Development of Musculoskeletal Disease Risk Factor Assessment (MDRFA) Model for the Factory Workers in Bangladesh

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Abstract

Musculoskeletal diseases can be dependent on numerous environmental and individual factors. The existing methods leave out several important factors during the calculation of risks. Hence, this paper has the purpose to create and examine a way for employees to estimate their own risk of developing musculoskeletal problems employing the Musculoskeletal Disease Risk Factor Assessment (MDRFA) approach. Exactly 112 male cement manufacturing workers participated in this cross-sectional investigation. Participants were interviewed to acquire data about their own possessions. Information on the objects was gleaned through perceiving their work and talking to them. Additionally, they were given the Cornell questionnaires for musculoskeletal pain and instructed to complete them out in Persian (CMDQ). A model was developed using Structural Equation Modeling (SEM) effect coefficients. This technique was verified using a linear regression analysis, and the final score was categorized using the Receiver Operating Characteristic (ROC). The musculoskeletal symptoms are seen to be considerably influenced by either the individual's own characteristics (total coefficient of 0.27) or by physical (total coefficient of 0.51) and psychological (total coefficient of 0.11). Items' computed coefficients were utilized to formulate the MDRFA equation. The ideal cut-off values for the final score of the approach were 14.32, 18.56, and 22.59, creating four distinct categories. The MDRFA approach could adequately explain 73% of risks, but the Rapid Entire Body Assessment (REBA) approach could only justify 51% of risks. Prediction of musculoskeletal disorders relies heavily on personal, physical and psychological characteristics. This methodology may allow for more precise prediction of the occurrence of certain diseases.

Keywords
Musculoskeletal diseases, MSD, Risk Factors, Cement Factory, Ergonomics.

1. Introduction

The human body's musculoskeletal system is an intricate framework of muscle groups, ligaments, tendons, bones, and other connective tissue components that work together in order to provide mobility, stability, and support (Araújo et al. 2019; Schram et al. 2020). The system has the responsibility of performing physical activities such as walking, running, climbing, and carrying matrices. This system can be distorted due to poor posture, overexertion, exposure to repetitive force, lifting heavy weight, vibrations, etc. (Yang et al. 2020; Mondal et al. 2022). Musculoskeletal diseases are caused by this distortion, which causes pain or damage to the musculoskeletal system (MSDs). Muscles, tendons, bones, and associated structures including the lower spine can all be affected by a group of treated conditions known as musculoskeletal disorders (Ghasemi et al. 2020). It is a major cause of long-term impairment, missed work owing to illness, low productivity, and an inferior standard of life (Falahati et al. 2019; Khoshakhlagh et al. 2017). MSD disorders do not appear suddenly; they develop slowly and reveal various signs. When MSDs first begin to develop, the body of an individual will experience discomfort following work. (Black, Hawks, and Keene, 2009). If this indication is ignored for a long period of time, strains begin to build up throughout the body, resulting in discomfort in various body limbs such as the shoulder, neck, elbow, upper and lower back, and extremities (knee, forearms, feet, fingers, hands and so on) (Whysall, 2006; Kumar et al. 2018). If the remedy is not performed effectively, the person will suffer from a variety of chronic musculoskeletal illness (Rezaee et al. 2014; Thetkathuek et al. 2018). These ailments include the condition known as carpal tunnel syndrome, tendinitis, progressive spine disease, pulmonary outlet syndrome, and tension collar syndrome (Rezaee and Ghasemi, 2013; Kalteh HO et al. 2018). Every year, billions of people throughout the world are affected by these diseases. MSD differs worldwide, ranging from 14% to almost 42% (Joshi and Deshpande, 2020). MSDs have a negative impact on employees' abilities, living quality, and absence pattern (Khoshakhlagh AH et al. 2017). Back pain and muscular pain are estimated to impact 25% and 23% of European employees, respectively (Hagberg et al. 2012). MSDs account for 31.8% of the total instances of injury resulting in days away from work, in response to the Bureau of Labor Statistics in the United States (Bhattacharya, 2014). Each year, the International Labor Organization (ILO) picks up around 160 million reports of work-related diseases all around the globe (Niu, 2010). These diseases have become a major issue in both countries that are developing and developed (Widanarko, 2014). Bangladesh, like the rest of the world, is often impacted by various MSD challenges. These challenges may affect individuals of any gender, age, or socioeconomic status (Bevan 2015; Bowers et al. 2018). Between 1990 and 2016, disability-adjusted life years (DALY) linked to orthopedic injuries rose by 61.7%, and by 19.6% between 2006 and 2016 (Smith et al. 2014).

MSDs having economical as well as health consequences (Yelin et al. 2016). The expenses associated with treating physical disorders in the United States is projected to be $127.4 billion. The expenses of work-related musculoskeletal disorders range from 0.5 to 2% of GDP in industrialized and developing nations (Piedrahita, 2006). According to previous research, working populations and occupational sectors experience these diseases substantially more frequently than the overall population (Pourtaghi, et al. 2011). It is additionally shown that a wide range of factors influence the prevalence of MSDs in the workplace. Each of these components can be categorized into three distinct groups: personal, psychological, and physical (Da Costa BR et al. 2010; Falahati M et al. 2019). Physical factors are a major category of effective factors. In a working population, characteristics such as posture, vibration, high load, repeated movement, and strong effort may be a predictor of multisite and acute regional musculoskeletal pain (Herin et al. 2014). Repetitive action, uncomfortable posture, labor length, weight, force, and static muscular activity are all musculoskeletal risk factors in the cleaning job (Kumar et al. 2008).

Physical risk factors for work-related musculoskeletal conditions include awkward posture, a strong grip, repetition, vibration, force, and a combination of exposure (Seidel DH et al. 2019). Potentially hazardous workloads and working atmospheres include dynamic loads, recurrent loads, force exertions, unanticipated and sudden movements, stationary loads, and concerns pertaining to the environment (Hildebrandt V et al. 2001). Repeated throwing motions damage the radial nerve in the elbow and wrist regions (Aoki M et al. 2005). The key ergonomic factors that cause upper extremity musculoskeletal problems are strong force, uncomfortable posture, and interface stress. (Pullopdissakul S et al. 2013). Individuals' upper-extremity diseases were substantially correlated to particular traits such as BMI, age, amount of physical activity, smoking status, as well as working hours (Karwan et al. 2015). Moreover, age, sex, education, smoking, working time, and drinking are all documented personal factors related to occupational injuries and accidents (Khanzode et al. 2001). Job insecurity, dissatisfaction, and mental and occupational stress are the psychological risk factors causing for MSDs.

Previous researches have been studied about musculoskeletal disorders only upon physical matrices. All of these components are recognized as potential workplace hazards that may have a significant impact on the frequency of musculoskeletal ailments among workers. Some of them include working in static positions, doing too much labor, being exposed to excessive vibration, and bending or twisting too much. Personal and psychological matrices, in addition to those found in the workplace, have a significant influence in the onset of musculoskeletal problems. Each person has a unique risk of developing a musculoskeletal condition, and these factors reflect that. Aging, smoking, body mass index, degree of physical activity, sadness, and discontent were all associated with upper limb disorders. Ovako Working Posture Analysis System (OWAS) and Novel Ergonomic Postural Assessment Method (NERPA) are only two of the many observational instruments developed to estimate the possibility of acquiring a musculoskeletal disorder on the job.

Unfortunately, these techniques take into account just some of the characteristics associated with occupational risk and don't utilize any personal information in their calculations. When the latter elements are used for risk assessment of musculoskeletal problems, a more precise forecast may be made. As a consequence, the purpose of this research was to create and test a physical and personal matrices-based risk assessment model, as well as a psychological component model, for musculoskeletal disorders among cement plant workers.

1.1 Objectives
The following are the study's objectives:
1.To compile a thorough list of key MSD Literature-based risk factors and to categorize various MSD risk factors.
2.To develop a model that will more accurately assess the risk of musculoskeletal disorders.

2. Literature Review
Many researches have been performed regarding work related musculoskeletal disorder. The current study is attempting to create a model that will more correctly forecast the risk of musculoskeletal problems in cement manufacturing workers from a Bangladeshi perspective. Our study also deals with psychological factors which wasn't worked on previous research. For this research, maximum data were gathered from the working individuals. Some information was gathered from various renowned journals, reports and also from different handbooks and publications.

2.1 MSD risk factors
Researchers have uncovered numerous MSD risk factors. Nonetheless, some of them have been able to classify these risk variables. As a result, defining a generic approach to categorizing MSD risk factors has yet to be completed. This section examines MSD risk factors identified in the literature in three contexts: personal, physical and psychological. The REBA method, CMDQ scores, and ROC curves are also covered in this section. Table 1 illustrates the MSD risk categories with risk factors.

