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RESEARCH

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The relationship between iron deficiency anemia with restless leg syndrome and sleep quality in workers working in a textile factory in Iran: a cross-sectional study

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Abstract

Background The aim of this study is to investigate the relationship between iron deficiency anemia with restless leg syndrome (RLS) and sleep quality in workers working in a textile factory in Iran. This cross-sectional study was conducted on 216 workers working in a textile factory in Iran. In addition to demographic and occupational variables, Pittsburgh Sleep Quality Index (PSQI) and RLS questionnaires were used for the data collection. To investigate iron deficiency anemia, 2 CC of blood was taken from the brachial artery with the help of a 10-CC syringe with a blue or pink tip. Then, relevant data were entered into SPSS26 and analyzed.

Results The mean (S. D.) age of the workers was 32.23 (6.14) and 60.6% of them were women. The prevalence of iron deficiency anemia was 21.2 and 69.5% in men and women, respectively. Most of the workers were in moderate condition in terms of RLS severity, and 78.2% had sleep disorders. There was an inverse and significant correlation between age (β= −0.200), work experience (β= −0.160), hemoglobin (β= −0.149), and ferritin (β= −0.186) with global PSQI score (*P* value<0.05). Also, an inverse and significant correlation was observed between age (β= −0.164), hemoglobin (β= −0.548), and ferritin (β= −0.410) with RLS score (*P* value<0.05). However, there was a direct and significant correlation between TIBC level and RLS score (β= 0.227) and global PSQI score (β= 0.395) (*P* value<0.05).

Conclusions Intervention programs to reduce iron deficiency anemia and periodic screening programs to identify sleep disorders and RLS in textile factory workers seem necessary.

Keywords Iron deficiency anemia, Restless leg syndrome, Sleep quality, Textile factory

Background

Restless leg syndrome (RLS) is a neurological disorder that is characterized by a strong desire to move the legs while resting and an unpleasant feeling in the legs such as throbbing, burning, or tingling [1, 2]. People with RLS have an irresistible urge to move their legs and describe it as an unpleasant feeling that worsens with periods of immobility. If people cannot control this strong desire to move their limbs, they often experience involuntary muscle jumps [3, 4]. To diagnose this disorder, special criteria have been proposed

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by the International Restless Legs Syndrome Studies Association, which include (1) frequent movement of the legs with abnormal sensitivity in the skin of the legs, (2) temporary relief of unpleasant symptoms by moving the legs, (3) onset or aggravation of symptoms with resting or not moving the legs, and (4) beginning or aggravation of symptoms in the evening or at night [5–7].

The prevalence of RLS in the general population is 2–15%. This disease can occur at any age; however, its prevalence increases with age [8, 9]. The primary reason for the referral of patients with RLS to medical centers is a sleep disorder. Patients with moderate to severe severity of this syndrome may sleep less than 5 h a night. This has caused RLS to be considered the fourth cause of insomnia after mental disorders, drug abuse, and sleep-related breathing disorders [10, 11]. More than 90% of patients with RLS have a sleep disorder and are looking for medical care to cure their sleep disorder [12]. Some studies have shown that patients with RLS are 4.7, 3.5, and 2.6 times more susceptible to panic attacks, anxiety, and depression than healthy people [13]. People with moderate to severe RLS may experience chronic sleep deprivation, daytime sleepiness, and stress. This situation interferes with the patients' daily functional roles and prevents them from enjoying life and has negative effects on social activities, family life, and work efficiency [6]. RLS is usually divided into 2 types: the primary or idiopathic type usually has a family pattern and the secondary type is related to other diseases. Iron deficiency, kidney dysfunction, and kidney and thyroid problems are among the most common diseases associated with RLS [14, 15]. Although the pathophysiology of RLS is still not fully understood, however, one of the important theories proposed regarding the relationship between iron deficiency anemia and the occurrence of sleep disorders, especially RLS, is that iron deficiency causes RLS by disrupting the dopamine level of the brain and D3 receptor activity [16].

