



Comfortable Driver's Car Seat Dimensions Based on Malaysian Anthropometrics Data

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(Received 20 Nov 2015; accepted 14 Jan 2016)

Abstract

Background: Driving posture discomfort can contribute to musculoskeletal disorders (MSDs), injuries, lumbar pain and fatigue. The three main objectives of this study were to identify the level of awareness for correct and safe driving posture, health implication to their body parts and to propose a suitable car seat fit dimensions appropriate for Malaysian drivers' population.

Methods: The two methodologies used for the study conducted in 2014 were direct manual measurement of 62 anthropometric data involving 1312 subjects and using a survey questionnaire involving 136 subjects to perform subjective evaluation on driving posture discomfort based on 5 points Likert scale.

Results: Results showed 77% of the subjects that took part in the survey agreed that driving posture may influence their discomfort during driving. In short the car drivers were aware on the importance of correct and safe driving posture. However, they are still lacking in terms of knowledge and exposure to practice the correct posture. In addition, survey respondents believed the body parts that experienced discomfort are the neck (50%), followed by the upper back (47.06%), lower back (45.59%), left buttock (39.71%), right buttock (38.97%), right shoulder (33.82%) and then the right foot ankle (23.53%).

Conclusion: Drivers' awareness level and attitude toward correct and safe driving posture correlates positively to their physical health and comfort. Based on the Malaysian anthropometric data, this study has proposed a set of comfortable dimensions for driver's seat: backrest width (480 mm) and height (646 mm); cushion width (503 mm) and length (381 mm).

Keywords: Comfortable, Driving posture, Anthropometry, Car seat, Dimensions

Introduction

Every car drivers have their own preferred driving position and posture that may differ from each other. The criteria of comfort in driving may be perceived differently by drivers with different physical built or gender. A safe and comfortable driver's seat plays a very important role in car design and fabrication (1). "Today, car drivers are more concerned with their driving safety and comfort, thus they per-

ceived that comfort must have the same level of importance as with functional and aesthetic design of automobile" (2). Therefore, ergonomics is a very important factor that needs to be incorporated in the design of driver's car seat to satisfy drivers' requirements to ensure drivers' safety and comfort (3-7). Ergonomically designed driver's car seat is important because it could enhance drivers' safety and

comfort while they are driving and controlling the car. Twenty percent of road accidents were due to driver's physical fatigue (8). Physical fatigue and musculoskeletal disorders among drivers were mainly due to incorrect driving postures (9, 10).

Seat features such as the surface form, cushion type, back seat and pan angle, lumbar support, modifiability and location control (steering and pedal), field of view and space head availability can affect the driving posture (11). Car seat comfort has a strong relationship with the postural support characteristic of the driver's car seat; therefore, it is important to design a car seat that can contribute towards comfort and seating adjustability (12). Meanwhile Mehta et al. suggests driver's car seat designer needs to incorporate users' population anthropometric data to increase drivers' safety and comfort level (13). Drivers' car seat comfort is identified as the short-term effect of a seat on a human body (14). Subjective and objective evaluation methods can be used to measure human comfort and perception by using survey questionnaire (15). Deros et al. (16) had conducted a valid vehicle seat discomfort survey (VSCS) to evaluate driver's car seat that was reliable and valid for determining car seat discomfort from human perception.

"In general, there are two types of research areas in the design of drivers' car seats: studies on the positional and anthropometric requirements for car seats and studies on the seats' comfort performances" (17). Anthropometric data is an important parameter for determining comfortable car seat design and usually are taken between the 5th and 95th percentile of the user population. This principle is called the seat fit parameters and is important in ensuring comfort for the users (18, 19).

The three main objectives of this study were to identify the level of awareness for correct and safe driving postures, health implication to their body parts and to propose a suitable driver's car seat fit dimensions appropriate for Malaysian car drivers' population.

Materials and Methods

This study involved a group of car drivers aged between 18 to 60 yr old conducted in 2014. The range

of participant's age was according to the minimum age legally to obtain driving license (20) and the minimum age before entitled as senior citizens (21). The data collection in this study was divided into two parts: first, subjective evaluation using survey questionnaire; and second the anthropometry data measurement.

1) Subjective Evaluation

A total of 136 physically healthy car drivers participated in the subjective evaluation. The two main purposes of this subjective evaluation were first, to identify the level of awareness on the importance of correct and safe driving posture; and second, to identify the current driving postures practiced and their effect on the drivers' physical health. The survey questionnaire comprise of three sections: personal information; driving activities and body parts symptoms survey based on discomfort scale. The first section on personal information includes information, such as driving frequency, car type, transmission type and history of accident if any. For the second section, the questions focused on their awareness of the correct driving posture. The third section display a picture for identifying the body parts that were experiencing discomfort or pain using a 5-points Likert scale (22).

2) Anthropometric Data Measurement

For anthropometry data collection, the dimensions of 62 body parts were measured from 1312 respondents. All anthropometric data collected were based on MS ISO 7250 standard (23). The anthropometric data were measured and recorded in the data form before being transferred into the computerised anthropometric database. The equipment used in measuring the anthropometric data is the Anthropometer as shown in Fig. 1.

