Postural Assessment and Risk Evaluation of Workers among Selected Textile Industries in Lagos, Nigeria

ABSTRACT

Textile industry workers specifically Nigerians often encounter health challenges associated with Work-Related Musculoskeletal Disorders (WRMSDs) stemming from factors like uncomfortable postures, repetitive tasks, prolonged sitting or standing, and inadequate workplace design. This study evaluated the risk level of workers associated with working postures for selected textile industries in Lagos, Nigeria. Five textile manufacturing companies were randomly selected in Lagos State. Standard nordic questionnaires were administered to workers to assess their demography and musculoskeletal issues such as fatigue, stress, back pain, headache, and dissatisfaction. The working postures (neck, trunk, leg, upper arm, lower arm, and wrist positions) of the selected workers were obtained from the pictures captured during engagements on different factory operations. These positions were used to obtain Rapid Entire Body Assessment (REBA) scores and the associated risk levels utilizing the REBA Employee Assessment Worksheet. Based on WRMSDs, the data revealed that 88% of workers suffer from fatigue, 45% experience stress, 73% report back pain, 75% suffer from headaches, and 34% of workers are dissatisfied with their working environment. Analysis of the workers' physical environment showed that 55% are exposed to excessive heat, 71% are subjected to noise and dust, and nearly half (48%) are involved in manual materials handling. A large number of workers in the five selected textile manufacturing industries face significant risks of musculoskeletal disorders.

Keywords: *Work-related musculoskeletal disorders, Textile industry, Rapid entire body assessment, Ergonomics, Occupational safety and health.*

1. INTRODUCTION

Ergonomics is the study of the interaction between people and machines/tools and the factors that affect the interaction [1]. Its purpose is to improve the performance of systems by improving human-machine/tool interaction [2]. Ergonomics research has been proven to provide benefits in improving human conformance and effectiveness when using tools, such as the foot pedal used by surgeons [3]. Ergonomics seeks to minimize the adverse effects of the environment on people and thus enables each person to maximize his/her contribution to a given job [4,5].

The occupational health and safety seeks to sustain the working capacity of the work force as well as to identify, assess, and avoid risks and hazards within the work environment [6]. Ergonomics, as described above, combines all these issues to improve worker competence, health, and safety and maintain industrial production through better design of the work place [7]. WRMSDs are a leading cause of occupational health-related issues for the worker [8]. WRMSDs can be described as the disorders of the tendons, muscles, nerves, and joints associated with exposure to work risk factors, further resulting in pain discomfort, and functional impairment [9].

Industrial workers such as textile workers, are subjected to higher risks and discomfort due to prolonged hours of work and unnatural postures [10]. Scholarly studies have suggested that one of the worst aspects of sewing machine operations in the textile manufacturing industry is the body posture operators are forced to assume throughout the workday [11]. Several factors such as repetition, force, contact stress, vibrations, and environment, contribute to injury and discomfort in an industrial environment. Industrial work is visually demanding and needs a high degree of accuracy and concentration [12].

In the textile industry, the major risks generally do not arise from direct dangerous hazards, instead, the real risk is hidden in indirect hazards that affect over time due to repetitive jobs [13]. The problems often begin as minor pains, but then they can turn into incapacitating disorders that affect the daily life standards of the workers [14]. Ergonomics aims to prevent these types of problems by controlling the risk factors, such as vibration, repetition, working environment, force, and posture before the occurrence of disorders [15]. Therefore, the number of ergonomics risk assessment studies in this industry has significantly increased in the recent decade [16].

Research so far indicates that most textile factories are labor-intensive more than other sectors in terms of WRMSDs caused by uncomfortable working postures, repetition of tasks, prolonged working in sitting or standing positions, and bad workplace design [17]. Workplace risk, however, is one of the key areas requiring attention so that overall well-being at the workplace can be assured by investigating issues and recommending strategies that can help designers in the promotion of design solutions [18]. However, the research aimed to investigate the risk levels associated with workers' postures in five selected textile industries in Lagos, Nigeria.