Many studies were done on the general population; however, there are few studies on the relationship between iron deficiency anemia with RLS and sleep quality, especially among textile industry workers as an important industry in Iran's economy. Therefore, considering the importance of taking care of the health of the workforce in order to increase efficiency and productivity in production on one hand and the high prevalence of sleep disorders and RLS in industrial jobs, especially workers working in the textile industry on the other hand [17, 18], the present study was carried out with the aim of investigating the relationship between iron deficiency anemia with RLS and sleep quality in workers working in the Kavir textile factory in Semnan (Iran).

Methods

Study design and subjects

This cross-sectional study was conducted on 216 workers working in the Kavir textile factory in Semnan (Iran). The study was conducted as a census. Inclusion criteria consisted of experience of at least 1 year of night work, absence of physical (such as neurological disorders) or mental disorders, and no addiction to alcohol and narcotics. Exclusion criteria consisted of consumption of iron supplements and lack of interest to participate in the study.

How to conduct the study

In addition to demographic and occupational variables, two questionnaires were used to collect data. (1) Pittsburgh Sleep Quality Index (PSQI) questionnaire which has already been validated and reliable in Iran and consists of 7 sections ((1) subjective sleep quality, (2) sleep latency, (3) sleep duration, (4) habitual sleep efficiency, (5) sleep disturbances, (6) use of sleeping medication, (7) daytime dysfunction) and 19 questions. Each question is scored on a Likert scale from 0 to 3 (0= no sleep problem, 1= moderate sleep problem, 2= serious sleep problem, and 3= very serious sleep problem). The Epworth Sleepiness Scale (ESS) can range from 0 to 24 which 0–9 = normal range and >9 = abnormal range of sleepiness. The PSQI questionnaire which has already been validated and is reliable in Iran [19]. (2) Restless Leg Syndrome (RLS) questionnaire which includes 7 questions ((1) discomfort from restless legs; (2) desire to move legs; (3) sleep disturbance due to restless legs; (4) severity of tiredness or sleepiness during the day; (5) severity of restless legs; (6) impact restless legs on social, occupational, or family activities; and (7) the effect of restless legs on mood) and each question is scored on a Likert scale from 0 to 6. The RLS score can range from 0 to 42 which 0 = normal, 1–10 = mild, 11–20 = moderate, 21= severe, and 22–42 = very severe. The RLS questionnaire which has already been validated and is reliable in Iran [20]. Before the questionnaires were given to the participants, the objectives of the research were explained to them. Then a training session was held on how to complete the questionnaires.

To investigate iron deficiency anemia, 2 CC of blood was taken from the brachial artery with the help of a 10-CC syringe with a blue or pink tip. Then, it was transferred to the test tube without using anticoagulants and clot activators until it clots. In the next step, it was stirred with a glass stirring tube and finally centrifuged. After centrifugation, the liquid obtained from the serum was free of fibrinogen. CBC was performed using a Mindray device (made in China). In our study, according to the definition of the World Health Organization, hemoglobin

less than 13 mg/dL for men and less than 12 mg/dL for adult women is considered as iron deficiency anemia.

Statistical analysis

Data were analyzed by SPSS26. The mean, standard deviation, and frequency (%) were used for the descriptive analysis of the data. Then, the Pearson correlation coefficient and independent sample *t* tests were used to investigate the relationship between demographic, occupational characteristics, and laboratory parameters with global PSQI and RLS scores in the workers under study, and the *P* value was considered less than 0.05.

Ethics consideration

First, the aims of the research were explained to the participants, and their informed consent was then obtained. This study was performed according to the principles expressed in the Declaration of Helsinki and was approved by the Deputy of the Research and Ethics Committee of Semnan University of Medical Sciences (ID: IR.SEMUMS.REC.1395.71).

