Original Article

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Radiology Section

Prevalence of Musculoskeletal Pain among Sonographers in Makkah Province and Factors Associated with the Pain: A Cross-sectional Study

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ABSTRACT

Introduction: Work-related musculoskeletal pain is a serious public health issue affecting healthcare providers, particularly, sonographers. The lack of research into this issue, together with the limited knowledge of factors associated with pain among Saudi sonographers promoted the authors to perform this study.

Aim: To explore the prevalence of work-related musculoskeletal pain and potential factors related to this disorder among sonographers.

Materials and Methods: This cross-sectional study targeted 102 sonographers working in the Radiology Departments of hospitals located in the Makkah province from September 2019 to February 2020. The questionnaire comprised 27 questions-11 questions related to demographic and psychosocial, nine on work scheduling and task factors (average time per scan and amount of job tasks), one on anatomical areas affected by pain over the last six months, six questions on work-related posture factors (position of the body during scanning). Bivariate analysis was considered to investigate the relationships between work-related musculoskeletal pain and potential factors affecting the musculoskeletal system of sonographers.

Results: The prevalence of work-related musculoskeletal pain among Saudi sonographers was 81 (98.78%), and the pain was located at a single or multiple body sites, with the highest being in shoulders (70, 86.4%), followed by lower back (61, 75.3%), hand and wrist (58, 71.6%). Mental stress was only associated with shoulder pain (p-value: 0.03), and demographic factors (institution type) were related to hand and wrist pain (p-value ≤0.003). Upper back pain was significantly related to work-related posture factors (p-value ≤0.008), and both work related posture factors, as well as task factors, have shown a significant relationship with lower back pain (p-value ≤0.04).

Conclusion: Work-related musculoskeletal pain is highly prevalent among Saudi sonographers and the pain from different anatomical parts were found to be associated with different factors including psychological, demographic, task, and work-related posture factors.

Keywords: Lower back, Mental stress, Radiology, Shoulders

INTRODUCTION

The painful injuries of the musculoskeletal system that are caused by workplace activities are known as Work-Related Musculoskeletal Disorders (WRMSDs) [1]. These disorders include muscles, nerves, ligaments, and tendons of different body parts. WRMSDs were first documented by Craig M in 1985 [2], and then they were intensely investigated by scholars between 1996 and 2017 [3-9]. The incidence of these disorders may increase in the future as a result of continuous exposure to risk factors at workplace [10]. Additionally, WRMSDs can negatively influence the working life of healthcare providers, particularly sonographers, by restricting their extremities' movement resulting in lower productivity and poor quality care services [10]. Also, these are associated with a considerable economic burden, estimated at $87.6 billion in the USA [11]. It has been estimated that the annual cost of compensation claims on WRMSDs in the United States of America (USA) is between 20 billion dollars suggesting that WRMSDs are a serious health concern that should be addressed [10].

Work-related musculoskeletal pain among sonographers have rarely been investigated in eastern societies, such as the Saudi population. Only one study explored the prevalence of work related musculoskeletal pain among Saudi sonographers, and did not investigate the risk factors of work related musculoskeletal pain by anatomical parts [12]. The global demand for ultrasound is growing overtime, due its desirable characteristics including safety and non invasive nature [13]. Accordingly, the workload on sonographers, such as number of scans, and working hours is expected to increase, which in turn, could escalate the risk of work related musculoskeletal pain.

The causes of work-related musculoskeletal pain are multifactorial and include work-related postures, demographic, psychosocial, and scheduling task factors [14]. Importantly, these risk factors vary geographically due to differences in working environment, practices, and cultures among countries. For instance, workload and psychosocial factors have been shown to cause work related musculoskeletal pain among Sweden sonographers [15], while work-related posture and ergonomic factors have been reported to be precursors of work related musculoskeletal pain among Australian and Nigerian sonographers [7,16]. In Pakistan, scheduling and task factors have been shown as potential determinants of work related musculoskeletal pain among sonographers [17]. Therefore, it is crucial to investigate the relationship between these factors and work related musculoskeletal pain among Saudi sonographers.

The purpose of this study was to investigate the prevalence of work related musculoskeletal pain among Saudi sonographers in Makkah province. Also, it was designed to explore the potential factors associated with work related musculoskeletal pain.

MATERIALS AND METHODS

This cross-sectional study was conducted among sonographers in Makkah province, Saudi Arabia between September 2019 to February 2020.

Sample size estimation: Using a 95% confidence interval, a 5% margin error, and a 84% prevalence of work-related musculoskeletal pain from a previous study [12], atleast 76 sonographers were required to conduct the study. Considering that there were nearly 102 registered sonographers working at government and private hospitals in Makkah region, the survey was sent to all sonographers working in the region.

Inclusion criteria: The on duty ultrasound technologists working at private and government hospitals in the main cities (Jeddah, Altaif, and Makkah), and conducting general, gynaecological, and obstetrical ultrasound examinations were invited to participate in the current study.

Exclusion criteria: Sonographers who performed cardiac ultrasound investigations, had a history of trauma related to accidents, or are currently retired were excluded from the study.

