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Ergonomic Intervention Models for Reducing Musculoskeletal Disorders of Public Taxi Drivers

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Abstract - *Musculoskeletal disorders (MSDs) of Taxi drivers' lead to their health issues. It is less known about the causes of musculoskeletal (MSK) pain and discomfort among taxi drivers. Also, it indicates that professional drivers' safety was at risk due to work-related stress. The performance of people working in taxi sector, has come to depend on their working environment and work-related variables like rest time, working hours, and posture condition. This work compared how night shift drivers were exposed to risk at work and investigated the association night shift workers and day time working drivers connected to musculoskeletal disorders present.*

The working conditions connected to the drivers are studied, involvement in MSDs is determined. The work included both descriptive and statistical studies and identified the connections between the variables. In addition, the difficulties of the individuals were identified, and the significance of selected factors was assessed by using Statistical Package for Social Sciences (SPSS).

This project work shows that job stress had a significant impact on professional drivers' performance on working in both day time and night shift. Moreover, statistically significant differences were identified. The work also done comprehensive postural analysis and assessed the ergonomic risks faced by taxi drivers using Rapid Upper Limb Assessment (RULA) and Ovako Working Posture Assessment System (OWAS) scores. The work suggests ergonomic intervention models for reducing drivers' MSDs, improving postural ergonomics and overall well-being. The proposed models enhance their comfort, reduce the risk of musculoskeletal disorders, and promote long-term health and safety).

***Key Words*:** Musculoskeletal Disorders, RULA, OWAS, Ergonomic interventions, Work place safety.

1. INTRODUCTION

Three-wheeler vehicles, often known as auto rickshaws are still an important part of India's urban and rural transportation systems. These automobiles provide economical and convenient travel options, especially in congested urban areas and isolated places with not enough traditional public transportation systems. Considering their extensive use and possible environmental impact, undertaking three-wheeler research in India is critical.

Musculoskeletal disorders (MSDs) are a class of illnesses that affect the muscles, bones, tendons, ligaments, and other musculoskeletal system components. MSDs can cause pain, discomfort, and movement limitations, resulting in decreased productivity and quality of life. Taxi drivers' musculoskeletal disorders (MSDs) more and more hazardous to their health and it is less known about the causes of musculoskeletal (MSK) pain and discomfort that result in MSDs. The performance of people working in taxi sector, has depend on their working environment and psychological work variables. This study compared how different categories of transportation workers were exposed to risk at work and investigated the association between workplace stress and operational performance of public taxi drivers based on their work schedule.

1.1 Objectives

- To analyze the working timings of taxi drivers and connection with their musculoskeletal symptoms and disorders.
- To determine the major ergonomic risk factors and health issues associated to the musculoskeletal symptoms and disorders of taxi drivers.
- To identify and suggest appropriate ergonomic interventions to reduce the musculoskeletal risks using different techniques

1.2 Scope of the Project

Designing three-wheeler vehicles with better seat cushions, adjustable seats, and useful controls helps promote appropriate posture and reduce stress on the musculoskeletal system. Encouraging drivers to take regular breaks during their shifts in order to exercise and release muscle stress. To improve flexibility and strength, promote activities and relaxing methods that especially target the muscles and joints affected by three-wheeler driving. Training drivers on good ergonomics, posture, and self-care behaviours to reduce the chance of getting MSDs Maintaining three-wheelers properly helps avoid vibrations and shocks, which can lead to musculoskeletal discomfort. It is possible to lower the incidence and impact of MSDs among three-wheeler drivers by targeting these causes and implementing preventive measures, therefore increasing their well-being and overall work performance. The project's goal is to discover and manage the muscle illnesses that are common among vehicle drivers. It means studying the causes, symptoms, and consequences of skeletal disease related to this occupational group. The research will also offer methods and strategies to promote the health and well-being of automobile drivers, with the goal of lowering the incidence and severity of muscular disorders.

