

# PREVALENCE AND RISK FACTORS OF MUSCULOSKELETAL DISORDERS AMONG NATURAL GAS FIELD WORKERS

By

<sup>1</sup>Abo Salem MA, <sup>1</sup>Mahrous OA, <sup>1</sup>Kasemy ZA, <sup>1</sup>Allam HK and <sup>2</sup>Mohsen M.

<sup>1</sup>*Department of Public Health and Community Medicine, Faculty of Medicine, Menoufia University,*

<sup>2</sup>*The Egyptian Natural Gas Holding Company (EGAS).*

## Abstract

**Introduction:** Workers at natural gas fields are continuously exposed to numerous hazardous materials and working conditions that place them at continuous risk of injury or death. **Aim of work:** To study the prevalence of musculoskeletal disorders among workers in a natural gas field and the risk factors for it as well as relationship between the resultant health disorders and the working conditions. **Materials and methods:** a cross-sectional study carried out in “The Egyptian Natural Gas Holding Company “on 172 workers distributed into 109, 32 and 31 workers from Operational, Administrative and Support services departments respectively. An equal number (172 subjects) was chosen randomly from the factory workers’ relatives as controls. All participants were subjected to a pre-designed questionnaire fulfilling personal, occupational history and clinical examination. Cases detected by clinical examination were subjected to radiological investigations ( X ray and MRI). **Results:** About 47.7 % of the workers had regional musculoskeletal pain. Low back pain was the most prevalent one (30.5%) followed by knee pain (17.1%). The percentage of musculoskeletal pain was significantly higher among workers with over 9 years work duration (P=0.00). Of all workers with pain, abnormal findings detected in X ray accounted for 35.4% and those detected in MRI imaging were 40.2%. In MRI results, muscle affection was the most prevalent finding (39.4%). The highest rates of all of MSDs were found among workers in Operation department. **Conclusion:** Musculoskeletal manifestations were prevalent among studied workers. X ray and MRI results detected many cases with diseases affecting the joints and intervertebral discs that needed an urgent treatment.

**Key words:** Musculoskeletal disorders, Natural gas Workers, Low back pain, Knee pain and Risk factors.

## Introduction

Musculoskeletal disorders (MSDs) are degenerative diseases and inflammatory conditions that cause pain and impair normal activities (Côté et al., 2013). MSDs are injuries or pain in the body's joints, ligaments, muscles, nerves, tendons, and structures that support limbs, neck and back. MSDs can arise from a sudden exertion (e.g., lifting a heavy object), or they can arise from making the same motions repeatedly (repetitive strain), or from repeated exposure to force, vibration, or awkward posture (Gatchel, et al., 2011). Examples of specific MSD disorders are carpal tunnel syndrome, epicondylitis, and tendinitis (Barbe et al., 2013). MSDs are the most frequent health complaint by European, United States and Asian Pacific workers (Hauke et al., 2011) and the third leading reason for disability and early retirement in the USA (Sprigg et al., 2007). Work-related MSDs can increase disability (Andersen et al., 2012), impair quality of life and lead to loss of work time with financial consequences for the individual, employers and society (Tinubu et al., 2010). MSDs are widespread in many

occupations, including those with heavy biomechanical load like construction and factory work, and those with lighter loads like office work (Sprigg et al., 2007). In a study of workers in Norway's offshore petroleum industry over 12 years (1992-2003), work-related MSDs made up half of all occupational diseases (Morken et al., 2007).

## Aim of work

To study the prevalence of musculoskeletal disorders among workers in a natural gas field and the risk factors for it as well as relationship between the resultant health disorders and the working conditions.

