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AS SESSMENT OF MUSCULOSKELETAL DISORDERS AND RISK FACTORS IN PUBLIC TRANSPORT BUS DRIVERS USING THE RULA METHOD

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Abstract: Driver postural analysis is crucial for enhancing vehicle design and ergonomics, focusing on increasing driver safety and comfort. It identifies and addresses ergonomic issues that could lead to discomfort, musculoskeletal disorders (MSD), fatigue, or injury, improving the overall driving experience. This research employs the Rapid Upper Limb Assessment (RULA) method to analyze the posture of 30 bus drivers in Telangana, India, assessing their risk for musculoskeletal disorders (MSDs). The analysis, conducted using AUTOCAD and CATIA software, revealed that a substantial 97% of the drivers are at high risk for musculoskeletal disorders (MSDs), with their RULA scores ranging between 5 and 6. This finding highlights the critical need for ergonomic improvements in their driving environments, additionally, 3% are in a medium-risk category, suggesting potential ergonomic issues. The study proposes ergonomic interventions like redesigning driver seating, educational programs on safe postures, and regular breaks to reduce risks. This research contributes to the field of automotive ergonomics, emphasizing the need for tailored solutions to enhance driver safety and comfort.

Keywords: Rapid Upper Limb Assessment; Musculoskeletal disorders; Ergonomics.

I.INTRODUCTION

Driver postural analysis is an essential tool for improving the design and ergonomics of vehicles and promoting drivers' safety and comfort. It allows for identifying and correcting ergonomic issues that may contribute to discomfort, MSD. fatigue, or injury, ultimately leading to a safer and more comfortable driving experience. Massaccesi *et al*.,[1] assessed work-related upper-limb disorders in rubbish-collection and road-washing vehicle drivers using RULA, adjustable seats showed better posture scores. Giuseppe *et al*., [2]conducted a biomechanical study to analyse car driver posture for ergonomic vehicle design using optoelectronics and pressure sensors. Mohd Azrin *et al*., [3] optimized car seat design using Catia software to reduce stress on the lower back. Clare *et al*., [4]studied support aids for disabled drivers and identified challenges in ergonomics design and user acceptance. Michelle Rae *et al.,*[5] observed patrol officers during day and night shifts to identify postural stability differences and improve vehicle interiors to minimize injury risks. Gowtham *et al*., [6] used virtual ergonomics to assess seating comfort for bus drivers and recommended adjustments based on anthropometry. Philipp *et al*., [7] optimized driving postures for different load scenarios using musculoskeletal inverse dynamic simulation and prediction models. Sung *et al*.,[8]used 3D manikins and an adjustable seating buck to analyse suitable driving environments based on driving postures. Cuong Tran *et al*.,[9]developed a marker less system to explore 3D driver posture dynamics for driver assistance. Samrat Dev *et al*.,[10]investigated MSDs among male bus drivers, identifying neck pain as the second highest complaint.

II. METHODOLOGY

Driver seating posture analysis is a critical aspect of automotive ergonomics, focusing on how a driver's position while operating a vehicle can affect their comfort, safety, and performance. Here are the standard methods used in such analyses:

- Anthropometric Measurements:
- RULA (Rapid Upper Limb Assessment)
- REBA (Rapid Entire Body Assessment)

The current study focuses on the RULA analysis tool to predict the risk of musculoskeletal disorders for drivers. The study suggests how the posture adopted while driving can lead to long-term health issues in the upper limbs and how adjustments in car design or driving habits might mitigate these risks.
The Rapid Upper Limb Assessment (RULA) actively assesses the risk of work-related upper limb disorders using the following steps:

2.1 Observing the Task: Thirty public transport bus drivers were selected for the present study to predict work related musculoskeletal disorders the demographic data were tabulated in the table 1.

2.2 Recording Postures: Requested thirty participants to sit on the simulator comfortable and posture of all participants were capture with camera and measured in AUTOCAD software as shown in figure 1.