2. METHODOLOGY

The subject of the current research on drivers' musculoskeletal disorders (MSDs) outlines the strategy used for data collection, statistical analysis, and model construction. It provides a detailed description of the processes performed to explore and analyze the factors contributing to MSDs among drivers. The goal of this project is to improve the working conditions and overall health of taxi drivers. By addressing the specific challenges, they face, such as work-related stress and MSDs, we can contribute to creating a safer and more supportive environment for taxi drivers, enhancing their performance, job satisfaction, and long-term well-being. The preliminary data collection approach is discussed in the first portion of the methodology that Identifying the target population of drivers, establishing acceptable sampling procedures, and determining the sample size required for the study are all part of this process. It explains the data collection methods used to capture useful information on variables linked to driving circumstances, ergonomic considerations, psychological factors, and individual characteristics, such as surveys, questionnaires, or direct observations. It also emphasizes the efforts taken to assure the data's validity and dependability. The following part focuses on the statistical analysis approaches used in the study.

The methodology part further works into the model analysis approach. It describes the creation and testing of models for postural analysis to investigate the selected factors and drivers' MSDs. This may necessitate the use of jack software used modelling based on the average values collected from the survey and those values were used for the design of human models and environment. Additionally, ergonomic modifications to the work environment and vehicles can be made to reduce the risk of MSDs and promote better postures for the wellbeing and it helps to eliminate the future risks that encounter the driver's life.

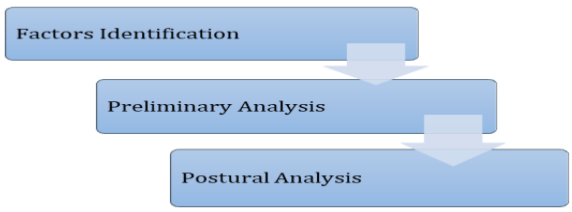

Fig -1: Methodology

2.1 Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) is a valuable statistical technique widely used to study the relationship between drivers' activities and musculoskeletal disorders (MSDs). Researchers gather information through conversations and interviews with drivers about their workplace experiences, driving conditions, and ergonomic challenges related to MSDs. EFA is then used to identify key factors associated with MSDs by grouping similar variables. These factors help pinpoint potential driving-related contributors to MSDs. Armed with these insights, researchers can create targeted interventions to improve workplace ergonomics, driving conditions, and overall well-being of drivers, thereby enhancing road safety. The factors potentially linked to MSDs in drivers encompass personal attributes, work conditions, and lifestyle choices such as physical characteristics, experience, job satisfaction, exercise habits, rest breaks, and health conditions. Understanding these factors empowers stakeholders to implement effective improvements and reduce MSD risks among drivers.

2.2 Preliminary Analysis

The research focused on three-wheeler taxi drivers from the Trivandrum circle, aiming to evaluate their musculoskeletal health. To collect initial data, the Nordic Musculoskeletal questionnaire was used, which helped measure the presence and intensity of discomfort related to factors like prolonged sitting, repetitive movements, awkward postures, and vibration exposure. Participants rated the severity of these elements and specified the body areas affected. The study sought to gather detailed information on the prevalence and location of musculoskeletal discomfort using this questionnaire. The data collected were statistically validated using SPSS, a widely-used statistical analysis and data management program. Descriptive statistics were employed to summarize the data's characteristics, and inferential tests like t-tests determined the significance of observed associations or differences. The goal was to derive evidence-based suggestions for interventions or strategies to address musculoskeletal health issues among taxi drivers. Shift work and fixed-time work were identified as common work schedules for auto taxi drivers, with potential impacts on drivers' well-being and social lives. Interventions such as sleep hygiene education and scheduling adjustments were recommended to improve overall driver health and quality of life.

2.3 Data Collection

In the study on musculoskeletal disorders (MSDs) among auto cab drivers, data was collected using a structured questionnaire specifically designed for the research. The questionnaire encompassed various sections covering different categories. These sections included collecting demographic information such as age, gender, years of cab driving experience, and any pre-existing musculoskeletal issues. Work-related factors were gathered, including working hours, shift schedules, rest breaks, driving duration, and exposure to conditions that may contribute to MSD complaints. The questionnaire also aimed to assess the presence and severity of musculoskeletal complaints, prompting drivers to rate the frequency and intensity of pain or discomfort in different body areas like the neck, shoulders, back, or limbs. Additionally, drivers' impressions of ergonomic factors at their workplace, such as seating quality, vibration, working conditions, and overall comfort while driving, were investigated. The questionnaire was administered to auto taxi drivers either in paper format or electronically, allowing for detailed data collection on work-related factors, symptoms, and ergonomic characteristics. This comprehensive approach facilitated a thorough analysis of the associations between these variables and the occurrence of MSDs among auto taxi drivers.

