Shiraz E-Med J. In Press(In Press):e84279. doi: 10.5812/semj.84279.

Published online 2019 June 9. **Research Article**

The Relationship Between Leg Muscle Cramps and Sleep Quality in Pregnant Women Visited the Health Centers in Tabriz

Ameneh Mansouri [1], Ellahe Bahrami-Vazir [2], Sakineh Mohammad-Alizadeh-Charandabi [3], Fatemeh Ghelichkhani [4] and Mojgan Mirghafourvand [3,*]

[1]Department of Midwifery, Kamali Hospital, Alborz University of Medical Sciences, Karaj, Iran
[2]Department of Midwifery, Faculty of Nursing and Midwifery, Ilam University of Medical Science, Ilam, Iran
[3]Department of Midwifery, Social Determinants of Health Research Centre, Faculty of Nursing and Midwifery, Tabriz University of Medical Sciences, Tabriz, Iran
[4]Department of Midwifery, Faculty of Nursing and Midwifery, Iran University of Medical Sciences, Tehran, Iran

[*]*Corresponding author*: Department of Midwifery, Social Determinants of Health Research Centre, Faculty of Nursing and Midwifery, Tabriz University of Medical Sciences, Tabriz, Iran. Tel: +98-9143206121, Fax: +98-4134772699, Email: mirghafourvand@gmail.com

Received 2018 September 15; **Revised** 2019 March 19; **Accepted** 2019 March 26.

Abstract

Background: Leg muscle cramps (LMCs) and sleep disorders are a common problem during pregnancy, and may be correlated.
Objectives: The aims of this study were to determine the features of LMCs and sleep quality as well as their association in the third trimester of pregnancy.
Methods: This cross-sectional study was conducted on 439 pregnant women referred to health centers/posts of Tabriz, Iran, in 2014. The participants were selected through double stage cluster sampling method. Data were collected by using a socio-demographic questionnaire, Pittsburgh sleep quality index and leg muscle cramp characteristics questionnaire. Chi-square, Independent *t*, Pearson and Spearman correlation and Mann-Whitney U tests were used for data analysis.
Results: The mean ± SD total sleep quality score was 8.8 ± 3.9, within a possible score range of 0 to 21. About 84% of the women had sleep quality disturbances. LMCs were observed in more than half of the participants and there was a statistically significant correlation between the occurrence of LMCs and total sleep quality score (P = 0.001) and sub domains of sleep disturbances and daytime dysfunction (P < 0.001). There was also a significant relationship between occurrence of sleep quality disturbances and occurrence of LMCs (P = 0.006).
Conclusions: The present study showed that leg muscle cramps and sleep disorder are common during pregnancy and sleep quality disturbances are correlated with occurrence of leg muscle cramps. Prevention and treatment actions should be considered in the prenatal care.

Keywords: Leg Muscle Cramp, Sleep Quality, Pregnancy

1. Background

Leg muscle cramps (LMCs) are defined as the sudden and involuntary tonic-clonic painful contractions of leg muscles (1), which usually occur at nights and may lead to sleep disturbances (2, 3). LMCs are common during pregnancy, especially in the third trimester (4), with a prevalence of 30% to 55% (4, 5).

The mechanism of LMCs during pregnancy is unclear (4) and their possible causes are metabolic and physiological changes during pregnancy (4, 6), increased pressure on the leg muscles, pressure on the blood vessels and nerves due to uterine enlargement, imbalance between absorption and excretion of electrolytes and vitamins and the need for fetuses to absorb minerals and vitamins from their mothers (4-8).

The relationship between LMCs and sleep disorder is not known. In the study of Hensley et al., LMCs were associated with daytime sleepiness, sleep latency and daytime dysfunction (4), while in the study of Jahdi et al., no relationship was found between LMCs and sleep disorder (9).

Physiological and hormonal changes in pregnancy may affect sleep (10). Not finding a comfortable sleep position (11), common pregnancy complications (10), low back pain and LMCs during pregnancy may lead to sleep disorder (11); and sleep quality decreases with the progress of pregnancy (12). About 6% to 46% of pregnant women have sleep disturbances (12), and they may experience decreased overnight sleep, frequent night-time waking and sleep apnea (11).

