



# The relationship between lifestyle, driving anger and dangerous driving behaviours—An explorative study in a Chinese sample

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## ABSTRACT

Drivers who exhibit dangerous driving behaviours, such as aggressive, risky, and negative emotion cognition driving, are more likely to be involved in road crashes. A key motivator behind unsafe driving behaviours is driving anger. However, it is unclear whether lifestyle, driving anger, and dangerous driving behaviours are related. A total of 344 Chinese drivers with a formal driving license were asked to complete the socio-demographic information, the Chinese lifestyle questionnaire (Self-designed), the 14 items Driving Anger Scale (DAS), and the Dula Dangerous Driving Index (DDDI). The Chinese driver's lifestyles were analysed using Exploratory Factor Analysis (EFA), revealing a four-factor structure ("Culture", "Workaholism", "Sports" and "Amusement"). The 14 items DAS factor structure was determined using a Confirmatory Factor Analysis (CFA), yielding a two-factor structure ("Safety Concern anger" and "Arrival Concern anger"). Based on Hierarchical Multiple Regression (HMR), only "Workaholism" was associated with aggressive, risky, and negative emotion cognition driving. The trait driving anger was examined as a mediator between the "Workaholism" and dangerous driving (aggressive, risky, and negative emotion cognition driving) through a Structural Equation Modelling (SEM) approach. "Workaholism" was shown to influence these dangerous driving behaviours through trait driving anger. Lastly, this article discussed the theoretical and practical implications and research limitations.

## 1. Introduction

During the last 40 years, China has witnessed rapid urbanization and motorisation, which inevitably accompanied by road crashes. Road crashes can exert a severe negative impact on the country's development and stability to a considerable extent. As reported by [1], there were 159,335 automobile accidents in 2019, resulting in 157,157 injuries, 43,413 deaths, and 1.35 billion RMB in monetary losses. Meanwhile, it was estimated that dangerous driving behaviours (e.g., speeding, dangerous overtaking, illegal lane changing, etc) roughly account for 24% of the total number of motor vehicle accidents [2]. Driving anger is a common emotion on Chinese roads [3,4]. According to Suo, Cong [5], 17.33 million anger events were recorded in 2015. Also, a survey of 2023 drivers found that nearly 80% had experienced anger behind the wheel [6].

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### 1.1. Driving anger and dangerous driving behaviours

Driving anger is generally conceptualised into two modalities: trait driving anger and state driving anger [7]. The former refers to how likely an individual is to become angry (e.g., how much anger they experience when confronted with anger-provoking situations), whereas the latter is a transitory emotional status that can be activated by surrounding traffic annoyance [8]. To assess the degree of an individual's trait driving anger, a measurement named Driving Anger Scale (DAS) was developed by Deffenbacher, Oetting [7], which has long (33 items) and short versions (14 items). The long version contains six broad anger-provoking categories (e.g., slower driving; discourtesy from other drivers; hostility from other drivers; police presence; illegal driving; and traffic obstructions). The long DAS has been validated in numerous studies over the past decades with a consistent factor structure [9]. However, the structure of the short version is controversial even in the same study country. For example, Ge, Zhang [10] found a one-factor solution in China, but Zhang, Chan [11] demonstrated a three-factor solution. It has been well established that driving anger is associated with individual characteristics. For instance, young drivers tend to show a higher trait driving anger than elder drivers [4,12]. Male drivers report more driving anger traits than females [3,13], and tend to express anger through non-adaptive ways, i.e., verbal, physical and vehicle [14]. Moreover, some studies found that females are more likely to get angry while encountering road discourtesy and hostile gestures [15, 16], or there were no significant gender differences in the total trait driving anger level [17].

Existing literature illustrated that dangerous driving behaviours (e.g., aggressive and risky driving) have a positive association with crashes [18–20], traffic penalty points [21,22], and traffic fines [23]. A measurement named Dula Dangerous Driving Index (DDDI) [24] assessed four dangerous driving behaviours: aggressive driving (AD), risky driving (RD), negative cognitive emotion driving (NCED), and drunk driving (DD). The concept of aggressive driving is defined as driving with the intent of harming or disrupting other road users physically or psychologically [24]. For example, a driver deliberately honks at another driver. Driving anger has been considered a primary motivator behind aggressive driving [25,26]. From a meta-analysis perspective, Bogdan, Măirean [27] selected 51 studies conducted in the driving anger domain from 1994 to 2016, indicated a positive and moderate association ( $r = 0.38$ ) between trait driving anger and aggressive driving. Risk driving behaviours always cover driving behaviours without hostile or harmful intentions toward other drivers, but it has potential negative driving outcomes, such as speeding and running red lights [28]. Indeed, driving anger is also related to risky driving [29,30]. Specifically, Mirón-Juárez, García-Hernández [31] found that the expression of physical anger strongly influences risky driving. A recent study by Li, Zhang [32] using electroencephalography demonstrated drivers' risk-taking propensity increased when angry. Negative emotion cognition driving was also encompassed by DDDI, which refers to such negative emotions as anger, frustration and irritation related to vehicle driving (e.g., losing cognitive ability and judging other's actions as inappropriate or "stupid"). Some studies found that experiencing negative emotions (e.g., anger) while driving increased speeding and traffic violations [33–35]. Drunk driving was defined as driving in a drunk/in-sober state, which showed a higher tendency toward traffic collisions [36]. However, drunk driving was always considered as a separate research branch by researchers [37,38]. Due to the fact that drunk driving occurs after drinking alcohol, and its motivation differs from aggressive, risky, and negative emotion cognition driving behaviours [37].

