

# REPORTED MUSCULOSKELETAL SYMPTOMS AMONG LABORATORY WORKERS, IN RELATION TO INDIVIDUAL AND WORK-RELATED PHYSICAL FACTORS.

By

El-Helaly M<sup>1,2</sup>, Elsherbeny E<sup>2</sup>, Haji A<sup>1</sup>, Assiri M<sup>1</sup> and Fadlelmula A<sup>1</sup>

<sup>1</sup> Department of Infection Prevention and Control, King Abdulaziz Medical City, Riyadh, Saudi Arabia and

<sup>2</sup>Community Medicine Department, Faculty of Medicine, Mansoura University, Egypt.

## Abstract

**Introduction:** Work-related musculoskeletal disorders are deliberated as an important cause of occupational disability in industrial countries. It is responsible for a high absenteeism rate from work. Laboratory technicians and biochemist are suffering from some workplace risk factors for musculoskeletal disorders such as shoulder and backache, joint pain and muscles fatigue, which are intensified by work settings. **Aim of work:** This study aimed to examine the musculoskeletal symptoms prevalence among the laboratory workers in relation to their individual and work-related physical factors. **Material and methods:** This cross-sectional study was carried out among 269 laboratory workers who were working in a research medical laboratory, Saudi Arabia, during the period from May to December 2016. The data were collected using a questionnaire on personal demographic characteristics, workload, and physical features at work. Both Nordic Musculoskeletal Questionnaire (NMQ) and Dutch Musculoskeletal Questionnaire (DMQ) were used to evaluate the ergonomic risk factors and to study the prevalence of musculoskeletal symptoms among the participants. **Results:** The study revealed that the total 12 months prevalence of musculoskeletal symptoms at anybody site of the laboratory workers, preceding the study, was 52.04%. The reported musculoskeletal symptoms were mostly linked to the shoulders (33.5%), low back (27.5%), upper back (26.5%), followed by neck (23.0%). About three quarters of those who had musculoskeletal symptoms were female ( $p < 0.01$ ). Among the physical work-related factors, activity necessitating exertion of arms/hands, static or awkward positions during work, long periods pipetting and repetitive tasks were significantly higher among those who reported musculoskeletal symptoms compared to those who did not. **Conclusion:** Nearly half of the laboratory workers reported annual prevalence of musculoskeletal symptoms affecting mostly shoulders, low back, upper

back and neck. Ergonomic interventions, reducing risk factors and physical exercises are recommended control measures to reduce the musculoskeletal symptoms among the laboratory workers.

**Keywords:** Laboratory workers, Musculoskeletal symptoms, Ergonomic, Individual, Physical.

## Introduction

Work-related musculoskeletal disorders (WMSDs) are known as musculoskeletal disorders produced or worsen by work and described as discomfort, impairment, disability or persistent pain in joints, muscles, tendons, and other soft tissues, with or without physical manifestations (Polanyi, 1997, Kea and Seob, 2007, Tinubu et al., 2010 and da Costa and Vieira, 2010). They are deliberated as an important reason of occupational harm and disability in industrial countries (Smith et al., 2003 and Choobineh et al., 2006) responsible for a high absenteeism rate from work (Kuijjer et al., 2012).

Health care professionals, comprising microbiologist, pathologist, technician and biochemist are suffering from some workplace risk factors for musculoskeletal disorders such as shoulder and backache, joint pain and muscles fatigue, which are intensified or sustained by work settings (Agrawal et al., 2014).

Several studies labelled work-related risk factors for musculoskeletal disorders, such as long work-shifts, lack of work-rest schedule during work, repetitive movements, the combination of strain and repetitiveness, poor postures, vibrations, static muscular constraints, movements requiring extreme hand and arm postures, strained hand and arm movements, sudden muscular effort, short work cycles, task invariability, short deadlines, high cognitive demand, lack of autonomy over work, low temperatures in the work environment, exposure to vibrations, mechanical compression on tissues, negative psychosocial situations and individual susceptibility (Carayon and Smith, 2000; Ramadan and Ferreira , 2006)

Moreover, laboratory professionals are susceptible to injury because of their awkward posture during work at microscope for long time and turning knobs repeatedly to adjust the workstation (Agrawal et al., 2014).