2. MATERIALS AND METHODS

2.1 Selected Textile Industries

For this study, five textile industries were selected in Lagos Nigeria. These industries are Sunflag Group Nigeria Limited; Haffar Industrial Company Limited; Afprint Nigeria PLC; Atlantic textile manufacturing company limited and Da Viva Faison Limited. Postural assessments were conducted on workers in various sections in these textile industries, such as spinning, looming, warping, and weaving.

These specific textile industries were chosen as the study area due to their standardized operations, equipment, and production processes, which distinguish them from other textile manufacturing industries in South-West Nigeria. Additionally, the administrative departments of these companies facilitated access to data and aided in data collection through the distribution of questionnaires and interviews.

2.2 Data Collection Techniques

Identifying and rectifying awkward postures in the workplace involves employing various techniques. Before addressing awkward postures through methods such as redesigning the workplace, tools, equipment, or tasks, it is crucial that an Ergonomist first identify the awkward postures. Two primary methods for identifying awkward postures that contribute to musculoskeletal disorders which include self-report and observational method were used in this study.

2.2.1 Self-report method

This method was used to gather data that contributes to the workers' health condition or work-related disorder via interviews or questionnaires. The first section of the questionnaire

in was designed to collect the demographic data of the workers including age, gender, marital status, qualification, work experience, and the designation of the workers on the job. WRMSDs were investigated with a standard nordic musculoskeletal questionnaire, inquiring about the workers' health and safety, their working environment, workplace design layout and operation, equipment, and material handling. The concluding section of the questionnaire and contained information for evaluating body parts such as the neck, shoulder, wrist, upper back, and lower back.

2.2.2 Observational method

In the observational method, postural assessment is done to measure the exposure to risk factors on different body parts and body segments. In this study, the REBA observational method was used as shown in Figure 1. Workers were recorded using a video recording device, and their most awkward postures were observed and captured for REBA analysis, using the REBA Employee Assessment Worksheet.

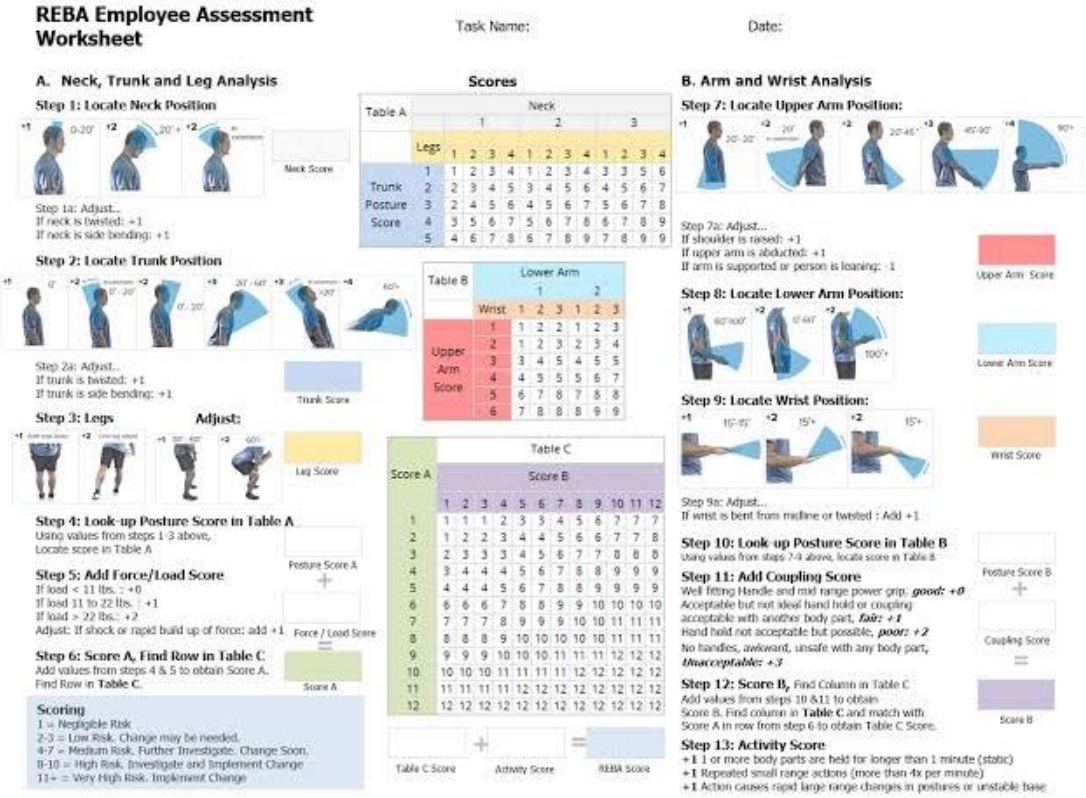


Figure 1: REBA assessment worksheet [19].