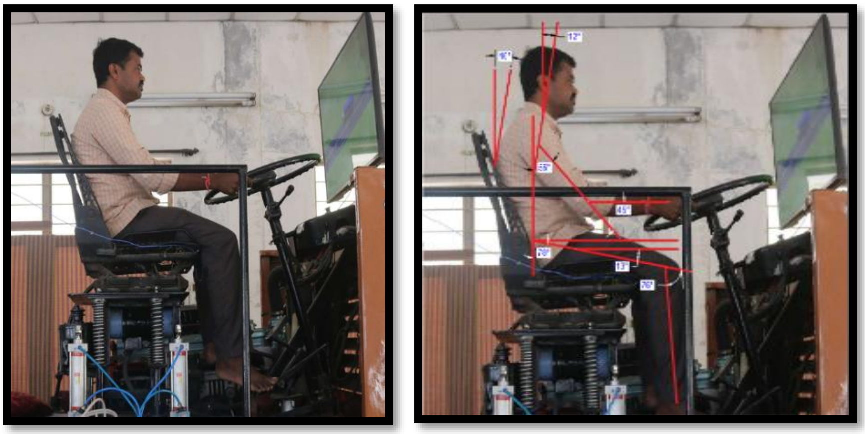
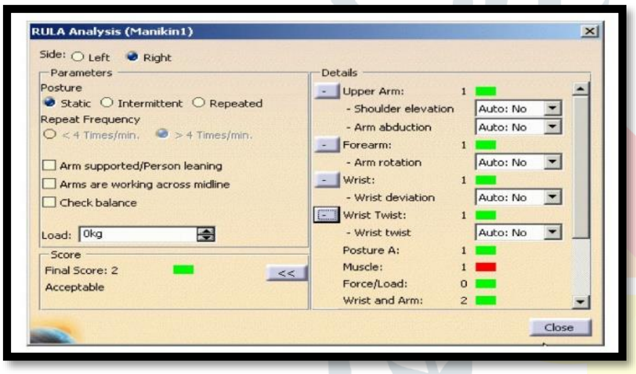


Figure.1 Prediction of posture angles

2.3 Scoring Upper Limb Postures: A RULA Analysis in CATIA software used to assign scores to each body part. This includes considering the angles and rotations of the neck, trunk, and upper limbs, and noting if the posture is static, repeated, or involves forceful exertions as shown in figure 2.



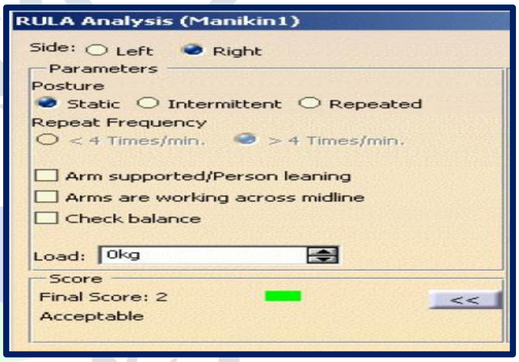


Figure.2 RULA analysis score of group A and group B

Figure.3 RULA analysis final score

2.4 Calculating the Score for Each Section: The body is divided into two groups for scoring:

- Group A includes the arm, wrist, and hand.
- Group B includes the neck, trunk, and legs.

Each group is scored separately, and the scores are combined to generate the overall RULA score.

2.5 Determining the Final RULA Score: The scores from Group A and Group B are added to determine the final score, which indicates the level of intervention required. Scores range from 1-2 (low risk) to 5-7 (high risk, requiring immediate changes).

2.6 Making Recommendations for Improvements: Based on the final score, specific recommendations are made to improve the ergonomics of the task, such as changes in tool design, workstation layout, or task methods.

2.7 Conducting Follow-Up Assessments: After changes are implemented, follow-up assessments are conducted to ensure that the ergonomic risks have been effectively mitigated. This approach is used in real-time to identify and address ergonomic risks in the workplace, particularly those affecting the upper limbs.

