Research Article

Risk factors for work-related musculoskeletal disorders among medical laboratories professionals

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ABSTRACT

Background: Laboratory health-care workers, including pathologist, microbiologists, and technicians, are exposed to number of risk factors in the workplace for musculoskeletal disorders (MSDs). However, the individual impact of these risk factors on laboratory professionals among Indian laboratory professionals is unknown. **Objective**: The aim of our study was to know the risk factors and its individual contribution for work-related MSD (WMSD) among laboratory professionals. **Materials and Methods**: It was a cross-sectional study done on medical laboratory professionals in Udupi district of Karnataka state. Risk factors were categorized into personal and workstation which was identified using a validated questionnaire. It included questions regarding demographic data, occupational history, and question-related to various workstations including general, standing, computer, pipetting, microscope, and microtome workstations. Univariate logistic regression analysis was used to study the risk factors for WMSD. Multivariate logistic regression analysis was used to study the independent risk. **Results:** A total of 250 subjects participated in the study. Female paramedical staff in younger age was found to be at higher risk. Among various workstations, computer workstation and pipetting workstation were found to be the most important contributory factors in WMSD with people having 2.5 and 1.4 times higher risk of WMSD compared to people at no risk. **Conclusion**: Laboratory professionals are strongly encouraged to adopt preventive measures toward personal and workstation-related risk factors before symptoms develop.

KEY WORDS: Work Related Musculoskeletal Disorders; Occupational; Health Risk; Cumulative Trauma; Laboratory Professional

INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) are the MSDs to which the work environment and the performance of work contribute significantly.[1] WMSDs are an increasing health problem in workplaces (WHO 2003).[2]

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It has been reported that health-care workers other than laboratory professionals do experience MSDs as well as respiratory symptoms at a rate exceeding the rate of workers in construction, mining, and manufacturing.[3] Health-care workers, including pathologists, microbiologists, and technicians, are exposed to number of risk factors in the workplace for MSDs such as back and shoulder injuries and even other joints and muscles exertion, which are aggravated or prolonged by work conditions. The prevalence of WMSD among laboratory professionals is 21.2%.[4] The main functions of the laboratory professionals are to perform analytic tests and procedures on body fluids and tissues taken from patients and to provide the results of these tests to physicians to confirm the diagnosis, determine prognosis or ascertain or assess the patient's treatment.

Laboratory professionals work, very often demands the use of awkward and static postures, high repetition, excessive reaching, compression or contact stress, forceful or static exertions, pinch grip lifting, and repetitive motions. The daily routine work of these professionals also includes several hours of microscope and computer work.[5] A survey among 244 cytotechnologists, a typical example of microscope-using employees, demonstrated that more than 80% of participants suffered from musculoskeletal discomfort including headache, neck pain, stiffness, back pain, and upper extremity discomfort.[6] These risk factors predispose them for WMSD. However, the individual impact of these risk factors on laboratory professionals among Indian laboratory professionals is unknown. Hence, the aim of our study is to know the risk factors and its individual contribution for WMSD among medical laboratory professionals.

MATERIALS AND METHODS

The Manipal University ethical committee clearance was obtained before the study. This study was a cross-sectional survey involving laboratory professionals (lab technicians, pathologists, microbiologists, and biochemistry technologist) belonging to Udupi district of Karnataka state. The target sample size was the whole community of laboratory professionals in the selected district. Participants that were in the age group ranging from 19 to 60 years and working as a professional for at least last 1 year were included in the study. Subjects who gave a history of unhealed fractures, recent dislocations, inflammatory arthritis, tumors, diagnosed psychiatric illness, and recent traumatic soft tissue injuries, diagnosed disc lesion and those who refused to participate were excluded from the study.

Personal and workstation risk factors were identified using interview method by researcher using self-prepared validated questionnaire. The questionnaire covered personal risk factors which were comprised demographic data, occupational case history in terms of years of experience and number of hours of work, involvement in any physical activity, and individual perception of their general health.

Workstation-related risk factors in workplace were evaluated by "workstation evaluation" component of this questionnaire. This had various components which evaluated the risk factors related to or arising because of laboratory bench top, lab chairs, pipetting, microscopes, working in standing position, micromanipulation, microtome/cryostat, and computer work. All the workstation was analyzed for its appropriateness based on self-reported questions as interviewed by the researcher.

