

RAPID UPPER LIMB ASSESSMENT AMONG MALAYSIAN MULTI-PURPOSE VEHICLE'S DRIVER

ABSTRACT

Conditions of comfort driving may be perceived differently by drivers with different physical built or gender where right sitting position plays a big element in maintaining body health. Therefore, the objective of this paper is to analyze anthropometric data of Multi-Purpose Vehicle's (MPV) driver using Rapid Upper Limb Assessment (RULA) technique. RULA was performed on various MPVs seats. The outcome of this study indicated that seat posture among the MPVs driver required further investigation. This outcome suggested for further advanced research conduct in the future.

Keywords :Rapid Upper Limb Assessment (RULA),Multi-Purpose Vehicle's (MPV), anthropometrics, musculoskeletal disorder (MSD)

1. INTRODUCTION

Driver's seat is an important component in car manufacturing process. This is because every car driver has his / her own preferred driving position that may vary from each other. Discomfort sitting condition tend to make one to modify sitting position (Holland K. and Minnis G.,2020) or take timely sitting break (Huizen J. and Minnis G.,2018). **Sitting posture and musculoskeletal disorder (MSD) are considered serious issues by researchers in wide-range of industries and activities such as agriculture (Arya et al. 2022), emergency medical surveillance (Xu et al., 2021), lifting process (Ibrahim(a) et al., 2018) etc.** A safe and comfortable driver's seat plays a very important role in car seat design and fabrication. Today, drivers are more concerned with their driving safety and comfort, thus they perceived that comfort must have the same level of importance as with functional and aesthetic design of automobile. Therefore, ergonomically designed driver's seat is important because it could enhance drivers' safety and comfort while they are driving and controlling the car (Mohamad, et al., 2016). Driver's seat comfort while driving needs to be differentiated from the comfort of sitting on a chair at home, in the office or at the workplace. This shows that driver's seat comfort in car has distinctive comfort value compared to other types of seats. Driving posture discomfort can contribute to MSD problem injuries, lumbar pain, and fatigue. The MSD problem is a condition where a part of musculoskeletal system is injured over time. The disorder occurs when a body part is continually used to work hard, stretch farther, impact more directly or functions at a greater level than it is supposed not to. The MSD impact could be either acute or chronic where in both conditions could cause damage on a joint, muscle and bone. However, others area can be strained and their response to that trauma may be an injury.

In order to choose the best driver's seat, consideration of several criteria is required. These including whether it is comfortable, easy to use, and adjustability in sitting condition. An ergonomics driver's seat can be a particular seat designed to reduce stress and strain on a body while drivers sitting to control vehicle. Long trip spends a lot of time on driver's seat. This condition could cause repetitive stress disorder, an injury to a part of the body due to overusing or exerting too much stress on that body part. This repetitive stress disorder leads to MSD. Car seat comfort has a strong relationship with the postural support characteristic to the driver's. Therefore, it is important to design a car seat that can contribute towards comfort and seating adjustability. Discomfort and lower back pain are frequent complaints reported by drivers. Drivers tend to experience pain more often as it is more difficult to

shift body positions while driving. Low-frequency whole-body vibration in moving cars can contribute to effects on the lower back. The shape of the vehicle seat itself may put pressure on selected parts of the legs, back, and buttocks. This contact can lead to pain or discomfort at pressure points and may affect blood flow to the legs and feet. Therefore, the objective of this research is to analyze sitting posture among Multipurpose Vehicle's (MPV) driver using Rapid Upper Limb Assessment (RULA) method. MPV is selected due to this vehicle are commonly used for long journey. This study is limited to Malaysian MPVs drivers only. It hopes that this study could alleviate the MSD among drivers.

2. METHODOLOGY

In order to achieve the objective of this research, an orderly approach was drawn. This approach including main parts of data collection and analysis. Flow chart illustrated below simplified methodology implemented in this research in order to complete research objective.

