Effect of Musculoskeletal Disorders on Health-Related Quality of Life of Light Engineering Maintenance Personnel

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ABSTRACT

Background and Objective: Good health is an important prerequisite for growth of any organisation. Health-related quality of life (HRQOL) is an important outcome of health. Any adversity in health such as musculoskeletal disorders (MSD) will affect HRQOL. Modern defence system has significant role of electrical, electronic and Instrument technicians in armed forces. Despite their intensive role, little is known about MSDs & HRQOL in these technicians.

Method: 164 Electrical, telecom and instrument technicians were assessed for MSDs and HRQOL, using Nordic Musculoskeletal Questionnaire (NMQ) and RAND 36-Item Health Survey 1.0. All eight domains of HRQOL were compared for personnel having MSDs with those who were unaffected. Effect of MSDs and its symptomatology was assessed on physical component score (PCS), mental component score (MCS) and 'Well being' scores of HRQOL using logistic regression.

Results: High prevalence of MSDs (73.45%) and negative effect of MSDs on all domains of HRQOL was noted. Though presence of MSDs, multiple MSDs, increase frequency and severity of pain negatively affected PCS, MCS was affected only with increased frequency of pain. MSD, frequency and severity of pain had significant negative impact on Well-being.

Conclusion: There is high prevalence of MSDs among light maintenance defense personnel and these MSDs have adverse effect on HRQOL. We suggest regular screening and suitable preventive/therapeutic measures to control the occurrence and its symptoms, thereby maintaining optimum HRQOL.

Key Words: Musculoskeletal Disorders, Quality of life, Light maintenance, Defense, Electrician, Telecom, Mechanics

INTRODUCTION

Musculoskeletal disorders (MSDs) are a group of inflammatory and degenerative disorders in different body segments. They are triggered by movement at work and related risk factors and have common expressions of pain with variable intensity¹. MSDs are characterized by symptoms of pain, fatigue and paraesthesia. They lead to varying degrees of disability, increase absenteeism at work, reduced productivity, and higher compensation costs. MSDs are highest work-related health issues worldwide regardless of degree of industrialization in country². It is comorbidity having highest economic burden^{3,4} and accounts for 40% of the cost of work-related injuries⁵. It adversely affects the physical and mental wellbeing of workers and is associated with the psychosocial dissatisfaction, physical discomfort and low occupational work performance.

Health-related quality of life (HRQOL) is defined as the individual's subjective perception of health status, disease and

treatment, psychological, physical and social functioning, and overall wellbeing⁶. The measure of HRQOL is significantly important for any industry, as studies have established that the worker's health status directly affects its performance and output⁷. Economic growth and industrial development has shifted the focus towards working environment and wellbeing of workers⁷. Ergonomics interventions have been suggested as proactive step to reduce MSDs and improve HRQOL⁸.

The technological development of military equipment has enhanced the application of electrical, telecommunication and optical instruments. Light engineering maintenance workers play an important role for repair, maintenance and calibration of such components/ subsystems. They are exposed to various risk factors of repetitive movements, awkward posture, vibration, inadequate workstation, inadequate rest, shift work, and work pressure etc. Higher exposure to a combination of physical and psychosocial risk factors may

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be responsible for development of musculoskeletal disorders (MSDs) in light engineering maintenance worker^{9,10}. Researchers have highlighted the presence of MSDs as over-use injuries in electricians, telecommunication workers, and similar jobs^{10,11}. The most commonly reported symptoms are inflammations of tendons such as tenosynovitis, epicondylitis and nerve compression disorder like carpal tunnel syndrome, sciatica and other degenerative change¹²⁻¹⁴.

Most relevant studies in the field, relating MSDs and HRQOL are reported on industrial workers, where heavy physical load and manual material handling is involved¹⁵⁻¹⁸. Though light engineering maintenance workers have equally important role in repairing and maintaining sophisticated optical, electrical and telecommunication equipment, literature lacks insight into MSDs and its effect on HRQOL among electricians, telecommunication and optical instrument mechanics. Therefore, we aimed and planned this study, to assess the impact of MSDs on HRQOL of light engineering maintenance workers. The effect of frequency and degree of severity of pain on HRQOL was assessed too. SF-36 questionnaire was used for assessment of quality of life for measuring health-related outcome from the worker's point of view.