A total of 260 subjects were identified and screened for inclusion and exclusion criteria. Of which, 10 were excluded (6- <1 year experience, 4-diagnosed disc lesion). A total of 250 subjects participated in the study. After taking informed consent, the participants were interviewed using validated questionnaire to check the risk factors.

Data Analysis

For analysis of workstation risk factors, workstation was divided into six components (general, pipetting, microscope, microtome, standing, and computer workstation). Each workstation was assessed based on the activities carried out at the station. Each activity was scored 1 if favorable and 0 if not favorable. The scores were summed up, and value was generated for each workstation and was finally categorized as no risk, low risk, and high risk.

No risk - <20% of workstation activities are not favorable, low risk - 20-60% workstation components are not favorable, and high risk - >60% workstation items are not favorable.

All the data collected were analyzed by SPSS version 15.0 software. Frequency and percentage were used to summarize all categorical variables. Univariate logistic regression analysis was used to study the risk factors for WMSD. Multivariate logistic regression analysis was used to study the independent risk.

RESULTS

A total of 250 subjects participated in the study. Out of these 45 subjects had one or more self-reported WMSDs in various body regions.

Table 1 shows the demographic characteristics of the participants. The mean age of the participants was 30.64±9.8 years. The numbers of females were more compared to males. 60.4% of the participants were in normal body mass index (BMI) category. 7.2% of the study participants had hypertension or diabetes as one of the comorbidities. The majority of the participants were laboratory technicians (92.4%). The median duration of experience was 6 years with an average of 8.13 working hours in a day. Among 250 participants, 78.4% were not involved in any kind of physical activity and 85.2% of them rated their general health as good.

Personal Risk Factors for WRMSD

As seen in Table 2, WMSD was exclusively seen in the younger age group. The females in this study were at 1.5 times higher at risk for WMSD as compared to the males. The majority of the participants with WMSD were paramedical staff (Table 1). In this study, majority of the participants with WMSD was in the normal category of BMI, and 35.6% of the participants with WMSD were having comorbid conditions (hypertension 22.3% and diabetes 13.4%). The median duration of experience was found to be 6 years in both the group. The mean duration of hours of work for WMSD was found to be significantly higher as compared to participants without symptoms.

Workstation Risk Factors for WRMSD

As mentioned in the analysis workstation risk factors were analyzed under six different components, i.e., standing, general, computer, pipetting, microscope, and microtome workstation.

As seen in Table 3 among all workstation, computer workstation was the found to be the most important contributory factor in WMSD with odds ratio (OR) 2.5 (95% confidence interval [CI]: 0.9-7.0). Next workstation which was found to be significant in contribution of WRMSD was pipetting with OR 1.4 (95% CI: 0.5-3.5) All other workstation, i.e., microtome, standing, general workstation, and microscope workstation had a lesser risk of WMSD.

Table 1: Demographic characteristics of participants

Demographic characteristics	*n* (%)
Age	
20-35	190 (76.0)
36-60	60 (24.0)
Gender	
Male	66 (26.4)
Female	184 (73.6)
BMI	
<18	50 (20.0)
18-25	149 (59.6)
>25	51 (20.4)
Occupation	
Medical	19 (7.6)
Paramedical	231 (92.4)
Comorbidities	
HTN	11 (4.4)
Diabetes	7 (2.8)
Duration of experience (median, IQR)	6 (3.12)
Number of hours in a day at work (mean±SD)	8.25±1.8

BMI: Body mass index, HTN: Hypertension, SD: Standard deviation

Computer Workstation

As seen in Table 3, this workstation was at 2.5 times higher risk in development of WMSD. In this study, 197 participants were involved in computer task. This workstation was analyzed under following components-presence of computer work for less than and more than 2 h, absence of low back support, screen not at eye level, absence of foot rest, and inappropriate hand posture while using mouse.

In our study, 93.3% of the participants with WMSD had to work on computer for <2 h and 51.6% of the participants reported the absence of low back support in the chair at this workstation which was at 1.1 times higher risk in the development of WMSD. It was observed that 20% of the participants had inappropriate screen height. 33.3% participants reported absence of foot rest on computer workstation as a risk for WMSD (OR 0.54, CI: 0.26-1.1, $P = 0.104$). 40% of the participants with WMSD reported inappropriate posture while using mouse and keying which could be one of the contributory factors in WMSD.