### 1.2. Lifestyle and unsafe driving behaviours

Research interests in lifestyles and driving behaviours were sparked by the increasing realisation that motivation and attitude had moderate impacts on driving behaviours, outside of the traffic context and environment [39,40]. As suggested by Lööv and Miegel [41], lifestyle is the way of people live and is assumed to be an expression of humans. Lifestyle is therefore a set of practices an individual embraces because they satisfy utilitarian needs and form a narrative of personal identity [42]. Hence, lifestyle might affect driving behaviours in some way. For instance, the individual has the likelihood to drive in drunk status if he/she is addicted to alcohol in daily life. On the other hand, someone who pursues a healthy lifestyle, such as regular exercise, may place more emphasis on safe driving in practices [43]. As Miegel [44] stated, lifestyle could be assessed in three aspects: a level of basic values, attitudes and actions. By using this approach, the scholars divide several factors to reflect how people live, and these factors define the fundamental values, interests and leisure activities in moral, religious, material and aesthetic aspects [41,45].

A summary of previous lifestyle measurements and driving behaviour studies can be found in APPENDIX A. As a result of country and regional cultural differences, no standard lifestyle questionnaire was applied in previous studies. In fact, these four lifestyle aspects have been selected by previous researchers to present different angles of people living: 1) Amusement, referring to how people spend their leisure time in relation to the value of materials for recreation. 2) Culture, including activities reflecting cultural value, such as reading books, listening to music, and learning history. 3) Religion, relating to the individual's conviction of God's existence and religious beliefs. 4) Sports, suggesting the performing sports activities and going to sports games. These correspond to the structure of lifestyle as discussed previously.

Lifestyle profiles were found to impact driving behaviours in previous studies. To be specific, Chliaoutakis, Koukoulis [43], Chliaoutakis, Darviri [46] found that both "Religion" and "Culture" negatively related to aberrant driving behaviours. Gnardellis, Tzamalouka [47] suggested that religion significantly and negatively affects drowsy driving. Papadakaki, Kontogiannis [48] proved that the "Amusement" lifestyle profile could be positively associated with drowsy driving and daily sleepiness. Dabirinejad, Tavakoli Kashani [49] used a Structural Equation Modelling (SEM) approach to predict aberrant driving among Iranian car drivers. The results indicated that driver's attached importance to the "Morality" facet in their life could significantly reduce aggressive violations ( $\beta = -0.26, p < 0.01$ ).

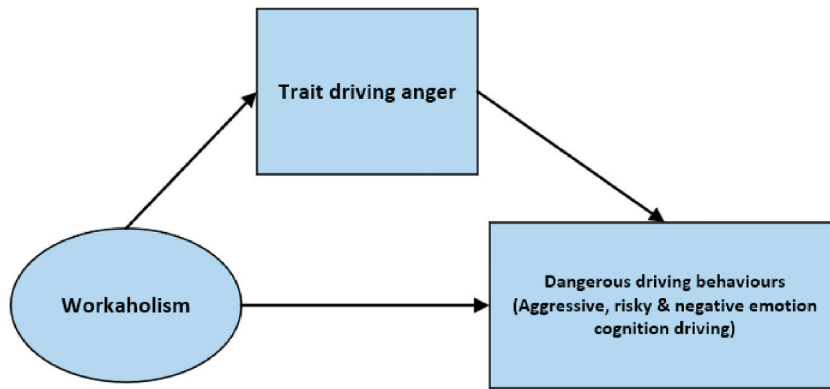


Fig. 1. Proposed mediated model.

### 1.3. Present study rationale and objectives

As discussed earlier, literature provides evidence that driving anger is a crucial factor that might encourage AD, RD and NECD. China has different driving situations compared to the western countries because such unsafe driving behaviours are engrained (e.g., continual lane changing and tailgating) [50–52], which could also result in the potential crashes. More importantly, the roads and streets are often filled with a large group of pedestrians and cyclists [53]. There can be many unexpected situations while driving such as sudden presence or acceleration of cyclists from the side direction, due to these road users' differing levels of road safety consciousness [19,54], resulting in driving anger and further enhancing dangerous driving behaviours. Apparently, a well-established scale is beneficial for researchers to understand the nature of a regional sample characteristics and differences [55]. There is, however, a lack of consistency in the factor structure of the 14 items of the DAS in China, which may hinder future research on driving anger.

Undoubtedly, China has experienced development at an unprecedented rate over the past four decades. It is possible that Chinese people developed healthy and unhealthy lifestyles during urbanization, such as playing with electronic gadgets instead of engaging in social interaction, especially during the COVID-19 pandemic wreaked around the world. Meanwhile, the increasingly rapid pace of the modern and urban lifestyle contribute to the accumulated stress and negative emotions in people's daily lives or work Li, Wang [56]. A previous survey conducted by showed that 77.6% of Chinese senior professional managers experienced high levels of job stress and negative emotion [57]. Additionally, Li, Wang [56] revealed that employment challenges and hindrances have a positive relationship with driving anger, and more engaged employees might explore more anger while driving in the Chinese context. However, such extreme emotional expression is typically disapproved in Chinese culture [58]. In other words, anger emotion is not supposed to be expressed towards people and social networks, which may negatively affect the harmony of the individual's personal relationships. According to the Cognitive Neo-association Theory [59,60], aversive events might produce negative affect, automatically stimulating various thoughts, memories, and physiological responses related to aggression or its tendencies. As a result, those who recently experienced negative things or trivial matters from their daily life or work might express their anger on the road due to emotional repression, and these types of drivers are more likely to perceive a driving situation as hostile or threatening [61]. Based on previous discussions, it is well known the links between specific lifestyle profiles and driving behaviours. However, it remains unclear how lifestyle impacts driving anger.

To the best of our knowledge, no study examines the relationship between lifestyle, driving anger and dangerous driving behaviours. Herein, the present study aims to investigate the association between the Chinese driver's lifestyle, driving anger and dangerous driving behaviours (e.g., AD, RD and NECD) and presents a mediated model among these components, which may provide new insights into the driving anger and driving behaviour research domains. The main objectives of this study are as follows.