Table 1. Complete list of important risk factors for MSDs

SL No.	MSDs risk categories	MSDs risk factors	References
01	Personal risk factors	Body mass index	(Dobner and Kaser, 2018).
02		Age	(Barlas and Izci, 2018)
03		Smoking	(Patanavanich and Glantz, 2020).
04		Work experience	(Barlas and Izci, 2018)
05		Ergonomics awareness level	(Brain, 2017)
06		General health status	(Mohanty and Niyonsenga, 2019)
07		Physical fitness level	(Rydzik and Ambroży, 2021)
08	Physical risk factors	Posture group 1	(Joshi and Deshpande, 2020)
09		Posture group 2	(Joshi and Deshpande, 2020)
10		Static activity	(Seyed Mohammadreza Hosseinian, 2019)
11		Contact status	(Lin Wang et al. 2022)
12		Repetitive activity	(Kim et al. 2022)
13		Coupling	(Emad Alyan et al. 2021)
14		Load	(L Widodo et al. 2019)
15		Force	(Kim et al. 2022)
16		Rapid and sudden movement	(T. Corser, 2007)
17		Hand-arm vibration	(Bispo et al. 2022)
18		Throwing motion	(Bispo et al. 2022)
19		Whole-body vibration	(Vandyck and Papoe, 2014)
29		Temperature	(Katarina Katić, 2020)
21		Work-rest cycle	(Hanne Christensen et al. 2000)
22	Psychological risk factors	Job dissatisfaction	(Jiskani F et al. 2020)
23		Job insecurity	(Sekkay, F et al. 2018)
24		Mental & occupational stress	(Bazazan et al. 2019)
25		Effort-reward imbalance	(Yang, M et al. 2021)

2.2 Personal risk factors

The risk of personal elements for MSD is related to numerous features of a person's physical characteristics. The key features of these risk variables taken by previous literature may be found here. There is a strong link between MSD symptoms and age. MSD issues, for instance, are more common among the elderly due to physiological limitations, Age-related decreases in physiological capacities, such as physical strength and resilience, make MSD problems, for instance, more prevalent among the aged (Bispo et al. 2022). It has been determined that old-age MSD difficulties result from a reduced physical capacity to tolerate heavy tasks (Caporale et al. 2022). Work experience and MSD symptoms are also related. The work experience of employees may assist them in determining the root causes of MSD challenges (e.g., strong effort, maintaining uncomfortable postures). They avoided engaging in the activity that was giving rise to MSD difficulties, which markedly decreased the number of MSD concerns. Based to one study, knowledgeable employees have a lower risk of MSD than those with fewer years of experience (Kashif et al. 2022). According to research, those with higher BMIs are more likely to develop musculoskeletal problems such as osteoarthritis, low back discomfort, and tendinitis (J. Dobner et al. 2022).

This is because extra body weight puts additional strain on the joints, resulting in joint deterioration and discomfort (Helena et al. 2022). Smoking has been related to osteoporosis, rheumatoid arthritis, and back discomfort, among other musculoskeletal disorders (Roengrudee et al. 2020). Stopping smoking may help lower the likelihood of getting these illnesses while also improving general musculoskeletal health (Stephen Babb et al. 2015). The influence of MSDs on overall health varies on the severity of the condition, the kind of MSD, and the individual's overall health (Itismita Mohanty et al. 2019). MSDs may cause physical inactivity due to discomfort, stiffness, and reduced mobility (Hyoyeon Ahn et al. 2020). People suffering with MSDs may struggle to do physical activities such as exercising, athletics, or even everyday tasks such as moving, walking, or sitting for a long time (Rafael E. Reigal et al. 2020). Physical treatment, physiotherapy, and other kinds of rehabilitation may also assist people with MSDs improve their physical fitness (Griban Grygoriy et al. 2020). The amount of ergonomics awareness in a given context relates to the level of knowledge, awareness, and implementation of ergonomic concepts (Kishore P et al. 2017). Ergonomics is a research area of how to design and organize objects that people use so that people and things can interact as effectively and securely as feasible. (Brain B et al. 2017). It is the study of how people interact with their surroundings and the equipment they use to execute activities, intending to improve safety, comfort, and productivity (Bauba S. Komaet al. 2019).

2.3 Physical risk factors

The physical risk factors for MSD disorders include a variety of biomechanical abnormalities as well as the working environment (Dohyung Kee et al. 2020). Working posture, frequent motion, force, displacement from equilibrium positioning of the body, vibration, structure, inadequate illumination, and loudness are just a few of the most effective risk factors identified by prior research (Ade P. Tubagus et al. 2018). Working posture and MSD concerns are inextricably linked. One of them is coupling. During movement, it is the interaction of numerous joints and postural muscles (Emad Alyan et al. 2021). Coupling status may be changed in musculoskeletal disorders, resulting in changes in movement patterns and possibly contributing to the development or treatment of thecondition (Lukman Irshad et al. 2019). The pressure given to a specific region of the body when it interacts with a hard or pointed matrices, or when the body weight is focused on a small area, is referred to as contact stress (Lin Wang et al. 2022). Contact stress, particularly in the joints and bones, may have a role in the development of musculoskeletal issues (Jiahui Liu et al. 2019). The greater the load-carrying period, the higher the chance of getting MSDs. The amount of weight carried, as well as the frequency with which the load is carried, all contribute to the risk of MSDs (L Widodo et al. 2019). Extended load carrying may put excessive stress on the muscle system, tendons, and joints, resulting in tiredness, discomfort, and damage. Carrying weights that are heavy or awkwardly shaped, in particular, may increase the risk of getting MSDs (Xu Yong et al. 2019).

Force injuries may be either acute or permanent. Acute injuries happen quickly, usually as a consequence of a singular occurrence or accident, and may include fractures, dislocations, and strains (Kim, W. J. et al. 2022). Excessive force may also contribute to postural issues and musculoskeletal abnormalities, leading to chronic discomfort and malfunction (Sekkay F. et al. 2018). In musculoskeletal disorders, static activity includes tasks that involve holding a fixed or immobile posture for a lengthy period of time (Seyed Mohammadreza Hosseinian, 2019). Because of the continual and repeated loading of the muscles and joints, this may result in the development of musculoskeletal illnesses (Tobias Hellig et al. 2018). It entails long durations of sitting at a desk, standing in one position for long periods of time, and holding an item in the same posture for an extended amount of time (Kirsten Huysamen et al. 2018). These activities may cause muscular fatigue, joint discomfort, and stiffness, leading to more severe problems such tendinitis, bursitis, and carpal tunnel syndrome (Blanka Horváthová et al. 2018). It refers to actions or motions that are done frequently, generally with minimal variety in body posture or movement pattern. When these actions are done over a long length of time, they may produce tension and exhaustion in the tissues and muscles involved, which can develop to MSDs (Kim, W. J. et al. 2022). Musculoskeletal disorders (MSDs) are diseases that affect the muscles, tendons, ligaments, nerves, and joints as a result of repeated action. MSDs can cause pain, stiffness, weakness, and a limited range of motion. (Ruzairi K et al. 2022). Quick and rapid movements might be dangerous for those who have musculoskeletal diseases. Sudden movements in people with musculoskeletal diseases may put extra strain on already weakened muscles, bones, and joints, resulting in greater discomfort and damage (T. Corser, 2007). Sudden twisting or turning motions, for example, might induce strain or injury in the ligaments and muscles of the afflicted joint (Paul and Carolyn, 2010). When executed repetitively or with bad technique, the throwing motion includes a complex interaction of muscles, bones, and joints and is often connected with musculoskeletal diseases (Bispo et al. 2022). Elbow injuries, knee injuries, rotator cuff injuries, back injuries, and ankle injuries are some of the most frequent musculoskeletal diseases linked with throwing. When employees utilize vibrating machinery or tools, the vibrations are passed to their hands and arms, causing a variety of health concerns (Kim, W. J. et al. 2022). These include carpal tunnel syndrome, tendonitis, tenosynovitis, and other hand and wrist illnesses. Long-term hand-arm vibration exposure may also result in "vibration white finger," a type of Raynaud's disease. This condition causes the fingers to turn white, numb, and fuzzy, and it can be extremely painful (Tang, L. et al. 2022).

Whole body vibration may be effective for musculoskeletal diseases, according to research. For instance, it has been shown to improve bone density and lower the chance of fractures in people with osteoporosis (Tang, L. et al. 2022). Whole body vibration has also been shown to reduce pain, enhance function, and enhance quality of life in those with osteoarthritis of the knee and low back. It's believed that the mechanical activation delivered by whole-body vibration may encourage bone development, enhance circulation, and boost muscular strength and flexibility (Vandyck and Papoe, 2014). Temperature can have a significant impact on musculoskeletal disorders (MSDs), both in terms of ambient temperature and localized temperature changes in the afflicted region (Katarina Katić et al. 2020). Ambient temperature: Cold temperatures may make MSD symptoms worse, including stiffness and pain, by restricting blood supply to the affected region and forcing muscles and joints to contract. Warm temperatures, on the other hand, may help in enhancing blood flow, loosening muscles, and lowering pain and stiffness (Velt and Daanen, 2017). In a work-rest cycle, working periods are alternated by rest or break times. This enables the body to heal and avoids the buildup of tension and exhaustion that may result in MSDs (Hanne Christensen et al. 2000). The work-rest cycle may be adjusted to a person's unique requirements and the demands of their employment. Depending on the volume of labor, the amount of physical activity necessary, and the person's physical capabilities, the cycle's length and frequency may change (Richard M. Kesler et al. 2018).