Pipetting Workstation

About 173 participants were involved in pipetting task. As seen in Table 3, at this workstation those with a high score had 1.4 times higher risk of developing WMSD as compared to

Table 2: Association between personal risk factors and WMSD

Variables	WMSD (*n* %)		OR	95% CI
	Present	Absent		
Age (years)				
20-35	45 (23.6)	145 (76.3)	-	-
36-60	0	60 (100.0)		
Gender				
Male	9 (13.6)	57 (86.3)	1.0	
Female	36 (19.5)	148 (80.4)	1.54	0.7-3.4
Occupation				
Medical	9 (47.3)	10 (52.6)	1.0	0.07-0.5
Paramedical	36 (15.5)	195 (84.4)	0.20	
BMI				
<18	9 (18.0)	41 (82.0)	1.0	-
18-25	31 (20.8)	118 (79.1)	1.1	0.5-2.7
>25	5 (9.8)	46 (90.1)	0.4	0.1-1.5
Duration of experience median (IQR)	6 (3.5, 14.5)	6 (3, 12)	-	-
Hours in a day at work (mean±SD)	8.4±1.4	8.0±1.9	1.1	0.24-5.4

OR: Odds ratio, CI: Confidence interval, WMSD: Work-related musculoskeletal disorders, BMI: Body mass index, SD: Standard deviation

Table 3: Relationship between workstation risk factors for WMSD

Workstation risk factors	WMSD (*n* %)		Odds ratio (95% CI)
	Present	Absent	
Computer workstation (*n*=197)			
Low risk	5 (11.2)	40 (88.8)	1.0
Moderate risk	35 (24.3)	109 (75.6)	2.5 (0.9-7.0)
High risk	2 (25.0)	6 (75.0)	2.6 (0.4-16.9)
Pipetting workstation (*n*=173)			
Low risk	8 (11.7)	60 (88.2)	1.0
High risk	17 (16.1)	88 (83.8)	1.4 (0.5-3.5)
Microscope workstation (*n*=212)			
Low risk	19 (17.7)	88 (82.2)	1.0
Moderate risk	16 (16.1)	83 (83.8)	0.9 (0.4-1.9)
High risk	3 (50.0)	3 (50.0)	-
General workstation (*n*=250)			
Low risk	27 (20.3)	106 (79.6)	1.0
Moderate risk	17 (15.1)	95 (84.8)	0.5 (0.2-1.1)
High risk	1 (20.0)	4 (80.0)	-
Microtome workstation (*n*=19)			
Low risk	0	2 (100.0)	-
High risk	4 (23.5)	13 (76.4)	
Standing workstation (*n*=224)			
Low risk	0	4 (100.0)	-
Moderate risk	21 (12.8)	143 (87.1)	
High risk	9 (16.0)	47 (83.9)	

lower score. This workstation was analyzed under following headings-use of more force while pipetting and shoulder not relaxed while pipetting.

It was observed in the study that 20.0% of the participants with WMSD reported the use of more force while doing pipetting task. These forces are reported during opening of sample tubes while pipetting task, which requires force to open and close them. The fastenings on sample tubes varied, some had a simple "snap" lid which has a tight-fitting seal and was difficult to open and close. In our study, we did not find the use of force as statistically significant risk factor for WMSD with OR 0.7 (95% CI: 0.27-1.7, P = 0.430). Forces were also reported while thumb applied the pressure which puts excessive strain on the one digit and significantly increases the risk of a strain. In our study, 6.7% of the participants with WMSD were pipetting in awkward posture.

Microscope Workstation

In this study, 212 participants reported using microscope workstation. We did not find it having statistically significant contribution for the development of WMSD. This workstation was analyzed under following components: Awkward posture, unsupported arms while using microscope, absence of leg space and feet support, and absence of work break.

It was observed during the study that 51.1% of participants with WMSD reported using microscope in awkward posture acquired mainly due to unsupported arm in many participants. However, we did not find this as a statistically significant risk factor. Because of lack of awareness regarding appropriate posture, many of study participants who were using microscope in awkward posture, i.e., elevated shoulder, underreported the usage of awkward posture (Figure 1). 11.1% of the participants did not had leg space as well as feet support at microscope workstation that contributed for the awkward posture (Figure 2) which could be a risk factor for WMSD. However, we did not find any significant relation of this with WMSD. The absence of work break was also reported among 4.4% of the participants with WMSD with 1.0 times higher risk of WMSD.