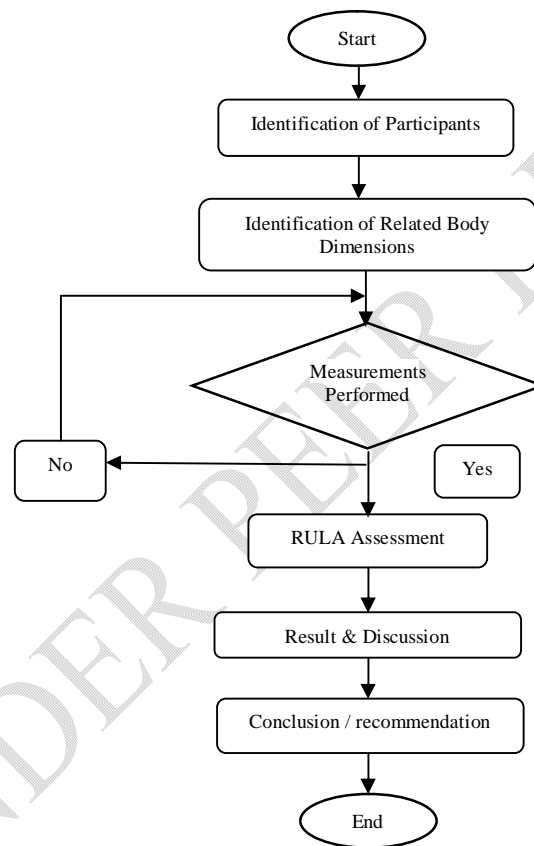


Figure 1: Experimental flow chart

2.1. DATA COLLECTION

Total of 32 males MPVs driver in Malaysia participated in this study and this total sample size

participants should be statistically accepted [Pernegeret *al.*, 2015]. This minimum sample size regards to limitation of statistical anthropometrics database available at Malaysia with respect specific population (J.F. Rohaniet.*al.*,2015). Participants age ranged from 20 to 60 years old.They were healthy with no injury or experiencing cumulative trauma disorder (CDT). Dimensions in related to sitting posture were gathered. Those including stature (body height), sitting height, lower leg length (popliteal height), hips breadth buttock-popliteal length (seat depth) ,eye height, sitting and interscye breadth. All dimensions performed while participants sitting on various model of MPV. Those sitting posture are as the following diagram noted 1,2,4,5,7 and 10 accordingly.

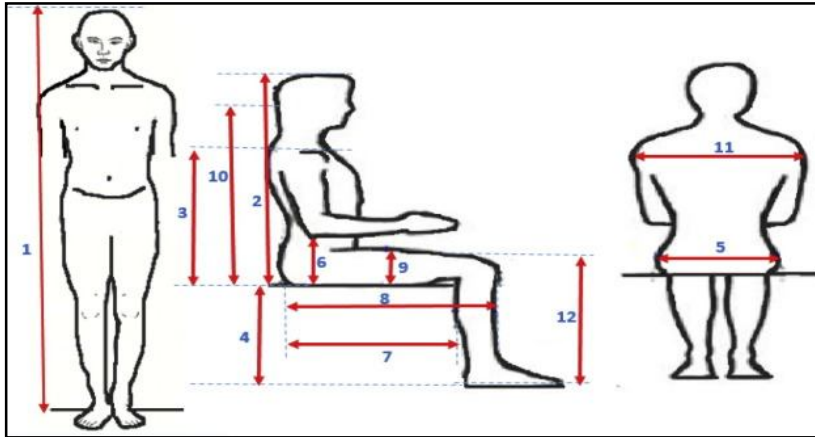


Figure 2. Body dimensions in related to sitting posture collected .All dimensions are related to sitting posture.