## Materials and methods

- **Study design:** a cross-sectional study
- **Time and place of study:** this study was carried out from the beginning of June 2015 to the end of June 2016 at one of natural gas fields of "The Egyptian Natural Gas Holding Company (EGAS)" which is located in the petroleum industrial zone, Edku city, Bohira governorate.
- **Study population:** The total workforce in the field is (1329

workers) distributed all over the three main departments as follows: Operational departments: Including [Petroleum engineering, drilling, exploration, maintenance, instruments, mechanical, electrical, turbo machinery, inspection, planning, industrial safety and production follow up] occupied by (845) workers, Administrative departments : Including [finance, materials, tendering and contract, public relations, human resources and legal affairs] occupied by (246) workers and Support services departments: Including [clinic, telecom and information technology, security, transportation, catering and accommodation] occupied by (238) workers. The study was carried out on 172 workers distributed into 109, 32 and 31 workers from Operational, Administrative and Support services departments respectively. All workers were chosen randomly. An equal number (172 subjects) was chosen randomly from the factory workers' relatives as controls.

- **Study sample:** Based on past review of literature (Sadeghian, 2012) that

demonstrated the prevalence of musculoskeletal disorders among oil field workers to be 86.7 %, sample size has been calculated using the following equation:  $n = (z^2 \times p \times q) / D^2$  at power 80% and CI 95%, the sample size was 157 participants. To avoid drop out, the sample size was increased by 10% to be 172 participants distributed as follows: Operational departments: 109 workers, Administrative departments: 32 workers and Support services departments: 31 workers.

#### - **Study methods:**

Three visits to the processing gas plant were carried out during the period from June to July 2015 aiming at characterizing and observing the steps of the industrial process, identifying the hazards to which workers were exposed and observing safety measures used. All participants were subjected to:

- I. **Questionnaire:** The participants were asked to fill a pre-designed questionnaire. This questionnaire included:

**A. Personal data:** name, age, residence, etc.

**B. A detailed occupational history:**

Present and past (duration of employment, nature of job, mean hours of the daily work, number of days worked/week) and additional jobs.

**C. Complaint and present history of health problems:**

Including musculoskeletal pain, restricted movement, fatigue, weakness, numbness, parasthesia, muscle spasm, referred pain, headache, joint swelling, bleeding disorders, pallor, skin redness and present medication: dose, duration of administration.

**D. Past history:** Serious diseases as diabetes mellitus, hypertension, previous operations, drug allergy and hospital admission.

**E. Family history:** Similar conditions in siblings or parents.

**II. Clinical Examination:** all chosen workers and controls were subjected to clinical examination.

**A. General examination**

**B. Locomotor System Examination:**

a. Inspection b. Palpation c. Range of Motion which includes (Active and Passive range of motion),

**C. Special tests that include:**

Median Nerve Compression test, Tinel's sign, Phalen's test, Hawkins impingement test, Vertex Compression Test and Bulge sign, Lachman's test, McMurry's Test and Thomas test .

**III. Radiological investigations:** the participants who showed positive symptoms and signs in clinical examination were subjected to radiological investigations which included

**A. X-ray** (radiography)

**B. (MRI) Magnetic Resonance Imaging**

**Consent**

Written formal consents were signed by all participants before testing and each one was asked to do his best.

**Ethical approval**

Two official approvals were obtained from the Ethics Committee of Faculty of Medicine of Menoufia University and The Egyptian Natural

Gas Holding Company (EGAS) which is located in the petroleum industrial zone, Edku city, Bohira governorate.

### **Data Management**

Statistical analysis was generated using the SPSS statistical software (SPSS, Inc., Chicago, IL, USA) (SPSS16, 2007). Results are expressed as no and %. Chi-square was test used for qualitative variables. P-value  $\leq 0.05$  was set to be significant.

### **Results**

This study included 172 workers in a natural gas field and 172 controls. All of them were eligible and agreed to take part in the survey. No female field workers, male workers were only employed in this field. All personnel in the field work 12-hours shifts per day for one week and then have one week off.

