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Addo, Abigail Asabea, Arizie, Francis, Boakye, Anthony Edward, Hormenu, Thomas, Adu-Gyamfi, Addae Boateng and Charles-Unadike, Veronica Okwuchi (2026) Factors influencing compliance with road safety protocols by commercial drivers at Hohoe in the Volta region of Ghana: a cross-sectional study. Frontiers in Environmental Health, 5. p. 1818304.

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frontiers in Environmental Health

TYPE Original Research
PUBLISHED 21 May 2026
DOI 10.3389/fenvh.2026.1818304

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RECEIVED 26 February 2026
REVISED 04 April 2026
ACCEPTED 14 April 2026
PUBLISHED 21 May 2026

CITATION
Addo AA, Arizie F, Boakye AE, Hormenu T, Adu-Gyamfi AB and Charles-Unadike VO (2026) Factors influencing compliance with road safety protocols by commercial drivers at Hohoe in the Volta region of Ghana: a cross-sectional study.
Front. Environ. Health 5:1818304.
doi: 10.3389/fenvh.2026.1818304

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Factors influencing compliance with road safety protocols by commercial drivers at Hohoe in the Volta region of Ghana: a cross-sectional study

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Introduction: Looking at the divisional distribution of crashes and casualties in the first half of 2022 in the Volta region of Ghana, the Hohoe division recorded just 7 crashes, accounting for 3.6% of all reported crashes, one of the lowest among the divisions in the region. Notably, no fatalities were reported, suggesting relatively better road safety performance during this period. Therefore, this study aimed to investigate the factors that contributed to compliance among commercial drivers at Hohoe in the Volta region of Ghana during the first half of 2022—a period when the area reportedly recorded comparatively better road safety outcomes than other regions.
Methods: Using cross–sectional survey design and the census sampling technique, 395 (100%response rate) commercial drivers were recruited for the study. A structured questionnaire was used to measure key variables. Data were analyzed using frequency distribution, Pearson's chi–square test, and binary logistic regression in SPSS version 27.
Results: The study found that 89% of commercial drivers observed compliance. Significant positive associations were found between compliance and sociodemographic characteristics ($p < .001$), human factors ($p < .001$), vehicle factors ($p < .001$), environmental factors ($p < .001$), and road factors ($p < .001$).
Discussion: The study findings, therefore, suggest that a multi–pronged policy approach that addresses vehicles, roads, the environment, human factors, and driver skills is critical for improving road safety protocols compliance among commercial drivers at Hohoe. By targeting both structural and human dimensions of road safety, authorities can reduce traffic violations, prevent accidents, and promote safer transport operations in the Volta region.

KEYWORDS
driver safety behavior, human factors in road safety, occupational safety, road safety compliance, safety management, traffic safety behavior

Introduction

Road traffic deaths and injuries remain a major global health and development challenge (1, 2). Globally, there were an estimated 1.19 million road traffic deaths in 2021—a 5% decrease when compared to the 1.25 million deaths in 2010 (1, 2). As of 2019, road traffic crashes were noted to be the leading cause of death of children and youth age 5–29 years, and were claimed to be the 12th leading cause of death when all ages are considered (2–4). Two-thirds of deaths occur among people of working age (18–59 years), causing huge health, social and economic harm throughout society (5). It was established that 92% of these deaths occur in low- and middle-income countries (1). The risk of death is three times higher in low-income countries than high-income countries despite these countries having less than 1% of all motor vehicles (1).

In Ghana, road accident statistics from 2020 to 2025 indicate that the overall burden of road crashes has been rising, with fatalities showing a particularly pronounced upward trend (6–8). In 2020, a total of 14,886 road crashes were recorded (9). Between 2021 and 2022, annual fatalities increased from 1,800 to 2,890, with over 14,000 injuries reported each year (10, 11). In 2023, there were 14,135 crashes, resulting in 2,276 deaths and 15,409 injuries (12). In 2024, the number of crashes slightly decreased to 13,489, yet fatalities rose to 2,494, with 15,607 injuries reported (13, 14). During the first half of 2024 alone, 6,653 crashes caused 1,237 deaths, averaging nearly seven fatalities per day (13, 14).

In 2025, between January and June, 7,289 road crashes were recorded, resulting in 1,504 deaths and approximately 8,300 injuries, with pedestrians accounting for a significant proportion of the victims (8). By August 2025, cumulative figures showed 9,626 crashes nationwide, causing 1,937 deaths and 10,957 injuries, highlighting increasing concerns over road safety (8). Commercial vehicle drivers, who contribute substantially to road usage and passenger movement, represent a notable share of those involved in these incidents (15). Their level of compliance with national road safety protocols has direct implications for crash occurrence, injury severity, and fatality rates (16). Therefore, to reduce accident risks, and foster public trust, maintaining road safety compliance is essential. Compliance refers to drivers adhering to road safety protocols as well as regulations and laws to ensure safe and responsible driving (17). However, to stay on top of compliance, it is essential for commercial vehicle operators to understand, and implement specific regulations, maintaining vehicle standards, and regularly monitoring both driver behavior and vehicle conditions (17).

