Journal of Engineering
Research and Education
Vol. 6 (2012) 105-114

The sitting posture of Malaysian compact car drivers

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ABSTRACT

Accidents involving transports is one of the leading causes of acquired disabilities and fatalities nationwide that has affected all sectors of populations regardless of age, gender, income and geographic regions. Comparing various modes of transports, land transportation could be the most dangerous and costliest in terms of losses of materials and human lives. Although efforts have been done to reduce the risks and the statistics of accidents, the results are still far from encouraging and of concern to many. Research on the causes and contributors to accidents are critically essential. Drivers are recognized as one of the contributors to accidents need to be probed. Hence, a study on the driver's performance (drivability) is inevitable in an effort to eliminate or to reduce the staggering accident rates. Driving a vehicle should be considered a task that is not commonly free from muscular discomforts on body limbs. Because comfortable driving postures also become a major contributor on fatigue while driving, an experiment is conducted using picture recognition software. When driving, posture is considered a significant factor in discomfort, thus an experiment for obtaining data concerning comfortable driving posture and seat angle was conducted. Actual observed driving postures were compared with recommendations in the literature.

Keywords - *Picture recognition software, Drivability, Driving discomfort, Driving posture.*

INTRODUCTION

Car accidents are the leading cause of acquired disability nationwide. A car accident also known as traffic collision/motor vehicle collision/motor vehicle accident/car crash, is when a road vehicle collides with another vehicle, pedestrian, animal, road debris, or other geographical or architectural obstacle . From a global perspective, it was estimated that approximately 16% of the world's burden of disease was attributable to injury in 1998 (Krug, E.G.; 2000). Due to this alarming figure, the government has launched the Road Safety Plan 2006-2010 in March, 2006 with the objectives to reduce fatality rates to 2 fatalities per 10,000 registered vehicles, 10 fatalities per 100,000 population and 10 fatalities per billion vehicles kilometer traveled (KTV) by year 2010. (Source; Ministry of Transport, 2006).

In particular, injuries attributable to motor vehicle accidents (MVAs) are expected to be the third contributor to worldwide burden of disease by the year 2020 (Murray, C.J.;1997). Drivers are considered to be a major contributor to accidents. It is believed that 57% of accident causes are attributable to drivers. Hence, solving the driver’s factor in accidents may well reduce 57% of the accidents. A research/study can be done on the driver’s performance in order to eliminate or at least reduce yearly percentage of accident rate. Bekiaris (Bekiaris et. al; 2003) suggested a new concept for modeling and evaluating a driver’s performance which was termed as drivability.

Fatigue during driving is a serious problem in transportation system and is believed to be a direct contributor of road accidents (Gander et al, 1993). For instance, road related injury costs billion of dollars (Donovan et al, 1994) with studies suggesting that fatigue was responsible for up to 20-30% of road fatalities (Camkin, 1990) which occurred in situations in which driving hours were very long (McDonald, 1984; Hamelin, 1987). With increasing awareness of the high prevalence and severe consequences of work related musculoskeletal disorders, it has become obvious that successful prevention requires a better understanding of the causes and risk factors of the disorders.

It appears that the backrest inclination and set pan angle should have an effect on the mechanical loads on the spine and thus on the propensity for low back pain. Back rest inclinations between 95º and 120º have been recommended for various sitting activities such as office seating, driving, crane operating and being a car passenger. (Dunlap and Kephart, 1954; Dreyfuss, 1959; Stier, 1959; McFarland and Stoudt, 1961; Keegan, 1962; Jones, 1969; Murrell, 1969; Kroemer, 1971; Diffrient et al, 1974; Granjean, 1980).

In the studies of Anderson (Anderson *et al*, 1975; Anderson *et al* 1979), it was demonstrated that an increase of the backrest inclination to 110º had a more positive effect on the muscular activity than did a lumbar support. Thus it is reasonable recommendation by Marianne (Marianne *et al*, 1994) that 110º or greater inclined backrests are needed for drivers who are subjected to prolonged sitting with or without whole body vibration.