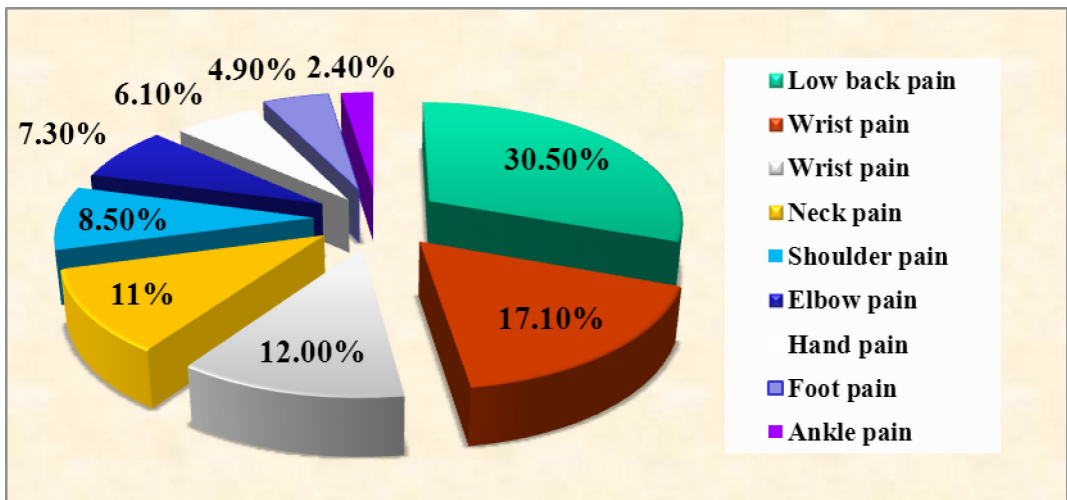
**Table (1): Comparison between studied workers and control regarding present musculoskeletal symptoms**

Present musculoskeletal symptoms	Studied group (No.=172)		Control (No.=172)		P value
	No.	%	No.	%	
Musculoskeletal pain					
Yes	82	47.7	8	4.7	<0.001**
No	90	52.3	164	95.3	
Painful movement					
Yes	66	38.4	5	2.9	<0.001**
No	106	61.6	167	97.1	
Pain during rest					
Yes	25	14.5	3	1.7	<0.001**
No	147	85.5	169	98.3	
Progressive pain					
Yes	39	22.7	4	2.3	<0.001**
No	133	77.3	168	97.7	
Repetitive pain					
Yes	41	23.8	9	5.2	<0.001**
No	131	76.2	163	94.8	
Tingling hand or feet					
Yes	44	25.6	4	2.3	<0.001**
No	128	74.4	168	97.7	
Muscle power					
Affected	43	25.0	6	3.5	<0.001**
Normal	129	75.0	166	96.5	
Muscle tone					
Affected	29	16.9	2	1.2	<0.001**
Normal	143	83.1	170	98.8	
Peripheral sensation					
Affected	12	7.0	3	1.7	<0.05*
Normal	160	93.0	169	98.3	
Joint reflexes					
Affected	16	9.3	5	2.9	<0.05*
Normal	156	90.7	167	97.1	

\*Significant difference

\*\* Highly significant difference

Table 1 : showed that musculoskeletal pain, painful movement, pain during rest, progressive pain, repetitive pain and tingling hand or feet were significantly higher among studied workers group when compared to control group ( $P=0.00$ ). Also regarding items of locomotor system examination, (affected muscle power, muscle tone affected peripheral sensation and joint reflexes), all were significantly higher among studied workers group when compared to controls .



**Fig 1: Distribution of the types of musculoskeletal pain among the studied workers group**

(Fig1) : showed that musculoskeletal pain was found in 47.7% of the studied group. It is distributed into low back pain 30.5% followed by knee pain 17.1%, wrist pain 12.2%, neck pain 11.0%, shoulder pain 8.5%, elbow pain 7.3%, hand pain 6.1%, foot pain 4.9% and ankle pain 2.4%.