General Workstation

This workstation was analyzed under following parameters: Unadjustable height, unpadded edges, absence of leg space, uncomfortable chair, increased work hours, absence of job rotation, and inappropriate light at workstation.

It was observed from the study that none of the workstation had adjustable height. 42.2% of the participants with WMSD had to work on the surface with unpadded edges and it

was one of the contributory factors with 4.3 times higher risk in the development of WRMSD which was found be statistically significant. Another factor which causes risk at general workstation is the absence of leg space. We found this at 1.2 times risk for development of WMSD. 13.3% of the participants reported that their chair is uncomfortable. Although we did not find it statistically significant, many researchers[7,8] have reviewed that the chair has a direct influence on body alignment (posture). Another task which demands sitting posture for long is writing work. In this study, 82.2% of the participants with WMSD were involved in writing work for <2 h and 13.3% are involved in writing task for >4 h. However, we did not get any significant association of this with WMSD.

About 42.2% of the participants reported that they have no job rotation, so they have to do the same task throughout the job. Although we did not find job rotation as significant risk factor, many studies have focused on the beneficial effect of job rotation in reducing WMSD.

In this study, we found only 4.4% of participants reporting inappropriate light at workstation.

Microtome Workstation

Microtome workstation was also not found significant factor in contribution of WMSD statistically. However, it is difficult to confirm this because of very less number of participants in this workstation as total of only 19 participants were involved in this task. Although the risk factors were dominant at this workstation for example inappropriate microtome grip (Figure 3) forcing the awkward deviation of wrist while in use (OR 0.46, CI: 0.03-6.9, $P = 0.576$), non-motorized microtome and absence of leg clearance (OR 0.91, CI: 0.07-11.5, $P = 0.946$) forcing them to maintain awkward and static posture.

Standing Workstation

A total of 224 participants were involved in standing work. This workstation was analyzed under following components-prolonged standing work, inappropriate posture while standing, perceived table height while standing, absence of foot rest/ledge and anti-fatigue mat. In this study, 46.7% of the participants with WMSD reported prolonged standing work in the laboratory, but we did not find it statistically the risk in the development of WMSD. During the study, it was observed that due to lack of awareness regarding ideal ergonomic design, 57.8% of the participants with WMSD reported inappropriate height of table top. Few participants (8.9%) perceived that they do not keep their body upright while in standing work and it was found that they are at 1.2 times higher risk of WMSD (CI: 0.4-3.9). Reason for underreporting could be a lack of awareness regarding appropriate posture. Another component in standing workstation was absence of foot rest which may contribute in the development of WMSD. 37.8% of the participant with WMSD reported absence of footrest or ledge while standing work.

To identify independent risk factor we did multivariate logistic regression analysis and it was found that occupation mainly paramedical professionals were at highest at risk in the development of WMSD with adjusted OR 0.2 (CI: 0.07-0.5). However, statistically, this could have resulted because of very few participants from medical profession in the study.

DISCUSSION

In this study, we found 18% prevalence of WMSD. Personal risk factors which could have contributed to WMSD were identified as young age, female professionals, paramedical staff, and duration at work. The presence of WMSD among younger age group is supported by the fact that this problem is being experienced more among younger professionals.[9] Thus, we can strongly relate these musculoskeletal symptoms with work and not due to an aging effect. This underlines the importance of addressing this problem not only in middle-aged to older employees but in the younger ones, at an early stage in their career**.**

In this study, females were found at higher at risk for WMSD which could be due to the fact that majority of the participants in the study were females. Most of the studies that have been carried out to study the risk for WRMSD have been done on female participants or have a skewed gender distribution toward females. The reason could be the larger number of female population in this profession. Ratio of male and female in our study was similar to the study reported by Fritzsche et al.[9,10] Moreover during the study period, it was found that female outnumbered males in this profession. However, we did not look at the working pattern of females other than at work for, e.g., work at house and with children.

It was observed in our study that majority of clinical load is borne by paramedical staff as compared to medical professionals who are also involved in teaching and thus have some amount of relaxation time between the laboratories activities. This could have resulted in a larger number of paramedical profession with WMSD. However, this difference was statistically not significant with an OR of 0.20 (95% CI 0.07-0.5).

We also observed that statistical test shows that even the normal BMI is a significant risk factor with OR 1.2. This could have occurred because of larger population in normal BMI group.