Results

A total of 216 workers working in the Kavir textile factory in Semnan (Iran) were investigated. Table 1 shows the demographic, occupational characteristics, and laboratory parameters of the workers under study. As can be seen, the mean (S.D) age of the workers was 32.23 (6.14) and 60.6% of them were women and 81.9% had no academic education. Also, the mean (S.D) levels of hemoglobin, mean corpuscular volume (MCV), ferritin, and total iron-binding capacity (TIBC) of the population under study were 12.03 (1.91) gr/dl, 81.64 (6.23) μm^3, 27.54 (2.21) ng/ml, and 352.94 (11.94) µg/d, respectively. The prevalence of iron deficiency anemia was 21.2 and 69.5 % in men and women, respectively. Other details can be seen in Table 1.

Table 2 shows the severity distribution of restless legs syndrome in workers under study. The mean score (S.D) of restless legs syndrome was 17.74 (4.78), and the majority of textile factory workers had mild (36.3%) or moderate (41.2%) restless legs syndrome. Also, while men did not have severe or very severe restless legs syndrome, in contrast, 36.7% of female workers had severe or very severe restless legs syndrome.

Table 3 shows the distribution of the Pittsburgh Sleep Quality Index (PSQI) and its scales in the workers under study. The mean (±S.D) of the Global PSQI score was 9.17 (±2.28). In total, 78.2% had sleep disorders and it was 74.1% and 80.9% in men and women, respectively. In addition, the most observed sleep disorders in the studied subjects were related to subjective sleep quality (91.2%), daytime dysfunction (90.7%), sleep disturbances (86.1%), and use of sleeping medication (76.9%), respectively.

Table 1 Demographic, occupational characteristics, and laboratory parameters of the workers under study

Quantitative variables	**Mean**	**S.D.***	**Min**	**Max**
Age (year)	32.23	6.14	22	59
Work experience (year)	7.9	3.3	3	14
Number of shifts per week	1.3	0.7	1	4
Number of hours of work shift	8	0.4	4	12
Hemoglobin (gr/dl)	12.03	1.91	9	16
MCV (μm^3)	81.64	6.23	48	95
Ferritin (ng/ml)	27.54	2.21	4	89
TIBC (µg/d)	352.94	11.49	108	500
Qualitative variables	**Number**	**%**		
Sex				
Male	85	39.4		
Female	131	60.6		
Education level				
Non-academic	177	81.9		
Academic	39	18.1		
Iron deficiency anemia				
Male				
<13	18	21.2		
>13	67	78.8		
Female				
<12	91	69.5		
>12	40	30.5		

* S.D : standard deviation

Table 4 shows the relationship between demographic, occupational characteristics, and laboratory parameters with global PSQI and restless legs syndrome scores in the workers under study. As can be seen, the result of the Pearson correlation coefficient test showed that there is an inverse and significant correlation between age (β= 0.200), work experience (β= −0.160), hemoglobin (β= −0.149), and ferritin (β= −0.186) with global PSQI score (*P* value<0.05). Also, an inverse and significant correlation was observed between age (β= −0.164), hemoglobin (β= −0.548), and ferritin (β= −0.410) with restless legs syndrome score (*P* value<0.05). However, there was a direct and significant correlation between TIBC level and restless legs syndrome score (β= 0.227) and global PSQI score (β= 0.395) (*P* value<0.05). In addition, the result of the independent sample *t* test showed that the mean scores of global PSQI (8.46 ± 1.97 vs. 9.63 ± 2.35) and restless legs syndrome (10.60 ± 2.93 vs. 16.5 ± 1.64) in women

Table 2 Severity distribution of restless legs syndrome in workers under study

Severity of restless legs syndrome	***N***	**%**	**Male**		**Female**	
			N	**%**	***N***	**%**
Mild (0–10)	79	36.3	56	65.9	23	17.6
Moderate (11–20)	89	41.2	29	34.1	60	45.8
Severe (21)	23	10.6	-	-	23	17.6
Very severe (22–40)	25	11.6	-	-	25	19.1
Total	216	100	85	100	131	100
Restless legs syndrome score	**Mean**		**S.D.**	**Min**		**Max**
	17.74		4.78	7		25

Table 3 Distribution of the Pittsburgh Sleep Quality Index (PSQI) and its scales in the workers under study

