Most participants reported light menstrual flow (60.0%), and analgesics were the most commonly used method for pain relief (80.0%) (See Table 1).

Table 1. Demographic Characteristics of Participants (N = 30)

Variable	N	%
Age		
22	4	13.3
23	1	3.3
24	7	23.3
25	8	26.7
26	7	23.3
27	3	10.0
Mean ± SD: 24.73 ± 1.48		
Department		
Physiotherapy	10	33.0
Nursing	7	23.4
MLS	9	30.0
Radiology	4	13.3
Duration of Cycle		
21	2	6.7
22	0	0.0
23	0	0.0
24	0	0.0
25	4	13.3
26	0	0.0
27	0	0.0
28	18	60.0
29	0	0.0
30	6	20.0
Mean ± SD: 27.53 ± 2.29		
Flow Light	18	60.0
Heavy	12	40.0
Relief Exercise	5	16.7
Analgesics	24	80.0
Nothing	1	3.3

Table 2 presents the median NPRS scores for the TENS and HCP groups across all treatment days. At baseline (pre-treatment), median pain scores were comparable between the two groups. However, post-treatment scores were consistently lower in the HCP group compared to the TENS group, resulting in larger median reductions in pain (ChangeNPRS). These patterns of greater pain reduction in the HCP group were visually illustrated in the box plot figures depicting the first treatment day of each month, as

well as in the line chart summarizing trends over time (Figure1-4). Together, these findings highlight the consistently superior short-term analgesic effect of HCP treatment compared with TENS.

Table 2: Median NPRS scores for each group across time.

Timepoints	Variables	TENS Group	HCP Group
1	PreNPRS	7	7
	PostNPRS	5	3
	ChangeNPRS	2	4
2	PreNPRS	7	6
	PostNPRS	5	3
	ChangeNPRS	1	3
3	PreNPRS	5	5
	PostNPRS	3	2
	ChangeNPRS	2	3
4	PreNPRS	7	7
	PostNPRS	5	3
	ChangeNPRS	2	4
5	PreNPRS	6	7
	PostNPRS	5	4
	ChangeNPRS	1	3
6	PreNPRS	5	6
	PostNPRS	4	2
	ChangeNPRS	2	3
7	PreNPRS	7	7
	PostNPRS	5	4
	ChangeNPRS	2	3
8	PreNPRS	7	7
	PostNPRS	5	3
	ChangeNPRS	2	4
9	PreNPRS	5	6
	PostNPRS	4	2
	ChangeNPRS	2	3

Friedman test results (Tables 3 and 4) indicated that while both interventions reduced pain, however, there was no statistically significant change in pain reduction throughout the treatment days for either group: TENS group, χ^2 (8) = 9.77, p = 0.282; HCP group, χ^2 (8) = 8.84, p=0.356.

Table 3. Friedman Test for Pain Reduction Across Nine Days in TENS Group (N = 15)

Months	Timepoint	Mean Rank	χ^2 (df)	P value
Month 1	Day 1	4.90		
	Day 2	4.57		
	Day 3	5.47		
			9.77 (8)	0.282
Month 2	Day 1	5.23		
	Day 2	4.57		
	Day 3	4.23		
Month 3	Day 1	5.60		
	Day 2	6.23		
	Day 3	4.20		

Table 4. Friedman Test for Pain Reduction Across Nine Days in HCP Group (N = 15)

Months	Timepoint	Mean Rank	χ^2 (df)	P value
Month 1	Day 1	5.67		
	Day 2	5.03		
	Day 3	3.93		
			8.84 (8)	0.356
Month 2	Day 1	5.90		
	Day 2	4.87		
	Day 3	4.83		
Month 3	Day 1	4.80		
	Day 2	5.83		
	Day 3	4.13		

As shown in Table 5, the HCP group exhibited significantly greater pain reduction throughout the treatment days compared to the TENS group. These differences remained statistically significant after

controlling for multiple comparisons using the Holm–Bonferroni method (all adjusted $p < 0.05$). The differences in mean ranks between the two groups were consistent, with large effect sizes across most time points ($r = 0.50–0.78$).

The results also revealed that participants with light menstrual flow experienced significantly greater pain relief than those with heavy flow ($U = 58.50$, $Z = -2.10$, $p = .036$), as shown in Table 6.