2.4 Psychological risk factors

Psychosocial elements of employees, employment management practices, and employee benefits policies are all linked to psychological risk factors. Employee work discontent, mental and occupational stress, job instability, effort-reward imbalance, and so on are some of the best examples of these risk variables drawn from previous studies. Unhappiness at work is directly related to MSD difficulties (Barlas and Izci, 2018). Those who work in high-stress occupations are more likely to suffer from a variety of mental health conditions (such as anxiety, depression, and so on) (Bazazan et al. 2019). Their poor mental health is leading their work performance to deteriorate daily. Their job dissatisfaction grows over time. Employees are more likely to have MSD concerns if they are frequently dissatisfied with their jobs (Bispo et al. 2022). Different objectives are given to various employees to accomplish the organization's aim. Workers can close the gap by raising their production if there is a smaller difference between their capacity and the goal they have been given. It has been established that employees who consistently experience mental and professional stress are more likely to experience MSD issues (Barlas and Izci, 2018). Nevertheless, if the gap is wide, the workers are unable to close it by raising their productivity, which results in an increase in mental and occupational stress for workers. The majority of MSD concerns are caused by employment insufficiency. To stay in the competitive job market, a worker must continually look for steady employment. However, if a corporation has a high rate of hiring and firing, employees will always experience anxiety and sadness because they are afraid of losing their jobs (Jiskani et al. 2020). Employees who constantly face job insecurity are more likely to suffer from MSD. The effort-reward divide is another key driver to MSD difficulties. To achieve their objectives, the majority of employees must exert considerable effort. They frequently expect to be compensated by management for their efforts (Ruzairi et al. 2022). However, the majority of organizations do not present any incentives to their employees in order to honor their dedication. Employees suffer from depression as a result. Depression can also occur when top achievers are treated unfairly when getting rewards, even if the company has an award system in place. Depressed workers may be affected by MSD concerns (Vandyck et al. 2014).

2.5 REBA method

The Rapid Entire Body Assessment (REBA) method is used to assess the postural risks associated with various occupational tasks (Joshi and Deshpande, 2020). It is often used in ergonomics to assess the degree of risk connected to the repeated or extended usage of a certain position. The REBA approach takes into account a number of variables, including body posture, force being delivered, grip type, task length, and task frequency (Dohyung Kee et al. 2020). It then gives a score based on these elements to evaluate the task's degree of risk. The REBA evaluation procedure involves observing the work being carried out, analyzing it into its component parts, and providing a score to each part according to the previous considerations. The task's total risk level is then calculated by summing the scores (Abi Varghese et al. 2022). On the basis of the findings, suggestions may be made to improve posture and lower the risk of injury. To evaluate the ergonomic risks connected to a range of jobs, REBA is a fast and simple instrument (Afrianto Nugroho et al. 2021).

2.6 CMDQ scores

A collection of self-report questions known as the Cornell Musculoskeletal Discomfort Questionnaires (CMDQ) is used to measure the frequency and intensity of musculoskeletal pain in 12 several body parts, including the neck, shoulders, wrists, and back (Hedge et al. 1999). Researchers at Cornell University created the CMDQ, which has numerous variants based on the particular body location being evaluated (Afifehzadeh-Kashani et al. 2011). Each version has a set of questions on the frequency, length, and severity of pain felt in that specific body area as well as how it affects everyday activities (Erman Çakıt, 2019). To assist detect ergonomic risk factors that could be causing employees' musculoskeletal pain, the CMDQ is often used in ergonomic examinations. Employers may adapt work activities, tools, and workstations to lower the risk of musculoskeletal disorders and increase worker comfort and productivity by recognizing these risk factors (Steffi Kreuzfeld et al. 2016). The CMDQ is a helpful instrument for measuring and monitoring musculoskeletal discomfort at work. It may assist employers and safety experts in identifying possible ergonomic risks and putting into practice efficient treatments to stop accidents and advance worker health and safety (Erdinc, Oguzhan et al. 2011).

2.7 Structural equation modeling (SEM)

SEM (Structural Equation Modeling) is a statistical technique for studying variable correlations. It is a flexible framework for testing complex models with several interrelated variables (Jodie B et al. 2012). In the social sciences, psychology, anmarketing research, SEM is often used to investigate complicated causal connections between variables. The primary concept underlying SEM is to put to the test a theoretical model that describes how various variables are connected to one another (Karl G et al. 2018). A graphic that depicts the predicted connections between variables is generally used to describe the model. SEM enables researchers to evaluate the strength and direction of many associations between variables at the same time, while accounting for measurement error and other causes of variation (Weston and Gore, 2016). To evaluate their theoretical model, SEM researchers utilize a mix of confirmatory factor analysis (CFA) and regression analysis. The CFA approach is used to estimate the model of measurement, which identifies the latent variables hidden behind observable data (Liu and Wu, 2007). Following that, regression analysis is utilized to estimate the structural model, which represents the links between the latent variables and their relationships. SEM is a valuable tool for researchers that enables them to test complicated hypotheses and investigate various correlations between variables (MacCallum and Austin, 2000). It does, however, need a solid grasp of statistical modeling and data analysis methodologies. Moreover, SEM may be computationally demanding and may need the use of specialist software (Muthen and Satorra, 1995).

2.8 Receiver operating characteristic (ROC) curve

A Receiver Operating Characteristic (ROC) curve is a graphical representation of the performance of a binary classifier at various categorization levels (Jerome Fan et al. 2015). It's a graph that examines the true positive rate (TPR) to the false positive rate (FPR) at different threshold levels. The TPR is the percentage of real positives that the classifier properly identifies, while the FPR is the proportion of actual negatives that the classifier wrongly identifies as positives (Karimollah Hajian-Tilaki, 2013). A ROC curve's diagonal line symbolizes the effectiveness of a random classifier, whilst a ROC curve that crosses across the top left corner of the plot symbolizes the effectiveness of an ideal classifier. The region under the ROC curve (RUC) indicates the overall performance of the classifier, with an increased RUC indicating higher performance (Hanley and McNeil, 1982). ROC curves are often utilized in machine learning, medical diagnosis, and other domains where binary categorization is required. They make it possible to visualize and compare the performance of several classifiers, as well as to choose an optimal classification threshold depending on the trade-off between TPR and FPR (Seong Ho Park et al. 2004).

3. Methods and Data Collection

3.1 Methodological Approach

An inter-sectional study was carried out in Labanchara, Khulna, Bangladesh, between 2022 and 2023. The responses of 112 masculine employees from different sectors in Bangladesh were polled for this study in order to act as a sample as a whole and provide input to the formula's development. We achieved this by personally visiting several departments and observing employees at work. Workplace risks and circumstances were also documented.
Then we gathered together, spoke about what they were seeking to accomplish, and made our decisions. These occupations were chosen so that we could collect a wide range of data points from a wide number of possible results for all of the risk factors. The cement is prepared by crushing and grinding the beginning ingredients, mixing them with each other in the correct amounts, then torching the resulting mix in a kiln, and subsequently grinding the burnt product that is known as "clinker," along with about 5% gypsum.

3.2 Data Collection

To begin, some of the participants' personal variables, such as age, employment experience, height, weight, smoking, and sickness history, were acquired from workers' medical files as recently as six months. Subjects' other personal characteristics, such as physical fitness, general health status, ergonomics awareness was also collected via interviews. The Likert scale which is a five-point form ranging 0 to 4 was used to obtain the score for each of the personal matrices. Table 2 shows the scoring guidelines for personal stuff. Next, by monitoring their jobs and talking with them, information about the physical matrices was gathered. Coupling, awkward posture, noise, contact stress, force, twisting, load, repetitive activity, static activity, quick and rapid movement, hand-arm vibration, throwing motion, temperature, vibration in whole body, and rest cycle time during work were among the matricess examined. Table 3 shows the grading guidelines for physical matrices. The areas connected with each of the organs of the body during work time were analyzed, and the final ratings of groups A and B were calculated applying REBA method tables. Group A's score was computed using posture scores from the upper arm, lower arm, and wrist, whereas Group B's score was generated using posture ratings from the neck, trunk, and legs (Enez et al. 2019). Table 4 shows the psychological matrices which are job dissatisfaction, job insecurity, mental and occupational stress, and effort-reward imbalance. Other categories' values were evaluated during work time using Likert scales with values ranging from 0 to 4. The load parameter's final score was decided using the amount of load holding time and the maximum load weight, while the force parameter's final score was derived using the amount of work time and the greatest force value. Participants were also asked to fill out the Cornell musculoskeletal pain questionnaire (CMDQ) in Bengali during rest intervals.

This survey evaluates the dimensions of intensity (a little uncomfortable, modestly uncomfortable, and quite uncomfortable), frequency (never, 1-2 occasions last week, 3-4 times last week, once a day, and many times a day), and interruptions (none at all, a little interfered, and significantly interfered) in twelve body regions over the previous week (Fagarasanu and Kumar, 2006) Scores for frequency (0, 1.5, 3.5, 5, and 10) and severity (0, 5, and 10) are used to determine the total score of discomfort brought on by musculoskeletal problems for each body location were multiplied and then added (Erdinc et al. 2011) The reliability and validity of this CMDQ assessment were also tested (Afifehzadeh-Kashani et al. 2011). Cronbach's coefficient alpha was found to be 0.955, 0.961, and 0.969 for frequency, intensity, and interference dimensions, respectively (Afifehzadeh-Kashani et al. 2011). The total value of musculoskeletal symptoms determined by the CMDQ questionnaire served as the gold standard. After identifying the musculoskeletal uncomfortable feelings in the individual's body parts, medical documentation for these illnesses were reviewed, and tests were undertaken to establish that the survey responses were accurate. The REBA approach's ultimate score was obtained by studying the characteristics of coupling, position, force/load, and muscle use, as well as assessing the predicting capacity of the two instruments (Kong, Y.K et al. 2018).