The Cochran formula, developed by William G. Cochran in 1963, is used to determine the sample size needed to estimate proportions in a population with a specific level of confidence. It uses variables like the confidence level, estimated population proportion, and desired margin of error. By inputting these values, researchers can calculate the minimum sample size required for the estimation. The formula assumes basic random sampling and that the estimated proportion represents the whole population. For a limited population size, the formula is adjusted accordingly. For example, with a population size of around 2000, a confidence level of 95%, a margin of error of 5%, and a population proportion of 0.9, the calculated sample size would be 130. Therefore, a sample of 130 three-wheeler taxi drivers would be chosen for the estimation.

2.4 Statistical Analysis (T-Test)

The t-test is a statistical test that is used to assess whether there is a significant difference in the means of two groups. It is frequently used to determine the importance of a factor or variable in relation to a given outcome, dependent variable, or independent variable. The test determines if the observed difference in means is due to chance or indicates an actual difference in the population. The t-test computes a t-value based on the difference in means, variability among groups, and sample sizes. The t-value is then compared to a critical value based on the desired degree of significance (typically 0.05 or 0.01). If the determined t-value is more than the critical value, it indicates that there is a significant difference between the groups. Depending on the nature of the data and the research issue, the t-test can be performed in a variety of ways. When comparing the means of two separate groups, the independent samples t-test is used, but the paired samples t-test is used when comparing the means of related or paired data. Researchers can detect which factors have a statistically significant impact on outcome factors by running t-tests on the acquired data. It helps in grasping the meaning and contribution of numerous aspects in the context of the study, allowing for further analysis and interpretation of the findings.

2.5 Postural Analysis

In this study, the Siemens Tecnomatix Jack program was utilized for posture analysis, allowing for a comprehensive examination of various postures and their potential impact on workers. To evaluate working postures, two widely used methodologies, RULA (Rapid Upper Limb Assessment) and OWAS (Ovako Working Posture Assessment System), were employed. The RULA score assessed the upper body posture and movement, focusing on arm, wrist, and neck positioning to identify potential risks associated with these body parts. On the other hand, the OWAS score provided a more extensive evaluation of the entire body's posture, considering joint alignment and positioning. By comparing the results from both methodologies, the researchers gained a deeper understanding of postures causing significant issues and needing attention. This comparison helped establish connections between RULA and OWAS findings and identify postures that could potentially increase the risk of musculoskeletal disorders (MSDs) among workers. The goal was to identify risky postures and implement suitable interventions and ergonomic changes to reduce the risk of MSDs. The combination of Siemens Tecnomatix Jack software and RULA and OWAS techniques facilitated a detailed assessment of working postures and improved the understanding of postural risks, allowing for targeted interventions to enhance worker well-being and reduce the risk of MSDs.

Table -1: RULA Score and Corresponding Description

Score	Level of MSD Risk
1-2	Negligible Risk, No Action Required.
3-4	Low Risk, Change May Be Needed.
5-6	Medium Risk, Further Investigation, Change Soon
6+	Very Risk, Implement Change Now

Table -2: OWAS Score and Corresponding Description

Score	Action Required
1	No Corrective Measures Needed
2	Corrective Measures Required in Near Future.
3	Corrective Measures Requires as Soon as Possible.
4	Required Corrective Measures Immediately

When there is a dispute between the OWAS and RULA scores, particular criteria are used to classify a posture as high-risk. If the RULA score is 5 or greater and the OWAS score is 2, the posture is deemed high-risk and requires attention. Similarly, a high-risk posture is defined as having an RULA score of 4 or less and an OWAS score of 3 or above.

2.6 Ergonomic Interventions

In this study, 3-wheeler taxi drivers underwent a postural correction intervention using the Siemens Tecnomatix Jack software. The goal was to improve high-risk postures identified by assessment methodologies. The software allowed for a comprehensive analysis of postures and their effects, leading to specific interventions to optimize body positions during work. This involved creating ergonomic recommendations and changes to seating arrangements for more comfortable sitting, reducing the risk of musculoskeletal problems. The software provided visual simulations and real-time feedback, making the intervention personalized and effective. The aim was to enhance ergonomics, well-being, and comfort for taxi drivers. As part of the ergonomic interventions, three seat models were implemented, with the third model being the most advanced. It featured an adjustable height seat with better suspension for a smoother ride and an upright leg position, minimizing the risk of MSDs. Additionally, the choice of soft materials reduced vibrations, improving driver comfort, and reducing fatigue. Overall, these interventions represent a significant step in improving driver well-being and safety. Continued focus on ergonomic interventions will be crucial for enhancing driver comfort and overall working conditions in the future.