Data collected were analysed using SPSS software. Data could also be manually approximated using the following formula.

$$k^{\text{th}}\text{percentile} = \bar{x} \pm z\sigma$$

Where ;

k^{th} = Population percentile

z = Constant

$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$ = Mean

$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$ = Standard deviation

k^{th} percentile	10 or 90	5 or 95	2.5 or 97.5	1 Or 99
le				
z value	± 1.28	± 1.64	± 1.96	± 2.33

The percentiles values obtained by multiplied constant z value and added or subtracted accordingly to the mean / average. The above simplified formula in the form of percentile values and standard deviation are commonly applied by many researchers to categorized anthropometric data accordingly (M. Deros *et al.*, 2015, Mohd. Yusuffet *al.*, 2016, MdDawalet *al.*, 2016, Ibrahim (b) and Mohd A, 2017)

2.2. RULA ASSESSMENT

RULA assessment aim to identify driver's sitting position using anthropometric data. This assessment was performed using the above statistical data. RULA assessment was performed in order to identify body segments that experiencing posture related problem which need to be improved. RULA assessment performed using CATIA V5, an engineering and design leading software which capable of designing, simulating and analyzing prior to the actual products manufacture in range of industries including aerospace, automotive, consumer goods, industrial machinery and etc. where actual shape of parts designed could be assembled and viewed. CATIA V5 also capable of performing ergonomics ergonomic design & analysis. Alternatively, other relevant software such as Ergo-Fellow 2.0 by FBF SISTEMAS could also perform RULA (Ayub Y. and Shah Z.A., 2018). Steps of RULA assessment including preparation CAD model of components and 3D scenario, manipulating manikin, changing the anthropometric variables, creating links between manikin & geometry/components and human activity analysis. RULA assessment resulted to RULA score of 1 to 7 with specific color and comment reported. Scale 1 noted the least concerned and 7 noted the most concerned accordingly. The summary of scale indicated is as the following Table 1.

Table 1: Level of MSD indicator

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 high risk, implement change now

3. RESULT AND DISCUSSION

Data taken were analysed and summarized accordingly as of Table 2.

Table 2 : Summary of anthropometrics data

Dimensions (cm)	Mean	Std. Deviation	Min	Max	Percentiles		
					5th	50th	95th
Standing height	160.19	9.35	139	175	143.55	160.19	175.00
Sitting height	82.72	5.86	70	90	70.00	82.72	90.00
Popliteal height	42.64	2.42	36	47	37.95	42.64	46.35
Hips breadth	43.13	6.24	29	60	32.90	43.13	56.10
Length of buttock to popliteal	45.63	3.30	38	50	38.65	45.63	50.00
Sitting eye height	71.47	10.67	24	83	48.05	71.47	82.35
Interscye breadth	47.25	7.46	36	78	37.30	47.25	63.70

From statistical data obtained, RULA assessment was performed using CATIA software. An example of RULA analysis performed among average male MPVs driver shows as of the following Figure 3(a) and (b).