Most of the literature focused on incidence and prevalence of work related musculoskeletal disorder among healthcare professionals with little focus on the laboratory workers.

Aim of work: the present study aimed to estimate the prevalence of reported musculoskeletal symptoms among laboratory workers with regard to their individual and work-related physical factors.

### **Materials and methods**

- **Study design:** A cross-sectional study.
- **Place and duration of the study:** King Abdullah Research Center, Saudi Arabia. It was carried out during the period from May to December 2016
- **Study sample:** Out of 295 laboratory workers, 273 agreed to join in the study. Inclusion criteria: were age group ranging from 19 to 60 years and work experience equal or more than one year. Exclusion criteria: were history of unhealed fractures, recent dislocations, inflammatory arthritis, tumors, recent traumatic soft tissue injuries, diagnosed disc lesion or present history of pregnancy.
- **Study method:** A self-administered questionnaire was distributed and filled by our study participants, including four parts.
  - The first part involved questions about personal demographic features as sex, age, educational level and smoking.
  - The second part collected data about the occupational health practice among laboratory workers to environment place, and work program.
  - The third part included questions on work-related musculoskeletal symptoms and limited activities caused by these symptoms in 12 months prior to the survey .This part was recorded using a questionnaire based on the Nordic Questionnaire for the analysis of musculoskeletal symptoms (Kuorinka et al., 1987). The original structure (English version) of the Nordic Questionnaire assessing the existence of any discomfort or pain symptom in one

of the nine body areas including neck, shoulders, elbows, wrists/hands, upper back, low back, hips/thighs, knees, and ankles/feet.

- The fourth part used the Dutch Musculoskeletal Questionnaire (DMQ) (Hildebrandt et al., 2001) for assessing the musculoskeletal workload and associated physical risk factors such as force application, static and dynamic load, repetitive load, sitting, standing, working postures, ergonomic computer workstation, and other ergonomic factors including work with certain laboratory instruments or machines such as microscopes, microtomes, pipettes and biosafety cabinets. The questions were answered in a dichotomous way by (Yes/No).

### **Consent**

An informed written consent was obtained from all workers before participation. They were informed that all collected data will be confidential and used for scientific purposes only. They were informed also that no invasive or painful techniques would be carried upon them.

### **Ethical approval**

The authors have obtained all necessary ethical approval from King Abdulla Research Center Saudi Arabia, confirming that this study is not against the public interest and that the release of information is allowed by legislation.

### **Data management**

Data were analyzed using SPSS software (version 17.0 for Windows; SPSS Inc., Chicago, IL, USA). Univariate analysis was implemented so that the possible associations between individual and work-related physical factors as independent variables and reported musculoskeletal symptoms as dependent variable appear. Quantitative variables were described as mean and standard deviations while qualitative variables were described as frequencies and percentages. For inferential part of the univariate analysis, Chi-square test or Fisher's exact test was used for categorical data, Student's t-test was used for continuous independent parametric data and Mann-Whitney U test were used for continuous independent nonparametric data. The statistical significance level was set at  $\leq 0.05$  and highly statistical level was set at  $\leq 0.01$ .

## Results

A total of 273 laboratory workers out of 295 who worked in the research laboratory of the King Abdullah International Medical Research Center, Riyadh, Saudi Arabia ; agreed to join in the study forming 92.5% participation rate. However, four workers were excluded from the study leaving 269 laboratory workers who represented our study participants. Among the four excluded workers, three had past history of musculoskeletal injuries and one had work experience less than one year.

