ORIGINAL ARTICLE

Driving Behaviour, Road Crash Involvement, Working Commute (MyDRIVE) Questionnaire: Testing Data Quality, Scaling Assumptions, Reliability and Validity Among Malaysian Medical Doctors

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ABSTRACT

Introduction: The Driving Behaviour, Road Crash Involvement, Working Commute (MyDRIVE) questionnaire was developed to assess medical doctors' experience with road crash involvement. The objective of this research was to validate the driving behavioural component of MyDRIVE for medical practitioners in Malaysia. **Method:** This was a multi-stage study involving item specification, domain specification and domain assessment. Following item pools among the experts, Malaysian Medical Association (MMA) members and their contacts who are partially or fully registered with the Malaysian Medical Council (MMC) were surveyed via an online questionnaire between April 2020 and May 2021. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) was done with 150 participants and 824 participants, respectively on separate analysis to ensure the factor validity. We examined the standardized loadings, AVE and CR to determine the convergent validity. The discriminant validity was tested through the Fornell-Larcker matrix. Reliability analysis was performed through Cronbach alpha and composite reliability. **Results:** EFA resulted in reduction of items from 44 items to 23 items with six constructs. Composite reliability (CR) revealed all domains have a CR of above 0.7, except for Driving Under Alcohol Influence (DAI) (0.605). The remaining factors are Distracted Mind & Negative Emotion (DMNE) (0.843), Safe Driving Habit (SDH) (0.862), Fatigue Driving (FD) (0.903), Recreational & Prescribed Driving (RPD) (0.748), and Driving Under Influence of Caffeine (DCI) (0.836). For discriminant validity the square root of AVE for all constructs were greater than its correlations with other latent constructs. **Conclusion:** Our study finds the driving behavioural component of the MyDRIVE questionnaire among the Malaysian medical doctors to have good reliability and validity. Future studies should consider using MyDRIVE's driving behaviour component to assess driving behaviour among doctors.
Malaysian Journal of Medicine and Health Sciences (2023) 19(SUPP17):25-32. doi:10.47836/mjmhs.19.s17.4

Keywords: Medical doctor, driving behaviour, commuting, work place, crash involvement

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INTRODUCTION

Road crash involvement (RCI) is a major cause of mortality and morbidity, especially in low and middle income countries(1,2). In Malaysia, the number of road accidents have increased over the last 10 years and was reported to be more than 560,000 by the Ministry of Transport Malaysia (3). This includes commuting accidents, which are accidents on routes taken while commuting to and from work. Notably, commuting accidents have been on the rise in Malaysia, and were reported to be more than 26,000 in 2012. This number increased nearly 50% within last 6 years (4). Healthcare

workers including doctors are part of these statistics and it has been noted that more than 500 cases have been reported from 2014 to 2016 (5). This statistics has significant impact not only on the healthcare sector, which is an integral part of society, but also on the economy (6).
There are several factors contributing towards RCI, which is a complex situation and includes the environment, type of transport and also human error (7). Socio-demographic and behavioural factors associated with driving are the elements that have been reported to be significantly associated with commuting accidents and their severity (7).

Healthcare professionals play a key role in sustaining the health of the community, particularly through their work contribution . However, some factors influence their work related matters, such as work commute, RCI and driving behaviour. There are several questionnaires on driving behaviour such as the Driving Behaviour Questionnaire (DBQ) (8) , the Occupational Driver Behaviour Questionnaire (ODBQ) (9), and the Dula Dangerous Driving Index (DDDI) (10), however none look specifically into healthcare workers and doctors. Although these questionnaires assessed relevant driving behaviour factors such risky driving, negative emotions, aggressive driving, driving violations or errors, but not all these factors were assessed in one tool. Furthermore, they did not address the issues of what healthcare professional or doctors in particular struggle with, which is the fatigue and tiredness that comes with being a healthcare professional (6).

