

## REVIEW ARTICLE

# Differences between fixed day shift nurses and rotating and irregular shift nurses in work-related musculoskeletal disorders: A literature review and meta-analysis

Wen-Pei Chang PhD, RN<sup>1,2</sup>  | Yu-Xuan Peng RN, BS<sup>3</sup>

<sup>1</sup>School of Nursing, College of Nursing, Taipei Medical University, Taipei, Taiwan

<sup>2</sup>Department of Nursing, Shuang Ho Hospital, Taipei Medical University, New Taipei City, Taiwan

<sup>3</sup>Department of Nursing, College of Nursing, Tzu Chi University, Hualien, Taiwan

## Correspondence

Wen-Pei Chang, Department of Nursing, Shuang Ho Hospital, Taipei Medical University, No.291, Zhongzheng Rd., Zhonghe, New Taipei City 23561, Taiwan.  
Email: 10479@s.tmu.edu.tw

## Abstract

**Objectives:** Work-related musculoskeletal disorders (WMSDs) are common occupational injuries for nurses. Furthermore, rotating and irregular shift work may exacerbate muscle tension and pain in nurses. The objective of this study was to examine the differences between fixed day shift (FDS) nurses and rotating and irregular shift (RS + IS) nurses in WMSDs using a systematic literature review and meta-analysis. **Methods:** Databases including PubMed, CINAHL, Cochrane Library, EBSCOhost, and Google Scholar were searched for relevant studies published between 2010 and 2020 using the target keywords.

**Results:** This study obtained data on a total of 18 199 nurses, among which 12 786 comprised the RS + IS group and 5413 constituted the FDS group. The result of the heterogeneity test was  $Q = 79.27$  ( $P < .001$ ) and  $I^2 = 57.11\%$ , indicating that heterogeneity existed among the studies. Subgroup analyses were also conducted with four groups: neck pain ( $n = 1818$ ), shoulder and upper limb pain ( $n = 2525$ ), back pain ( $n = 11 962$ ), and hip and lower limb pain ( $n = 1894$ ). Significant differences were found between the RS + IS group and the FDS group with regard to back pain, with the forest plot presenting an odds ratio equaling 1.40 (95% CI: 1.19–1.64,  $P < .001$ ).

**Conclusions:** This meta-analysis indicated that RS + IS nurses are more likely to experience back pain associated with WMSD than are FDS nurses. The results can serve as a reference to the clinical management for work improvement and thereby reduce or prevent the adverse effects of rotating and irregular shift work on back pain experienced by nurses.

## KEYWORDS

fixed day shift, meta-analysis, non-standard work hours, nurse, rotating and irregular shift, work-related musculoskeletal disorder

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2021 The Authors. *Journal of Occupational Health* published by John Wiley & Sons Australia, Ltd on behalf of The Japan Society for Occupational Health

## 1 | INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) are common occupational injuries.<sup>1</sup> Clinical nursing is a physically demanding work as nurses must take care of patients and meet operational needs. In the long term, the physiological load of nursing often leads to WMSDs. Smith et al investigated WMSDs in 206 Chinese nurses during the previous year and found that 70% of those nurses suffered from WMSDs, most of which consisted of discomfort in the lower back.<sup>2</sup> In contrast, Trinkoff et al surveyed nurses in Illinois and New York, USA, places which are known for ethnic diversity, and found that among 1163 nurses, 74% expressed having moderate or severe musculoskeletal pain in the neck, shoulders, or back, in which the discomfort persisted for at least 1 week per month in the past year. The nurses had sought help from doctors and took medication such as analgesics, skeletal muscle relaxants, and steroids. Furthermore, some of the nurses lost their motivation for work, recreation, or non-work activities and in severe cases, quit their job.<sup>3</sup> WMSDs in nurses are mainly caused by shifting patients (which includes helping patients turn over or get in and out of bed), routine treatments in nursing, poorly designed work environments, and remaining active for prolonged periods of time.<sup>4</sup> The physiological loads created by these nursing activities are all risk factors of WMSDs in nurses.<sup>5</sup>

Clinical nurses must deal with daily routine work in busy wards, patient care and treatment, and correspondence for various matters. Their jobs are time-consuming, complicated, and full of stress, and they are often on tight schedules, all of which are associated with WMSDs.<sup>6,7</sup>

Moreover, nurses must often work shifts, defined as work that is not fixed day shifts (FDSs). Aside from the conventional rotating shift work involving two or three shifts, fixed night shifts and/or evening shifts are also broadly regarded as rotating shift work.<sup>8</sup> Working rotating and irregular shifts, which causes the physiological burden of disrupted circadian rhythms in the body, may also exacerbate muscle tension and pain.<sup>9</sup>

Nurses are prone to WMSDs in the lower back, shoulders, neck, back wrists, knees, and ankles.<sup>10</sup> Trinkoff et al<sup>11</sup> investigated the correlation between nursing staff scheduling and WMSDs and discovered that nurses working shifts aside from the day shift felt musculoskeletal discomfort in at least one of three places: neck, shoulder, and back. Another large-scale longitudinal study discovered that the odds ratios of nurses working rotating and irregular shifts and suffering from WMSDs in the neck, shoulders, and back were, respectively, 1.18, 1.29, and 1.27 times that of nurses not working rotating and irregular shifts.<sup>10</sup> Thus, nurses have more occupational health concerns, and rotating and irregular shifts work renders nursing an occupation at high risk of musculoskeletal discomfort.<sup>12</sup>

Caruso and Waters<sup>9</sup> published a literature review that found inconsistent results in studies on the correlation between rotating and irregular shifts work and WMSDs. The objective of this study was to conduct a meta-analysis on literature published in the last decade to understand whether nurses working FDSs and rotating and irregular shifts experience differences in WMSDs in various parts of the body due to the time of their work shift. We aimed to understand the correlation between work shift and WMSDs in nurses working different types of shifts, and the study results can serve as a reference to formulate countermeasures to mitigate WMSDs.