Sleep disorder during pregnancy can lead to adverse

consequences such as diabetes, hypertension, Cesarean section (13), preterm labor (14), as well as loss of quality of life (15), depression and mood disorders during pregnancy and postpartum period (16, 17).

LMCs in pregnancy have been studied by Sohrabvand and Karimi (5). The sleep quality and sleep disorder in pregnancy have been investigated by Effati-Daryani et al. (15) but no study has been conducted in Iran on the features of LMCs (number of cramps, the duration of cramping and the severity of pain) during pregnancy and its relationship with sleep quality.

2. Objectives

Considering the potential impact of pregnancy on LMCs, the sleep quality and the effect of sleep quality on the outcome of pregnancy, this study was conducted to determine the features of LMCs and sleep quality as well as their association in the third trimester of pregnancy.

3. Methods

3.1. Study Design and Participants

A descriptive-analytical cross-sectional study was conducted on pregnant women visiting Tabriz health centers. The inclusion criteria included pregnant women aged 15 - 49, at the twenty-eighth week of pregnancy and above, education level primary school or higher. The exclusion criteria included chronic diseases and taking sleep medications.

3.2. Sample Size

Considering the prevalence of 54% LMCs in the third trimester of pregnancy, the sample size of the study of Sohrabvand and Karimi (5) was calculated to be 328 participants, while α was equal to 0.05 and the acceptable error rate was 0.1. Due to the use of cluster sampling, the calculated sample size was multiplied by 1.5 (design effect) and the final sample size was calculated to be 439.

3.3. Sampling

Sampling was conducted using the two-stage cluster method. Fourteen health centers and 15 health bases were randomly selected from among the 42 health centers and 44 health bases in Tabriz. In Iran, the majority of pregnant women visit public health centers and bases. Therefore, a list of 28-week pregnant women with prenatal care records in these health centers and bases was prepared and the study samples were selected randomly from each of the centers. The researcher contacted them using the telephone number of the individuals in their records, and gave them an explanation of the reasons for doing this study, manner of research and confidentiality of the information. They were then evaluated in terms of inclusion or exclusion criteria. In case of being eligible, they were asked to visit the health center to fill out the questionnaires. After attending the health center, the informed consent for participation in the research was taken from participants and the information was collected using questionnaires filled out by the participants. Questionnaires were completed via self-report.

3.4. Data Collection Tool

The data collection tool included a demographic information questionnaire, Pittsburgh sleep quality index (PSQI), LMCs features questionnaire and the visual analog scale (VAS). Demographic information and LMC features questionnaires were made by the researchers and the questions of LMCs questionnaire included the occurrence of leg muscle cramps, number of cramps and duration of cramps.

Pittsburgh sleep quality index (PSQI) was used to measure the sleep quality. This standard questionnaire had 18 questions with seven sub-scales, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication, and daily daytime dysfunction. The score for each question was from 0 to 3 and the score for each sub-scale was maximum 3. The total mean scores of the sub-scales formed the total score of the research instrument in the range of 0 - 21, so that the higher score indicating the lower sleep quality. A score of 5 and above indicates poor sleep quality. The reliability, sensitivity and specificity of the questionnaire were equal to 0.83, 89.6% and 86.5%, respectively (18) which have been used in various studies in Iran (15, 19).

The severity of pain caused by LMCs was measured by the visual analog scale (VAS) scale, with a score of 0 to 10, so that 0 indicated the lack of pain, and 10 indicated severe pain. This questionnaire was first used by Freyd (20). The reliability of the questionnaire in terms of repeatability was 95% (21).

The content validity was used to determine the validity of the tools used. The questionnaires were provided to ten faculty members of Tabriz University of Medical Sciences. According to their views, the necessary modifications were made to the questionnaires.