3.3 Predictive model

The prevalence of musculoskeletal issues was predicted in this study via structural equation modeling (SEM). The first phase involved developing a prediction model that assessed the influence of independent variables—personal, physical, and psychosocial factors—on the overall evaluation of musculoskeletal discomforts. The MDRFA model was then generated using the indirect impact values for each of these model parts.

3.4 Statistical analyses

The information was entered into the statistical package for social sciences (SPSS) edition 26. To assess the model's robustness to breaches of the normalcy assumption, Spearman and Pearson correlation coefficients were obtained. Following that, a conceptual framework was created in the AMOS software. The MDRFA equation was then built using the indirect effect coefficients of the physical and personal things. Finally, using receiver operating characteristic (ROC) curve analysis, the MDRFA score was separated into four levels. The validity of the created tool was evaluated using linear regression analysis. The risk level frequency distributions in the CMDQ, REBA, and methods were also determined.

Table 2. The rating procedure of the individual matrices.

Matrices	Rating	Matrices	Rating
Body mass index (Kilogram per square meter)	Less than 22.5 (0) 22.5 to 25 (1) 25 to 27.5 (2) 27.5 to 30 (3) More than 30 (4)	Ergonomics awareness level	Very high (0) High (1) Moderate (2) Low (3) Very low (4)
Age (years)	Less than 20 (0) 20 to 29 (1) 30 to 39 (2) 40 to 49 (3) More than 49 (4)	General health status	Very good (0) Good (1) Moderate (2) Bad (3) Very bad (4)
Smoking (Cigarette per day)	0 (0) 1 to 5 (1) 6 to 10 (2) 10 to 20 (3) More than 20 (4)	Physical fitness level	Very good (0) Good (1) Average (2) Poor (3) Very poor (4)
Work experience (years)	1 to 5 (0) 6 to 10 (1) 11 to 15 (2) 16 to 20 (3) More than 20 (4)		

Table 3. The rating procedure of the physical matrices.

Matrices	Rating	Matrices	Rating
Posture group 1	Evaluating the worstand most common postures for the trunk, neck and legswhen working andscoring themutilizing the REBA method's table	Static activity	Never (0) Little (1) Sometimes (2) Much (3) Very much (4)
Posture group 2	Evaluating the worstand most common arm, wrist, and lower-arm posturesthat occur while working, andcomputing score Busing the REBA method's table.	Repetitive activity	Never (0) Little (1) Sometimes (2) Much (3) Very much (4)

Maximum load weight	Less than 5 kg (0) 5 to 10 kg (1) 10 to 15 kg (2) 15 to 20 kg (3) More than 20 kg(4)	Rapid and sudden movement	Never (0) Little (1) Sometimes (2) Much (3) Very much (4)
Load carryingtime	- Never (0) - Less than 2 h (1) - 2 to 4 h (2) - 4 to 6 h (3) - More than 6 h (4)	Hand-armvibration	Never (0) Little (1) Sometimes (2) Much (3) Very much (4)
Contact stress	- Never (0) - Little (1) - Sometimes (2) - Much (3) - Very much (4)	Throwing motion (such ashitting with a hammer or hand)	Never (0) Little (1) Sometimes (2) Much (3) Very much (4)
Maximum force value	- Less than 1 kg (0) - 1 to 2 kg (1) - 2 to 4 kg (2) - 4 to 6 kg (3) - More than 6 kg (4)	Whole-bodyvibration	Never (0) Little (1) Sometimes (2) Much (3) Very much (4)
Work time	- Less than 2 h (0) - 2 to 4 h (1) - 4 to 6 h (2) - 4 to 8 h (3) - More than 8 h (4)	Temperature	Neutral (0) Slightly warm orcool (1) Warm or cool (2) Hot or cold (3) Very hot or cold (4)
Coupling status	- Very good (0) - Good (1) - Acceptable (2) - Poor (3) - Very poor (4)	Work – rest cycle(rest duration per 2 h)	Without rest (4) 15 min (3) 30 min (2) 45 min (1) 60 min and more (0)

Table 4. The rating procedure of the psychological matrices.

Matrices	Rating	Matrices	Rating
Job dissatisfaction	Very low (0) Low (1) Moderate (2) High (3) Very high (4)	Mental and occupational stress	Very low (0) Low (1) Moderate (2) High (3) Very high (4)
Job insecurity	Very low (0) Low (1) Moderate (2) High (3) Very high (4)	Effort-rewardimbalance	Very low (0) Low (1) Moderate (2) High (3) Very high (4)

4. Results

4.1 Numerical Results

Table 5 depicts the distribution of the variables statistically which is in under consideration. The CMDQ score and personal and physical matrices correlation coefficient are shown in Table 6. The CMDQ score correlated most strongly with age and general health state, respectively. The physical elements' relationships to the posture group 1 and group

2 factors were the most significant. For the psychological matrices, job dissatisfaction and mental stress are strongly correlated. The theoretical model is depicted in Figure 1. Personal matrices had a total coefficient of 0.27, physical matrices had a total value of 0.58, and psychological matrices had a total coefficient of 0.11 on musculoskeletal disorder. The corresponding coefficients that indicate the factors' influence on the emergence of musculoskeletal issues are shown in Table 7. The variables general health status (0.299) and physical activity level (0.302) exhibited the highest indirect impact coefficients on MSD symptoms in personal matrices. Posture groups 1 (0.507) and 2 (0.523) of the posture group, on the other hand, had the strongest indirect impacts among the physical components. The strongest indirect impact for psychological matrices was shared by job discontent (0.212) and cognitive and occupational stress (0.227). Table 8.displays variable effect coefficients in creating musculoskeletal symptoms.

Table 9 displays the goodness-of-fit indices for the MDRFA model. As a consequence, the model's fitness was verified. The following variables' indirect effect coefficients were utilized to build the MDRFA equation:

MDRFA = [(0.243 × BMI) + (0.253 × A) + (0.147 × S) + (0.224 × WE) + (0.143 × EAL) + (0.299 × GHS) + (0.302 × PFL) + (0.507 × PGA) + (0.523 × PGB) + (0.488 × L) + (0.179 × CS) + (0.429 × F) + (0.411 × C) + (0.388 × SA) + (0.354 × RSM) + (0.388 × RA) + (0.266 × HAV) + (0.421 × TM) + (0.162 × WBV) + (0.251 × T) + (0.366 × WRC) + (0.212 × JD) + (0.175 × JI) + (0.227 × MOS) + (0.155 × ERI)]

Here BMI is the body mass index score, A is the age score, S is the smoking score, WE is the work experience score, EAL is the ergonomics awareness score, GHS is the general health status score, and PFL is the physical fitness score. PGA is the score for posture group 1, PGB is the score for posture group 2, L is the load score, and CS is the contact stress score., F is the force score, C is the coupling score, SA is the static activity score, RM is the rapid movement score, RA is the repetitive activity score, HAV is the hand-arm vibration score, TM is the throwing motion score, WBV is the whole-body vibration score, T is the temperature score, WRC is the work-rest cycle score JD is the job dissatisfaction score, JI is the job insecurity score. MOS is for psychological and stress at work, and ERI stands for effort-reward imbalance. Force variables and load score scores are also calculated as follows:

$$L = \frac{T_L * W_L}{4}$$

Where T_L is the total time for carrying the load score and W_L is the load weight score for maximum

$$F = \frac{T_w * V_F}{4}$$

Where T_W is the work time score and V_F is the maximum force value score

Table 5. The variables under consideration's statistical distribution

Matrices		Range	Mean	Median	S. D
Personal Matrices	Body Mass Index	0-5	1.36	1	.98
	Age	0-5	2.04	2	.99
	Smoking	0-4	.62	1	.67
	Work experience	0-6	2.12	2	1.42
	Ergonomics awareness level	0-4	2.08	2	1.01
	General health status	0-5	1.7	2	1.02
	Physical fitness level	0-6	1.92	2	1.16
Physical Matrices	Posture group 1	1-10	4.88	4.5	2.17
	Posture group 2	1-9	4.62	4	2.11
	Load	0-5	1.04	1	.92
	Contact Stress	0-5	.52	0.5	.54
	Force	0-5	1.38	1	.81
	Coupling	0-5	1.42	1	1.14
	Static activity	0-5	2.12	2	.90
	Repetitive activity	0-5	1.08	1	.67
	Rapid & sudden movement	0-5	2.04	2	.88
	Hand-Arm vibration	0-5	1.46	1	.76

	Throwing motion	0-5	1.38	1	.85
	Whole body vibration	0-5	1.14	1	.97
	Temperature	0-5	1.48	1	1.07
	Work-rest cycle	0-5	2.58	3	1.20
Psychological Matrices	Job dissatisfaction	0-5	2.36	2	.91
	Job insecurity	0-5	1.97	2	.36
	Mental & occupational stress	0-5	2.65	2	1.24
	Effort-reward imbalance	0-5	1.28	2	1.10
CMDQ score		0-1580	512.9	497.3	534.6