Questionnaires	**No (%)**	**Mild (%)**	**Moderate (%)**	**Severe (%)**
Pittsburgh Sleep Quality Index (PSQI)				
Subjective sleep quality	19 (8.8)	102 (47.2)	64 (29.6)	31(14.4)
Sleep latency	79 (36.6)	98 (45.4)	38 (17.6)	1 (0.5)
Sleep duration	138 (63.9)	58 (26.9)	20 (9.3)	-
Habitual sleep efficiency	94 (43.5)	31 (14.4)	69 (31.9)	22 (10.2)
Sleep disturbances	30 (13.9)	-	39 (18.1)	147(68.1)
Use of sleeping medication	50 (23.1)	94 (43.5)	44 (20.4)	28 (12.9)
Daytime dysfunction	20 (9.3)	72 (33.3)	89 (41.2)	35 (16.2)
Global PSQI score	**Mean**	**S.D***	**Min**	**Max**
	9.17	2.28	2	15
		N	**%**	
Sleep disorder	Yes (>9 score)	169	78.2	
	No (≤9 score)	47	21.8	
Sleep disorder in men	Yes (>9 score)	63	74.1	
	No (≤9 score)	22	25.9	
Sleep disorder in women	Yes (>9 score)	106	80.9	
	No (≤9 score)	25	19.1	

were significantly higher than men (P value<0.05) (Table 4).

Discussion

While the prevalence and clinical characteristics of RLS and its relationship with laboratory indicators are different based on the general population, a detailed evaluation of this condition has not been reported in industrial workers of Iran; therefore, we investigated the relationship between iron deficiency anemia with RLS and sleep quality in workers working in Kavir textile factory in Semnan (Iran). The results of this study showed the prevalence of iron deficiency anemia was 21.2 and 69.5% in men and women, respectively. The majority of textile factory workers had mild (36.3%) or moderate (41.2%) RLS and also 78.2% had sleep disorders. There is an inverse and significant correlation between age, work experience, hemoglobin, and ferritin with global PSQI score. Also, an inverse and significant correlation was observed between age, hemoglobin, and ferritin with the RLS score. However, there was a direct and significant correlation between TIBC level and RLS score and global PSQI score.

In our study, there was an inverse and significant statistical relationship between the sleep disorder score and hemoglobin blood level and ferritin, which are in line with the results of other studies. For example, Baraz et al.'s study showed a statistically significant relationship between sleep quality and hemoglobin blood levels in hemodialysis patients and considered increasing hemoglobin levels to be an effective factor in reducing sleep disorders []. In another study conducted by Hyoeun Bae et al. in Korea aimed at the prevalence of RLS in patients with iron deficiency anemia, 40.3% of patients had RLS, the majority (82%) of which was severe and very severe. Also, patients with iron deficiency anemia and RLS had more sleep disorders and

Table 4 Relationship between demographic, occupational characteristics, and laboratory parameters with global PSQI and restless legs syndrome scores in the workers under study

Quantitative variables	**Global PSQI score**		**Restless legs syndrome score**	
	r*	***P*value**	***r***	***P*value**
Age (year)	−0.200	0.003	−0.164	0.016
Work experience (year)	−0.160	0.019	−0.108	0.115
Number of shifts per week	−0.033	0.627	0.062	0.365
Number of hours of work shift	−0.022	0.752	−0.071	0.300
Hemoglobin (gr/dl)	−0.149	0.029	−0.548	<0.001
MCV (μm^3)	0.062	0.364	−0.110	0.107
Ferritin (ng/ml)	−0.186	0.006	−0.410	<0.001
TIBC (µg/d)	0.227	<0.001	0.395	<0.001
Qualitative variables	**Variable**	**Mean**	S.D	****P*value**
Global PSQI score	Male	8.46	1.97	0.024
	Female	9.63	2.35	
Restless legs syndrome score	Male	10.60	2.93	<0.001
	Female	16.5	1.64	
Global PSQI score	Non-academic	8.11	1.36	0.146
	Academic	7.96	1.89	
Restless legs syndrome score	Non-academic	16.83	2.24	0.339
	Academic	16.64	1.89	

Independent sample *t* test. *rPearson correlation coefficient

emotional problems than patients with iron deficiency anemia without RLS [22]. The study of Allen et al. aimed at estimating the prevalence of RLS in patients with iron deficiency anemia and showed that the prevalence of this disorder in the population with iron deficiency is 9 times that of the general population. Also, patients with iron deficiency anemia and RLS reported poorer sleep quality, decreased sleep time, increased fatigue, and decreased energy during the day compared to patients without RLS. Finally, they recommended iron therapy interventions to reduce the complications and symptoms of RLS [23].