- 1) Investigating the factor structure of the 14 items DAS in a Chinese sample.
- 2) Exploring Chinese drivers' lifestyle patterns and examining the explanatory power of lifestyle components on AD, RD, and NECD.
- 3) Testing whether trait driving anger could mediate between lifestyle component "Workaholism" and dangerous driving behaviours (See Fig. 1).

## 2. Methodological approach

### 2.1. Procedure

Using online data collection tools to investigate driving behaviour has been shown to be valid in previous research [62]. In addition, due to the COVID-19 situation safety concern and high internet penetration (70.4%) in China [63], the data collection exercise decided to adopt an online survey. A commonly used survey platform in China is (<https://www.wjx.cn>), used by many

**Table 1**  
Participants Socio-demographic details (N = 332).

Characteristics	N	Proportion
<b>Gender</b>		
Males	173	52.1%
Females	159	47.9%
<b>Age groups</b>		
18–24 years old	88	26.5%
25–34 years old	195	58.7%
35–44 years old	43	13.0%
Over 45 years old	6	1.80%
<b>Tenure of the driving license</b>		
≤1 year	56	16.9%
2–3 years	107	32.2%
4–5 years	73	22.0%
6–10 years	81	24.4%
>10 years	15	4.5%
<b>Annual driving mileage</b>		
≤5000 km	103	31.0%
5001–10000 km	138	41.6%
10,001–20000 km	79	23.8%
>20,000 km	12	3.6%

researchers in the field of traffic safety in China, such as Zhang, Chan [11]. Importantly, this platform can apply techniques to filter invalid participants, e.g., using screening checks during the survey. The sole criterion to participate in the survey was to hold a valid Chinese driving license. The ethics committee of the Southwest Forestry University approved this study (SWFU2019J0190).

The research aims, anonymity and confidentiality were assured to the participants that their data is only for scientific research purpose and will not share to any third parties. Before accessing the formal survey webpage, participants were required to agree to the consent form. Finally, 344 participants were recruited to complete the questionnaire, and 12 participants were excluded from the formal analysis due to several data filtration rules (e.g., contradictory answers, same score for one or more scales, excessive time usage). The whole formal data collection process was in the April of 2022. There were 332 valid respondents (173 males and 159 females) in the present study, with the mean age of the sample 34.6 (SD = 7.3). The socio-demographic information lists in Table 1, using studies by [10,54,64] as a guide for segmentation.

## 2.2. Measurements material

Three parts are included in the questionnaire. In the first section, participants were asked to provide their personal information, including age, gender, the years of driving license acquired (“≤1 year”, “2–3 years”, “4–5 years”, “6–10 years”, “>10 years”), annual mileages (“≤ 5000 km”, “5001–10000 km”, “10,001–20000 km”, “>20,000 km”), and the traffic penalty points received in the last year. In the second part, participants responded to lifestyle-related questions. In the last part of the questionnaire, trait driving anger and driving behaviour questionnaires were presented.

**Lifestyle questionnaire.** Initially, a 19 items lifestyle with four dimensions (Amusement, Culture, Sports and Workaholism) draft was designed based on previous studies such as [47,49]. However, in order to better reflect Chinese driver’s living patterns and to avoid bias, an items suggestion survey was conducted in mid-October 2021. During this period, the initial version of the lifestyle questionnaire was published online (<https://www.wjx.cn>) and then shared through social medias (e.g., such as WeChat, QQ and car fans forum) to indicate their frequency of performing such activities. In addition, it welcomed any further information regarding potential lifestyle items. Finally, 239 participants (mean age = 32.4, SD = 6.7) attended this survey. According to the frequency of their suggestions, three lifestyle items were added: “Going for a walk”, “Participate in a company party”, and “Go shopping with friends”. Thus, the 22 items lifestyle questionnaire was decided to apply in the formal study, and each item records on a 5-point scale ranging from (“1 = almost never”) to (“5 = almost always”), asking participants to report their frequency on these live patterns.

**14 items Driving Anger Scale (14 items DAS).** The 14 items DAS was developed by Deffenbacher, Oetting [7], and it describes the anger-provoking situations, asking participants to report to what extent the anger amount they feel when encountering these driving anger situations on a 5-point scale (“1 = not at all” to “5 = very much”). This measurement has cost a short time to respond and also keeps high reliability ( $\alpha = 0.80$ ) and show a high correlation ( $r = 0.95$ ) with the long version (33 items) [7]. The translation procedure of DAS was as follows. Translators who were proficient in both English and Chinese independently translated the English version of DAS, and discussed their separate translation outcomes when their first draft was completed. This discussion was undertaken to ensure accuracy, fluency, and appropriateness in the context of Chinese culture. Afterwards, the Chinese translation was delivered and back-translated to English to check for inconsistencies and errors. Next, a joint Chinese version was sent to ten respondents before the formal survey, to clarify whether there were any confusion and unambiguous items for understanding. Finally, the revision was based on the 10 participants’ feedback and comments.

**Dula Dangerous Driving Index (DDDI).** The Chinese version of DDDI [20] was used in the present study, which contained 28 items with four subscales: Aggressive Driving (AD, 7 items,  $\alpha = 0.770$ ), Risky Driving (RD, 10 items,  $\alpha = 0.817$ ), Negative Cognitive Emotion Driving (NCED, 9 items,  $\alpha = 0.766$ ) and Drunk Driving (DD, 2 items,  $\alpha = 0.671$ ). The participants were asked to indicate the

frequency to perform these dangerous driving behaviours on a 5-point scale from (“1 = never”) to (“5 = always”).

### 2.3. Statistical analysis strategy

A combination of SPSS and AMOS was used for data analysis. Considering that the lifestyle questionnaire was self-designed and based on previous studies, an Exploratory Factor Analysis (EFA) with principal component extraction and varimax rotation was conducted to show the dimension of the Chinese driver’s lifestyle structure. Also, with the aim of exploring the predictive power of lifestyle factors on aggressive, risky, and negative emotion cognition driving, an intercorrelation was used to examine the relationship among demographic variables, lifestyle components, total DAS score and driving behaviours variables. Following that, the Hierarchical Multiple Regression (HMR) was applied to investigate the influence of lifestyle components and trait driving anger on aggressive, risky, and negative emotion cognition driving behaviours.