Study Procedure

A Google form link was created and sent through a WhatsApp group of sonographers. The link was also shared on Twitter, and Facebook. Monthly follow-up messages were send to remind participants to complete the survey. Before filling out the survey, participants were asked to read the opening statement of the survey which informs them about the objectives of study, inclusion criteria, instructions on how to fill out the survey, and if they are willing to participate. To ensure anonymity, and confidentiality of participants' information, personally identifying information was not requested in the questionnaire. The Helsinki guidelines were followed to conduct this study.

Questionnaire: The survey was designed based on reviewing current literature [18,19], and comprised of 27 closed multiple choice questions, written in English language. These questions were divided into several domains; the first domain covers demographic and psychosocial information (11 questions); the second domain focuses on work scheduling and task factors details (nine questions); the third domain is related to anatomical areas affected by pain in the last six months (one question); the last domain is about work-related postures (six questions). Before distributing the questionnaire, the survey was reviewed by an expert for the content validity. The reliability of questionnaire was examined by Cronbach's alpha that was found to be closer to 0.70 (Cronbach's alpha=0.683).

STATISTICAL ANALYSIS

The data were analysed by Statistical Package for Social Sciences (SPSS) version 25.0. Only those anatomical parts affected by pain with high prevalent rates (more than 60%) were considered for analysis in this study (shoulders, lower back pain, wrist and hand, and upper back pain). Frequencies and percentages were computed to describe categorical variables, while medians as well as means were used to represent continuous variables. To investigate the relationships of demographic information, psychosocial information, work scheduling and task factors, and work-related postures with anatomical areas affected by pain in the last six months data, bivariate analysis such as chi-square test, independent median test, and t-test were used as appropriate. The p-values below 0.05 were considered to be significant.

RESULTS

A total of 82 out of 102 sonographers responded to the survey (response rate: 80.3%). The majority of them were female (71.95%). Of the 82 sonographers, 75.60% were from Jeddah city and nearly 68% were from public health sector. In terms of work related posture, majority of sonographers hold transducers with palmer grip (82%), sit in one position for long time (79.26%) [Table/Fig-1].

Irrespective of the site of pain, a total of 81 (98.78%) of sonographers experienced work-related musculoskeletal pain over the last six months. This pain was reported in single and multiple body parts sites with the highest being in shoulder (86.4%), lower back (75.3%), hand and wrist (71.6%), and upper back region (60.5%) [Table/Fig-2].

Population characteristics		All participants n (%)
Participants' number (%)		82 (100)
1. Demographic and psychosocial information		
Age (Years)	Age >40	22 (26.8)
	Age ≤40	60 (73.2)
City	Jeddah	62 (75.60)
	Makkah	13 (15.85)
	Taif	7 (8.53)
Sex	Female	59 (71.95)
	Male	23 (28.05)
Years of experience (years)	>6	41 (50)
	4-6	12 (14.63)
	1-3	16 (19.51)
	<1	13 (15.85)
Institution	Public	56 (68.3)
	Private	26 (31.7)
How satisfied are you with your profession?	Satisfied[1]	67 (81.7)
	Dissatisfied[2]	15 (18.3)
Have you ever had a psychological fatigue during work over the last 6 months?	Yes, I have[3]	67 (81.7)
	No, I have not[4]	15 (18.3)
Have you ever had a mental stress during work over the last 6 months?	Yes, I have mental stress[5]	69 (84.1)
	No, I have not[6]	13 (15.9)
How do you rate your general health status over the last six months on a scale of 3 points	Good[7]	54 (65.9)
	Average[8]	25 (30.5)
	Below average[9]	3 (3.7)
Perform regular physical activity during leisure times	Yes	67 (81.7)
	No	15 (18.3)

Height median (interquartile range) cm		163 (158-168)
2. Work scheduling and task factors details		
Working hours per day	≤7 hr	16 (19.51)
	≥8 hr	66 (80.48)
Number of scans performed per day	1-10 scans	11 (13.4)
	11-20 scans	46 (56.1)
	21-30 scans	13 (15.9)
	31-40 scans	10 (12.2)
	+41 scans	2 (2.4)
The duration of break time (mins)	No break time	15 (18.3)
	30 min	18 (22)
	45 min	4 (4.9)
	60 min	45 (54.9)
Average time per scan (minutes)	10-20 min	56 (68.3)
	21-25 min	22 (26.8)
	+25 min	4 (4.9)
Doing portable ultrasound	Yes	71 (86.6)
	No	11 (13.4)
Number of hours doing portable ultrasound per day mean (±standard deviations)		3.48 hrs (±1.45)
Repetitive tasks[10]	Yes	76 (92.6)
	No	6 (7.3)
I have too many tasks at hand	Yes	73 (89)
	No	9 (11)
I find my work tasks difficult	Yes	63 (76.82)
	No	19 (23.17)
3. Anatomical areas affected by work related musculoskeletal pain	**Yes**	**81 (98.78%)**
	No	**01 (01.22%)**
4. Work-related postures		
The transducer is hold by palmer/power grip	Yes	73 (89)
	No	9 (10.97)
Sitting in one position for long time	Yes	65 (79.26)
	No	17 (20.73)
Sitting on awkward position[11]	Yes	66 (80.48)
	No	16 (19.51)
The trunk of body is in asymmetrical position[12]	Yes	63 (76.8)
	No	19 (23.17)
More than two hours, I sit with lifted shoulders[13]	Yes	54 (65.85)
	No	28 (34.14)
My hand is placed in a straight line with my arm	Yes	71 (86.58)
	No	11 (13.41)