**Table (2): Prevalence of musculoskeletal disorders among studied workers group by clinical examination and radiological investigations**

Findings	Studied Workers group (No.=172)	
	No.	%
<b><u>Clinical examination</u></b>		
- Musculoskeletal pain	82	47.7
- Painful movement	66	38.4
- Pain during rest	25	14.5
- Progressive pain	39	22.7
- Repetitive pain	41	23.8
- Tingling hand or feet	44	25.6
- Affected muscle power	43	25.0
- Affected muscle tone	66	38.4
- Affected joint reflexes	29	16.9
- Affected peripheral sensation	12	7.0
<b><u>X-ray</u></b>		
<b>Normal</b>	53	64.6
<b>Abnormal</b>	29	35.4
- Fracture	1	3.4
- Bony cyst	2	6.9
- Shoulder erosion	5	17.2
- Elbow erosion	4	13.8
- Wrist erosion	3	10.3
- Knee erosion	10	34.5
- Ankle erosion	4	13.8
<b><u>MRI</u></b>		
<b>Normal</b>	49	59.8
<b>Abnormal</b>	33	40.2
- Cervical disc prolapse	8	24.2
- Lumbosacral disc prolapse	12	36.4
- Muscle affection	13	39.4

Table 2: shows that musculoskeletal pain accounted for 82 workers (47.7%). Also the studied workers showed affected muscle power in 25.4%, painful movements and affected muscle tone in 38%. Abnormal findings detected by X ray were present in 29 workers (35.4%) and those detected in MRI imaging were 40.2%.



**Table (3): Comparison between those with musculoskeletal pain and those without among the studied workers group regarding nature of work**

Nature of work among the studied workers group	Musculoskeletal pain				$\chi^2$ test	P value	OR (CI 95%)
	Present (n=82)		Absent (n=90)				
	No.	%	No.	%			
Long standing Yes No	51 31	55.4 38.8	41 49	44.6 61.3	4.78	<0.05*	1.97 (1.07-3.62)
Vibration Yes No	27 55	65.9 42.0	14 76	34.1 58.0	5.41	<0.05*	2.66 (1.28-5.55)
Climbing stairs Yes No	15 67	60.0 47.8	10 80	40.0 52.2	1.78	>0.05	1.79 (0.76-4.25)
Heavy weight lifting Yes No	14 68	60.9 45.6	9 81	39.1 54.4	1.85	>0.05	1.85 (0.76-4.55)
Long sitting Yes No	22 60	68.8 42.9	10 80	31.3 57.1	7.00	<0.05*	2.67 (1.18-6.03)
Over twisting Yes No	11 71	61.1 46.1	7 83	38.9 53.9	1.46	>0.05	1.84 (0.68-4.99)
Duration of work/Y >9 ≤9	50 32	61.0 39.0	31 59	34.4 65.6	12.12	0.001**	2.97 (1.60-5.53)

\*Significant difference

\*\* Highly significant difference

Table 3 : showed that musculoskeletal pain was significantly higher among studied workers group with long standing (P=0.03, OR=1.97), vibration (P=0.02, OR=2.66) and long sitting (P=0.03, OR=2.67). Also it shows a highly significant difference between those with ≥9 years' work duration (P<0.001, OR=2.97).