Due to the statistics mentioned above, affecting not only healthcare sector but the economy, we have looked into ways to overcome RCI among healthcare workers by development of this tool. This initiative can have great potential and acts as a step towards their healthcare specifically but leading to better general health. Therefore, this study looks specifically into the development and validation of a questionnaire, designed to investigate the working environment and commuting behaviour of medical doctors in Malaysia.

MATERIALS AND METHODS

Research Instrument: Driving Behaviour, Road Crash Involvement, Working Commute (MyDRIVE) Questionnaire

MyDRIVE consists of six sections (A-F). Section E looks into driving behaviour and this section is validated in this study as it uses a scoring system, while the rest of the sections are descriptive questions pertaining to sociodemography, health status, workplace, workplace information and incidences of RCI.

Section A: 5 items on socio-demographic background (age, ethnicity, gender, marital status and educational background).
Section B: 7 items on health status including smoking and exercise. For smoking and exercise components, we used a Likert scale from 1 to 5 (1=never, 5=always). The other 5 questions were based on a non-Likert scale.
Section C: 20 items were on workplace information, including napping and chemical exposure. These questions were mainly multiple choice and open-ended.
Section D: 8 items were on work commute information. These questions were mainly multiple choice and open-ended.
Section E: This is the section to be validated and discussed below.
Section F: 24 items were on RCI. These were a mix of open-ended, multiple choice and Likert scale items.

Section E Driving behaviour component

This part is validated in this study. There are 44 items. These questions used the Likert scale of 1 to 5 (1=never, 5=always). There are some scales that ask negative habits, and were reverse coded during analysis.

First, items were generated deductively based on literature review. Following that, the items generation were inductively enriched through brainstorming of our own experiences as professional medical doctors and licensed drivers for at least more than 20 years. Content validation was done through an expert panel consisting of Public health medicine specialists, and two family medicine specialists.

The items looked into the type of driver which asks about careful driving and following traffic regulation. The regulations specifically were in relations giving signal when overtaking, changing lane, or turning, keeping safe distance from the vehicle in front, which are important factors to assess driving behaviour (11,12). Other items were on driving habits, which includes wearing seat belt (13) and following speed limit(14). Studies show speeding was associated with higher health care costs for younger drivers, male drivers have higher health care costs when involved in angular, head-on, rear-end crashes, and sideswipe crashes(14,15). Other items were asked on the use of hand-held device which has been known to cause RCI (16). Other questions involved the driver's habit when raining strictly following vehicle's manufacturer maintenance schedule.

This tool also looked into inattention, distraction, mind wandering and day dreaming, which are also major contributors to car crash. Inattention increases, risk of car crash are essential factors that causes 25% car crashes, is a major contributor to road crashes (17,18). Driver distraction was reported in 9.5% crashes, driver distraction is cause of serious causality crashes(19–21). Mind-wandering increases risk of car crash, reduces driving attention, mind wandering driver drives closer to the kerb, affects driver's road visual scanning, is related to high risk of accident, reduces speed, reduces driving attention and causes lateral deviation(16,22–24).

Fatigue and tiredness questions were included. It assessed if the subject were nodding off, asked about driving focus and falling asleep while driving (6,7,25–27). Microsleep and sleepiness has been known to cause car accidents (16,26,28). Other questions also assessed use of substances such as use of alcohol and recreational drugs (14,15). Lastly the questions ask on driving for fun as excitement and thrill associated with speeding and drink-driving(29).

Study design

This cross-sectional online questionnaire based survey was conducted between April 2020 and May 2021 among Malaysian Medical Association (MMA) members and their contacts who were either fully or partially registered with the Malaysian Medical Council (MMC). We distributed the questionnaire online (Google form) due to the restrictions of COVID-19 pandemic and for the convenience of respondents in order to minimize attrition.

Sampling method

Sampling was based on non-probability sampling. Respondents were recruited through emails and notifications on the MMA website. Close contacts of respondents who were also medical doctors were invited to participate in the survey. All respondents who participated in the survey gave their informed consents.

