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Work-related musculoskeletal pain and disorders among ultrasound practitioners in Saudi Arabia: A cross sectional study

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ABSTRACT

Background: work-related musculoskeletal disorders (WRMSKDs) in ultrasound (US) imaging become common because different US tests need US practitioners to conduct different physical activities and movements. Consequently, physically exposed US practitioners acquire certain pains and injuries in the shoulders, neck, back, hands, wrists, elbows, and others. *Methods:* A cross-sectional study design was used. A total of 222 US practitioners from governmental, private, and educational hospitals across the Kingdom of Saudi Arabia (KSA) were enrolled during the period from January to March 2020. Data was collected using an online electronic questionnaire distributed via social media applications. *Result:* The age of the participants ranges from 25 to 56 years. There were 81 (36.48%) male and 141 (63.51%) female participants. Around 57% of participants were working on general ultrasound imaging and cardiovascular imaging, 82% of participants had been working on the same technique for a long time, examining 11–20 patients per day and feeling pain at around the middle of their working shift. Moreover, 78% of participants were suffering from WRMSDs. Ultimately, 60% of participants used rest, medication, and physiotherapy sessions as treatments. A strong correlation was found between the examination time, working hours, and type of examination with WRMSKD ($P<0.001$). *Conclusion:* The finding of this study conclude WRMSKDS are the major problem among Saudi sonographers and would contribute to reduces the WRMSKDs by applying effectives methods for safe working setting and to achieving healthy life for sonographers as well as to enhance the performance.

Keywords: Ultrasound scan, Neck and right shoulder pain, Elbow and wrist pain, Upper and lower back pain, Repetitive scanning, Bending and twisting during scan, Prolong period during scan

1. INTRODUCTION

Medical imaging modalities such as X-ray, ultrasound, computed tomography and magnetic resonance imaging play an important role in patient's treatment path. Radiographers perform several physical activities during their clinical practice (e.g. handling of imaging equipment's and patients) (Kumar et al., 2004). These kinds of physical activities would increase the risk of work-related musculoskeletal disorders (WRMSKDs) (Kumar et al., 2004). During the last few decades, WRMSKDs have been exposed to several professions including healthcare workers. A high incidence of WRMSKDs was found between Saudi dentists and physical therapists which have impacted negatively on their life and work performance (Iqbal and Alghadir, 2015; Alghadir et al., 2015; Alwatban et al., 2021; Sultan et al., 2021; Alzeyadi et al., 2022).

Diagnostic medical ultrasound (US) is not excluded. US are a widely available, low-cost, radiation-free imaging modality commonly used in recent decades (Wareluk and Jakubowski, 2017). However, scanning for long and repeated periods, and engagement in US work with special muscles and joints, result in WRMSKDs (Zhang and Huang, 2017). In 1993, WRMSKDs were first recognized amongst cardiac US practitioners, and many surveys were conducted to recognize the extent of the problem in US imaging departments (Coffin, 2014). These WRMSKDs refer to muscles, joint or nerve discomfort in different human body parts which are attributable to the nature of the work (Gasibat et al., 2017). In Saudi Arabia, about 29.3% of radiologists who used US in their clinical practice being prevented from some normal activity because of musculoskeletal pain (Alshammari et al., 2019). The prevalence of WRMSKDs, and pain among US practitioners in Riyadh city, Saudi Arabia, has been reported as 84% (Al-Rammah et al., 2017).

Common risk factors of WRMSKDs including awkward postures, repetitive movements, prolonged static work, manual handling of materials, and forceful exertions were also highlighted in the literature (Evans et al., 2009). The neck, shoulders, upper back, elbows, wrists, hands, lower back, hips, knees, and ankles are common sites of WRMSKDs and US practitioners usually experience high pressure on these areas during scanning (Hossain, 2018). The significance of identifying WRMSKDs in clinical sonography arise from the nature of the medical sonographic assessment, during which US practitioners conduct different physical activities and movements using various awkward postures, repetitive movements, poor positioning, suboptimal lighting, and mental stress (Rambabu and Suneetha, 2014; Hammad et al., 2017; Xie et al., 2017; Zakerian et al., 2015). Understanding WRMSKDs among US practitioners is substantial to avoid overlooking symptoms and longstanding damage and provides guidance to use ergonomic interventions and practice better efficacy (Sweeney et al., 2021).

