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### Prevalence of Musculoskeletal Disorders (MSDs) among workers in Pump Manufacturing Industry

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**Abstract-** This study aims to quantify the prevalence of work-related musculoskeletal disorders (MSDs) and risks among workers in pump manufacturing industry. Workers from pump manufacturing industry were mostly affected by musculoskeletal injury and prolonged work nature and poor workplace environment. Data were collected with the help of the Nordic musculoskeletal questionnaire and by direct observations. The statistical analysis carried out reveals that 67.39% of pump manufacturing industry workers reported MSDs. The highest prevalence rate has been found in the feet (48.26%). In total, 46 workers from different age, experience workers were considered for this study. Age, experience, marital status, stress in the job were the risk factors which significantly ( $p < 0.05$ ) associated with the reported MSDs. Among the different factor for getting fatigue, the workers reported with the maximum discomfort during work at awkward posture (60.9%) with Odds ratio as 9.486 and 95% CI is 2.277-39.036. Socio-demographic factors, awkward posture and repetitive movements contribute to cause MSD among pump manufacturing workers. Results suggest that to undertake further studies on different preventive measures and ergonomics intervention to reduce the risks of LBP among workers in pump manufacturing industry.

**Keywords-** work-related musculoskeletal disorders, risk factors, occupational disorders, pump manufacturing workers, ergonomics.

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#### I. INTRODUCTION

Musculoskeletal disorders (MSDs) are an important public health problem in both developed and developing countries, with substantial impact on quality of life and a substantial economic burden in compensation costs, lost wages and productivity. Psychosocial demands have also been identified as possible risk factors for MSDs. Non-occupational factors such as obesity, sports activities and gender have also been associated with MSDs, but the findings of previous studies have been inconsistent. The aim of this study was to identify the factors associated with MSDs among workers who were employed in pump manufacturing industry [1]. Musculoskeletal disorders (MSDs) can affect the body's muscles, joints, tendons, ligaments and nerves. Most work-related MSDs develop over time and are caused either by the work itself or by the employees working environment [2]. MSDs are put into different categories according to pain location. Most work-related MSDs develop over time and are caused either by the work itself or by the employees working environment.

The severity of MSD can vary. MSDs are extremely common and increases with age. Work is important in lives of men and women; nonetheless, it can become a health hazard when it is carried out in an inappropriate way [3]. During working hours, industrial workers are exposed to a number of physical tasks that create fatigue, pain, and discomfort, leading to musculoskeletal disorders (MSDs). In order to cope with the intense competition, complex products requiring the assembly of several components are being produced by manufacturing industries [4].

The International Labour Organization (ILO) and the World Health Organization (WHO) regard MSDs as a work related disease, which is also referred to as a “new epidemic” that should be researched and solved. MSDs have a huge impact on work-related absence and a high proportion of days lost is due to MSDs [6]. These factors place stress on muscles and joints, affect the soft tissues of the neck, shoulder, elbow, hand and wrist [10]. The objective measures such as heart rate, electromyography (EMG) and pressure distribution. The RULA technique is a subjective measure has been widely used to assess postural effect on individual body parts [12]. Employers are mostly from the rural areas and unaware of an ergonomic working environment, workstation design and working postures. Due to the poor ergonomic workplace design and the risk factors such as repetitive movement for both upper and lower extremities, awkward posture led to severe pain on shoulder muscles, knee and ankle/foot and low back region for the workers India in order to investigate the work-related MSD and its associated risk factors using the Nordic based Questionnaire. In addition, the Odds ratio is used to describe the probability of each category risk factor to cause MSD among pump manufacturing industry [13]. The Statistical Package for the Social Sciences software, version 1.0 (IBM, SPSS, Chicago, Illinois, USA) was used for entry and analysis of the collected data. Descriptive statistics were presented as numbers and percentages for categorical data. Univariate and multivariable logistic regression were used to calculate the odds ratios (ORs) and antecedent 95% confidence intervals (95% CIs) for the independent factors for LBP among pump manufacturing industry in the study. In the multivariable analysis, age and BMI were handled as continuous variables, while other categorical variables were dichotomized. All variables were included in the multivariable analysis [18]. Other than the occupational risk factors, several factors like smoking, education and other individual factors such as age, sex, physical fitness, body mass index (BMI), strength, motor control were associated with the occurrence of LBP. The study is confined to a limited strength of 46 pump manufacturing industry workers under the age groups from 18 to 71. The number of workers was 46 people in total and the purpose of the study and its benefits were explained to those involved in this study [19]. The statistical analysis carried out reveals that 67.39% of pump manufacturing industry workers reported MSDs. In total, 46 workers from different age, experience workers were considered for this study. Age, experience, marital status, stress in the job were the risk factors which significantly ( $p < 0.05$ ) associated with the reported MSDs. Among the different factor for getting fatigue, the workers reported with the maximum discomfort during work at awkward posture (60.9%) with Odds ratio as 9.486 and 95% CI is 2.277-39.036. The study also investigates the association between the personal characteristics, physical workload, psychosocial factors and workplace characteristics with complaints of the lower back, upper back, shoulder, neck, hand/wrist, thigh, knee and foot among pump manufacturing industry [21].