Sample size calculation

For sample size calculation, the item-subject ratio of 1: 10 was used for each item in the questionnaire (30,31). Therefore, based on 44 items in section E, the calculated sample size was 528 (including possible 20% attrition rate).

Statistical analysis

The data set was analysed using SPSS version 24.0. Descriptive statistics was generated to evaluate the response distribution and completeness of data. Cronbach's α coefficient was a measure used to evaluate (assess) the reliability, or internal consistency for a set of test items. Construct validity was explored to see how well (the extension) results aligned with theory-based hypotheses (32).

Exploratory Factor Analysis (EFA)

EFA was conducted among 150 respondents. The principal axis factoring method and oblique rotation (Promax) were employed. Eigen values were set greater than 1.0, and 0.4 as cut-off points for communality and factor loading (33). In the study, standardized factor loading is defined as 0.60 and above, while communalities are defined as 0.50 (34). The reliability index of Cronbach alpha was also calculated, and a value of 0.70 and above is considered good and 0.50 is acceptable.

Confirmatory Factor Analysis (CFA)

In order to eliminate ambiguity on dimensionality, we proceeded our analysis with CFA. The sample for CFA was derived from different sample. It was conducted among 824 respondents. Maximum likelihood method as implemented in IBM SPSS Amos 24 was employed. Several indices were utilized to assess the model's fit. If the χ^2 value is non-significant ($p > 0.05$), it indicates an acceptable fit. However, it should be noted that this statistic is contingent on sample size, and larger samples may lead to statistically significant results. To overcome this issue, Jureskog and Surbom proposed using χ^2/df, and Ullman established a criterion of $\chi^2/df < 5.0$ for acceptable fit (35,36). The study computed two fit indices, namely, the comparative fit index (CFI) and the goodness of fit index (GFI), both of which range from 0 to 1. Values above 0.90 are generally considered indicative of acceptable fit, although a value of > 0.95 was suggested by Hu and Bentler as indicative of good fit. Additionally, the root mean square error of approximation (RMSEA) was calculated, with values less than 0.08 indicating adequate fit. (36–38).

The composite reliability (CR) was used to determine the reliability of the CFA model. Values between 0.60 and 0.70 are considered acceptable in exploratory research, while values above 0.70 are required in more advanced stages (34). Convergent validity was evaluated by comparing the average variance extracted (AVE), while discriminant validity was assessed by comparing the square root of AVE (√AVE) and the square of the correlation between factors. To ensure convergent validity, consideration must be given to the indicator's factor loading, CR, and AVE, with an AVE value of greater than 0.50 considered adequate (39).

To assess discriminant validity, the Fornell-Lacker criterion was applied, which involves comparing the square root of AVE with the correlation of latent constructs(40). In order to demonstrate good discriminant validity, a latent construct should primarily account for the variance in its own indicators, which means that its square root of AVE should be greater than its correlations with other latent constructs (34).

Ethical statement

This study has received ethics clearance from Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia (NMRR-18-3983-40609).

RESULTS

EFA was conducted among 150 respondents, while the CFA was conducted among 824 respondents. Table I depicts the mean ages for EFA and CFA which were mean (sd) 36.4 (8.9) and 29.2 (3.6) years respectively. For both CFA and EFA the majority of respondents were female, Malay, married, holding a basic medical degree

with no known illnesses.

Sociodemographic data

Sociodemographic data of both EFA and CFA respondents is presented in Table I.

Exploratory Factor Analysis (EFA)

Table II shows the initial EFA. Starting with 44 items, 23 items remained. The Cronbach alpha value is good except for the driving under the influence of alcohol (Cronbach alpha =0.59)

Scale and Total Behaviour Items

Analysis revealed six constructs namely ; Distracted Mind & Negative Emotion (DMNE); Safe driving habits (SDH); Fatigue driving (FD); Recreational & prescribed driving (RPD); Driving under caffeine influence (DCI); Driving under alcohol influence (DAI)(Table II).There were six items for both DMNE and SDH, four items for (FD), three RPD, two for both DCI and DAI. The details of each item can be found in Table III.