To the author's knowledge, and except of few studies that have investigated the prevalence and causes of musculoskeletal pain among radiographers or/and sonographers in Saudi Arabia (Al-Mohrej et al., 2016; Al Shammari et al., 2019; Al-Rammah et al., 2017), there are no studies in the literature focused on the symptoms, signs, common sites, and potential risk factors of WRMSKDs among US practitioners across Saudi Arabia. The study aims to determine the prevalence of WRMSKDs among US practitioners in the western region of Saudi Arabia

2. MATERIALS AND METHODS

Ethical considerations

Ethical approval was obtained from the research committee of the College of Applied Medical Sciences (No. 2020/78/307/DRD) issued on 02/11/2020. The confidentiality of the participants' information was assured. The research does not include identifying information of individual subjects.

Study design

This was a cross-sectional study in which an online survey questionnaire was distributed via social media including WhatsApp, Facebook, and Telegram among US practitioners who worked in governmental, private hospitals and clinics across the country during the period 1st January to 31st March 2020. A non-probability convenience sampling technique was used in this study with the participation of a total of 222 US practitioners. The inclusion criteria correspond to all the Saudi US practitioners who work in all hospitals or/and clinics across the country. The questionnaire was constructed and designed to feature all study variables related to the research including participants' demographically data, type of US examination usually performed, working hours, years of work, and area of pain suffered. A pilot study was conducted prior to embarking with the main study with the help of three experts: US clinical specialists and academic lecturers. Minor corrections were made to the survey based on the comments received. The complete data were collected, organized, and prepared electronically in a computer system for the purpose of analysis.

Statistical analysis

The data were analysed using the "Statistical Social Sciences Package" (SPSS), version 25, (IBM corp., Armonk, NY), and a P-value <0.05 was considered significant. Statistical estimates of the relevant study parameters were achieved using the chi-square test. Person chi-square test was used to determine whether there is a statistically significant difference between experiencing musculoskeletal symptoms and the length of an examination, working hours, and type of scanning performed.

3. RESULTS

This study involved 222 participants. The age of the participants ranged from 25 to 56 years. The sample included 81 (36.48%) male and 141 (63.51%) female participants (Table 1). The results (table 2 – 5 and graph 1-4) shows that there is a relationship between the length of an examination, working hours, type of scanning performed and experiencing musculoskeletal symptoms ($p < 0.05$).

Table 1 The distribution of participants according to their age, place of work, years of experiences, working hours, total number of examinations and patients.