In the ordinary condition of a three-wheeler taxi driver, they usually sit with their feet on the pedals or floor, and their hands rest on the handlebar with a slight bend. While driving in this posture, there is insufficient lower back support, resulting in poor spinal alignment and increased stress on the back. This can lead to musculoskeletal disorders (MSDs) such as lower back pain, discomfort in the neck and shoulders, and injuries to the wrists and hands. The absence of proper support and constant strain during driving contribute to the development of these health issues. Lower back pain is a common problem due to prolonged sitting without adequate support, and improper hand positioning on the handlebar can lead to discomfort and injuries. Being aware of these risks is essential in addressing ergonomic challenges faced by three-wheeler taxi drivers. Interventions like providing ergonomic seats with lumbar support and adjustable handlebars can improve posture and reduce spinal strain. By addressing these concerns and promoting better ergonomics, the aim is to minimize MSDs' occurrence and enhance the overall well-being of three-wheeler taxi drivers.

First intervention for three-wheeler taxi drivers, a new seat was introduced that lacked a separate back support area and adjustable height for the seated area. Despite maintaining the same hand position on the handlebar and an upright body alignment, this seat design failed to provide effective back support. The absence of proper back support could lead to poor spinal alignment and increased stress on the spine, potentially causing musculoskeletal discomfort and injuries. While the new seat may offer some improvement in comfort, it falls short in addressing posture alignment concerns. As a result, it may not effectively reduce the risk of musculoskeletal issues among drivers. To enhance ergonomics and reduce the likelihood of MSDs, alternative measures should be explored. For instance, adding lumbar support cushions or making ergonomic modifications to the handlebar area could promote better sitting posture and provide improved support for the driver's spine and upper body. It is essential to acknowledge the limitations of this seat design and seek more effective solutions to prioritize the drivers' well-being and safety.

In second model a new bucket seat installed in the three-wheeler taxi brought numerous benefits, significantly improving the drivers' seating experience. With its elevated position, the seat provided better visibility of the road, enhancing safety and awareness while driving. The higher seat position also promoted a more comfortable driving posture, reducing strain on the neck and improving overall ergonomic alignment. The bucket seat's adjustability was a key advantage, allowing drivers to customize their seating position. This feature helped alleviate pressure points, reduce discomfort, and prevent the development of musculoskeletal issues during long drives or rest periods. Additionally, the seat design incorporated shock-absorbing properties, minimizing the impact of vibrations commonly experienced while driving on uneven surfaces. This, in turn, reduced physical stress and fatigue, contributing to a more comfortable and less physically taxing driving experience. The adjustable height feature of the bucket seat ensured proper leg positioning and support, promoting optimal blood circulation, and reducing the risk of discomfort or strain during prolonged drives. Furthermore, the dedicated backrest with ergonomic contours and lumbar support provided crucial support to the lower back, maintaining the natural curvature of the spine, and reducing the risk of lower back pain and musculoskeletal issues. In conclusion, the installation of the bucket seat greatly enhanced the overall driving experience for three-wheeler taxi drivers. Its increased height, adjustability, shock absorption, adjustable seat height, and effective back support all combined to provide improved comfort, reduced physical stress, and enhanced safety during both driving and resting periods.

In the final model, the bucket seat previously adopted for three-wheeler taxi drivers has been further improved with the addition of an armrest. This comprehensive seat design offers numerous benefits, significantly enhancing driver comfort and reducing potential issues. The increased height of the bucket seat still provides better visibility and a more comfortable driving position. The adjustable seat height allows for optimal leg positioning, reducing strain and promoting blood circulation. The armrest adds extra support for the driver's hands and arms, reducing fatigue and potential musculoskeletal problems. The seat design effectively reduces vibrations, minimizing physical stress and fatigue. The improved back support and inclined seat design help reduce the risk of lower back pain and other musculoskeletal disorders associated with prolonged sitting. Additionally, the inclined seat allows for a comfortable resting position during breaks. Overall, the final model greatly improves the seating experience for three-wheeler taxi drivers, addressing ergonomic concerns, reducing the risk of MSDs, and enhancing driver comfort and well-being during driving and resting periods.