The Volta region, a major transport and commercial hub, recorded 247 crashes in 2021 involving 423 vehicles, resulting in 64 fatalities and 268 injuries (18). In 2022, the number of crashes fell to 193, involving 318 vehicles, with 48 fatalities and 133 injuries, and pedestrian accidents decreased by 13.2% (19). However, in 2023, crashes rose sharply to 427, involving 705 vehicles, resulting in 127 fatalities and 431 injuries. In 2024, the upward trend continued with 525 crashes involving 869 vehicles, causing 89 fatalities and 419 injuries (18). In the first quarter of 2025, the region reported 124 crashes involving 201 vehicles, resulting in 28 deaths and 142 injuries. Although the number of crashes and vehicles involved declined slightly by 2.4% compared to the same period in 2024, fatalities increased by 40%, and injuries surged by 52.7%, highlighting a worrying rise in the severity of road accidents in the region (18).

Looking at the divisional distribution of crashes and casualties in the first half of 2022, the Ho division recorded the highest numbers across all categories in the region, with 112 crashes, 187 vehicles involved, 18 fatalities, 58 injuries, and 18 pedestrians knocked down (18). Tongu division had the highest number of fatalities, with 18, matching the Ho division (18). In contrast, Hohoe, Kpando, and Ketu divisions all recorded just 7 crashes each representing 3.6% of crashes, the lowest in the region (19). A comparison with the first half of 2021 reveals that the Ho division saw a 15% decrease in crashes (from 132 in 2021 to 112 in 2022). Keta division saw an 11% reduction (from 35 to 31), while Tongu division experienced a 43% decrease (from 51 to 29). Ketu division recorded a 65% drop (from 20 to 7), and Kpando division saw a 40% increase (from 5 to 7). Hohoe division also experienced a 75% increase in crashes (from 4 to 7). However, Hohoe division reported no fatalities, suggesting relatively better road safety performance during this period (19). In terms of road safety compliance, commercial motorcycle riders in Hohoe demonstrated a moderate adherence to regulations, with a compliance rate of 59.2% (20). This suggests that while a significant portion of riders follow safety guidelines, there remains a substantial group engaging in behaviors that could increase their risk of accidents (20).

Besides, a high level of compliance, ceteris paribus (that is, when all other influencing factors are held constant), enhances road safety, which in turn reduces the loss of human lives and material assets essential for economic growth and development (21). Hence, examining the influence of socio-demographic, human, vehicle, environmental, and road factors on compliance among commercial drivers in Hohoe in the Volta Region of Ghana, is essential. Compliance with road safety protocols is inherently multifactorial (22). Socio-demographic characteristics such as age, education, and driving experience shape drivers' knowledge, attitudes, and risk perception. Human factors, including fatigue, substance use, and driving behavior, directly influence adherence to safety protocols. Vehicle-related factors, particularly roadworthiness and maintenance status, may either facilitate or constrain safe driving practices. In addition, environmental conditions and road characteristics—such as weather, traffic density, road design, signage, and surface conditions—play critical roles in determining drivers' ability and willingness to comply with established road safety protocols (23–25).

Prior studies including Poku et al. (15), Dotse et al. (24), Almatar (26), El-Gendy et al. (27), Gyimah (28), Zeng et al. (29), Asiamah et al. (30), Amoadu and Akoto-Buabeng (31), Teye-Kwadjo et al. (32), Nanga et al. (33), Taiwo and Kumi (34), Ojo et al. (35) investigated commercial (professional) drivers. For instance, some of these studies (15, 24, 26–29) examined broader determinants of road traffic accidents among commercial drivers. Notably, none of these studies specifically addressed the factors influencing compliance. Consequently, existence evidence failed to

Abbreviations

CO-OP, co-operative transport union; DV, dependent variable; GPRTU, Ghana private road transport union; GMTA, global millennium transport association; IV, independent variable; PROTOA, the progressive transport owners association; RA, research assistant; SPSS, statistical package for social science.

explain what factors may have contributed to compliance among drivers at Hohoe in the Volta region during the first half of 2022—a period when the area reportedly recorded comparatively better road safety outcomes than other regions. This study seeks to address this gap by examining the determinants of road safety protocols compliance in this context. The study may contribute by expanding the discourse from crash determinants to compliance determinants, thereby enriching road safety performance. The findings may offer practical value by informing strategies aimed at reducing road traffic injuries and fatalities, advancing national road safety goals, and supporting global road safety targets such as the Sustainable Development Goal Target 3.6. The objectives of this study are to: (1) examine if socio-demographic factors of commercial drivers influenced road safety protocols compliance at Hohoe in the Volta region of Ghana during the first half of 2022; (2) ascertain the extent to which human factors influenced road safety protocols compliance among commercial drivers at Hohoe in the Volta region of Ghana during the first half of 2022; (3) analyze if vehicle factors influenced road safety protocols compliance among commercial drivers at Hohoe in the Volta region of Ghana during the first half of 2022; (4) assess whether environmental factors predicted road safety protocols compliance among commercial drivers at Hohoe in the Volta region of Ghana during the first half of 2022; and lastly, (5) determine whether road factors influenced road safety protocols compliance among commercial drivers at Hohoe in the Volta region of Ghana during the first half of 2022.