3.5. Statistical Analysis

Data analysis was conducted using SPSS V. 21. Normality of quantitative data was investigated with Skewness and Kurtosis. The overall sleep score, sleep disturbances, and

severity of pain had normal distribution; and the subjective quality of sleep, sleep latency, sleep duration, sleep efficiency, the use of sleep medications, day time dysfunction, number of LMCs per week and duration of LMCs had non-normal distribution.

In order to determine the relationship between the overall score of sleep quality and the sub-scales of sleep quality with LMCs, the sub-domains with normal distribution were examined by Independent *t*-test; and the sub-domains with non-normal distribution were examined by Mann-Whitney U test. The relationship between the overall score of sleep quality and the sub-scales of sleep quality with the duration and number of LMCs per week were examined using the Spearman correlation test; and the relationship between the overall score of sleep quality and the sub-scales of sleep quality with severity of LMCs in the sub-scales that had normal distribution were examined using the Pearson correlation test; and sub scales with non-normal distribution were examined using the Spearman correlation test. The relationship between occurrence sleep quality disturbances with occurrence LMCs was measured by chi-square test, and its relationship with the duration of cramping and the number of LMCs was measured by Mann-Whitney U test. The relationship between occurrence sleep quality disturbances with severity of LMCs measured by Independent *t*-test. The significance level in the tests was less than 0.05.

4. Results

The average age of participants was 27.5 years, the majority of them (94%) were housewives, about one third (36%) had high school education (Table 1).

The mean ± standard deviation (SD) of the overall sleep score was 8.8 ± 3.9, ranging from 0 to 21; and 84.1% of pregnant women had sleep quality disturbances. The highest mean ± SD of the score was related to the subscales of sleep latency (1.5 ± 1.1) and sleep disturbances (1.5 ± 0.6); and the lowest mean ± SD scores belonged to the sub-scales of taking sleep medications (0.03 ± 0.3) (Table 2).

More than half of the participants (57.9%) suffered from LMCs and the mean ± SD of the number of LMCs per week was 6.6 ± 7.8, duration of LMCs was 40.2 ± 178.1 minutes and pain severity was 6.0 ± 2.6 in terms of VAS (Table 2).

There was a statistically significant relationship between LMCs and total score of sleep quality (P = 0.001) and sub scales of sleep disturbances and day time dysfunction (P < 0.001). There was also a statistically significant relationship between the number of LMCs per week and the subscale of sleep disturbances (P = 0.036). Duration of LMCs per week had a significant relationship with total score of sleep quality (P = 0.002), sub scales of sleep latency (P = 0.021), sleep duration (P = 0.010), sleep efficiency (P = 0.039) and sleep disturbances (P = 0.044). There was also a significant relationship between the severity of pain and total sleep quality (P = 0.037), subscales of sleep duration (P = 0.004) and sleep efficiency (P = 0.039). There was also a significant relationship between occurrence of sleep quality disturbances and occurrence LMCs (P = 0.006) (Table 3).

Table 1. Socio-Demographic Characteristics in Pregnant Women (N = 439)

Characteristics	Values[a]
Age, y	27.5 ± 5.8
Educational level, y	
Primary	65 (14.8)
Secondary, high school	150 (34.2)
Diploma	158 (36)
University	66 (15)
Employment, housewife	413 (94.1)
Sufficiency of income	
Completely	42 (9.6)
To some extent	320 (72.9)
Absolutely not	77 (17.5)
Parity	
1	184 (41.9)
2	154 (35.1)
≥ 3	101 (23)

[a]Values are expressed as mean ± SD or No. (%).

Table 2. Sleep Quality and Characteristic of LMCs in Pregnant Women (N = 439)

Variable	Values[a]
Total sleep quality score	8.8 ± 3.9
Subjective sleep quality	1.1 ± 1.1
Sleep latency	1.5 ± 1.1
Sleep duration	1.3 ± 1.2
Habitual sleep efficiency	1.7 ± 1.2
Sleep disturbance	1.5 ± 0.6
Use of sleeping medication	0.03 ± 0.3
Daily daytime dysfunction	1.3 ± 1.0
Number of LMCs per week	6.6 ± 7.8
Duration of LMCs, min	40.2 ± 178.1
Pain severity of LMCs (VAS)	6.0 ± 2.6
Occurrence LMCs	254 (57.9)
Occurrence sleep disturbances	369 (84.1)

Abbreviations: LMCs, Leg Muscle Cramps; VAS, visual analog scale.
[a]Values are expressed as mean ± SD or No. (%).