Table 6. The CMDQ score and the matrices correlation coefficient

Matrices		Pearson coefficient	Spearman coefficient
Personal Matrices	Body Mass Index	.469**	.467**
	Age	.589**	.554**
	Smoking	.311*	.290*
	Work experience	.598**	.591**
	Ergonomics Awareness Level	.396**	.308**
	General Health Status	.520**	.463**
	Physical Fitness Level	.509**	.489**
Physical Matrices	Posture group 1	.756**	.677**
	Posture group 2	.764**	.723**
	Load	.561**	.532**
	Contact Stress	.223**	.207**
	Force	.565**	.523**
	Coupling	.461**	.364**
	Static Activity	.462**	.422**
	Repetitive movement	.506**	.588**
	Rapid and sudden movement	.420**	.403**
	Hand-Arm Vibration	.610**	.592**
	Throwing Motion	.535**	.467**
	Whole Body Vibration	.451**	.442**
	Temperature	.329**	.360**
	Work-Rest Cycle	.374**	.391**
Psychological Matrices	Job dissatisfaction	.367**	.322**
	Job insecurity	.205**	.195**
	Mental & occupational stress	.455**	.410**
	Effort-reward imbalance	.125**	.136**

**P less than 0.01.

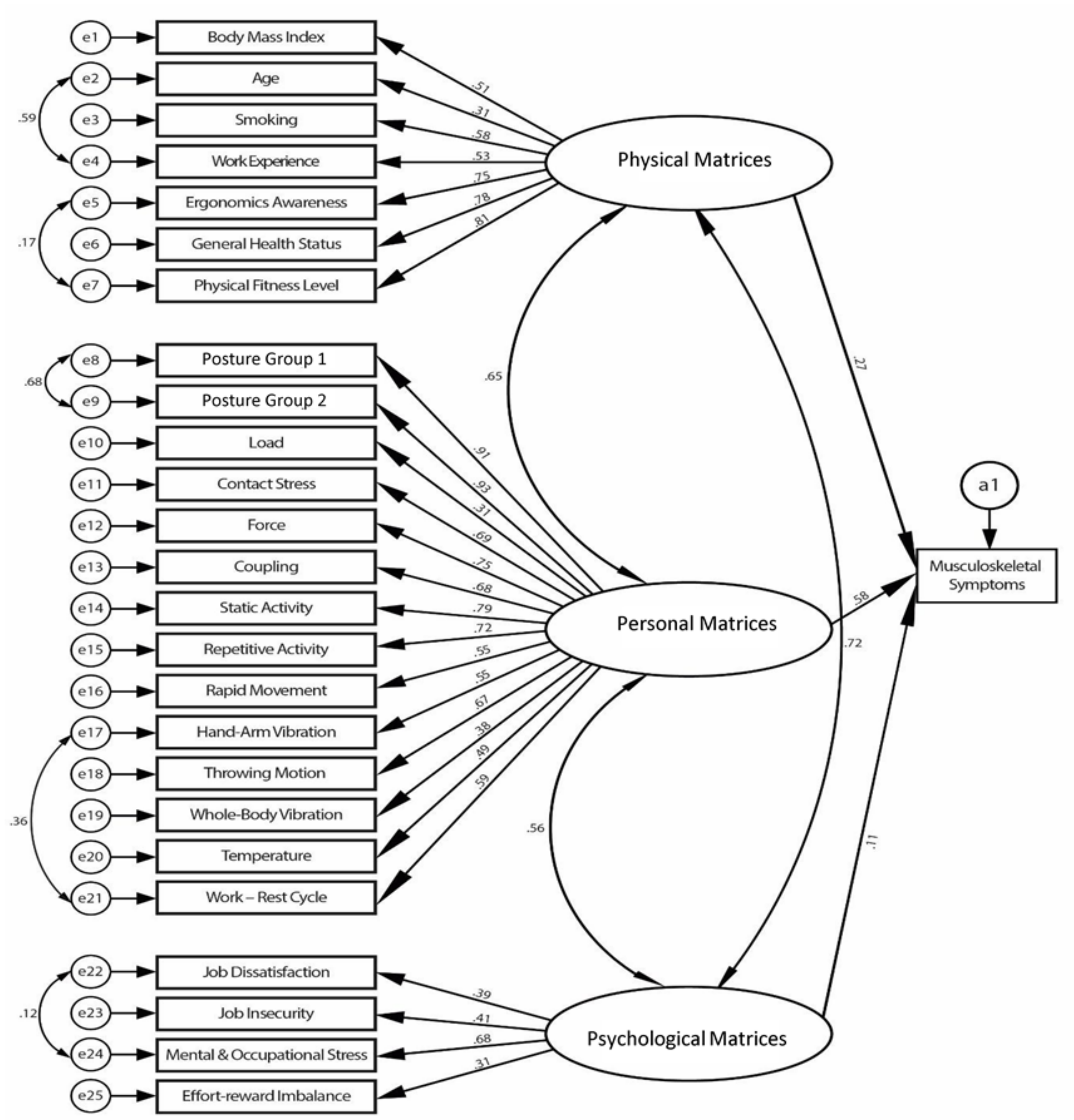


Figure 1. The drawn Musculoskeletal Disease Risk Factor Assessment (MDRFA) model

Table 7. Significance level of the model's matrices

Variables	**Factor loading**	**β Value**	**P Value**	**Significance**
Personal Matrices →Musculoskeletal symptoms	.868	.096	.001	Yes
Physical Matrices→Musculoskeletal symptoms	.672	.098	.002	Yes
Psychological Matrices→Musculoskeletal symptoms	.732	.046	.035	Yes

Table 8. Variable effect coefficients in creating musculoskeletal symptoms.

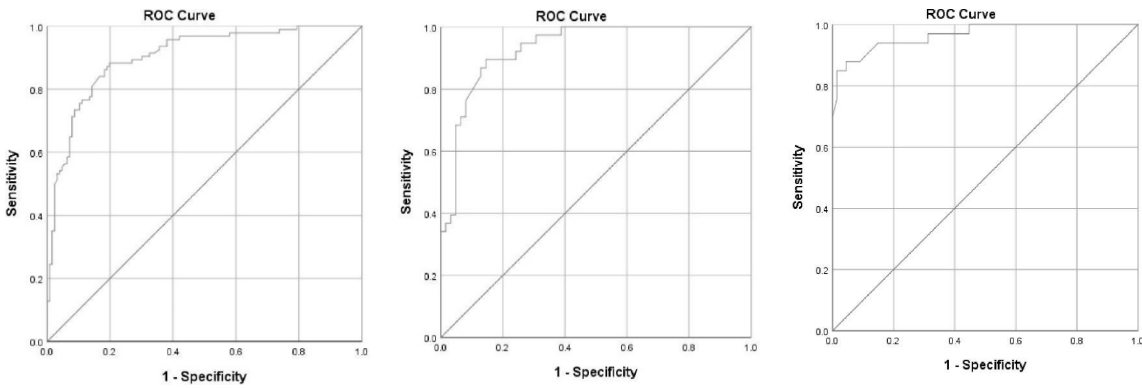
Matrices		Direct Value	Indirect Value	P-value
Personal Matrices	Body mass index	.515	.243	P less than 0.001
	Age	.317	.253	P less than 0.001
	Smoking	.589	.147	P less than 0.001
	Work experience	.531	.224	P less than 0.001
	Ergonomics awareness level	.752	.143	P less than 0.001
	General health status	.783	.299	P less than 0.001
	Physical fitness level	.814	.302	P less than 0.001
Physical Matrices	Posture group 1	.913	.507	P less than 0.001
	Posture group 2	.936	.523	P less than 0.001
	Load	.315	.488	P less than 0.001
	Contact status	.691	.179	P less than 0.001
	Force	.757	.429	P less than 0.001
	Coupling	.688	.411	P less than 0.001
	Static activity	.792	.388	P less than 0.001
	Repetitive activity	.728	.354	P less than 0.001
	Rapid and sudden movement	.552	.388	P less than 0.001
	Hand-arm vibration	.552	.266	P less than 0.001
	Throwing motion	.671	.421	P less than 0.001
	Whole-body vibration	.384	.162	P less than 0.001
	Temperature	.498	.251	P less than 0.001
	Work-rest cycle	.596	.366	P less than 0.001
Psychological Matrices	Job dissatisfaction	.391	.212	P less than 0.001
	Job insecurity	.414	.175	P less than 0.001
	Mental & occupational stress	.686	.227	P less than 0.001
	Effort-reward imbalance	.313	.155	P less than 0.001

Table 9. Goodness-of-fit indices of the analyzed model.

Index	Name	Threshold of Fitness	Obtained Value
Absolute fitness indices	Adjusted goodness-of-fit index (AGFI)	>.9	.902
	Goodness of fit index (GFI)	>.9	.907
Comparative fitness indices	Incremental fit index (IFI)	0-1	.925
	Normed fit index (NFI)	>.9	.914
	Comparative fit index (CFI)	>.9	.924
Normed fit index	Normed Chi-square (X^2/df)	1 to 3	2.250
	Root mean squared error of approximation (RMSEA)	<.1	.074

4.2 Graphical Results

Figure 2 depicts the ROC (receiver operating characteristic) curves. Cutoffs of 14.32 (sensitivity =.813, specificity =.836), 18.56 (sensitivity =.915, specificity =.866), and 22.59 (sensitivity =.937, specificity =.961) were shown to be best for discriminating between moderate and low risk, moderate and high risk, and high and very high risk. The estimate of the area under the receiver's operating characteristic curve (AUC) estimates ranged from.885 to .900 (95%CI: .810, .959) ($p < .001$) to .911 (95% CI: .930, .997) ($p < .001$) and .968 (95% CI:939, .998) ($p < .001$).



(a) (b) (c)

Figure 2. Displays the Receiver operating characteristic (ROC) curves for the risk zones (a) low to moderate, (b) moderate to high, and (c) high and very high.