3. RESULTS AND DISCUSSION

3.1 Demographic Characteristics

The demographic information of the workers across the five textile industries includes age, gender, marital status, qualification, work experience, and employment designation. Across five textile industries serving as study areas, a total of 350 workers participated in the survey, with 70 workers sampled from each industry. Analysis of the questionnaire responses revealed that 55% of the workforce comprises females, primarily engaged in the weaving department, while 45% are males employed as laborers, machine operators, or production helpers.

Figure 2(a) illustrates that 20% of the sampled population falls within the age bracket of 21-30 years, 47% are aged between 30-40 years, and 33% are above 40 years old. This indicates that the workforce in these textile industries consists predominantly of adults in their prime. It is worth noting that different age groups may exhibit distinct levels of physical capability and resilience. Older workers might be more susceptible to musculoskeletal issues due to decreased flexibility and strength, while younger workers could be more resilient but may lack experience in identifying and mitigating risks.

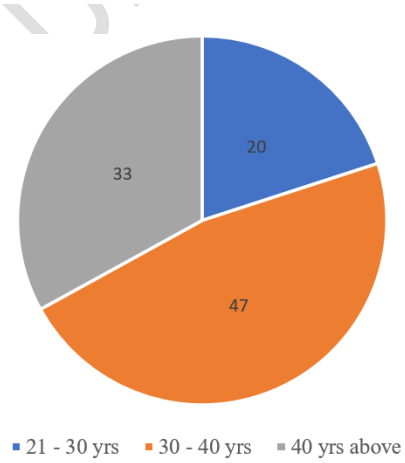
As depicted in Figure 2(b), 66% of the workers are single, while 34% are married. Marital status could indirectly influence risk assessment through factors such as stress levels and motivation. For instance, individuals with familiar obligations may be more inclined to adhere to safety protocols to safeguard against injury and maintain steady employment. Conversely, single workers may exhibit a heightened commitment to their tasks due to fewer marital burdens, potentially enhancing industry productivity

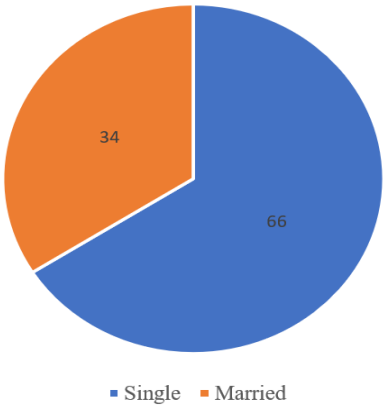
.

Figure 2(c) displays the educational qualifications of the workers, revealing that 24% possess only a Primary School Leaving Certificate, 28% hold a Secondary School certificate, 32% have obtained a National or Higher National Diploma, while 16% boast a Bachelor's or Master's degree. High levels of education and specialized training have the potential to augment workers' comprehension of occupational risks, empowering them to assess and mitigate such risks effectively. Moreover, individuals with higher qualifications are likely better equipped to appreciate the significance of maintaining optimal posture and ergonomics within the workplace.

Figure 2(d) illustrates the distribution of workers' years of experience, indicating that 63% have amassed between 1 and 10 years of experience, 31% possess 11 to 20 years of experience, and 6% have over 20 years of experience. Experience is significant in risk assessment. Those with higher experience in the industry tend to exhibit heightened awareness of potential hazards and adhere to safer work practices. Furthermore, their familiarity with ergonomic principles often translates into improved posture maintenance.

