

## ORIGINAL ARTICLE

# DETERMINANTS OF CHARACTERISTICS AND DISCOMFORT ON SEATING POSTURE AMONG ELDERLY TAXI DRIVERS: A PILOT STUDY RESULT.

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## ABSTRACT

**Purpose:** Elderly taxi drivers among the whole taxi drivers are rapidly growth in Malaysia. The older taxi community may continue to serve their service even after retirement age of sixty years old. Therefore, older taxi drivers need to take specific consideration during driving activities according to ability and capability to sustain their life and minimizing injuries and avoiding accidents. **Objective:** This study is aimed to determine the characteristics and discomfort seating posture among elderly taxi drivers. **Methodology:** A pilot study was conducted with elderly taxi drivers using a self-administered questionnaire. It included questions on socio-demographic data, work characteristics and discomfort seating posture of the affected body part. Purposive method sampling used base on inclusive criteria; age 60 years old and above, self-driving taxi more than 1 year, no disabilities and driving using a national car. SPSS software used to analyse data. **Results:** The majority were employed by companies (59.1%) and worked more than eight hours daily (90.9%). The majority (95.5%) driving distance more than 150km per-week. More than half respondents (59.1%) having feeling back pain past 12 months. The highest feeling of discomfort on seating posture among elderly taxi drivers is at right buttock (50.0%) and left buttock is only (45.5%). At the lower back body parts indicates the highest (36.4%) discomfort on seating posture compares to other parts. **Conclusions:** An elderly taxi drivers potentially having MSD causes of current car seat design and the seating posture may not follow ergonomics principles. Most of the respondents had low awareness of important seating posture to improve their lifestyle and health.

**Keywords:** Discomfort, elderly taxi drivers, car seat design, seating driving posture.

## INTRODUCTION

Malaysia is now facing a challenge to the changing of the demographic profile of the population. Malaysia's population in the year 2000 approximately 23.3 million and this number will be continued grown year by year to achieve vision 2020. Expected the aging community may continue to serve their services even though after pension, this influenced by their past environment. Besides that, elderly people need specific consideration to sustain their life according to ability and capability in the challenging world. Therefore, these communities prefer to be taxi drivers to replace previous jobs after retirement to continue their life and family. According to data in the year 2014 from Land Public Transport Commission (SPAD)<sup>1</sup>, approximately 64,547 registered taxi drivers in Malaysia. These numbers also represent taxi drivers under category elderly. World Health Organization (WHO) describe people who age above 60 years old falls into a category of elderly. The characteristic of elderly people may different to other younger group of ages in terms of physiological, sensory, perceptual, motor and cognitive abilities that may impact on how elderly drivers interact with vehicles (taxi) and driving behavior<sup>2</sup>. These changes would decrease elderly in ability, strength, reduced ability to process information; slowed reaction and hearing

loss<sup>3</sup>. The elderly taxi drivers are also exposed to fatigue on long hours driving per-day due to bad seating postural and seat design that does not follow anthropometric of a user. Those elements could be factors to develop cumulative injury which is related to musculoskeletal disorders (MSD's) especially injuries at the lower back body part.

Numerous factors make elderly taxi drivers distinct from other professions in term of exposure values when working with MSD related jobs. In the first place is time factor; the previous study stated most of the taxi drivers spent the longer time in driving compared to others driving profession -professional driver ;lorry driver, bus driver, train driver<sup>4,5</sup>. According to Yang Y. et al. 2014, average working time is 10.5 hours per day for 6.4 days per week, and individual taxi drivers spend an average of 3.5 hours waiting for passengers each day. The second factor is related to the space between a taxi and other vehicles<sup>7</sup>. The confined space of taxi may develop stains on lower back posture at lumber spines, which make taxi drivers at a higher low back pain and other MSDs<sup>7</sup>. Several researchers like Bovenzi and Zadini 1992; Chen et al., 2005; Funakosh et al., 2004, and SBM Tamrin et al. 2007 found other occupational factors such as whole-body vibration, long working hours, limited driving space, total

mileage, long distance driving, monotonous driving, time employed as a taxi driver, job dissatisfaction, and job stress may contribute injuries on low back pain and also related to MSDs in generally. From previous literature, fatigue is always associated with long duration of driving. Fatigue resulting from long-term driving can affect driver performance, and are classified into physical and mental fatigue. On the other hand, physical fatigue is mainly caused by driving posture<sup>12</sup>. The taxi drivers have a high risk of damaging the human biological clock rhythm and a risk of fatigue, depression, tension, insomnia and others diseases<sup>6</sup>. That is why ergonomic approach has to be applied in ensuring comfortable driving posture.

