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Effect of stretching exercises versus thermotherapy on restless legs syndrome symptoms, pain, and quality of sleep among pregnant women

Abeer Hassan Shamekh

Obstetric and Gynecological Nursing Department, Faculty of Nursing, Alexandria University, Egypt

Naglaa Zaki Hassan

Obstetric and Gynecological Nursing Department, Faculty of Nursing, Alexandria University, Egypt

Zohour Ibrahim Rashwan

Pediatric Nursing Department, Faculty of Nursing, Alexandria University, Egypt | Nursing Department, College of Health Sciences, University of Bahrain, Zallaq, Kingdom of Bahrain

Naglaa Fathy Fathalla

Obstetric and Gynecological Nursing Department, Faculty of Nursing, Alexandria University, Egypt

Abstract--Background: Restless legs syndrome (RLS) is a sensory-motor disorder affecting up to one in three pregnant women, which peaks during the third trimester and is linked to poor pregnancy outcomes. Symptoms typically worsen during a period of inactivity, especially at night, resulting in sleep disruption or deprivation. This study aimed to compare the effects of stretching exercises versus thermotherapy on RLS symptoms and sleep quality among pregnant women. Study design: A quasi-experimental study was carried out at the antenatal outpatient clinic of Maternity University Hospital. A sample of 60 pregnant women was randomly assigned to two groups. One group was instructed to perform leg stretching exercises daily for one week, and the other group applied thermotherapy. They rated their RLS symptoms, pain level, and sleep quality at baseline and after receiving interventions. Results: the severity of RLS symptoms declined to a mild level among pregnant women immediately and after one week of performing stretching exercises (53.3%, 93.3%), compared to 6.7% and 63.3% of those who applied thermotherapy ($p=0.001$, $p=$

0.02). After applying stretching exercise, 33.3% and 46.7% of pregnant women reported mild pain immediately after and one week later, compared to 10% and 73.3% of those who received thermotherapy application at their second and third pain assessment ($p = 0.028$, $p = 0.035$). One week after interventions, 93.3% of the stretching exercise group had good sleep quality, compared to 73.3% of the thermotherapy group ($p=0.038$). Conclusion: Both leg-stretching exercise and warm water thermotherapy have been proven to be effective, simple, and inexpensive interventions that alleviate RLS symptoms and pain among pregnant women. However, leg stretching exercise showed a superior effect. Since the daily application of the interventions for seven days helped the pregnant women to be mitigated such a great source of discomfort, they exhibited better sleep quality. Integrating non-pharmacological nursing for pregnant women with RLS for obtaining subtle and cumulative effects as well as maximizing symptom relief is recommended.

Keywords---stretching exercises, thermotherapy, restless legs syndrome, pain, sleep quality, pregnant women.

Introduction

Restless legs syndrome (RLS) is a common sensory-motor disorder affecting pregnant women, also known as Willis-Ekbom disease. According to the International RLS Study Group (Allen et al., 2003), this condition has four main diagnostic criteria; (a) a strong desire to move the legs associated with (b) a feeling of deep creeping motion especially (c) during a period of inactivity or rest. It is accompanied by (d) unpleasant painful sensation that is relieved by leg movement. This condition is mainly classified into primary and secondary. It could be related to idiopathic or genetic factors or secondary to pregnancy or other medical conditions such as renal insufficiency (Jafarimanesh et al., 2020b).

Pregnancy is thought to be an important etiologic factor that aggravates the occurrence of RLS (Sönmez and Aksoy Derya, 2018). It affects up to one-third of pregnant women, which peaks during the third trimester of pregnancy and then gradually declines after delivery (Darvishi et al., 2020). Although symptoms tend to be improved after labor, women who experience RLS during pregnancy are more likely to develop the chronic idiopathic form of such disorder (Goecke et al., 2020). The exact etiology of RLS during pregnancy has remained unclear. However, Jafarimanesh et al. (2020b) suggested three main factors that could explain the occurrence of this kind of illness during pregnancy. These factors include but are not limited to, an increase in the prolactin or estrogen levels, a decrease in the mother's physical activities during pregnancy, as well as the metabolic changes during pregnancy e.g., iron and folic acid deficiency.