From table 10, it is found that there is a total four category of risk we have estimated. Those categories are lower (fewer than 14.32), moderate (14.32-18.56), higher (18.56- 22.59) and very high which is greater than 22.59.

Table 10. The risk ranges and their corresponding MDRFA values.

Risk ranges	**Corresponding score**
Lower level	< 14.32
Moderate level	14.32 to 18.56
Higher level	18.56 to 22.59
Very high level	More than 22.59

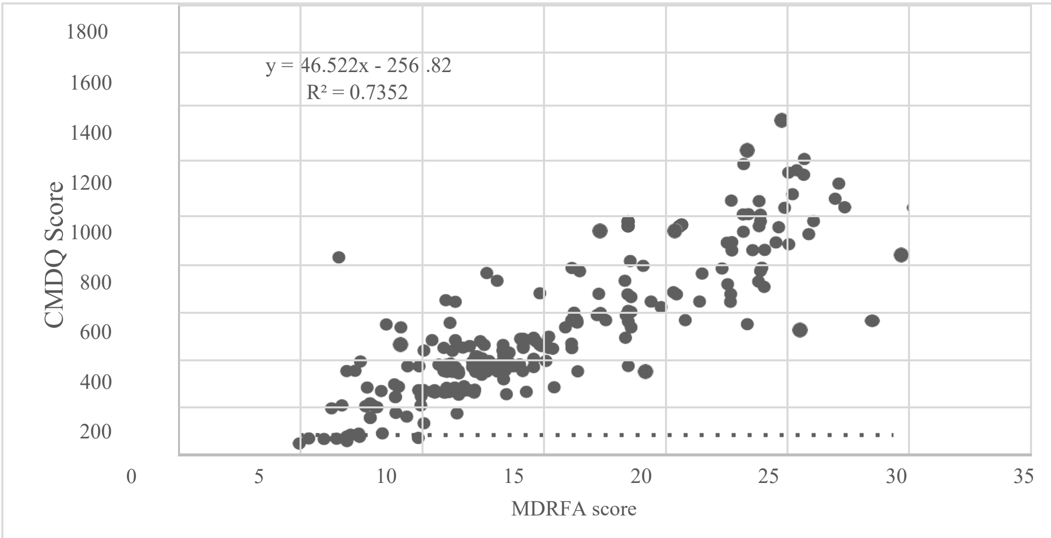


Figure 3. CMDQ score and MDRFA score in linear regression curve for validity

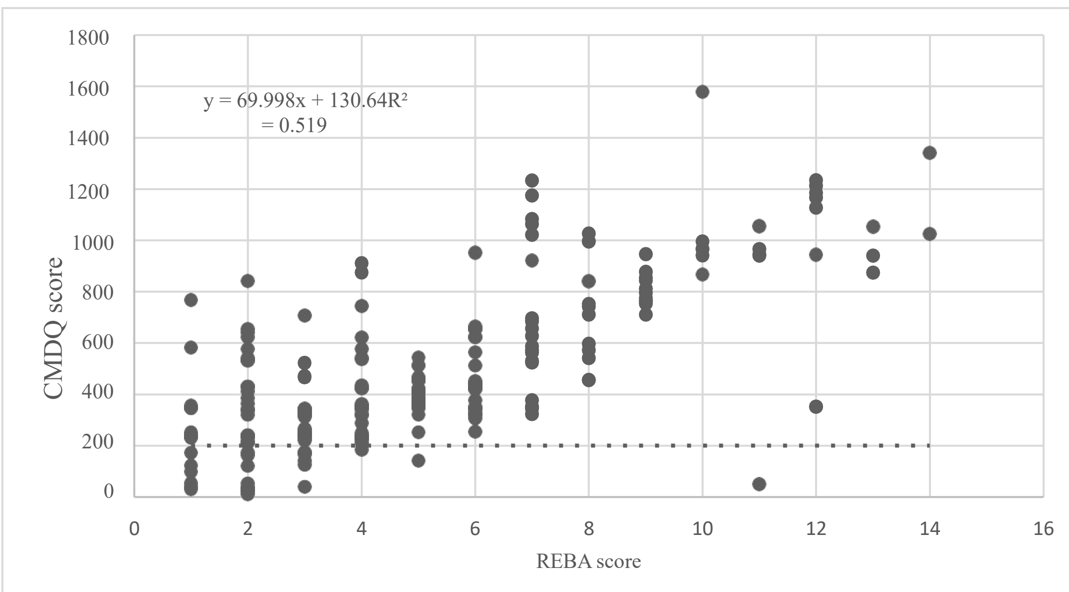


Figure 4. CMDQ score and REBA score in linear regression curve for validity

From the evidence presented, we may see that the MDRFA is a better predictor of the musculoskeletal symptoms than the REBA method, where MDRFA predict the 0.673 percent, on the other hand REBA predicts 0.51 percent. This lends credence to the notion that the MDRFA may be preferable for recognizing and assessing musculoskeletal symptoms, which might result in more effective approaches for preventing and treating these issues. Researchers emphasize that the results of this study shouldn't be extrapolated too far from the original sample. There is a need for more research to validate these findings and determine the most effective strategy for predicting musculoskeletal symptoms. The distribution of frequencies of the relative dangers computed by CMDQ, MDRFA, and REBA is shown in Figure 5. Despite knowing that the REBA technique increased the likelihood of musculoskeletal diseases, the frequency of the various risk regions in the MDRFA model remained somewhat comparable to that of the CMDQ evaluation.

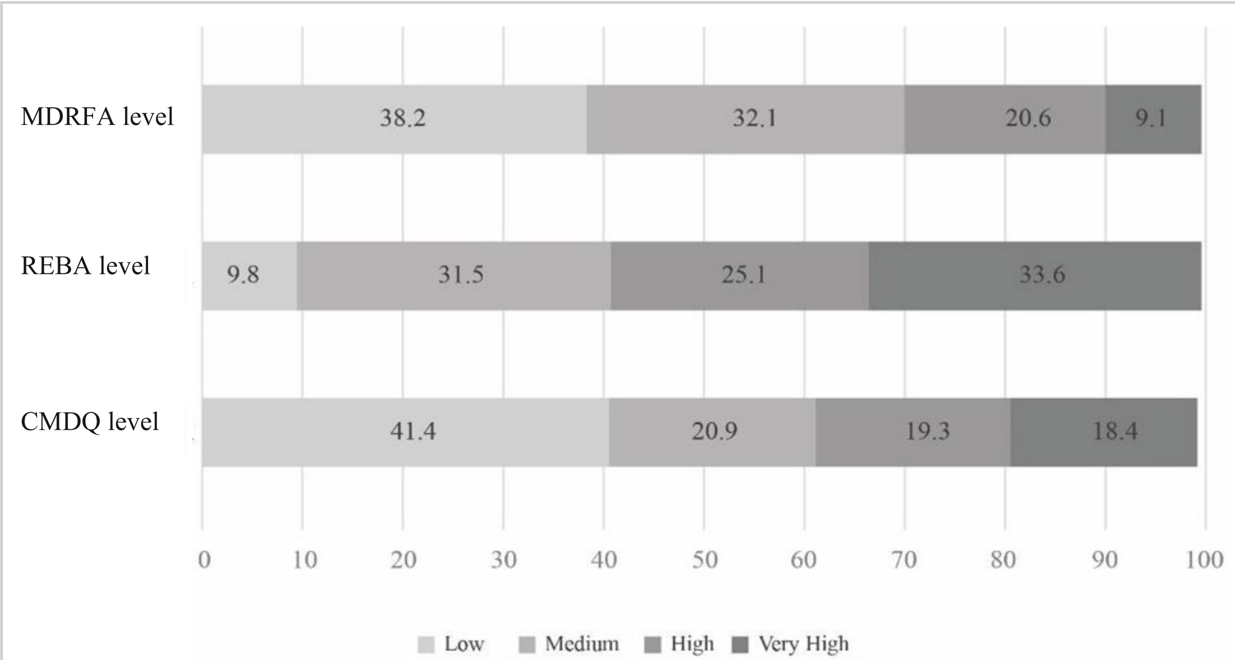


Figure 5. CMDQ, MDRFA and REBA frequency distribution of the risk levels assessed by the approach

5. Discussion

The current study's findings revealed that the researched matrices might cause significant differences in people's musculoskeletal symptoms. From the theoretical model, 0.27 of the total co-efficient was identified for personal matrices which may have a substantial impact on the score of musculoskeletal symptoms. As we aged up, our muscles, bones, and joints undergo natural wear and tear, this can enhance the odds that one will develop certain conditions such as osteoarthritis and osteoporosis (Barlas and Izci, 2018). We also loss of bone density, reduced muscle mass and strength, increased risk of arthritis etc. with parallelly we grow up (Caporale et al. 2022). People who are physically inactive or have poor overall fitness are more likely to develop musculoskeletal disorders, as their muscles and joints are not as strong and resilient as those of more active individuals (Rydzik and Ambroży 2021). Being overweight or obese is also contribute to musculoskeletal disorders, as excess weight puts extra strain on the joints and enhances the risk of conditions such as osteoarthritis (Hyoyeon Ahn et al. 2020). Smoking also have a negative impact on the musculoskeletal system, as it can reduce blood flow to the muscles and joints, impair healing, and increase the risk of certain conditions such as osteoporosis (Patanavanich and Glantz, 2020). On the other hand, 0.58 of the total co-efficient was identified for physical matrices which may have a substantial impact on the score of musculoskeletal symptoms. Bones, joints, muscles, tendons, and other tissues that make up the musculoskeletal system, which is responsible for movement and support of the body (Joshi and Deshpande, 2020). When a person performs the same motion over and over again, it can put excessive strain on specific muscles, tendons, and joints, leading to strain injuries such as tendinitis, carpal tunnel syndrome, and rotator cuff injuries (Ruzairi et al. 2022).