## II. METHODS

### 2.1 Workplace

This study was conducted among pump manufacturing industry workers located in Coimbatore in the state of Tamil Nadu, India. Observations were carried out during the study period regarding the working environment, work nature and risk factors. The workplace comprises various manufacturing sections like winding, machining, painting, inspection and assembly, etc.

### 2.2 Participants

The study is confined to a limited strength of 46 pump manufacturing industry under the age groups from 18 to 71. The number of workers was 46 people in total and the purpose of the study and its benefits were explained to those involved in this study. All are full-time workers performing pump manufacturing and assembly for at least 7 h/day. The managers and other office workers belonging to pump manufacturing industry were excluded from this study because they do not have a heavy or more physical workload.

### 2.3 Data Collection

Data was collected using the Nordic based Questionnaire specifically designed for the current study. The questionnaire consists of information on worker background, psychological, illness history and other work-related information. Worker background includes age, gender, marital status, work experience, alcohol and tobacco consumption status. Psychological questions like job satisfaction and job stress; work-related information like working hours, rest time, repetitive motion (for upper and lower extremities, lower back), and awkward posture (for upper and lower extremities, lower back) were also included. The questionnaire also analyzes about the frequency of pain distribution in overall anatomical sites such as the neck, shoulder, upper and lower back, upper and lower extremities. In work related section, questions such as frequencies of repetitive motion for upper and lower extremities, and the current work activity that involves awkward posture for anatomical sites and its frequencies are recorded as well. This survey was performed in the month of January 2019. In this study, data are collected with a set of questionnaires and by direct observations. The risk factors are studied through direct observation during working hours. Participants about their work. They were asked to choose any one from the following choices: low, moderate and high. Finally, subjects were asked to quantify the overall discomfort in body regions with regard to the assessment values. The data collections and investigations are carried out only for the pump manufacturing industry (n = 46).

### 2.4 Data Analysis

The statistical analyses were performed using  $\chi^2$  tests and 95% confidence intervals (CI).  $X^2$  tests were used to assess the relationship between sociodemographic and workplace factors (independent variables) and reported musculoskeletal complaints (dependent variable). Prevalence (%) and 95% CI were used to find the prevalence of musculoskeletal pain in different anatomical sites by age group and years of work experience. The data examined are from various anatomical sites including the neck, shoulder, upper/lower back, upper/lower, wrist, hips and knee/foot. So, to analyze it better, the age and experience group is considered in the present study. All the statistical analysis with frequency distributions of respondent, psychosocial factors and the prevalence of MSD were carried out using SPSS v1.0 software package. Descriptive statistics were determined for demographic, occupational and health characteristics of the study population. The prevalence of MSD was evaluated for all three categories of kitchen workers. The Odds ratio and 95% confidence intervals were evaluated using Binary Logistic regression analysis to determine the association of MSD with independent variables like personal factors, health factors and work-related factors of all three work categories.

### III. RESULTS

The study sample consisted of 46 pump manufacturing industry workers. The majority of them belonged to the  $\leq 25$  age group (65.21%). The vast majority (80.43%) of them had an above high school education. Nearly (69.56%) of them were unmarried. It was found that 91.3% of them had good health unfortunately 39.13% of workers only were involved in playing outdoor games and exercises in the institutional playground after work. The BMI status depicts that 19.56 % are underweight, 77.73% are normal and 8.7% are overweight **Table 1**.

Nearly (38.7%) half of the participants had low back pain during the previous 3 months, while the prevalence of pain in the legs, knee, lower back and wrists were 16.1%, 15.7%, 14.4%, and 12.3% respectively. Specifically this current study focused on low back region because of its highest prevalence and discomfort during work. The socio-demographic characteristics of the kitchen workers were summarized in **Table 1**. Among the study population; no one was involved in whole body vibration (WBV). There was significant difference ( $p < 0.005$ ) between groups in awkward posture. The various factors like age, education, marital status, exercise/ games activities, stress due to work and getting tired at work.

