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 intensity. 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 country. It is comorbidity having highest economic burden and accounts for 40% of the cost of work-related injuries. 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 wellbeing. 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 output. Economic growth and industrial development has shifted the focus towards working environment and wellbeing of workers. Ergonomics interventions have been suggested as proactive step to reduce MSDs and improve HRQOL.

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...
be responsible for development of musculoskeletal disorders (MSDs) in light engineering maintenance worker. Researchers have highlighted the presence of MSDs as overuse injuries in electricians, telecommunication workers, and similar jobs. 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 change.

Most relevant studies in the field, relating MSDs and HRQOL are reported on industrial workers, where heavy physical load and manual material handling is involved. 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 questionnaire was constructed into three parts: Part ‘A’. Bearing demographic and personnel details, Part ‘B’ as NMQ 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 criteria. 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 health. The three-second order factor was further calculated: Physical component score (PCS), Mental component score (MCS) and ‘Well-being’. 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 health. 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 pain). 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

\[ y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p \quad \text{Eq (1)} \]

Where x denotes log odd ratio of second order domain of HRQOL, and \( \beta_1, \beta_2 \ldots \) 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 ≤35Years             | 39 (23.78) | 32.25 (6.39) |
| Age > 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) |
| ≥30                      | 6 (3.65) |
| Duration of Employment   |       |
| ≤15 Years                | 135 (84.75) |
| >15 Years                | 29 (17.68) |
| Working Hours            |       |
| Up to 8                  | 11 (6.70) |
| >8–10                    | 142 (88.69) |
| >10                      | 1 (0.05) |
| Shift Work               |       |
| Yes                      | 109 (66.46) |
| No                       | 55 (33.53) |
| Smoking                  |       |
| Yes                      | 84 (51.21) |
| No                       | 80 (33.12) |

**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 |

**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 | Mean (SD) | Mean (SD) | Mean (SD) |
|-----------------------|-----------|-----------|-----------|
| PCS                   |           |           |           |
| 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)|

Table 4: Effect of MSDs Prevalence on HRQOL Domain

| HRQOL  | Effect of Prevalence of MSDs on HRQOL | Effect of Type of MSDs on HRQOL |
|--------|--------------------------------------|---------------------------------|
|        | Mean (SD) | t (p Value) | Mean (SD) | t (p Value) |
| GH     | No MSDs   | 70.1 (6.6) | 3.415 (0.001)* | Single MSD | 62.4 (15.4) | -748 |
|        | MSDs      | 63.7 (17.1) | (0.000)* | Multi MSDs | 64.7 (18.2) | (0.45) |
| BP     | No MSDs   | 94.2 (7.2) | 9.507 (0.000)* | 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 (0.000)* | 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 (0.000)* | 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 (0.000)* | 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 (0.000)* | 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 (0.000)* | 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 (0.000)* | 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 (17.7) | 14.521 (0.000)* | Single MSD | 81.5 (13.6) | 9.393 |
|        | MSDs      | 65.1 (28.0) | (0.000)* | Multi MSDs | 68.9 (20.0) | (0.000)* |
| MCS    | No MSDs   | 88.13 (4.33) | 11.643 (0.000)* | 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 (0.000)* | Single MSD | 70.9 (10.3) | 5.227 |
|        | MSDs      | 69.4 (10.7) | (0.000)* | Multi MSDs | 68.1 (10.5) | (0.000)* |

*Values indicate 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).

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

| Model  | Parameters                          | Coefficient | P value | Adjusted R square |
|--------|-------------------------------------|-------------|---------|-------------------|
| M1     | Presence of MSDs (Y/ N)             | .647        | .000 *  | 0.555             |
| (PCS)  | Single MSDs/ Multiple MSDs          | -.431       | .000 *  |                   |
|        | Frequency of Pain                   | -.653       | .000 *  |                   |
|        | Severity of Pain                    | -.415       | .000 *  |                   |
| M2     | Presence of MSDs (Yes/ No)          | .267        | .111    | 0.532             |
| (MCS)  | Single MSDs/ Multiple MSDs          | .065        | .556    |                   |
|        | Frequency of Pain                   | -.835       | .000 *  |                   |
|        | Severity of Pain                    | -.229       | .019    |                   |
| M3     | Presence of MSDs (Yes/ No)          | .716        | .000 *  | 0.324             |
| (Well Being) | Single MSDs/ Multiple MSDs   | -.024       | .776    |                   |
|        | Frequency of Pain                   | -.695       | .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 in164 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 worker10,13. Ours is the first study to relate HRQOL with MSDs in defense maintenance personnel.