Various roles within the textile industry entail differing degrees of physical exertion and exposure to specific risks. For instance, workers engaged in manual material handling or machine operation encounter distinct ergonomic challenges compared to their counterparts in administrative positions. Consequently, the designation of employment significantly influences the nature of postural and risk assessments required for each role. However, it is noteworthy that production helpers and technicians, constituting 22% and 29% of the workforce respectively, as depicted in Figure 2(e), may face heightened exposure to work-related risks compared to the technologists and engineers.





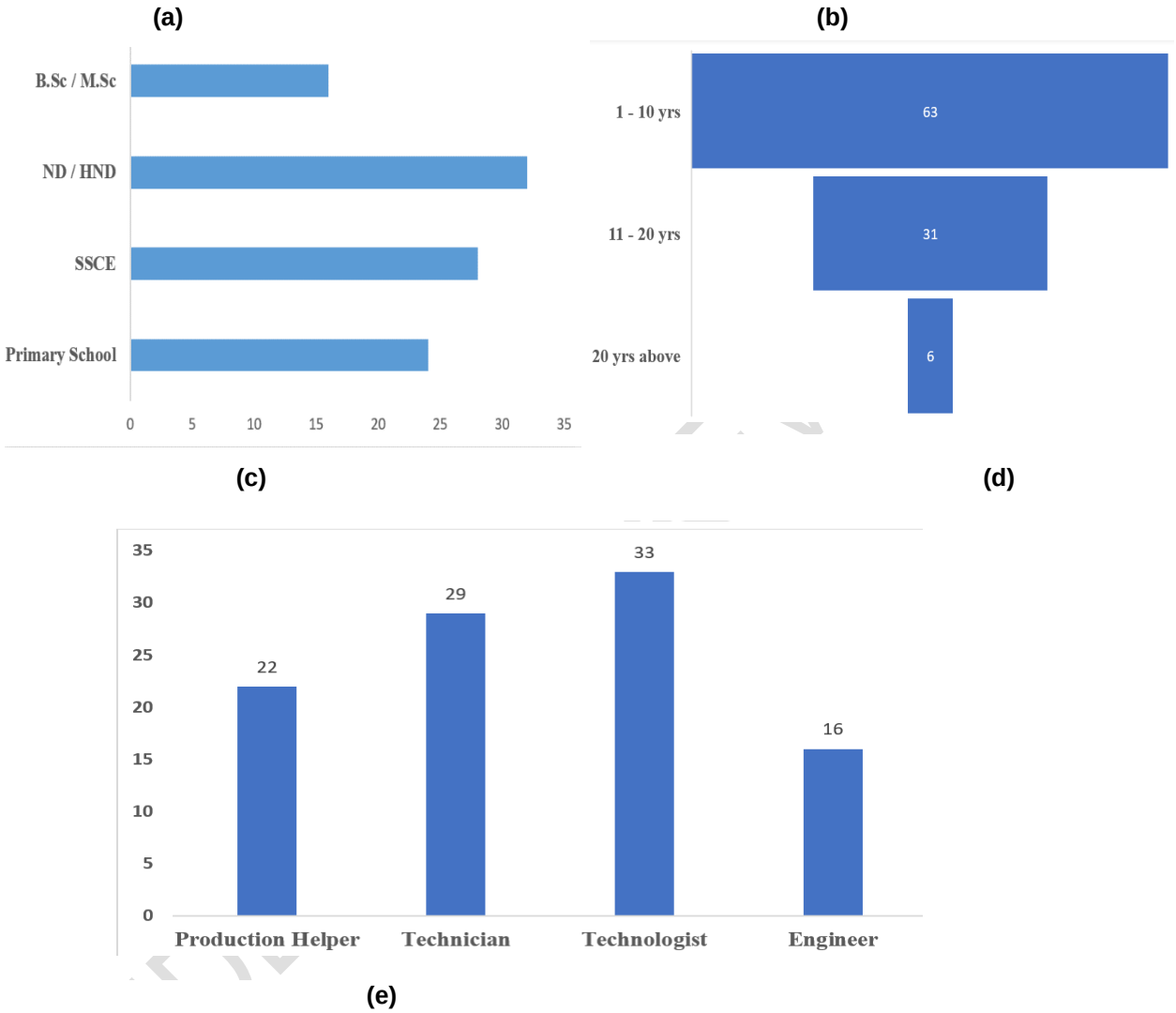


Figure 2: Demographic information of the workforce in the selected textile industries: (a) age range (b) marital status (c) qualification (d) years of experience and (e) designation of employees.