Table 3. Relationship Between LMCs and Total Sleep Quality Score and Sub Domains and Sleep Disturbances

Variable	Characteristic of LMCs			
	Occurrence LMCs	Number	Duration	Pain Severity
Total sleep quality score	0.001[a]	0.400[b]	0.002[b]	0.037[c]
Subjective sleep quality	0.203[d]	0.208[b]	0.079[b]	0.784[b]
Sleep latency	0.109[d]	0.392[b]	0.021[b]	0.445[b]
Sleep duration	0.161[d]	0.920[b]	0.010[b]	0.004[b]
Habitual sleep efficiency	0.331[d]	0.605[b]	0.039[b]	0.039[b]
Sleep disturbance	< 0.001[a]	0.036[b]	0.044[b]	0.304[c]
Use of sleeping medication	0.238[d]	0.739[b]	0.0905[b]	0.717[b]
Daily daytime dysfunction	< 0.001[d]	0.307[b]	0.227[b]	0.825[b]
Occurrence sleep disturbances	0.006[e]	0.549[d]	0.149[d]	0.053[a]

Abbreviation: LMCs, leg muscle cramps.
[a] Independent *t*-test.
[b] Spearman correlation test.
[c] Pearson correlation test
[d] Mann-Whiney U test.
[e] Chi-square test.

5. Discussion

The present study was conducted for the first time in Iran with the aim of determining the relationship between LMC features and sleep quality in the third trimester of pregnancy. More than half of the pregnant women (58%) had LMCs and 84% had sleep quality disturbances. There was a significant relationship between LMCs and overall score of sleep quality and sub scales of sleep disturbances and day time dysfunction.

There was also a significant relationship between the number of LMCs per week and the sub scale of sleep disturbances. There was a statistically significant relationship between the duration of LMCs per week and the overall score of sleep quality and sub-scales of sleep latency, sleep duration, sleep efficiency and sleep disturbances. This relationship was also observed between the severity of pain and the overall score of sleep quality and subscales of duration of sleep and sleep efficiency. There was also a significant relationship between occurrence of sleep quality disturbances and occurrence of LMCs.

In the present study, more than half of the participants (58%) suffered from LMCs. The average number of LMCs per week was 6.6, the mean duration of LMCs was 40 minutes, and the severity of cramps was 6 based on VAS. Sohrabvand and Karimi reported LMCs in the second half of pregnancy by 54% (5). Valbo and Bohmer reported LMCs in pregnancy by 45%; and 54% of LMCs occurred after 25 weeks of pregnancy (2). Mindell et al. also reported a high incidence of LMCs from the second month of pregnancy to the end of pregnancy by 21% to 50%, and the highest frequency (50%) was reported to be in the eighth month of pregnancy and above (11). The results of these studies were consistent with the present study indicating that LMCs are a common problem in the third trimester of pregnancy. The prevalence of LMCs in non-pregnant women was reported to be 33% in the systemic review performed by Hallegraeff (22). The difference in the prevalence of LMCs may be due to the effect of pregnancy on LMCs (4).

In a study by Valbo and Bohmer, 76% of pregnant women often had LMCs twice a week, and 81% had LMCs at nights (2). The inconsistency of their results with the results of the present study may be due to the difference in the time of research. In the present study, LMCs were examined in the third trimester of pregnancy; but in the study of Valbo, LMCs during pregnancy were examined after delivery; and therefore, forgetting the frequency of MLCs might be effective on the results of this study. Grandner and Winkelman studied LMCs in women aged 18 - 80 years old and reported its prevalence as less than 15 times a month (23). Roffe et al. reported that the mean number of LMCs in women over the age of 65 were 4.4 (24). In the systematic review study done by Hallegraeff et al., the duration of LMCs in female and male participants aged 51 to 75 years were from a few seconds to a maximum of 10 minutes (22). The effect of pregnancy on the number, duration, and severity of LMCs may be the reason for the inconsistency of the results of their study with the results of the present study.