**Table (4): Distribution of present musculoskeletal symptoms among studied group in different departments**

Present musculoskeletal symptoms	Studied workers group						$\chi^2$ test	P value
	Administration workers (No.=32)		Operations workers (No.=109)		Support services workers (No.=31)			
	No.	%	No.	%	No.	%		
Musculoskeletal pain								
Yes	8	25.0	67	61.5	7	22.6	22.73	<0.001**
No	24	75.0	42	30.5	24	77.4		
Pain during rest								
Yes	0	0.0	22	20.2	3	9.7	8.83	<0.05*
No	32	100	87	79.8	28	90.3		
Progressive pain								
Yes	10	31.3	22	20.2	7	22.6	1.73	>0.05
No	22	68.8	87	79.8	24	77.4		
Repetitive pain								
Yes	0	0.0	33	30.3	8	25.8	12.57	0.002*
No	32	100	76	69.7	23	74.2		
Tingling hand or feet								
Yes	12	37.5	21	19.3	11	35.5	6.27	<0.05*
No	20	62.5	88	80.7	20	64.5		
Muscle power								
Affected	6	18.8	30	27.5	7	22.6	1.13	>0.05
Normal	26	81.3	79	72.5	24	77.4		
Painful movement								
Yes	12	37.5	51	46.8	3	9.7	14.07	<0.001**
No	20	62.5	85	53.2	28	90.3		
Peripheral sensation								
Yes	1	3.1	10	9.2	1	3.6	2.21	>0.05
No	31	96.9	99	90.8	30	96.4		
Joint reflexes								
Affected	0	0.0	15	13.8	1	3.6	7.21	<0.05*
Normal	32	100	94	86.2	30	96.4		

\*Significant difference

\*\* Highly significant difference

Table (4): Distribution of pr Table 4 showed that musculoskeletal pain, pain during rest, repetitive pain, painful movements and affected joint reflexes were significantly higher among operation workers than both of administration and support service workers. But tingling hand and feet was significantly higher among support services workers than administration and operation service workers.

### Discussion:

Field jobs like (explorations, drilling, maintenance, cleaning of high storage tanks and any confined-space entry operations) were described as partially physically demanding tasks: involving frequent kneeling, twisting, bending of the trunk, and working above shoulder height, working with a bent back and walking across the wide field area. This explains the high prevalence of musculoskeletal pain among field workers (field of natural gas in petroleum industry) which was 47.7% when compared to controls 4.7% (Table 1). This is in agreement with Morken et al, 2007 who detected that work-related musculoskeletal disorders among oil industry found to be up to (47%). Husebø et al, 2001 reported that work-related musculoskeletal disorders among oil industry found to be up to (46%). Also in Parkes and Swash, 2005, a British study, MSDs were reported to be the most prevalent health problem among oil field workers accounting for 23% of all sick bay consultations. Also Chen et al, 2005 found that 56% workers had at least one complaint in the previous 12 month. A study conducted

by Sadeghian et al., 2012 showed that the prevalence of musculoskeletal complaints among Iranian oil field workers was (86.7%) in the previous 12 months. In a British study, MSDs were reported to be the most prevalent health problem among oil field workers (Parkes and Swash, 2005). Although the prevalence of MSDs among the studied workers is higher than that of controls, it is still lower than other studies. The reason for low prevalence of MSDs among oil field workers in our study is that the complaint was reported for the previous 6 month not for a whole year as that mentioned in the previous studies. This means that the prevalence may be even higher than that reported in other studies if the whole year is reported. Also this difference may be related to using of different research methods or even different demographic or work characteristics of the workers.

The most prevalent musculoskeletal pain was low back pain 30.5% followed by knee pain 17.1%, wrist pain 12.2%, neck pain 11.0%, shoulder pain 8.5%, elbow pain 7.3%, hand pain 6.1%, foot pain 4.9% and ankle pain 2.4% ( Fig 1). That was familiar with a study done by

Borayek, et al 2011 where the prevalence of musculoskeletal complaint for low back region was (31.9 %), knee (16.3 %), shoulder (28.3 %), wrist (23.2 %), neck (15.2 %), foot (12.3 %), thigh (10.9 %), elbow (10.1 %), while upper back region complaint was the least prevalent one (4.7 %). Also this is in agreement with previous study in China, where the most prevalent MSD among oil field workers was low back pain 32 % followed by neck (25 %), shoulder (20.1 %), knee (20 %), wrist (13.5 %), foot (10.2 %), thigh (8.4 %) and elbow (7.5 %) (Chen et al., 2005). In a similar longitudinal British survey conducted in (2000-2005), low back pain was reported 34% (Parkes, 2008). Another finding was reported by Chung and Kee, 2000 indicating that (78.5%) of the workers performing tasks that require trunk twisting were reported to have experienced low back pain. Andersen et al., 2007 reported association between back and other regional musculoskeletal pain. In the different studies, variability in prevalence rates of MSDs among oil workers may be accepted due to variation in case-definitions used as regard to complaint duration or severity. Also may be due to the different quantity

or quality of the actual tasks done by the workers.