Car seat design is important for drivers to feel comfort and safe, especially to elderly taxi drivers while driving. The sitting posture while driving needs to be differentiated from the comfort of sitting on a chair at various environment such as at home, in the office or at the workplace such as in a factory or other industries. According to Andreono et al.(2002), driver's seat comfort in a car has distinctive comfort value compared to others types of seats. The drivers can show discomfort naturally if his body felt pressured, burdened and emotion destruction. Research conducted by Baba Md Deros et al. 2015, adjustability of the driver's seat was the most cited parameter to increase the safety and comfort level. At the worst situation, elderly drivers will feel pain and injury at upper torso body part especially lower back body part. The elderly body muscles are fragile and easily to obtain injury and takes a time to recover compared to younger people. Back pain is the third most common health problem reported by individuals compared to headaches and tiredness<sup>6</sup>.

Ergonomics is one of the significant factors to be considered in designing a seat. Drivers' seats such as seat pans, seat inclination, sitting without lumbar support and awkward body posture bending during driving were reported in MSDs on lower back pain. According to Kroemer et al. (2003), ergonomics is the application of scientific principles, methods, and data drawn from a variety of disciplines to the development of engineering systems in which people play a significant role. One of the most important contributions that ergonomics can provide to the automobile design process is information of the physical size of driver, and his/her preferred postures<sup>12</sup>. A comfortable and safe driver's seat plays a very important role in car design and fabrication. As mentioned by Na et. al. (2005), drivers comfort was as important as the functional and aesthetic design of automobiles since users (elderly) were more and more concerned about safety and comfortable driving. Current bundling of the knowledge on comfort

and discomfort has been limited, while the need for this knowledge is crucial since people use products related to comfort every day<sup>17</sup>. The application of ergonomics in ensuring comfortable and safe posture for elderly taxi drivers to ensuring better lifestyle and minimize the health problem on work-related musculoskeletal disorders (MSD's).

This pilot study focus to 1) determine the characteristics on driving background such as working hours, distance driving, health status, years experience on taxi driving, feeling pain any body part over last 12 month and last 7 days; 2) discomfort level on seating posture among elderly taxi drivers.

## METHODS

The design of this study was a cross-sectional survey using a questionnaire to investigate characteristics of driving background and prevalence of MSD's on seating posture among a representative sample of elderly taxi drivers in Malaysia. The study was conducted around Kuala Lumpur city area. A purposive sampling was chosen and only 22 respondents participate in the study. Criteria sample has been choose; age above 60 years old, who have a driving history of at least 1 years driving a taxi, registered under SPAD, used a national car as a taxi and who had a history of major surgery or history of neurological problems were excluded. Eight taxi drivers refused to participate in the study. A small token offered as an acknowledgment in the form of gifts for those completed the survey. The survey took approximately 10 -15 minutes per- person to complete. The participants were asked kindly and if they agree, then complete information related to work characteristics, some health issues of taxi drivers and seating posture was given.

A self- administered questionnaire which was design for this study was distributed to the participants. The first part of the questionnaire included questions on socio-demographic factors (age, race, marital status, education level, status jobs, income, and smoking) and past medical history. The second part included questions on characteristics of elderly taxi drivers such as total pick up passenger per- day, resting time, working hours, years worked as a taxi driver, type employment, total distance driving per-week, regular time start driving, working until late night, competency driving confident level, having back pain last 12 month and past 7 days and numbers of near miss accident. The third part included questions on the body part discomfort map from each body part on the sitting driving position. The modified questions adapt n adopt from the United States driving ergonomics program (Attached 1). A body