MATERIALS AND METHODS

A cross-sectional survey study was conducted on military personnel involved in electrical, telecommunication and instrument repair and maintenance. When considering maintenance work, all three job trades had similar job content, in terms of work load, working postures that usually required being on chair or bench, use of small work tools, working hours, physical load and combat role. Electricians have expertise of repair and maintenance of electrical components and subsystems used in defense machineries. Telecommunication maintenance personnel are trained to maintain computer subsystems, communication and radar systems; while Instrument Maintenance personnel deal with repair/ maintenance and calibration of defence optical devices and dial gauges, and digital interfaces of various machineries. They were grouped and termed as Light maintenance personnel. After giving confidentiality assurance and taking informed consent, 198 respondents were enrolled in the study. Systemic illness such as hypertension, diabetes, heart disease, neurological issues were considered under exclusion criteria. Any respondents bearing a history of illness, such as degenerative or autoimmune inflammatory joint disorders or viral illness in the last year, that could have affected the response to MSDs were also excluded from the study. After considering the exclusion criteria and excluding the incomplete forms, a total of 164 personnel were assessed out of 198 enrolled personnel, making a response rate of 82.82%.

A thorough briefing of how to fill the questionnaire was given to all personnel enrolled in the study. The question-

naire was constructed into three parts: Part 'A'. Bearing demographic and personnel details, Part 'B' as NMQ¹⁹ and Part 'C' as MOS Short form-36 (SF-36). The presence of MSDs was defined as ache, pains, or discomfort in any of the nine body regions marked in body chart of NMQ and was defined as per NIOSH criteria²⁰. The aches and pain in head and stomach were excluded, as they could be related to systemic illness. Health related QOL (HRQOL) was assessed in eight domains:

1. Physical functioning (PF)
2. Bodily pain (BP)
3. Role limitations due to physical health problems (RP)
4. Role limitations due to personal or emotional problems (RE)
5. Emotional wellbeing (MH)
6. Social functioning (SF)
7. Energy/fatigue (VT)
8. General health perceptions (GH)

It also includes a single item that provides an indication of perceived change in health²¹. The three-second order factor was further calculated: Physical component score (PCS), Mental component score (MCS) and 'Well-being'²². To avoid recall bias, HRQOL was marked as per perception in the previous 4 weeks. Answers were calculated as per RAND SF-36 calculations and ranged from 0 to 100, where '0' meant poor health and 100 is optimal health²³. Pain intensity was assessed using Numeric pain scale (0-10 scale) and frequency of occurrence by a five-point scale ranging from never-rarely-sometimes-often-very often. For further assessment, numeric rating on pain scale was converted to five-point rating (0: No pain, 1-3: mild pain, 4-6: moderate pain, 7-9: severe pain and 10: unbearable pain²⁴. The investigation period was from 14 Mar 2015 to 10th Dec 2018 and was from geographic locations in India, such that different terrain and altitude were covered. The investigator travelled and collected the data. This study was approved for ethical consideration by Research review committee of NMIMS.

STATISTICAL METHODS

Descriptive statistical analysis of demographic details including age, education, marital status, BMI, employment duration, working hours, shift work, smoking and MSD prevalence was done. Further personnel were assessed as having single and multiple (more than two) MSDs. Effect of presence of MSDs was assessed on various domain of HRQOL, using ANOVA and unpaired t-test. Logistic regression analysis was done to assess effect of MSDs and its variable on HRQOL. Presence of MSDs, extent of MSD (single or multiple), intensity and frequency of pain were taken as predictor and PCS, MCS, and well-being as response variable.

The general logistic regression model for p number of predictors is given by

$$= \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \dots + \beta_p x_p \quad \text{Eq (1)}$$

Where x denotes log odd ratio of second order domain of HRQOL, and $\beta_1, \beta_2, \dots$ etc. is regression coefficient for p variable of interest.

Equation (1) is used to formulate logistic models to examine the effect of presence of MSD, Type of MSD (single or multiple), intensity of pain/symptoms and frequency of symptoms on response variables, taken as second order domain of HRQOL (MCS, PCS and Well-being).