Workers who showed musculoskeletal pain by clinical examination were subjected to radiological investigations; the most frequent findings on X-ray imaging were joints articular erosion distributed into shoulder (17.2%), elbow (13.8%), wrist (10.3%), knee (34.5%) and ankle (13.8%) erosions. Abnormal MRI results accounted for (40.2%), where muscle affection was detected in 13 workers (39.4%) of the affected workers and intervertebral disc disease that distributed into lumbosacral disc prolapse (36.4%) and cervical disc prolapse (24.2%) (Table 2). The intervertebral disc disease detected by radiological investigation in our study (involving lumbosacral and cervical disc prolapse) accounted for 11.6% of the whole number of the studied workers which is similar to the study done by Fernandes and Carvalho, 2000 on 1026 oil workers in northeast Brazil, who reported that intervertebral disc disease prevalence was 10.5%.

Musculoskeletal pain was significantly higher among studied

workers group with long standing ( $P=0.03$ ,  $OR=1.97$ ), vibration ( $P=0.02$ ,  $OR=2.66$ ) and long sitting ( $P=0.03$ ,  $OR=2.67$ ) (Table 3). This is in agreement with Chee 2004 who after adjusting for confounding effects, pain was significantly associated with sitting ( $OR\ 1.6$ ,  $95\% CI = 1.2-2.1$ ) and lifting ( $OR\ 1.6$ ,  $95\% CI = 1.1-2.0$ ), climbing steps ( $OR\ 3.5$ ,  $95\% CI = 1.6-7.9$ ), and hand/wrist movement ( $OR\ 1.6$ ,  $95\% CI= 1.1-2.3$ ). Workers who were exposed to prolonged standing had 2.7 times higher odds ( $95\% CI = 1.9-3.9$ ) of suffering from pain in the lower limbs.

In our study, there was a highly significant difference in the percentage of musculoskeletal pain among those with over 9 years work than others (61.9%) (Table 3). This was in partial agreement with study conducted in the offshore petroleum industry in Norway, where over 12 years resulted in back and knee problems that accounted for 20 and 12% of work-related musculoskeletal disorders (Morken et al., 2007).

According to our results, the highest rates of all of MSDs were found among workers in operation department (Table

4). This was in agreement with a study done by Morken et al. (2007) and Sadeghian et al, (2012) in an oil field, workers of operation department reported the highest prevalence of MSDs.

### Conclusion

Musculoskeletal manifestations were prevalent among workers in the natural gas field (EGAZ). The most prevalent musculoskeletal complaint was low back pain followed by knee pain, wrist pain, neck pain, shoulder pain, elbow pain, hand pain, foot pain and ankle pain respectively. X ray and MRI results detected 29 and 33 abnormal cases respectively with diseases affecting the joints and intervertebral discs that needed an urgent treatment.

### Recommendations

Only a representative sample has been studied. It is better if the entire work force of the field is subjected to clinical examinations and investigations. Workers with positive signs should be subjected to thorough investigations and treatment followed by changing their work to another one suitable to their health condition Health

education programs and ergonomics should be provided to all workers especially operation workers.

### **Conflicts of interest**

No conflict of interest

### **Funding**

No special funds

### **Acknowledgment**

We acknowledge all participants as well as the team who provided assistance in manuscript preparation.