Out of the 62 body parts dimensions measured, only seven body dimensions were used in this study because they are directly related with the development and design of driver's cars seat. The seven body parts as shown in Fig. 2 are: stature [1], sitting height [2], popliteal height [3], interscye breadth [4], hip breadth [5], sitting shoulder height [6] and buttock to popliteal length [7].

Collected data were then statistically analysed using the Statistical Packages for Social Sciences

Software (SPSS) for Windows (version 16.0) and Microsoft Excel 2010.



Fig. 1: Anthropometer

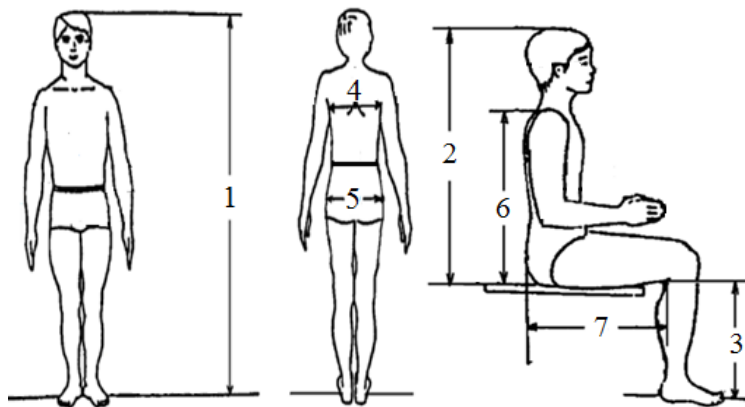


Fig. 2: Anthropometry Body Measurement

Results

1) Subjective Evaluation

The respondents' personal information was collected in the first section and shown in Table 1.

The results from second section of the subjective evaluation, which focuses on the respondents awareness of the correct driving postures is shown in Fig. 3.

The third section was used to identify the body parts that experienced discomfort due to driving activities. Respondents were required to fill up the 5-Likert scale on the body diagram in Fig. 4.

■ Aware ■ Not Aware ■ Not Concern

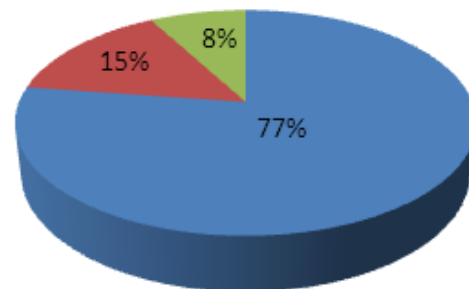


Fig. 3: Percentage pie chart of driving posture influence

Table 1: Data on Personal Information

Information		Total	Percent (%)
Gender	Male	58	42.7
	Female	78	57.4
Ethnic	Malay	116	85.3
	Chinese	16	11.8
	Indian	3	2.2
	Others	1	0.7
Occupation	Student	68	50
	Workers	68	50
Car Type	Compact	61	44.9
	Sedan	67	49.3
	MPV	8	5.9
Car Model	Proton	53	39
	Perodua	55	40.4
	Toyota	14	10.3
	Honda	7	5.1
	Others	7	5.1
Transmission Type	Automatic	72	52.9
	Manual	64	47.1
History of Accident	Yes	49	36
	No	87	64
		Mean	S.D
Age		33.13	15.69
Driving Experience (Year)		13.48	10.21
Driving Frequency (No)		5.29	2.56

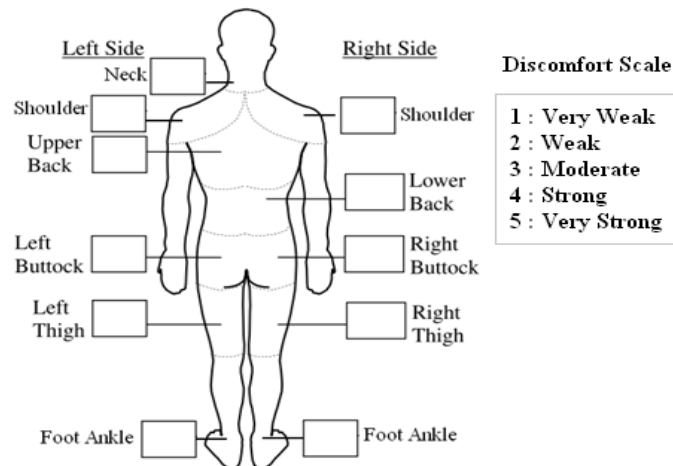


Fig. 4: Body Diagram Source: Kyung & Nussbaum (22)

2) Anthropometric Data for Car Seat Fit Parameters

The anthropometric data gathered were analysed and calculated for its mean, standard deviation, 5th and 95th percentiles values. The values of 5th

and 95th percentile were chosen in order to represent 90% of Malaysian population. Table 2 shows the collected anthropometry data for seven body parts dimensions chosen for this study.