In the present study, the mean overall score of sleep quality was 8.8%; and 84% of pregnant women had sleep quality disturbances. The highest mean score was observed in the sub-scales of sleep latency and sleep disturbances; and the lowest mean score was observed in the subscales of taking sleep medications. Studies conducted us-

ing the PSQI questionnaire, have shown the overall score of sleep quality in a wide range. Blair et al. reported the overall score of sleep quality in the 19 - 30 week of pregnancy as equal to 6.9 and the frequency of sleep disorder as equal to 57% (14); but Jahdi et al. reported the average overall score of sleep quality in the second trimester of pregnancy as equal to 7.7 and the frequency of sleep disorder as equal to 87.2 (9). Effati-Daryani et al. reported the mean overall score of sleep quality in the second and third trimester of pregnancy as equal to 3.6; and the prevalence sleep quality impairment as equal to 6%. The highest mean score was observed in the sub-scale of day time dysfunction and the lowest mean score was observed in the sub-scale of taking sleep medications (15). In the meta-analysis performed by Sedov et al., the mean overall score of sleep quality with the PSQI questionnaire was equal to 3.5 in the second trimester of pregnancy and 7.3 in the third trimester of pregnancy. As the gestational age increased, sleep quality decreased and the prevalence of sleep quality impairment during pregnancy varied from 6% to 46% (12).

In the present study, the overall score of sleep quality had a significant relationship with LMCs, the duration of cramping and the severity of pain. There was also a significant relationship between sleep disturbances and the number of LMCs and the duration of cramping, as well as between occurrence of sleep quality disturbances and occurrence of LMCs. In the studies of Hensley et al. and Mindel et al., LMCs led to sleep disturbances, day-time sleepiness, day time dysfunction, inability to concentrate, and irritability in pregnancy (4, 11). In the study of Valbo and Bohmer, the severity of pain caused by LMCs during pregnancy led to nighttime awakening (2), while there was no statistically significant association between LMCs and sleep disorder in the second trimester of pregnancy in the study of Jahdi et al. (9) which is not consistent with the results of the present study. The reason for this may be the difference in gestational age when examining the association between LMCs and the quality of sleep. In a systematic review of women and men aged 51 - 75 by Hallegraeff et al., LMCs had an association with sleep disturbances (22). An examination of 18 to 80 years old women by Grandner and Winkelman revealed the relationship between LMCs and sleep disorder such as difficulty in falling asleep (sleep latency), difficulty in the continuation of sleep, daytime sleepiness, taking sleep medications and duration of sleep (23). The results of the study by Hawke et al. on the relationship of LMCs with reduced sleep efficiency (25) and the results of the study of Grandner and Winkelman on the relationship of foot LMCs with sub-scales of sleep disturbances, sleep latency, difficulty in continuation of sleep, taking sleep medications and the duration of sleep (23) are not consistent with the results of the present study, which may be due to the reduction in the length of nightly sleep during pregnancy (11) and the reduced use of medications during pregnancy due to concerns about injury to the fetus.

The present study had strong points, including the inclusion of women in reproductive age (15 - 49 years old), and consideration of no limits for these women. The PSQI standard questionnaire used in various studies in Iran and in the world was also used in the present study to examine the sleep quality.

The first limitation of the present study was to conduct a cross-sectional study. Therefore, it was not possible to study the features of LMCs and sleep quality in different months of pregnancy. Due to the cross-sectional nature of the study, it was not possible to determine the causal relationships correctly. The lack of access to the objective scales for examining the LMCs was another limitation.