### **References**

1. Andersen JH, Haahr JP and Frost P (2007): Risk factors for more severe regional musculoskeletal symptoms: A two-year prospective study of a general working population. *Int J of Rheum Dis*; 56: 1355-1364.
2. Andersen LL, Clausen T, Burr H and Holtermann A (2012): Threshold of musculoskeletal pain intensity for increased risk of long-term sickness absence among female healthcare workers in eldercare. *PLoS One*, 7. 10.1371/journal.pone.0041287.
3. Barbe MF, Gallagher S, Massicotte VS, et al (2013): The interaction of force and repetition on musculoskeletal and neural tissue responses and sensorimotor behavior in a rat model of work-related musculoskeletal disorders. *BMC Mus Dis*; 14: 303.
4. Borayek GE, El-Toukhy MA and Abd El Azeem AM (2011): Impact of onshore oil drilling works on musculoskeletal system and quality of life among a group of Egyptian drilling workers. *Zag Med J*; 17 (4): 152-166
5. Chee HL (2004): Work-related Musculoskeletal Problems among Women Workers in the Semiconductor Industry in Peninsular Malaysia. *Int J Occup Environ Health*; 10:63-71.
6. Chen WQ, Yu IT-S and Wong TW (2005): Impact of occupational stress and other psychosocial factors on musculoskeletal pain among Chinese offshore oil installation workers. *Occup Environ Med*; 62: 251-256.
7. Chung M and Kee D (2000): Evaluation of lifting tasks frequently performed during fire brick manufacturing processes using NIOSH lifting equations. *Int J Ind Erg*; 25: 423-433.
8. Côté JN, Ngomo S, Stock S, et al (2013): Quebec Research on Work-related Musculoskeletal Disorders. *Relations industrielles*; 68 (4): 643-660.
9. Fernandes R and Carvalho F (2000): Intervertebral disc disease among oil drilling workers. *Cadernos de Saude Publica*; 16: 661-669.
10. Gatchel RJ and Kishino N (2011): Pain, musculoskeletal injuries, and return to work. In J. C. Quick and L. E. Tetrick (Eds.) (*Handbook of occupational health psychology* (2nd Ed). Washington, DC: American Psychological Association.
11. Hauke A, Flintrop J, Brun E, Rugulies C and Reiner A (2011): The impact of work-related psychosocial stressors on the onset of musculoskeletal disorders in specific body regions: A review and meta-analysis of 54 longitudinal studies. *Work & Stress*; 25 (3): 243-256.
12. Husebø T, Ravnås E. and Lauritsen O (2001): Trends in risk level - the Norwegian shelf. Phase 2 Summary Report. Stavanger: Norwegian Petroleum Directorate
13. Morken T, Mehlum IS and Moen BE (2007): Work-related musculoskeletal disorders in Norway's offshore petroleum industry. *J Occup Med*; 57: 112-117.
14. Parkes KR (2008): Social support and musculoskeletal disorders Literature review and data analysis. University of Oxford, Health and Safety Executive, Research Report 594.

- 
15. Parkes KR and Swash S (2005): Offshore sickbay consultations in relation to age, job factors and self-reported health. University of Oxford, research report 364.
  16. Sadeghian F, Sadeghian A, Rae M and Kasaeian A (2012): Musculoskeletal Disorders among Oil Field Workers: Influences of Health Beliefs, Mental Health and Somatisation Tendency. *J Med Sc*, 12: 114-120.
  17. Sprigg CA, Stride CB, Wall TD, Holman DJ and Smith PR (2007): Work characteristics, musculoskeletal disorders, and the mediating role of psychological strain: A study of call center employees. *J Appl Psych*; 92 (5): 1456–1466.
  18. Tinubu BM, Mbada CE, Oyeyemi AL and Fabunmi AA (2010): Work-Related Musculoskeletal Disorders among Nurses in Ibadan, South-west Nigeria: A cross-sectional survey. *BMC Musc Dis*; 11-12.