Distracted Mind & Negative Emotion (DMNE) talks about focus during driving and any negative emotions

Table I: Sociodemographic data of both EFA and CFA respondents

	EFA n=150 n, %	CFA n=824 n, %
Age mean (±sd) years	36.4 (±8.9)	29.2 (±3.6)
Gender		
Male	72 (48.0)	266 (71.5)
Female	78 (52.0)	558 (67.7)
Ethnicity		
Malay	78 (52.0)	589 (71.5)
Chinese	30 (20.0)	104 (12.6)
Indian	34 (22.7)	93 (11.3)
Others	8 (5.3)	38 (4.6)
Status		
Married	98 (65.3)	356 (43.2)
Single	46 (4.7)	462 (56.1)
Separated / Divorced	6 (4.0)	6 (0.7)
Education		
Medical degree	91 (60.7)	483 (58.6)
Masters	48 (32.0)	32 (3.9)
PhD	5 (3.3)	1 (0.1)
Others	6 (0.0)	308 (37.4)
Medical Illness		
Yes	43 (28.7)	171 (20.8)
No	107 (71.3)	653 (79.2)

Table II: Exploratory Factor Analysis (EFA)

Construct	Items	CODE	1	2	3	4	5	6	Chronbach Alpha
DMNE#	Q46 (b) Nodded off while stopping (last 2 weeks)	DMNE 1	0.863						0.87
	Q45 (c) Driven in a bad mood	DMNE 2	0.777						
	Q45 (b) Driven when tired	DMNE 3	0.684						
	Q44 (a) Mind-wandering state	DMNE 4	0.678						
	Q44 (c) Distraction	DMNE 5	0.612						
	Q48 (a) Lost focus while driving (last 2 weeks)	DMNE 6	0.596						
SDH	Q42 (c) Drive more carefully when raining	SDH 1		0.797					0.84
	Q42(b) Keep safe distance from the vehicle in front	SDH 2		0.792					
	Q42 (a) Give signal when overtaking, changing lane or turning	SDH 3		0.765					
	Q42 (g) Follow Speed limit	SDH 4		0.627					
	Q42 (d)Wear seatbelt when in vehicle	SDH 5		0.614					
	Q41 (a) Careful driver type	SDH 6		0.551					
FD#	Q47 (b) Fall asleep while stopping (last 2 weeks)	FD 1			0.826				0.87
	Q47 (a) Fall asleep while driving (last 2 weeks)	FD 2			0.818				
	Q46 (a) Nodded off while driving (last 2 weeks)	FD 3			0.711				
	Q46 (b) Nodded off while stopping (last 2 weeks)	FD 4			0.696				
RPD#	Q49 (c) Consume traditional supplements before driving	RPD 1				0.965			0.71
	Q50 (b) Consume traditional supplements during driving	RPD 2				0.642			
	Q50 (a) Consume prescribed medicine during driving	RPD 3				0.554			
DCI#	Q50 (a) Consume caffeine during driving	DCI 1					0.890		0.86
	Q49 (a) Consume caffeine before driving	DCI 2					0.837		
DAI#	Q50 (c) Consume alcohol during driving	DAI 1						0.790	**0.59**
	Q49 (e) Consume alcohol before driving	DAI 2						0.675	

 # reverse coded items: items with the reverse code were re-coded before the analysis was done, to indicate, the higher score, the safer the driver

