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Applicability of the contextual mediated model to predicting road crashes in Ghana and the United Kingdom

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ABSTRACT

Models of driver crash risks have been developed in high income countries (e.g., the contextual mediated model). However, the extent to which these models apply to motoring in low and middle income countries, which bear the majority of the world's road crash fatalities is unknown. We investigate the applicability of a modified contextual mediated model which distinguishes between distal and proximal factors that increase crash liability. The model was applied to 404 UK and 478 Ghanaian motorists to examine the extent to which the processes underlying crash risk are culture specific. Path analyses showed that distal factors (e.g., anxiety, distracted driving susceptibility) predicted crash involvement directly and indirectly through errors, violations and hazard monitoring in both countries. Hazard monitoring was a significant predictor of crash involvement, independent of DBQ factors in both UK and Ghana, highlighting its importance in understanding driver behaviour and crash risk. The findings provide empirical support for the usefulness of the revised contextual mediated model to explain driving behaviour in Ghana as well as the UK.

1. Introduction

Road traffic fatalities impose a large burden on human life with 1.35 million deaths globally every year (World Health Organization, 2018a; World Health Organization, 2018b). The worst affected countries are found in the Global South (Low and Middle-Income Countries [LMICs]), where 93 % of the global deaths from road traffic injury occur (World Health Organization, 2023a; World Health Organization, 2023b). However, road traffic crashes also lead to substantial human and economic costs in higher income countries such as the UK. Across the globe there is evidence that driver-related behavioural factors contribute about 95 % to crash causation (Petridou and Moustaki, 2000). Behavioural factors have not been given adequate attention in LMICs' research and policy, relative to their contribution to this public health challenge (Lagarde, 2007). The case of Ghana exemplifies the contribution of road crashes to mortality and morbidity in Africa. The death rate from road crashes increased by 83.6 % between 1991 and 2011 (Hesse and Ofosu, 2014) and grew 12–15 % annually 2008–2015 (NRSC, 2016).

In High Income Countries (HICs), behaviours identified to increase crash liability include risk taking, violations of traffic safety regulations and those that relate to human performance limitations; errors and lapses (de Winter and Dodou, 2010). Models of road traffic crash risks in HICs (e.g., the Contextual Mediated Model [Sümer, 2003], discussed below) may also be applicable to understand road traffic risk in LMICs. However, validation in new environments is required because of cultural variations in the driving context

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(Coleman, 2014; Mohan, 2002). Local driving environment and culture may influence the relationships between specific factors and driver crash risks (Nordfjærn et al., 2014). Little work has been done in this area (Staton et al., 2016).

1.1. The contextual mediated model (Sümer, 2003)

The model explains the links between behavioural factors, crash risks and crash involvement based on research in HICs. The model distinguishes between distal factors and proximal factors in the prediction of crash involvement. The proximal factors are both stable (e.g., violations and errors) and transitory variables (e.g., drunk driving) that are closer to crash involvement and are modelled to directly increase the risk of crashes. The distal factors (e.g., safety attitudes, fatalistic beliefs and personality) are those that create the tendency to engage in risky driving behaviours that in turn predict crash involvement. In addition, distal factors may have direct effects on crash risk. Sumer (2003) found that personality factors, for instance, had an impact on road crashes through their effects on driving-related behaviour such as violations.

If the Contextual Mediated Model can be applied and modified to LMICs then it can inform policy-based prevention and training in order to reduce the heavy public health burden of road crashes in these areas. The applicability of the contextual model to LMICs requires further exploration; It is possible that there are psychological factors that are important to crash risk in LMICs such as Ghana which have been less frequently studied in the research literature that has focused on HICs. The LMIC context may also alter the level at which the antecedents of risky driving are present in comparison to HICs and there may be variations in the extent to which structures are in place to control dangerous practices.

1.2. Application of the contextual mediated model to Ghana

In this paper we test the applicability of a revised version of the Contextual Mediated Model (see Fig. 1) to the Ghanaian context. The model was revised (modified with additions) on the basis of findings from our prior qualitative study in Ghana (Dotse, Nicolson & Rowe, 2019) and other general literature on behavioural factors that predict road crashes. These modifications were necessary to account for cultural and contextual differences in driving behaviour and crash risk factors between High-Income Countries (HICs) and Low and Middle-Income Countries (LMICs).The revised model proposes a number of distal factors; personality (e.g., impulsivity), beliefs, attitudes (e.g., risk perception), stress related factors (e.g., fatigue) and socio-demographic factors that may predict crash involvement both directly and indirectly. The model further proposes hazard monitoring, violations and errors as proximal factors (behavioural crash risks) that may have direct links to crash involvement and may mediate the links between distal factors and crash

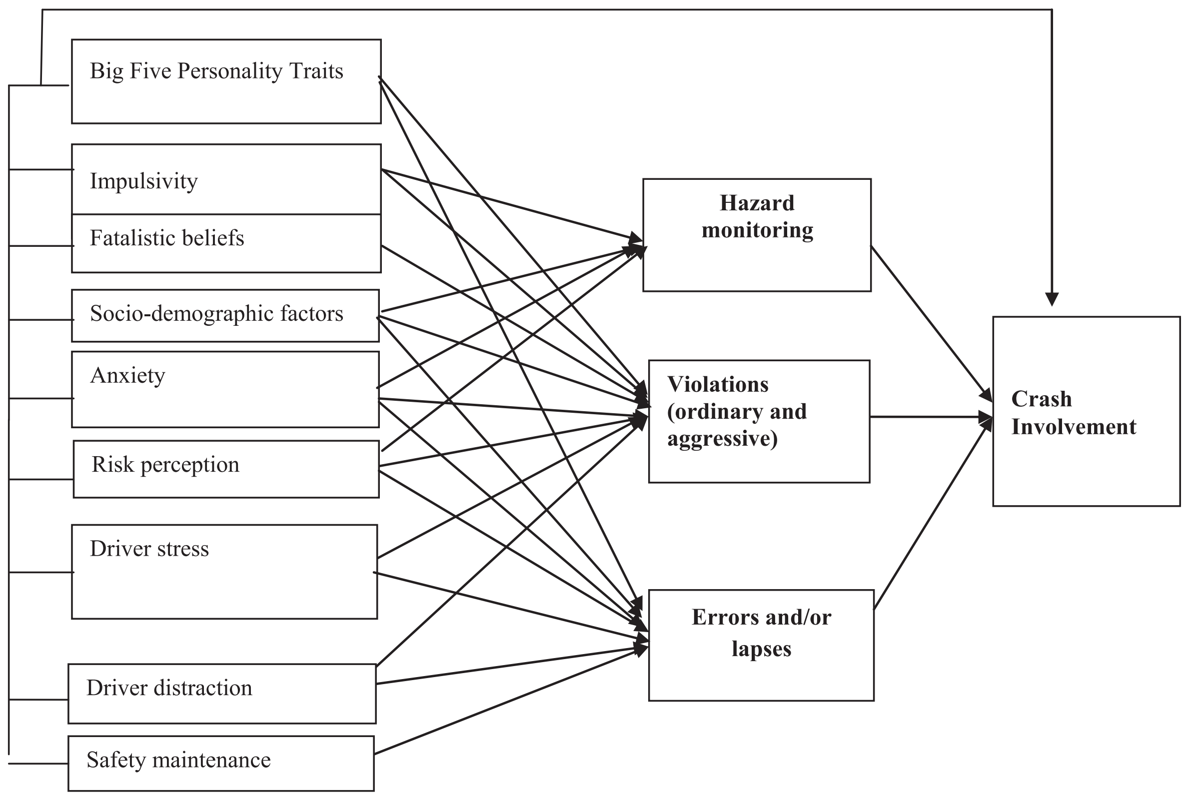

Fig. 1. Revised hypothesised contextual mediated model of the behavioural predictors of road crashes (adapted from Sümer, 2003).

involvement.

The present study aimed to model the processes underlying risky driving behaviours in Ghana and compare them to the processes underlying risky driving in the UK through the application of the revised Contextual Mediated Model (see Fig. 1). Ghana has a high rate of road traffic fatalities, with an increasing trend over the past decades (World Health Organization, 2023a). In contrast, there is a lower rate of fatalities in the UK; the rate fell dramatically 1980–2010, with little change since then (Department for Transport, 2023). These differences provide a valuable context for comparing the applicability of the revised Contextual Mediated Model in both countries. Samples of drivers from Ghana and UK completed a battery of questionnaires measuring the components of the model. The demographic and socio-economic contexts of the UK and Ghana differ significantly. In Ghana, there is a higher proportion of commercial drivers compared to the UK, where private vehicle ownership is more common. Additionally, the driving environments and regulatory frameworks in these countries vary, with Ghana facing challenges such as less stringent enforcement of traffic laws and poorer road infrastructure.

Based on evidence from HICs (e.g., Constantinou et al., 2011) the Big Five personality dimensions were hypothesized to predict crash involvement indirectly through violations and errors while the link between impulsivity and crash involvement was predicted to be mediated by hazard monitoring, violations and errors. Existing findings indicate that fatalistic beliefs are often associated with risk-taking behaviours (Slovic et al., 1981; Teye-Kwadjo, 2019) rather than attentiveness to hazards. Therefore, in the present study

Table 3a
Models (direct and indirect) of the effects of distal factors on crashes via proximal/behavioural factors (hazard, violations, errors and lapses) for Ghana and UK.