3.2 Analysis of Work-Related Musculoskeletal Disorders (WRMSDs) and Work Environment in the Nigerian Textile Industry

Table 1: highlights a concerning trend of WRMSDs and challenging working conditions among textile workers in Lagos. High Prevalence of WRMSDs shows that a staggering 88% of workers report experiencing fatigue, indicating potential physical and mental strain. 73% and 75% of workers suffer from back pain and headaches, respectively, suggesting significant discomfort likely arising from work postures and physical demands. 45% of workers experience stress, highlighting the psychological impact of the work environment. Notably, 34% of workers express dissatisfaction with their work environment, potentially linked to the physical factors listed below.

Demanding Physical Work Environment shows that 55% of workers face excessive heat exposure, which can contribute to fatigue, and dehydration, and exacerbate existing musculoskeletal issues. 71% are exposed to noise and dust, creating a potentially stressful and uncomfortable work environment. This can also hinder communication and focus. 48% of workers are involved in manual materials handling, which can lead to awkward postures and increased risk of injuries.

Correlations and Concerns show the high prevalence of WRMSDs strongly suggests a connection to the reported physical work environment factors. Excessive heat, noise, and dust can exacerbate fatigue, stress, and musculoskeletal pain. Additionally, manual materials handling likely contributes directly to back pain and other WRMSDs symptoms. This data raises significant concerns about the health and well-being of textile workers in Nigeria. The high prevalence of WRMSDs and worker dissatisfaction point towards a need for immediate interventions to improve working conditions.

Features observations can be implementing ergonomic practices like adjustable workstations and proper posture training can significantly reduce musculoskeletal strain. Providing adequate ventilation and cooling systems can address excessive heat exposure. Hearing protection and dust control measures can create a more comfortable and healthy work environment. Investing in mechanical aids for material handling can minimize the risk of injuries.

Table 1: A Concerning Trend of Work-Related Musculoskeletal Disorders (Wmsds)

Factor	Percentage of Workers Affected WMSDs
Fatigue	88%
Stress	45%
Back Pain	73%
Headaches	75%
Dissatisfaction with Work Environment	34%
Physical Work Environment	
Excessive Heat Exposure	55%
Noise and Dust Exposure	71%
Manual Materials Handling	48%

3.3 Postural Analysis

The assessment of awkward postures in the workplace was conducted categorically, and Table 2 provides insights into the frequency distribution of each posture. Notably, the neck position, with over 46% of workers maintaining a position exceeding 20 degrees for prolonged periods during work occurred most frequently. This suggests a significant portion of workers enduring potentially detrimental neck positions. Additionally, 10% of workers were observed to hold their necks in extension, indicative of poor posture and neck positioning.

Regarding trunk positions, 10% of workers exhibited extension, a posture deemed highly unfavorable. This extension in trunk position correlated with the 10% of workers exhibiting neck extension, likely due to the interconnected movement of the neck and trunk. Such postures were notably observed among workers accessing textile yarn on wrapping machines. The most common trunk position, noted in 38% of workers, fell within the 20 to 60-degree range. Conversely, a trunk position of 0 degrees or within the 0 to 20-degree range poses minimal postural risk, yet 43% of workers maintained these positions.

A commendable 77% of workers maintained a proper standing posture, ensuring balanced foot placement on the ground while working. This practice facilitates an even

distribution of pressure exerted from the ground to the feet. It was revealed that 24% of workers exhibited a squatting posture with knees bent within the 30 to 60-degree range while maintaining balanced foot positioning a favorable stance for manual lifting. Conversely, 13% of workers encountered discomfort during squatting due to inadequate foot placement.