RESEARCH METHODOLOGY

The automotive industry strongly encourages research in the field of objective comfort assessment especially dedicated to the seat and related postures (Gyi et al, 1998; Guenaelle, 1995). Driver posture is one of the most important issues to be considered in this study.

For this test, 100 subjects were involved. The subject was required to sit on driver's seat in their comfortable driving posture. The study requires the knowledge of the posture of the subjects when they are at their most comfortable state (comfort level). According to (Gordon et al., 2006) (see Figure 1.1), a postural factor of interest is truck-thigh angle and knee angle. Due to this it was suggested that a sticker be used on the subject's body as markers to calculate these angles. However, due to the hesitation of the subjects in letting stickers be stuck on their bodies, this plan was not carried through. Suggestion that the angle need to be calculated is mark with sticker cannot be done. This is due to subjects's hesitate to let unknown people just simply stick the sticker all over the body. A posture of subjects seating at the most comfortable level (comfort level). So, a postural factor of interest is truck-thigh angle and knee angle (Gordon et al., 2006) (see Figure 1).

Alternatively, to calculate this angle, 2 options can be used, either the traditional way (i.e. manual measurement) or the modern way (i.e. using software – ERGOMASTER software)

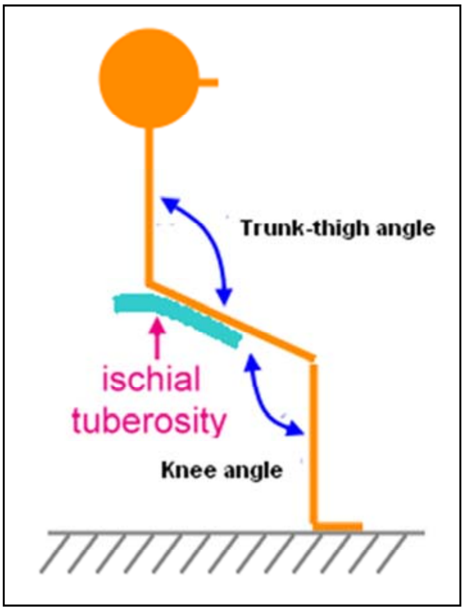

Figure 1: Trunk-Thigh angle and Knee angle measurement

In this study, only the modern technique was used. Picture Recognition Software was used in finding the trunk-thigh angle and knee angle. Picture recognition Software was used due to its reliability and could avoid hassle by reducing time and effort in the measurement process. For this method, subjects are required to seat in the driver's seat. The picture of the subjects when they are at their preferred and most comfortable seat angle was taken during the setup. However, some conditions need to be considered during this photo session. The picture must be snapped from the side view of the subject's posture and at the same eye level. This is to ensure that the picture taken is valid and reliable to be recognized by the picture recognition software. Later the picture will be processed using picture recognition software.

Prior to the photo session, each subject was informed on the nature of study being conducted and the requirements needed. This is due to the fact that subjects are selected randomly and so had no knowledge of the study being conducted. Only consenting participants were allowed to continue with the photo shoot. The subject is given 3 minutes to make him/her self comfortable in the driver's seat and with the surrounding environment before the angle measurement was done. The same procedure was repeated until the 100th subject.

When using the software, photo taken from previous photo session being used. When the selected photo (example in Figure 2) will be open in picture recognition software. The command box in this software will give instruction step by step what to do next. During this stage, 3 point are needed to be marked on the human posture. After the required points are marked on the subject's posture figure, the button to compute angle is executed and the postural angle result is in the designated area. In this study, the thigh was maintained at horizontal level so that outcomes would have common reference with a horizontal baseline.