Unfortunately, RLS has been linked to poor pregnancy outcomes. According to Minár et al. (2013), pregnant women who are RLS positives had a higher risk of serious complications during pregnancy such as threatened abortion, premature labor, and intrauterine growth retardation. Besides, Ramirez et al. (2013) found a

significant risk of getting preeclampsia in pregnant women with RLS symptoms. Moreover, RLS leads to daily fatigue, disruption of the ability to work, and social isolation. These problems lead to a poor quality of life and have a negative impact on social activities (Aliasgharpour et al., 2016). The RLS symptoms usually become worse at night, leading to sleep disturbances or deprivation, which in turn impairs the alertness of pregnant women during such a critical period (Mitchell, 2011). It's noteworthy that, sleep quality influences the type of delivery, the duration of the labor stages, neonate's Apgar score, and birth weight (Gupta et al., 2016). In that sense, Lee and Gay (2004) cited that women who sleep less than 6 hours or have interrupted sleep patterns experience prolonged labor and were more likely to have cesarean deliveries.

Chronic sleep deprivation during pregnancy activates the hypothalamo-pituitary-adrenal axis thus leading to abnormal immune responses (Gupta et al., 2016). Additionally, Schuh-Hofer et al. (2013) reported that sleep curtailment for a single night may exacerbate a state of anxiety and induce generalized hyperalgesia. Sleep deprivation impairs endogenous nociceptive-inhibitory function and increases the occurrence of pain. Thus, being deprived of sleep might not only induce hyperexcitability of the central nervous system, especially for those who suffer from chronic pain but may also serve as a primary etiological factor for discomfort. This may in turn ensure a vicious cycle; the increased pain associated with RLS results in poor sleep quality and this insomnia lowers pain thresholds, which then contributes to hyperalgesia.

Different pharmacological and non-pharmacological strategies have so far been recommended for managing RLS. Dopaminergic medications, anti-epileptics, and iron supplementation are the usual pharmacological treatments for this condition. However, these drugs have serious side effects on the fetus. Hence, the application of non-medicinal interventions is advisable for pregnant women to minimize the adverse effects of medication on the growing fetus (Augustina et al., 2020). The maternity nurses face the challenge of controlling and relieving RLS-associated manifestations. Non-pharmacological strategies are safe, simple, self-practiced, and cost-effective which may contribute to enhancing women's quality of life. Among these interventions, acupuncture, foot massage, transcutaneous electric nerve stimulation, vibration pad, compression devices, counterstrain manipulation, walking, infrared therapy, stretching exercise, and thermotherapy application are commonly used in RLS management (Augustina et al., 2020).

Warm water application or thermotherapy is a popular modality for managing symptoms that affect muscles and skeletal systems as RLS. It raises the skin temperature and enhances blood circulation. It results in increasing oxygen supply and nutrients to the affected tissues, which in turn alleviates the unpleasant symptoms. According to Kaplan et al. (2021), in their study, they found positive outcomes of hot water application on RLS during pregnancy. On the other hand, researches confirmed that movement based strategies can reduce the RLS-associated manifestations. Among the movement therapy methods, stretching exercises which considered one of the main therapeutic approaches that improve muscles' circulation, flexibility, and facilitate nutrition delivery to the cells. So, it may be beneficial in reducing the severity of RLS symptoms (Shahgholian et al., 2016). Up to the researcher's knowledge, scarce studies have

been undertaken to determine the effect of alternative nursing modalities on RLS during pregnancy. So, there is a need for sparking research that aims to explore the impact of these interventions on RLS symptoms and quality of sleep among pregnant women. Such knowledge paves the road for nurses to use safe, effective, easy to apply, and costless methods to control RSL.

Aim of the study

This study aimed to compare the effects of stretching exercises versus thermotherapy on RLS symptoms and sleep quality among pregnant women.

Research hypotheses

- Pregnant women who perform leg stretching exercises exhibit lower RLS symptoms severity and pain level than those who applied thermotherapy.
- Pregnant women who perform leg stretching exercises exhibit higher sleep quality than those who applied thermotherapy.

Materials and Methods

Materials

Research design and setting

A quasi-experimental, pre-posttest, two groups study was carried out at the antenatal outpatient clinic of Maternity University Hospital. in Alexandria, Egypt. This setting was chosen as it is the largest maternity health agency in Alexandria and has a high turnover of pregnant women.