The postural assessment revealed that the predominant position of the upper arm fell within the range of -20 to 20 degrees, constituting 31% of instances, as depicted in Table 2. This posture, characterized by minimal risk with a score of +1, is deemed comfortable and typically exerts less influence on the final REBA score. Conversely, maintaining the upper arm in positions less than -20 degrees, observed in 20% of the workers, particularly when pulling a yarn cart, may elevate muscle fatigue and discomfort, heightening the risk of musculoskeletal disorders. Positions beyond 90 degrees may induce overextension and strain on the shoulder joint, escalating the likelihood of injury and discomfort during extended work periods. Additionally, abduction of the upper arm from the body results in discomfort, contributing to musculoskeletal issues.

For the Lower Arm, adhering to positions within the 60 to 100-degree range fosters optimal alignment with the wrist and hand, diminishing the probability of strain and discomfort. However, only 60% of workers maintained this favorable Lower Arm position. Deviating beyond 100 degrees or below 60 degrees may result in awkward wrist and hand orientations, potentially amplifying the risk of repetitive strain injuries like carpal tunnel syndrome.

Ensuring Wrist positions fall within the -15 to 15-degree range promotes neutral alignment, mitigating the likelihood of wrist strain and discomfort. Conversely, deviations beyond 15 degrees in either direction may precipitate wrist misalignment, heightening the risk of musculoskeletal disorders such as tendonitis or wrist pain. Notably, 65% and 35% of workers exhibited wrist bending or twisting away from the midline, either within the -15 to 15-degree range or beyond 15 degrees, as illustrated in Table 2.

Table 2: Body Segment Position and the Frequency

Region	Position	Frequency (%)
Neck	Greater than 20	46
	Range 10 to 20	44
	In extension	10
Trunk	0 deg	7
	Range 0 to 20	36
	Range 20 to 60	38
	In extension	10
	Greater than 60	9
Leg	Balanced on ground	77
	Not balanced	23
Upper Arm	Range -20 to 20	31
	Less than -20 (extension)	20
	Range 20 to 45	19
	Range 45 to 90	17
	Greater than 90	13
Lower Arm	Range 60 to 100	69
	Range 0 to 60 or 100+	31
Wrist	Range -15 to 15	65
	Less -15 Greater than 15	35

3.4 Statistical Analysis

The average Neck Score of 1.96 suggests that workers generally maintain a moderate neck posture as shown in Table 3. The range from 1 to 3 indicates variability, with some workers possibly experiencing discomfort or strain due to poor neck positioning. The mean Trunk Score of 3.19 implies that workers tend to maintain a relatively upright trunk posture on average. However, the variability from 1 to 5 suggests that some workers may adopt suboptimal trunk positions, which could increase the risk of musculoskeletal issues.

With an average Leg Score of 1.47, workers typically maintain a satisfactory leg posture. The mean Upper Arm Score of 2.83 suggests that workers generally maintain a moderate upper arm posture. However, the range from 1 to 6 indicates variability, with some workers possibly adopting positions that could lead to muscle fatigue or discomfort. The 5%, 50%, and 95% columns represent the percentile values of the data distribution. For instance, the 5th percentile (5%) indicates the value below which 5% of the workers fall. Similarly, the 50th percentile (50%) represents the median value, and the 95th percentile (95%) indicates the value below which 95% of the workers fall as represented by Table 3. However, the average REBA Score of 7.85 indicates that workers, on average, experience moderate levels of musculoskeletal risk during their tasks in the textile manufacturing industry. However, the variability from 1 to 13 suggests that some workers may be at higher risk due to poor posture or task demands.

The REBA assessment shows that 36% whose postures are assessed have a medium risk level. 37% of the workers have a high-risk level and 17% of the workers have a very high risk as shown in Figure 3. Overall, workers in the selected textile manufacturing industries suffered musculoskeletal disorders due to bad postural positions.