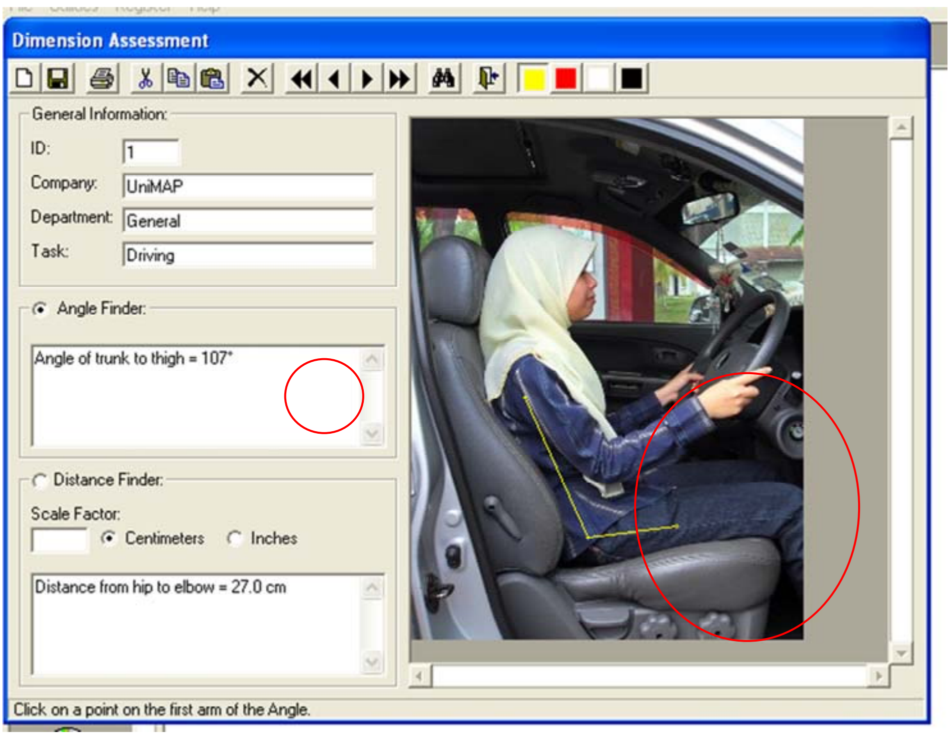

Figure 2: The angle setting

RESULT

The results of the photo analysis are shown in Table1. From the 100 subjects tested, 35 were male and 65 were female.

DISCUSSION AND ANALYSIS

When driving, posture is considered a significant factor in discomfort, thus an experiment for obtaining data concerning comfortable driving posture and seat angle was conducted. Actual observed driving postures were compared with recommendations in the literature. Results for both trunk-thigh angle and knee angle were index in that there was a difference in preferred driving postures between Korean, Caucasians and Malaysian. After the photos underwent the recognition process, comfort angles for trunk-thigh angle for all respondents is shown in Figure 1.5 below. From the table, it can be concluded that the female comfort angle is larger than the male angle.

Table 1: Results from the photo's analysis using picture recognition software

Subject	Male	Female	Trunk-Thigh Angle	Knee Angle
1		*	94	122
2		*	89	116
3		*	100	107
4		*	101	125
5	*		96	115
6	*		100	127
7	*		105	135
8	*		97	120
9	*		107	118
10	*		104	135
11		*	82	83
12		*	88	100
13		*	87	125
14		*	85	126
15		*	95	116
16		*	100	113
17		*	81	92
18		*	90	108
19		*	107	131
20		*	111	119
21		*	106	116
22		*	103	111
23		*	104	128
24		*	104	
25		*	87	105
26	*		103	133

27		*	97	106
28		*	92	103
29		*	106	112
30		*	91	95
31		*	101	124
32		*	109	145
33		*	106	131
34	*		103	129
35	*		109	137
36	*		116	111
37	*		114	108
38		*	109	136
39		*	107	139
40		*	106	128
41		*	104	122
42	*		104	128
43	*		113	146
44		*	99	126
45		*	109	141
46		*	101	
47		*	95	110
48	*		91	85
49		*	100	106
50	*		112	141
51	*		96	88
52	*		101	129
53	*		110	148
54	*		106	126
55		*	87	110
56		*	86	119
57		*	108	146
58		*	104	
59	*		114	156
60		*	112	114
61		*	107	106
62		*	87	80
63		*	93	100
64		*	100	103
65		*	99	129
66	*		100	122
67	*		120	136
68	*		115	133
69	*		115	128
70		*	98	139
71		*	102	135
72		*	87	107
73	*		111	134