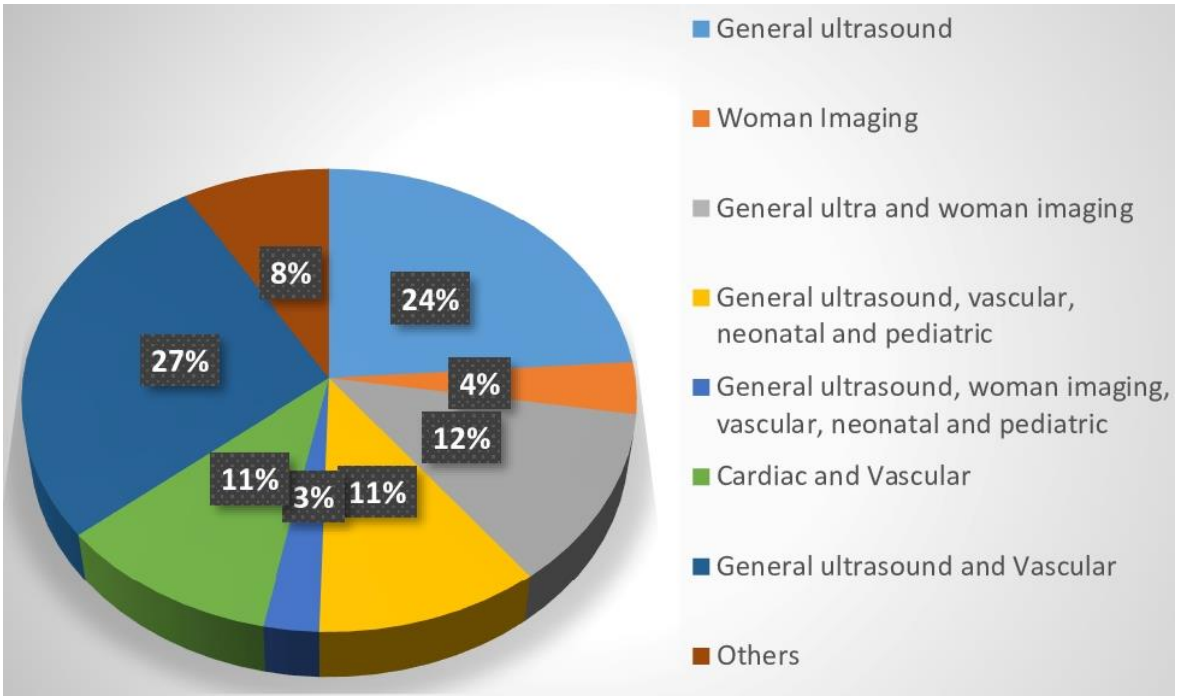
Age Categories	Frequency	Percentage	Place of work	Frequency	Percentage
25–35 years	106	48.15	Academic hospital	39	17.6
36–45 years	81	36.48	Private clinic	34	15.3
46–56 years	35	15.74	Private hospital	60	27.1
-	-	-	Public hospital	89	40.8
Experience	Frequency	Percentage	Working hours	Frequency	Percentage
1–7 years	115	51.66	2–4 hours	6	2.71
8–14 years	86	38.69	5–8 hours	121	54.6
15–20 years	21	9.45	9–12 hours	95	42.79
Total number of examinations/ days	Frequency	Percentage	Avg Examination time per patient	Frequency	Percentage
11–15 patients	119	53.60	1–7 mins	115	51.82
16–20 patients	56	25.22	8–14 mins	86	38.83
5–10 patients	47	21.17	15–20 mins	21	9.45
Total	222	100.0	Total	222	100.0

Table 2 shows the distribution of participants according to their body posture during scanning and their use of the same technique for long periods of time.

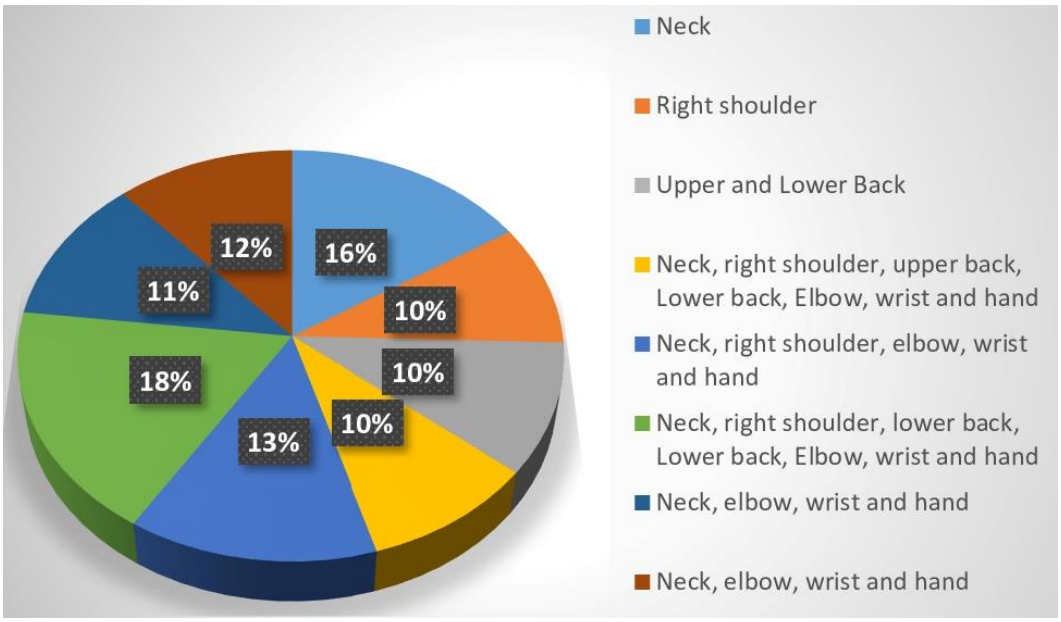
Body posture during scanning	Frequency	Percentage	Using same technique for long time	Frequency	Percentage
Alternative, position	129	58.33	No	41	18.5
Sitting	56	25.00	Yes	180	81.1
Standing	37	16.67	Yes, No	1	.5
Total	222	100.0	Total	222	100.0

Table 3 shows the distribution of participants according to regular physical activity and perception about health status.