To ensure the structure of DAS, an EFA and a Confirmatory Factor Analysis (CFA) were conducted prior to the structural equation model. Finally, a structural equation modelling (SEM) approach was used to investigate the mediated effects between lifestyle components and dangerous driving behaviours, e.g., aggressive, risky, and negative emotion cognition driving. Several indicators were used to test the model fit, such as the ratio of Chi-square value to  $df(\chi^2 / df)$  less than 3, goodness of fitness (GFI) index, adjusted goodness fitness index (AGFI) over than 0.95, and root mean square error of approximation (RMSEA) less than 0.06, indicating excellent model fit [65]. There was also a report on the direct, indirect, and total effects of the mediation model.

## 3. Results

### 3.1. The results of EFA on the lifestyle questionnaire

After conducting the EFA with the varimax rotation approach, it was determined that KMO was 0.775, and the Bartlett test of sphericity was significant at 0.001 level, indicating the lifestyle data were suitable for factor structure analysis. In addition, all factors’ eigenvalues were larger than 1, and the items crossed loading or loading value less than 0.40 were removed. Based on this, four dimensions of lifestyle structure with 18 items emerged. In total, 46.69% of the variance can be attributed to the four factors of “Culture”, “Workaholism”, “Sports”, and “Amusement”. The EFA results can be found in Table 2. Additionally, the Cronbach alpha value was also calculated for each dimension, reflecting an acceptable internal reliability of the scale.

### 3.2. The results of CFA approach on 14 items DAS

To investigate the initial factor structure of the 14 items DAS, an EFA with varimax rotation was performed in SPSS. As a result of the EFA, 14 items were shown to have a two-factor structure; each item was loading over 0.40. A CFA was thus conducted to determine whether this two factors solution was appropriate. The first attempt used the 14 items DAS with two factors, but the model fitness could not meet the indices requirement because of the lower loading (i.e., less than 0.50) of item 5, “You pass a radar trap”, and it was removed from the model. Also, as Zhang, Chan [11] indicated, this item exerts the lowest anger level (mean score = 1.54) among Chinese drivers. In addition, the Lagrange Multiplier Tests (LM) suggested that one error pair (e2-e3) should be theoretically covaried, indicating some variance of these items were not explained by latent factors, which followed the rules of Modification Indices (MIs)

**Table 2**  
Exploratory Factor Analysis results of the 18 items lifestyle questionnaire.

Items	Culture [α = 0.71]	Workaholism [α = 0.77]	Sports [α = 0.68]	Amusement [α = 0.72]	Mean	SD
Going to concert	0.722				1.93	0.99
Writing	0.668				1.88	0.90
Going to museum	0.635				2.55	0.97
Playing the instrument	0.603				1.64	0.91
Travel	0.550				2.97	1.01
Participate in company social engagement		0.783			2.77	1.05
Participate in a company party		0.762			2.99	1.01
Participate in company team activities		0.760			2.91	1.05
Working overtime		0.682			3.08	1.11
Jogging			0.776		3.21	1.12
Going to gym			0.680		3.27	1.15
Swimming			0.558		2.33	1.17
Going for a walk			0.556		3.92	1.01
Participate in team sports activities (e.g., basketball, football, etc)			0.410		2.57	1.22
Chat online with friends				0.712	4.36	0.83
Watching short videos via a platform				0.692	4.21	0.92
Party/dinner with friends				0.548	3.29	0.83
Going to the cinema				0.437	3.24	0.89



Fig. 2. 13 items with two factors of the Driving Anger Scale (DAS).

equal and greater than 15 [55]. After modification, all items' loading values were over 0.50, thus 13 items with two factors DAS were determined, respectively called "Safety Concern anger (SC)" and "Arrival Concern anger (AC)", they were significantly and moderately associated ( $r = 0.61$ , See Fig. 2). SC refers to the driving anger situations threatening drivers' safety, e.g., item 3, "Someone backs right out in front of you without looking". AC includes driving context associated with drivers' arrival blocking, e.g., item 7, "Someone is

Table 3  
Descriptive information of the 13 items with two factors Driving Anger Scale (DAS).

Dimensions	Item	Mean (SD)	Skewness	Kurtosis
<b>Safety concern</b>	(Cronbach's $\alpha = 0.855$ )	3.30 (0.97)	-0.38	-0.97
SC1 (DAS1)	Someone is weaving in and out of traffic	3.32 (1.03)	-0.33	-0.34
SC2 (DAS2)	A vehicle on a mountain road will not pull over and let people by	3.14 (1.24)	-0.21	-0.96
SC3 (DAS3)	Someone backs right out in front of you without looking	3.57 (1.31)	-0.49	-0.95
SC4 (DAS4)	Someone runs a red light or stop sign	3.38 (1.32)	-0.22	-1.15
SC5 (DAS9)	Someone makes an obscene gesture toward you about your driving	3.27 (1.39)	-0.21	-1.17
SC6 (DAS13)	A truck kicks up sand or gravel on the car you are driving	3.09 (1.35)	-0.93	-1.18
<b>Arrival concern</b>	(Cronbach's $\alpha = 0.710$ )	2.96 (0.68)	-0.96	-0.23
AC1 (DAS6)	Someone speeds up when you try to pass him/her	2.98 (1.04)	0.15	-0.49
AC2 (DAS7)	Someone is slow in parking and is holding up traffic	3.24 (1.07)	-0.19	-0.69
AC8 (DAS8)	You are stuck in a traffic jam	3.51 (1.02)	0.12	0.46
AC3 (DAS10)	Someone honks at you about your driving	3.07 (1.07)	-0.13	-0.69
AC4 (DAS11)	A bicyclist is riding in the middle of the lane and is slowing traffic	3.22 (1.05)	0.13	-0.74
AC5 (DAS12)	A police officer pulls you over	2.02 (1.04)	0.94	0.31
AC6 (DAS14)	You are driving behind a large truck and you cannot see around it	3.20 (1.09)	0.13	-0.69

slow in parking and is holding up traffic". Overall, all the indices showed excellent model fitness that  $\chi^2/df = 2.155$ , GFI = 0.97, AGFI = 0.95, RMSEA = 0.052. The descriptive information of the 13 items of DAS can be found in Table 3.