The presence of comorbid conditions could also be one of the risk factor in the development of WMSD. Association of

hypertension and diabetes with MSD is supported by various researches in literature.[11,12]

In this study, the duration of experience had no role in the occurrence of WRMSD. Our result is similar to study conducted by Ibrahim and Mohanadas on staffs of specialized health-care center where author reported duration of employment as a little influence to the prevalence of MSD.[13]

In this study, duration of work was significant risk factor for WMSD with OR 1.16 (95% CI: 0.24-5.4). Similar finding was reported by Fritzsche et al. in a study on health risk among pathologist were author reported that increasing working hours were significantly associated with musculoskeletal problems.[9]

At computer workstation, inappropriate sitting posture attained by the professional while doing computer related task which is also influenced by chair and plays major role in risk for WMSD. It is known that when a person sits in a chair, the natural tendency for most people is to slouch over or slouch down in the chair after some time, and this posture can overstretch the spinal ligaments and strain the discs and surrounding structures in the spine and absence of low back support adds the impact of it on musculoskeletal system (Figure 4).

Inappropriate screen height could be another reason for WMSD which was noted in our study. This was similar to many earlier studies reporting visual discomfort and musculoskeletal strain, particularly in the neck and shoulders with inappropriate computer screen height. Higher monitor placement causes neck extension thereby increasing visual demands when using bifocals. On the other hand, an extreme low location is often associated with musculoskeletal symptoms caused due to continuous flexion at the neck. In addition to this, the absence of footrest either lead to excess of knee flexion while sitting or slouched back because of posterior pelvic tilt while sitting. This overall can affect upper back and shoulder posture leading to altered mechanics and contributing to MSD because of altered habitual posture.

WMSD due to inappropriate posture while using mouse and keying is supported by a study evaluating effects of typing at different wrist postures. Author observed the change in carpal tunnel pressure during various hand postures while typing. The study confirms the significant increase in carpal tunnel pressure with awkward hand posture while typing leading to musculoskeletal conditions like carpal tunnel syndrome.[14]

At pipetting workstation, we did not find application of force as the statistically significant risk factor. This was in contrast to study by Björksten et al., who reported that amount of time spent pipetting influences the prevalence of thumb-related MSD.[15] The pipetting task forces the use of awkward posture mainly forward bending of neck, sustained shoulder abduction and elbow flexion (Figure 5). Not only this, the depression of plunger while transferring the fluid also causes repeated loading of thumb. All these could have predisposed to WMSD. During depression of plunger, neck and shoulder muscles have to work statically which is harmful. However, we did not find any significant association between awkward posture during pipetting and WMSD *(P* = 0.667). This could be because of lesser number of subjects in the study who were involved in pipetting task.

Standing or sitting at the wrong height while pipetting will put additional strain onto the upper limbs. If the working height is too low, the person will stoop over their work and put strain on their back and neck. If the working height is too high, the person's shoulders and arms will be working in an elevated position and this will put tension on the muscles. If the arms are held unsupported away from the body, then the muscles in the upper arms and shoulder work statically to maintain this position and therefore tire quickly.[15]

At microscope workstation, we observed that while using microscope, participants were not keeping their arms supported. Constant use of hands and forearm to maneuver microscope knob leads to increased sustained activity of trapezius muscle. This is supported by Marcus et al. who noticed reduced electromyographic (EMG) activity of trapezius, cervical paraspinal muscles, forearm muscles involved in operating the knobs and handles after giving support of the forearms.[16] Furthermore, at this workstation, absence of leg space would have led to increased adoption of awkward posture. In earlier studies, it has been seen that this awkward posture causes increase EMG activity of trapezius and midthoracic paraspinal muscle.[16] This is supported by Shreya Maulik reported in her study on laboratory technicians and graded microscope users at high risk for WMSD based on the Rapid entire body assessment and Rapid upper limb assessment score.[17]

Contribution of absent work break in WMSD is supported by study on computer professionals were author recommended intra work pause so that muscles get rest from static load.[18] Another study by Zwahlen et al. in 1984 on computer operators had reported that rest break is beneficial in reducing musculoskeletal discomfort.[19]