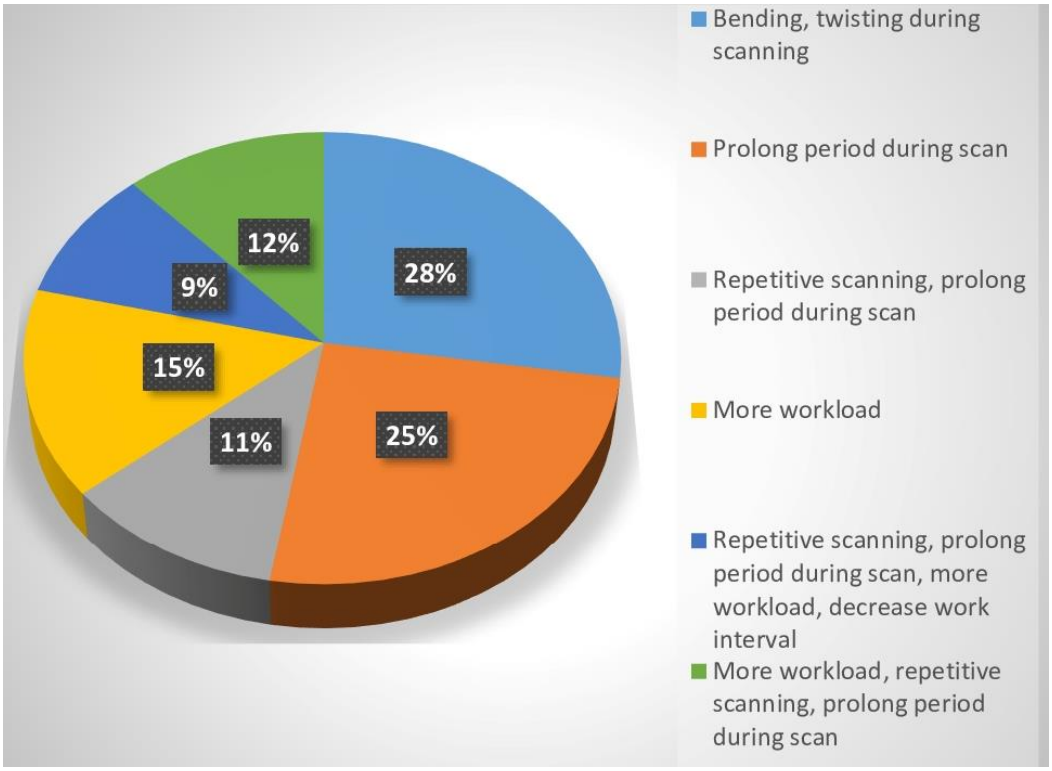
Regular physical activity	Frequency	Percentage	Perception about health status	Frequency	Percentage
Less/Never	35	15.7	Fair	78	35.13
Permanently	54	24.3	Good	130	58.55
Sometimes	133	60	Poor	14	6.30
Total	222	100.0	Total	222	100.0