## 2 | METHODS

### 2.1 | Selection criteria

The literature selection criteria in this study were as follows: peer-reviewed journal papers in English published between 2010 and 2020 and focusing on nurses (including midwives). The WMSDs collected in this study were defined as the fatigue, compression, and injury of muscle or surrounding tissue due to a part of the body bearing an excessive workload for prolonged periods of time, such that inflammation gradually amasses into unrecoverable musculoskeletal injury.<sup>13</sup> There were no age nor gender restrictions; however, the studies had to include an RS + IS group and a FDS group as well as the numbers of nurses in these two groups with WMSDs in the neck, shoulders and upper limbs, back, hips, and lower limbs. Any fixed shift beginning between 7:00 and 9:00 in the morning was defined as FDS, and the remaining shifts were defined as RS + IS.<sup>14</sup>

### 2.2 | Collection process and screening results

The meta-analysis in this study complied with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework and ultimately included 17 studies.<sup>15</sup> The keywords included in our search were musculoskeletal disorders, musculoskeletal pain, back pain, back disorders, neck pain, shoulder pain, rotating shift, night shift, and nurses. Using a combination of these keywords, 347 papers were obtained from relevant databases. After eliminating 29 duplicates, 318 studies remained. After reading the abstracts of these studies, another 290 studies that clearly did not fit our inclusion criteria were eliminated. The remaining 28 studies were then read to determine whether they fit the inclusion criteria. Of the 28 studies, 11 were eliminated for the following reasons, including not having an FDS group, also including other types of medical personnel, or not specifying

where the WMSDs were. Figure 1 presents the literature collection process.

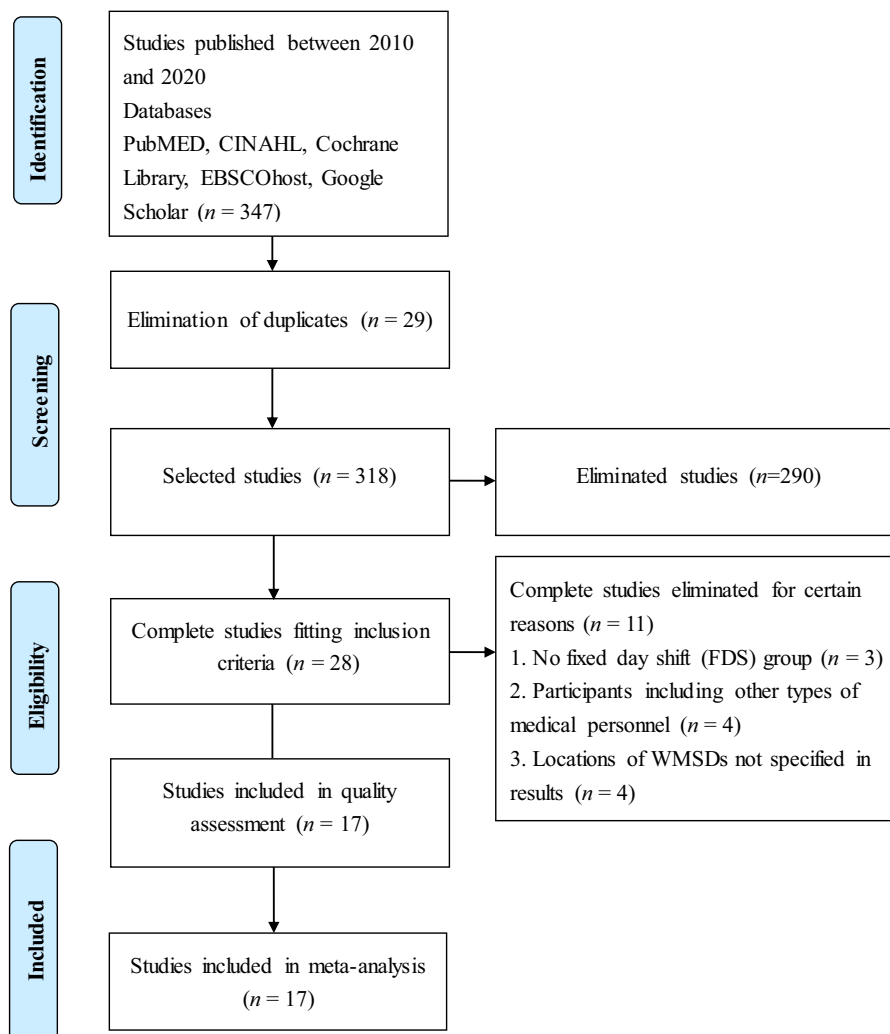
### 2.3 | Literature quality

The authors reviewed the studies obtained using one of the critical appraisal instruments developed by the Joanna Briggs Institute (JBI), which is an independent, international, non-profit research organization that has created a number of study review checklists to assess literature validity. The checklists are selected based on the research design of the study, and the content of the checklists revolves around sample representativeness, instrument reliability and validity, and appropriateness of statistical analysis.<sup>16</sup> The JBI critical appraisal standards used for the observational studies in this study included the five following items: 1. whether the study was based on random or pseudorandom samples, 2. whether the criteria for inclusion in the sample were clearly defined, 3. whether outcomes were

assessed using objective criteria, 4. whether sufficient descriptions of groups were given if comparisons were made, and 5. whether appropriate statistical analysis was used. The response for each item was “No”, “Yes”, or “Unclear”. Only “Yes” responses received 1 point; 0 points were given for any other response. Only studies with a total score of 4 or higher were included in the analysis.<sup>16</sup> All 17 studies met the requirements and had good literature quality on the whole. For the credibility of the meta-analysis, a total of 17 studies (35 sets of data) were included in the analysis for the calculation of odds ratios (ORs). The appraisal process was independently completed by the two authors, and then the results were cross compared to ensure the confirmability of the study results.