Table 3: Descriptive Statistic of the Scores

	Count	Mean	Std	Min	Max	5%	50%	95%
Neck Score	100	1.96	0.82779981	1	3	1	2	3
Trunk Score	100	3.19	1.11640657	1	5	1	3	5
Leg Score	100	1.47	0.67352533	1	3	1	1	3
Upper Arm Score	100	2.83	1.42172892	1	6	1	2	5
Lower Arm Score	100	1.31	0.4648232	1	2	1	1	2
Wrist Score	100	2.04	0.81550629	1	3	1	2	3
Coupling Score	100	0.39	0.58422011	0	2	0	0	1.05
Activity Score	100	1.52	0.97938344	0	3	0	1	3
REBA Score	100	7.85	2.80466783	1	13	3	8	12.05

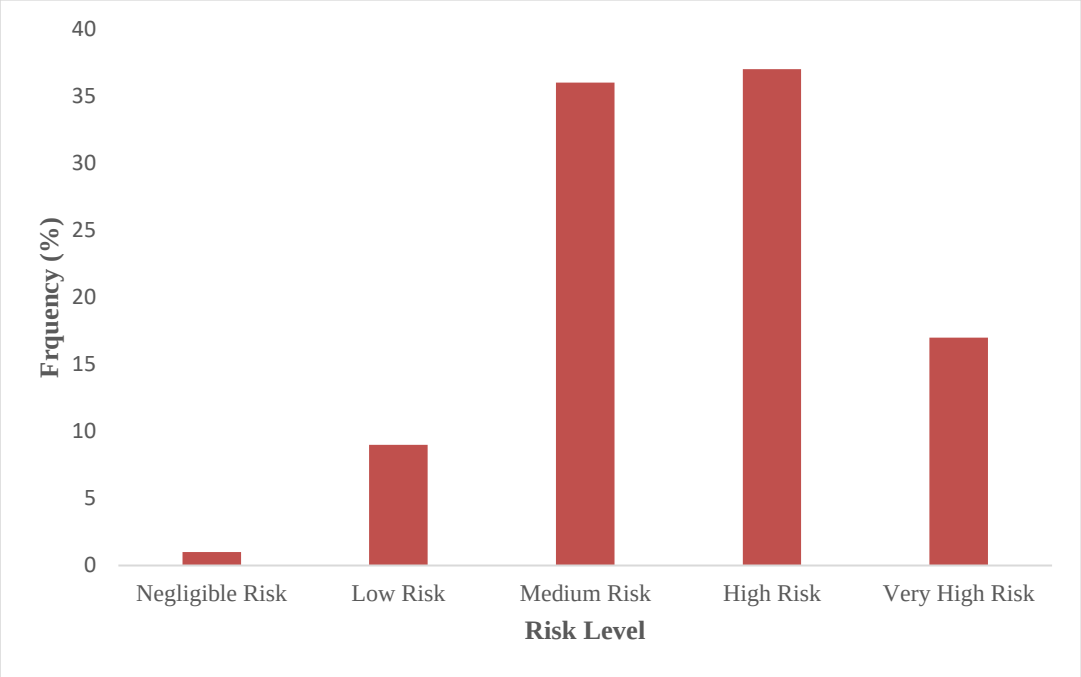


Figure 3: Frequency of the REBA Risk Level

4. CONCLUSION

The demographic characteristics, postural analysis, and statistical analysis provide comprehensive insights into the occupational risks faced by workers in the textile manufacturing industry. The demographic analysis revealed a predominantly adult workforce, with a significant representation of females in weaving departments and males in labor-intensive roles. Age, marital status, educational qualifications, work experience, and employment designation were identified as key factors influencing workers' risk perception and posture maintenance behaviors. The postural analysis highlighted several concerning trends, such as prolonged neck positions exceeding 20 degrees and suboptimal trunk positions, which may contribute to musculoskeletal discomfort and injury. While some workers exhibited favorable postures, others faced challenges, particularly in maintaining proper arm and wrist positions. Statistical analysis provided further insights into the distribution of posture scores and the average REBA score, indicating moderate levels of musculoskeletal risk among workers. Correlation analysis identified significant associations between posture scores and the REBA score, emphasizing the importance of addressing specific postural factors to reduce injury risk. The study recommended that utilizing tools like the REBA score enables organizations to quantify ergonomic risks and prioritize corrective actions.

Disclaimer (Artificial intelligence)
Author(s) hereby declare that NO generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts.