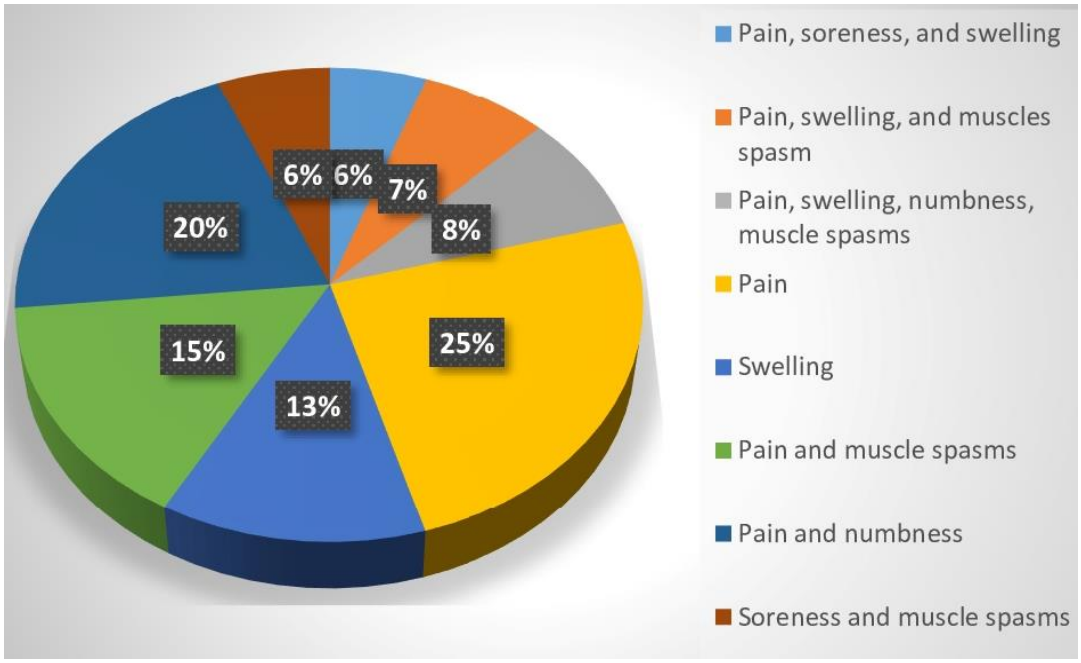
Graph 1 shows the scanning category type among all participants.



Graph 2 shows the affected body parts among all participants



Graph 3 shows the reason for injury category among all participants.



Graph 4 shows musculoskeletal symptoms among all participants.

Table 4 shows the category related to the time when pain was felt and the treatment choices among all participants.

Time of feeling pain			Treatment Options		
Categories	Freq	Percentage	Categories	Freq	Percentage
End of working time	86	39.8	Take some rest	68	30.56
Middle of working time	73	33.3	Take some rest and medication	37	16.67
Middle and end of working time	25	11.1	Take some rest, physiotherapy sessions, and medication	35	15.74

Start and end of working time	5	0.9	Take some rest, sessions in physiotherapy	40	18.52
Start and middle of working time	8	3.7	Surgery	16	6.48
Start of working time	25	11.1	Physiotherapy sessions, exercise, medication	26	12.03
Total	222	100.0	Total	222	100.0

Table 5 shows the distribution of participants according to the pain is felt and the practitioners' gender

Time of Feeling Pain	*Gender*		*Total*
	Female	*Male*	
End of working time	43	30	73
From the beginning of the working time	14	8	22
From the beginning of the working time, end of working time	11	4	15
From the beginning of the working time, middle of working time	10	2	12
From the beginning of the working time, middle of working time, end of working time	5	11	16
Middle of working time	41	14	55
Middle of working time, end of working time	18	11	29
Total	142	80	222

4. DISCUSSION

WRMSKDs have been identified as a major occupational problem among healthcare professionals, including sonographers. The WRMSKDs, caused by incorrect working positions, are considered a major public health issue worldwide (Sweeney et al., 2021). Although limited studies have investigated the prevalence and causative factors of musculoskeletal pain among radiographers or/and sonographers, the symptoms, signs, common sites, and potential risk factors of WRMSKDs among US practitioners across Saudi Arabia have been spares in the literature.

This current study was designed to evaluate the WRMSKDs and the nature, type, and location of disorders and pain among US practitioners. A total of 222 sonographers participated in this study. This study found that pain alone, or pain with numbness or muscle spasm were the most common symptoms of WRMSKD among Saudi US practitioners. This result is in line with the previous study conducted by Zhang and Huang, (2017) who reported that pain in the neck, right shoulder; lower back, right wrist, upper back, right forearm, and left shoulder are the most frequently affected parts of the bodies of US practitioners. Alaniz and Veale, (2013) found that up to 90% of US practitioners experience pain during US examinations. The neck and right shoulder were indicated as the most common sites of pain in this study. Similar results were highlighted by Freng et al., (2016) who reported that 93.5% of WRMSKDs are found in the neck, 92.2% in the shoulder, 83.2% in the lower back, followed by wrist, hand, upper back, and elbow; neck and shoulder pain are attributed to psychological fatigue, shoulder abduction, trunk bending and a twisted position. Additional studies indicated that US practitioners have a high prevalence of neck and upper limb pain (Simonsen et al., 2020; Russo et al., 2002).