Table 2: Anthropometry data of 1312 Malaysian respondents with 708 males & 604 females (mm)

Body Dimensions	Male			Female		
	5%tile	95%tile	Mean \pm S.D	5%tile	95%tile	Mean \pm S.D
Stature	1582.20	1780.00	1687.60 \pm 59.43	1480.00	1660.00	1567.10 \pm 58.25
Sitting Height	750.00	940.00	856.28 \pm 61.18	675.00	890.00	799.03 \pm 76.10
Popliteal Height	401.45	510.00	448.06 \pm 32.42	370.00	500.00	423.78 \pm 39.08
Interscye Breadth	310.00	480.00	378.15 \pm 47.30	280.00	422.10	347.64 \pm 47.47
Hip Breadth	298.45	485.50	367.36 \pm 63.06	292.10	503.00	380.23 \pm 66.00
Sitting Shoulder Height	470.00	645.55	561.64 \pm 61.55	417.00	593.60	516.85 \pm 62.31
Buttock To Popliteal Length	412.90	560.55	472.64 \pm 44.21	381.40	550.00	458.01 \pm 54.03

Discussions

Table 1 shows the demographic distribution of respondents involved with respect to gender in the subjective evaluation using the survey questionnaire are 78 females (57.3%) and 58 males (42.7%). Meanwhile, according to ethnic background, vast majority of the respondents were Malays with 116 (85.3%), followed by 16 Chinese respondents (11.8%), 3 Indian respondents (2.2%) and others (0.7%).

Figure 3 shows 77% of Malaysian drivers were aware that driving posture may influence their comfort and discomfort during driving. Meanwhile, 15% of respondents were not aware that driving posture can influence their comfort and discomfort and the rest 8% do not shows any concern.

The third section was used to identify the body parts that experienced discomfort due to driving activities. Figure 4 shows results of the survey on the body diagram. Data collected showed majority of the body parts that experienced discomfort were: the neck (50%), followed by the upper back

(47.06%), lower back (45.59%), left buttock (39.71%), right buttock (38.97%), right shoulder (33.82%) and then the right foot ankle (23.53%).

The concern in car seat fit parameters values is to accommodate a design that can cater a wide range of population anthropometric data (19). The constraining or targeted anthropometric values used are usually taken between the 5th and 95th percentile (18, 19). The parameters used in developing car driver seat width minimum parameter should be large and can cater the largest interscye breadth in the population (18, 19, 24). For this case, the minimum value is the 95th percentile male. As for the back seat height, the sitting shoulder height for 5th percentile female is chosen as it can accommodate the population without restricting their vision while driving. As for the cushion width parameters, it must be able to satisfy the largest hip breadth of the population with additional clearance for clothing. From the anthropometric data in Table 2, the largest value is from the 95th percentile female as female usually had slightly wider pelvis bone than male for reproduc-

tive purpose. The female pelvis is more widely separated causing a widening of the hips with respect to the male (25). For the case of cushion length, it is suggested to provide for the smallest value of buttock to popliteal length of the population that is the 5th percentile female because if the cushion is too long then it can put pressure on

the back of the individual legs that may contribute to discomfort and health concern (18, 19).

The proposed driver's car seat dimensions suitable and acceptable for Malaysian population are shown in Table 3. The proposed driver's car seat dimensions were compared with values from past researches from population in various countries.

Table 3: Proposed dimensions for driver's car seat (mm)

	Current	Daruis et al. (24)	Reed et al. (19)	Pheasant (26)	Tiley (27)	Kolich (18)
Back Seat Width	480	449.38	471	500	406-560	514
Back Seat Height	417	460.14	414-551	550	545-595	-
Cushion Width	503	441.79	500	435-500	406-560	446-483
Cushion Length	381.4	379.15	305	435	406	362

From the data shown in Table 3, it can be seen that these five past researchers have recommended different values. Different values are due to different population anthropometric data used. The anthropometric data are different between ethnic groups and may differ within populations (28, 29). Divergent values of seat fit parameters were also found between the Malaysian anthropometric data from this study and Daruis et al. (24). This may be due to the different values of sample used. Daruis et al. (24) had developed an anthropometric data based from 216 subjects only, which include 121 males and 95 females, meanwhile this study had gathered anthropometric dimension from 1312 Malaysian respondents with 708 males and 604 females. It is recommended for researchers who are conducting anthropometry data collection to include larger sample size (30). A larger sample size may produce results that are more representative of the target population (31).

Conclusions

This study had identified the level of drivers' awareness and their attitude toward the correct and safe driving posture and its effect on their physical health. Besides that, this study has also contributed in determining the appropriate dimensions of fit parameters in driver's car seat devel-

opment based on the 1312 comprising of 708 males and 604 females Malaysians anthropometric data gathered. The recommended dimensions for car driver seat are as follows: back seat width (480 mm); back seat height (417 mm); cushion width (503 mm) and cushion length (381.4 mm). It is hoped that the outcomes of this study will be able to assist the automotive manufacturers and designers in designing a suitable and acceptable drivers' car seat that is appropriate with the Malaysian population through ergonomics approach. The results obtained and discussed in this study can serve as a baseline for drivers and also automotive makers in Malaysia in providing more comfortable and safer driver's seat and workspace for the Malaysians population.

Ethical Consideration

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission) have been completely observed by the authors.

Acknowledgments

The authors declare that there is no conflict of interests.

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