III.RESULTS AND DISCUSSIONS

The data were determined using CATIA software and depicted in Figure 4 and Table 2. The RULA scores from thirty participants present significant findings regarding the ergonomic risks in the evaluated environment. The data show that most (97%) participants scored within the 5–6 range on the RULA scale. This score indicates a high-risk level, necessitating immediate investigation and changes. Such scores strongly suggest that if these individuals continue with their current postures for prolonged periods, they are at a high risk of developing severe musculoskeletal disorders (MSDs).

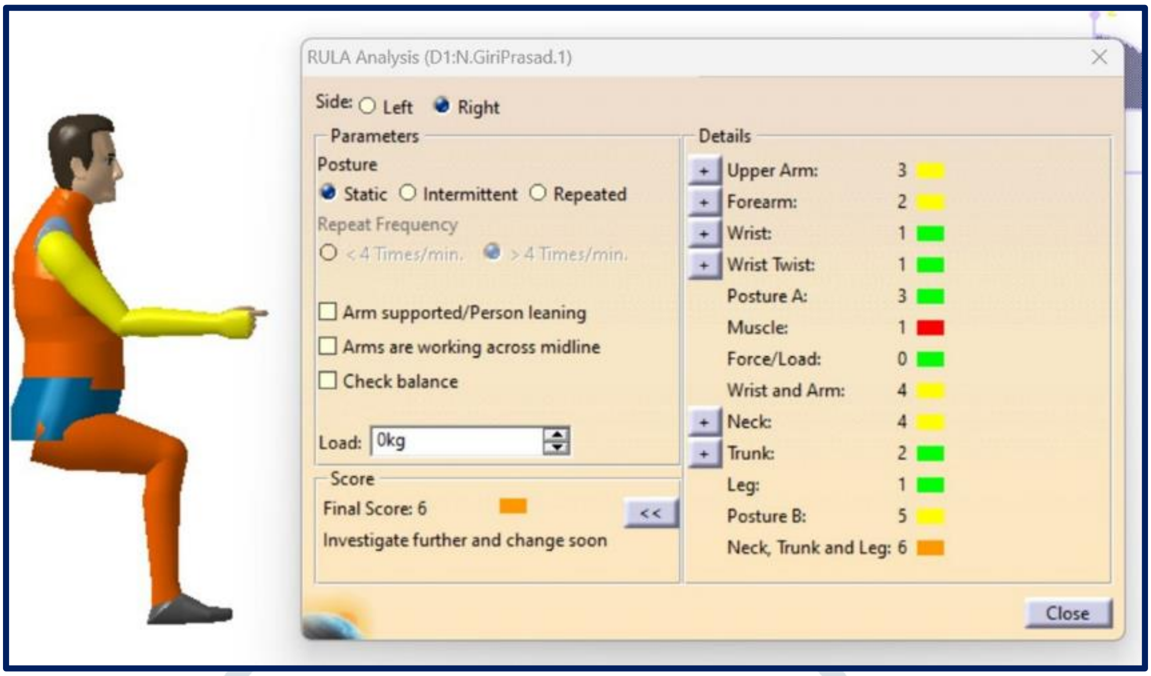


Figure. Error! No text of specified style in document. **4** RULA analysis final score of

This result aligns with previous studies cited [11-16], which have consistently reported a high prevalence of MSDs among bus drivers. These studies underscore the importance of seat adjustability and ergonomic improvements in mitigating vibration exposure and reducing physical fatigue. Furthermore, the specific mention of low back pain among bus drivers in the literature [18] reinforces the need for ergonomic enhancements in this occupational group.