Table III: Scale and total behaviour items

Factor	Construct	Definition	Items
1	Distracted Mind & Negative Emotion (DMNE)	Driver's focus during driving and any negative emotions that may be related towards driving	6
2	Safe Driving Habit (SDH)	Following driving regulations and good driving practice	6
3	Fatigue Driving (FD)	Sleep and microsleep during driving	4
4	Recreational & Prescribed Driving (RPD)	Consumption of medicine either for recreational or therapeutic use	3
5	Driving Under Influence of Caffein (DCI)	Consumption of caffein while driving	2
6	Driving Under Influence of Alcohol(DAI)	Consumption of alcohol while driving	2

that may be related towards driving. Next, safe driving habits (SDH) questions are on following driving regulations. The construct fatigue driving (FD) asks about sleep and microsleep during driving, while recreational & prescribed driving (RPD) looks into use of medicine either for recreational or therapeutic use. The final two constructs driving under influence of caffein (DCI) or alcohol(DAI) are self-explanatory.

Convergent and Construct Validity

The convergent and construct validity done on 824 participants is shown in Table IV.

Confirmatory Factor Analysis (CFA) confirmed this 6-factor solution and the fit indices generally support the fit of the model to the data : X2 = 3835.5, df = 454, X2/df = 3.210, p < 0.000, NFI = 0.925, TLI = 0.935, CFI = 0.947, and RMSEA = 0.052.

Table IV: Convergent and Construct Validity

Construct	Items	Loading	AVE	CR
DMNE	DMNE 1	0.673		
	DMNE 2	**0.562**		
	DMNE 3	0.650		
	DMNE 4	0.771		
	DMNE 5	0.732		
	DMNE 6	0.725	**0.475**	0.843
SDH	SDH 1	0.851		
	SDH 2	0.834		
	SDH 3	0.786		
	SDH 4	0.614		
	SDH 5	0.655		
	SDH 6	0.512	0.518	0.862
FD	FD 1	0.773		
	FD 2	0.752		
	FD 3	0.882		
	FD 4	0.928	0.701	0.903
RPD	RPD 1	0.886		
	RPD 2	**0.497**		
	RPD 3	0.707	0.511	0.748
DCI	DCI 1	0.918		
	DCI 2	0.772	0.719	0.836
DAI	DAI 1	0.855		
	DAI 2	**0.433**	**0.459**	**0.605**

In general, the composite reliability of all constructs is acceptable, except for "Driving under alcohol influence", which is 0.605. In both "Distracted Mind & Negative Mood" and "Driving under alcohol influence," the AVE values were 0.475 and 0.49, respectively. By rule, the AVE should be higher than 0.5. However, in our case, the value of 0.4 is acceptable due to the condition that if the AVE value is less than 0.5, but composite reliability is higher than 0.6. Therefore, the convergent validity of the construct is satisfactory and achieved for every construct (Fornell and David, 1981). Figure 1 shows the Confirmatory Factor Analysis (CFA).

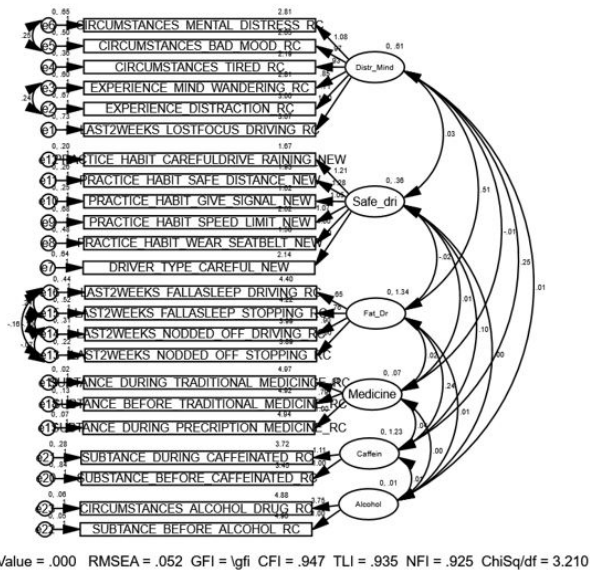

Figure 1: Confirmatory Factor Analysis (CFA)

All domains have adequate convergence or internal consistency. Based on the average variance extracted (AVE), convergent validity was clearly adequate for all domains. Discriminant validity is generally adequate for the six constructs as the values of the square root of AVE (√AVE) are generally higher than the correlation coefficients between the latent constructs (Table V).