74	*		108	137
75	*		104	109
76	*		104	140
77	*		111	121
78	*		117	137
79	*		96	136
80	*		103	130
81	*		105	148
82		*	87	122
83		*	93	105
84		*	98	97
85	*		100	129
86		*	98	122
87		*	101	102
88		*	96	121
89		*	99	117
90		*	104	133
91		*	104	124
92		*	107	123
93		*	94	142
94		*	104	111
95		*	98	138
96		*	100	106
97		*	107	122
98		*	100	120
99	*		104	127
100	*		98	129

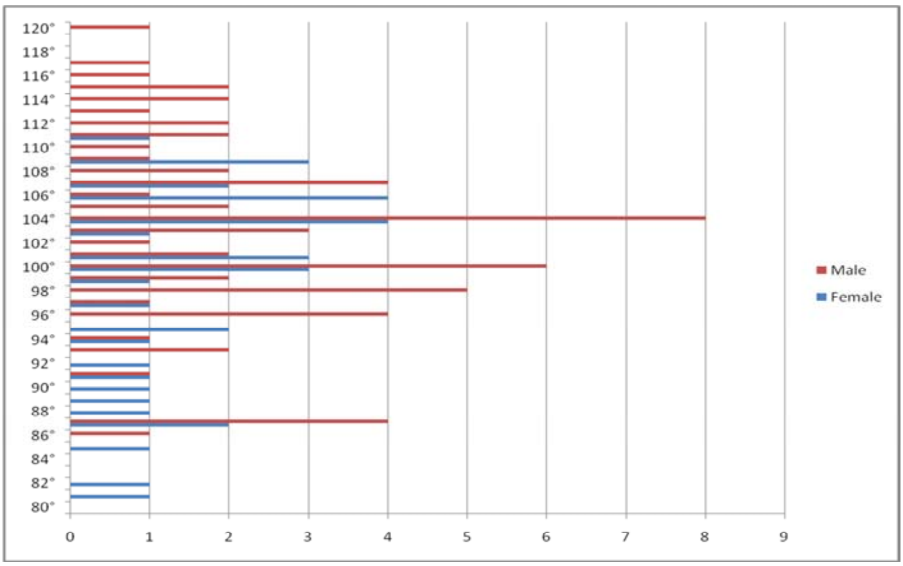

Figure 3: Subjects Vs Trunk-Thigh angle according to gender

According to the graph plotted above (see Figure 3) , male had larger trunk-thigh angle compared to female.

As for the knee angle (see Figure 4), both genders roughly have the same comfort angle posture.