3. RESULTS AND DISCUSSION

The study had three main phases: first, they assessed musculoskeletal complaints using a questionnaire. Then, they analyzed the participants' working postures using two assessment systems, RULA and OWAS, to identify any potential concerns. Finally, interventions were implemented to address these issues and improve working conditions, aiming to reduce the risk of musculoskeletal disorders. The study emphasized the importance of improving driver posture to promote long-term health and well-being while minimizing the risk of musculoskeletal problems. Overall, the findings highlighted the relationship between posture and musculoskeletal health among drivers, emphasizing the need for ergonomic measures to protect their health and comfort on the job.

3.1 Preliminary Analysis

The study included 130 three-wheeler taxi drivers, with 61.5% working irregular shift schedules and 38.5% working during the day. The drivers' age ranged from 22 to 65 years, with an average age of 35.99 years. Their average height was 1.6976 meters, average weight was 71.02 kilograms, and average BMI was 24.72. The drivers had varying levels of experience, ranging from one to twenty-five years, with an average of 8.14 years. Regarding job satisfaction, 60% of shift workers expressed dissatisfaction, while only 40% of fixed time workers reported being extremely satisfied. Shift workers also reported lower rest frequency, longer working hours, and a higher incidence of health issues compared to fixed time workers. The study shed light on the relationship between demographic factors, work conditions, and musculoskeletal health among three-wheeler taxi drivers. It highlighted the prevalence of irregular shift schedules and their potential impact on job satisfaction and health issues. Understanding these factors is crucial for developing targeted interventions to improve the drivers' well-being and mitigate the risk of musculoskeletal disorders. The study found that among shift workers, a higher percentage reported more frequent hospital visits, with 50% reporting periodic visits and 27.5% visiting the hospital once a week. In contrast, among fixed time workers, a smaller percentage reported more frequent hospital visits. Regarding leave frequency, 52.5% of shift workers reported taking leave on a regular basis, with 23.75% taking leave once a week. In comparison, 40% of fixed time workers reported taking a few days off, with 30% taking leave every two months. In terms of posture discomfort, 58.75% of shift workers reported high degrees of uncomfortable posture during work, with 27.5% reporting extremely uncomfortable posture. Among fixed time workers, 40% reported mildly uncomfortable postures. These findings indicate that shift workers generally experience more frequent hospital visits, have a greater need for leave, and report higher levels of uncomfortable posture compared to fixed time workers. Understanding these differences can help in designing targeted interventions to improve the well-being and working conditions of both groups of taxi drivers.

3.2 MSD Risks in Different Body Parts

According to the collected data on various demographic factors such as age, height, weight, experience, and shift schedule to understand the characteristics of the participants. They also gathered information on the prevalence and severity of MSDs in different body areas, including the neck, shoulders, back, elbows, wrists, knees, hips, thighs, ankles, and feet. The findings revealed that most of the participants were shift workers, highlighting the prevalence of non-standard schedules among taxi drivers. Shift workers reported higher rates of discomfort and health issues, and they were more likely to visit the hospital frequently compared to fixed-time workers. The study identified that both groups of workers experienced uncomfortable postures and prolonged standing or sitting in their job activities. However, shift workers generally faced more severe discomfort and pain due to prolonged static postures. In terms of MSDs, shift workers reported a higher occurrence of issues in various body areas, notably the neck, shoulders, upper back, and lower back. On the other hand, fixed-time workers had lower rates of MSDs in multiple body regions.