The results of factor analysis revealed six constructs. These constructs are ; Distracted Mind & Negative Emotion (DMNE); Safe driving habits (SDH); Fatigue driving (FD); Recreational & prescribed driving (RPD); Driving under caffeine influence (DCI); Driving under alcohol influence (DAI). The possibility of unidimensionality at higher order constructs was examined, but results were not in favour. This indicates that there are constructs for safe driving behaviour that cannot be explained as a single latent construct.

DISCUSSION

The objective of this research was to create and validate a questionnaire specifically looking into doctors' driving

Table V: Composite reliability (CR), the square root of the average variance extracted (AVE) and correlations between constructs (off-diagonal)

	Construct	1	2	3	4	5	6	AVE	CR
1	DMNE	0.690						0.475	0.843
2	SDH	0.069	0.720					0.518	0.862
3	FD	0.559	-0.030	0.840				0.701	0.903
4	RPD	-0.045	0.035	0.074	0.840			0.511	0.748
5	DCI	0.285	0.152	0.184	0.151	0.850		0.719	0.836
6	DAI	0.056	-0.051	0.042	0.180	0.056	0.680	0.459	0.605

behaviour, naming it the MyDRIVE questionnaire. From the initial 44 items, it is now reduced to 23 items with six constructs. The psychometric properties of this questionnaire were shown to be satisfactory, and the questionnaire also demonstrated good face validity.

As mentioned earlier, to ensure convergent validity, we considered indicator's factor loading, CR, and AVE, with an AVE value of greater than 0.50 to be considered adequate (39). In this study, all domains have a CR of above 0.5. The lowest was Driving Under Alcohol Influence (DAI) (0.605).

We applied the Fornell-Lacker criteria to asses discriminant validity. Discriminant validity is generally adequate for the six constructs as the values of the square root of AVE (√AVE) are generally higher than the correlation coefficients between the latent constructs (34). We report the CR and the √AVE to be mostly between 0.5-0.9 and correlations between constructs at mostly 0.8 exhibiting good reliability and validity of our scales.

However, we noticed that the DAI construct had a slightly low correlation between constructs √AVE and CR of 0.609, 0.459, and 0.605 respectively. This suggests more efforts to categorise this influence on driving behaviour. Although alcohol and driving are significantly related to bad driving behaviour (14,15), perhaps the population in this study that were majority Malay and Muslims was not the best to depict this.

We also found that there was no possibility of unidimensionality at higher order constructs, indicating that safe driving behaviour cannot be explained as a single latent construct.

Despite being the pioneer to create a driving behaviour tool among doctors in Malaysia, this study is limited to one country's doctors population only and not representative of other populations. The non-probability sampling method could lead to bias to those who are actively online and who are in the know on MMA activities.

Further research is needed to better understand the underlying factors of safe driving behavior. Additionally, further studies could explore the relationships between the identified constructs to gain a deeper understanding of the issue.

CONCLUSION

Our study finds the driving behavioural component of MyDRIVE questionnaire among the Malaysian medical doctors to have good reliability and validity. Future studies should consider using MyDRIVE's driving behaviour component to assess driving behaviour among doctors.

ACKNOWLEDGEMENT

We would like to thank the Ministry of Education Malaysia (MoE) for funding this study, under the Fundamental Research Grant Scheme (FRGS); grant number: FRGS/1/2018/SKK01/UPM/03/, and also the Director General of Health Malaysia for the permission to publish this article. Finally, we would like to thank the Malaysian Medical Association (MMA) for helping us to disperse the questionnaires to its members.

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