### 3.3. The intercorrelation among demographic variables, lifestyle, trait driving anger and dangerous driving behaviours

Table 4 lists the correlation among demographic variables, lifestyle factors, trait driving anger and DDDI sub-scales. The gender was negatively correlated to AD ( $r = -0.141, p < 0.05$ ), RD ( $r = -0.133, p < 0.05$ ) and DD ( $r = -0.138, p < 0.05$ ). Meanwhile, the "Workaholism" factor was found to be positively related to AD ( $r = 0.190, p < 0.01$ ) and RD ( $r = 0.218, p < 0.01$ ). Moreover, "Culture" and "Workaholism" positively related to the trait driving anger, but the magnitude differed. Furthermore, driver's annual mileage positively correlated with traffic penalty points in the last year ( $r = 0.365, p < 0.01$ ). More importantly, trait driving anger showed a positive correlation with NECD ( $r = 0.376, p < 0.01$ ), AD ( $r = 0.273, p < 0.01$ ) and RD ( $r = 0.234, p < 0.01$ ).

Next, an independent *t* test was performed to compare gender differences in reporting dangerous driving behaviours. A Cohen's *d* was used to determine the effect size, where  $0.10 < d < 0.25$ , being a small effect,  $0.25 < d < 0.40$  being a medium effect,  $d > 0.40$  being a large effect [66]. The results revealed that males exhibited more on AD ( $t = 2.585, p < 0.01$ , mean = 1.71 and 1.52, Cohen's *d* = 0.29). Males also showed a high propensity on RD ( $t = 2.450, p < 0.05$ , mean = 1.86 and 1.70, Cohen's *d* = 0.27) and DD ( $t = 2.571, p < 0.05$ , mean = 2.42 and 2.16, Cohen's *d* = 0.28) compared to females, but there was no significant difference in NECD between males and females ( $t = 0.303$ , ns, mean = 2.52 and 2.50, Cohen's *d* = 0.03).

Furthermore, an ANOVA revealed significant differences ( $F = 8.488, p < 0.001$ ) among each driving experience group ("≤1 year", "2–3 years", "4–5 years", "over 6 years") in the number of traffic penalty points received during the past year. Further, a *post hoc* test showed that drivers have "4–5" years driving experience received more points in the last year (mean = 2.89) than those drivers have "over 6 years driving experience" (mean = 2.40), "driving 2–3 years" (mean = 2.10) and "driving less than 1 year" (mean = 0.43).

### 3.4. The results of predicting aggressive, risky and negative emotion cognition driving

A Hierarchical Multiple Regression (HMR) was used to probe the predictive power of demographic characteristics, lifestyle patterns and trait driving anger on aggressive driving (AD), risky driving (RD) and negative emotion cognition driving (NECD). All analyses regarded driving behaviours as a dependent variable. In order to predict AD and RD and control covariate effects, demographic information had to be entered first, followed by the four lifestyle components. Finally, the trait driving anger calculated by the mean score of DAS was entered in the last step. However, no demographic variables were included in the NECD regression model since they were not significantly correlated (See Table 4). The results are presented in Table 5, Table 6, Table 7.

For aggressive driving, there was only 3% variance could be explained by gender factor ( $\beta = -0.136, p < 0.05$ ), but the overall 7.5% variance of predicting driving aggression was achieved after entering the lifestyle component "Workaholism" ( $\beta = 0.181, p < 0.01$ ), and the gender effect was still significant in step 2. Unfortunately, other lifestyle elements could not predict aggressive driving. Trait driving anger exerted a greater impact on aggressive driving ( $\beta = 0.253, p < 0.001$ ). Overall, the model explained 13.7% of aggressive driving. Besides, gender ( $\beta = -0.130, p < 0.05$ ) and "Workaholism" effects ( $\beta = 0.177, p < 0.01$ ) were still significant to explain the driving aggression when trait driving anger was included in the model.

With regard to the prediction of risky driving, the gender effect could contribute 3.5% variance. Contrary to HMR model of aggressive driving, two lifestyle dimensions provided explanations for risky driving, respectively "Culture" ( $\beta = 0.136, p < 0.05$ ) and "Workaholism" ( $\beta = 0.199, p < 0.001$ ), contributing to a 5.4% variance in risky driving prediction. Trait driving anger further provided 3.8% model predictive power, but the magnitude ( $\beta = 0.165, p < 0.001$ ) on risky driving was weaker than predicting aggressive driving. A total of 12.7% of the variance in risky driving could be explained by this model.

"Workaholism" positively influences on negative emotion cognition driving ( $\beta = 0.260, p < 0.001$ ), contributing to 3.7% variance of model explanatory power, but the other three lifestyle patterns had no significant impacts on the model. Additionally, trait driving anger showed a greater impact on negative emotion cognition driving ( $\beta = 0.378, p < 0.001$ ) compared to aggressive and risky driving. This provides an additional prediction power of 16% for variance.