[Table/Fig-1]: Population characteristics.
(1) comfortable; (2) uncomfortable; (3) feeling of fatigue and tiredness during work; (4) no feelings of fatigue and tiredness during work; (5) feeling of emotional and physical pressure during work; (6) no feelings of emotional and physical pressure during work; (7) good physical health; (8) moderately physically impaired; (9) severely physically impaired; (10) performing frequent or continuous similar tasks for a long period of time without enough recovery time; (11) Unnatural sustained position due to reaching the affected body part away from the sonographer's body during bedside exam. It includes sitting with flexion/extension of the wrist, excess abduction of the shoulders, forward flexion of the shoulders, bending/twisting at the waist, and bending or rotating the neck; (12) sitting with sustained bending/twisting at the waist; (13) sitting with sustained excess abduction of the shoulders and/or sustained forward flexion of the shoulders

Body part	Number of participants (%)
Shoulder	70 (86.4)
Lower back pain	61 (75.3)
Hand and wrist	58 (71.6)
Upper back pain	49 (60.5)
Neck	47 (58)
Elbow	31 (38.3)
Leg	30 (37)
Knee	19 (23.5)
Hip/buttocks	15 (18.5)

[Table/Fig-2]: Prevalence of work-related musculoskeletal pain by anatomical parts; Total N=81 participants who experienced work-related musculoskeletal pain; Participants facing pain at more than one site.

Sonographers who suffered from shoulder pain are more likely to have mental stress during their work (p-value: 0.03), participants with hand and wrist pain were more likely to be younger (p-value=0.001), female (p-value=0.001), employed at public hospitals (p-value=0.003) [Table/Fig-3].

Compared to respondents who did not experience any lower back pain over the last six months those who had lower back pain performed portable ultrasound (p-value=0.01), had higher average number of hours doing portable ultrasound (p-value=0.02), and sat in one position for long time during procedure (p-value=0.01) [Table/Fig-4,5]. Sonographers with upper back pain sat either on awkward position (p-value=0.001), or with their trunk in asymmetrical position during procedure (p-value=0.008) [Table/Fig-5].