part discomfort map diagram of 28 body parts divided into neck, upper back, middle back, left elbow, right elbow, lower back, left buttock, right buttock, left hip, right hip, left thigh, right thigh, left knee, right knee, left calf, right calf, right foot, left foot, stomach, right forearm, left forearm, right wrist, left wrist, chest, right upper arm, left upper arm, right shoulder and left shoulder to assist the elderly taxi drivers in identifying the correct body parts in answering the questions. The questions utilized a simple phrase such as “ Within last week do you feeling any discomfort with any body parts during driving (works); 1) comfort 2) less comfortable 3) uncomfortable 4) very uncomfortable” and score value begin from 1 to 4.

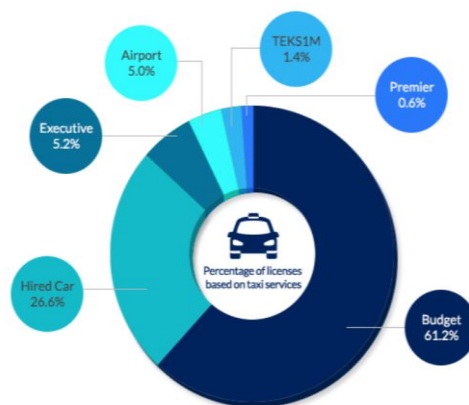
The interview was conducted in parking places of station bus, train station, shopping malls and taxi stand areas in Serdang city and Putrajaya. A selected taxi was choosing in this study which registered licensed with SPAD under taxi services budget and hired car (kereta sewa). According to the statistic year 2014, taxi services budget (61.2%) and hired car (26.6%) was higher taxi registered licensed with SPAD compared to others category (Figure 1 and Figure 2). Besides that, this taxi also classified as an economy taxi and design the car seat underline standard/normal specification compared to others taxi services (Figure 3). The analysis was performed using Social Package for Social Sciences (SPSS) software version 20. Descriptive statistics were obtained for all the variables in the study.

Figure 1 : Number of license based on Taxi Services.

Taxi Services	Number of Licenses	Percentage (%)
Budget	39,505	61.2
Airport	3135	5.0
Premier	376	0.6
Hired Car	17,224	26.6
TEKSIM	935	1.4
Executive	3372	5.2
<b>TOTAL</b>	<b>64,547</b>	<b>100</b>

Source from SPAD, 2014

Figure 2: Percentage of license based on Taxi Services



Source from SPAD, 2014

Figure 3: Break down of Taxi Services

Kelas Teksi	Teksi			Lapangan Terbang	Kereta Sewa
	Bajet	Premier	Eksekutif		
Jenis Perkhidmatan					
# lesen	39,056	170	2,884	2,226	16,012
• Individual	18,759 (48%)	-	957 (33%)	435 (20%)	13,923 (87%)
• Company	20,297 (52%)	170 (100%)	1,927 (67%)	1,791 (80%)	2,089 (13%)
Mekanisme Kadar Tambang	• Bermeter (Jarak & Masa)	• Bermeter (Jarak & Masa)	• Bermeter (Jarak & Masa)	• Zon (Jarak sahaja)	• Perjalanan dalam KM (Jarak sahaja)
Kawasan Operasi	• Lembah Kelang • Johor Bahru • Pulau Pinang	Lembah Kelang	Seluruh Semenanjung Malaysia	Lapangan Terbang tertentu	Seluruh Semenanjung Malaysia

Source from SPAD, 2014

## RESULTS

### Socio- demographic characteristics of the elderly taxi drivers

All respondents were males. Mean ( $\pm$ SD) age of the respondents was  $62.5 \pm (2.8)$  years and age ranged from 60 to 70 years. The majority was Malays (40.9%) second was India (36.3%), married (90.9%), secondary school (68.2%) for education level and the majority (63.6%) living with spouse and sons and mean members of the house was  $4.3 \pm (1.6)$  from 2 to 8 members per-house. The majority (95.5%) of respondents work as full-time taxi drivers and works under the company (59.1%) and the rest (40.9%) self-employed. Mean income per-month RM  $2250 \pm 1008.4$  from RM700 to RM4000. Most of them in a good health (45.5%) and not smoking (68.2%). The details socio-demographic are showed in Table 1.