### 2.4 | Statistical analysis

Data analysis was performed using the software package Comprehensive Meta-Analysis (CMA) 3.0. The variance



**FIGURE 1** Flowchart of literature search process

TABLE 1 Summary of literature included in meta-analysis

Authors (Years)	Location	Design	Gender	Age (M ± SD)	Definition of shift work	Work attributes
Abou El-Soud et al (2014) <sup>16</sup>	Egypt	cross-sectional	F	20–40 occupying 65.3%	Fixed night shifts or rotating among morning, afternoon, and night shifts	70% in internal medicine and surgical wards
Arsalani et al (2014) <sup>17</sup>	Iran	cross-sectional	F/M	30–39 occupying 38%	Not fixed morning shifts	37.8% in internal medicine and surgical wards
Attarchi et al (2014) <sup>18</sup>	Iran	cross-sectional	F/M	32.2 (6.1)	Fixed night shifts or rotating among morning, afternoon, and night shifts	Not mentioned
Buja et al (2013) <sup>19</sup>	Italy	cross-sectional	F/M	38.04 (8.2)	Rotating among morning, afternoon, and night shifts or rotating between morning and afternoon shifts	Not mentioned
Burdalak et al (2012) <sup>20</sup>	Poland	cross-sectional	F	40–60	Rotating shifts with night shifts in the rotation	Not mentioned
Dlungwane et al (2018) <sup>21</sup>	South Africa	cross-sectional	F/M	40–49 occupying 33%	Fixed night shifts	49% in obstetrics and gynecology wards
Fujii et al (2019) <sup>22</sup>	Japan	cross-sectional	F	35.8 (10.6)	Fixed night shifts	76.5% in wards
Ibrahim et al (2019) <sup>23</sup>	Malaysia	cross-sectional	F/M	<30 occupying 59.5%	Rotating among morning, afternoon, and night shifts	70.3% in internal medicine department
June and Cho (2010) <sup>24</sup>	Korea	cross-sectional	F/M	27.2 (4.3)	Night shifts at least 6 days a month	ICUs only
Mekonnen (2019) <sup>25</sup>	Ethiopia	cross-sectional	F/M	31.39 (7.01)	Not mentioned	Not mentioned
Ovayolu et al (2014) <sup>26</sup>	Turkey	cross-sectional	F/M	26–33 occupying 62.3%	Not fixed morning shifts	ICUs only
Raeisi et al (2014) <sup>27</sup>	Iran	cross-sectional	F/M	32.4 (6.7)	Any shifts outside of period from 7:00 in the morning to 6:00 in the evening	Not mentioned
Samaei et al (2017) <sup>28</sup>	Iran	cross-sectional	F/M	33.6 (3.18)	Rotating among morning, afternoon, and night shifts	No restrictions
Shafiezhadeh (2011) <sup>29</sup>	Iran	cross-sectional	F/M	30–40 occupying 50.6%	Rotating among morning, afternoon, and night shifts	No restrictions
Yao et al (2019) <sup>30</sup>	China	cross-sectional	F/M	28.9 (5.6)	Rotating shifts with night shifts in the rotation	49.3% in internal medicine and surgical wards
Zhang et al (2019) <sup>31</sup>	China	cross-sectional	F/M	31.1 (7.6)	Not fixed morning shifts	Ambulance nurses
Zhao et al (2012) <sup>32</sup>	Australia	longitudinal	F/M	43.4 (9.9)	Not fixed morning shifts	No restrictions

Note: Abbreviation: Female, F; Male, M; Mean, M; Standard Deviation, SD.