In the current study, it was also found that bending and twisting during scanning, and prolonged periods of scanning, were the most common causes of WRMSKDs, and these findings are consistent with several previous studies conducted in various regions (Hossain, 2018; Rambabu and Suneetha, 2014). Murphy, (2017) reported that causes of WRMSKDs are multifactorial, and the most common include exerted physical effort during US examinations, task repetition, awkward and strained postures (unlike the neutral position of the body), and contact pressure. It was also reported that unnatural postures during US scanning cause musculoskeletal disorders (Suzuki et al., 2015). This was reinforced later by Murphy et al., (2017) who reported similar results. Janga and Akinfenwa, (2012) stated that several consecutive working days, and no regular breaks during each day, have a positive correlation with WRMSKDs. Further study showed that shoulder pain is caused by arm abduction, which leads to decreased blood flow to the shoulder; neck pain is induced through the tilting of the head and neck to see fine structures on an image; back pain is caused by twisting the body; joint pain stems from repetitive flexion and extension movements of the joints leading to micro-trauma; and hand and finger pain is caused by pinching and gripping during scanning (Harrison and Harris, 2015).

The severity of experiencing musculoskeletal symptoms shows a significant relationship in this study with the length of an examination, working hours and type of scanning performed. Similar results were indicated by (Junejo et al., 2017 and Zhang and Hung, 2017). This may have a negative effect on the sonographer's quality of life (e.g. career, social) (Garnaes et al., 2021). Regarding the management of WRMSKDs, several studies recommended that reducing the number of working hours, patient numbers, taking regular rest breaks, adopting a sitting posture during working hours, and performing regular physical exercise are associated with a reduction in WRMSKDs (Zhang et al., 2017). Simonsen et al., (2020) endorsed the need to modify US equipment, so it can be adjusted with the US practitioners' anthropometrics and encouraging them to vary their posture and movements during their shifts at work. This study revealed that 54.6% and 42.79% of the participants work for 5–8 and 9–12 hours per day, respectively, and examine more than 10 patients each day. Both male and female sonographers in this study felt the maximum of their pain at the end of the working day. Wareluk and Jakubowski, (2017) reported that overusing the musculoskeletal system is a serious problem among US practitioners, which results in various health issues, a problem for which there is low awareness. They reported that taking breaks during working hours, optimizing the workplace, and adopting a correct posture during scanning have a high impact on reducing WRMSKDs (Wareluk and Jakubowski, 2017).

Harrison and Hariss (2015) reported that taking rest periods during work and varying workloads during the day are effective ways to allow muscles and tendons to relax during working hours. In addition, regular physical exercise has a role in reducing stress and improving blood supply to the joints. It was found that the bi-planar US scanning technique may reduce stress on the US practitioners' arms, which could, consequently, reduce WRMSKDs (Stenberg and Elliott, 2013). Ultimately, US practitioners are responsible for their own safety, skills, and knowledge to guarantee the best quality healthcare. To reduce the risk of WRMSKDs, US practitioners should adjust their workstations to accommodate a comfortable neutral seated or standing position, reduce their working hours (to less than 8 hours per day) and number of examinations (less than 10 patients per day), take breaks between examinations, and take part in regular physical exercise. Companies, hospitals, medical centres, and US practitioners should ergonomically optimize their equipment, including adjusting their examination table, and using movable chairs and couches to reduce risk factors.

Further ergonomic studies are an important topic for future research to assess working practices during US scanning and to determine appropriate ways to reduce the risk of injury for each type of US scanning.

Limitations

A limitation of this study relates to the fact that it was difficult to find the exact number of the sonographers' population in Saudi Arabia to calculate the sample size; however, the non-probability convenience sampling technique was used. This technique allowed the researchers to reach those who are conveniently available. An additional potential limitation is sampling bias, online survey might have been completed by those who are suffering from WRMSDs and who are more active on social media or/and online. Therefore, the results need to be treated with causation as it may not be generalised to the whole Saudi sonographers' population.