Subjects

A convenience sampling of 60 pregnant women who fulfilled the following inclusion criteria was recruited: suffering from RLS according to the IRLSSG criteria during the third-trimester of a singleton pregnancy; rated restlessness severity greater than ten on the RLS Rating Scale, and compliant with an iron supplement to exclude iron deficiency and the associated poor tissue oxygenation which may interfere with the effectiveness of the intervention. While, women who had a high-risk pregnancy, e.g., preeclampsia, diabetes, and placenta previa as well as had leg cramps, periodic limb movement disorder, leg edema, myalgia, peripheral neuropathy, leg injuries, and anxiety were excluded from the study. The researchers interviewed 802 pregnant women to detect those who meet the previously mentioned criteria and suffer from moderate to severe RLS symptoms. The detected cases were 71 pregnant women. Epi info program version 10 was used to estimate the sample size using the following parameters; population size of 71, Confidence coefficient of 95%, expected frequency of 50%, and acceptable error of 5%. The minimum sample size required was 60 pregnant women. During the study period (September to the end of November 2021), 60 out of 71 pregnant eligible women who agreed to participate in the study were randomly assigned to two equal parallel groups using a random number generator program; one participant was assigned to the stretching exercise group (30 women), and the

next one was assigned to the thermotherapy group (30 women), as illustrated in Figure 1.

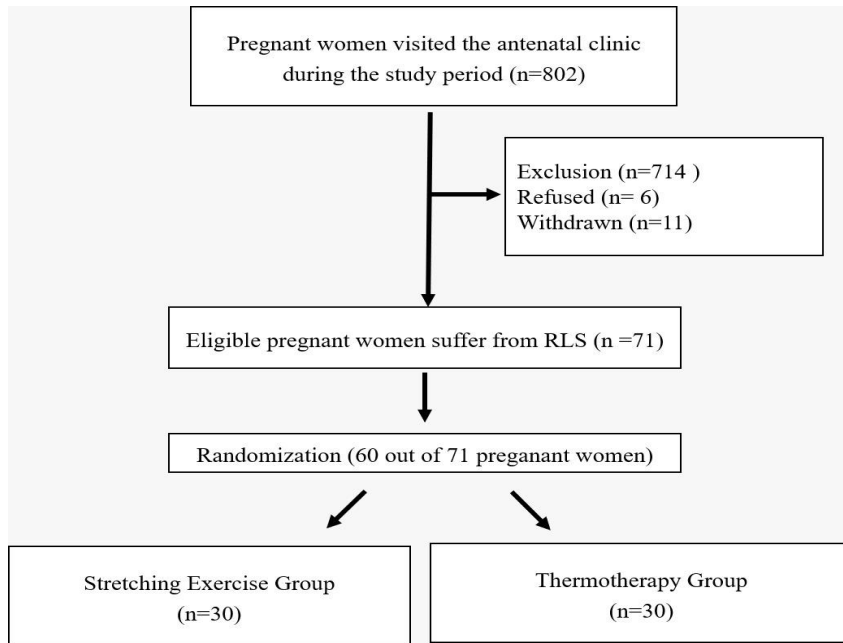


Figure 1. Flow chart of participants' recruitment process

Instruments

Tool I: RLS Rating Scale

This tool was adopted from the International RLS Study Group (Allen et al., 2003). The scale was designed to grade the severity of RLS symptoms. It is composed of ten items rated on a four-point Likert scale ranging from mild (1) to very severe (4). The total scores ranged from 10 to 40. The severity of women's restless leg symptoms was categorized as follows; very severe symptoms (scores 31- 40), Severe (scores 21- 30), Moderate (scores 11-20), Mild (scores 1-10). Abetz et al. (2006) tested RLS Questionnaire Rating Scale for validity and reliability. The concurrent validity was $r = 0.70$, and internal consistency, $\alpha=0.81$. The socio-demographic data such as age, education level, occupation, and residence as well as current pregnancy profile such as weeks of gestation, compliance with antenatal visits, and planning for the current pregnancy were attached to this tool.

Tool II: Numeric Pain Rating Scale (NPRS)

This tool was adopted from the Clinical Manual for Nursing Practice (McCaffery and Beebe, 1993). It is a unidimensional measure of pain severity in adult individuals; the 11-point numeric scale varies from "0" (no pain) to "10" (severe pain). It was used to assess four levels of pain: 0 = no pain, 1-3= mild pain, 4-6 = moderate pain, 7-10 = severe pain.

Tool III: Groningen Sleep Quality Scale (GSQS)

This scale is used to assess the subjects' sleeping patterns and overall sleep quality. It consists of 15-items that scored as true or false. One point was given for all the true items except items 8, 10, and 12 had reversed scores. The scoring system of this scale is as follows; the first question is not counted toward the total score therefore, scores ranged from 0 to 14. According to the total scores, the sleep quality was categorized into three categories; normal refreshing sleep "score 0-2", slightly disturbed sleep "scores 3-9", and poor quality of sleep "scores 10-14". In a validation study, the mean score on the scale was 6.0 ± 4.2 and Cronbach's alpha for internal consistency was 0.88 (Meesters et al., 1993).