Demographic and psychological information		All participants n (%)	Shoulder pain n (%)		p-value	Lower back pain n (%)		p-value	Hand/Wrist pain n (%)		p-value	Upper back pain n (%)		p-value
			Yes	No		Yes	No		Yes	No		Yes	No	
Participants' number (%)		81 (100)	70 (86.4)	11 (13.6)	**<0.001**	61 (75.3)	20 (24.7)	**<0.001**	58 (71.6)	23 (28.4)	**<0.001**	49 (60.5)	32 (39.5)	0.07
Age (years)	Age >40 y	22 (27.2)	17 (24.3)	5 (45.5)	0.14	13 (21.3)	9 (45)	0.08	10 (17.2)	12 (52.2)	**0.001**	14 (28.6)	8 (25)	0.72
	Age ≤40 y	59 (72.8)	53 (75.7)	6 (54.5)		48 (78.7)	11 (55)		48 (82.2)	11 (47.8)		35 (71.4)	24 (75)	
City	Jeddah	61 (75.3)	56 (80)	5 (45.5)	0.12	45 (73.8)	16 (80)	0.69	43 (74.1)	18 (78.3)	0.68	38 (77.6)	23 (71.9)	0.83
	Makkah	13 (16)	10 (14.3)	3 (27.3)		11 (18)	2 (10)		9 (15.5)	4 (17.4)		7 (14.3)	6 (18.8)	
	Taif	7 (8.6)	4 (5.7)	3 (27.3)		5 (8.2)	2 (10)		6 (10.3)	1 (4.3)		4 (8.2)	3 (9.4)	
Gender	Female	59 (72.8)	53 (75.7)	6 (54.5)	0.14	46 (75.4)	13 (65)	0.36	48 (82.8)	11 (47.8)	**0.001**	37 (75.5)	22 (68.8)	0.5
	Male	22 (27.2)	17 (24.3)	5 (45.5)		15 (24.6)	7 (35)		10 (17.2)	12 (52.2)		12 (24.5)	10 (31.3)	
Years of work experience	>6 y	41 (50.6)	35 (50)	6 (54.5)	0.91	28 (45.9)	13 (65)	0.51	25 (43.1)	16 (69.6)	0.17	28 (57.1)	13 (40.6)	0.12
	4-6 y	12 (14.8)	10 (14.3)	2 (18.2)		10 (16.4)	2 (10)		10 (17.2)	2 (8.7)		9 (18.4)	3 (9.4)	
	1-3 y	15 (18.5)	13 (18.6)	2 (18.2)		12 (19.7)	3 (15)		13 (22.4)	2 (8.7)		7 (14.3)	8 (25)	
	<1 y	13 (16)	12 (17.1)	1 (9.1)		11 (18)	2 (10)		10 (17.2)	3 (13)		5 (10.2)	8 (25)	
Institution type	Public	55 (67.9)	47 (67.1)	8 (72.7)	0.71	42 (68.9)	13 (65)	0.74	45 (77.6)	10 (43.5)	**0.003**	32 (65.3)	23 (71.9)	0.53
	Private	26 (32.1)	23 (32.9)	3 (27.3)		19 (31.1)	7 (35)		13 (22.4)	13 (56.5)		17 (34.7)	9 (28.1)	
Job satisfaction	Satisfied[1]	66 (81.5)	55 (78.6)	11 (100)	0.08	48 (78.7)	18 (90)	0.25	45 (77.6)	21 (91.3)	0.15	38 (77.6)	28 (87.5)	0.26
	Non-stratified[2]	15 (18.5)	15 (21.4)	0 (0)		13 (21.3)	2 (10)		13 (22.4)	2 (8.7)		11 (22.4)	4 (12.5)	
Presence of psychological fatigue	yes[3]	67 (82.7)	60 (85.7)	7 (63.6)	0.07	51 (83.6)	16 (80)	0.71	47 (81)	20 (87)	0.5	42 (85.7)	25 (78.1)	0.37
	No[4]	14 (17.3)	10 (14.3)	4 (36.4)		10 (16.4)	4 (20)		11 (19)	3 (13)		7 (14.3)	7 (21.9)	
Mental stress	Had mental stress[5]	69 (85.2)	62 (88.6)	7 (63.6)	**0.03**	52 (85.2)	17 (85)	0.97	52 (89.7)	17 (73.9)	0.07	42 (85.7)	27 (84.4)	0.86
	Had no mental stress[6]	12 (14.8)	8 (11.4)	4 (36.4)		9 (14.8)	3 (15)		6 (10.3)	6 (26.1)		7 (14.3)	5 (15.6)	
Health status	Good[7]	53 (65.4)	48 (68.6)	5 (45.5)	0.16	38 (62.3)	15 (75)	0.43	36 (62.1)	17 (73.9)	0.41	31 (63.3)	22 (68.8)	0.44
	Average[8]	25 (30.9)	19 (27.1)	6 (54.5)		20 (32.8)	5 (25)		19 (32.8)	6 (26.1)		17 (34.7)	8 (25)	
	Below average[9]	3 (3.7)	3 (4.3)	0 (0)		3 (4.9)	0 (0)		3 (5.2)	0 (0)		1 (2)	2 (6.3)	
Perform regular physical activity during leisure times	Yes	66 (81.5)	57 (81.4)	9 (81.8)	0.97	47 (77)	19 (95)	0.07	46 (79.3)	20 (87)	0.42	40 (81.6)	26 (81.3)	0.96
	No	15 (18.5)	13 (18.6)	2 (18.2)		14 (23)	1 (5)		12 (20.7)	3 (13)		9 (18.4)	6 (18.8)	
Height median (interquartile range) cm		163 (158-168)	165 (16-170)	162 (157-168)	0.41	164 (160-169)	162 (157-167)	0.08	170 (164-175)	160 (156-164)	**<0.001**	162 (160-165)	163 (156-169)	0.93

[Table/Fig-3]: Relationships of demographic and psychological factors to the pain at different anatomical body parts; The total N participants considered were 81 who showed Prevalence of work-related musculoskeletal pain.
Comfortable; (2) uncomfortable; (3) feeling of fatigue and tiredness during work; (4) no feelings of fatigue and tiredness during work; (5) feeling of emotional and physical pressure during work; (6) no feelings of emotional and physical pressure during work; (7) good physical health; (8) moderately physically impaired; (9) severely physically impaired

Scheduling and task factors		Number of participants (%)	Shoulder pain n (%)		p-value	Lower back pain n (%)		p-value	Hand and wrist n (%)		p-value	Upper back pain n (%)		p-value
			Yes	No		Yes	No		Yes	No		Yes	No	
Working hours per day	≤7 hours	16 (19.8)	13 (18.6)	3 (27.3)	0.5	10 (16.4)	6 (30)	0.2	15 (25.9)	1 (4.3)	0.1	4 (8.2)	12 (37.5)	0.1
	Between 8 and 10 hours	65 (80.2)	57 (81.4)	8 (72.7)		51 (83.6)	14 (70)		43 (74.1)	22 (95.7)		45 (91.8)	20 (62.5)	