### 3.5. The results of the mediated effect of trait driving anger between lifestyle and dangerous driving behaviours

The results of the HMR prediction model suggested that "Workaholism" lifestyle factor significantly predicted AD, RD and NECD, which serves to test the mediated model as proposed in Fig. 1. Dangerous driving behaviours was measured by calculating the mean score of DDDI without DD. Trait driving anger was assessed as the mean score of two factors DAS as shown in Fig. 2. A structural equation model based on a maximum likelihood (ML) approach was applied in the AMOS, using bootstrapping (5000 bootstrap samples were generated) for examining the mediated effect on dangerous driving behaviours. As the Lagrange Multiplier test suggested, the MIs between error pairs 1 and 2 should be covaried to due to their larger MIs [67]. The case has commonly occurred when items were similarly interpreted by participants [55], e.g., Participate in company team activities and Participate in company social engagement. Finally, the model fitness indices met the criteria threshold ( $\chi^2/df = 1.265$ , GFI = 0.989, AGFI = 0.978, RMSEA = 0.021). As shown in Fig. 3, the effect of "Workaholism" on dangerous driving behaviours was mediated by the trait driving anger. The indirect effect of "Workaholism" on trait anger, the direct effect between "Workaholism" and dangerous driving, and the total effects were all significant. The details of all effects as standardised coefficient and their confidential interval (95% level) can be found in the Table 8. The indirect effect was quite weak ( $\beta = 0.027, p < 0.01$ ), compared to the direct impact of "Workaholism" on dangerous driving ( $\beta =$

**Table 4**  
Intercorrelation between demographic information, lifestyle patterns, trait driving anger and dangerous driving behaviours.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Gender	1													
2 Age	-.082	1												
3 Driving license tenure	-.122*	.641**	1											
4 Annual mileage	-.181**	.387**	.502**	1										
5 Points	-.147**	.173**	.226**	.365**	1									
6 Culture	-.008	.021	.099	.154**	.059	1								
7 Workaholism	-.057	.094	.157**	.329**	.192**	.294**	1							
8 Sports	-.217**	.100	.246**	.239**	.181**	.380**	.331**	1						
9 Amusement	.042	-.053	.049	.081	.125*	.122*	.187**	.196**	1					
10 NECD	-.017	.063	.094	.034	.009	-.014	.169**	-.018	.016	1				
11 AD	-.141*	.039	.095	.091	.053	.137*	.190**	.057	-.042	.586**	1			
12 RD	-.133*	-.022	.065	.080	.056	.162**	.218**	.061	.028	.621**	.673**	1		
13 DD	-.138*	-.059	-.069	.035	-.018	.334**	.133*	.100	-.158**	.231**	.503**	.451**	1	
14 DAS	-.040	.024	.076	-.007	-.012	.123*	.113*	.096	.132*	.376**	.273**	.234**	.068	1

Notes: 1 = Males; Points = Traffic penalty points received in the last year; NECD = Negative cognitive/emotional driving; AD = Aggressive driving; RD = Risky driving; DD = Drunk driving; DAS = Mean of total DAS score, \*p < 0.05, \*\*p < 0.01.



**Table 5**  
Results of HMR model of aggressive driving (AD).

HMR model in AD		Standardised $\beta$	$t$	$R^2$	$\Delta R^2$	F
Step 1	Gender	-0.136	-2.468*	0.03	0.03	3.421*
Step 2	Gender	-0.139	-2.497*	0.075	0.045	3.773***
	Culture	0.115	1.943			
	Workaholism	0.181	3.072**			
	Sports	-0.078	-1.030			
Step 3	Amusement	-0.073	-1.316	0.137	0.061	6.397***
	Gender	-0.130	-2.402*			
	Culture	0.094	1.641			
	Workaholism	0.177	3.098**			
	Sports	-0.079	-1.203			
	Amusement	-0.101	-1.809			
	Trait driving anger	0.244	4.793***			

Note: 1 = males; \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

**Table 6**  
Results of HMR model of risky driving (RD).

HMR model in RD		Standardised $\beta$	$t$	$R^2$	$\Delta R^2$	F
Step 1	Gender	-0.127	-2.309*	0.035	0.035	3.959**
Step 2	Gender	-0.138	-2.498*	0.089	0.054	4.547***
	Culture	0.136	2.305*			
	Workaholism	0.199	3.399***			
	Sports	-0.093	-1.396			
Step 3	Amusement	-0.005	-0.075	0.127	0.038	5.878***
	Gender	-0.132	-2.416*			
	Culture	0.122	2.090*			
	Workaholism	0.196	3.398***			
	Sports	-0.094	-1.509			
	Amusement	-0.021	-0.383			
	Trait driving anger	0.165	3.092***			

Note: 1 = males; \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

**Table 7**  
Results of HMR model of negative emotion cognition driving (NECD).

HMR model in NECD		Standardised $\beta$	$t$	$R^2$	$\Delta R^2$	F
Step 1	Culture	-0.047	-0.093	0.037	0.037	2.501**
	Workaholism	0.260	3.474***			
	Sports	-0.072	-1.146			
Step 3	Amusement	-0.002	-0.006	0.175	0.160	13.499***
	Culture	-0.081	-1.428			
	Workaholism	0.183	3.327**			
	Sports	-0.077	-1.327			
	Amusement	-0.043	-0.829			
	Trait driving anger	0.378	7.399***			

Note: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

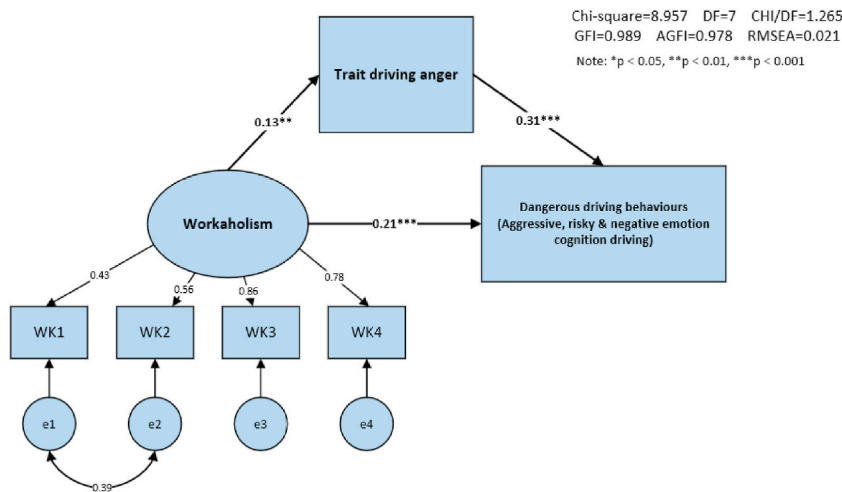


Fig. 3. Mediator model between lifestyle and dangerous driving behaviours (Standardised coefficient).