REFERENCES

1. Manuel H, Marta G, Manuel D, Ángel-Jesús C: An overview of REBA method applications in the world. International Journal of environmental and puplic health, 2020, pp 1-22. ; doi:10.3390/ijerph17082635

2. Koirala R, Nepal, A. A Literature Review on Ergonomics, Ergonomics Practices, and Employee Performance. Quest Journal of Management and Social Sciences. 2022; 4 (2): 273-288
3. Herwanto D, Suzianti A. An environmental ergonomics review of small medium enterprises workplace condition in Indonesia. ACM International Conference Proceeding Series, 2020;213–218. https:// doi.org/10.1145/3400934.3400974
4. Onawumi AS, Oyawale FA. Ergonomic Survey of Commercial Motor Cyclists in Nigeria. The International Journal of Engineering and Science (IJES). 2016; 5 (2):23-28.
5. Manzoor H, Qutubuddin SM, Katur PRK, Kesav R. Digital Human Modeling in Ergonomic Risk Assessment of Working Postures using RULA- Proceedings of the International Conference of Industrial Engineering and Operations Management Bangkok, Thailand, 2019;12 (3):5-7.
6. Koshy K, Syed H, Luckiewicz A, Alsoof D, Koshy G, Harry L. Interventions to improve ergonomics in the :perating theatre: A systematic review of ergonomics training and intra-operative microbreaks. Annals of Medicine and Surgery, 2020;55(1):135–142. https://doi.org/10.1016/j.amsu.2020.02.008
7. Qutubuddin SM, Hebbal SS, Kumar ACS. An ergonomic study of work-related musculoskeletal disorder risks in Indian Saw Mills, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 2013;7(5):7-13.
8. Rana MA, Ahmed SS, Awan N, Siddique N. Prevalence of work-related musculoskeletal disorder among dentists teaching hospitals. Research article in Open access, 2024, 74 (7):1265-1269
9. Jagadish R, Asif A, Samee Q, Ayesha S, Qutubuddin SM. Ergonomic Risk Assessment of Working Postures in Small Scale Industries. Grenze International Journal of Engineering and Technology, 2018; 2(11):202-208.
10. Amanawa DE, Eze D. Industrial Relations' Impact on Labor Management: A Nigerian Perspective. International Journal of Academic Multidisciplinary Research (IJAMR), 2024; 8 (1): 265-272
11. Bakken B, Steffen T. Work engagement and health among industrial workers. Scandinavian Journal of Organizational Psychology, 2012; 4 (1):1-18
12. Panhale V, Prachita W, Dhruvi D, Drasti D. Evaluation of Musculoskeletal Pain and Posture in Embroidery Workers of Mumbai – A cross-sectional study. International Journal of Health Sciences and Research, 2020;10 (1):22-37.
13. Razieh J, Parviz K, Tayebeh N, Mahin KT, Norooz T, Atefeh MN. Textile Industry Hazard Identification and Risk Assesment by using HASAN Methods. Archives of Occupational Health, 2019; 3 (4):438-442.
14. Narayanan CM, Baby VY. Ergonomic Factors Affecting Employees in the Textile Industry are being improved. International Journal of Engineering Science and Innovative Technology. 2013; 5 (2):276–281.
15. Bathrinath S, Bhalaji RKA, Saravanasankar S. Risk analysis in Textile Industries using AHP-TOPSIS. Materials Today Proceedings, 2021; 45 (2):1257-1263. https://doi.org/10.1016/j.matr.2020.04.722
16. Gade R, Chandurkar P, Upasani H, Khushwaha D. Ergonomic Intervention to Improve Safety and Productivity. International Journal on Textile Engineering and Processes, 2015; 1 (12):79-88.
17. Lu M, Lowe BD, Howard NL, Meyers AR, Fox RR, Dong RG, Baker BA. Work-related Musculoskeletal Disorders. Modern Occupational Diseases Diagnosis, 2022; 353 287
18. Hofmann DA, Burke MJ, Zohar D. 100 years of occupational safety research: From basic protections and work analysis to a multilevel view of workplace safety and risk. Journal of Applied Psychology, 2017; 102 (3):375-388.
19. Middleworth M: REBA employee assessment worksheet. 2012, www.ErgoPlus.com.