Number of scans performed per day	1-10 scans	10 (12.3)	9 (12.9)	1 (9.1)	0.41	7 (11.5)	3 (15)	0.83	7 (12.1)	3 (13)	0.72	5 (10.2)	5 (15.6)	0.95
	11-20 scans	46 (56.8)	37 (52.9)	9 (81.8)		36 (59)	10 (50)		33 (56.9)	13 (56.5)		29 (59.2)	17 (53.1)	
	21-30 scans	13 (16)	13 (18.6)	0 (0)		9 (14.8)	4 (20)		8 (13.8)	5 (21.7)		8 (16.3)	5 (15.6)	
	31-40 scans	10 (12.3)	9 (12.9)	1 (9.1)		8 (13.1)	2 (10)		8 (13.8)	2 (8.7)		6 (12.2)	4 (12.5)	
	+41 scans	2 (2.5)	2 (2.9)	0 (0)		1 (1.6)	1 (5)		2 (3.4)	0 (0)		1 (2)	1 (3.1)	
The duration of break time (mins)	No break time	15 (18.5)	14 (20)	1 (9.1)	0.2	11 (18)	4 (20)	0.9	13 (22.4)	2 (8.7)	0.1	11 (22.4)	4 (12.5)	0.1
	30 mins	18 (22.2)	13 (18.6)	5 (45.5)		14 (23)	4 (20)		14 (24.1)	4 (17.4)		12 (24.5)	6 (18.8)	
	45 mins	4 (4.9)	4 (5.7)	0 (0)		3 (4.9)	1 (5)		4 (6.9)	0 (0)		0 (0)	4 (12.5)	
	60 mins	44 (54.3)	39 (55.7)	5 (45.5)		33 (54.1)	11 (55)		27 (46.6)	17 (73.9)		26 (53.1)	18 (56.3)	
Average time per scan	10-20 mins	56 (69.7)	48 (68.6)	8 (72.7)	0.7	41 (67.2)	15 (75)	0.7	38 (65.5)	18 (78.3)	0.3	35 (71.4)	21 (65.6)	0.8
	21-25 mins	21 (25.9)	18 (25.7)	3 (27.3)		17 (27.9)	4 (20)		16 (27.6)	5 (21.7)		12 (24.5)	9 (28.1)	
	+25 mins	4 (4.9)	4 (5.7)	0 (0)		3 (4.9)	1 (5)		4 (6.9)	0 (0)		2 (4.1)	2 (6.3)	
Doing portable ultrasound	Yes	70 (86.4)	62 (88.6)	8 (72.7)	0.1	56 (91.8)	6 (30)	**0.01**	48 (82.8)	22 (95.7)	0.1	43 (87.8)	27 (84.4)	0.6
	No	11 (13.6)	8 (11.4)	3 (27.3)		5 (8.2)	14 (70)		10 (17.2)	1 (4.3)		6 (12.2)	5 (15.6)	
Number of hours for portable ultrasound per day mean (±standard deviations)		3.48 hrs (±1.45)	3.46 (±1.34)	3.64 (±2.11)	0.7	3.69 (±1.34)	2.85 (±1.63)	**0.02**	3.19 (±1.34)	3.22 (±1.53)	0.1	3.63 (±1.51)	3.25 (±1.36)	0.1
Repetitive tasks[1]	Yes	75 (92.6)	65 (92.2)	10 (90.9)	0.8	56 (91.8)	19 (95)	0.6	54 (93.1)	21 (91.3)	0.7	47 (95.9)	28 (87.5)	0.2
	No	6 (7.4)	5 (7.1)	1 (9.1)		5 (8.2)	1 (5)		4 (6.9)	2 (8.7)		2 (4.1)	4 (12.5)	
I have too many tasks at hand	Yes	73 (90.1)	63 (90)	10 (90.9)	0.9	55 (90.2)	18 (90)	0.9	52 (89.7)	21 (91.3)	0.8	45 (91.8)	28 (87.5)	0.5
	No	8 (9.9)	7 (10)	1 (9.1)		6 (9.8)	2 (10)		6 (10.3)	2 (8.7)		4 (8.2)	4 (12.5)	
I find my work tasks difficult	Yes	62 (76.5)	55 (78.6)	7 (63.6)	0.27	49 (80.3)	13 (65)	0.16	45 (77.6)	17 (73.9)	0.72	36 (73.5)	26 (81.3)	0.41
	No	19 (23.5)	15 (21.4)	4 (36.4)		12 (19.7)	7 (35)		13 (22.4)	6 (26.1)		13 (26.5)	6 (18.8)	

[Table/Fig-4]: Relationships of work scheduling and task factors to the pain of different anatomical body parts. The total N participants considered were 81 who showed Prevalence of work-related musculoskeletal pain.
(1) Performing frequent or continuous similar tasks for a long period of time without enough recovery time