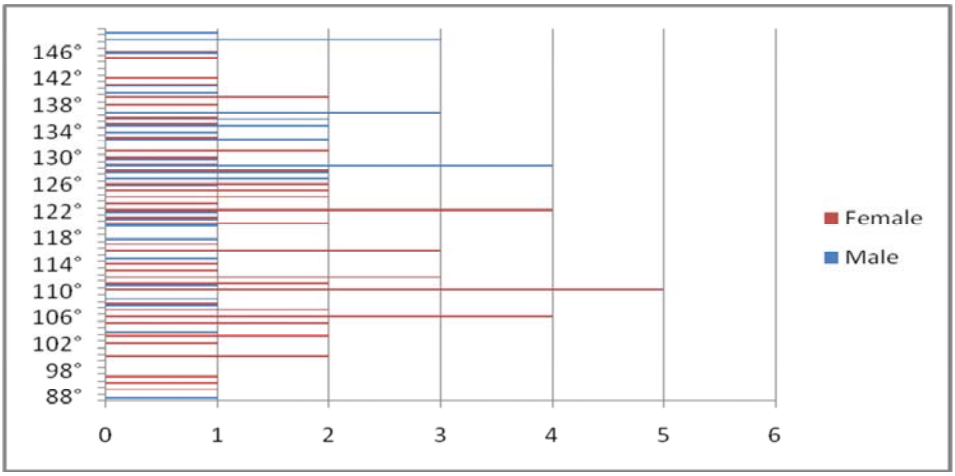

Figure 4: Subjects Vs Knee angle according to gender

In Table 2, which shows the trunk-thigh angle between Caucasians (that is Rebiffe, Grandjean and Porter & Gyi) and the observed postures (i.e. Malaysian), it can be seen that the comfort angle values are roughly the same but a bit smaller when compared to the Koreans (Se Jin Park et. al.) Meanwhile as for knee angle, comparing between the Caucasians and the observed postures as stated in the literature, it has a greater range of values. (Rebiffe, 1969; Granjien, 1980; Porter and Gyi, 1998). These results indicate that there is a difference of preferred driving postures between Malaysian, Korean and Caucasians

Table 2: Table: Comparison of observed angles for comfort (in degree with the literatures)

Classification	Rebiffe (Caucasians)	Grandjean (Causians)	Porter & Gyi (Causians)	Se Jin Park et. al. (Korean)	Observed Postures (Malaysian)
Trunk-thigh angle	95º-120º	100º-120º	90º-115º	103º-131º	Mean Range = 101.08º 81º-120º
Knee angle	95º-135º	110º-130º	99º-138º	120º-152º	Mean Range = 121.21° 88°-156°

In particular, there was a strong positive correlation (0.99) between trunk-thigh and knee angle. According to observations by Se Jin Park (Se Jin Park et. al;2000), the trunk-thigh angle was related to all postural angles where when the trunk-thigh increased, the knee angle, elbow angle, foot-calf angle and shoulder angle also increased.

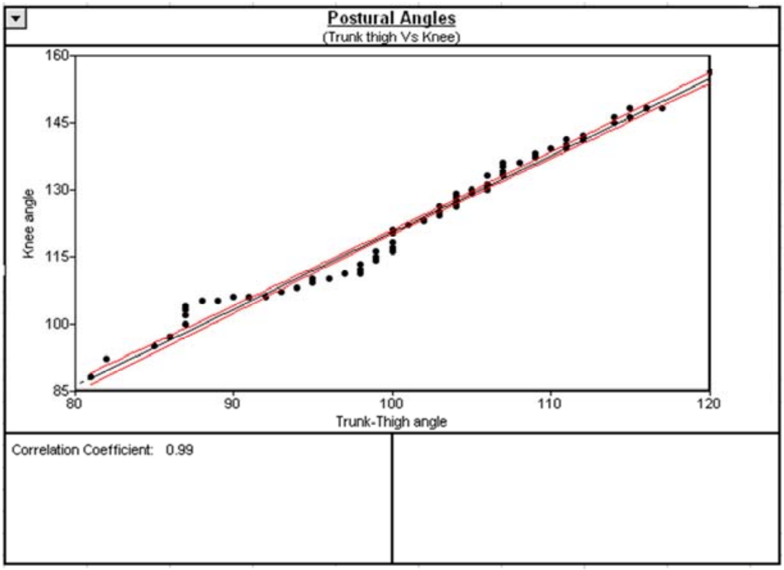

Figure 1.7: Comparison between Trunk-Thigh angle and Knee Angle

CONCLUSION

Comfort angle (driving posture) while driving is one of the factor contributing to fatigue while driving. From this study, it can be concluded that recommended comfort angle for trunk-thigh angle is 81º-120º and knee angle is 88º-156º for Malaysians in which there is a slight difference between these values if comparison is made between Koreans and Caucasians.

It is well documented that physically monotonous/repetitive work is associated with an increase in pain for the whole body region. However in vehicles, vibrations are mostly pointed out as the main cause of musculoskeletal problems. It has not really been proven that posture and task handling contributes to the same problem.

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