Table 5. Comparison of Pain Reduction between TENS and HCP Groups

Month	Timepoint	TENS Mean Rank	HCP Mean Rank	U	Z	p-value	Adjusted p-value	Effect Size (r)
Month 1	Day 1	9.53	21.47	23.0	-3.820	0.00013	0.00106	0.70
	Day 2	10.23	20.77	33.5	-3.367	0.00075	0.00227	0.61
	Day 3	11.00	20.00	45.0	-2.951	0.00316	0.00632	0.54
Month 2	Day 1	9.60	21.40	24.0	-3.743	0.00018	0.00109	0.68
	Day 2	9.90	21.10	28.5	-3.590	0.00033	0.00165	0.66
	Day 3	8.80	22.20	12.0	-4.277	0.00001	0.00017	0.78
Month 3	Day 1	11.23	19.77	48.5	-2.738	0.00617	0.00617	0.50
	Day 2	9.60	21.40	24.0	-3.796	0.00014	0.00102	0.69
	Day 3	9.90	21.10	28.5	-3.584	0.00033	0.00135	0.66

Table 6. Association between Menstrual Flow Type and Pain Reduction

Flow Type	N	Mean Rank	U	Z	Sig. (2-tailed)
Light	18	18.25	58.500	-2.101	0.036
Heavy	12	11.38			

Presented in table 7 is the result of test of association between pain reduction, duration of menstrual flow and participants pain relief preference. The result shows, no significant association between pain relief and duration of mensural flow ($p=0.952$); and pain relief preference ($p=0.417$).

Table 7. Association of Days of Flow, and Pain Relief Method with Pain Reduction

Variable	Groups (N)	Mean Rank	χ^2(df)	p
Days of Flow	4days (n=9)	15.28	0.343 (3)	0.952
	5days (n=9)	16.83		
	6days (n=2)	15.50		
	7days (n=10)	14.50		
Relief Method	Exercise (n=5)	12.40	1.752 (2)	0.417
	Analgesic (n=24)	16.48		
	No treatment (n=1)	7.50		