5. CONCLUSION

Work-related musculoskeletal disorders are a major public health problem among Saudi US practitioners caused mainly by incorrect working positions. Pain alone, or pain with numbness or muscle spasm, are the most common symptoms of WRMSKD in US practitioners. Most Saudi US practitioners were found with one or more symptoms of upper, middle, or lower back pain, neck pain, shoulder pain, elbow pain, wrist pain, and hand pain. The pathogenesis of WRMSKDs is multifactorial, including bending, twisting during scanning, and prolonged scanning periods. Safety standards should be guaranteed for US practitioners to reduce the risk of WRMSKDs.

Author Contributions

A.M.O, study concept and supervision; W.M.A., wrote and edited the language and revised the article; A.H.A, M.G.K, and S.F.A, data collection; S.A.A, wrote the final article; A.M.A., final revision of the article; E.O.A., final edition of the language; M.Z.E., revised results; K.M.A., final revision of the article. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement

This study has been approved by the research committee of the College of Applied Medical Sciences (No. 2020/78/307/DRD) issued on 02/11/2020.

Abbreviations

WRMSKD: work-related musculoskeletal disorders
US: Ultrasound
KSA: Kingdom of Saudi Arabia
SPSS: Statistical Social Sciences Package
IBM: international business machines
NY: New York

Funding

This study has not received any external funding.

Conflicts of interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Al Shammari M, Hassan A, Al Dandan O, Al Gadeeb M, Bubshait D. Musculoskeletal symptoms among radiologists in Saudi Arabia: a multi-center cross-sectional study. BMC Musculoskeletal Disorders 2019; 20(1): 1-10.
2. Alaniz J, Veale BL. Stretching for sonographers: a literature review of sonographer-reported musculoskeletal injuries. J Diag Medical Sonography 2013; 29(4): 188-190.
3. Alghadir A, Zafar H, Iqbal Z. A. Work-related musculoskeletal disorders among dental professionals in Saudi Arabia. J Phys Ther Sci 2015; 27(4): 1107-1112.
4. Al-Mohrej OA, AlShaalan NS, Al-Bani WM, Masuadi E M, Almodaimegh HS. Prevalence of musculoskeletal pain of the neck, upper extremities and lower back among dental practitioners working in Riyadh, Saudi Arabia: a cross-sectional study. J Brit Med open 2016; 6(6): e011100.
5. Al-Rammah TY, Aloufi AS, Algaeed SK, Alogail NS. The prevalence of work-related musculoskeletal disorders among sonographers. ISO Press 2017; 57(2): 211-219.
6. Alwatban OJA, Alshammari SA, Alrabiah BK, Alsadhan KF, Alwhibi MW. The association between smartphone usage and musculoskeletal pain among medical residents in Riyadh, Saudi Arabia during covid-19 pandemic. Medical Science 2021; 25(115): 2383-2391
7. Alzeyadi AA, Elsiddig AI, Khan MA, Alkhaldi SA, Alrumaym AH, Alzaidi GA, Alharthi EK, Al-Thomali SK, Alotaibi WT. Prevalence of musculoskeletal disorders among health care workers during covid-19 pandemic in the western region of Saudi Arabia. Medical Science 2022; 26:ms104e2106. doi: 10.54905/dissi/v26i121/ms104e2106
8. Coffin CT. Work-related musculoskeletal disorders in sonographers: a review of causes and types of injury and best practices for reducing injury risk. Reports Med Imaging J 2014; 7(1): 15-26
9. Evans K, Roll S, Baker J. Work-related musculoskeletal disorders (WRMSD) among registered diagnostic medical sonographers and vascular technologists: a representative sample. J Diag Med Sonography 2009; 25(6): 287-299.
10. Feng Q, Liu S, Yang L, Xie M, Zhang Q. The prevalence of and risk factors associated with musculoskeletal disorders among sonographers in Central China: A cross-sectional study. PLoS One 2016; 11(10): e0163903.
11. Garnaes KK, Mørkved S, Salvesen Ø, Tønne T, Furan L, Grønhaug G, Vasseljen O, Johannessen HH. What factors are associated with health-related quality of life among patients with chronic musculoskeletal pain? A cross-sectional study in primary health care. BMC 2021; 22(1):1-2.
12. Gasibat Q, Simbak NB, Aziz AA, Petridis L, Tróznai Z. Stretching exercises to prevent work-related musculoskeletal disorders: A review article. J Sports Sci Med 2017; 5(2):27-37.
13. Hammad LF, Zaidi U, Awad SS, Elkholi SMA, Diouri H. Prevalence, Ergonomics, Sociodemographic Correlates with Musculoskeletal Injuries among Sonographers in Riyadh, KSA. CIBTech 2017; 6 (2): 33-42.
14. Harrison G, Harris A. Work-related musculoskeletal disorders in ultrasound: Can you reduce risk? Ultrasound 2015; 23(4): 224-230.
15. Hossain MD, Aftab A, Al Imam MH, Mahmud I, Chowdhury IA, Kabir R I, Sarker M. Prevalence of work related musculoskeletal disorders (WMSDs) and ergonomic risk assessment among readymade garment workers of Bangladesh: A cross sectional study. PloS one 2018; 13(7): e0200122.