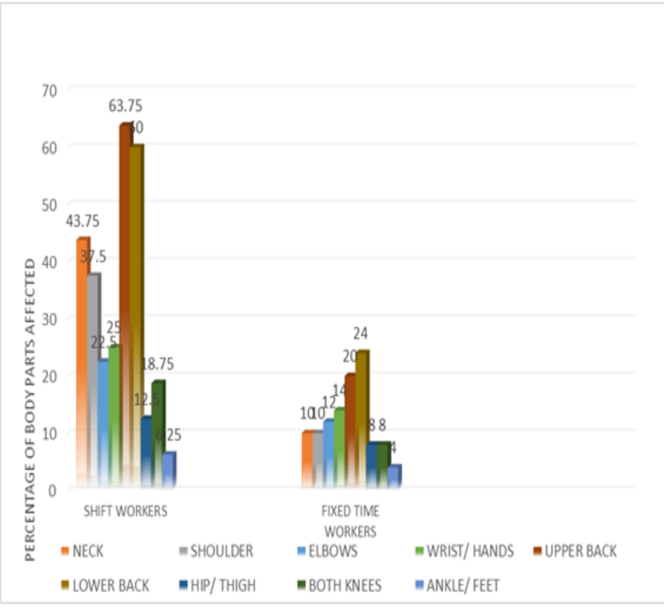

Chart -1: Percentage of MSD in Different Body Parts for Taxi Drivers

3.3 Correlation Analysis

The study found strong connections between certain factors and musculoskeletal disorders (MSDs) in specific body areas. Factors like age, shift rest and work duration, health issues, and posture are significantly linked to neck and shoulder problems. Rest frequency, work duration, health issues, and awkward postures are associated with issues in the elbows, wrists, and hands. Knee problems are influenced by work duration, rest frequency, posture, and health issues. Similarly, ankle and feet problems are connected to work duration, rest frequency, posture, and health concerns. Addressing these factors can improve musculoskeletal health and reduce MSD risks in those areas.

3.4 Testing Factors Significance

The t-test is a statistical technique used to compare the means of two independent groups and assess if there is a significant difference between them. It is widely employed in research and data analysis when studying categorical variables or comparing different populations. Researchers use software like SPSS to calculate the t value, degrees of freedom, and p-value, which helps determine the statistical significance of the variables under investigation.

Table -3: T- Test Result

Sl No	Variables/ Factors	Mean & Sd		p	t
		Day/ Fixed Workers	Shift Workers		
1	Age	29.90(5.234)	39.80(11.053)	0.000	6.873
2	Height	1.6998(5.234)	1.6963(0.07696)	0.797	0.258
3	Weight	71.24(10.265)	70.89(10.614)	0.852	0.187
4	Bmi	24.753(3.852)	29.705(3.767)	0.944	0.070
5	Experience	6.54(3.376)	9.14(6.750)	0.040	2.90
6	Exercise	3.38(1.413)	3.15(1.351)	0.355	0.928
7	Job Satisfaction	3.96(1.029)	1.60(0.866)	0.620	0.497
8	Rest Frequency	3.04(1.068)	4.41(0.822)	0.000	7.761
9	Working Hours	3.00(1.050)	4.42(0.823)	0.000	8.09
10	Health Issues (Due to Vibration...)	3.06(1.018)	4.24(1.022)	0.000	6.40
11	Leave Frequency	3.68(1.047)	4.25(0.864)	0.545	6.07
12	Hospital Visit Frequency	3.00(1.010)	4.22(0.954)	0.000	6.9
13	Awkward Posture	3.10(1.074)	4.41(0.822)	0.000	7.8
14	Sit/Stand In One Place Frequency	3.08(1.066)	4.42(0.823)	0.000	8.01

The table of p-values from the t-tests shows significant differences between shift workers and day drivers in various demographic and occupational factors. Shift work has a considerable impact on characteristics such as age, experience, rest frequency, working hours, health issues, hospital visit frequency, and posture. These findings highlight the need for further research on the specific effects of shift employment. Overall, the t-test results provide statistical evidence of the significant influence of shift work on the studied population.

3.5 Postural Analysis

Combining the JACK software with the OWAS and RULA tools offers a systematic approach to assess ergonomic risks associated with repetitive actions of three-wheeler taxi drivers. The integration allows for a more comprehensive evaluation of their postures, identifying high-risk positions based on established thresholds. In cases where scores differ, specific criteria can be used to evaluate the level of risk. Overall, this combination enhances the accuracy and efficiency of posture analysis for these drivers, helping to address potential ergonomic concerns effectively.

Model 1: Ordinary Sitting Condition

The regular sitting posture of a three-wheeler taxi driver raises significant ergonomic concerns. The position with feet on the pedals or floor, hands on the handlebar without support, and a tilted body can lead to musculoskeletal issues. Insufficient lumbar support can also cause poor spinal alignment and stress on the spine, increasing the risk of musculoskeletal disorders (MSDs) such as lower back pain, neck and shoulder discomfort, and wrist or hand injuries.