	Hazard Monit.	Violations	Errors	Hazard	Ord. Viol	Aggress Viol.	Errors	Lapses
	GH	GH	GH	UK	UK	UK	UK	UK
Anxiety								
Direct effect	−0.11*	**0.47*** **	**0.13***	−0.10	0.08	0.22**	**0.09***	0.18*
Indirect effect (95 % CI)	−0.01 (−0.02, 0.01)	**0.04** (0.01, 0.05)**	**0.07** (0.02, 0.11)**	0.00 (−0.00, 0.00)	0.00 (−0.02, 0.02)	0.01 (−0.00, 0.01)	**0.12** (0.04, 0.47)**	0.00 (−0.01, 0.02)
Total effect	−0.11	**0.51*** **	**0.20** **	−0.10	0.08	0.23**	**0.21** **	0.18
Impulsivity								
Direct effect	−0.42***	0.06	0.11*	−0.33***	0.13	0.02	**0.56** **	0.37**
Indirect effect	0.03** (0.01, 0.04)	0.00 (−0.01, 0.01)	0.01 (−0.01, 0.02)	0.00 (−0.01, 0.00)	0.00 (−0.01, 0.01)	0.00 (−0.00, 0.00)	**0.10* (0.01, 0.12)**	0.00 (−0.01, 0.00)
Total effect	−0.39***	0.06	0.12	−0.33***	0.01	0.02	**0.66*** **	0.37
Extraversion	na							
Direct effect	na	0.04	0.02	−0.13**	0.15*	0.09	0.18**	0.09
Indirect effect	na	0.00 (−0.01, 0.01)	0.00 (−0.01, 0.01)	0.00 (−0.00, 0.01)	0.00 (−0.01, 0.01)	0.00 (−0.01, 0.02)	0.01 (−0.00, 0.02)	0.00 (−0.01, 0.00)
Total effect	na	0.04	0.02	−0.13**	0.15*	0.09	0.07	0.09
Agreeableness								
Direct effect	na	−0.07*	−0.16**	na	−0.14*	−0.12	−0.18**	na
Indirect effect	na	−0.00 (−0.01, 0.01)	0.00 (−0.01, 0.02)	na	−0.00 (−0.01, 0.01)	−0.01 (−0.02, 0.01)	−0.02 (−0.06, 0.01)	na
Total effect	na	−0.07	−0.16**	na	−0.14	−0.13	−0.20**	na
Conscientiousness								
Direct effect	na	na	−0.39***	na	na	na	na	na
Indirect effect	na	na	−0.01 (−0.05, 0.03)	na	na	na	na	na
Total effect	na	na	−0.40***	na	na	na	na	na
Neuroticism								
Direct effect	−0.11*	0.12*	0.14*	**−0.26*** **	0.02	0.19**	0.19**	na
Indirect effect	0.01 (−0.01, 0.02)	0.00 (−0.01, 0.02)	0.00 (−0.01, 0.00)	**0.14** (0.09, 0.43)**	0.00 (−0.01, 0.02)	0.01(−0.03, 0.01)	0.08 (−0.02, 0.00)	na
Total effect	−0.10*	0.12*	0.14*	**−0.12** **	0.02	0.20**	0.27**	na
Openness								
Direct effect	na	−0.01	−0.09*	0.19**	−0.01	−0.05	na	na
Indirect effect	na	−0.00 (−0.01, 0.02)	−0.00 (−0.01, 0.01)	−0.01 (−0.01, 0.01)	−0.00 (−0.00, 0.01)	−0.00 (−0.02, 0.01)	na	na
Total effect	na	−0.01	−0.09*	−0.20**	−0.01	−0.05	na	na

* $p < 0.05$, ** $p < 0.01$, ** *$p < 0.001$.
95% CI (confidence interval, based on 10,000 bias-corrected bootstrapped samples).
N (GH = 478, UK = 404).
NA = Not Applicable.
Significant mediation effects are in bold phases.

fatalistic beliefs were expected to relate to crash involvement through only violations. Socio-demographic factors were modelled to relate to crash involvement both directly and indirectly through the mediators; hazard monitoring, violations and errors based on the literature (e.g., de Winter & Dodou, 2010; Evans, 2000). Anxiety and risk perception were hypothesised to relate to crash involvement indirectly through all three mediators; hazard monitoring, violations and errors (Sümer, 2003). The driver stress factors (e.g., fatigue) and distraction were hypothesized to relate to crash involvement via violations, errors and hazard monitoring (Ge et al., 2014; Olson et al., 2009) while the link from safety maintenance practices to crash involvement was predicted to be mediated by errors. We hypothesized that safety maintenance practices would predict crash involvement via errors because proper maintenance of a vehicle is crucial for its safe operation. Poor maintenance can lead to mechanical failures, which may result in errors during driving. For instance, a poorly maintained braking system can cause a driver to misjudge stopping distances, leading to errors. Aside from the indirect effects the model also examined direct paths between the distal factors and crash involvement.

In the Ghanaian sample two factors; errors and violations were measured using the Driver Behaviour Questionnaire (DBQ; Reason et al., 1990). The two factors (errors and violations) were expected in the DBQ for Ghana based on a previous Ghanaian factor analysis (Dotse & Rowe, 2021). Four DBQ factors (aggressive violations, ordinary violations, slips and errors) were measured in the UK sample. The four factors were expected in the UK based on the factor structure most commonly reported in HICs (e.g., Lajunen et al., 2004). Economic conditions in Ghana, where resources for vehicle maintenance is limited (Dotse et al., 2019), could lead to a higher incidence of driving errors and crashes. In contrast, the UK, with better economic conditions and stricter vehicle maintenance regulations, might exhibit different patterns of driving behaviour and crash risk Table 3a.

Table 3b
Models (direct and indirect) of the effects of distal factors on crashes via crash risks (hazard, violations, errors and lapses) for Ghana and UK.

	Hazard monit.	Violations	Errors	Hazard	Ord. Viol	Aggress Viol.	Errors	Lapses
	GH	GH	GH	UK	UK	UK	UK	UK
Fatalistic Beliefs								
Direct effect	na	**0.11****	**0.22*****	na	−0.07	0.01	na	na
Indirect effect (95 % CI)	na	**0.04** (0.01, 0.03)**	**0.07* (0.01, 0.04).**	na	−0.02 (−0.00, 0.00)	0.00 (−0.00, 0.01)	na	na
Total effect	na	**0.15***	**0.29*****	na	−0.09	0.01	na	na
Risk perception								
Direct effect	**0.15****	**−0.10****	−0.02	0.10*	−0.02	−0.14*	−0.03	−0.03
Indirect effect	**−0.05* (−0.02, −0.01)**	**−0.09** (−0.02, −0.22)**	−0.00 (−0.01, 0.01)	−0.00 (−0.01, 0.00)	−0.00 (−0.01, 0.01)	−0.00 (−0.00, 0.01)	−0.00 (−0.00, 0.00)	−0.00 (−0.00, 0.00)
Total effect	**0.10***	**−0.19****	−0.02	0.10	−0.02	−0.14	−0.03	−0.03
Aggression								
Direct effect	na	**. 20****	0.03	na	0.14*	0.02	0.06	0.01
Indirect effect	na	**0.11** (0.03, 0.32)**	0.00 (−0.01, 0.01)	na	0.01 (−0.00, 0.00)	0.00 (−0.01, 0.01)	0.00 (−0.01, 0.00)	0.00 (−0.00, 0.00)
Total effect	na	**0.31****	0.03	na	0.15*	0.02	0.06	0.01
Dislike for driving								
Direct effect	na	0.10*	0.14*	−0.17**	0.01	0.06	0.08	0.13*
Indirect effect	na	0.00 (−0.01, 0.01)	0.00 (−0.01, 0.01)	0.00 (−0.00, 0.01)	0.00 (−0.01, 0.01)	0.00 (−0.01, 0.01)	0.00 (−0.00, 0.00)	0.00 (−0.00, 0.00)
Total effect	na	0.10	0.14*	−0.17**	0.01	0.06	0.08	0.13*
Fatigue								
Direct effect	na	**0.19*****	**0.16***	na	0.27***	0.18**	0.13*	0.07
Indirect effect	na	**0.16** (0.02, 0.04)**	**0.08* (0.01, 0.04)**	na	0.00 (−0.01, 0.01)	0.00 (−0.01, 0.02)	0.00 (−0.01, 0.00)	0.00 (−0.00, 0.00)
Total effect	na	**0.35*****	**0.24****	na	0.27***	0.18**	0.13*	0.07
Thrill seeking								
Direct effect	na	0.06	0.17**	**−0.49*****	0.22**	0.09	0.03	0.10
Indirect effect	na	0.00 (−0.01, 0.01)	0.11** (0.01, 0.03)	**0.04* (0.01, 0.02)**	0.01 (−0.01, 0.01)	0.01 (−0.00, 0.01)	0.00 (−0.00, 0.00)	0.00 (−0.00, 0.00)
Total effect	na	0.06	0.28***	**−0.45*****	0.23	0.10	0.03	0.10
Distraction								
Direct effect	**−0.19***	0.10*	**0.21****	**−0.12***	0.28***	0.03	**0.12****	0.18*
Indirect effect	**−0.11* (−0.02, −0.08)**	0.00 (−0.01, 0.01)	**0.09* (0.01, 0.05)**	**−0.10* (−0.02, −0.03)**	0.00 (−0.01, 0.01)	0.00 (−0.01, 0.01)	**0.11* (−0.00, 0.01)**	0.03 (−0.01, 0.00)
Total effect	**−0.30*****	0.10*	**0.30*****	**−0.22****	0.28***	0.03	**0.23****	0.21**

* $p < 0.05$, ** $p < 0.01$, ** *$p < 0.001$.
95% CI (confidence interval, based on 10,000 bias-corrected bootstrapped samples).
N (GH = 478, UK = 404).
NA = Not Applicable.
Significant mediation effects are in bold phases.