Work-related posture factors		All participants n (%)	Shoulder pain n (%)		p-value	Lower back pain n (%)		p-value	Hand and wrist n (%)		p-value	Upper back pain		p-value
			Yes	No		Yes	No		Yes	No		Yes	No	
The transducer was hold by palmer/ power grip	Yes	72 (88.9)	62 (88.6)	10 (90.9)	0.8	54 (88.5)	18 (90)	0.8	49 (84.5)	23 (100)	0.4	43 (87.8)	29 (90.6)	0.6
	No	9 (11.1)	8 (11.4)	1 (9.1)		7 (11.5)	2 (10)		9 (15.5)	0 (0)		6 (12.2)	3 (9.4)	
Sitting in a one position for long time	Yes	64 (79)	56 (80)	8 (72.7)	0.58	52 (85.2)	8 (40)	**0.01**	42 (72.4)	22 (95.7)	0.5	41 (83.7)	23 (71.9)	0.2
	No	17 (21)	14 (20)	3 (27.3)		9 (14.8)	12 (60)		1 (17.2)	16 (69.6)		8 (16.3)	9 (28.1)	
Sitting on awkward position[1]	Yes	65 (80.2)	58 (82.8)	7 (63.6)	0.13	52 (85.2)	7 (35)	**0.04**	45 (77.6)	20 (87)	0.3	45 (91.8)	12 (37.5)	**0.001**
	No	16 (19.8)	12 (17.1)	4 (36.4)		9 (14.8)	13 (65)		13 (22.4)	3 (13)		4 (8.2)	20 (62.5)	
The trunk of body is in asymmetrical position[2]	Yes	63 (77.8)	55 (78.6)	8 (72.7)	0.6	50 (82)	13 (65)	0.1	42 (72.4)	21 (91.3)	0.1	43 (87.8)	12 (37.5)	**0.008**
	No	18 (22.2)	15 (21.4)	3 (27.3)		11 (18)	7 (35)		16 (27.6)	2 (8.7)		6 (12.2)	20 (62.5)	
More than two hours, I sit with lifted shoulders[3]	Yes	53 (65.4)	50 (71.4)	3 (27.3)	**0.004**	42 (68.9)	11 (55)	0.2	38 (65.5)	15 (65.2)	0.9	35 (71.4)	18 (56.3)	0.16
	No	28 (34.6)	20 (28.6)	8 (72.7)		19 (31.1)	9 (45)		20 (34.5)	8 (34.8)		14 (28.6)	14 (43.8)	
My hand is placed in a straight line with my arm	Yes	70 (86.4)	60 (85.7)	10 (90.9)	0.6	54 (88.5)	16 (80)	0.33	49 (84.5)	21 (91.3)	0.41	41 (83.7)	29 (90.6)	0.37
	No	11 (13.6)	10 (14.3)	1 (9.1)		7 (11.5)	4 (20)		9 (15.5)	2 (8.7)		8 (16.3)	3 (9.4)	

[Table/Fig-5]: Relationships of work-related posture factors to the pain of different anatomical body parts; Total participants considered were 81 who showed prevalence of work-related musculoskeletal pain.
(1) Unnatural sustained position due to reaching the affected body part away from the sonographer's body during bedside exam. It includes sitting with flexion/extension of the wrist, excess abduction of the shoulders, forward flexion of the shoulders, bending/twisting at the waist, and bending or rotating the neck; (2) sitting with sustained bending/twisting at the waist; (3) sitting with sustained excess abduction of the shoulders and/or sustained forward flexion of the shoulders

DISCUSSION

The findings from this study show that the prevalence of work-related musculoskeletal pain is high among Saudi sonographers and the pain occurs frequently in shoulder, lower back, hand and wrist. This high prevalence is in line with national and international studies that similarly reported prevalence between 75.17% and 98.3% [12,17,20]. It can be assumed that the global high prevalence of work-related musculoskeletal pain is due to a public stigma where the reporting rate of pain by sonographers is low and not encouraged as an acceptable part of their job. Therefore, overcoming this stigma would help in relieving this high prevalence and improve the incidence of diagnosis.

In the current study, the pain was very common in shoulder and lower back regions of Saudi ultrasound technologists. Okeji M et al., who investigated WRMSDs among fifty-one Nigerian sonographers found that 41% of sonographers experience back pain and a quarter suffer from wrist pain [7]. A study from Pakistan reported a higher rate of low back pain (53%) among ultrasound technologists [17]. Furthermore, a cross-sectional study conducted on Chinese population showed that sonographers perceived higher prevalence

of neck (93.5%), and shoulder pain (92.2%) [20]. The differences with the current study may be attributed to differences in workload, body postures, and work environment of these populations. In consistent to our study, Feng Q et al., study reported higher shoulder pain among Chinese sonographers due to sustained unnatural position during scanning and shoulder abduction [20]. Ergonomic environment also has been shown to cause upper extremity pain among Chinese and Nigerian sonographers [7,20], and lower back pain among Pakistani ultrasound technologists [17]. In combination with the factors mentioned above, heavy workload and an absence of break time have been found to cause back pain and wrist pain among Nigerian technologists [7].

Similar to the present study, Arvidsson I et al., study shows that half of Swedish female sonographers commonly reported shoulder pain [15]. This can be expected, since Swedish and Saudi sonographers suffer from a higher work stress level [21,22], and mental stress has been considered as important contributing factors in work-related shoulder pain [18].

It is not surprising that those using portable ultrasound machine for a longer time are experiencing lower back pain in the current study. The nature of portable ultrasound procedures requires twisting the trunk of body, excessive arm abduction to reach the region of interest, and frequent repetitive movements due to poor ergonomic of equipment and patients. Therefore, proposing guidelines that improve practice and minimise the risk of pain is recommended. Furthermore, female sonographers were more likely to experience hand and wrist pain in the present study. Gender differences in the presentation of hand and wrist pain has been documented by previous studies. In line with the present study, Silverstein BA et al., Armstrong TJ et al., and Schulte PA et al., reported that female sonographers are more prone to hand and wrist pain [23-25]. Schoenfeld A et al., also showed that carpel tunnel syndrome injuries are more prominent among females [26].