Long periods of holding the body in inappropriate positions can also result in musculoskeletal diseases since it places additional strain on the musculoskeletal system. (Seyed Mohammadreza Hosseinian, 2019). Lifting heavy objects or performing forceful exertions can also contribute to musculoskeletal disorders, especially if the body is not properly aligned or the muscles are not strong enough to support the weigh (L Widodo et al. 2019). Exposure to vibration, such as using power tools, can also cause musculoskeletal disorders, as it can damage the joints and cause pain (Bispo et al. 2022). Work-related upper extremity musculoskeletal problems were influenced by 0.56 with total coefficient for physical factor and 0.11 for personal factor respectively (Park et al. 2010). In this order, the variables linked with musculoskeletal discomforts were and 0.09 for work-home balance 0.14 for workload, 0.61 for physical demands, and 0.13 for gender (Maakip et al. 2016). Together with psychological factors, they influence 0.11 percent of all musculoskeletal symptoms. Those who work in high-stress occupations are more likely to suffer from a variety of mental health conditions (such as anxiety, depression, and so on) (Bazazan et al. 2019). Their poor mental health is leading their work productivity to deteriorate on a daily basis. Their level of job unhappiness eventually increases. It is more probable for employees to experience MSD issues if they consistently experience work discontent (Bispo et al. 2022). Different employees are assigned various targets in order to reach the organization's vision. Workers can close the gap by raising their production if there is a smaller difference between their capacity and the goal they have been given. It has been established that employees who consistently experience mental and professional stress are more likely to experience MSD issues (Barlas and Izci, 2018). Nevertheless, if the gap is wide, the workers are unable to close it by raising their productivity, which results in an increase in mental and occupational stress for workers. The majority of MSD concerns are caused by employment insufficiency. To stay in the competitive job market, a worker needs to keep searching for a steady employment. However, if a corporation has an elevated rate of recruitment and termination, employees are bound to encounter anxiety and sadness because they are concerned about losing their employment (Jiskani et al. 2020).

Employees who endure job uncertainty on a regular basis are more prone to develop MSD. The effort-reward divide is another key driver to MSD difficulties. To achieve their objectives, the majority among staff members must exert considerable effort. They frequently expect to be compensated by management for their efforts (Ruzairi et al. 2022). Nevertheless, the majority of organizations do not present any incentives to their employees in order to honor their dedication. Employees suffer from depression as a result. Depression can also occur when top achievers get treated unfairly when getting rewards, even if the company has a recognition system in place. Depressed workers may be affected by MSD concerns (Vandyck and Papoe, 2014). The factors associated with the largest indirect effect ratios affecting the frequency of musculoskeletal issues were general medical condition, physical fitness level, and job experience. Low overall wellness, such as obesity, poor nutrition, and chronic medical conditions like diabetes etc. are the reason of increasing the risk of developing musculoskeletal disorders. Persons who have weak core muscles or poor posture, for example, they may be more prone to developing back pain or other musculoskeletal problems. maintaining good physical fitness through regular exercise and activity can help reduce the risk of musculoskeletal disorders. Strengthening exercises, stretching, and cardiovascular exercises can all help improve posture, joint mobility, and overall physical health, which can reduce the likelihood of developing musculoskeletal problems. Workers who stay on the job for an extended period are more prone to suffering from MSDs. because they have been exposed to the physical demands of their job for a longer period of time.

Repetitive motions on assembly line work, was the reason for wear and tear on the muscles and tendons over time, leading to conditions like carpal tunnel syndrome or tendinitis. According to the study's findings, signs of MSD were more prevalent among nursing employees who reported poor or very poor health, were over 40, had chronic conditions, were employed for over a decade, slept little, and worked more than eight hours per day and no fewer than forty hours per week (Kalkim et al. 2019). The current study's findings suggested that overall health state and physical fitness were more important than age and job experience. The fittest individuals had far fewer illnesses than their fewer fit competitors (Rintala et al. 2015). As a result, if elderly people keep up their physical fitness, they can lower their risk of developing serious musculoskeletal illnesses. Load, repeated movement, posture group 1, posture group 2, force, tossing motion, static activity, and coupling exhibited the biggest indirect effects on physical matrices, in that order. Throwing motion places significant stress on the joints, muscles, and tendons involved in the movement. When the same motion is repeated over and over again, it was caused strain and damage to the muscles, tendons, and joints involved in that movement. Popular observational approaches, including as RULA, REBA, and NERPA, employ these matrices to determine the likelihood of musculoskeletal problems (Li et al. 2019). Also, it was shown that physical factors including lifting/pulling and posture had the greatest impact on diseases of the upper extremities that are caused by work-related musculoskeletal problems (Park et al. 2010). Psychological factors also effect the MSDs. As a consequence, the current study's findings are consistent with those of previous investigations. Quick action, contact stress, vibration throughout the body, hand-arm vibration, the temperature, as well as the work-rest cycles are all important factors in the development of the unique technique. Its use, while having lower impact coefficients, can provide a more precise prediction of musculoskeletal issues. The researchers noted that the ROC curves' clinical diagnosis was reliable (Jerome Fan et al. 2015). It was found that the MDRFA model can more accurately estimate the likelihood of musculoskeletal disorders when compared to the REBA technique. That might be as a result of the MDRFA model evaluating more variables. Furthermore, it has been revealed that the REBA approach overestimates a number of low moderates to high-risk postures (Sabino L. et al. 2018). Furthermore, it was demonstrated that the REBA fails to discover any relatively safe workstations and classifies a large proportion of workstations as being at high risk (Chiasson et al. 2012). The MDRFA model does not overstate the probability of musculoskeletal issues, in contrast to the REBA method. Indeed, this disadvantage was eliminated by the unique equipment, and the estimates were remarkably accurate.

6. Conclusion

According to the findings of this study, personal psychological characteristics, along with physical factors, have an essential role in predicting musculoskeletal illnesses. As a result, the MDRFA model has the ability to monitor for and assess the risk of musculoskeletal disorders in people with a variety of personal, physical, and psychological characteristics. Furthermore, concerns about an exaggeration in examinations has been addressed as a result of the MDRFA model, and it can now reliably forecast the probabilities of musculoskeletal illnesses. As a result, using this instrument may notify users to potential hazards and prevent the development of skeletal-related issues. Furthermore, certain factors, such as ergonomic perception, smoking, and so on, might be regarded as organizational challenges. As a result, it is recommended that organizational elements influencing musculoskeletal illnesses be used separately in developing the following models. To reduce the frequency of MSDs amongst employees, risk variables must be identified and the employee's risk level must be estimated. The potential rate for causing MSD problems was calculated in this investigation. More precise working positions should be prioritized in order to mitigate the effects of MSD difficulties on a limited budget. This new method may also help safety supervisors construct a risk assessment evaluation instrument in their organizations.

6.1 Limitation and future scope of the study

This research, like many others, has some limitations. Initially, our investigation did not embrace crucial risk variables for MSD. This survey solely included men as employees. As an outcome, all human MDS variations were not tested. Additional studies in different societies and settings may be required to extrapolate the results of the investigation. In addition, subsequent studies might incorporate female employees, who have been excluded from the current study.