Cigarette smoking and current health status was reported as not significant. **Table 2** identifies the results of risk factors that Associated MSD. The odds ratio and 95% CI (Confidence Interval) reported perfect association between reported MSD and other factors. Regarding health factor, it was identified that awkward posture among pump manufacturing industry workers had a higher OR and it reports the increase in risk of developing MSD (OR = 9.486; 95% CI = 2.277-39.036) and reported that it was significant associated with MSD. High level of during pump manufacturing operation was the second contributing factor to the MSD Excessive forces during pump manufacturing operation were reported as third contributing factor to MSD as shown in **Table 2**.

The Odds ratio (OR) represents the probability of MSD occurrence comparing to the reference groups. The confidence interval (95%CI) represents the interval level (maximum and minimum). This infers that the probability of causing MSD increases with increase in age ( $p < 0.005$ ). BMI had a significant effect on the reported MSD.

**Table 1.**

Relationship between the sociodemographic, health and workplace factors and reported musculoskeletal disorders (MSDs) ( $n = 46$ )

		n(46)	MSD Yes(31)	MSD No(15)	Chi.sq. value	DoF	P value
Age	<25	30	22	8	1.390	2	0.499
	26-45	7	4	3			
	>45	9	5	4			
Education	Primary	1	1	0	0.954	3	0.812
	Intermediate	3	2	1			
	High school	5	4	1			
	Above high school	37	24	13			
BMI	Underweight	9	7	2	1.000	2	0.606
	Normal	33	22	11			
	Overweight	4	2	2			
Marital	Single	32	21	11	0.149	1	0.699
	Married	14	10	4			
Smoking	Yes	7	6	1	1.261	1	0.261
	No	39	25	14			
Exercise	Yes	18	10	8	1.885	1	0.170
	No	28	21	7			
Health status	Good	42	28	14	0.115	2	0.734
	Average	4	3	1			
	Bad	0	0	0			
Level of stress	Low	28	21	7	3.372	2	0.185
	Moderate	17	10	7			
	High	1	0	1			
Tired	Yes	28	21	7	1.885	1	0.170
	No	18	10	8			
Experience	<5	31	22	9	0.629	2	0.730
	5-10	3	2	1			
	>10	12	7	5			
Satisfaction	Low	23	15	8	0.836	2	0.659
	Moderate	13	10	3			
	High	10	6	4			
Micro breaking	Yes	46	31	15	-	1	0.726
	No	0	0	0			
Repetitive work	Yes	16	11	5	0.021	1	0.886
	No	30	20	10			
Awkward posture	Yes	28	24	4	10.932	1	<0.005
	No	18	7	11			
Excessive force	Yes	22	18	4	3.994	1	0.046
	No	24	13	11			
Elbow pain	Yes	18	11	7	0.531	1	0.466
	No	28	20	8			
Shoulder pain	Yes	18	12	6	0.007	1	0.933
	No	28	19	9			