Table Error! No text of specified style in document.**.1** RULA analysis scores of 30 participants

S. No	Posture-A	Posture-B	Final RULA Score
D01	3	5	6
D02	3	5	6
D03	3	5	6
D04	2	2	5
D05	3	5	6
D06	3	5	6
D07	2	5	5
D08	3	5	6
D09	3	5	6
D10	3	5	6
D11	3	5	6
D12	3	5	6
D13	3	5	6
D14	3	5	6
D15	3	5	6
D16	3	5	6
D17	3	5	6
D18	3	5	6
D19	3	5	6
D20	3	5	6
D21	3	5	6
D22	3	5	6
D23	3	5	6
D24	3	5	6
D25	3	5	6
D26	3	5	6
D27	3	1	3
D28	3	5	6
D29	3	5	6
D30	3	5	6

On the other hand, a smaller fraction (3%) of participants fell into the 3–4 range, which, while less alarming, still signals a need for investigation and potential changes. This range suggests a medium level of risk where ergonomic adjustments can prevent the escalation of risk and potential health issues.
The study focuses on identifying the ergonomic comfort posture angles for individual drivers. The presentation of a sample comfort posture in the figure offers a visual guide for ergonomic improvements. This proactive approach reduces the current ergonomic risks and contributes to a broader understanding of optimal driving postures tailored to individual needs.

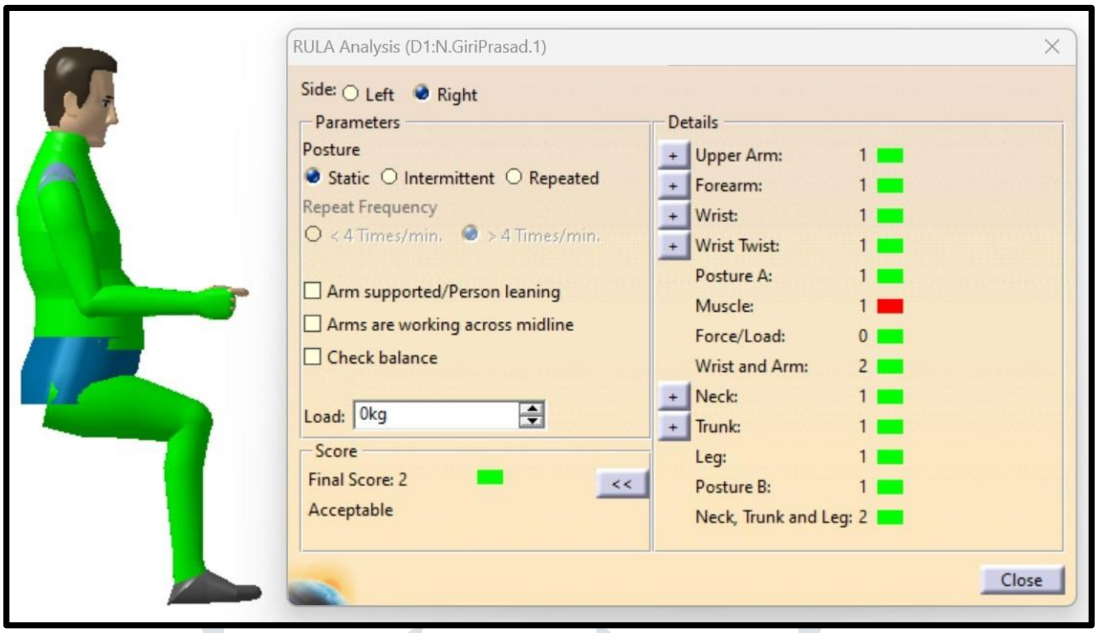


Figure.5 RULA analysis score after adjustment of posture angles

IV.CONCLUSION

The Rapid Upper Limb Assessment (RULA), conducted on a sample of thirty drivers from Telangana, India, has provided valuable insights into the ergonomic risks associated with their driving postures. With 90% of the participants registering in the medium-risk category of 5 to 6 on the RULA scale, it is evident that the current driving postures might lead to musculoskeletal discomfort or disorders if not addressed promptly.
These consistent medium-risk scores highlight the need for specific ergonomic improvements, which could include:

- Re-evaluation and redesign of the drivers' seating and controls,
- Educational programs focusing on safe driving postures and
- Implementing regular breaks to reduce the strain of prolonged static postures.

Furthermore, while the lower risk scores of approximately 10% of the participants do not call for immediate action, they suggest that even minor ergonomic enhancements can significantly benefit these drivers' long-term health and comfort.

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