A potential explanation for these findings is that women have different muscle composition, physiology, contractile characteristics, and performance from men [27]. Compared to men, women have a smaller quantity of skeletal muscle (fibers) which might reflect their limited muscle strength and minimal muscular endurance, and make them more susceptible for work related musculoskeletal pain [27,28].

In contrast to the present study, Okeji M et al., did not depict the relationship between work related musculoskeletal pain and sex; however, this study was based on small sample size and the majority of participants (69%) were males which might underestimate the relationship [7]. Additionally, studies have shown a significant relationship between age and work-related musculoskeletal pain [7,17,29]. Likewise, findings of present study showed that lower back pain, hand and wrist pain are more prevalent in younger sonographers. Theoretically, the risk of work-related musculoskeletal pain should increase with aging since several degenerative changes, such as bone stiffness, and osteoarthritis might take place in the musculoskeletal system of this age group. However, the prevalence of hand and wrist pain in younger age group in the current study is more likely due to the heavy workload that younger sonographers experienced.

Moreover, the authors explore for the first time that hand and wrist pain is very common among sonographers working at public hospitals. This finding is plausible, since Saudi public hospitals providing healthcare services for more than 62% of in-patient care [30], and the demand for ultrasound procedures is increasing overtime resulting in an increase of workload on sonographers and risk of having work-related musculoskeletal pain. In the current study, it is noted that taller sonographers are more likely to perceive with work related musculoskeletal pain, such as hand and wrist pain. This finding is in line with the study of Okeji M et al., [7] and in contrast with other study conducted by Junejo and his team. It is unclear how sonographer's height can seriously affect musculoskeletal system of healthcare providers. This link might be explained by the quantity of muscle (muscle mass) among taller people which is found to be associated with musculoskeletal pain [31]. Therefore, further studies are needed with considering muscle mass of participants to explore the potential relationship between height and work-related musculoskeletal pain.

In a sharp contrast to those who have a good posture (neutral position) while they perform scanning, those siting with a sustained bending or twisting at the waist for long time, sitting in one position for long time, or sitting in a sustained unnatural position (described in the tables above) to reach the area of interest experience back pain. This is in agreement with the findings of a Chinese study that reports those who have inefficient scanning postures during ultrasound procedure have four times higher risk of lower back pain [20].

Knowledge of factors that are related to work-related musculoskeletal pain is essential in clinical practice. The present findings can be used to inform stakeholders about the potential factors which negatively influence the health and well-being of workers. Also, they are helpful for policy makers to establish proactive and preventive work safety programs to keep the staff free of such physical pains. To reduce the high prevalence of work-related musculoskeletal pain, a multifactorial method that include the awareness about this disorder, educating sonographers regarding the potential factors that cause this health issue and the implementation of preventive measures that ensure the safety among sonographers is recommended.

To date, there is no much evidence on the prevalence of work-related musculoskeletal pain and factors associated with it in Saudi Arabia, and therefore this study may constitute the initial knowledge base on this subject, to guide further investigations in the future.

Limitation(s)

Being a cross-sectional survey, the findings are prone to a recall bias. Although the sample size of our work is limited, the data are likely to be representative of the selected population. Additionally, due to the limited number of respondents who experienced no pain in this work, it was very difficult to investigate the contribution of risk factors on work-related musculoskeletal pain using logistic regression analysis.

CONCLUSION(S)

The prevalence of work-related musculoskeletal pain among Saudi sonographers is very high and the pain was more prominent in shoulder, lower back, hand and wrist, and upper back areas. Factors including mental stress, height, sex, age, work scheduling, and work-related posture have been shown to be related with higher rates of work related musculoskeletal pain. Thus, raising the awareness of work-related musculoskeletal pain among sonographers and establishing best practices that preserve health and well-being of sonographers is needed in Saudi Arabia. This can be done by addressing the factors that predispose these sonographers to such musculoskeletal pain.

REFERENCES

[1] Melhorn JM. Cumulative trauma disorders and repetitive strain injuries. The future. Clin Orthop Relat Res. 1998;(351):107-26.
[2] Craig M. Sonography: An occupational health hazard? Journal of Diagnostic Medical Sonography. 1985;1(3):121-26.
[3] Necas M. Musculoskeletal symptomnatology and repetitive strain injuries in diagnostic medical sonographers: A pilot study in Washington and Oregon. Journal of Diagnostic Medical Sonography. 1996;12(6):266-73.
[4] Pike I, Russo A, Berkowitz J, Baker JP, Lessoway VA. The prevalence of musculoskeleta disorders among diagnostic medical sonograhers. Journal of Diagnostic Medical Sonography. 1997;13(5):219-27.
[5] Schoenfeld A. Ultrasonographer's wrist-an occupational hazard. Ultrasound in Obstetrics & Gynecology: The official Journal of the International Society of Ultrasound in Obstetrics and Gynecology. 1998;11(5):313-16.