2. Method

2.1. Sample and data collection

2.1.1. Ghana

A total of 478 Ghanaian drivers aged between 23 and 86 years (*Mean = 39.5, SD = 12.51*) responded to the survey. The driving experience of participants (4.81 % of cases missing) ranged between < 1—46 years of driving (*Mean = 15.81, SD =* 11.04). The participants' daily hours of driving ranged between < 30 mins − 10 + hrs *(Mean = 3.36, SD = 1.82*) with 0.4 % doing up to8 hrs + of non-stop driving on long journeys *(Mean = 2.97, SD = 1.39)*. Both the commercial (80 %) and non commercial (20 %) vehicle drivers were included in the sample. Data were collected from three regions (Greater Accra, Ashanti, and Volta) in Ghana. Commercial drivers were recruited and provided data at major lorry terminals located in the regional capitals; Accra, Kumasi, and Ho respectively. Private car and truck drivers were recruited through personal approaches in the premises of public and private organisations and mutual acquaintance. For the Ghanaian sample 2.1 % held license class 'A' (mopeds; 50—250 cc +), 41.6 % held class 'B' (cars < 3000 kg), 27.2 % held class 'C'(33 seater/trucks; 3000—5500 kg), 14.9 % held class 'D' (vehicles ≤ 8000 kg), 6.1 % held class 'E' (tractors/ bulldozers), and 5 % held class 'F' (vehicles > 8000 kg).

2.1.2. UK

For the UK sample, 404 valid responses were obtained through an online questionnaire. Participants ranged in age from 18 to 75 years (Mean = 34.10, SD = 14.12) and included both licensed and unlicensed drivers. Their driving experience range from 6 months to 58 years (*Mean = 14.39, SD = 13. 24)*. The participants daily hours of driving ranged between < 30 mins − 10 + hrs *(Mean = 2.25, SD = 1.0)*. One percent drove up to 8hrs non-stop on long journeys *(Mean = 3.78, SD = 0.74)*. The eligibility criterion was holding a full driving licence, however, 8 participants (1.9 %) indicated that they did not hold valid driving licences (and therefore were driving illegally) but drove regularly. The UK participants with invalid licenses were retained to ensure comparability with the Ghanaian dataset, which included drivers with varying levels of compliance with licensing regulations. This approach aimed to capture a broader range of driving behaviours and experiences, providing a comprehensive understanding of driving behaviours and crash risks in both

Table 3c
Models (direct and indirect) of the effects of distal factors on crashes via crash risks (hazard, violations, errors and lapses) for Ghana and UK.

	Hazard monit.	Violations	Errors	Hazard	Ord. Viol	Aggress Viol.	Errors	Lapses
	GH	**GH**	**GH**	**UK**	**UK**	**UK**	**UK**	**UK**
Maintenance								
Direct effect	0.10*	**0.22*** **	**0.13** **	na	−0.10	−0.22**	na	na
Indirect effect (95 % CI)	0.01(−0.02, 0.02)	**0.06* (0.02, 0.04)**	**0.04* (−0.02, −0.01)**	na	−0.00 (−0.00, 0.00)	−0.00 (−0.01, 0.02)	na	na
Total effect	0.09*	**0.28*** **	**0.17***	na	−0.10	−0.22**	na	na
Age								
Direct effect	na	**−0.15***	0.01	na	−0.31***	−0.13*	**0.25*** **	0.35***
Indirect effect	na	**−0.04* (−0.03, −0.01)**	0.00 (−0.01, 0.01)	na	−0.03 (−0.23, −0.07)	−0.10 (−0.11, 0.03)	**0.09**(0.09, 0.27**	−0.02 (−0.02, 0.06)
Total effect	na	**−0.19** **	0.00	na	−0.34***	−0.23**	**0.34** **	0.33***
Sex								
Direct effect	−0.02	0.05	−0.02	na	0.26**	**0.28** **	**−0.29*** **	−0.22*
Indirect effect	0.01(−0.35, 0.24)	0.02 (−0.06, 0.09)	−0.03 (−0.04, 0.03)	na	0.01 (−0.13, 3.89)	**0.21** (0.19, 3.00)**	**−0.14** (−0.30, −4.22)**	−0.02 (−0.88, 3.90)
Total effect	−0.01	0..07	−0.05	na	0.27**	**0.49*** **	**−0.43*** **	−0.24**
Mileage								
Direct effect	**−0.24*** **	**0.20*** **	**0.20*** **	na	0.02	0.00	0.02	0.03
Indirect effect	**0.05* (−0.24, −0.03)**	**0.06***(0.05 0.25)**	**0.07* (0.01 0.19)**	na	0.00 (−1.12, 0.89)	0.00 (−0.82, 0.97)	0.00 (−1.23, 1.00)	0.01 (−0.91, 1.29)
Total effect	**−0.19** **	**0.26*** **	**0.27** **	na	0.02	0.00	0.02	0.04
Experience								
Direct effect	0.01	0.03	−0.15**	0.21**	0.27***	0.10	−0.13	**−0.24** **
Indirect effect	−0.00 (−0.01, 0.01)	0.01(−0.01, 0.02)	−0.01(−0.02, 0.01)	−0.01 (−01, 0.04)	0.03 (−0.07, 0.01)	0.08 (−06, 0.21)	−0.02 (−0.05, 0.02)	**−0.05* (−0.11, 0.00)**
Total effect	0.01	0.04	−0.16**	0.20**	0.29***	0.18*	−0.15*	**−0.29** **

* $p < 0.05$, ** $p < 0.01$, ** *$p < 0.001$.
95% CI (confidence interval, based on 10,000 bias-corrected bootstrapped samples).
N (GH = 478, UK = 404).
na = not applicable.
Significant mediation effects are in bold phases.

countries. Including these participants enables a more nuanced understanding of the impact of regulatory compliance on driving behaviour and crash risk. The questionnaire was distributed through the Qualtrics online platform (www.qualtrics.com) Table 3b.

2.1.3. Ethics

Ethical approval for the study was obtained from the relevant institutional review boards in both Ghana (Ethics Committee for the Humanities – University of Ghana: ECH 109/15-16) and the UK (University of Sheffield Department of Psychology – Reference Number: 007634). Participants were informed about the purpose of the study, and their consent was obtained before participation. Confidentiality and anonymity were assured, and participants were informed that they could withdraw from the study at any time without any consequences. Data were securely stored and only accessible to the research team. The study adhered to the ethical guidelines outlined by the American Psychological Association and the British Psychological Society Table 3c.

2.2. Measures

2.2.1. Proximal factors

2.2.1.1. Driver behaviour. We used a 27 item version of the DBQ (Lajunen et al., 2004) that included an additional 'drink and drive' item taken from Mattsson (2012) for both the Ghanaian and the UK samples. Typical results from testing the factorial structure of DBQ in HICs distinguish ordinary violations (8 items, e.g., overtake a slow driver on the inside), aggressive violations (3 items, e.g., sound your horn to indicate your annoyance to another road user), errors (8 items, e.g., failed to check rear-view mirror before pulling out or changing lanes, etc.) and lapses (8 items, e.g., get into the wrong lane approaching roundabout or a junction) (Lajunen et al., 2004). This version of the DBQ has been subjected to robust factorial invariance testing by a number of researchers (e.g., Mattsson, 2012; Stanojević, Lajunen, Jovanović, Sârbescu, &Kostadinov, 2018). The drink and drive item has been found to load onto the ordinary violation component (Mattsson, 2012). Respondents indicate how often they engage in each of the behaviours on a six-point Likert scale (never = 0, hardly ever = 1, occasionally = 2, quite often = 3, frequently = 4, nearly all the time = 5). The DBQ factors had Cronbach alphas ranging from 0.73 to 0.87 in both samples, indicating acceptable reliability. Crash involvement (crash resulting in injury, death or damage to property and which involve at least one vehicle) 'while you were driving' was measured through self-report as in previous studies (Iversen and Rundmo, 2004; Ulleberg and Rundmo, 2003).