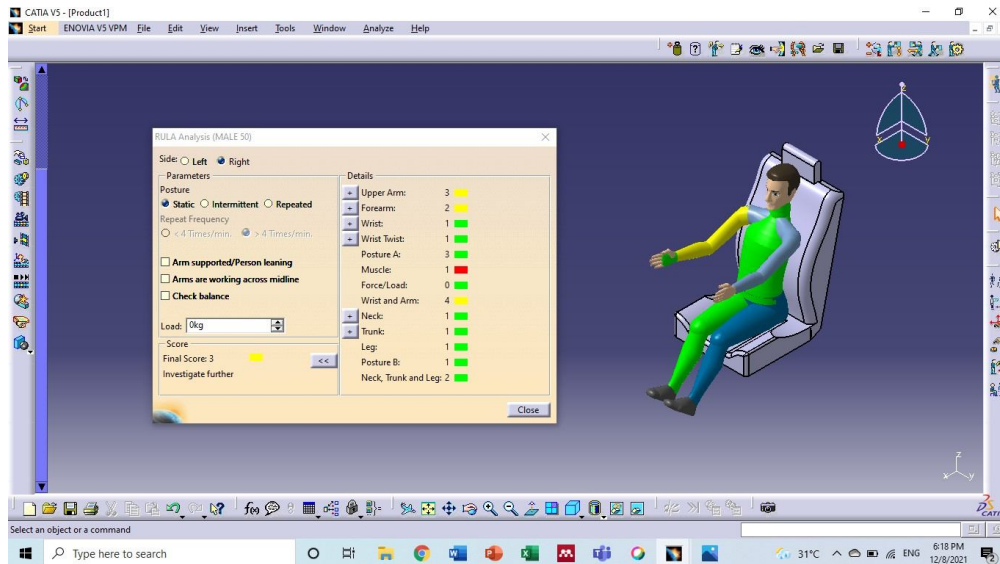


Figure3(a):RULAscorefor50thpercentileofmaleparticipant.(Isometricview)

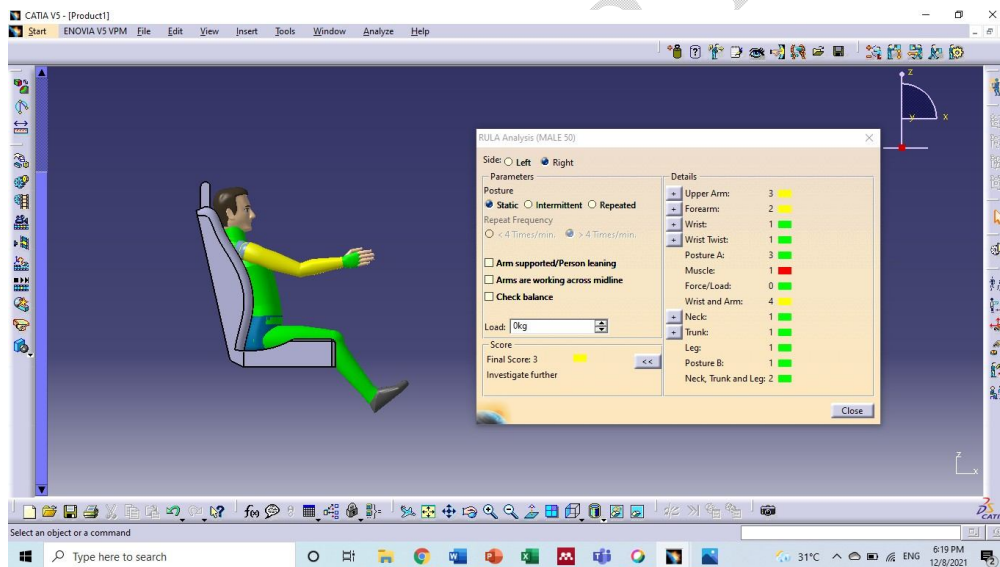


Figure3(b):RULA scorefor50thpercentileof maleparticipant.(Left view)

The final RULA assessment results noted on problematic postures at different percentile value summarized on Table 3.

Table3 :RULAassessment result forevery posture.

Problematic Posture	Population Percentiles	Score	Color Code	Indicator
the upper arm, forearm, muscle, wrist and arm	5 th	3		InvestigateFurther
	50 th	3		InvestigateFurther
	95 th	3		InvestigateFurther

It was noted that problematic posture of the upper arm, forearm, muscle and wrist and arm need to be further investigated.

4. CONCLUSION

In this paper, the objective of RULA assessment using anthropometric data of MPV's driver are achieved as this assessment could detect problematic MPV's driver postures. Based on the results obtained, most of the participants did not fit to the correct ergonomic sitting posture of the MPV's seat as the overall RULA assessment indicated yellow in color, suggesting further investigation require. This could be concluded to several clarifications. Firstly, the Malaysian male drivers may not fit into the MPV's driver's seats design. Secondly, data taken may not be accurate as simple measurement was performed. Thirdly, MPV's driver may not practice to the correct sitting position. Therefore, it is suggested further research be conducted such as gathering more data of Malaysian MPV's driver and using more advance techniques such as vehicles motion comfort (de Winkel *et al.*, 2023). This is very important as future result obtained would be useful for future references to re design MPV's seat as the right sitting posture contributed an important factor in maintaining the body health.