**Table 1: Personal demographic characteristics of all study participants (No=269)**

Variables	Range	Mean $\pm$ SD <sup>a</sup>
Age (years)	24-64	37.48 $\pm$ 8.91
BMI	17.43-41.44	26.7 $\pm$ 0.86
Work experience (years )	1-28	7.84 $\pm$ 6.16
	No=269	%
<b>Education level</b>		
High school	14	5.2
University	215	79.9
Post graduate	40	14.9
<b>Smoking</b>		
Nonsmoker	246	91.4
Current smoker	23	8.6
<b>Gender</b>		
Female	180	66.9
Male	89	33.1

aSD : Standard deviation,

BMI:Body Mass Index

Table (1) showed that our study participants had a mean age of 37.48 $\pm$ 8.91 years and a mean work experience of 7.84 $\pm$ 6.16 years. Females formed 66.9% of the studied group. Most of the participants completed their university education (79.9%).

**Table 2: Total reported musculoskeletal symptoms in 12 months among the laboratory workers (No=269).**

Body sites	12 months prevalence of musculoskeletal symptoms	
	No	%
Anybody site	140	52.04
Shoulders	90	33.5
Low back	74	27.5
Upper back	70	26.5
Neck	62	23.0
Ankle/feet	57	21.2
Wrist/hands	54	20.1
knees	34	12.6
Hip/thighs	23	8.6
Elbows	22	8.2

Table (2) showed that the overall 12 months prevalence of musculoskeletal symptoms at anybody site among the laboratory workers was (52.04%). The most common sites were the shoulders (33.5%), low back (27.5%), and upper back (26.5%), followed by neck (23.0%). In addition, shoulder and low backache formed each 13.4 % of the symptoms caused limitation of the participants' activity in 12 months (data were not tabulated).

**Table 3: Distribution of individual factors among the laboratory workers (No=269), according to the presence of musculoskeletal symptoms in 12 months.**

Factors	Musculoskeletal symptoms in 12 months		p value
	Absent (No=129)	Present (No=140)	
	(Mean ± SD)	(Mean ± SD)	
Age (years)	38.02±9.49	36.97 ±8.35	0.34 <sup>a</sup>
BMI	26.39 ±4.57	26.99 ±4.63	0.28 <sup>a</sup>
Work experience (years)	7.91±6.85	7.79±5.46	0.87 <sup>c</sup>
	No (%)	No (%)	
<b>Gender</b>			
Female	72 (55.8)	108 (77.1)	<b>&lt;0.01<sup>*b</sup></b>
Male	57 (44.2)	32 (22.9)	
<b>Education level</b>			
High school	6 (4.7)	8 (5.7)	<b>&lt;0.01<sup>*b</sup></b>
Bachelor's Degree	94 (72.9)	121 (86.4)	
Post graduate	29 (22.5)	11(7.9)	

a Using Student-t test,

b Using Chi-square test,

c Using Mann-Whitney test,

BMI: Body Mass Index.

\*: Statistically significant

Table (3) showed that females formed (77.1 %) of those who reported musculoskeletal symptoms compared to (55.8%) of those who did not ( $p < 0.01$ ). Moreover, most of the participants who reported musculoskeletal symptoms had bachelor' degree (86.4%) compared to those who did not (72.9%) ( $p < 0.01$ ). On the other hand, age, BMI and work experience did not differ significantly between the two groups.

**Table 4: Distribution of work-related physical factors among the laboratory workers (No=269), according to the presence of musculoskeletal symptoms in 12 months.**