2.2.1.2. Hazard monitoring. This construct was measured using a 2-item self-report sub-scale of the Driver Stress Inventory ([DSI] Matthews et al., 1997). It is the revised form of the alertness sub-scale of the Driver Behaviour Inventory ([DBI] Glendon et al., 2014) that assesses stress vulnerability among drivers. An example item was, "I make an effort to see what's happening on the road a long way in front of me". Participants indicated how strongly they agreed with each of the statements that relate to their everyday driving on a scale of 0 (not at all) to 10 (very much). A higher score on the sub-scale represented more attentive hazard monitoring. The hazard monitoring scale had Cronbach alpha of 0.78 in the Ghanaian sample and 0.81 in the UK sample. Subjective measures of hazard perception have been found to correlate with objectively measured hazard perception performance (Āb ele et al., 2018). Hazard perception skill has been found to be associated with crash risk (Horswill, Hill & Jackson, 2020).

2.2.2. Distal factors

2.2.2.1. Driver stress. The remaining four components of the DSI (Matthews et al., 1997) were used to measure driver stress, each with 2 items per scale. The dimensions were; Aggression (e.g., I really dislike other drivers who cause me problems), Dislike of driving (e.g., I feel tense or nervous when overtaking another vehicle), Fatigue (e.g., I become sleepy when I have to drive for several hours), Thrill-seeking (e.g., I like to raise my adrenaline levels while driving). The observed alpha coefficients for the subscales ranged from 0.73 to 0.87 in a British sample and from 0.69 to 0.85 in a US sample (Matthews et al., 1997). Higher scores on the sub-scales represent higher stress. Driver stress, mental health and daily hassles have been found to correlate with DBQ measures in previous research (e.g., Delhomme, & Gheorghiu, 2021). The driver stress negative affect factor was related to both lapses and errors, whereas driver stress risk taking was the strongest correlate of violations (Rowden et al., 2011).

2.2.2.2. Anxiety. The short form of the trait dimension of the State-Trait Anxiety Inventory (STAI-T-6) (Marteau & Bekker, 1992) was completed. Examples items are, "I worry too much over something that really doesn't matter" and "I feel secure" (reverse coded). For each item, participants indicated 'how they generally feel' by checking one of the following alternatives: (1) Almost never, (2) Sometimes, (3) Often, (4) Almost always. A Cronbach alpha of 0.73 was observed for the Trait Anxiety factor (Marteau & Bekker, 1992). Dula et al. (2010) found higher levels of anxiety to be associated with greater levels of dangerous driving. Similarly, trait anxiety was found to predict poor driver behaviour (Wong et al., 2014).

2.2.2.3. Impulsivity. We used the short form of the Barratt Impulsiveness Scale (BIS-15; Spinella, 2007) which measures impulsivity-related behaviours in the general population. It measures 3 facets of impulsivity; non-planning (e.g., "I plan tasks carefully"; reverse coded), motor impulsivity (e.g., "I do things without thinking") and attention impulsivity (e.g., "easily bored solving thought problems"). Items are rated on a 4-point Likert scale (1 = rarely/never, 2 = sometimes, 3 = often and 4 = almost always). A higher score indicates greater impulsivity. The scale is treated as unidimensional in the present study. The overall scale has been found to be reliable in previous work (α = 0.83; Meule et al., 2015).

2.2.2.4. Personality. The 10 item abbreviated version of the Big Five Inventory (BFI) (Rammstedt& John, 2007) was used. The scale has been validated with English and German samples. The BFI consists of 10 short-phrase items, rated on a five-step scale; 1 = strongly disagree, 2 = disagree a little, 3 neither disagree nor agree, 4 = agree a little and to 5 = strongly agree. The items were selected using both expert judgment and empirical item analyses to represent the core (i.e., most prototypical) traits that define each personality domain (John, 1990). Two BFI items address each Big Five dimension with acceptable psychometric properties; Mean retest stability coefficients were 0.72 – 0.80 in US, 0.78- 0.80 in Germany, and 0.75 overall, demonstrating that the BFI-10 scales achieved acceptable stability over 6–8 weeks in both cultures. The items cover the dimensions of extraversion, agreeableness, conscientiousness, neuroticism and openness.

2.2.2.5. Fatalistic beliefs. The index for belief in fate measure (Kouabenan, 1998) consists of nine items which describe situations referring to popular beliefs expressing a certain level of fatalism or superstition and to which participants express their agreement on a scale of 1–4 (strongly agree, agree, disagree, and strongly disagree). The items cover issues of fate, evil spirits mystery, conspiracy, hearse seeing (seeing a hearse signifies impending disaster), transgressions, black cat (signifies a bad omen), mascots (a person, animal, or object that is thought to bring luck), and consultation of clairvoyants. The measure was devised for professional drivers and validated in a Francophone African culture; Cote d'Ivoire (α = 0.78; [Kouabenan, 1998]).

2.2.2.6. Risk perception. Risk perception was measured with two items used by Ulleberg and Rundmo (2003). First, the respondents rated their subjective evaluation of the probability of them (relative to an average driver) being involved in a future crash, ranging from 1 (not probable at all) to 7 (very probable). Second, they expressed how worried and concerned they were regarding being hurt in a crash, ranging from 1 (not worried at all) to 7 (very worried). Higher scores represent higher crash risk perception.

2.2.2.7. Distraction. The Susceptibility to Driver Distraction Questionnaire (SDDQ) **(**Feng, Marulanda, &Donmez, 2014) was completed. Self-reported frequency of distraction engagement in the course of driving was assessed by pairing the question stem 'When driving, you…' with six driver distractions: (1) have phone conversations, (2) manually interact with a phone (e.g., sending text messages), (3) adjust the settings of in-vehicle technology (e.g., radio channel or GPS), (4) read roadside advertisements, (5) visually dwell on roadside accident scenes if there are any, and (6) chat with passengers if there are any. Responses were made on a Likert scale scored from 1 (never) to 5 (very often).

2.2.2.8. Safety maintenance. Two items that measure vehicle mechanical maintenance practices related to safety were used (Newnam et al., 2002). The questions ask how likely a driver is to do the following before driving; (1) check the water in the radiator and (2) check the pressure in the tyres. Responses are anchored on a 5 point Likert scale; very unlikely (1) to very likely (5). The scale was validated among 204 Australian fleet drivers and was internally consistent with Cronbach's alpha of 0.81 for a work vehicle, and 0.79 for a personal car (Newnam et al., 2002).

2.2.2.9. Socio-demographic factors. Other information that was collected included; the number of years of driving (experience), average weekly driving mileage, sex, age, and level of formal education.

2.3. Data analysis strategy

The primary analyses involved mediation analyses of the relationship between distal factors and crash involvement via proximal factors. To achieve this we adopted Anderson and Gerbing's (1988) two-step model estimation process. In the first step a measurement model was constructed to examine the factor structure and correlations between the latent constructs via Confirmatory Factor Analysis (CFA). The measurement model related each construct to their latent indicators. Next, the measurement model was extended to a Structural Equation Model (SEM) with the addition of the hypothesized relationships mediating relationships between proximal and distal variables in predicting the crash involvement outcome.

CFA was first used to confirm the factor structure of the DBQ in the Ghana and UK samples. In the Ghanaian sample, the initial model specified a 2-factor model identified as most appropriate in a previous Ghanaian sample (Dotse and Rowe, 2021). The CFA on the UK data specified the 4-factor DBQ structure typically reported in HICs (e.g., Lajunen et al., 2004). The drink-drive item was as modelled as part of ordinary violations based on its performance in previous cross-cultural studies in the UK (Mattsson, 2012).

The model parameters were estimated using Robust Maximum Likelihood Estimation (MLR; Muthen & Muthen, 2012). MLR utilises the Satorra-Bentler $\chi 2$ statistic (1988) which corrects the scaling of the $\chi 2$ statistic (and thus of CFI, TLI and RMSEA) when assumptions of multivariate normality are not met. Standard errors are computed (for model parameter estimates) that are similarly robust to deviations from multivariate normality (Byrne, 2013). The adequacy of models was assessed using three fit indices; Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI). Values of RMSEA ≤ 0.08, CFI and TLI ≥ 0.90 indicate adequate model fit (Hu and Bentler, 1999) while RMSEA ≤ 0.06, with CFI and TLI ≥ 0.95 indicate excellent model fit (Bentler, 1990). Only the fully standardised estimates were reported in the study. All models were estimated in Mplus v.7.11 (Muthen and Muthen, 2012).

Models of direct and indirect effects were examined in which distal factors were modelled as predictors of crash involvement via errors, violations and hazard monitoring (our proximal risk factors for crash involvement [see Fig. 1]). To test the meditational paths, 95 % confidence intervals (95 % Bias-Corrected Bootstrapped Confidence Intervals [BCa CI's]) were computed from 10,000 bootstrap samples (MacKinnon, Lockwood, & Williams, 2004). Next, the CFA model was extended with a series of structural models; the hypothesized model (M2; all mediators entered at the same time) that included the direct and indirect paths (partial mediation; see Fig. 1for the hypothesized model) and (M3) the full mediation (direct paths removed) were tested. To test the predictive effect of covariates; sex, age, mileage and experience (years in driving) were added to the models. Inclusion of these variables in the models ensures that spurious relationships between factors were not identified as a result that both are related to age, sex, mileage and experience. Covariate results are not discussed.