REFERENCES

1. Arya K.T., Ramana C., Ravindra Reddy B., Hari Babu B. and Ramana M. V. (2022). Comparison of Anthropometric Parameters of Women and Men Agricultural Workers Pertaining to Tractor Operator Workspace. *Current Journal of Applied Science and Technology* 41(44): 53-60, no.94328.
2. Ayub Y. and Shah Z.A. (2018). Assessment of Work Related Musculoskeletal Disorders in Manufacturing Industry. *Journal of Ergonomics* 8: 233. doi: 10.4172/2165-7556.1000233.
3. de Winkel K.N., Irmak, T., Happee R., Shyrokau B. (2023). Standards for passenger comfort in automated vehicles: Acceleration and jerk. *Applied Ergonomics* 106: 103881.
4. Huizen J. and Minnis G. (2018). Sitting positions for good posture. <https://www.medicalnewstoday.com/articles/321863> (Access on 24th April 2022).
5. Holland K. and Minnis G. (2020). What's the Best Sitting Position for Good Posture? <https://www.healthline.com/health/sitting-positions> (Access on 24th April 2022).
6. Ibrahim(a), Mohd H., Mohd, A., Raja M. Raja M., Ngah N., Shari N., Che I. Muhd F., Mohamad Y. Mohamad H, Rani, Muhamad S. (2018). Assessment of ergonomics factors for lifting process in working environment. *International Journal of Current Research*, 10(09): 73638-73643.
7. Ibrahim(b), Mohd H and A. Mohd, N. Aainaa, (2017). The Assessment of Grip Span According to the Anthropometrics Data Among Technical College Students in Malaysia – A Preliminary Study *Australian Journal of Basic and Applied Sciences*, 11(9): 131-135.

8. M.DerosB., Hanief Hassan N.H., DaruisD.D. and MohdTamrinS. B. (2015). Incorporating Malaysian's Population Anthropometry Data in The Design Of An Ergonomic Driver's Seat. World Conference on Technology, Innovation and Entrepreneurship. Procedia - Social and Behavioral Sciences 195 (2015) 2753 – 2760
9. MdDawal, SW., Ismail, Z., Yusuf, K., Abdul-Rashid, SH., MdShalahim, NS., Abdullah, NS. and MohdKamil, NS., (2015). Determination of the significant anthropometry dimensions for user-friendly designs of domestic furniture and appliances – Experience from a study in Malaysia Measurement 59 : 205–215.
10. Mohamad D., M.DerosB., DaruisD.D., RamliN.F. and SukadarinE. H. (2016). Comfortable Driver's Car Seat Dimensions Based on Malaysian Anthropometrics Data. Iranian Journal of Public Health 45(1):106-113
11. Mohd. Yusuff, R., Daruis Dian, D.I., MdDawal, S.Z., and Hassan, S.N., (2016). Development of an Anthropometry Database for Malaysian Population: Problem and Challenges Malaysian. Journal of Public Health Medicine 2016, Volume 16 (Suppl. 2): 36-43.
12. PernegerT.V., Courvoisier D.S., HudelsonP.M. and Gayet-AgeronA., (2015). Sample size for pre-tests of questionnaires, Quality of Life Research, Volume 24: 147–151
13. RohaniJ.F., Abdul Rania M.R., AdeyemiA.J. and ArowoloM.O. (2015). Level of Implementation of Ergonomic Based School furniture for Malaysian Children. Proceedings 19th Triennial Congress of the IEA, Melbourne, pp: 9-14
14. Xu Y., Lavender S.A., and Sommerich C.M. (2021). The efficacy of a lifting strap as an ergonomic intervention for EMS providers: Does it make it easier to raise a supine patient to an upright sitting posture? Applied Ergonomics 94:103416.