5.1. Conclusions

In the present study, more than half of the women had LMCs and more than three quarters of women had sleep disturbances. There was a significant relationship between LMCs and overall score of sleep quality and sleep quality impairment. Considering the wide range of sleep disturbances, midwives' care during pregnancy should be considered in order to prevent, identify and treat sleep disturbances.

Acknowledgments

We would like to thank authorities of Tabriz University of Medical Sciences for the scientific and ethical approval and financial support of this research.

Footnotes

Authors' Contribution: Study concept and design and acquisition of data: Mojgan Mirghafourvand, Sakineh Mohammad-Alizadeh-Charandabi and Ameneh Mansouri; analysis and interpretation of data, and drafting of the manuscript: Mojgan Mirghafourvand, Sakineh Mohammad-Alizadeh-Charandabi, Ameneh Mansouri and Ellahe Bahrami-Vazir; critical revision of the manuscript for important intellectual content: Mojgan Mirghafourvand, Fatemeh Ghelichkhani and Ellahe Bahrami-Vazir; study supervision Mojgan Mirghafourvand. The manuscript has been read and approved by all the authors.

Conflict of Interests: The authors declare that they have no conflict of interest.

Ethical Approval: This study was approved by Research Committees of Tabriz University of Medical Sciences.

Funding/Support: Financial support was provided by the Deputy of Research, Tabriz University of Medical Sciences.

Patient Consent: The informed consent for participation in the research was taken from all participants.