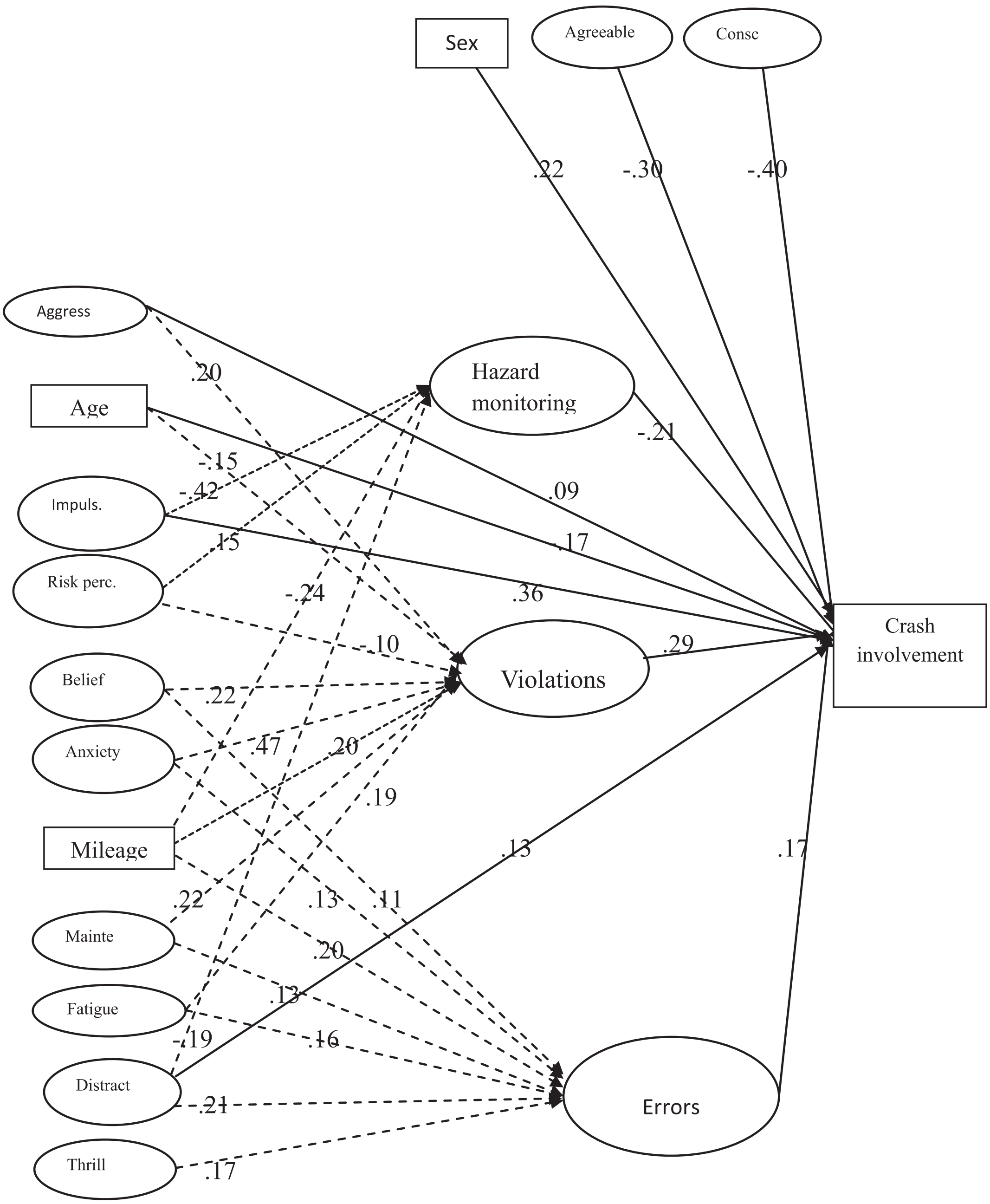

Fig. 2. Path diagram: mediation model for the prediction of crash involvement from distal factors via proximal factors in Ghana. Note: Indirect paths are shown in dotted lines and only significant paths are shown.

3. Results

3.1. Demographic factors

The Ghanaian sample consisted predominantly of commercial drivers (80 %), whereas the UK sample included a mix of private and commercial drivers. The average age of drivers in Ghana was higher (Mean = 39.5 years) compared to the UK (Mean = 34.1 years; $t(880) = 7.99$, $p < 0.05$). Additionally, the gender distribution differed, with a higher proportion of male drivers in Ghana (85 %) compared to the UK (60 %).

3.2. Factor structure of the DBQ (Ghana and UK)

In the Ghana data, the CFA indicate that the two factor DBQ model (violations and errors) based on 24 items has a better fit for the data ($\chi^2 = 831.98$ (118), $p < .001$, RMSEA = 0.09, CFI = 0.96; TLI = 0.96) than a 1-factor model ($\chi^2 = 853.57$ (151), $p < .001$, RMSEA = 0.10, CFI = 0.93; TLI = 0.92). A 3-factor model (violations, errors and lapses) has a poorer fit ($\chi^2 = 1110.42$ (169), $p < .001$; RMSEA = 0.11, CFI = 0.87; TLI = 0.86) than the 1-factor model while the 4-factor model (ordinary violations, aggressive violations, errors and lapses) had the worst fit ($\chi^2 = 1933.75$ (177), $p < .001$; RMSEA = 0.17, CFI = 0.89; TLI = 0.89). An excellent fit was obtained for the present 2-factor structure as indexed by the CFI and TLI and the 0.09 RMSEA fit was acceptable (Hu and Bentler, 1999).

Two competing models; 3-factor and 4-factor were specified for the UK data based on existing findings (e.g., Lajunen et al., 2004; Reason et al., 1990). The 3-factor model (violations, errors and lapses) gave a good fit ($\chi^2 = 1068.44$ (321) $p < .001$, RMSEA = 0.08, CFI = 0.97; TLI = 0.97) but the 4-factor model (ordinary violations, aggressive violations, errors and lapses) fit better ($\chi^2 = 979.08$ (318), $p < .001$; RMSEA = 0.07, CFI = 0.97; TLI = 0.96). In comparison, a 2-factor model (violations and errors) had a poor fit ($\chi^2 = 1149.89$ (290), $p < .001$, RMSEA = 0.10, CFI = 0.63; TLI = 0.60).

3.3. Measurement model CFA (Ghana and UK)

For the Ghanaian data, the measurement model, M1, consists of 18 latent constructs (15 distal and 3 proximal constructs) while the UK had 20 latent constructs (15 distal and 5 proximal), as there were 4 DBQ factors in the UK and 2 in Ghana. The Ghanaian measurement model (see Table 1, M1a in the Appendices) showed adequate fit with all items having significant (all $p < .001$) and strong loadings (0.58 – 0.92) on their respective latent variables. No theoretically sound modification indices were suggested that could have improved model fit via the MPlus modification indices routine. Similarly, the full measurement model (M1) for the UK data (see Table 2, M1b in the Appendices) showed satisfactory fit to the data with all items having significant (all $p < .001$) and strong loadings (0.50 – 0.89) on their respective latent variables.

3.4. Testing the structural model

The measurement models indicated that the latent variables required to test the proposed mediating pathways from distal factors to crash involvement were effectively estimated from the observed variables in both the Ghana and UK datasets. Self-reported number of crashes within the last 12 months was the outcome variable and demographic variables; age, sex, mileage and experience were included as distal factors to predict proximal factors and crash involvement. The goodness of fit indices of several nested models were compared prior to selecting the final models in the two data sets. The partial mediation model (direct and indirect paths; See Tables 1–2 in Appendices) with all mediator variables included (M2) provided a better fit to the data than the full mediation model which only contained indirect paths (M3) in both the UK and Ghana datasets. A chi-square difference test revealed that M3 had significantly worse fit than M2 in both the Ghanaian (χ^2 (1) = 23.81, $p < 0.001$) and UK ($\chi 2$ (1) = 21.69, $p < 0.001$) samples.

3.4.1. Ghanaian mediation results

Tables 4a-4b show the direct and indirect pathways included in Model M2. This includes prediction of crashes directly from the distal factors and indirectly via the proximal factors. Fig. 2 presents the path diagram. All three proximal pathways to crashes; from hazard monitoring ($B = -0.21$, $p < 0.05$), violations ($B = 0.29$, $p < 0.05$) and errors ($B = 0.17$, $p < 0.05$) were significant. The direction of the effects was that lower levels of hazard monitoring and higher frequencies of violations and errors were associated with higher crash involvement.

3.4.1.1. Anxiety. The path from anxiety to crash involvement (See Tables 4a-4b) was fully mediated by the combined effect of violations and errors; higher levels of anxiety were associated with more frequent violations and errors which predicted higher crash involvement. The paths from anxiety to violations and errors were significant. The indirect paths from anxiety to crash involvement via the mediators, violations and errors, were significant as indicated by the 95 % BCa CI's which did not include zero. The direct path from anxiety to crashes ($B = 0.01$, $p = 0.94$) was non-significant.