**Background and characteristics of the elderly taxi drivers.**

Driving 6>10 times (54.5%) per-day elderly taxi drivers for pick up and send passenger and 45.4% driving more than 11 times per-day and average mean driving per-week were 55.2±40.3 from 8 times to 200 times per week. Half (54.4%) of elderly taxi drivers never take rest in a week and the majority (90.9) of them total hours driving per-day more than 8 hours. Distances driving in per-week more than 150km were 95.5%. Sleep nap while during waiting passenger and prediction 2 to 3 hours waiting hours to obtain passenger per-day were reported by 45.5%

and 77.3% respectively. Morning (50%) were frequent time to begin driving and 54.5% elderly taxi driver always driving until midnight? Confident level driving skills reported 59.1% were confident. Over than 59.1% complained having back pain last 12 months and only 45.5% reported feeling back pain past 7 days. Most of them always (86.4%) carry passenger luggage into boot and luggage weight carry more than 11kg (59.1%). Table 2 reported, total higher driving experience as elderly taxi drivers were 45.5% which is 6 years to 15 years and follow by 40.9% which means more than 16 years.

**Tables 1: Socio- demographic characteristics.**

Variables	N(%)	Mean ±(SD)	Min.	Max.
<b>Gender</b>				
male	22(100)			
female	0			
<b>Age</b>		62.5±2.8	60	70
60>65	19(86.4)			
66>75	3(13.6)			
<b>Race</b>				
Melays	9(40.9)			
India	8(36.4)			
Cina	5(22.7)			
<b>Religions</b>				
Islam	9(40.9)			
Hindu	8(36.4)			
Buddha	5(22.7)			
<b>Marital status</b>				
Married	20(90.9)			
divorce	2(9.1)			
<b>Education</b>				
Primary school	7(31.8)			
Secondary school	15(68.2)			
<b>Living with</b>				
Alone	1(4.5)			
Spouse	7(31.8)			
Spouse and sons	14(63.6)			
<b>Members of house living</b>		4.3±1.6	2.0	
<b>Status current jobs</b>				
Full time	21(95.5)			
Part time	1(4.5)			
<b>Jobs sectors</b>				
Company	13(59.1)			
Self - employed	9(40.9)			
<b>Income per-month</b>		2250±1008.4	700	
<b>Health status</b>				
Good	10(45.5)			
Very good	1(4.5)			
Average	5(22.7)			
Not good	6(27.3)			
<b>Smoking status</b>				
Yes/frequent	7(31.8)			
No/never	15(68.2)			

N= 22

**Table 2 : background and characteristics elderly taxi drivers**

Variables	N(%)	Mean $\pm$ (SD)	Min.	Max.
<b>Driving per-day</b>				
6>10times	12(54.5)			
>11times	10(45.5)			
<b>Average driving per-week</b>		55.2 $\pm$ 40.3	8	200
<b>Take rest per-week</b>				
Yes	10(45.5)			
No	12(54.5)			
<b>Total hours driving per-day</b>				
1>7hours	2(9.1)			
>8 hours	10(90.9)			
<b>Distance driving per-week</b>				
51>100km	1(4.5)			
>150km	21(95.5)			
<b>Sleep nap waiting passenger</b>				
Yes	10(45.5)			
No	12(54.5)			
<b>Waiting hours passenger per-day</b>				
<1 hours	3(13.6)			
2>3hours	17(77.3)			
>4hours	2(9.1)			
<b>Driving time</b>				
Morning	11(50.0)			
Afternoon	2(9.1)			
Evening/night	3(13.6)			
Anytime	6(27.3)			
<b>Driving until midnight</b>				
always	12(54.5)			
Not frequent	4(18.2)			
Never	6(27.3)			
<b>Confident level driving skills</b>				
Average	2(9.1)			
Confident	13(59.1)			
So confident	7(31.8)			
<b>Past 12 month feeling back pain</b>				
Yes	13(59.1)			
No	9(40.9)			
<b>Past 7 days feeling back pain</b>				
Yes	10(45.5)			
No	12(54.5)			
<b>Carry luggage into boot</b>				
Always	19(86.4)			
Not really	3(13.6)			
Never	0			
<b>luggage weight</b>				
6>10kg	6(27.3)			
>11kg	13(59.1)			
Never	3(13.5)			
<b>Total driving experience</b>				
1>5 yrs	3(13.6)			