Table 8

The summary of the standardised indirect, direct, and total effect of “Workaholism” on dangerous driving behaviours.

Effect types	Workaholism	CI at 95% level
Indirect effect	0.027**	[0.006–0.081]
Direct effect	0.214***	[0.088–0.325]
Total effect	0.253***	[0.123–0.375]

Note: \*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001.

0.214,  $p < 0.001$ ). Meanwhile, the “Workaholism” was positively related to the trait driving anger ( $\beta = 0.130, p < 0.01$ ).

#### 4. Discussion and conclusion

##### 4.1. Discussion

This study integrates lifestyle, driving anger, and driving behaviours to probe the factor solution for Chinese drivers’ lifestyle patterns, and whether lifestyle components explain dangerous driving behaviours (i.e., aggressive, risky and negative emotion cognition driving). In addition, to examining whether the trait driving anger could be a mediator between dangerous driving behaviours and lifestyle. Hopefully, this study may contribute to new knowledge and understanding of lifestyle, driving anger, and driving behaviour.

After conducting an Exploratory Factor Analysis (EFA), a four-factor lifestyle structure emerged, accounting for 46.69% of the total variance, higher than previous studies, such as 36% by Chliaoutakis, Koukoulis [43] and 45% by Dabirinejad, Tavakoli Kashani [49]. It also demonstrated adequate internal consistency, which might be applied to other studies in China examining driving behaviours and living patterns. Nevertheless, items such as “Playing video games”, “Going to a mall with friends”, “Reading literature”, and “Listening to music” failed to meet the factor loading criteria (over 0.40) and were eliminated from further analysis. Possibly due to the different lifestyle patterns of the individuals. In other words, not all people prefer to shop at malls, since shopping online is also an option. There was a cross-loading matter for “Playing video games”, which was removed for further analysis, despite the fact that the rating score was quite high for participants (mean = 3.52).

The CFA was applied to probe the structure of the 14 items DAS. After removing the irrelevant items, the model fit the present sample data well, and the two factors “Safety Concern anger (SC)” and “Arrival Concern anger (AC)” with 13 items structure DAS have finally been identified. The trait driving anger was assessed through rating driving situations covered by SC and AC factors, but this structure was inconsistent with a one factor structure by Ge, Zhang [10], Sullman and Stephens [68], and a three factors solution by Zhang, Chan [11]. The item 10, “Someone honks at you about your driving” was labelled as the AC factor in the present study instead of hostile gesture, since individuals might receive honking in arrival blocking situations. For example, following drivers might honk to alert the late driver after the traffic signal changes from red to green. Moreover, some DAS items relevant to the safety aspect of the driver could evoke a large amount of anger, such as item 2, “A vehicle on a mountain road will not pull over and let people by” (mean = 3.14), and item 3, “Someone backs right out in front of you without looking” (mean = 3.57). They were compared with the previous

study by Zhang, Chan [11], with a corresponding mean of 3.37 and 3.30.

The relationship between socio-demographic characteristics and dangerous driving behaviours was also investigated. There were significant gender differences in aggressive, risky, and drunk driving behaviours, suggesting males performed these unsafe behaviours more often than females. These findings are in agreement with past research [69,70]. In terms of driving experience, drivers with 4–5 years of driving experience received more traffic penalty points than novice drivers (driving  $\leq 1$  year) and intermediate drivers (driving between 2 and 3 years). This replicated the findings in a previous Chinese study by Tao, Zhang [71]. This could be explained by experienced drivers showing less risk perception [72]. Interestingly, as the Chinese proverb states that “those who drown are always good swimmers”, and those experienced drivers could readily perceive themselves are skilful in their driving skill and performance, which might hamper their risk perception to some extent and potentially increase crash risks.

It was found that “Workaholism” ( $\beta = 0.181, p < 0.01$ ) was the only significant predictor among lifestyle profiles of aggressive driving behaviours, which is responsible for 5.4% variance in explaining aggressive driving behaviour. The “Culture” component lifestyle could assist in explaining the risky driving behaviour in addition to “Workaholism”, but the effect of “Workaholism” ( $\beta = 0.199, p < 0.001$ ) was more significant than “culture” ( $\beta = 0.136, p < 0.05$ ). Interestingly, the magnitude of “Workaholism” in predicting risky driving was larger than aggressive driving. On the basis of the present results, “Workaholism” could have a more profound effect on risky driving than driving aggression. It is possible that this case is caused by the increasing number of vehicles on China’s roads, and crowded traffic conditions are becoming more severe. Consequently, to arrive at destination punctually on a daily commuting trip, drivers have to take advantage of every opportunity to perform risky behaviour such as speeding and illegal overtaking [51,73]. It should also be noted that the relationship between “Culture” and risky driving was positive. In light of this, we cannot support Dabirinejad, Tavakoli Kashani [49]’s result. This is probably due to the time pressure effect while driving [74], because the “Culture” items in this study were mainly focused on time-urged events after EFA. In order to attend the concert or travel (e.g., driving to the airport), participants had to arrive in time, which could promote them to engage in risky driving behaviours (e.g., speeding and dangerous overtaking). In contrast to previous studies [43], our study failed to support the “Sports” dimension related to dangerous driving behaviours, possibly due to the fact that the current items selection of “Sports” were not significant for explaining dangerous driving behaviours. In addition, a significant predictor of negative emotion cognition driving was trait driving anger, as found in an earlier study [10]. Also, “Workaholism” promoted engaging in negative emotion cognition driving behaviours, indicating that intensively engaging in job might lead to driving with negative emotions [75].