Generally, although the pathophysiology of RLS is still not fully understood; however, dopaminergic system disorder, genetics, and iron deficiency have been mentioned among the causes of this disease [14, 24]. The reduction of iron in the substantia nigra and the reduction of cerebrospinal fluid ferritin in patients with RLS show that the disorder in iron metabolism is one of the causes of this syndrome [25]. Blood iron plays an important role in oxygenating the brain parenchyma, making many neurotransmitters (especially monoamine types) and enzymes in the nervous system, and its deficiency causes aggravation of many mental disorders such as depression, anxiety, and stress. Disturbance in brain dopamine level and D3 receptor activity due to iron deficiency is one of the theories proposed in the field of RLS occurrence [16, 26]. Also, some studies have suggested that RLS is due to dysfunction of the basal ganglia, which controls movement and uses the brain chemical dopamine. Dopamine is needed to produce purposeful muscle activity and movement. Disturbances in these pathways frequently lead to involuntary movements [15, 24].

In our study, the prevalence of iron deficiency anemia was higher in women than in men. Also, while men did not have severe or very severe RLS, in contrast, 36.7% of female workers had severe or very severe RLS. In line with our results, studies have shown that female shift workers, in addition to the mentioned problems, due to the negative effect of working conditions on their eating habits and quality, as well as being in reproductive age, which is considered as one of the periods of increased iron needs of the body, are more exposed to iron-induced anemia [27, 28].

In our study, an inverse and significant correlation was observed between age and work experience with global PSQI and RLS scores. This finding was consistent with similar studies in this field [21]. In addition to sleep disorders and RLS, other studies have also reported a high prevalence of anxiety and depression in youth workers [3031]. Perhaps one of the reasons for the higher prevalence of sleep disorder and RLS in workers with lower age and work experience is the lack of work experience, high work stress, and the inability to adapt quickly to the existing work conditions, although investigating the exact causes of this issue requires more studies.

This study has a number of limitations that need to be noted. First, this cross-sectional study was conducted on one group, and there was no control group, while studies such as a case-control study with two groups with equal sample size can increase the statistical efficiency. Second, in a cross-sectional study, it is difficult to examine the causal relationship because the two variables are examined simultaneously and is unclear which one occurred before the other, in other words, the assumption of temporality is not considered; therefore, we need prospective cohort studies to overcome this limitation [32, 33]. Third, 60% of the investigated workers were women and the majority were of menstrual age. Considering there is a relationship between iron deficiency anemia and the menstrual cycle, this anemia may be due to the menstrual cycle rather than their occupation.

Conclusions

The present study showed a high prevalence of iron deficiency anemia, sleep disorder, and RLS in textile industry workers. Also, a significant correlation was observed between iron deficiency anemia and these disorders, so intervention programs to reduce iron deficiency anemia and periodic screening programs to identify sleep disorders and RLS in these workers seem necessary.

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Authors' contributions
DP, FGH, and MRS conceived the study, collected data, and performed the statistical analysis. MM and KM participated in the study design, drafted the manuscript, and contributed to the data analysis. DP, FGH, and MRS helped to draft the manuscript and revised it critically. The authors read and approved the final manuscript.

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Availability of data and materials
The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
This study was performed according to the principles expressed in the Declaration of Helsinki and was approved by the Deputy of the Research and Ethics Committee of Semnan University of Medical Sciences (ID: IR.SEMUMS.REC.1395.71). All the participants have accepted and signed the informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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