6>15yrs                      10(45.5)  
 >16yrs                        9(40.9)

N=22

Result from table 3 showed, the highest body part received complained very uncomfortable on driving posture among elderly taxi drivers were right buttock (50.0%) second higher were left buttock (45.5%) follow by lower back (36.4%) and body part likes neck and center back (22.7%) and upper back (18.2) still showed higher complained under category very uncomfortable compared others body parts. However, 45.5% feel uncomfortable at body part left hips and left thighs (36.4%) and also a centre back, lower back and left knee received same reported (36.4%)

category. Meanwhile, others body part also reported higher (31.8%) by elderly taxi drivers feeling uncomfortable while driving posture were upper back, right elbow, left buttock, right buttock, right hips and right knee compared to others body parts the result showed lower. In other words, the majority of elderly taxi drivers agree (77.3%) the discomfort at body parts happen from cause of bad car seat design. Other body parts complained are showed in Table 3.

**Table 3 : Body part discomfort driving posture**

Variables	N	Percentage (%)
<b>Neck</b>		
Comfortable	5	22.7
Less comfortable	7	31.8
uncomfortable	5	22.7
very uncomfortable	5	22.7
<b>Upper back</b>		
Comfortable	2	9.1
Less comfortable	9	40.9
uncomfortable	7	31.8
very uncomfortable	4	18.2
<b>Center back</b>		
Comfortable	4	18.2
Less comfortable	5	22.7
uncomfortable	8	36.4
very uncomfortable	5	22.7
<b>Left elbow</b>		
Comfortable	6	27.3
Less comfortable	10	45.5
uncomfortable	6	27.3
very uncomfortable	0	0
<b>Right elbow</b>		
Comfortable	5	22.7
Less comfortable	9	40.9
uncomfortable	7	31.8
very uncomfortable	1	4.5
<b>Lower back</b>		
Comfortable	4	18.2
Less comfortable	2	9.1
uncomfortable	8	36.4
very uncomfortable	8	36.4
<b>Left buttock</b>		
Comfortable	2	9.1
Less comfortable	3	13.6
uncomfortable	7	31.8
very uncomfortable	10	45.5
<b>Right buttock</b>		
Comfortable	1	4.5
Less comfortable	3	13.6
uncomfortable	7	31.8
very uncomfortable	11	50.0
<b>Left hips</b>		
Comfortable	2	9.1

	Less comfortable	3	13.6
	uncomfortable	10	45.5
	very uncomfortable	7	31.8
<b>Right hips</b>			
	Comfortable	3	13.6
	Less comfortable	6	27.3
	uncomfortable	7	31.8
	very uncomfortable	6	27.3
<b>Left thighs</b>			
	Comfortable	3	13.6
	Less comfortable	11	50.0
	uncomfortable	8	36.4
	very uncomfortable	0	0
<b>Right thighs</b>			
	Comfortable	3	13.6
	Less comfortable	13	59.1
	uncomfortable	5	22.7
	very uncomfortable	1	4.5
<b>Left knee</b>			
	Comfortable	2	9.1
	Less comfortable	9	40.9
	uncomfortable	8	36.4
	very uncomfortable	3	13.6
<b>Right knee</b>			
	Comfortable	2	9.1
	Less comfortable	10	45.5
	uncomfortable	7	31.8
	very uncomfortable	3	13.6
<b>Left calf</b>			
	Comfortable	5	22.7
	Less comfortable	12	54.5
	uncomfortable	5	22.7
	very uncomfortable	0	0
<b>Right calf</b>			
	Comfortable	6	27.3
	Less comfortable	12	54.5
	uncomfortable	4	18.2
	very uncomfortable	0	0
<b>Left and right shoulder</b>			
	Comfortable	5	22.7
	Less comfortable	10	45.5
	uncomfortable	6	27.3
	very uncomfortable	1	4.5
<b>Upper wrist left side</b>			
	Comfortable	6	27.3
	Less comfortable	11	50.0
	uncomfortable	4	18.2
	very uncomfortable	1	4.5
<b>Upper wrist right side</b>			
	Comfortable	6	27.3
	Less comfortable	12	54.5
	uncomfortable	4	18.2
	very uncomfortable	0	0
<b>Chest</b>			
	Comfortable	12	54.5
	Less comfortable	6	27.3
	uncomfortable	3	13.6
	very uncomfortable	1	4.5
<b>Left wrist</b>			
	Comfortable	9	40.9
	Less comfortable	8	36.4
	uncomfortable	4	18.2
	very uncomfortable	1	4.5