3.4.1.2. Personality

3.4.1.2.1. Big Five personality. Agreeableness and conscientiousness had direct effects on crashes without passing through a mediator. Both factors were negatively related to crash involvement as shown in Fig. 2. Table 4a shows agreeableness predicted violations and errors and conscientiousness predicted errors. However, the indirect paths to crashes from agreeableness and conscientiousness via violations and errors were non-significant; the 95 % BCaCI's included zero. The other three dimensions of the Big Five Personality were not independently significant predictors of crash involvement.

3.4.1.2.2. Impulsivity. Impulsivity was related to poor hazard monitoring and predicted crash involvement indirectly via this route. In addition, Fig. 2 shows that the direct path between impulsivity and crashes ($B = 0.36, p < 0.001$) was significant. Therefore, hazard monitoring only partially mediated the association between impulsivity and crash involvement and the remaining association was not mediated by errors or violations. The direction of the relationship indicates that higher impulsivity was related to higher crash risk.

3.4.1.2.3. Aggression and thrill seeking. There was a significant indirect path between aggression and crash involvement via violations (See Tables 4a-4b). Higher aggression was associated with higher violations. As shown in Fig. 2, the direct path to crash involvement from aggression ($B = 0.09, p < 0.05$) was significant. The association between thrill-seeking and crashes involvement was

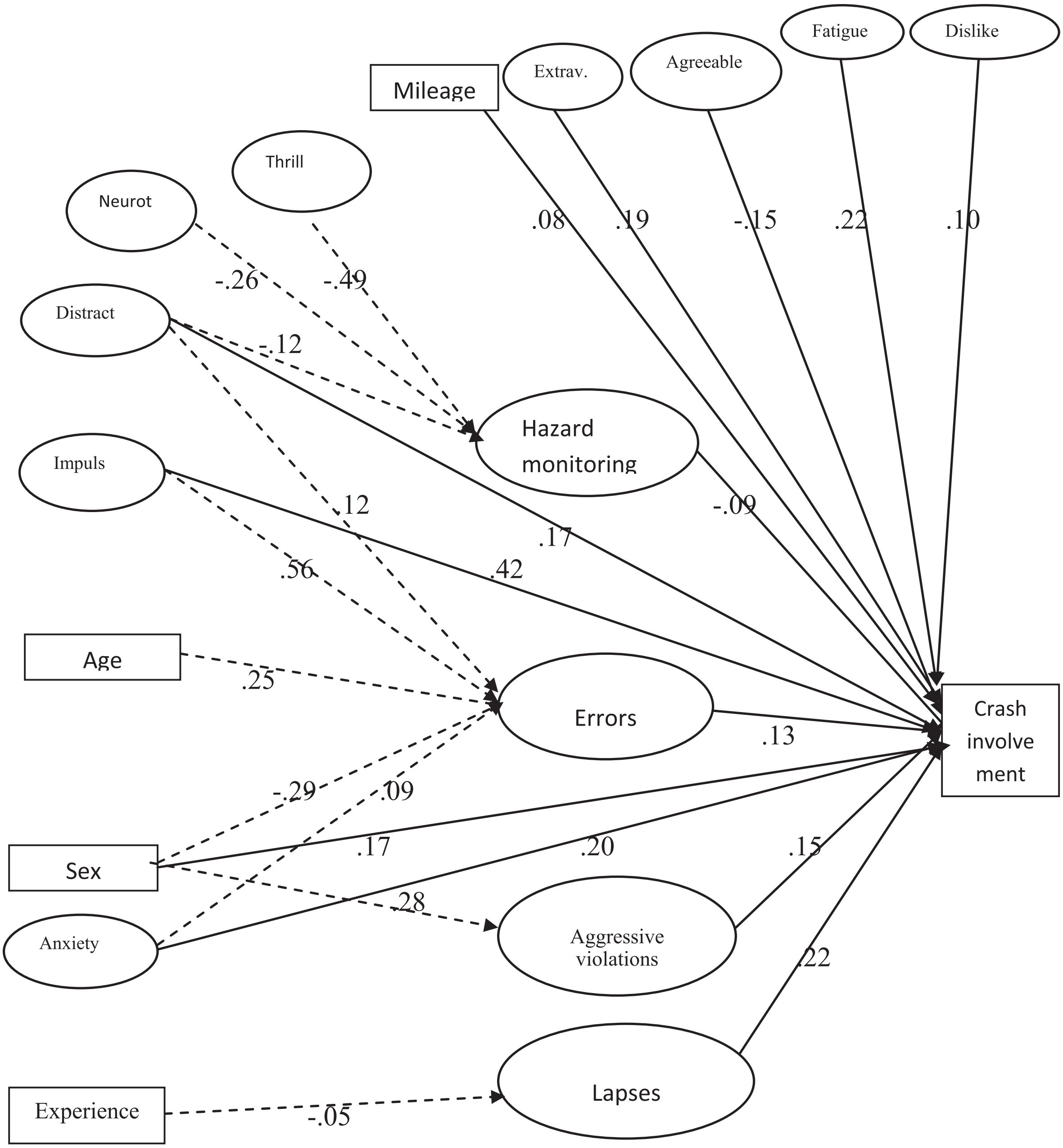

Fig. 3. Path diagram: mediation model for the prediction of crash involvement from distal factors via proximal factors in UK. Note: Indirect paths are shown in dotted lines. Only significant paths are shown.

fully mediated by errors. Higher levels of thrill seeking were related to higher frequency of errors that in turn predicted crash involvement. The direct path from thrill seeking to crash involvement ($B = 0.04$, $p = 0.24$) was non-significant.

3.4.1.3. Safety attitudes; risk perception and fatalistic beliefs

3.4.1.3.1. Risk perception. The association between risk perception and crash involvement was fully mediated by significant indirect pathways via hazard monitoring and violations (Table 4a). Lower levels of risk perception were associated with lower levels of hazard monitoring and higher levels of violations that in turn were related to crash propensity. As Fig. 2 shows the direct path from risk perception to crashes ($B = -0.06$, $p = 0.06$) was non-significant.

3.4.1.3.2. Fatalistic beliefs. Violations and errors jointly mediated the path from fatalistic belief to crash involvement. Stronger fatalistic beliefs were related to higher violation and error frequencies which in turn predicted crash propensity; significant indirect pathways are shown in Table 4b. The direct path from fatalistic beliefs to crash involvement ($B = 0.01$, $p = 0.69$) was not significant.

3.4.1.4. Distracted driving susceptibility. The association of susceptibility to distraction with crash involvement was partially mediated by indirect pathways through hazard monitoring and errors (See Tables 4a-4b). Higher levels of distraction were associated with poorer hazard monitoring and higher frequency of errors. As shown by Fig. 2, the direct path from distraction to crash involvement ($B = 0.13$, $p < 0.01$) was also significant, showing mediation was only partial.

3.4.1.5. Maintenance. There were significant indirect pathways (See Tables 4a-4b) from maintenance practices to crash involvement via violations and errors. More frequent maintenance practices were related to higher violations and errors that predicted crash propensity. The direct path to crash involvement from maintenance practices ($B = 0.01$, $p = 0.81$) was not significant.

3.4.1.6. Fatigue. The association between fatigue and crash involvement was fully mediated by indirect paths via violations and errors (See Tables 4a-4b). Higher levels of fatigue were associated with higher frequency of violations and errors. The direct path to crash involvement from fatigue ($B = 0.03$, $p = 0.59$) was non-significant.

3.4.2. UK mediation results

The UK model had the same structure as the Ghanaian model except that violations had two components; ordinary and aggressive and there were separate errors and lapses factors. In the UK sample, ordinary violations were highly correlated with aggressive violations ($r = 0.75$); errors ($r = 0.54$) and lapses ($r = 0.65$). These correlations (See Tables 4a-4b in the Appendices) indicate that drivers who frequently commit ordinary violations are also likely to commit aggressive violations and errors. The aggressive violations were highly correlated with errors ($r = 0.70$)and with lapses ($r = 0.65$).The path diagram for UK is presented in Fig. 3. Four of the 5 proximal pathways to crash involvement specified for the UK were independently significant; hazard monitoring (B = -0.09, $p < 0.05$), aggressive violations ($B = 0.15$, $p < 0.05$), errors ($B = 0.13$, $p < 0.05$) and lapses ($B = 0.22$, $p < 0.001$). Ordinary violations were not independently significant ($B = 0.03$, $p = 0.06$), however. The direction of the effects indicates that lower levels of hazard monitoring and higher frequencies of aggressive violations, errors and lapses were associated with higher crash involvement.

3.4.2.1. Anxiety and driver crash risks. Similar to the Ghana analysis, the link to crash involvement from anxiety was partially mediated by errors. Higher levels of anxiety were linked to more frequent errors that were related to higher crash involvement. Unlike the Ghana analyses, however, there was no indirect path from anxiety to crashes via violations; anxiety was associated with aggressive violations but the overall indirect pathway was non-significant. As shown in Fig. 3, the direct path to crashes from anxiety was significant($B = 0.20$, $p < 0.01$).

3.4.2.2. Personality factors and driver crash risks

3.4.2.2.1. Neuroticism. The path from neuroticism to crash involvement was fully mediated by hazard monitoring. Higher levels of neuroticism were linked to lower hazard monitoring which predicted higher crash involvement. The direct path from neuroticism to crashes was non-significant (B = 0.01, $p = 0.41$). As shown in Table 4a, the path from neuroticism to hazard monitoring was significant as was the indirect path from neuroticism to crashes via hazard monitoring.