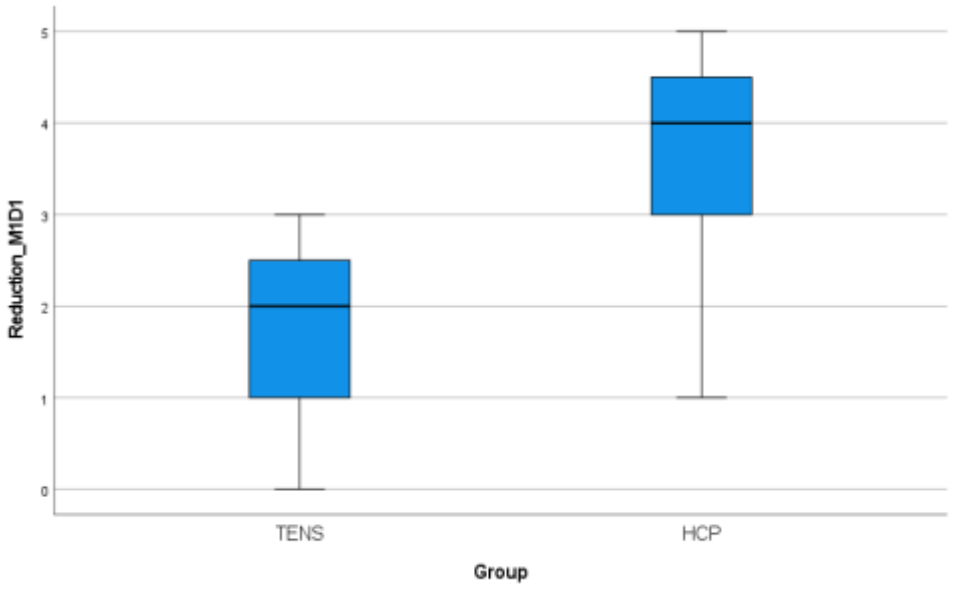

Figure 1: Median Pain Reduction Scores in TENS and HCP Groups at Month 1, Day 1

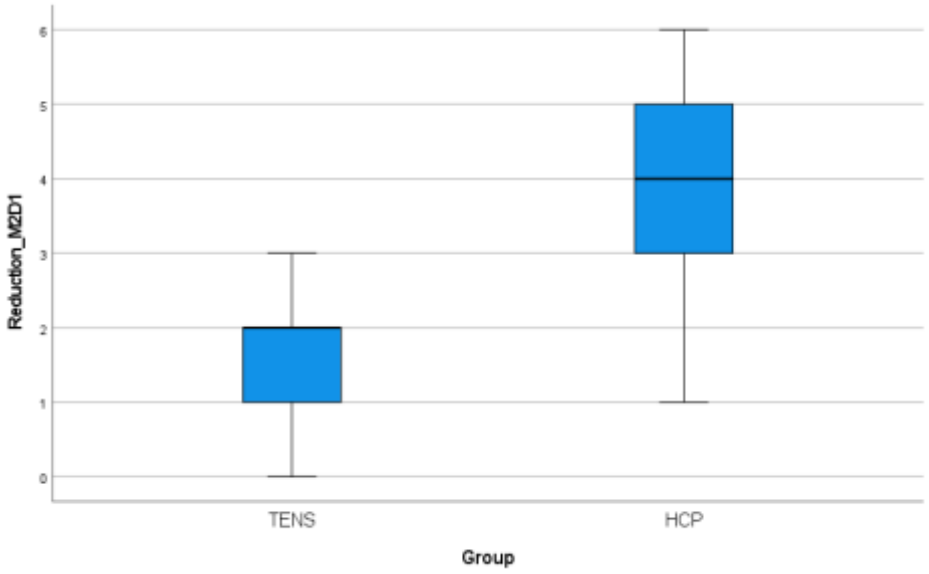

Figure 2: Median Pain Reduction Scores in TENS and HCP Groups at Month 2, Day 1

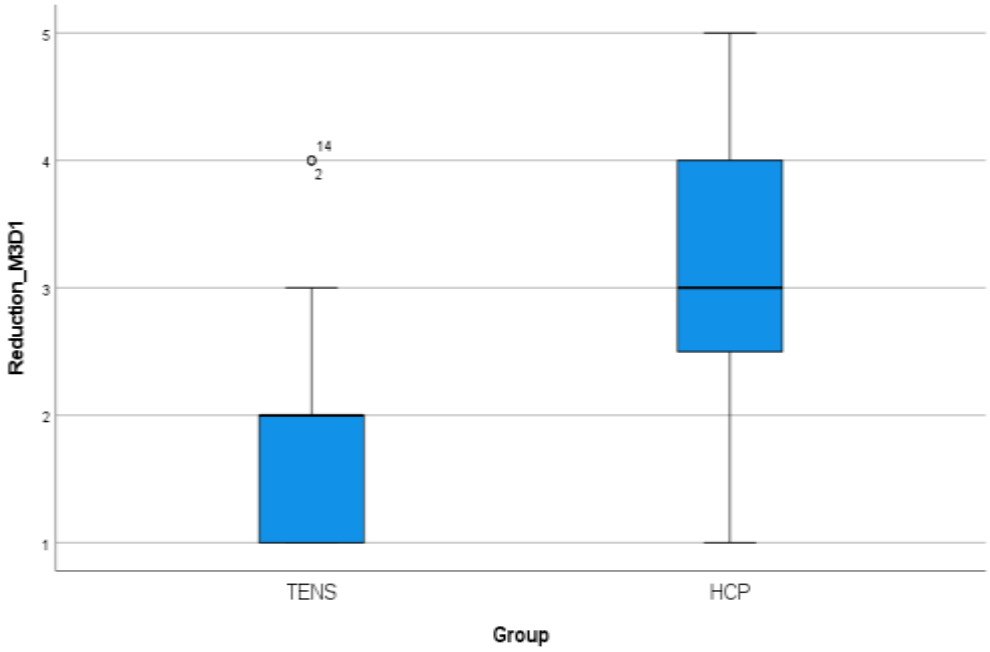

Figure 3: Median Pain Reduction Scores in TENS and HCP Groups at Month 3, Day 1

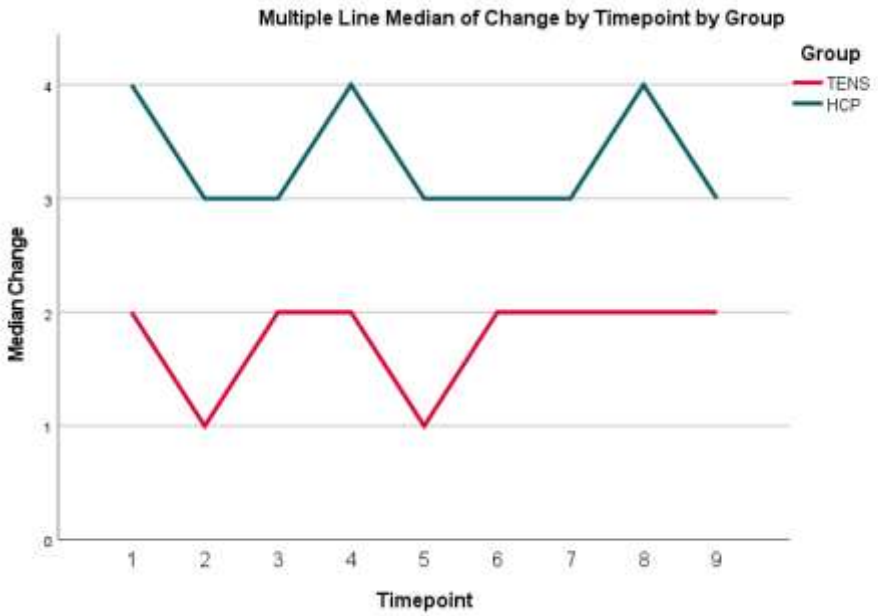

Figure 4: Line Chart of median pain reduction over nine time-points by group

4.0 Discussion

The purpose of the study was to compare the effectiveness of TENS and HCP on dysmenorrhea amongst female interns in Federal Medical Center, Owo. Although the study observed no statistically significant reduction in pain intensity within either the TENS or HCP groups over the treatment period, a significant difference in pain reduction was detected between the two groups. This apparent paradox warrants careful consideration. The lack of significant within-group pain reduction may be attributed to several factors, including sample size limitations, variability in individual pain perception, or the relatively short duration of the intervention. Small sample sizes can reduce the statistical power to detect within-group changes, even when clinically relevant improvements occur (Julious, 2005). Additionally, menstrual pain can be highly variable both within and between individuals, which may obscure subtle treatment effects when assessed over a limited timeframe (Lacovides *et al.,* 2015)

Despite the absence of significant within-group changes, the significant between-group difference suggests that HCP therapy may provide superior pain relief relative to TENS, supporting its relative clinical efficacy. This finding aligns with the physiological mechanisms underlying heat therapy, which enhances pelvic blood flow and relaxes uterine muscles (Jo *et al.,* 2018), potentially providing more consistent analgesic benefits. In contrast, TENS acts primarily through modulation of pain signaling pathways without directly influencing uterine contractility or blood flow. The between-group significance therefore may reflect differences in therapeutic mechanisms rather than absolute within-group efficacy over the short term.

It is also important to consider that measurement sensitivity and timing of pain assessments can influence detection of statistically significant changes (Schneider *et al.,* 2021). Pain intensity may fluctuate throughout the menstrual cycle, and single or infrequent assessments might not capture transient but meaningful pain relief. Future studies with larger samples, longer intervention durations, and more frequent pain measurements are recommended to clarify these dynamics and confirm the comparative effectiveness of these modalities.