After a rigorous literature review, we found that most studies on defense personnel are only done on fighting arms and recruits, barin very few on maintenance personnel11,18. These studies are mostly related to psychosocial stress or organizational issues 25-29. 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 operations30,31. 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 MSD 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 requirement13. 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 personnel\textsuperscript{15}. 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 sufferings\textsuperscript{15}. 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 Indian\textsuperscript{14}. 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.

**Acknowledgement:** We express our sincere thanks to respondents and supervisors for their support and help in data recording. We express our gratitude to senior defense officer, colleagues and mentors for their guidance throughout the research.

**Conflict of interest:** None

**Financial support:** None

**REFERENCES**

1. Doeа GS, Oliveira CC da C, Lima SO. Musculoskeletal symptomatology and quality of life of patients with work-related musculoskeletal disorders. Esc Anna Nery - Rev Enferm. 2016;20(4):1–9.
2. De Carvalho MP, Schmidt LG, Soares MCF. Musculoskeletal disorders and their influence on the quality of life of the dockworker: A cross-sectional study. Work. 2016;53(4):805–12.
3. Da Costa JT, Baptista JS, Vaz M. Incidence and prevalence of upper-limb work related musculoskeletal disorders: A systematic review. Work. 2015;51(4):635–44.
4. Bhattacharya A. Costs of occupational musculoskeletal disorders (MSDs) in the United States. Int J Ind Ergon. 2014;44(3):448–54.
5. Yasobant S, Rajkumar P. Work-related musculoskeletal disorders among health care professionals: A cross-sectional assessment of risk factors in a tertiary hospital, India. Indian J Occup Environ Med. 2014;18(2):75.
6. Morken T, Riise T, Moen BE. Frequent Musculoskeletal Disorders and Health Related Quality of Life – A Prospective Study. 2002;
7. Deokju Kim, Soohee Park, Dongjoo Yang, Milim Cho, Chanuk Yoo, Juhyung Park, Jajeop Chung, Eun Mi Choi, KyungHae Han YY. The relationship between obesity and health-related quality of life of office workers. J Phys Ther Sci. 2015;27(1):663–6.
8. Kushwaha P, Deepak K PVK. Ergonomic assessment and workstation design of shipping crane cabin in steel industry. Int J Ind Ergon. 2016;52:29–39.
9. Pandey V, Chakraborty T, Mukhopadhyay S. Prevalence of musculoskeletal disorders , levels of physical activity and perceived quality of life amongst construction site managers in Mumbai : A case study. 2012;43:447–51.
10. Crawford, L, S, Mcmillan. Musculoskeletal disorders within the telecommunications sector — A systematic review. Int J Ind Erg. 2008;38:56–72.
11. Roli Dave, Ali Irani VN. Work Related Musculoskeletal Disorders in Electrical, Telecommunication and Instrument Mechanics of Armed forces. Int J Occup Saf Heal. 2020;10(1):18–27.
12. Kristy N. Carlisl AWP. Psychological Distress and Pain Reporting in Australian Coal Miners. Saf Health Work. 2014;5(4):203–9.
13. T. Morken, B. Moen, T. Riise, O. Bergum, L. Bua, S. H. Vigeland Hauge, f S. Holien, A. Langedrag, H.-O. Olson, S. Pedersen, I. L. Liehjell Saue f GMS and VT. Prevalence of musculoskeletal symptoms among aluminium workers. Occup Med (Chic Ill). 2000;50(6):414–21.
14. Meksawi S, Tangtrakulwanich B, Chongsuvivatwong V. International Journal of Industrial Ergonomics Musculoskeletal problems and ergonomic risk assessment in rubber tappers : A community-based study in southern Thailand. Int J Ind Ergon [Internet]. 2012;42(1):129–35.
15. Oliveira A, Nogueira, H, Diniz A BD. Psychosocial indicators among aircraft maintenance workers with and without neck and shoulder musculoskeletal symptoms. Work. 2012;41:5699–701.
16. Jun-ming Lu, Li-jen Twu, Mao-jiun J Wang. International Jour-
nal of Industrial Ergonomics Risk assessments of work-related musculoskeletal disorders among the TFT-LCD manufacturing operators. Int J Ind Ergon. 2016;52:40–51.