Method

Initially, the researchers approached the pregnant women of both groups in the waiting area of the antenatal clinic, established rapport, and collected the socio-demographic data and current pregnancy profile. Moreover, baseline RLS symptoms severity, pain, and women's sleep quality were assessed.

Interventions

The researchers selected two interventions to alleviate RLS symptoms, and pain and enhance sleep quality. According to literature, stretching exercise promotes blood flow and enhances muscle flexibility and strength while thermotherapy has a soothing effect; enhances tissue oxygenation, and diminishes muscle spasms (Hanafy and Gbr, 2018; Kaplan et al. 2021; Shahgholian et al., 2016). For the stretching exercises group; the researchers explained to the women how to perform the stretching exercises through different visual materials like videos & pictures, provided a demonstration of each step, and emphasized that they could perform this exercise at any comfortable position, either standing, sitting, or dorsal. The procedure included four main steps: calf muscle, front thigh, hip flexor stretches, and ankle rotations.

- The woman was asked to extend her arms flat against a wall, palms facing forward and elbows nearly straight. They slightly bent their right knee and stepped back a foot or two with their left leg while keeping their heel and foot flat on the floor. Then, they were advised to hold for between 20 and 30 seconds, then alternate legs and repeat this step ten times more.
- Front thigh stretches: The women were asked to stand parallel to a wall for balance and pull one of their ankles toward the rear while maintaining a straight leg, hold for 20 to 30 seconds, swap legs, and repeat ten times more.
- Hip flexor stretches: The women were instructed to lie on their back, slowly lift one leg and hug their knee toward the chest until they felt a gentle hip stretch, making sure to keep the back relaxed and the opposite leg flat on the surface. Then they were asked to hold for 20-30 seconds, switch legs, and repeat the exercise ten times.
- Ankle rotations: The researcher instructed the woman to sit on the edge of a chair, with both feet firmly planted on the ground, and raise her right foot three inches off the ground while pointing her toes. They were also asked to

form a circle toward the right side, beginning with their toes and remaining stationary with the remainder of their legs. This step was followed by performing 10-15 circles in one direction, then swapping directions and performing another 10-15 circles in the opposite direction. The same steps were done to the left foot.

At the end of the session, women were informed to practice 30 minutes stretching exercises per day for one week. The researchers instructed every woman about the importance of compliance with the intervention they assigned to. For the thermotherapy group, women were instructed to warm the water to 43–47 C° using a water thermometer or test it with the inner aspect of their wrists. They are also advised to avoid using too hot or too cold water. Then immerse their legs for 20 minutes in the warm water at a height where the water level can reach their knees. The researchers emphasized that the procedure should be done every night for one week. For both groups, the intensity of RLS and pain severity of pregnant women of the two groups were reassessed after the first session.

Follow-up

The researchers contacted the pregnant women of the two groups daily and ascertained that they performed the interventions. Participants were also instructed to attend the antenatal outpatient clinic of Maternity University Hospital. after one week for follow- up where the intensity of RLS symptoms, severity, pain level, and sleep quality were reassessed.

Ethical considerations

Approval for conducting the study was obtained from the Ethical Research Committee review board of Faculty of Nursing, Alexandria University (15/9/2021) and registered in ClinicalTrials.gov (NCT05261035). The researchers obtained permission for conducting the study from the responsible authorities of the study setting as well. The study was conducted in accordance with the principles of the Declaration of Helsinki, 7th revision (World Medical Association, 2022). Before applying the interventions, the researchers approached pregnant women who fulfilled the inclusion criteria and provided them with a detailed description of the nature of the interventions, their benefits, and any possible risks. Researchers also ascertained that participation in the study is entirely voluntary. Their right to refuse to participate or withdraw from the study at any time without any change of the quality of the provided care was also emphasized. Confidentiality of the obtained data, women's anonymity, and privacy were assured. After the participants' agreement, they signed written informed consent.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) version 20.0 was utilized for data analysis. Descriptive statistics included number, percentage, the mean, and standard deviation to describe demographic characteristics, pregnancy profile, the intensity of RLS symptoms' severity, pain level, and sleep quality. Kolmogorov-Smirnov test was used to check the normality of study variables, and it showed that they were not normally distributed. In the inferential statistics, a comparison

between the pregnant women in the two study groups regarding their mean age was done using, Mann-Whitney (Z) tests. All of the statistical analyses were considered significant at $P < 0.05$.