<b>Right wrist</b>	Comfortable	10	45.5
	Less comfortable	7	31.8
	uncomfortable	4	18.2
	very uncomfortable	1	4.5
<b>Left arm</b>	Comfortable	12	54.5
	Less comfortable	5	22.7
	uncomfortable	3	13.6
	very uncomfortable	2	9.1
<b>Right arm</b>	Comfortable	14	63.6
	Less comfortable	4	18.2
	uncomfortable	4	18.2
	very uncomfortable	0	0
<b>Stomach</b>	Comfortable	16	72.7
	Less comfortable	2	9.1
	uncomfortable	3	13.6
	very uncomfortable	1	4.5
<b>Left ankle</b>	Comfortable	6	27.3
	Less comfortable	9	40.9
	uncomfortable	5	22.7
	very uncomfortable	2	9.1
<b>Right ankle</b>	Comfortable	7	31.8
	Less comfortable	8	36.4
	uncomfortable	5	22.7
	very uncomfortable	2	9.1
<b>Discomfort body part cause of seat design</b>	Yes	17	77.3
	No	5	22.7

N = 22

## DISCUSSION

This study found that majority elderly taxi drivers work as full time and supervise under company to sustainable their life and family well-being, similar to previous studies taxicabs in Nigeria which are 85% of taxi drivers engaged in business driving as means of living<sup>18</sup>. Result income per month elderly taxi drivers in Malaysia RM 2250.00 showed similarity study AL- Dubai et al. (2012), taxi driver's income in Malaysia more than RM 2000.00. The smoking result not much different with the previous study<sup>19</sup>.

In this study, higher developing of MSDs was found among those who worked more than eight hours daily compared to those driving less working hours. This finding was consistent with that found by Miyamoto et al. 2008, driving long working hours. More times spend to pick- up and waiting for passenger daily or per-week lead to lower back pain injury<sup>20</sup>. Researcher Tamrin et al. 2007 stated, monotones in long distance driving influenced to factors lower back pain and others injury related to MDSs which means this result showed 95.5% elderly taxi drivers driving more than 150km per week it may potentially

lead to developing lower back pain. The study found that the past 12 month having back pain among taxi drivers in Malaysia was 59.1% and last seven days 45.5%; similar to that found in previous research in Japan and Taiwan, in which the prevalence of lower back pain among taxi drivers was 45.8% and 51% respectively<sup>21,7</sup>. Long experiences of working as taxi drivers related to discomfort in this study as elderly drivers with more than 6 years to 15 years of work may potential to have a problem on MSD. The previous study among professional drivers found a significant association between low back pain and duration of employment as a bus driver<sup>11</sup>. However, some author studies on taxi drivers did not find such relationship<sup>7</sup>.

In this study, discomfort on driving sitting body posture among elderly taxi drivers showed right buttock, left buttock, lower back, neck, center back and upper back, left hips, left thighs falls under category very uncomfortable and uncomfortable. It describes all body parts at back side which contact to the seat potentially has the problem on MSDs and lead to developing injury on lower back pain. According to Mohammad D. et al. 2016, comfortable car seat



driving able to achieve through dimension car set design should appropriate with anthropometry dimension of the user. In others word, comfortable sitting driving could reduce health problem and develop MSDs on cumulative. Previous studies found a significant association between low back pain and certain ergonomics factors such as the use of backrest support and driving in forward bending sitting posture<sup>7,23</sup>.