3.4.2.2.2. Impulsivity. The path from impulsivity to crash involvement was partially mediated by errors. Higher levels of impulsivity were associated with more frequent errors which predicted higher crash involvement. The path from impulsivity to crashes ($B = 0.42$, $p < 0.001$) was significant. The path from impulsivity to errors and the indirect path from impulsivity to crash involvement via errors were significant (See Tables 4a-4b).

3.4.2.2.3. The Big Five personality traits. Extraversion and agreeableness were directly related to crash involvement independently from the mediators. Higher extraversion and lower agreeableness was associated with higher risk of crash involvement. The paths from extraversion to hazard monitoring, ordinary violations and errors (See Tables 4a-4b) were also significant. The paths from agreeableness to ordinary violations and errors were significant. However, the 95 % BCaCI's for the indirect paths from extraversion and agreeableness to crashes included zero, indicating that they were non-significant ($p > 0.05$).

3.4.2.3. Thrill seeking. The path from thrill seeking to crash involvement was fully mediated by hazard monitoring, as indicated by the significant indirect path (Tables 4a-4b). The direction of the effects was such that higher levels of thrill seeking were associated with lower hazard monitoring which in turn predicted higher crash involvement. The direct path from thrill seeking to crashes ($B = 0.08$, p

$= 0.11$) was not significant.

3.4.2.4. Distraction susceptibility. The effect of distraction susceptibility on crash involvement was partially mediated by the combined effect of hazard monitoring and errors (Tables 4a-4b). Higher levels of distraction susceptibility predicted lower hazard monitoring and more frequent errors which in turn predicted higher crash involvement. The direct path from distraction susceptibility to crash involvement ($B = 0.17$, $p < 0.01$) was also significant as shown in Fig. 3.

3.4.2.5. Driver stress. Dislike for driving and fatigue predicted crash involvement independently from the mediators as shown in Fig. 3. Higher level of dislike for driving and driving when fatigued predicted greater crash involvement. Dislike for driving predicted hazards monitoring and errors while fatigue predicted errors, ordinary violations and aggressive violations (Tables 4a-4b). However, the indirect paths to crashes from dislike for driving and fatigue via the mediators were non-significant ($p > 0.05$) as the 95 % BCaCI's included zero.

4. Discussion

This study tested a model of the processes underlying risky driving behaviours in Ghana and compared them to the processes underlying risky driving in the UK. Broadly the revised contextual model was useful in understanding the relationships between psychological factors and crash risk in both UK and Ghana. That there are important differences between the countries, however, is illustrated by the differing factor structures of the DBQ. Confirmatory factor analyses showed that, in Ghana, the 24 item 2-factor (errors and violations) structure proposed by Dotse & Rowe (2021) was the best fitting model. By contrast the four-factor structure distinguishing ordinary from aggressive violations and lapses from errors fitted best in the UK data, as is consistent with existing UK DBQ analyses (e.g., Lajunen et al., 2004).

4.1. Proximal factors and crash involvement

Path modelling results showed the relationship between distal factors and crash involvement was mediated by proximal factors in both settings. The proximal factors tested in Ghana; hazard monitoring, violations and errors independently predicted crash involvement while 4 of the 5 proximal factors identified for the UK; hazard monitoring, aggressive violations, errors and lapses independently predicted crash involvement. The relationship found between the behavioural risks and crash involvement from both Ghana and the UK were generally congruent with many existing studies (e.g., de Winter and Dodou, 2010) that have demonstrated that the components of the DBQ are good predictors of crash involvement. In the present study, however, ordinary violations were not independently related to crash involvement in the UK data; the coefficient fell just below significance. However, the simple correlation between ordinary violations and crash involvement was significant with an estimated coefficient of 0.12 which is compatible with the association of 0.13 estimated in De Winter et al.'s (2015) *meta*-analyses. This indicates that ordinary violations did not significantly predict crashes in the mediation model due to correlation with other proximal predictors.

The relationship between hazard monitoring and crash involvement was independently significant in both Ghana and UK with poorer hazard monitoring linked to increased crash risk; this effect is independent of the correlations of hazard monitoring with errors and violations. Therefore, hazard monitoring may be measuring a construct involved in driving risk that is independent of choosing risky driving styles (violations) and from making mistakes while driving as indexed by DBQ errors (Boufous, Ivers, Senserrick, & Stevenson, 2011; Cheng, Ng, & Lee, 2011). This indicates it may be an important additional construct to measure in self-report studies aiming to understanding the role of driving behaviour in crash involvement in the context of higher and lower income countries. These findings align with studies in high-income HICs, such as Boufous et al. (2011) and Cheng et al. (2011), which found hazard monitoring to be a crucial component of driving safety.

This study tested several hypotheses regarding the relationships between distal factors (e.g., personality, stress, distracted driving susceptibility) and crash involvement, mediated by proximal factors (e.g., violations, errors, hazard monitoring). The key hypotheses and their resolutions are discussed.

4.2. Anxiety and driver crash risks

Anxiety was hypothesised to relate to crash involvement indirectly through all three mediators; hazard monitoring, violations and errors. The results showed that in Ghana, a combination of violations and errors fully mediated the relationship between anxiety and crash involvement. This pattern of results is consistent with the hypothesis that people higher in anxiety engage in more violations and errors which, in turn, increases their crash risk. Both our findings from Ghana and existing literature (e.g., Lucidi et al., 2019; Traficante et al., 2024) suggest that violations and errors play a crucial role in linking anxiety to crash involvement. In the UK the path from anxiety to crash involvement was partially mediated by errors but not violations; anxiety related both directly and indirectly to crashes. The link from anxiety to crashes through errors for the UK sample is consistent with existing studies in HICs (Bowen, Budden, & Smith, 2020; Matthews, 2002). Vulnerability to stress that leads to errors among highly anxious drivers were the explanations offered for these relationships (Bowen et al., 2020; Matthews, 2002). Working pressures and demands that often lead to higher anxiety reported among commercial drivers, who are some of the most vulnerable drivers to crashes in Ghana (Dotse et al., 2019) could explain the differences in the mediation links between Ghana and the UK.

4.3. Personality factors and driver crash risks

It was hypothesized that impulsivity would predict crash involvement through hazard monitoring, violations, and errors. The results showed that in Ghana impulsivity related both directly and indirectly through hazard monitoring to crashes (partial mediation) but there was no mediation via violations or errors. One possibility is that hazard monitoring is impaired at higher levels of impulsivity. These results are consistent with studies such as Sumer (2003) and Matthews (2002), which found impulsivity to be a risk factor for crashes due to its influence on risky behaviour and diminished hazard perception. In the UK the path from impulsivity to crash involvement was partially mediated by errors, as expected. The link to crashes from impulsivity through errors for the UK sample is supported by studies in HICs and could be attributed to vulnerability to stress (Matthews, 2002).

It was hypothesized that the Big Five personality dimensions would predict crash involvement indirectly through violations and errors. The results supported this hypothesis for agreeableness and conscientiousness in Ghana, and for extraversion and agreeableness in the UK. In Ghana, of the big-five personality factors, agreeableness and conscientiousness had direct effect on crashes, while in the UK extraversion and agreeableness related to crash involvement directly. These differences may reflect cultural influences on driving behaviour. For instance, other studies have highlighted the importance of cultural context in the impact of personality traits on risky behaviour (e.g., Al-Tit, 2020; Granie et al., 2021; Ulleberg & Rundmo, 2003). In Ghana, violations partially mediated the relationship between aggression and crash involvement. In the UK, neuroticism related indirectly to crash involvement through hazard monitoring. These findings are largely consistent with other studies (e.g., Lucidi et al., 2010; Ulleberg and Rundmo, 2003). Stronger path coefficients for the indirect effects of personality to risky driving behaviours (mediators) than the direct effects of personality on crash involvement were observed, indicating that the majority of the relationship between personality and crash involvement was explained by variations in the proximal measures of driving behaviour included in this study. These patterns of effects were similar to those observed in Sumer's model (Sümer, 2003). In Sumer's model, personality factors predicted crash involvement via their effects on driving behaviours. However relatively weaker path coefficients were observed between the personality factors and crash involvement than from personality to risky driving behaviours (Sümer, 2003). It is possible that the direct effect is mediated by some form of behaviour that is not fully captured by the mediating variables measured in the current study, such as safety orientation/skills (Lajunen, Parker & Stradling, 1998). The results of the present study suggest personality factors are important to crash prediction in both Ghana and UK but interventions targeted to reduce these effects may need to be targeted at different risky driving behaviours in each country.

In Ghana, errors fully mediated the path between thrill-seeking and crash involvement, contrary to expectation. Violations and errors were both moderately correlated with thrill-seeking in Ghana (See Appendices; Tables 4a-b). Although they are correlated, the model identified that the independent mediation involves errors rather than violations. It is often found that thrill-seeking relates to errors and crash involvement (Zhang et al., 2019). In our UK data, however, although there were simple correlations between thrill seeking and both errors and violations, the mediation model showed hazard monitoring fully mediated the relationship between thrill and crash involvement, contrary to expectation. This is consistent with the possibility that thrill seeking impairs hazard monitoring and this leads to crashes. Similar to the relationship observed in our results, hazard monitoring has been found to correlate negatively with thrill seeking elsewhere (e.g., Öz et al., 2010).