Work-related physical factors	Musculoskeletal symptoms in 12 months		p value <sup>a</sup>
	Absent (No=129)	Present (No=140)	
	No (%)	No (%)	
Prolonged standing	83(64.3)	95(67.9)	0.54
Prolonged sitting	78(60.5)	83(59.3)	0.84
Static posture	45(34.9)	83(59.3)	<b>&lt;0.01*</b>
Tasks require awkward position	33(25.6)	67(47.9)	<b>&lt;0.01*</b>
Tasks require arm/hand exertion	63(48.8)	108(77.1)	<b>&lt;0.01*</b>
Tasks require repetitive movements	77(59.7)	100(71.4)	<b>&lt;0.05*</b>
Work using computers	112(86.8)	120(85.7)	0.79
Comfortable chairs and Disks	65(50.4)	47(33.6)	<b>&lt;0.01*</b>
Frequent moving of heavy loads (more than 15 kg)	33(25.6)	30(21.4)	0.42
Work using Microscope	46(35.7)	50(35.7)	0.99
Work using Microtome	6(4.7)	8(5.7)	0.69
Work using Biosafety cabinet	47(36.4)	58(41.4)	0.4
Pipetting for long periods	19(14.7)	38(27.1)	<b>&lt;0.05*</b>

a: Using Chi-square test

\* : Statistically significant

Table (4) showed that work necessitating arms/hands exertion and working in awkward or static positions were significantly higher ( $p < 0.01$ ) among those who reported musculoskeletal symptoms (77.1%, 47.9 % and 59.3% respectively) compared to those who did not. Moreover, using comfortable chairs and desks was higher among workers who did not report musculoskeletal symptoms (50.4%) compared to those who reported (33.6%), with significant difference ( $p < 0.01$ ). Also, pipetting for long periods and doing repetitive tasks were significantly higher ( $p \leq 0.05$ ) among the participants who reported musculoskeletal symptoms (38%, 71.4% respectively) compared to those who did not (14.7% and 59.7% respectively).



## Discussion

The laboratory workers frequently report various musculoskeletal symptoms. Hence, the present study was conducted to assess the prevalence of reported musculoskeletal symptoms among them in relation to their individual and work-related physical factors considered as risk factors for work-related musculoskeletal disorders among other healthcare workers (HCWs).

The overall one-year prevalence of musculoskeletal symptoms among the laboratory workers at anybody site was 52.04% (Table 2), which was lower than that of nurses (from 60% to 93%) (Trinkoff et al., 2002, Gurgueira et al., 2003, Tinubu et al., 2010 and Attar, 2014), dentists (91.6%) (Aminian et al., 2012) and X-ray technicians (67%) (Lorusso et al., 2007); but near to that of physical therapists (from 47.6% to 53.5%) (Alrowayeh et al., 2010 and Grooten et al., 2011).

Moreover, shoulder was the most affected body site (33.5%) (Table 2) among the participants which could be related to strained hand and arm movements done by the laboratory

worker during their working hours (Mani and Gerr, 2000). But this was in disagreement with many studies done on laboratory workers in which neck formed the most prevalent site of work related musculoskeletal symptoms (Rahimi et al., 2010 and Fritzsche et al., 2012).

Low back was the second affected body site (27.5%) (Table 2); which is in concordance with a study done among pathologists to study work related musculoskeletal symptoms revealed that back pain represented the second affected site (21.6%). However, some authors stated that low back pain (LBP) was the most common complaint among healthcare professionals with one-year prevalence of 40-65.7% among nurses (Tinubu et al., 2010 and Attar, 2014); 32-56.5% among physical therapist (Alrowayeh et al., 2010 and Grooten et al., 2011) and 59.6% among X-ray technologists (Lorusso et al., 2007); however this was associated with patient handling and job strain (Ngan et al., 2010).

Concerning the relation between our participants' individual factors and the reported musculoskeletal

symptoms, the present study showed that female formed the majority of those who had musculoskeletal symptoms (Table 3). Many previous studies reported a female predominance in the prevalence of MSDs in both the general population (Mbada et al., 2012 and Mehrdad and Morshedizadeh, 2012) and working population. Also, another study assessed the work-related musculoskeletal disorders in a tertiary hospital in India, found that female healthcare professionals have 1.9 times higher risk for developing MSDs than male healthcare professionals (Salik and Ozcan, 2004 and Tinubu et al., 2010). Across occupations, women are more likely than men to report experiencing musculoskeletal symptoms (Treaster and Burr, 2004; Wijnhoven et al., 2006). This might be due to the physiological differences in the biology of women's muscles, tendons, and ligaments (Punnett and Herbert, 2000) and that women may have greater sensitivity to pain and discomfort than men (Treaster and Burr, 2004). Another explanation may be that women may have different exposures outside of work, such as a heavy domestic workload (Strazdins and Bammer, 2004). In our study, age,

BMI and work experience did not differ significantly between those who reported musculoskeletal symptoms and those who did not (Table 3), which was in agreement with another study carried out among central sterile supply technicians (CSSTs) (El-Helaly and Balkhy, 2015).