Results

Table 1 shows that 60% of pregnant women in the stretching exercise group and 56.7% of the thermotherapy group were 20 to less than 25 years old, with a mean age of 25.87 ± 5.29 years in the stretching exercise group and 25.90 ± 5.33 years in the thermotherapy group. Moreover, 60% and 53.33% of women in the two groups respectively had completed their secondary education. The table also showed that 73.3% and 83.3% of participants respectively were housewives. Pregnancy profile illustrated in the same table, more than half of participants (53.3%) in the stretching exercise group and 46.7% of the thermotherapy group were in 24 to less than 31 weeks of gestation. More than half of pregnant women in both groups were irregularly attending their antenatal visits (53.3% and 60% respectively) and a sizable proportion of them had planned pregnancy (76.7% and 83.3% respectively). There were no significant differences between the studied groups regarding socio-demographic variables and pregnancy profile.

Table 1
Socio-demographic Characteristics and Current Pregnancy Profile of Pregnant Women

Characteristics & Pregnancy Profile	Stretching Exercise Group (n=30)	Thermotherapy Group (n=30)	Significance
	No. (%)	No. (%)	
A. Socio-demographic data			
Age (years)			
20-<25	18 (60.0)	17 (56.7)	$\chi^2=0.119$
25-<30	5 (16.7)	6 (20.0)	$p=0.942$
30-39	7 (23.3)	7 (23.3)	
Mean \pm SD	25.87 ± 5.29	25.90 ± 5.33	$U=447.0$
Median	24.0	24.0	$p=0.964$
Education			
Read and write	6 (20.0)	6 (20.0)	
Primary	6 (20.0)	8 (26.67)	$\chi^2=0.403$
Secondary	18 (60.0)	16 (53.33)	$p=0.817$
Occupation			
Housewife	22 (73.3)	25 (83.3)	$\chi^2=1.490$
Employee	8 (26.7)	5 (16.7)	$p=0.529$
Residence			
Rural	18 (60.0)	16 (53.3)	$\chi^2=1.667$

Urban 12 (40.0) 14 (46.7) p=0.197

B. Pregnancy Profile

Weeks of gestation

24-<31 16 (53.3) 14 (46.7) x²=0.504
 31-<35 5 (16.7) 6 (20.0) p=0.959
 35-40 9 (30.0) 10 (33.3)

Antenatal visits

Regular 14 (46.7) 12 (40.0) x²=0.271
 Not regular 16 (53.3) 18 (60.0) p=0.602

Pregnancy planned

Yes 23 (76.7) 25 (83.3) x²=0.417
 No 7 (23.3) 5 (16.7) p=0.519

x²: Chi-Square Test FET: Fisher's Exact Test U: Mann Whitney Test
 *Significant at *P ≤ 0.05

Table 2 illustrates that 56.7% of pregnant women in the stretching exercise group and 60% of pregnant women in the thermotherapy groups, experienced severe RLS symptoms before applying the interventions. Immediately after the interventions, there was an obvious decline in RLS symptoms severity among pregnant women in the stretching exercise group. As, 53.3% of them reported mild RLS symptoms, compared to 6.7% of those in the thermotherapy group. One week later, the majority (93.3 %) of the stretching exercise group had mild symptoms, compared to 63.3 % of the thermotherapy group. Significant differences were found between the two groups immediately (p = 0.001) and one week after the interventions (p = 0.020), in favor of the stretching exercise group.

Table 2
Total RLS Symptoms of Pregnant Women in Stretching Exercise and Thermotherapy Groups Before, Immediate and After One Week of Interventions

Total RLS Symptoms	<u>Before</u>		Sig.	<u>Immediately After</u>		Sig.	<u>After One Week</u>		Sig.		
	<u>Stretching</u>			<u>Thermotherapy</u>			<u>Stretching</u>			<u>Thermotherapy</u>	
	<u>Exercise Group</u> (n=30) No. (%)	<u>Group</u> (n=30) No. (%)		<u>Exercise Group</u> (n=30) No. (%)	<u>Group</u> (n=30) No. (%)		<u>Exercise Group</u> (n=30) No. (%)	<u>Group</u> (n=30) No. (%)			
Mild (1-10)	0 (0.0)	0 (0.0)	x ² =0.627	16 (53.3)	2 (6.7)	x ² =16.817* p<0.001*	28 (93.3)	19 (63.3)	x ² =7.954* p=0.020*		
Moderate (11-20)	8 (26.7)	9 (30.0)	p=0.871	12 (40.0)	26 (86.7)		2 (6.7)	11 (36.7)			
severe (21-30)	17 (56.7)	18 (60.0)		2 (6.7)	2 (6.7)		0 (0.0)	0 (0.0)			
Very severe (31-40)	5 (16.6)	3 (10.0)		0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)			