Based on the mediation model, “Workaholism” may mediate its impact on dangerous driving behaviours to some extent. Total effect was ( $\beta = 0.253, p < 0.001$ ), direct effect was ( $\beta = 0.218, p < 0.001$ ), and the indirect effect from “Workaholism” toward trait driving anger was ( $\beta = 0.027, p < 0.01$ ). Accordingly, it could infer that workaholic drivers stuck in the intensive working context such as working overtime could express their negative emotions (i.e., anger) on roads, which further enhances performing aggressive and risky driving behaviours. Similar to the findings from previous work by Li, Wang [56], suggesting that engaged employees could experience more anger while driving. In fact, advocating a healthy lifestyle, and avoiding overworking periods has been proposed several times by representative public servant officers such as Li [76]. Due to the risk of road trauma involved, this issue deserves more attention.

#### 4.2. Conclusion

In conclusion, a self-designed lifestyle questionnaire was used to examine the relationship between lifestyle, driving anger, and dangerous driving behaviours. The lifestyle questionnaire included four dimensions (i.e., “Culture”, “Workaholism”, “Sports” and “Amusement”), showing adequate internal consistency and reflecting life patterns for Chinese drivers. Also, the 14 items Driving Anger Scale (DAS) was used in the present study, a total of the 13 items with two factor structures (e.g., Safety Concern anger and Arrival Concern anger) of DAS were found after CFA, which may be combined with other unsafe driving measurement scales in driving behaviour research. In addition, “Workaholism” was a significant predictor in aggressive, risky, and negative emotion cognition driving behaviours. More importantly, the trait driving anger was a mediator, mediating the relationship between “Workaholism” and dangerous driving behaviours (e.g., aggressive, risky, and negative emotion cognition driving behaviours). However, this model has only been tested in the Chinese sample and should be further examined in other developed and undeveloped countries or regions.

### 5. Practical implementation

According to current findings, traffic safety regulation should pay more attention to male drivers who have been driving for four to five years and who are involved in an intensive work context. In the meantime, the working scheme and countermeasures may need to be updated. In some cases, avoiding overworking can allow people to relax and release their stress or negative feelings from work, which results in an improvement of happiness and well-being. Moreover, psychological issues (e.g., depression, anger) should also be addressed, such as inviting psychologists to assist those suffering from heavy stress and negative emotions from work. It may reduce the negative emotions (e.g., anger) that occur during commuting trip. Regarding the transferability of findings, we should proceed with caution because we cannot declare that our findings are unique to China or that they can be generalized to other study regions and populations based on current results.

### 6. Limitations and future work

This study has certain limitations. Firstly, social desirability is an issue when using self-reported data, even if adopting an online

survey might somewhat offset the social desirability bias [35]. Thus, the self-report data relevant to the Dula Dangerous Driving Index (DDDI) might be not as the same as archival records. Secondly, the lifestyle questionnaire is self-designed based on previous relevant studies, although a lifestyle items pool suggestion acquisition survey was conducted, the representativeness (e.g., dimension consideration) should be regarded with more caution, because its explanatory variance is only 46.69% which might not totally reflect the lifestyle aspects of Chinese drivers (e.g., items in “Amusement” and “Sports”). Meanwhile, considering that there were only four items for “Workaholism”, the assessment of “Workaholism” might not be accurate and holistic (e.g., employees and employers). This measurement needs to be further modified in future work in accounting for a time changes and large sample size. Lastly, because of the study design and practical restriction, we did not assign any control group, so it is unclear whether the current findings in this study are unique to the Chinese population or could be applied to other study populations.

Future work could be improved on these points. Firstly, the current study does not examine the “Workaholism” lifestyle in the professional driver group. It is assumed that this factor would have a greater impact on professional drivers, so future studies could explore this dimension in the professional driver group (e.g., bus drivers). Secondly, the mediator effect is only considering the trait driving anger, but the link between lifestyle dimensions and state driving anger is unclear, which is also an important research branch of the driving anger field. Also, future work could compare the mediated effect magnitude in both trait and state driving anger on dangerous driving behaviours. Thirdly, it is unclear whether the findings in this study are solely applicable to the Chinese population or if they could be transferred to other study countries and populations. Future research is needed to clarify this. Lastly, we did not explore the association between lifestyle and drunk driving in this study due to its scope and theoretical basis; however, a significant and negative correlation was found between “Amusement” and drunk driving. Therefore, future studies could consider how living patterns influence drunk driving with a modified lifestyle questionnaire.

### Author contribution statement

Chenzhao Zhai: Conceived and designed the study; Performed the studys; Analysed and interpreted the data; Wrote the paper.  
Wenhui Xi: Funding acquisition; Supervision; Wrote the paper.

### Data availability statement

Data will be made available on reasonable request.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2023.e16900>.

### Appendix A

Study	Number of factors	Factors solution	Country
Chliaoutakis, Darviri [46]	10	Culture, Physical Exercise, Elegance, Car Addiction, Alcohol, Interest in Public Affairs, Amusement, Aggression, Religiousness, and Car as A Hobby	Greece
Møller [77]	3	Leisure Time, Friends And Driving Patterns	Denmark
Chliaoutakis, Koukoulis [43]	4	Amusement, Religion, Sports And Culture	Greece
Papadakaki, Kontogiannis [48]	5	Amusement, Culture, Religion, Sport And Yuppies	Greece
Gnardellis, Tzamalouka [47]	5	Amusement, Culture, Religion, Sport, And Work	Greece
Møller and Haustein [78]	1	Leisure Times Activities	Denmark
Dabirinejad, Tavakoli Kashani [49]	5	Religion, Morality, Car Hobby, Culture And Amusement	Iran

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