16. Iqbal Z, Alghadir A. Prevalence of work-related musculoskeletal disorders among physical therapists. Med Pr 2015; 66(4), 459-69.
17. Janga D, Akinfenwa O. Work-related repetitive strain injuries amongst practitioners of obstetric and gynaecological ultrasound worldwide. Gyne obstetrics 2012; 286(2): 353-356.
18. Junejo MA, Tahir SM, Behan RB. Prevalence and risk factors for work related musculoskeletal disorders among sonographer of Sindh Province Pakistan. J Liaquat Uni Med Health Sci 2017; 16(1): 29-36.
19. Kumar S, Moro L, Narayan Y. Perceived physical stress at work and musculoskeletal discomfort in X-ray technologists. Ergonomics 2004; 47(2): 189-201.
20. Murphey S. Work related musculoskeletal disorders in sonography. J Diag Medical Sonography 2017; 33(5),356-369
21. Rambabu T, Suneetha K. Prevalence of work related musculoskeletal disorders among physicians, surgeons and dentists: a comparative study. Med health sci res 2014; 4(4): 578-582.
22. Russo A, Murphy C, Lessoway V, Berkowitz J. The prevalence of musculoskeletal symptoms among British Columbia sonographers. App Ergonomics 2002; 33(5): 385-393.
23. Simonsen JG, Axmon A, Nordander C, Arvidsson I. Neck and upper extremity pain in sonographers–a longitudinal study. BMC Musculoskeletal Disorders 2020; 21(1): 1-11.
24. Stenberg B, Elliott ST. Can live bi-plane sonography reduce work-related musculoskeletal disorders of the wrist?. J Clin Ultrasound 2013; 41(3): 140-144.
25. Sultan I, Algouzi RM, Alasmari MA, Abdullah RA. The prevalence and factors associated with musculoskeletal pain among medical students at Ibn Sina National College, Jeddah, Saudi Arabia. Medical Science 2021; 25(118):3489-3496
26. Suzuki H, Saito T, Shimomura Y, Katsuura T. Effects of horizontal console position on operator muscular stress during abdominal ultrasonic diagnosis. J Med Ultrasonics 2014; 41(2): 155-162.
27. Sweeney K, Mackey M, Spurway J, Clarke J, Ginn K. The effectiveness of ergonomics interventions in reducing upper limb work-related musculoskeletal pain and dysfunction in sonographers, surgeons and dentists: a systematic review. Ergonomics J 2021; 64(1): 1-38.
28. Wareluk P, Jakubowski W. Evaluation of musculoskeletal symptoms among physicians performing ultrasound. J Ultrason 2017; 17(70): 154.
29. Xie Y, Szeto G, Dai J. Prevalence and risk factors associated with musculoskeletal complaints among users of mobile handheld devices: A systematic review. App ergonomics J 2017; 59: 132-142.
30. Zakerian SA, Abbaszadeh M, Janani L, Kazemi Z, Safarain MH. The prevalence of musculoskeletal disorders among ultrasound specialists and identifying their work-related risk factors. J Health Field 2015; 3(2): 33-42.
31. Zhang D, Huang H. Prevalence of work-related musculoskeletal disorders among sonographers in China: results from a national web-based survey. J Occup Health 2017; 59: 529-541
32. Zhang D, Yan M, Lin H, Xu G, Yan H, He Z. Evaluation of work-related musculoskeletal disorders among sonographers in general hospitals in Guangdong province, China. J Occup safety Ergonomics 2020; 6(4): 802-810.