FET: Fisher Exact Test x²: Chi-Square Test *Significant at P≤0.001
 Figure-2 also shows that the mean total scores of RLS symptoms among the stretching exercise and thermotherapy groups before (24.13±6.55 and 23.27

± 6.45), immediate (11.50 ± 7.02 and 15.93 ± 4.69), and after one week of intervention (6.80 ± 3.89 and 10.43 ± 6.11).

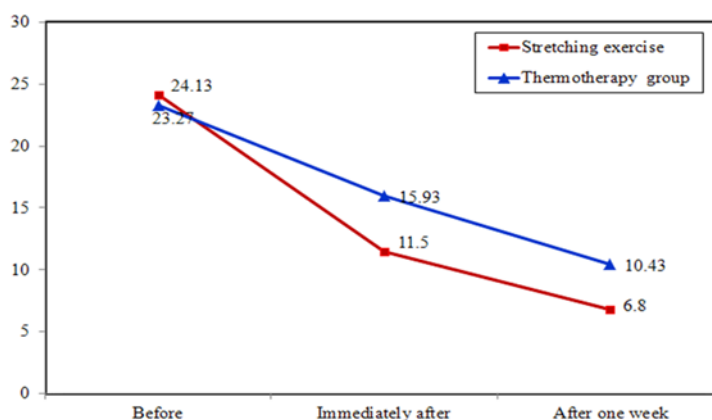


Figure 2. Total RLS Symptoms of Pregnant Women in Stretching Exercise and Thermotherapy Groups Before, Immediate, and After One Week of Interventions

Table 3 displays that 60% of pregnant women in the stretching exercise group and 70% of women in the thermotherapy group, reported severe levels of pain at the initial assessment. After applying stretching exercise, 33.3% and 46.7% of pregnant women reported mild pain immediately after and one week later. However, 10% and 73.3% of those received thermotherapy application at second and third pain assessment with significant differences between the two groups ($p=0.028$ for immediately after intervention and $p=0.035$ for one week later).

Table 3
Pain Levels of Pregnant Women in Stretching Exercise and Thermotherapy Groups Before, Immediate and After One Week of Interventions

Pain Levels	Before		Sig.	Immediately After		Sig.	After One Week		Sig.
	Stretching Exercise Group (n=30)	Thermotherapy Group (n=30)		Stretching Exercise group (n=30)	Thermotherapy Group (n=30)		Stretching Exercise Group (n=30)	Thermotherapy Group (n=30)	
	No. (%)	No. (%)		No. (%)	No. (%)		No. (%)	No. (%)	
No pain	0 (0.0)	0 (0.0)	$x^2=0.659$	0 (0.0)	0 (0.0)	$x^2=4.812^*$	16 (53.3)	8 (26.7)	$x^2=4.444^*$
Mild pain (1 - 3)	0 (0.0)	0 (0.0)	$p=0.417$	10 (33.3)	3 (10.0)	$p=0.028^*$	14 (46.7)	22 (73.3)	$p=0.035^*$
Moderate pain (4 - 6)	12 (20.0)	9 (30.0)		20 (66.7)	27 (90.0)		0 (0.0)	0 (0.0)	
Severe pain (7 - 10)	18 (60.0)	21 (70.0)		0 (0.0)	0 (0.0)		0 (0.0)	0 (0.0)	

FET: Fisher Exact Test

x^2 : Chi-Square Test

*Significant at $P \leq 0.05$

Figure-3 highlights a significant decline in the mean scores of pain intensity among the stretching exercise and thermotherapy groups before (6.93 ± 1.91 and 7.23 ± 1.72), immediate (4.13 ± 1.78 and 5.10 ± 1.03) and after one week of the interventions (0.90 ± 1.12 and 1.53 ± 1.22).