**TABLE 2** Number of samples for each WMSD location among FDS and RS + IS nurses

Category of location	Authors (Years)	Observation period	Location	RS + IS		FDS	
				Total	No. With pain	Total	No. With pain
Neck	Arsalani et al (2014) <sup>17</sup>	<1 week	Neck	415	112	100	27
	Attarchi et al (2014) <sup>18</sup>	<12 months	Neck	292	137	162	63
	Shafieezadeh (2011) <sup>29</sup>	<12 months	Neck	120	73	37	28
	Yao et al (2019) <sup>30</sup>	<12 months	Neck	510	366	182	106
<b>Total</b>				<b>1337</b>	<b>688</b>	<b>481</b>	<b>224</b>
Shoulder & upper limbs	Attarchi et al (2014) <sup>18</sup>	<12 months	Shoulder	292	132	162	59
	Attarchi et al (2014) <sup>18</sup>	<12 months	Elbow	292	55	162	33
	Attarchi et al (2014) <sup>18</sup>	<12 months	Wrist	292	118	162	51
	Shafieezadeh (2011) <sup>29</sup>	<12 months	Shoulder	120	55	37	16
	Shafieezadeh (2011) <sup>29</sup>	<12 months	Elbow	120	14	37	9
	Shafieezadeh (2011) <sup>29</sup>	<12 months	Wrist	120	57	37	23
	Yao et al (2019) <sup>30</sup>	<12 months	Shoulder	510	292	182	86
<b>Total</b>				<b>1746</b>	<b>723</b>	<b>779</b>	<b>277</b>
Back	Abou El-Soud et al (2014) <sup>16</sup>	<12 months	Lower back	95	76	55	43
	Arsalani et al (2014) <sup>17</sup>	<1 week	Lower back	415	165	100	39
	Attarchi et al (2014) <sup>18</sup>	12 months	Upper back	292	146	162	68
	Attarchi et al (2014) <sup>18</sup>	12 months	Lower back	292	182	162	79
	Buja et al (2013) <sup>19</sup>	12 months	Back	394	339	46	34
	Burdalak et al (2012) <sup>20</sup>	12 months	Back	354	163	371	179
	Dlungwane et al (2018) <sup>21</sup>	<1 week	Lower back	242	119	242	123
	Fujii et al (2019) <sup>22</sup>	<4 weeks	Lower back	2334	1418	722	375
	Ibrahim et al (2019) <sup>23</sup>	<12 months	Lower back	1071	819	221	170
	June and Cho (2010) <sup>24</sup>	<12 months	Lower back	1022	934	323	280
	Mekonnen (2019) <sup>25</sup>	<12 months	Lower back	329	227	89	39
	Ovayolu et al (2014) <sup>26</sup>	>1 month	Lower back	73	61	41	35
	Raeisi et al (2014) <sup>27</sup>	<12 months	Lower back	341	219	191	98
	Samaei et al (2017) <sup>28</sup>	<12 months	Lower back	205	145	38	24
	Shafieezadeh (2011) <sup>29</sup>	<12 months	Upper back	120	54	37	12
	Shafieezadeh (2011) <sup>29</sup>	<12 months	Lower back	120	58	37	20
	Zhang et al (2019) <sup>31</sup>	<12 months	Lower back	189	60	309	45
Zhao et al (2012) <sup>32</sup>	<12 months	Lower back	456	174	472	145	
<b>Total</b>				<b>8344</b>	<b>5359</b>	<b>3618</b>	<b>1808</b>
Hip & lower limbs	Arsalani et al (2014) <sup>17</sup>	<1 week	Knee	415	142	100	40
	Attarchi et al (2014) <sup>18</sup>	<12 months	Knee	292	151	162	69
	Attarchi et al (2014) <sup>18</sup>	<12 months	Ankle	292	105	162	43
	Shafieezadeh (2011) <sup>29</sup>	<12 months	Hip	120	35	37	6
	Shafieezadeh (2011) <sup>29</sup>	<12 months	Knee	120	64	37	23
	Shafieezadeh (2011) <sup>29</sup>	<12 months	Ankle	120	49	37	12
<b>Total</b>				<b>1359</b>	<b>546</b>	<b>535</b>	<b>193</b>
<b>Overall total</b>				<b>12 786</b>	<b>7316</b>	<b>5413</b>	<b>2502</b>

Note: Abbreviation: Rotating shift, RS; Irregular shift, IS; Fixed day shift, FDS.

(heterogeneity or homogeneity) among the results of the 17 studies was examined using Cochran's Q test, and the relative importance and direction of the research outcomes of the studies were displayed using forest plots, with the fixed effect model or the random effect model to calculate the pooling OR. Sensitivity analysis was conducted to determine whether the elimination of any study would influence the overall results. Funnel plots were used to show whether the positive or negative effects of the various study results were as symmetric as a funnel, and Egger's regression was applied.

### 3 | RESULTS

#### 3.1 | Overall analysis

This study obtained data on a total of 18 199 nurses, among which 12 786 comprised the RS + IS group and 5413 constituted the FDS group. Tables 1 and 2 present the basic information and statistics of the nurses. The result of the heterogeneity test of the 17 studies (35 sets of data) was  $Q = 79.27$  ( $P < .001$ ) and  $I^2 = 57.11\%$ , indicating that heterogeneity existed among the studies. Subgroup analyses were also conducted to determine whether the RS + IS group and the FDS group displayed differences in the location of their WMSDs. Four groups were analyzed: neck pain ( $n = 1818$ ), shoulder and upper limb pain ( $n = 2525$ ), back pain ( $n = 11 962$ ), and hip and lower limb pain ( $n = 1894$ ).

The sensitivity analysis indicated that the elimination of any study did not exert a significant impact on the pooling, OR 1.29 (95% CI: 1.15–1.46,  $P < .001$ ). The funnel plot was symmetric, thereby presenting no publication bias (Figure 2), and according to the linear regression (Egger's) analysis,  $P = .187$ , which means that there was no evidence indicating publication bias among the studies included in our meta-analysis.

#### 3.2 | Subgroup analysis: neck pain

This analysis involved four sets of data. The results of the heterogeneity test were  $Q = 9.69$  ( $P = .021$ ) and  $I^2 = 69.04\%$ , both indicating that heterogeneity existed among the studies. For this reason, the random effect model was chosen. The pooling OR presented by the forest plot was 1.18 (95% CI: 0.77–1.82,  $P = .440$ ), which did not reach the level of significance. This shows that RS + IS nurses were more likely to experience neck pain than were FDS nurses; however, the difference was not significant (Figure 3).