Majority elderly taxi drivers agree that this discomfort attributed of mismatch between anthropometry measurement and car seat dimensions and also selective design factors. The previous study was done by Deros et al. 2015, driver's seat design awareness which influenced the perception of drivers comfort and discomfort.

## CONCLUSION

In general, this study investigates the characteristic and discomfort of the present elderly taxi drivers on sitting body posture. From this study give us the preliminary perspective of characteristics taxi drivers among elderly especially on sitting posture to obtain comfort and reduce the injury. It also help us in the beginning to prevent MSDs or developing low back pain injury through determining which body part potentially may develop the cumulative injury. However, this result only can use a baseline to investigate more details and give us a concrete base to do further study on this topic. This is pilot study and insufficient sample size to represent population elderly taxi driver in Malaysia. More explore to investigate this topic will benefit to taxi drivers especially elderly community to improve their life and safety and also reduce problem-related to work MDS's by apply ergonomics approach in the further study.

## COMPETING INTERESTS

There is no conflict of interest.

## REFERENCES

1. Land Public Transport Commission, Malaysia. Available from <http://www.spad.gov.my/land-public-transport/taxis/key-statistics> (accessed 09 August 2016).
2. Herriotts, P. (2005). Identification of vehicle design requirements for older drivers. *Applied ergonomics*, 36(3), 255-262.
3. Smith, M. C. (1993). The reading abilities and practices of older adults. *Educational Gerontology: An International Quarterly*, 19(5), 417-432.
4. Figà-Talamanca, I., Cini, C., Varricchio, G. C., Dondero, F., Gandini, L., Lenzi, A., ... & Patacchioli, F. R. (1996). Effects of prolonged autovehicle driving on male reproductive function: a study among taxi drivers. *American journal of industrial medicine*, 30(6), 750-758.
5. Dalziel, J. R., & Job, R. S. (1997). Motor vehicle accidents, fatigue and optimism bias in taxi drivers. *Accident Analysis & Prevention*, 29(4), 489-494.
6. Yang, Y., Fan, X. S., Tian, C. H., Zhang, W., Li, J., & Li, S. Q. (2014). Health status, intention to seek health examination, and participation in health education among taxi drivers in jinan, china. *Iranian Red Crescent Medical Journal*, 16(4)
7. Chen, J. C., Chang, W. R., Chang, W., & Christiani, D. (2005). Occupational factors associated with low back pain in urban taxi drivers. *Occupational Medicine*, 55(7), 535-540.
8. Harrison, D. D., Harrison, S. O., Croft, A. C., Harrison, D. E., & Troyanovich, S. J. (1999). Sitting biomechanics part I: review of the literature. *Journal of manipulative and physiological therapeutics*, 22(9), 594-609.
9. Bovenzi, M., & Zadini, A. (1992). Self-reported low back symptoms in urban bus drivers exposed to whole-body vibration. *Spine*, 17(9), 1048-1059.
10. Funakoshi, M., Taoda, K., Tsujimura, H., & Nishiyama, K. (2004). Measurement of whole-body vibration in taxi drivers. *Journal of occupational health*, 46(2), 119-124.
11. Tamrin, S. B. M., Yokoyama, K., Jalaludin, J., Aziz, N. A., Jemoin, N., Nordin, R., ... & Abdullah, M. (2007). The association between risk factors and low back pain among commercial vehicle drivers in peninsular Malaysia: a preliminary result. *Industrial health*, 45(2), 268-278.
12. Hirao, A., Kitazaki, S., & Yamazaki, N. (2006). *Development of a New Driving Posture Focused on Biomechanical Loads* (No. 2006-01-1302). SAE Technical Paper.
13. Deros, B. M., Hassan, N. H. H., Daruis, D. D. I., & Tamrin, S. B. M. (2015). Incorporating Malaysian's Population Anthropometry Data in the Design of an Ergonomic Driver's Seat. *Procedia-Social and Behavioral Sciences*, 195, 2753-2760.
14. Xu, Y., Bach, E., & Orhede, E. (1997). Work environment and low back pain: the