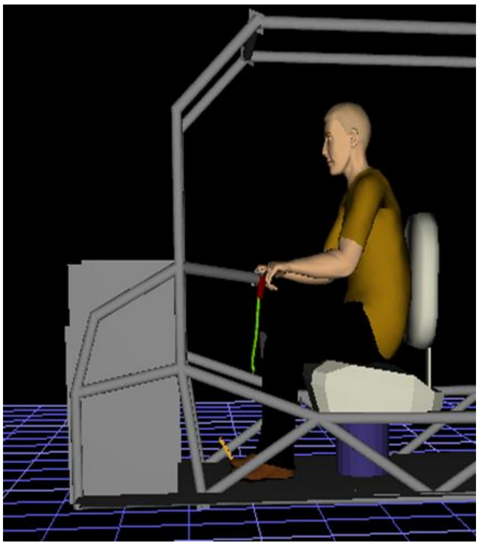

Fig -2: Ordinary Sitting Condition

The RULA score of 7 indicates that certain upper limb postures while driving may cause musculoskeletal strain, calling for further evaluation and potential ergonomic measures to reduce the risk of work-related MSDs. Similarly, an OWAS score of 2 highlights that the driver's actions involve postures or motions that can create higher musculoskeletal stress, signaling the need for changes to improve ergonomics and minimize the risk of injury.

Ergonomic Intervention 1: The First Modified Sitting Posture.

The replacement of the normal seat with an alternate seat did not significantly improve the postural analysis results for three-wheeler taxi drivers. The RULA score decreased to 6, indicating a moderate level of danger, but the OWAS score remained at 2, indicating the same level of musculoskeletal stress. This suggests that simply adjusting the seat may not be enough to address the ergonomic issues faced by the drivers. Additional measures, such as modifying the handlebar height and pedal position, optimizing the driver's posture and seating position, adjusting seat height and suspension, and ensuring correct body alignment, should be considered to create a safer and more comfortable working environment for the drivers. Further assessments are necessary to identify the root causes of high-risk postures and implement appropriate solutions to mitigate the observed postural disorders.

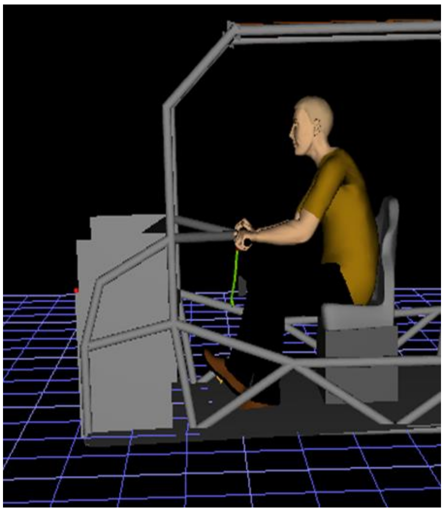

Fig -3: First Modified Sitting Posture.

Ergonomic Intervention 2: The Second Modified Sitting Posture

A bucket seat, like a car seat, was added in the second step of the alteration process. This seat raised the driver's height and improved their posture. The new seat significantly improved the postural analysis results and reduced strain on the driver's body. Continuous monitoring and evaluation of the driver's posture, comfort, and driving practices further enhance the overall ergonomics. Compared to the initial seat, the new seat resulted in lower postural risk scores, indicating improved safety and comfort for the driver. The adoption of the bucket seat effectively solved the ergonomic issues faced by the three-wheeler taxi driver.