#### 3.3 | Subgroup analysis: shoulder and upper limb pain

This analysis involved seven sets of data. The results of the heterogeneity test were  $Q = 13.88$  ( $P = .031$ ) and  $I^2 = 56.78\%$ , both indicating that heterogeneity existed among the studies. Thus, the random effect model was chosen. The pooling OR presented by the forest plot was 1.09 (95% CI: 0.81–1.47,  $P = .558$ ), which did not reach the level of significance. This shows that RS + IS nurses were more likely to experience shoulder and upper limb pain than were FDS nurses; however, the difference was not significant (Figure 3).

#### 3.4 | Subgroup analysis: back pain

This analysis involved 18 sets of data. The results of the heterogeneity test were  $Q = 44.26$  ( $P < .001$ ) and  $I^2 = 61.59\%$ , both indicating that heterogeneity existed among the studies. Thus, the random effect model was chosen. The pooling OR presented by the forest plot was 1.40 (95% CI: 1.19–1.64). This means RS + IS nurses were more

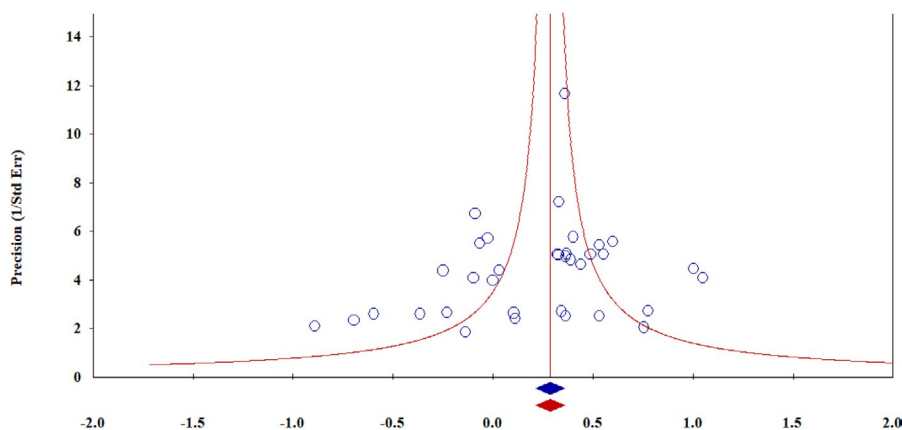
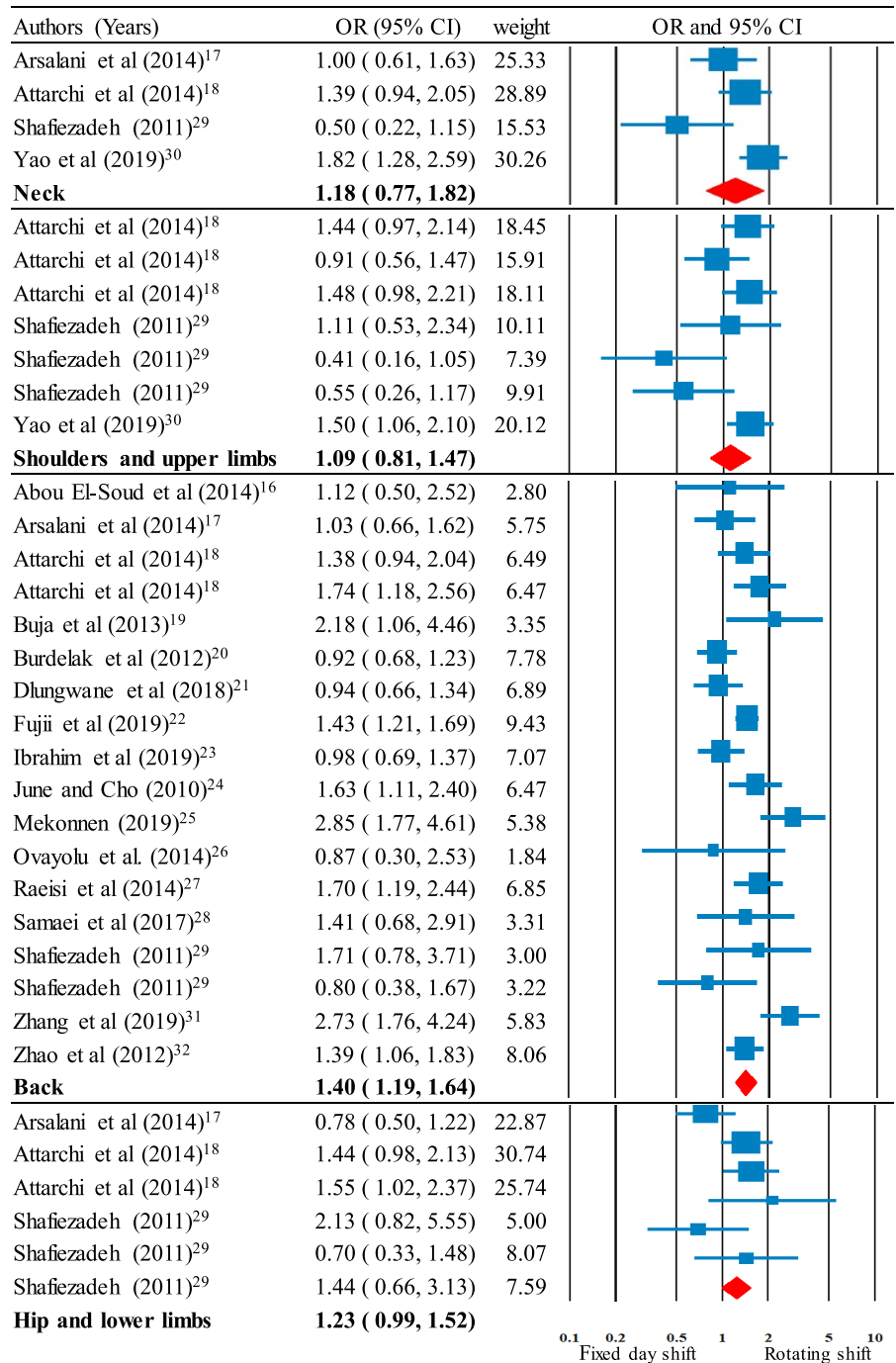