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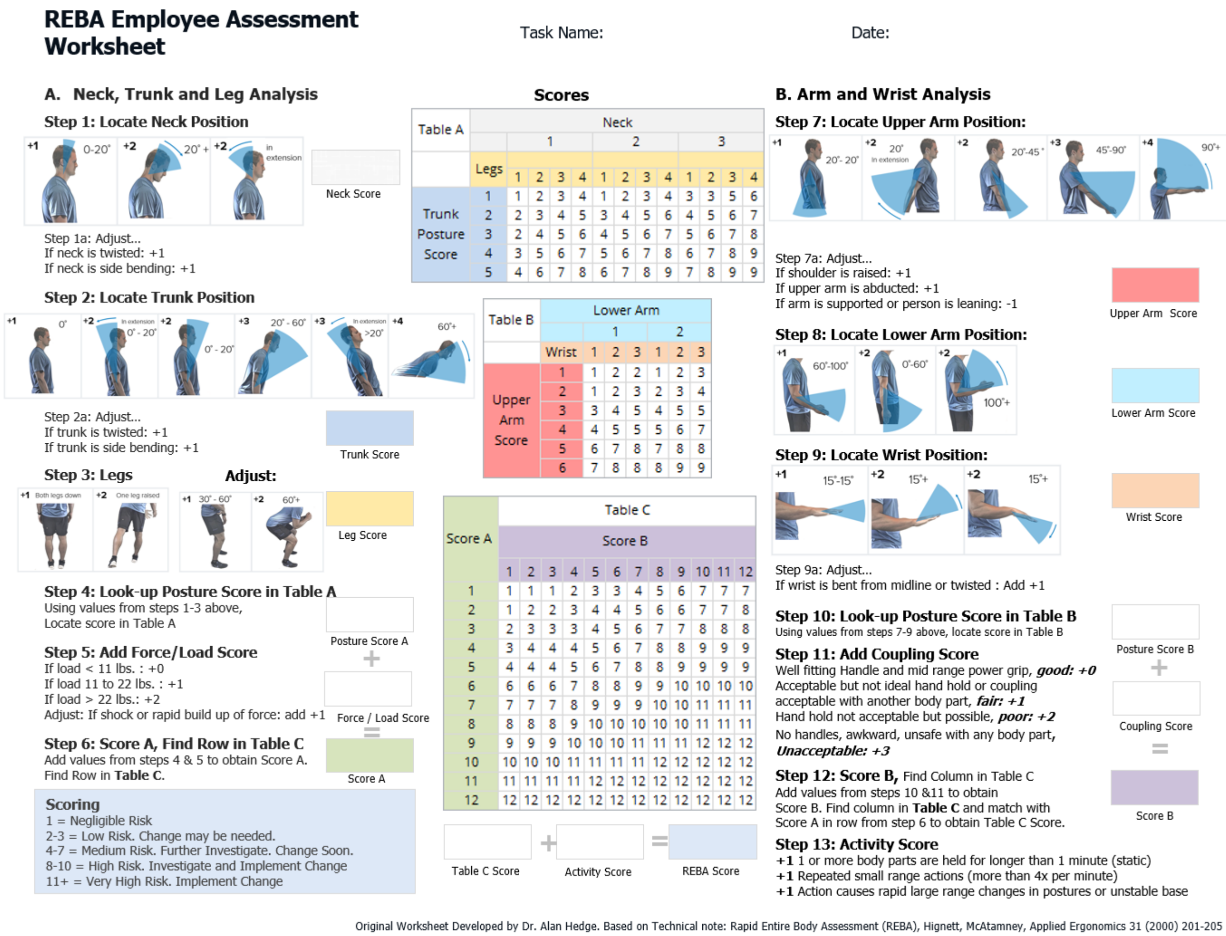
Appendix

REBA employee assessment worksheet (source: https://ergo-plus.com/reba-assessment-tool-guide/)



REBA Employee Assessment Worksheet

Task Name: Date:

A. Neck, Trunk and Leg Analysis

Step 1: Locate Neck Position

+1 0-20° +2 20°+ +2 in extension

Neck Score

Step 1a: Adjust...
If neck is twisted: +1
If neck is side bending: +1

Step 2: Locate Trunk Position

+1 0° +2 in extension 0°-20° +2 0°-20° +3 20°-60° +3 in extension >20° +4 60°+

Step 2a: Adjust...
If trunk is twisted: +1
If trunk is side bending: +1

Trunk Score

Step 3: Legs **Adjust:**

+1 Both legs down +2 One leg raised +1 30°-60° +2 60°+

Leg Score

Step 4: Look-up Posture Score in Table A
Using values from steps 1-3 above,
Locate score in Table A

Posture Score A

Step 5: Add Force/Load Score
If load < 11 lbs. : +0
If load 11 to 22 lbs. : +1
If load > 22 lbs.: +2
Adjust: If shock or rapid build up of force: add +1

Force / Load Score

Step 6: Score A, Find Row in Table C
Add values from steps 4 & 5 to obtain Score A.
Find Row in **Table C.**

Score A

Scoring
1 = Negligible Risk
2-3 = Low Risk. Change may be needed.
4-7 = Medium Risk. Further Investigate. Change Soon.
8-10 = High Risk. Investigate and Implement Change
11+ = Very High Risk. Implement Change

Scores

Table A	Neck												
		1				2				3			
	Legs	1	2	3	4	1	2	3	4	1	2	3	4
Trunk Posture Score	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	6	7	8	9	7	8	9	9

Table B	Lower Arm						
		1			2		
	Wrist	1	2	3	1	2	3
Upper Arm Score	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Score A	Table C Score B											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table C Score + Activity Score = REBA Score

B. Arm and Wrist Analysis

Step 7: Locate Upper Arm Position:

+1 20°-20° +2 20° in extension +2 20°-45° +3 45°-90° +4 90°+

Step 7a: Adjust...
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Upper Arm Score

Step 8: Locate Lower Arm Position:

+1 60°-100° +2 0°-60° +2 100°+

Lower Arm Score

Step 9: Locate Wrist Position:

+1 15°-15° +2 15°+ +2 15°+

Wrist Score

Step 9a: Adjust...
If wrist is bent from midline or twisted : Add +1

Step 10: Look-up Posture Score in Table B
Using values from steps 7-9 above, locate score in Table B

Posture Score B

Step 11: Add Coupling Score
Well fitting Handle and mid range power grip, ***good: +0***
Acceptable but not ideal hand hold or coupling
acceptable with another body part, ***fair: +1***
Hand hold not acceptable but possible, ***poor: +2***
No handles, awkward, unsafe with any body part,
Unacceptable: +3

Coupling Score

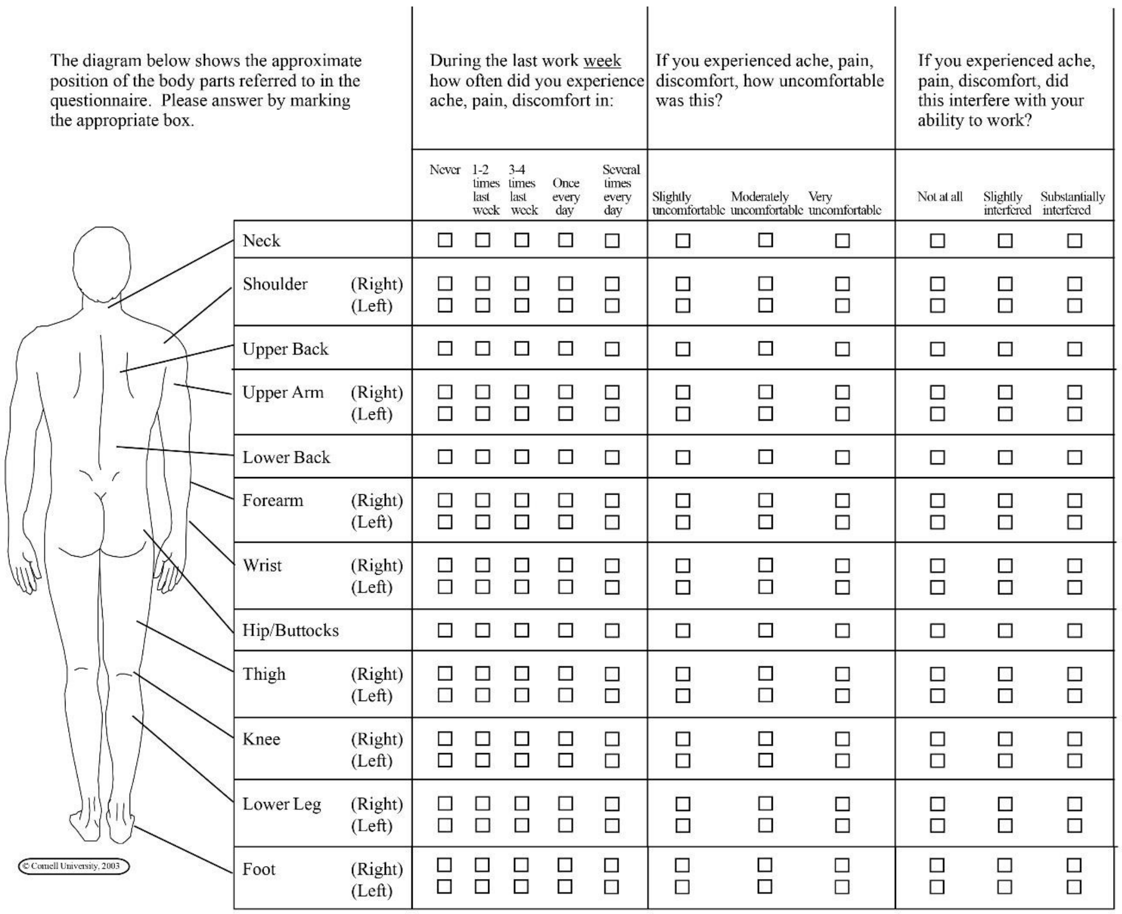
Step 12: Score B, Find Column in Table C
Add values from steps 10 &11 to obtain
Score B. Find column in **Table C** and match with
Score A in row from step 6 to obtain Table C Score.

Score B

Step 13: Activity Score
+1 1 or more body parts are held for longer than 1 minute (static)
+1 Repeated small range actions (more than 4x per minute)
+1 Action causes rapid large range changes in postures or unstable base

Original Worksheet Developed by Dr. Alan Hedge. Based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

CMDQ score sheet (source: https://www.researchgate.net/publication/51253827_Turkish_version_of_the_Cornell_Musculoskeletal_Discomfort_Questionnaire_Cross-cultural_adaptation_and_validation/figures?lo=1&utm_source=google&utm_medium=organic)



The diagram below shows the approximate position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.

		During the last work week how often did you experience ache, pain, discomfort in:					If you experienced ache, pain, discomfort, how uncomfortable was this?			If you experienced ache, pain, discomfort, did this interfere with your ability to work?		
		Never	1-2 times last week	3-4 times last week	Once every day	Several times every day	Slightly uncomfortable	Moderately uncomfortable	Very uncomfortable	Not at all	Slightly interfered	Substantially interfered
Neck		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Arm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Forearm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wrist	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hip/Buttocks		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Thigh	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knee	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Leg	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Foot	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

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