RESULTS

Descriptive analysis of demographic Characteristics of Light engineering Maintenance Personnel

Table 1: Demographic Characteristics of Light Engineering Maintenance Personnel

Personal Characteristics	n (%)	Mean (SD)
Age		
≤35 Years	39(23.78)	32.25(6.39)
> 35 Years	125(76.21)	
Marital Status		
Married	26 (15.85)	
Unmarried	138(84.14)	
Educational Qualification		
10+2	160 (42.41)	
Diploma	96 (25.32)	
Under Graduate	123(32.45)	
BMI (kg/m²)		
< 25	87 (53.08)	
25-29.99	71 (43.29)	27.30(2.06)
≥30	6 (3.65)	
Duration of Employment		
≤15 Years	135 (84.75)	
>15 Years	29 (17.68)	13.97(3.33)
Working Hours		
Up to 8	11(6.70)	
>8- 10	112(68.29)	9.70(1.62)
>10	41 (25)	
Shift Work		
Yes	109 (66.46)	
No	55 (33.53)	
Smoking		
Yes	84 (51.21)	
No	80 (13.12)	

MSD Prevalence

Single Versus Multiple WMSDs

Pain /symptoms in one body region were noted as single, while in one or more regions as multiple MSDs. In all, 73.45% light maintenance personnel reported MSDs, comprising of 43.82% as multiple MSDs and 29.62% as single MSDs. Prevalence of multiple MSDs (Table 2) was higher than Single MSDs among all job trades (64.44% vs. 44.44% in electrician, 47.91% vs. 19.79 % in telecom mechanics & 52.17% vs. 39.13% in instrument mechanics).

Table 2: Single Vs Multiple WMSDs in Various Job Trades of Light Engineering Maintenance Personnel

Job Trades (n)	Single WMSDs (%)	Multiple WMSDs (%)	Total WMSDs (%)
Electrician (45)	44.44	64.44	86.66
Telecom Mechanic (96)	19.79	47.91	67.70
Instrument Mechanic (23)	39.13	52.17	65.21
Total (164)	29.62	43.82	73.45

n : Number of Respondents in each category

Figure 1: Distribution of Single and Multiple WMSDs in Light Engineering Maintenance Defence Personnel.

Second Order Factors of HRQOL

Table 3 shows mean PCS, MCS and Well-being scores of HRQOL of personnel affecting with and without MSDs. It also details their score with respect to presence of type of MSDs (single or multiple), frequency and intensity of pain symptoms. All three, PCS, MCS, and well-being scores are negatively affected by the increase in frequency and severity of pain. PCS is more affected than MCS and Well-being.

Table 3: HRQOL Scores with Prevalence of MSDs, Frequency and Intensity of Pain

QOL Domain Parameters	PCS Mean (SD)	MCS Mean (SD)	Well Being Mean (SD)
Frequency of Pain			
Never	96.9 (4.1)	81.7 (3.9)	77.3 (5.8)
Rarely	82.9 (8.9)	81.4 (5.4)	75.7 (7.5)
Sometimes	77.3 (18.2)	77.8 (7.2)	75.3 (7.1)
Often	72.2 (18.5)	70.6 (9.3)	66.1 (10.4)
Very Often	67 (22.3)	63.7 (6.8)	65 (10.8)
Severity of Pain			
None	96.9 (4.1)	81.7 (3.9)	77.3 (5.8)
Mild	82.3 (14.9)	76.2 (11.9)	75.3 (8.1)
Moderate	74.3 (20.3)	71.8 (8.9)	68 (10.6)
Severe	69.2 (17.5)	71.4 (9.1)	68 (10.5)

Prevalence of MSDs

No MSDs	89.5 (17.77)	88.13 (4.33)	77.2 (5.7)
MSDs	65.1 (2.80)	72.59 (12.74)	69.4 (10.7)

Type of MSDs

Single MSDs	81.5 (13.6)	75.3 (11.2)	70.9 (10.3)
Multiple MSDs	68.9 (20)	69.1 (6.2)	68.1 (10.5)

Effect of MSD Prevalence on HRQOL

When first order domains of HRQOL were assessed, we found that all eight domains of HRQOL were negatively affected by presence of MSDs. All three second order factors (PCS, MCS Well-being) were also significantly affected in personnel suffering from MSDs. Even presence of MSDs at multiple sites affected all three second order factors of HRQOL, which was mainly due to negative effect of multiple MSDs on PF and MH. Other six first order factors of HRQOL (GH, BP, SF, VT, RP and RE) showed no significant difference between personnel affected with single or multiple MSDs (Table 4).