**Table 2.**

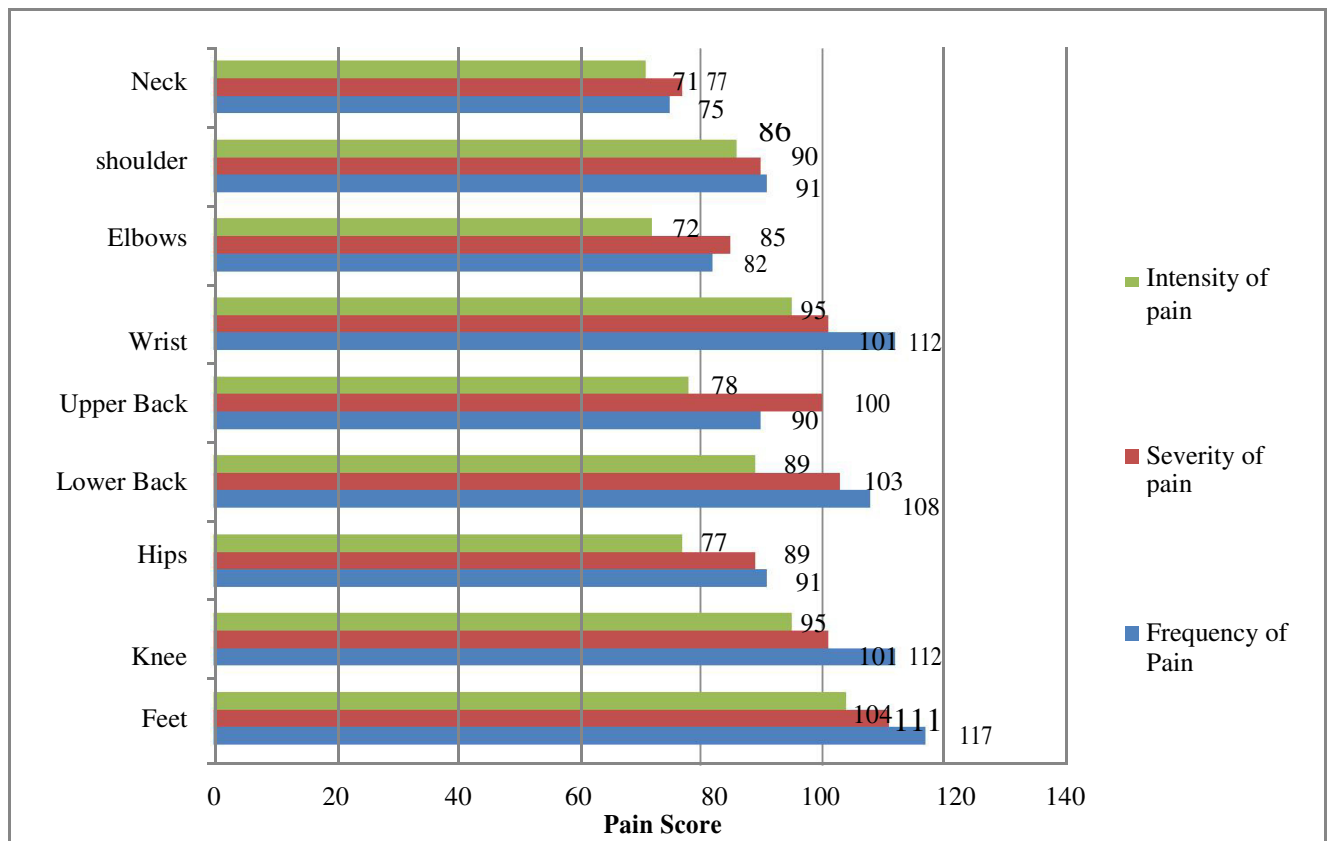
Factors associated with WMSDs of pump manufacturing workers and OR, 95% CI of reported MSD ( $n = 46$ )

		n(46)	MSD Yes(31)	MSD No(15)	OR	95% CI
Age	<25	30	22	8	Ref	
	26-45	7	4	3	2.062	0.376 - 11.309
	>45	9	5	4	2.200	0.469-10.301
Education	Primary	1	1	0	Ref	
	Intermediate	3	2	1	1.800	0.040- 79.429
	High school	5	4	1	1.000	0.024 - 40.278
	Above high school	37	24	13	1.653	0.062 - 43.445
BMI	Underweight	9	7	2	Ref	
	Normal	33	22	11	1.750	0.310- 9.872
	Overweight	4	2	2	3.500	0.283- 43.162
Marital	Single	32	21	11	Ref	
	Married	14	10	4	0.763	0.194- 3.005
Smoking	Yes	7	6	1	Ref	
	No	39	25	14	3.360	0.366- 30.808
Exercise	Yes	18	10	8	Ref	
	No	28	21	7	0.416	0.117- 1.473
Health status	Good	42	28	14	Ref	
	Average	4	3	1	0.285	0.031- 2.556
	Bad	0	0	0	3.800	0.069- 207.820
Level of stress	Low	28	21	7	Ref	
	Moderate	17	10	7	2.100	0.577-7.630
	High	1	0	1	8.600	0.315- 234.767
Tired	Yes	28	21	7	Ref	
	No	18	10	8	2.400	0.678- 8.489
Experience	<5	31	22	9	Ref	
	5-10	3	2	1	1.222	0.098- 15.231
	>10	12	7	5	1.746	0.437- 6.976
Satisfaction	Low	23	15	8	Ref	
	Moderate	13	10	3	0.562	0.119- 2.648
	High	10	6	4	1.250	0.271- 5.765
Micro breaking	Yes	46	31	15	Ref	
	No	0	0	0	2.032	0.038- 107.343
Repetitive work	Yes	16	11	5	Ref	
	No	30	20	10	1.100	0.299- 4.042
Awkward posture	Yes	28	24	4	Ref	
	No	18	7	11	9.428	2.277- 39.036
Excessive force	Yes	22	18	4	Ref	
	No	24	13	11	3.807	0.988- 14.666
Elbow pain	Yes	18	11	7	Ref	
	No	28	20	8	0.6286	0.179- 2.200
Shoulder pain	Yes	18	12	6	Ref	
	No	28	19	9	0.947	0.268-3.342