Regarding the work related physical factors, the present study showed that working in awkward or static postures were significantly higher ( $p < 0.01$ ) among laboratory workers who reported musculoskeletal symptoms compared to those who did not (Table 4). This was in concordance with other studies showing that working in awkward postures was significantly more frequent among healthcare professionals who had musculoskeletal symptoms compared to those who had not (El-Helaly and Balkhy, 2015). This is in agreement with studies among Laboratory workers which revealed that static working posture was associated with musculoskeletal disorders (Bongers et al., 1993). In addition, it was in accordance with study done for upper limb assessment among pathology laboratory workers and

showed that all the study subjects were at risk of musculoskeletal problems due to static working postures during laboratory work (Arora and Uparkar 2015). This may be clarified by other studies stated that awkward postures is a principal cause of musculoskeletal injuries (Ngan et al., 2010 and Grooten et al., 2011) and associated with low back pain (Roffey et al., 2010).

In addition, the results of the current study revealed that work requiring exertion of arms and hands was an another physical factor associated with musculoskeletal symptoms as our studied laboratory workers who reported musculoskeletal symptoms, exerted their arms or hands during work (77.1%) compared to those who did not ( $p < 0.01$ ) (Table 4). This was in agreement with other studies that reported significant association between musculoskeletal symptoms and hand/arm exertion among health care professionals (Agrawal, 2014 and El-Helaly & Balkhy, 2015).

Moreover, using comfortable chairs and desks was higher among workers who did not report musculoskeletal symptoms (50.4%) compared to those

who reported (33.6%), with significant difference ( $p < 0.01$ ) (Table 4). This supports the results of other studies which reported that the main risk factor for WMSDs is bad ergonomic layout in workstations, stressing on applying administrative and engineering regulation in laboratory environment as a preventive measure for WMSDs (Haile et al., 2012)

The current study revealed that pipetting for long periods was significantly ( $p \leq 0.05$ ) higher among the participants who reported musculoskeletal symptoms (38%) compared to those who did not (14.7%) (Table 4). This was supported by other studies which declared that the pipetting task requires neck and shoulder muscles to work statically when head and neck are beyond the neutral position (bend forward more than 30 degrees and arm is elevated without support for long period (Agrawal, 2014). Furthermore, our study showed that doing repetitive tasks was significantly higher ( $p \leq 0.05$ ) among the participants who reported musculoskeletal symptoms (71.4%) compared to those who did not (59.7%) (Table 4). This can be explained by

other studies concluding that MSDs develop because of repetitive, forceful or awkward movements of body and/or body parts of bones, joints, ligaments and other soft tissues (Arora and Uparkar, 2015).

In addition, the current study revealed that other physical factors such as sitting or standing for long periods and moving heavy loads more than 15 kg were accompanied with higher prevalence of musculoskeletal symptoms prevalence among laboratory workers, but with no statistically significant difference (Table 4).

The limitations of our study were relatively small sample size, using cross-sectional analytic design, relying on subjective data, which is endangered by exaggeration of symptoms or recall bias. However, the data was collected using the standardized Nordic Questionnaire (Kuorinka et al., 1987) and DMQ (Hildebrandt et al., 2001) as validation of both have been done and many authors used them to study the prevalence of musculoskeletal disorders among HCWs (Lorusso et al., 2007 and Attar, 2014).