Table 4: Effect of MSDs Prevalence on HRQOL Domain

Effect of Prevalence of MSDs on HRQOL				Effect of Type of MSDs on HRQOL		
HRQOL	MSD Presence	Mean (SD)	t (p Value)	Type of MSDs	Mean (SD)	t (p Value)
GH	No MSDs	70.1 (6.6)	3.415	Single MSD	62.4 (15.4)	-.748
	MSDs	63.7 (17.1)	(0.001)*	Multi MSDs	64.7 (18.2)	(0.45)
BP	No MSDs	94.2 (7.2)	9.507	Single MSD	65.8 (26.6)	-.338
	MSDs	66.9 (29.1)	(0.000)*	Multi MSDs	67.6 (30.9)	(0.73)
SF	No MSDs	83.3 (13.8)	4.030	Single MSD	72.2 (9.8)	.495
	MSDs	71.1 (24.2)	(0.000)*	Multi MSDs	70.2 (30.7)	(0.62)
VT	No MSDs	84.4 (8.1)	6.183	Single MSD	73.7 (9.6)	-1.517
	MSDs	75.1 (8.7)	(0.000)*	Multi MSDs	76.2 (7.9)	(0.13)
MH	No MSDs	87.5 (6.2)	6.014	Single MSD	84.2 (13.1)	6.757
	MSDs	77.7 (14.6)	(0.000)*	Multi MSDs	68.6 (11.6)	(0.000)*
PF	No MSDs	96.7 (3.3)	14.703	Single MSD	78.2 (16.7)	6.919
	MSDs	63.6 (23.9)	(0.000)*	Multi MSDs	53.1(22.9)	(0.000)*
RP	No MSDs	97.2 (7.9)	9.629	Single MSD	63.5 (33.5)	-.825
	MSDs	66.3 (32.4)	(0.000)*	Multi MSDs	68.4 (31.6)	(0.41)
RE	No MSDs	88.1 (17.6)	4.606	Single MSD	64.6 (34.6)	-1.844
	MSDs	70.5 (30.1)	(0.000)*	Multi MSDs	74.8 (25.8)	(0.06)
PCS	No MSDs	89.5 (17.77)	14.521	Single MSD	81.5 (13.6)	9.938
	MSDs	65.1 (2.80)	(0.000)*	Multi MSDs	68.9 (20)	(0.000)*
MCS	No MSDs	88.13 (4.33)	11.643	Single MSD	75.3 (11.2)	11.611
	MSDs	72.59 (12.74)	(0.000)*	Multi MSDs	69.1 (6.2)	(0.000)*
Well Being	No MSDs	77.2 (5.7)	5.962	Single MSD	70.9 (10.3)	5.227
	MSDs	69.4 (10.7)	(0.000)*	Multi MSDs	68.1 (10.5)	(0.000)*

*Values indicates statistically significant 't' scores

Logistic Regression

We carried out logistic regression analysis on personnel, using prevalence of MSDs, Type of MSD, frequency and severity of pain as independent variable and scores of second order factors of HRQOL (PCS, MCS & Well-being) as dependent variable. We derived three models (M1 –M3) to explain the effect of independent variable on PCS, MCS and Well-being domain of HRQOL (as described in table 5).

While presence of MSDs, multiple MSDs, increase frequency and severity of pain symptoms negatively affected PCS, only increased frequency of pain could affect MCS. Other predictor variable had no significant impact on MCS. While considering overall well-being, the three predictor variables (presence of MSD, frequency and severity of pain) had a significant negative impact. Presence of multiple MSDs had no significant different effect on 'Well-being' over single MSD.

Table 5: Logistic Model Derived Significance of effect on HRQOL (N= 164)

Model	Parameters	Coefficient	P value	Adjusted R square
M ₁ (PCS)	Presence of MSDs (Y/ N)	.647	.000 *	0.555
	Single MSDs/ Multiple MSDs	-.431	.000 *	
	Frequency of Pain	-.653	.000 *	
	Severity of Pain	-.415	.000 *	
M ₂ (MCS)	Presence of MSDs (Yes/ No)	.267	.111	0.532
	Single MSDs/ Multiple MSDs	.065	.556	
	Frequency of Pain	-.835	.000 *	
	Severity of Pain	-.229	.019	
M ₃ (Well Being)	Presence of MSDs (Yes/ No)	.716	.000 *	0.324
	Single MSDs/ Multiple MSDs	-.024	.776	
	Frequency of Pain	-.655	.000 *	
	Severity of Pain	-.612	.000 *	