FIGURE 2 Funnel plot of differences between FDS and RS + IS nurses in WMSDs



**FIGURE 3** Comparison of WMSDs locations in FDS and RS + IS nurses. ■ Single study result; —confidence interval; ◆combined effect. Abbreviations: 95% CI, 95% Confidence interval; FDS, Fixed day shift; IS, Irregular shift; OR, Odds Ratio; RS, Rotating shift



likely to experience back pain than were FDS nurses, and the difference was significant ( $P < .001$ ) (Figure 3).

### 3.5 | Subgroup analysis: hip and lower limb pain

This analysis involved six sets of data. The results of the heterogeneity test were  $Q = 9.39$  ( $P = .095$ ) and  $I$  squared = 46.73%, both indicating that heterogeneity existed among the studies. For this reason, the fixed effect model

was chosen. The pooling OR presented by the forest plot was 1.23 (95% CI: 0.99–1.52,  $P = .060$ ). This shows that RS + IS nurses were more likely to experience hip and lower limb pain than were FDS nurses; however, the difference was not significant (Figure 3).

## 4 | DISCUSSION

On the whole, the comparison of the RS + IS group and the FDS group in this meta-analysis indicated that more nurses

in the former group experienced WMSDs, particularly back pain. However, the differences between the two groups were not significant in terms of neck pain, shoulder and upper limb pain, or hip and lower limb pain.

In the 17 studies (35 sets of data) included in this meta-analysis, 11 sets of data indicated that RS + IS nurses suffered significantly more WMSDs than did FDS nurses.<sup>19,20,23,25,26,31–33</sup> Some researchers believe that RS + IS nurses are prone to feeling fatigued, and work fatigue is a precursor to chronic muscle injury.<sup>34</sup> Fatigue is a physiological condition resulting from an individual's physical state and psychological cognition that disrupt the balance of the body's internal environment.<sup>35</sup> Two main causes result in fatigue: a lack of sleep and interrupted sleep cycles. Fatigue is the body's response to a lack of sleep or long-term physical or mental effort. A lack of sleep or poor sleep quality not only causes fatigue, but it also slows responses at work, decreases alertness, impairs decision-making capacity, and leads to poor judgment as well as an inability to focus, all of which may result in endangerment and adverse consequences in the workplace.<sup>36</sup> Work-related fatigue, such as lactic acid accumulation and reduced mobility in the muscles, lowers the endurance and load-bearing capacity of muscles, which is why fatigue is associated with a higher incidence of WMSDs.<sup>35,37</sup> The core of the body's biological clock is the suprachiasmatic nucleus of the hypothalamus, in which a number of nerve cells converge. From here, neural signals are transmitted directly to the pineal gland, which is affected by light from the day and night cycle. During the night, the pineal gland secretes high concentrations of melatonin, which causes drowsiness and maintains sleep.<sup>38</sup> Because daily routines of FDS workers match their circadian rhythms, they can maintain an optimal mental state during work. On the contrary, RS + IS workers have irregular schedules. Owing to poor sleep environments and a daytime sleep period conflicting with their body's sleep-wake cycle, RS + IS workers often have difficulty falling asleep, staying asleep, or sleeping restfully, which may result in a shortened duration of sleep. Moreover, deep sleep is crucial for reducing physical fatigue; however, RS + IS workers have substantially less deep sleep during the day and thus have difficulty feeling rested after sleeping.<sup>39–41</sup> Thus, shift work is a crucial factor that influences the fatigue of nurses and may interfere with the steadiness of sleep.

The subgroup analyses in this study only found significant differences between the RS + IS group and the FDS group with regard to back pain. Among the 16 studies (18 sets of data) that examined back pain, eight sets of data indicated that RS + IS nurses were significantly more likely to experience back pain than were FDS nurses.<sup>19,20,23,25,26,28,32,33</sup> The relative weight used in Fujii et al<sup>23</sup> was 9.43% and higher than those used in the other 18 studies. A number of investigations

found that the most common location of WMSDs in nurses was in the back. Smith et al<sup>3</sup> surveyed 180 nurses at a teaching hospital and discovered that approximately 70% experienced WMSDs, the most common being in the lower back (56.7%), upper back (38.9%), shoulders (38.9%), and neck (42.8%). Smith et al<sup>42</sup> also investigated WMSDs in female nurses and found that the most common type was lower back pain ((59.0%), followed by pain in the shoulder (46.6%), neck (27.9%), knees (16.4%), and upper legs (11.8%). Lipscomb et al<sup>43</sup> derived a similar conclusion, with most instances of WMSDs in nurses being in the back.

Indeed, nursing work tends to cause back pain problems. If we look at the angle of trunk rotation from a biomechanical perspective, bad postures while shifting patients, lifting weights, or frequently bending over can put pressure on the spine and back muscles and in turn lead to back pain.<sup>44</sup> However, there are no other existing meta-analysis studies on whether the fatigue caused by rotating and irregular shifts work exacerbates back pain problems. More meta-analysis studies will be needed to address this issue.