Furthermore, the study revealed that participants with light menstrual flow experienced significantly greater pain relief than those with heavy flow. Previous studies have shown that heavy menstrual flow is associated with more pain as this is associated with more uterine contractions and tensed pelvic muscles (Celik *et al.,* 2009; Weisberg *et al.,* 2016; Yamamoto *et al.,* 2009). This suggests that the severity of menstrual flow may influence the effectiveness of non-pharmacological interventions such as TENS and HCP therapy, with lighter flow potentially associated with less intense uterine contractions and, consequently, a more favorable response to treatment (Tomás-Rodríguez *et al.,*2017). Additionally, the result of the present study found no difference in pain reduction among days of flow and relief method employed by the participants. This shows that more attention should be paid to individuals with heavy menstrual flow as HCP or TENS therapy may have to be combined with oral medications to improve greater pain reduction.

5.0 Clinical Implications of the Study

The integration of Transcutaneous Electrical Nerve Stimulation and Hydrocollator Pack therapy may serve as a viable adjunct to non-pharmacological pain management strategies for dysmenorrhea, particularly in settings where pharmacological options are limited or contraindicated. However, the application of these modalities should be approached with consideration for individual patient characteristics, resource availability, and established safety protocols. The observed greater pain-relieving effect among participants with lighter menstrual flow indicates that treatment efficacy may vary according to flow intensity. As such, tailoring interventions based on menstrual characteristics may enhance therapeutic outcomes. Further investigation is warranted to confirm these findings across broader and more diverse clinical populations.

6.0 Limitations of Study

A major limitation to this study was the small sample size, the variability in individual pain perception and the inability to confirm the truthfulness of participants abstinence from the use of analgesic such as non-steroidal anti-inflammatory drugs during the period of the study could have affected the result of the analysis. Caution should therefore be taken in generalizing the outcome of this study.

7.0 Conclusion

Evidence from this study showed that both Transcutaneous Electrical Nerve Stimulation (TENS) and Hydrocollator Pack (HCP) therapy produced modest reductions in dysmenorrhea-related pain; however, HCP therapy demonstrated significantly superior analgesic efficacy compared to TENS. The greater effectiveness of HCP therapy is likely due to its capacity to enhance pelvic blood flow and promote uterine muscle relaxation—mechanisms not directly influenced by TENS. Furthermore, pain relief was significantly more pronounced among participants with lighter menstrual flow, indicating that menstrual flow intensity is a key factor affecting treatment response. These findings show a necessity for personalized pain management approaches in dysmenorrhea, with heat therapy representing a particularly effective non-pharmacological option for individuals with dysmenorrhea. Further research is warranted to validate these findings across diverse populations and clinical settings.

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