*Values indicates statistically significant β coefficient

DISCUSSION

This study brings out high prevalence of MSDs and its negative impact on HRQOL among light engineering defence maintenance personnel. The total frequency of occurrence of MSDs were reported to be 230 in 164 light maintenance personnel, making it 73.45 % prevalence of MSDs. Out of which, 43.82 % personnel reporting multiple MSDs and 29.62 reported single MSDs. We have previously reported that neck (44.44%) and shoulder (27.76%) MSDs were highest, followed by ankle/ foot (14.81%), Elbow/ forearm (12.96%), low back (11.72%) and wrist/ finger (9.87%)¹¹. Similar high prevalence of MSDs has been reported in industrial maintenance and telecommunication worker^{10,13}.

After a rigorous literature review, we found that most studies on defense personnel are only done on fighting arms and recruits, baring very few on maintenance personnel^{11,18}. These studies are mostly related to psychosocial stress or organizational issues²⁵⁻²⁹. Ours is the first study to relate HRQOL with MSDs in defense maintenance personnel.

Combat potential of defence forces use long range electro-optical equipment in combination with telecommunication interfaces, enabling remote operations^{30,31}. This professes the significant role of telecom, electrical and instrument

mechanics to provide all-round technical support. Apart from usual ergonomic stressors and organisational stressors, the continuously developing technology poses additional stresses like increase cognitive workload, precision and accuracy. All these are potential risk factors of MSDs in these personnel involved in light maintenance work. Since MSDs are associated with varying degree of pain and disability, it's bound to affect HRQOL.

Our Study revealed a negative relationship between presence of MSDs and HRQOL among light maintenance defence personnel. All three second order factor: PCS, MCS and wellbeing were negatively affected with presence of MSD, at multiple site. Increase in pain intensity and frequency further deteriorated PCS, MCS and Well-being scores³². On further break-up, we noted that just presence of MSDs affects all eight first order factors of HRQOL. Though defence personnel have physically active and mentally strong personality, PF and MH deteriorated with presence of MSDs at multiple site. Symptoms at multiple area is disabling, reducing once strength of doing regular work and activities of daily living. As defense personnel have comparatively higher physical demands in terms of fitness activities and professional work; their skeletal structure has higher load bearing requirement³³. This requirement is hampered with multiple MSDs and in-

creased symptoms. Inability to meet the physical demands of work and normal functioning could induce nervousness, sadness, and low confidence, affecting MH of these personnel³⁴. Our Logistic regression analysis further deduced that MCS: over all expression of mental health is primarily more affected by repetitive symptoms than intensity. This is probably because defence personnel usually have higher pain threshold and acceptance of bodily sufferings³⁵. We discussed the output of the studies with their senior officers. It emerged that defense organizational culture professes cheerfulness, increased vitality, and increased willingness to participate in physical and social activities. Despite varying degrees of difficulties, they are motivated to work, which is why the MCS, Role of Emotional Well Being (RE), Vitality (VT) and Mental Health (MH) scores of MSD affected personnel are even better than those of normal health Indian³⁴.

Measures and interventions directed towards reducing various risk factors associated with MSDs, will also aid in improving HRQOL of defence personnel, and in return will be beneficial to defence organisations. Therefore, we recommend authorities to screen MSDs and take timely actions, where needed. It should be included in their annual health check-ups. This will also help in imparting accurate intervention and avoid worsening symptoms; thereby maintaining optimum HRQOL.

Despite being a cross-sectional survey, covering wide borders of the country, only 164 light maintenance defense personnel were assessed; as their numbers are less as compared to other speciality. To the best of our knowledge, this is first study relating MSDs with HRQOL of Light engineering defense maintenance personnel.

CONCLUSION

We found a negative correlation between presence of MSDs and HRQOL of defense personnel, involved in light maintenance work. As severity and frequency of symptoms increases, there is further deterioration in HRQOL. Defense personnel have stronger mental health as compared to others and MSD affects PCS more than MCS. Poor HRQOL will affect worker's motivation at work and so is detrimental to any organization. Therefore, we recommend responsible authorities to conduct screening programs and include assessment of MSDs as part of annual medical check-ups. Periodic HRQOL assessment should be done to track the health status of every personnel. Where needed appropriate preventive and therapeutic interventions should be carried out. Experimental studies relating prevention, intervention and their benefit are also recommended.

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