#### IV. DISCUSSIONS

This study investigates the risk factors associated with the work and the work-related musculoskeletal disorders caused for the individuals who work in the pump manufacturing industries in Tamil Nadu, India. Few previous studies such as HSP workers, women rebar workers, sugarcane farmers, and mine workers had demonstrated that these groups of workers are prone to MSD. The current study, results infer that 67.39% of workers are prone to MSD.



**Figure 1.** Comparison of pain score levels by body region among three categories of work in the pump manufacturing industries.

This finding was higher than the prevalence of MSD among HSP workers (62.5%) women rebar workers (57.7%) and underground mine workers in Zambia (42.6%) However, it is lower than the prevalence of MSDs among sugarcane farmers (88.70%) in Thailand home-based garment workers of 76.7% [21]. This variation might be due to the different workstation, work environment and tools used. Further, examination of HSP worker towards the pain prevalence spread in various anatomical sites infer that foot pain score was highest with 48.11%, wrist region 44.63%, knees of 44.01% , lower back pain score of 43.47%, upper back pain score 38.84%, shoulder region of 38.69%, hip pain score of 37.24%, elbow pain of 34.63% and neck region 32.31%. Current study results are in-line with the previous finding where, it was reported that severe flexion and bending was found to be significantly related to lower back pain. In addition, National Institute for Occupational Safety and Health review reported that there was a strong association between the low back disorders and the awkward postures. Thus, it is evident that pump manufacturing workers have high foot pain due to the awkward standing posture task that demands the monotonous and repetitive flexion.

## V. CONCLUSIONS

The present study concludes that discomfort regions were identified among the pump manufacturing industries workers with a higher prevalence ratio of discomfort level at the foot region and the wrist region. The NMQ and statistical analysis methods provide quite correct and appropriate validation. Thus the pump manufacturing industries workers participating in this research were found to have both MSDs and ergonomic risks, which do not appear to interfere with job performance or daily life. Still, it is suggested that ergonomic studies and engineering controls should be used to reduce WMSDs and discomfort levels among pump manufacturing industries workers in South India. Also the study should extend to collect fatigue level of discomfort region by Electromyography (EMG).

## VI. REFERENCES

- [1] Fernandes, R.D.C.P., Assunção, A.Á., Silvany Neto, A.M. and Carvalho, F.M., Musculoskeletal disorders among workers in plastic manufacturing plants. *Revista brasileira de epidemiologia*, 13(1), pp.11-20, 2010.
- [2] Buddhadev, N.P., Work-related musculoskeletal disorders: a survey of physiotherapists in Saurashtra region. *Age (years)*, 21(25), pp.27-5, 2012.
- [3] Vaghela, N.P. and Parekh, S.K., Prevalence of the musculoskeletal disorder among school teachers. *National Journal of Physiology, Pharmacy and Pharmacology*, 8(2), pp.197-201, 2018.
- [4] Nur, N.M., Dawal, S.Z. and Dahari, M., The prevalence of work related musculoskeletal disorders among workers performing industrial repetitive tasks in the automotive manufacturing companies. In *Proceedings of the 2014 International conference on industrial engineering and operations management*, Bali, Indonesia, 2014, January
- [5] Binoosh, S.A., Mohan, G.M. and Bijulal, D., Assessment and prediction of industrial workers' fatigue in an overhead assembly job. *South African Journal of Industrial Engineering*, 28(1), pp.164-175, 2017.
- [6] Luan, H.D., Hai, N.T., Xanh, P.T., Giang, H.T., Van Thuc, P., Hong, N.M. and Khue, P.M., Musculoskeletal Disorders: Prevalence and Associated Factors among District Hospital Nurses in Haiphong, Vietnam. *BioMed research international*, 2018.
- [7] Sealetsa, O.J. and Moalosi, R., A Survey of Musculoskeletal Disorder Prevalence in the Kiln Brick Molding Industry in Botswana. *J Ergonomics*, 4(10), pp.S4-010, 2014.
- [8] Briggs, A.M., Woolf, A.D., Dreinhöfer, K., Homb, N., Hoy, D.G., Kopansky-Giles, D., Åkesson, K. and March, L., Reducing the global burden of musculoskeletal conditions. *Bulletin of the World Health Organization*, 96(5), p.366, 2018.
- [9] N Saran Kumar, N Kaleeswaran, B Radha Krishnan, "Review on optimization parametrs in Abrasive Jet Machining process" , *International Journal of Recent Trends in Engineering and Research*, Volume 04, Issue 10; October- 2018 [ISSN: 2455-1457]. DOI:10.23883/IJRTER.2018.4388.HTNOQ
- [10] Bernard, B.P. and Putz-Anderson, V., *Musculoskeletal disorders and workplace factors; a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back*, 1997.
- [11] Vyas, R., Ergonomic assessment of prevalence of musculoskeletal disorders among Indian agricultural workers. *Journal of Ergonomics S*, 4, 2014.