4.4. Safety attitudes; fatalistic beliefs, risk perception, maintenance behaviour and driver crash risks

Besides personality factors, the present study addressed the role of a range of attitudes; fatalistic beliefs, risk perception and maintenance practices as distal predictors of crash involvement. Most of these distal factors performed a role in Ghana but not in the UK. It was hypothesized that fatalistic beliefs would relate to crash involvement through violations. The results supported this hypothesis in Ghana showing that stronger fatalistic beliefs were associated with violation frequency, which in turn was associated with crash propensity. This relationship was not significant in the UK. Interestingly the path between fatalistic beliefs and crash involvement was partially mediated by both violations and errors in Ghana. One possibility is that drivers who believe crashes are the result of supernatural forces believe that risky and careless driving will have less implications for crash risk. Fatalistic beliefs have been found to influence work injuries in general as they have a negative influence on a range of risk assessment and risk-taking behaviours (Mbebeb, 2020; McIlroy et al., 2022; Slovic et al., 1981).This factor may be more important to driver crash prediction in the Global South (Teye-Kwadjo, 2019). Themes of spiritual influences on crashes were prominent in a qualitative exploratory study on crash risks factors in Ghana (Dotse et al., 2019). Educational interventions have been demonstrated to be effective in developing safer driving behaviours (Tirla et al., 2024). It may be effective to target Ghanaian motorists' beliefs regarding fatalism with psychoeducational interventions.

It was hypothesized that risk perception would relate to crash involvement through hazard monitoring and violations. In the Ghanaian sample risk perception related indirectly to crashes through the combined effect of hazard monitoring and violations (full mediation) as expected. In the UK sample, where risk perception correlated moderately with the DBQ factors, the pathway to crash involvement was not mediated. The direction of the effect in the Ghanaian data indicated that lower perceived risk was related to higher rates of violation and lower level of hazard monitoring which in turn predict crash involvement. These findings are similar to those reported in HICs (e.g., Kummeneje, & Rundmo, 2020; Yuan et al., 2021).

Moderate positive correlations were found between distraction susceptibility and DBQ factors while distraction susceptibility related negatively to hazard monitoring in Ghana and the UK. As hypothesised, the effect of distraction on crash involvement was partially mediated by the combined effect of hazard monitoring and errors in Ghana and UK. This underscores the dangers of engaging in distracting activities while driving in both HICs and LMICs as highlighted in other work (e.g., Diegelmann et al., 2020; Ponte et al., 2021; Shaaban et al., 2020; Wundersitz, 2019).

The condition of a driver's vehicle has been proposed as an important factor that can contribute to crashes (Afwåhlberg, 2004). We hypothesized that safety maintenance practices would impact crash involvement via errors. In our UK sample we found poor maintenance practices were related to crash involvement, consistent with other work addressing this in HICs (United States Federal Motor Carrier Safety Administration [FMCSA], 2006). In Ghana, frequent maintenance practices were paradoxically associated with increased violations and errors. This contrasts with findings from HICs, where poor maintenance correlates with higher crash risks (e.g., Assemi, Hickman, & Paz, 2021; Haq et al., 2020; Haq et al., 2023). The path between maintenance practices and crash involvement was fully mediated via a combination of violations and errors. Unlike in HICs the use of poorly maintained vehicles, mostly for commercial passenger and goods transportation, is characteristic of Ghana and other countries in Africa. Many passenger transportation vehicles were not designed for this purpose and were modified locally for use as commercial passenger vehicles (See Dotse et al., 2019). One possible explanation for the Ghanaian findings is that the more frequently drivers maintain their vehicles, the better the condition of the vehicle which encourages risky driving behaviour such as speeding. Alternatively, people who are comfortable taking risks may be more likely to own vehicles that are less roadworthy and therefore require frequent maintenance. The relationships between maintenance behaviours and risky driving warrant further research in Ghana.

4.5. Effect of stress and fatigue on driver crash risks

It was hypothesized that driver stress and fatigue would relate to crash involvement through violations, errors, and hazard monitoring. The results showed that in Ghana the path between fatigue and crash involvement was fully mediated by a combination of violations and errors as was expected on the basis of data from HICs (e.g., Bener et al., 2017). In the UK dislike for driving and fatigue related directly to crash involvement rather than via any of the mediators and is congruent with existing literature (Al-Mekhlafi et al., 2020). As this study is cross-sectional, the direction of effect here could mean that people who have experienced a crash enjoy driving less. No mediation path was found for the stress indices in the UK. Long hours of work found among commercial drivers in Ghana (Dotse et al., 2019) may lead to the fatigue that was found to increase violations and errors leading to crashes (Haworth, 1995). In HICs such as the UK, regulations (e.g., tachograph rules) that prevent long working hours may mitigate the effect of fatigue on driving behaviour.

4.6. Limitations

There are some limitations to this study. First, this study was correlational; thus, causal inferences cannot be made. Although longitudinal data allow some stronger inferences concerning temporal ordering of variable associations, causal statements would still not be certain. More complex quasi-experimental designs (Jaffee, Strait, & Odgers, 2012) would be useful to strengthen the causal evidence base. Second, common-method variance may have contributed to prediction across exogenous and mediator variables as data were based on self-report. Given the nature of the problem studied, and particularly the context of LMICs, it was not possible to obtain objective information on crashes or driving behaviour. Further work validating the DBQ with objective crash measures in the Global South and with larger samples would be advantageous. Hazard monitoring was measured through self-reports in the present study but the concept is typically measured through video simulations (e.g., Horswill et al, 2020). However, the self-report measure of hazard monitoring was effective in predicting the dimensions of the DBQ in a validation study (Matthews et al., 1997) and in the Ghana sample but not in the UK sample; and was associated with crash involvement independently from DBQ errors in the present study. Testing the role of objectively measured hazard perception would be useful in understanding the mechanisms through which self-reported hazard monitoring plays its role.

The differences in sample characteristics between the UK and Ghana are significant and likely influenced the driving behaviours observed and the findings of this study. The Ghanaian sample had a higher proportion of commercial drivers, who may exhibit different driving behaviours compared to non-commercial drivers. Commercial drivers often face unique pressures and challenges, such as longer driving hours and stricter schedules, which can impact their driving behaviour and crash risk. In contrast, the UK sample, with a higher proportion of private drivers, may exhibit different patterns of driving behaviour. Furthermore, the gender split was not balanced; there was a higher proportion of males in both samples. This was particularly marked in Ghana where commericial drivers are predominantly male (Boadi-Kusi et al., 2016). These disparities underscore the importance of considering contextual factors when comparing driving behaviours across different countries.

Additionally, the socio-economic, infrastructural, and regulatory environments in Ghana and the UK are vastly different, which likely influenced the study's findings. In Ghana, limited resources for vehicle maintenance and less stringent traffic law enforcement may contribute to higher crash risks. These contextual differences must be taken into account when generalizing the results to other settings. The findings highlight the need for tailored interventions that address the specific challenges faced by drivers in different countries.

4.7. Conclusion

We found that distal factors related to crash involvement via proximal factors in Ghana and the UK. Overall, the findings provide empirical support to the revised contextual mediated model (following Sümer, 2003) to explain driving behaviour in Ghana as well as the UK. More mediating paths were observed for Ghana than the UK despite the higher number of mediators included in the UK models. This could be attributed to the revision process of the contextual mediated model that included some factors (e.g., beliefs) likely to be more important in the Ghanaian setting. Alternatively, the differences could also be attributed to higher rates of violations and errors reported by the Ghanaian sample compared to the UK sample that could mean a stronger relationship among the variables in Ghana. Regulation and enforcement may be less rigorous in Ghana than the UK (Dotse et al., 2019) which might mean that driving behaviour is more closely linked to crash involvement (Dotse & Rowe, 2021). Differences in the rating of many of the factors (e.g., fatigue) between Ghana and the UK could result from cultural differences in the interpretation of the items. The results from the present study suggest that the revised contextual model can partly explain the process underlying risky driving behaviours among drivers in Ghana and the UK. However, the differences in the results between the two settings show that the model may not be applied universally to all cultures. In comparison to the original contextual mediated model (Sümer, 2003), the present model had relatively more significant paths.

This study has several strengths. First, it applies a revised Contextual Mediated Model to both Ghanaian and UK samples, allowing for cross-cultural comparisons. Second, it includes a large sample size from both countries, enhancing the generalisability of the findings. Third, the study uses robust statistical methods, including Confirmatory Factor Analysis and Structural Equation Modelling, to validate the model and test the hypothesized relationships. As discussed above, findings from this study have implications for safety policies and interventions to reduce road crash fatalities in LMICs.

CRediT authorship contribution statement

J.E.K. Dotse: Writing – original draft, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Richard Rowe:** Writing – review & editing, Validation, Supervision, Conceptualization.

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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trf.2024.12.023.

Data availability

Data will be made available on request.

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