- influence of occupational activities. *Occupational and Environmental Medicine*, 54(10), 741-745.
15. Gyi, D. E., & Porter, J. M. (1998). Musculoskeletal problems and driving in police officers. *Occupational Medicine*, 48(3), 153-160
  16. Na, S., Lim, S., Choi, H. S., & Chung, M. K. (2005). Evaluation of driver's discomfort and postural change using dynamic body pressure distribution. *International Journal of Industrial Ergonomics*, 35(12), 1085-1096.
  17. Vink, P., & Hallbeck, S. (2012). Editorial: Comfort and discomfort studies demonstrate the need for a new model. *Applied ergonomics*, 43(2), 271-276.
  18. Onawumi, A. S., & Lucas, E. B. (2012). Ergonomic Investigation of Occupational Drivers and Seat Design of Taxicabs in Nigeria. *ARPJN Journal of Science and Technology*, 2(3), 214-220.
  19. AL-Dubai, S. A. R., Qureshi, A. M., Ismail, N. H., & Rampal, K. G. (2012). Prevalence and determinants of low back pain among taxi drivers in Malaysia. A cross sectional study. *Journal of Advanced Medical Research*, 2(4), 129-43.
  20. Miyamoto, M., Konno, S., Gembun, Y., Liu, X., Minami, K., & Ito, H. (2008). Epidemiological study of low back pain and occupational risk factors among taxi drivers. *Industrial health*, 46(2), 112-117.
  21. Funakoshi, M., Tamura, A., Taoda, K., Tsujimura, H., & Nishiyama, K. (2003). [Risk factors for low back pain among taxi drivers in Japan]. *Sangyo eiseigaku zasshi= Journal of occupational health*, 45(6), 235-247.
  22. Mohamad, D., Deros, B. M., Daruis, D. D., Ramli, N. F., & Sukadarin, E. H. (2016). Comfortable Driver's Car Seat Dimensions Based on Malaysian Anthropometrics Data. *Iranian Journal of Public Health*, 45(1), 106.
  23. Romli, A. (2009). Low back pain and association with whole body vibration among military armoured vehicle drivers in Malaysia.

Attached 1 : Body part discomfort map



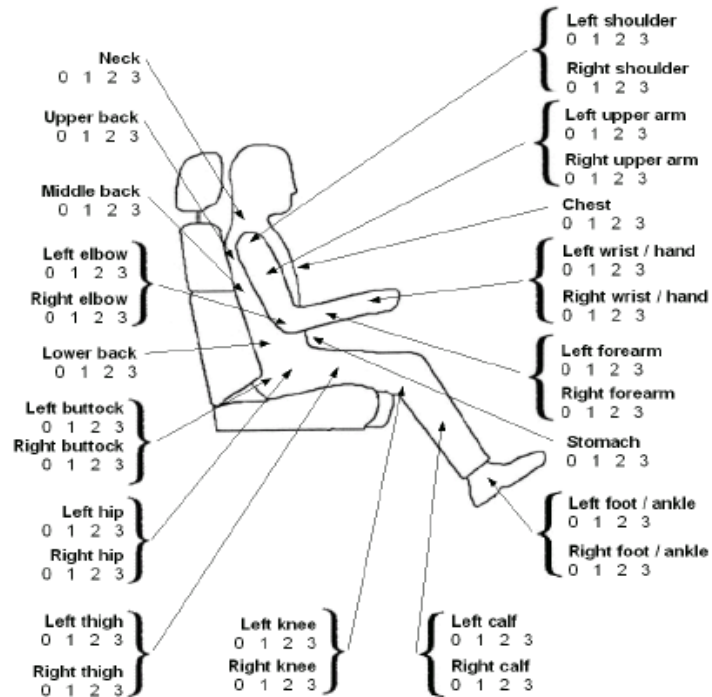
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**BODY PART DISCOMFORT MAP**

In a typical week do you experience any discomfort in the car you drive for work? Using the scale below, please circle the appropriate number.

- 0 No discomfort
- 1 Slight discomfort
- 2 Moderate discomfort
- 3 Considerable discomfort



What do you believe are the reasons for any of this discomfort (including anything at work or elsewhere)?

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