In addition to various risk factors related to workstation. One of the tasks which expose the laboratory professional to sharp edges is taking blood samples from the patient, which requires skill as well as precision. The laboratory professionals are exposed to contact stress from the work surface edge (Figure 6). Sharp edges on worktop predispose the laboratory professionals for contact stress which causes concentration of forces in small area restricting the flow of nutrient and oxygen-carrying blood in the blood vessels which often causes discomfort and results in pain.[20] Absence of leg space demands the use of awkward posture while working which may have contributed in WMSD.[21]

Figure 1: Awkward posture of hand, sustained shoulder elevation and repeated use of small muscles of hand and fingers

Figure 2: Microscope workstation showing the absence of leg space and use of elevated shoulder while viewing microscope

Figure 3: Awkward hand posture while using microtome

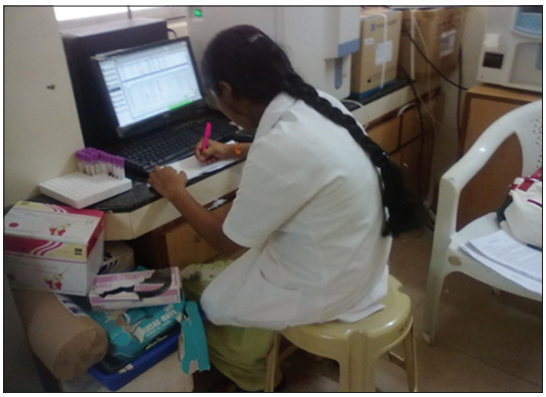

Figure 4: Computer workstation showing awkward posture due to inappropriate seating

Figure 5: Prolonged use of shoulder and upper limb elevation while pipetting

Figure 6: Awkward posture while taking blood samples from patient

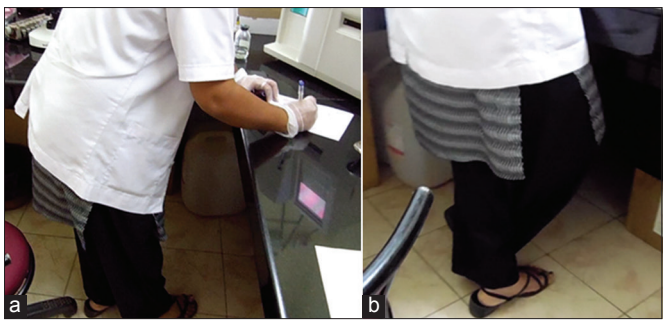

Figure 7: (a and b) Standing task and use of awkward posture

In addition, a chair meeting the ergonomic requirements is postulated to reduce the occurrence of musculoskeletal symptoms.[22] A mismatch in the dimensions of the chair impairs the ability of the postural muscles to support the body and could also lead to abnormal strain of the neuromuscular system, consequently causing pain. Individuals suffering from musculoskeletal symptoms related to prolonged sitting

are often advised to alter the chair of their workstations. Inappropriate light causes adjustment of posture to work especially neck, which may indirectly contribute to musculoskeletal pain.

Our observations at microtome workstation did not find any of these risk factors statistically associated with WMSD. The probable reason would have been that the less number of participants were present in the study that was using microtome.

Workstation requiring prolonged standing work, standing could have contributed in WMSD. Although we did not find it statistically significant, literature supports the fact that standing work demands sustained flexion of neck or bending of trunk very often for various laboratory related task, this could have increased the chances of WMSD while doing prolonged standing work.

In this study, few participants rated the height of table appropriate even while doing standing work and it is supported by literature that if work table height does not match the user the risk gets added up.[23] Prolonged and uneven weight distribution while standing (Figure 7) leads to standing with increased lordosis, which gets compensated with rounding of upper back ultimately leading to musculoskeletal symptoms because of altered posture and mechanics. While using footrest when in standing prevents this cycle which leads to development of symptoms.

Strength of the Study

This is the first study which included all the laboratory professionals covering all of the laboratory tasks. In this study, to minimize the effects of variation between the subjects, the differences between the participating workplace were kept to a minimum (e.g., from same type of organization doing same type of work and being financially equivalent.).

CONCLUSION

The WRMSD were more prevalent in younger age with females being at higher risk. Computer workstation and pipetting workstation were found to be the most important contributory factor in WRMSD with people having 2.5 and 1.4 times higher risk of WMSD compared to people at no risk. Therefore, medical laboratory professionals are strongly encouraged to adopt preventive measures toward personal and workstation-related risk factors before symptoms develop.

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