- [12] Prasath, K. Arun, B. Radha Krishnan, and Corresponding K. Arun. "Mechanical properties of woven fabric Basalt/jute fibre reinforced polymer hybrid composites." *Int. J. Mech. Eng* 2, no. 4 (2013): 279-290.
- [13] March, L., Hoy, D., Smith, E., Buchbinder, R., Cross, M., Brooks, P., Vos, T. and Woolf, A.D., Global and Country Specific Burden Of Musculoskeletal Disorders: a Report From The Global Burden Of Diseases Musculoskeletal Expert Group. In *Arthritis and Rheumatism* (Vol. 65, No. S10, pp. S34-S34). John Wiley and Sons Inc, 2013, January.
- [14] Basahel, A.M., Investigation of work-related Musculoskeletal Disorders (MSDs) in warehouse workers in Saudi Arabia. *Procedia Manufacturing*, 3, pp.4643-4649, 2015.
- [15] Shankar, S., Naveen Kumar, R., Mohankumar, P. and Jayaraman, S., Prevalence of work-related musculoskeletal injuries among South Indian hand screen-printing workers. *Work*, 58(2), pp.163-172, 2017.
- [16] Darragh, A.R., Huddleston, W. and King, P., Work-related musculoskeletal injuries and disorders among occupational and physical therapists. *American Journal of Occupational Therapy*, 63(3), pp.351-362, 2009.
- [17] Sharma, R., *Epidemiology of musculoskeletal conditions in India*. New Delhi, India: Indian Council of Medical Research (ICMR), 2012.
- [18] Gupta, G. and Tarique, A., Prevalence of Musculoskeletal Disorders in Farmers of Kanpur-Rural, India. *Journal of Community Medicine & Health Education*, 3(07), p.249, 2013.
- [19] Punnett, L. and Wegman, D.H., Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *Journal of electromyography and kinesiology*, 14(1), pp.13-23, 2004.
- [20] Alnaami, I., Awadalla, N.J., Alkhairy, M., Alburidy, S., Alqarni, A., Algarni, A., Alshehri, R., Amrah, B., Alasmari, M. and Mahfouz, A.A., Prevalence and factors associated with low back pain among health care workers in southwestern Saudi Arabia. *BMC Musculoskeletal Disorders*, 20(1), p.56, 2019.
- [21] Shankar, S., Shanmugam, M. and Srinivasan, J., Workplace factors and prevalence of low back pain among male commercial kitchen workers. *Journal of back and musculoskeletal rehabilitation*, 28(3), pp.481-488, 2015.
- [22] Hoy, D., March, L., Brooks, P., Blyth, F., Woolf, A., Bain, C., Williams, G., Smith, E., Vos, T., Barendregt, J. and Murray, C., The global burden of low back pain: estimates from the Global Burden of Disease 2010 study. *Annals of the rheumatic diseases*, 73(6), pp.968-974, 2014.
- [23] Subramaniam, S. and Murugesan, S., Investigation of work-related musculoskeletal disorders among male kitchen workers in South India. *International Journal of Occupational Safety and Ergonomics*, 21(4), pp.524-531, 2015.
- [24] Cromie, J.E., Robertson, V.J. and Best, M.O., Work-related musculoskeletal disorders in physical therapists: prevalence, severity, risks, and responses. *Physical therapy*, 80(4), pp.336-351, 2000.