### **Conclusion and recommendations**

The current study showed that whole 12 months prevalence of musculoskeletal symptoms at anybody site among the laboratory workers was (52.04%). They were mostly linked to the shoulder, low back, and upper back. The administration should periodically evaluate ergonomic design and apply preventive intervention to reduce the incidence of work-related musculoskeletal symptoms among laboratory workers at their workplace. Moreover, further studies should be carried out on a larger scale for additional valuation of the prevalence and risk factors of musculoskeletal disorders among laboratory workers.

### **Conflict of interest**

None

### **References**

1. Agrawa PR, Maiya AG, Kamath V and Kamath A (2014): Musculoskeletal disorders among medical laboratory professionals-a prevalence study. *Journal of Exercise Science and Physiotherapy*; 10(2): 77.
2. Alrowayeh HN, Alshatti TA, Aljadi SH, Fares M, Alshamire MM and Alwazan SS (2010): Prevalence, characteristics, and impacts of work-related musculoskeletal disorders: a survey among physical therapists in the State of Kuwait. *BMC musculoskeletal disorders*; 11(1): 116.
3. Aminian O, Alemohammad ZB and Sadeghniaat-Haghighi K (2012): Musculoskeletal disorders

- in female dentists and pharmacists: a cross-sectional study. *Acta Med Iranica*; 50(9): 635.
4. Arora A and Uparkar SM (2015): Ergonomic Risk Assessment in Pathology Laboratory Technicians. *International Journal of Rehabilitation Research*; 4: 15.
  5. Attar SM (2014): Frequency and risk factors of musculoskeletal pain in nurses at a tertiary center in Jeddah, Saudi Arabia: a cross sectional study. *BMJ Research Notes*; 7(1): 61.
  6. Bongers PM, de Winter CR, Kompier MA and Hildebrandt VH (1993): Psychosocial factors at work and musculoskeletal disease. *Scandinavian Journal of Work, Environment and Health*; 19(5): 297-312.
  7. Carayon P and Smith MJ (2000): Work organization and ergonomics. *Applied Ergonomics*; 31(6): 649-662.
  8. Choobineh A, Rajaeefard A and Neghab M (2006): Association between perceived demands and musculoskeletal disorders among hospital nurses of Shiraz University of Medical Sciences: a questionnaire survey. *International Journal of Occupational Safety and Ergonomics*; 12(4): 409-416.
  9. Da Costa BR and Vieira ER (2010): Risk factors for work-related musculoskeletal disorders: a systematic review of recent longitudinal studies. *American Journal of Industrial Medicine*; 53(3): 285-323.
  10. El-Helaly M and Balkhy HH (2015): Musculoskeletal complaints among central sterile supply technicians in relation to physical and psychosocial factors at work. *Journal of Environmental and Occupational Science*; 4(2): 78-83.
  11. Fritzsche FR, Ramach C, Soldini D, Caduff R, Tinguely M, et al (2012): Occupational health risks of pathologists-results from a nationwide online questionnaire in Switzerland. *BMC Public Health*; 12(1): 1054.
  12. Grooten WJ, Wernstedt P and Campo M (2011): Work-related musculoskeletal disorders in female Swedish physical therapists with more than 15 years of job experience: prevalence and associations with work exposures. *Physiotherapy Theory and Practice*; 27(3): 213-222.
  13. Gurgueira GP and Alexandre NMC (2003): Self-reported musculoskeletal symptoms among nursing personnel. *Revista Latino-Americana De Enfermagem*; 11(5): 608-613.
  14. Haile EL, Taye B and Hussen F (2012): Ergonomic workstations and work-related musculoskeletal disorders in the clinical laboratory. *Laboratory Medicine*; 43(2): e11-e19.
  15. Hildebrandt VH, Bongers PM, Van Dijk FJH, Kemper HCG and Dul J (2001): Dutch Musculoskeletal Questionnaire: description and basic qualities. *Ergonomics*; 44(12): 1038-1055.
  16. Kee D and Seo SR (2007): Musculoskeletal disorders among nursing personnel in Korea. *International Journal of Industrial Ergonomics*; 37(3): 207-212.
  17. Kuijjer PPFM, Van der Molen HF and Frings-Dresen MH (2012): Evidence-based exposure criteria for work related musculoskeletal disorders as a tool to assess physical job demands. *Work*; 41(1): 3795-3797.
  18. Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering-Sørensen F, et al (1987): Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Applied Ergonomics*; 18(3): 233-237.
  19. Lorusso A, Bruno S and L'abbate N (2007): Musculoskeletal complaints among Italian X-ray technologists. *Industrial Health*; 45(5): 705-708.
  20. Mani L and Gerr F (2000): Work-related upper extremity musculoskeletal disorders. *Primary Care: Clinics in Office Practice*; 27(4): 845-864.
  21. Mbada CE, Obembe AO, Alade BS, Adedoyin RA, Johnson OE, et al (2012): Work-related musculoskeletal disorders among health workers in a Nigerian Teaching Hospital. *TAF Preventive Medicine Bulletin*; 11(5):583-588.
  22. Mehrdad R and Morshedizadeh M (2012): Musculoskeletal disorders and ergonomic