References

1. Young G. Leg cramps. *BMJ Clin Evid*. 2009;**2009**. [PubMed: 19445755]. [PubMed Central: PMC2907778].
2. Valbo A, Bohmer T. [Leg cramps in pregnancy–how common are they?]. *Tidsskr Nor Laegeforen*. 1999;**119**(11):1589–90. Norwegian. [PubMed: 10385800].
3. Mansouri A, Mirghafourvand M, Mohammad Alizadeh Charandabi S, Khodabandeh F. [Prevalence of leg cramps in the third trimester of pregnancy and its relationship to nutritional behavior and consumption supplementation in pregnancy]. *J Sabzevar Univ Med Sci*. 2016;**23**(5):740–7. Persian. doi: 10.21859/sums-2305740.
4. Hensley JG. Leg cramps and restless legs syndrome during pregnancy. *J Midwifery Womens Health*. 2009;**54**(3):211–8. doi: 10.1016/j.jmwh.2009.01.003. [PubMed: 19410213].
5. Sohrabvand F, Karimi M. [Frequency and predisposing factors of leg cramps in pregnancy: A prospective clinical trial]. *Tehran Univ Med J*. 2009;**67**(9):661–4. Persian.
6. Miller TM, Layzer RB. Muscle cramps. *Muscle Nerve*. 2005;**32**(4):431–42. doi: 10.1002/mus.20341. [PubMed: 15902691].
7. Mansouri A, Mirghafourvand M, Charandabi SMA, Najafi M. The effect of Vitamin D and calcium plus Vitamin D on leg cramps in pregnant women: A randomized controlled trial. *J Res Med Sci*. 2017;**22**:24. doi: 10.4103/1735-1995.200271. [PubMed: 28413421]. [PubMed Central: PMC5377971].
8. Zhou K, West HM, Zhang J, Xu L, Li W. Interventions for leg cramps in pregnancy. *Cochrane Database Syst Rev*. 2015;**11**(8). CD010655. doi: 10.1002/14651858.CD010655.pub2. [PubMed: 26262909].
9. Jahdi F, Rezaei E, Behboodi-Moghadam Z, Hagani H. [Prevalence of sleep disorders in the pregnant women]. *Payesh*. 2013;**12**(6):629–35. Persian.
10. Cunningham FG, Leveno KJ, Bloom SL, Dashe JS, Hoffman BL, Casey BM, et al. *Williams Obstetrics*. 25th ed. New York: McGraw-Hill; 2019.
11. Mindell JA, Cook RA, Nikolovski J. Sleep patterns and sleep disturbances across pregnancy. *Sleep Med*. 2015;**16**(4):483–8. doi: 10.1016/j.sleep.2014.12.006. [PubMed: 25666847].
12. Sedov ID, Cameron EE, Madigan S, Tomfohr-Madsen LM. Sleep quality during pregnancy: A meta-analysis. *Sleep Med Rev*. 2018;**38**:168–76. doi: 10.1016/j.smrv.2017.06.005. [PubMed: 28866020].
13. Nodine PM, Matthews EE. Common sleep disorders: Management strategies and pregnancy outcomes. *J Midwifery Womens Health*. 2013;**58**(4):368–77. doi: 10.1111/jmwh.12004. [PubMed: 23855316].
14. Blair LM, Porter K, Leblebicioglu B, Christian LM. Poor sleep quality and associated inflammation predict preterm birth: Heightened risk among African Americans. *Sleep*. 2015;**38**(8):1259–67. doi: 10.5665/sleep.4904. [PubMed: 25845693]. [PubMed Central: PMC4507731].
15. Effati-Daryani F, Mirghafourvand M, Mohammad-Alizadeh-Charandabi S, Shiri-Sarand F, Zarei S. Sleep quality and its relationship with quality of life in Iranian pregnant women. *Int J Nurs Pract*. 2017;**23**(2). doi: 10.1111/ijn.12518. [PubMed: 28120358].
16. Bei B, Coo S, Trinder J. Sleep and mood during pregnancy and the postpartum period. *Sleep Med Clin*. 2015;**10**(1):25–33. doi: 10.1016/j.jsmc.2014.11.011. [PubMed: 26055670].
17. Mirghaforvand M, Mohammad-Alizadeh-Charandabi S, Zarei S, Effati-Daryani F, Shiri Sarand F. The relationship between depression and sleep quality in Iranian pregnant women. *Int J Women Health Reprod Sci*. 2016;**5**(2):147–52. doi: 10.15296/ijwhr.2017.27.
18. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The pittsburgh sleep quality index: A new instrument for psychiatric practice and research. *Psychiatry Res*. 1989;**28**(2):193–213. [PubMed: 2748771].
19. Saadati F, Sehhatiei Shafaei F, Mirghafourvand M. Sleep quality and its relationship with quality of life among high-risk pregnant women (gestational diabetes and hypertension). *J Matern Fetal Neonatal Med*. 2018;**31**(2):150–7. doi: 10.1080/14767058.2016.1277704. [PubMed: 28110597].
20. Freyd M. The graphic rating scale. *J Educ Psychol*. 1923;**14**(2):83–102. doi: 10.1037/h0074329.
21. Bijur PE, Silver W, Gallagher EJ. Reliability of the visual analog scale for measurement of acute pain. *Acad Emerg Med*. 2001;**8**(12):1153–7. [PubMed: 11733293].
22. Hallegraeff J, de Greef M, Krijnen W, van der Schans C. Criteria in diagnosing nocturnal leg cramps: A systematic review. *BMC Fam Pract*. 2017;**18**(1):29. doi: 10.1186/s12875-017-0600-x. [PubMed: 28241802]. [PubMed Central: PMC5330021].
23. Grandner MA, Winkelman JW. Nocturnal leg cramps: Prevalence and associations with demographics, sleep disturbance symptoms, medical conditions, and cardiometabolic risk factors. *PLoS One*. 2017;**12**(6). e0178465. doi: 10.1371/journal.pone.0178465. [PubMed: 28586374]. [PubMed Central: PMC5460850].
24. Roffe C, Sills S, Crome P, Jones P. Randomised, cross-over, placebo controlled trial of magnesium citrate in the treatment of chronic persistent leg cramps. *Med Sci Monit*. 2002;**8**(5):CR326–30. [PubMed: 12011773].
25. Hawke F, Chuter V, Burns J. Impact of nocturnal calf cramping on quality of sleep and health-related quality of life. *Qual Life Res*. 2013;**22**(6):1281–6. doi: 10.1007/s11136-012-0274-8. [PubMed: 23011494].