[6] Magnavita N, Bevilacqua L, Mirk P, Fileni A, Castellino N. Work-related musculoskeletal complaints in sonologists. Journal of Occupational and Environmental Medicine. 1999;41(11):981-88.
[7] Okeji M, Agwunna K, Onwuzu S, Nnaemeka J. Patterns of work-related musculoskeletal disorders among practicing sonographers in Enugu State, Nigeria. 2015;12(4):387-91.
[8] Gremark Simonsen J, Axmon A, Nordander C, Arvidsson I. Neck and upper extremity pain in sonographers-Associations with occupational factors. Applied Ergonomics. 2017;58:245-53. Doi: 10.1186/s12891-020-3096-9.
[9] 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(6):529-41.
[10] Murphey S. Work related musculoskeletal disorders in sonography. Journal of Diagnostic Medical Sonography. 2017;33(5):354-69.
[11] Dieleman JL, Baral R, Birger M, Bui AL, Bulchis A, Chapin A, et al. US spending on personal health care and public health, 1996-2013. JAMA. 2016;316(24):2627-46.
[12] Al-Rammah TY, Aloufi AS, Algaeed SK, Alogail NS. The prevalence of work-related musculoskeletal disorders among sonographers. Work (Reading, Mass). 2017;57(2):211-19.
[13] Labor USD. Occupational Outlook Handbook 2014-2015: Skyhorse; 2014.
[14] Evans K, Roll S, Baker J. Work-related musculoskeletal disorders (WRMSD) among registered diagnostic medical sonographers and vascular technologists: A representative sample. Journal of Diagnostic Medical Sonography. 2009;25(6):287-99.
[15] Arvidsson I, Gremark Simonsen J, Dahlqvist C, Axmon A, Karlson B, Björk J, et al. Cross-sectional associations between occupational factors and musculoskeletal pain in women teachers, nurses and sonographers. BMC Musculoskelet Disord. 2016;17:35. Doi: 10.1186/s12891-016-0883-4.
[16] Pallotta OJ, Roberts A. Musculoskeletal pain and injury in sonographers, causes and solutions. Sonography. 2017;4(1):05-12.
[17] Behan MAJSMTRB. Prevalence and risk factors for work related musculoskeletal disorders among sonographer of Sindh Province Pakistan. Journal of the Liaquat University of Medical and Health Sciences. 2017;16(1):29-36.
[18] Harrison G, Harris A. Work-related musculoskeletal disorders in ultrasound: Can you reduce risk? Ultrasound. 2015;23(4):224-30.
[19] Coffin C. Work-related musculoskeletal disorders in sonographers: A review of causes and types of injury and best practices for reducing injury risk. Reports in Medical Imaging. 2014;7:15-26. Doi: https://doi.org/10.2147/RMI.S34724.
[20] 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-e.
[21] Simonsen JG, Dahlqvist C, Enquist H, Nordander C, Axmon A, Arvidsson I. Assessments of physical workload in sonography tasks using inclinometry, goniometry, and electromyography. Saf Health Work. 2018;9(3):326-33.
[22] Zaidi U, Hammad LF, Awad SS, Elkholi SMA, Qasem HD. Relationship of ergonomics, lifestyle and job satisfaction among sonographers in Riyadh, KSA. Journal of Liaquat University of Medical & Health Sciences. 2019;17(03):127-34.
[23] Silverstein BA, Fine LJ, Armstrong TJ. Hand wrist cumulative trauma disorders in industry. Br J Ind Med. 1986;43(11):779-84.
[24] Armstrong TJ, Fine LJ, Goldstein SA, Lifshitz YR, Silverstein BA. Ergonomics considerations in hand and wrist tendinitis. The Journal of Hand Surgery. 1987;12(5 Pt 2):830-37.
[25] Schulte PA, Wagner GR, Ostry A, Blanciforti LA, Cutlip RG, Krajnak KM, et al. Work, obesity, and occupational safety and health. Am J Public Health. 2007;97(3):428-36.
[26] Schoenfeld A, Goverman J, Weiss DM, Meizner I. Transducer user syndrome: An occupational hazard of the ultrasonographer. European Journal of Ultrasound: Official Journal of the European Federation of Societies for Ultrasound in Medicine and Biology. 1999;10(1):41-45.
[27] Haizlip KM, Harrison BC, Leinwand LA. Sex-based differences in skeletal muscle kinetics and fiber-type composition. Physiology (Bethesda). 2015;30(1):30-39.
[28] Ansdell P, Thomas K, Hicks KM, Hunter SK, Howatson G, Goodall S. Physiological sex differences affect the integrative response to exercise: Acute and chronic implications. Experimental Physiology. 2020;105(12):2007-21.
[29] 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 Musculoskelet Disord. 2019;20(1):541.
[30] Walston S, Al-Harbi Y, Al-Omar B. The changing face of healthcare in Saudi Arabia. Ann Saudi Med. 2008;28(4):243-50.
[31] Yoo JJ, Cho NH, Lim SH, Kim HA. Relationships between body mass index, fat mass, muscle mass, and musculoskeletal pain in community residents. Arthritis & Rheumatology (Hoboken, NJ). 2014;66(12):3511-20.

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