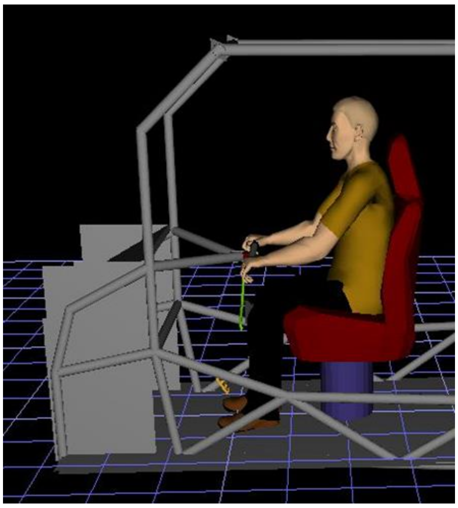

Fig -4: Second Modified Sitting Posture

Ergonomic Intervention 3: The Final Modified Sitting Posture

Initially, the seat replacement did not lead to significant improvements. However, the introduction of a car-like bucket seat with height adjustability, better support, and an armrest proved highly effective. This final model significantly reduced postural risks and mechanical stress on the driver's body. The RULA score decreased from 7 to 3, indicating a lower risk level, and the OWAS score remained at 1, indicating reduced physical stress. The improved seating system enhances comfort and lowers the likelihood of musculoskeletal issues. Overall, this comprehensive ergonomic approach prioritizes driver well-being and promotes a healthier work environment for three-wheeler taxi drivers.

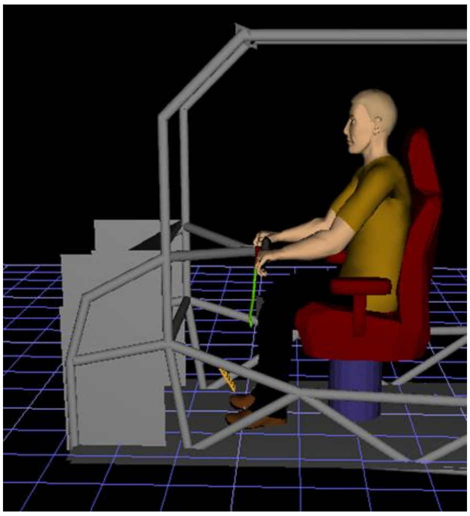

Fig -5: Final Modified Sitting Posture

Table 4: Conclusion of Result

	Ordinary Sitting Condition	First Modified Sitting Posture	Second Modified Sitting Posture	Final Modified Sitting Posture
RULA	7	6	4	3
OWAS	2	2	1	1

The model for improving drivers' posture and reducing the risk of musculoskeletal issues started with a seat replacement, which showed no significant changes. However, the introduction of a car-like bucket seat in the second stage improved the RULA score from 7 to 4 while maintaining the OWAS score at 3. The final model, with the addition of an armrest and continued focus on proper body posture, led to significant improvements. The RULA score further dropped to 3, and the OWAS score decreased to 1. The armrest provided upper-extremity support and comfort, while the emphasis on maintaining a good sitting position helped with spine and lower-extremity alignment. These interventions aim to reduce the likelihood of musculoskeletal disorders. Ongoing monitoring, evaluation, and driver feedback are crucial for the model's long-term success. To maximize its benefits, continuous training on posture management and proper armrest use should be provided.

3. CONCLUSIONS

The study aimed to tackle musculoskeletal disorders (MSDs) among 3-wheeler taxi drivers, considering both shift and fixed-time workers. The study included several stages of analysis, intervention, and evaluation in order to enhance working conditions and lower the risk of MSDs in both groups. The initial research considered demographic parameters as well as the prevalence of MSDs in various body parts for the whole driver population. Certain work-related characteristics were discovered to have a substantial impact on the drivers, particularly those who were working shifts. Shift employees reported higher levels of dissatisfaction, longer working hours, lower rest, and more health problems than fixed-time workers. Postural investigation with instruments like the Rapid Upper Limb Assessment (RULA) and the Ovako Working Posture Assessment System (OWAS) indicated that both shift and fixed-time workers had high-risk postures at work. These findings highlighted issues that drivers encounter. Based on the findings, changes were made to the work practices, arrangements, and seating arrangements for both shift and fixed-time personnel. The interventions were designed to improve posture, give more support, and promote comfort at work. The RULA and OWAS ratings were used to assess the effectiveness of these procedures. The approaches resulted in a progressive drop in the RULA and OWAS scores. The addition of an armrest to a bucket seat with increased height and adjusted body posture resulted in improved scores, indicating a lower risk of MSDs. This study's findings underline the importance of resolving work-related issues and offering ergonomic solutions for both shift and fixed-time workers. It is possible to establish a safer and healthier working environment for three-wheeler taxi drivers by applying these strategies. Regular monitoring, evaluation, are required to guarantee the beneficial effects are sustained. It is possible to reduce the prevalence of MSDs, improve driver well-being, and boost overall job satisfaction for 3-wheeler taxi drivers.

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