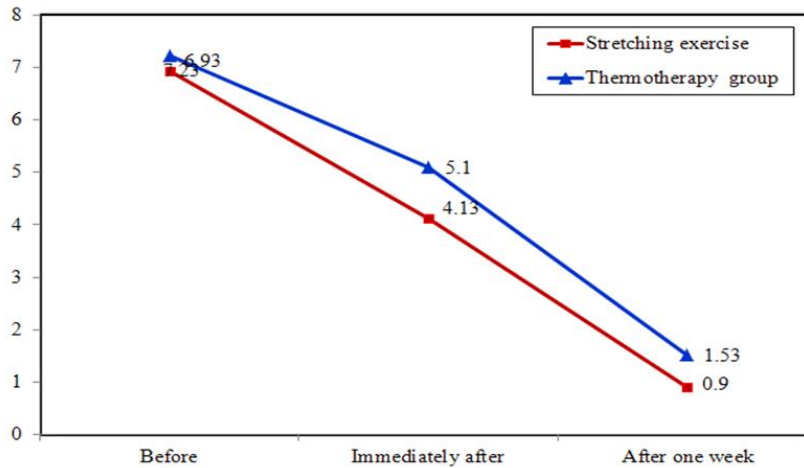


Figure 3. Pain Levels of Pregnant Women in Stretching Exercise and Thermotherapy Groups Before, Immediate, and After One Week of Interventions

Table 4 portrays that the majority of pregnant women in both the stretching exercise and thermotherapy groups (90% and 83.3%, respectively) had poor sleep quality at baseline assessment. One week after a daily application of the interventions, 93.3% of the stretching exercise group had good sleep quality, compared to 73.3% of the thermotherapy group, with a significant difference between the two groups ($p = 0.038$).

Table 4
Sleep Quality of Pregnant Women in Stretching Exercise and Thermotherapy Groups Before, and After One Week of Interventions

Sleep Quality	Before		Sig.	After One Week		Sig.
	Stretching Exercise Group (n=30)	Thermotherapy Group (n=30)		Stretching Exercise Group (n=30)	Thermotherapy Group (n=30)	
	No. (%)	No. (%)		No. (%)	No. (%)	
Good (0-4)	2 (6.7)	2 (6.7)	$\chi^2=1.135$ $p=0.846$	28 (93.3)	22 (73.3)	$\chi^2=4.320^*$ $p=0.038^*$
Fair (5-9)	1 (3.3)	3 (10.0)		2 (6.7)	8 (26.7)	
Poor (10-14)	27 (90.0)	25 (83.3)		0 (0.0)	0 (0.0)	

χ^2 : Chi-square test

*Statistically significant at $p \leq 0.5$

Discussion

Restlessness leg syndrome is likely affecting pregnant women approximately three times more than the general population (Tuna Oran et al., 2021). Accumulating evidence indicated that RLS symptoms are usually associated with adverse pregnancy outcomes. Sleep disruption is one of the major complaints of RLS, resulting in a deteriorative effect on the physical, mental, social, occupational,

and behavioral functions of pregnant women and their overall quality of life. Such sleep disturbances may result in excessive daytime sleepiness, which in turn has adverse effects on daily life activities (Silvestri and Aricò, 2019). Therefore, adopting the consensus clinical practice guidelines for RLS management is essential. The guidelines emphasize the importance of initiating RLS management during pregnancy and lactation safely with non-pharmacological interventions (Picchietti et al., 2015). These interventions encompass yoga, pneumatic compression devices, reflexology, massage with or without essential oils, thermotherapy, and moderate-intensity exercises like stretching exercises (Jahani Kondori et al., 2020; Silvestri and Aricò, 2019).

On investigating the effect of applying thermotherapy and stretching exercises, the findings of the current study revealed that more than half of pregnant women reported severe RLS symptoms and poor sleep quality before applying both interventions. At the same time, only a few participants had very severe symptoms in both groups, with no significant differences. Generally speaking, recent studies claimed that pain and sleep have an interdependent and reciprocal relationship which could be justified by the link between sleep disturbances and central sensitization which might imply overlapping mechanisms in the central nervous system. For instance, mesolimbic dopaminergic pathways play a fundamental role in both sleep regulation and endogenous analgesia. Consequently, decreased availability of dopamine may explain both sleep disturbances and inhibited endogenous analgesia among individuals with chronic pain (Finan and Smith, 2013). In addition, serotonergic pathways have shared modulatory mechanisms for regulating pain and sleep. Serotonin is important for top-down regulation of endogenous analgesia and circadian rhythm control. Serotonergic dysfunction can result in altered patterns of circadian behavior or even contribute to a disruption of sleep-wake homeostasis along with dysfunctional endogenous analgesia (Whitney et al., 2016).