17. Punnett L, Wegman DH. Work-related musculoskeletal disorders: The epidemiologic evidence and the debate. J Electromyogr Kinesiol. 2004;14(1):13–23.

18. Roli Dave, Ali Irani VN, Neekhra. Work Related Musculoskeletal Disorders in Defence Personnel Involved in Heavy Engineering Maintenance. Int J Ind Ergon. 2016;52:40–51.

19. Kuorinka I, Jonsson B, Vinterberg H, Biering-Sørensen F, Andersson G, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon. 1987;18(3):233–7.

20. Choi WJ, Kang YJ, Kim JY, Han SH. Symptom prevalence of musculoskeletal disorders and the effects of prior acute injury among aging male steelworkers. J Occup Health. 2009;51(3):273–82.

21. Hays RD, Sherbourne CD, Mazel RM. The rand 36 item health survey 1.0. Health Econ. 1993;2(3):217–27.

22. Anagnostopoulos F, Niakas D, Pappa E. Construct validation of the Greek SF-36 Health Survey. Qual Life Res. 2005;14(8):1959–65.

23. Lins L, Carvalho FM. SF-36 total score as a single measure of health-related quality of life: Scoping review. SAGE Open Med. 2016;4:205031211667172.

24. Gallach CH. The measurement of musculoskeletal pain intensity: a comparison of four methods. 2007;(July 2014).

25. Sharma S. Occupational stress in the armed forces: An Indian army perspective. IIMB Manag Rev [Internet]. 2015;27(3):185–95.

26. Fredric Gerr, Nathan B, Fethke, Dan Anton, Linda Merlino, John Rosecrance, Michele Marcus, Emory University, Atlanta, Georgia MPJ. A Prospective Study of Musculoskeletal Outcomes Among Manufacturing Workers: II. Effects of Psychosocial Stress and Work Organization Factors. Hum Factors Ergon Soc. 2013;56(1):178–90.

27. Knapijk JJ, Sharp MA, Canham-Chervak M, Hauret K, Patton JF, Jones BH. Risk factors for training-related injuries among men and women in basic combat training. Med Sci Sports Exerc. 2001;33(6):946–54.

28. Swedler DI, Knapijk JJ, Williams KW, Grier TL, Jones BH. Risk Factors for Medical Discharge From United States Army Basic Combat Training. Mil Med. 2013;176(10):1104–10.

29. Yancosek KE, Roy T, Erickson M. Rehabilitation programs for musculoskeletal injuries in military personnel. Curr Opin Rheumatol [Internet]. 2012;24(2):232–6. Project.sente6lib/Contents/Attachments/Yancosek/2012/Rehabilitation programs for musculoskeletal injury.

30. Hauret KG, Jones BH, Bullock SH, Canham-Chervak M, Canada S. Musculoskeletal injuries description of an under-recognized injury problem among military personnel. Am J Prev Med [Internet]. 2010;38(1 Suppl):S61-70. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20117601

31. Mattila VM, Parkkari J, Korpela H, Pihlajamäki H. Hospitalisation for injuries among Finnish conscripts in 1990-1999. Accid Anal Prev. 2006;38(1 Suppl):S61-70. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20117601

32. Nye NS, Pawlak MT, Webber BJ, Tchandja JN, Milner MR. Description and rate of musculoskeletal injuries in air force basic military trainees, 2012-2014. J Athl Train. 2016;51(11):858–65.

33. Lanyon LE. Functional strain in bone tissue as an objective, and controlling stimulus for adaptive bone remodelling. J Biomech. 1987;20(11–12):1083–93.

34. Agrawal R, Silva CD’. Assessment of Quality of Life in Normal Individuals Using the SF-36 Questionnaire. Int J Cur Res Rev. 2017;9(3).

35. Luncheon C, Zack M. Health-Related Quality of Life Among US Veterans and Civilians by Race and Ethnicity. Prev Chronic Dis. 2012;9(6):1–8.