## 5 | CONCLUSION

A meta-analysis was conducted and found that RS + IS nurses are more likely to experience WMSDs than FDS nurses, particularly back pain. It is hoped that the results can provide reference to clinical management for work improvement and thereby reduce or prevent the adverse effects of rotating and irregular shift work on the health of nurses.

## 6 | STUDY LIMITATIONS

In addition to shift work, the factors influencing WMSDs may also include age, BMI, years of service, work hours, work department, birth history, and exercise habits. However, these factors could not be controlled in this meta-analysis, which may affect the inference results. Furthermore, the incidence of WMSDs requires longer periods of time to amass; however, most of the studies included in our meta-analysis were cross-sectional studies that collected data from a single time point. This made it difficult to determine whether a causal relationship exists between the rotating and irregular shift work of nurses and their WMSDs.

## ACKNOWLEDGMENT

This research received no specific grant from any funding agency in the commercial or not-for-profit sectors.

## CONFLICT OF INTEREST

The authors have no conflict of interest.



## AUTHOR CONTRIBUTIONS

Wen-Pei Chang and Yu-Xuan Peng performed the literature search and helped write the manuscript; Wen-Pei Chang conceived and revised the article; and Wen-Pei Chang and Yu-Xuan Peng approved the final version of the manuscript.

## ORCID

Wen-Pei Chang  <https://orcid.org/0000-0002-4906-2136>

## REFERENCES

1. Fisher T. Role of occupational therapy in preventing work-related musculoskeletal disorders with recycling workers: a pilot study. *Am J Occup Ther.* 2017;71. <https://doi.org/10.5014/ajot.2017.022871>
2. Smith DR, Wei N, Kang L, Wang RS. Musculoskeletal disorders among professional nurses in Mainland China. *J Prof Nurs.* 2004;20:390-395.
3. Trinkoff AM, Lipscomb JA, Geiger-Brown J, Brady B. Musculoskeletal problems of the neck, shoulder, and back and functional consequences in nurses. *Am J Ind Med.* 2002;41:170-178.
4. Ba NA, Bn R, Noah R, Ja O, Quek KF. Work related musculoskeletal disorders in female nursing personnel: prevalence and impact. *Int J Collab Res Intern Med Public Health.* 2016;8:294-315.
5. Heidari M, Ghodusi Borujeni M, Kabirian Abyaneh S, Rezaei P. The effect of spiritual care on perceived stress and mental health among the elderlies living in nursing home. *J Relig Health.* 2019;58:1328-1339.
6. Finestone HM, Alfeeli A, Fisher WA. Stress-induced physiologic changes as a basis for the biopsychosocial model of chronic musculoskeletal pain: a new theory? *Clin J Pain.* 2008;24:767-775.
7. Linton SJ, Shaw WS. Impact of psychological factors in the experience of pain. *Phys Ther.* 2011;91:700-711.
8. Redeker NS, Caruso CC, Hashmi SD, Mullington JM, Grandner M, Morgenthaler TI. Workplace interventions to promote sleep health and an alert, healthy workforce. *J Clin Sleep Med.* 2019;15:649-657.
9. Caruso CC, Waters TR. A review of work schedule issue and musculoskeletal disorders with an emphasis on the healthcare sector. *Ind Health.* 2008;46:523-534.
10. Mehrdad R, Dennerlein JT, Haghghat M, Aminian O. Association between psychosocial factors and musculoskeletal symptoms among Iranian nurses. *Am J Ind Med.* 2010;53:1032-1039.
11. Trinkoff AM, Le R, Geiger-Brown J, Lipscomb J, Lang G. Longitudinal relationship of work hours, mandatory overtime, and on-call to musculoskeletal problems in nurses. *Am J Ind Med.* 2006;49:964-971.
12. Tojo M, Yamaguchi S, Amano N, et al. Prevalence and associated factors of foot and ankle pain among nurses at a university hospital in Japan: a cross-sectional study. *J Occup Health.* 2018;60:132-139.
13. Van Eerd D, Beaton D, Cole D, Lucas J, Hogg-Johnson S, Bombardier C. Classification systems for upper-limb musculoskeletal disorders in workers: a review of the literature. *J Clin Epidemiol.* 2003;56:925-936.
14. Akerstedt T. Psychological and psychophysiological effects of shift work. *Scand J Work Environ Health.* 1990;16:67-73.
15. Moher D, Liberati A, Tetzlaff J, Altman DG; The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA Statement. *PLoS Med.* 2008;6:e1000097.
16. Joanna Briggs Institute. *Joanna Briggs Institute Reviewers' Manual: 2014 edition.* Australia: The Joanna Briggs Institute.
17. Abou El-Souda AM, El-Najjar AR, El-Fattah NA, Hassan AA. Prevalence of low back pain in working nurses in Zagazig University Hospitals: an epidemiological study. *Egypt Rheumatol Rehabil.* 2014;41:109-115.
18. Arsalani N, Fallahi-Khoshknab M, Josephson M, Lagerström M. Musculoskeletal disorders and working conditions among Iranian nursing personnel. *Int J Occup Saf Ergon.* 2014;20:671-680.
19. Attarchi M, Raeisi S, Namvar M, Golabadi M. Association between shift working and musculoskeletal symptoms among nursing personnel. *Iran J Nurs Midwifery Res.* 2014;19:309-314.
20. Buja A, Zampieron A, Mastrangelo G, et al. Strain and health implications of nurses' shift work. *Int J Occup Med Environ Health.* 2013;26:511-521.
21. Burdelak W, Bukowska A, Krysicka J, Peplowska B. Night work and health status of nurses and midwives. Cross-sectional study. *Med Pr.* 2012;63:517-529.
22. Dlungwane T, Voce A, Knight S. Prevalence and factors associated with low back pain among nurses at a regional hospital in KwaZulu-Natal, South Africa. *Health SA Gesondheid.* 2018;23:1082. <https://doi.org/10.4102/hsag.v23i0.1082>
23. Fujii T, Oka H, Takano K, et al. Association between high fear-avoidance beliefs about physical activity and chronic disabling low back pain in nurses in Japan. *BMC Musculoskelet Disord.* 2019;20:572. <https://doi.org/10.1186/s12891-019-2965-6>
24. Ibrahim MI, Zubair IU, Yaacob NM, Ahmad MI, Shafei MN. Low back pain and its associated factors among nurses in public hospitals of Penang, Malaysia. *Int J Env Res Public Health.* 2019;16:4254. <https://doi.org/10.3390/ijerph16214254>
25. June KJ, Cho SH. Low back pain and work-related factors among nurses in intensive care units. *J Clin Nurs.* 2011;20:479-487.
26. Mekonnen TH. Work-related factors associated with low back pain among nurse professionals in East and West Wollega Zones, Western Ethiopia, 2017: a cross-sectional study. *Pain Ther.* 2019;8:239-247.
27. Ovayolu O, Ovayolu N, Genc M, Col-Araz N. Frequency and severity of low back pain in nurses working in intensive care units and influential factors. *Pak J Med Sci.* 2014;30:70-76.
28. Raeisi S, Namvar M, Golabadi M, Attarchi M. Combined effects of physical demands and shift working on low back disorders among nursing personnel. *Int J Occup Saf Ergon.* 2014;20:159-166.
29. Samaei SE, Mostafaei M, Jafarpour H, Hosseinabadi MB. Effects of patient-handling and individual factors on the prevalence of low back pain among nursing personnel. *Work.* 2017;56:551-561.
30. Shafizadeh KR. Prevalence of musculoskeletal disorders among paramedics working in a large hospital in Ahwaz, southwestern Iran in 2010. *Int J Occup Environ Med.* 2011;2:157-165.
31. Yao Y, Zhao S, An Z, et al. The associations of work style and physical exercise with the risk of work-related musculoskeletal disorders in nurses. *Int J Occup Med Env.* 2019;32:15-24.
32. Zhang Q, Dong H, Zhu C, Liu G. Low back pain in emergency ambulance workers in tertiary hospitals in China and its risk factors among ambulance nurses: a cross-sectional study. *BMJ Open.* 2019;9:e029264. <https://doi.org/10.1136/bmjopen-2019-029264>
33. Zhao I, Bogossian F, Turner C. The effects of shift work and interaction between shift work and overweight/obesity on low back pain in nurses: results from a longitudinal study. *J Occup Environ Med.* 2012;54:820-825.
34. Abdul Rahman H, Abdul-Mumin K, Naing L. Psychosocial work stressors, work fatigue, and musculoskeletal disorders: comparison