- hazards among Iranian physicians. *Archives of Iranian Medicine*; 15(6): 370.
23. Ngan K, Drebit S, Siow S, Yu S, Keen D , et al (2010): Risks and causes of musculoskeletal injuries among health care workers. *Occupational Medicine*; 60(5): 389-394.
  24. Polanyi MF, Cole DC, Beaton DE, Chung J, Wells R, et al (1997): Upper limb work-related musculoskeletal disorders among newspaper employees: Cross-sectional survey results. *American Journal of Industrial Medicine*; 32(6): 620-628.
  25. Punnett L and Herbert R (2000): Work-Related Musculoskeletal Disorders-38: Is There a Gender Differential, and if So, What Does It Mean? *Women Health*;38(6):474–492.
  26. Rahimi A, Vahdatpour B, Khosrawi S, Mogtaderi A, Sattari S, et al (2010): Work related musculoskeletal disorders among pathologist in Isfahan: a cross-sectional study. *Research Journal of Biological Sciences*; 5(12): 793-797.
  27. Ramadan PA and Ferreira M (2006): Risk factors associated with the reporting of musculoskeletal symptoms in workers at a laboratory of clinical pathology. *Annals of Occupational Hygiene*; 50(3): 297-303.
  28. Roffey DM, Wai EK, Bishop P, Kwon BK and Dagenais S (2010): Causal assessment of awkward occupational postures and low back pain: results of a systematic review. *The Spine Journal*; 10(1): 89-99.
  29. Salik Y and Özcan A (2004): Work-related musculoskeletal disorders: a survey of physical therapists in Izmir-Turkey. *BMC Musculoskeletal Disorders*; 5(1): 27.
  30. Smith D R, Ohmura K, Yamagata Z and Minai J (2003): Musculoskeletal disorders among female nurses in a rural Japanese hospital. *Nursing & health sciences*; 5(3): 185-188.
  31. Strazdins L and Bammer G (2004): Women, work and musculoskeletal health. *Social Science and Medicine*; 58(6), 997-1005.
  32. 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 Musculoskeletal Disorders*; 11(1): 12.
  33. Treaster DE and Burr D (2004): Gender differences in prevalence of upper extremity musculoskeletal disorders. *Ergonomics*; 47(5): 495-526.
  34. Trinkoff AM, Lipscomb JA, Geiger-Brown J and Brady B (2002): Musculoskeletal problems of the neck, shoulder, and back and functional consequences in nurses. *American Journal of Industrial Medicine*; 41(3): 170-178.
  35. Wijnhoven HA, De Vet HC and Picavet HS (2006): Prevalence of musculoskeletal disorders is systematically higher in women than in men. *The Clinical Journal of Pain*; 22(8): 717-724.