Tuna Oran et al. (2021), observed similar findings in their study of RLS prevalence and its effect on maternal quality of life during pregnancy. They concluded that approximately half of the pregnant women in the third trimester had severe symptoms. The current study also revealed a significant decline in the severity of RLS symptoms and pain among women in both groups immediately and after one week of applying the interventions. Both interventions were effective, but stretching exercise had a superior effect than warm water leg thermotherapy. After seven days of performing stretching exercises, these results suggested that the time duration of performing stretching exercises was probably enough to achieve its subtle and cumulative effects. This is consistent with a study conducted by Augustina et al. (2020) on the effect of Transcutaneous Electrical Nerve Stimulation (TENS) combined with stretching exercises on RLS in pregnant women. They concluded that stretching exercises combined with TENS resulted in a significantly higher positive outcome in RLS total scores.

Since RLS symptoms are intensified during a period of inactivity or rest, the improvement of symptoms with exercise activity could be explained in the light of the fact that practicing exercise increases cardiac output and blood flow, alleviating RLS symptoms by reducing peripheral hypoxia in muscles. It also increases endorphin and dopamine release, which has analgesic effects (Akbaş

and Yaman Sözbir, 2021). Therefore the similarity between our findings and Augustina et al. (2020) is consistent with what is elicited in the literature about the effect of stretching exercises. Regarding the effect of stretching exercise on pain severity, similar findings were reported by Augustina et al. (2020), who revealed that the mean of the Numeric Pain Rating Scale (NPRS) after stretching exercise was 4.93, while the mean of the NPRS in the control group was 7.60. Additionally, Lorena et al. (2015) stated in their systematic review about the effects of muscle stretching exercises on fibromyalgia that there was considerable improvement in all studies regarding pain, the quality of life, and physical condition. Again, Kim et al. (2018) reported that a stretching-based rehabilitation program significantly reduces pain and increases muscle flexibility and strength.

It is worthy of note that warm water leg thermotherapy also has a soothing effect, which was reflected in reducing the RLS symptoms and pain severity immediately after application and seven days later. In parallel, Kaplan et al. (2021) evaluated the effect of hot water application on pregnant women with RLS and concluded that applying hot water alleviated the RLS symptoms of pregnant women. Hanafy and Gbr (2018) claimed that the effectiveness of stretching exercises could be complemented with continuous ultrasounds heating before moving pregnant women's legs. Heating tissue before stretching will lead to a marked increase in the blood flow to the tissues which become more pliable and reach the maximum stretching abilities (Hanafy& Gbr, 2018). Additionally, the current finding is also consistent with Nasiriani and Eftekhari (2016), who found that more than half of hemodialysis patients' RSL symptoms became moderate following a hot water bag administration.

Altogether, the favorable effect of thermotherapy application reported in the literature is linked to the increased superficial heating, which reduces sympathetic nerve drive, dilates local blood vessels, and improves circulation to deep muscle structures (Mooventhan and Nivethitha, 2014). This enhances tissue oxygenation, promotes muscle elasticity, as well as decreases metabolite production, and diminishes muscle spasms (Becker et al., 2009; Cochrane, 2004). On the contrary, Jafarimanesh et al. (2020) compared the effect of thermotherapy versus cryotherapy in decreasing RLS symptoms during pregnancy", they recommended cold water application for greater relief of symptoms. Since the daily application of both stretching exercises and leg thermotherapy for seven days alleviated the pregnant women's RLS and pain, the results of the present study revealed an improvement in their sleep quality as well. Our findings also showed a more significant impact of stretching exercises than thermotherapy on the quality of sleep. Recently, Fauzi, & Triaswati, (2021) concluded that intradialytic stretching training might substantially reduce RLS symptoms and enhance sleep quality. Besides, a study conducted by (Jafarimanesh et al., 2020a) found that a warm foot bath improved sleep quality among pregnant women with RLS.

Conclusion

Both leg stretching exercise and warm water thermotherapy have been proven to be effective, simple and inexpensive non-pharmacological nursing interventions that alleviate RLS symptoms and pain among pregnant women. However, leg

stretching exercise showed a superior effect. Since, the daily application of the interventions for seven days helped the pregnant women to be mitigated from such a great source of discomfort, they exhibited a better sleep quality.

Recommendations

The authors suggested integrating both leg stretching exercises and thermotherapy for pregnant women with RLS to obtain subtle and cumulative effects of each of them and maximize symptoms relief. Adopting innovative non-pharmacological nursing interventions to alleviate RLS symptoms and pain is also recommended.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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