- between emergency and critical care nurses in Brunei Public Hospitals. *Asian Nurs Res.* 2017;11:13-18.
35. Thompson BJ. Does work-induced fatigue accumulate across three compressed 12 hour shifts in hospital nurses and aides? *PLoS One.* 2019;14:e0211715.
36. Lerman SE, Eskin E, Flower DJ, et al. Fatigue risk management in the workplace. *J Occup Environ Med.* 2012;54:231-258. <https://doi.org/10.1097/JOM.0b013e318247a3b0>
37. Gallagher S, Schall MC Jr. Musculoskeletal disorders as a fatigue failure process: evidence, implications and research needs. *Ergonomics.* 2017;60:255-269.
38. Khan S, Duan P, Yao L, Hou H. Shiftwork-mediated disruptions of circadian rhythms and sleep homeostasis cause serious health problems. *Int J Genomics.* 2018;2018:8576890. <https://doi.org/10.1155/2018/8576890>
39. Wright KP Jr, Bogan RK, Wyatt JK. Shift work and the assessment and management of shift work disorder (SWD). *Sleep Med Rev.* 2013;17:41-54.
40. Bazrafshan MR, Moravjeji F, Soleymaninejad N, Zare F, Rahimpour R, Zolghadr R. Prevalence and effects of sleep disorders among shift-working nurse. *Ann Trop Med Public Health.* 2018;11:13-18.
41. Richter K, Acker J, Adam S, Niklewski G. Prevention of fatigue and insomnia in shift workers-a review of non-pharmacological measures. *EPMA J.* 2016;7:16. <https://doi.org/10.1186/s13167-016-0064-4>
42. Smith DR, Ohmura K, Yamagata Z, Minai J. Musculoskeletal disorders among female nurses in a rural Japanese hospital. *Nurs Health Sci.* 2003;5:185-188.
43. Lipscomb J, Trinkoff A, Brady B, Geiger-Brown J. Health care system changes and reported musculoskeletal disorders among registered nurses. *Am J Public Health.* 2004;94:1431-1435.
44. Abdalla DR, Freitas FS, Matheus JPC, Walsh IAP, Bertinello D. Postural biomechanical risks for nursing workers. *Fisioter Mov.* 2014;27:421-427.

**How to cite this article:** Chang W-P, Peng Y-X. Differences between fixed day shift nurses and rotating and irregular shift nurses in work-related musculoskeletal disorders: A literature review and meta-analysis. *J Occup Health.* 2021;63:e12208. <https://doi.org/10.1002/1348-9585.12208>