The study further hypothesized that there is no statistically significant relationship between socio-demographic, human, vehicle, environmental as well as road factors, and road safety protocols compliance among commercial vehicle drivers at Hohoe in the Volta region of Ghana.

Theoretical framework and conceptual model

The study dwelled much on deterrence theory by Beccaria in 1764 (36). This theory emphasizes that compliance is primarily driven by individuals' perceptions of the certainty, severity, and swiftness of sanctions (36–38). In this regard, drivers are expected to comply with road safety protocols when they believe that violations will be detected and punished accordingly (39, 40). However, this study does not proceed on the assumption that compliance is solely determined by the existence of rules or by drivers' perceptions of enforcement effectiveness (39, 40). Rather, the study acknowledges that deterrence theory, in its classical form, does not fully account for a range of contextual and situational factors that may significantly influence driver behavior. Consequently, the primary aim of this study was to test the relevance of deterrence theory by examining additional factors that extend beyond its traditional scope.

The conceptual model (Figure 1) guiding the study therefore positions compliance with road safety protocols as the dependent variable, influenced directly by the five categories of independent variables: socio-demographic, human, environmental, vehicle, and road factors. Unlike a strict deterrence-based model, perceived enforcement (certainty, severity, and swiftness of punishment) is not treated as the sole explanatory pathway but rather as part of a broader context within which these factors operate. These variables represent dimensions that deterrence theory does not explicitly incorporate but which may shape, constrain, or even override deterrent effects in real-world settings. Socio-demographic characteristics, such as age, religion, household size, and years of driving, were examined to determine whether variations in background attributes influence compliance independently of

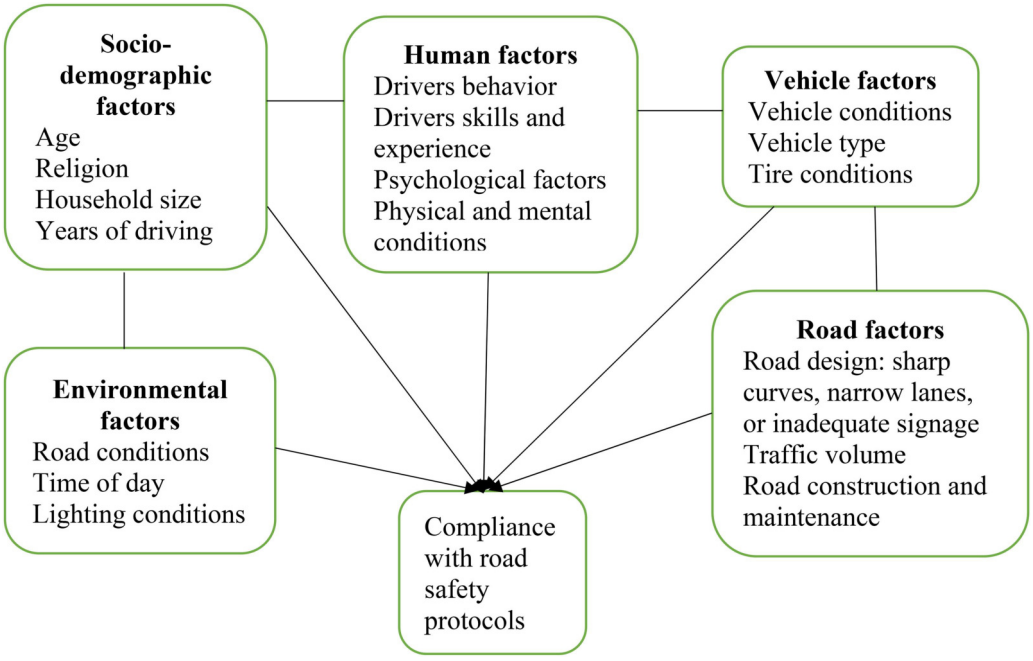

FIGURE 1
Conceptual model (authors' construction, 2023).

deterrence mechanisms. Human factors—including drivers' behavior, drivers' skills and experience, psychological factors, and physical and mental conditions—were also considered, given their direct impact on decision-making and behavior, particularly in situations where rational cost–benefit calculations (as assumed by deterrence theory) may be compromised.

Environmental factors, such as road conditions, lighting conditions, and time of day, were included to account for situational dynamics that may affect driving behavior irrespective of enforcement presence. Similarly, vehicle-related factors, including vehicle conditions, vehicle type and tire conditions, were examined as potential determinants of compliance that fall outside the explanatory scope of deterrence theory. Road infrastructure factors—such as road design: sharp curves, narrow lanes, or inadequate signage, traffic volume, and road construction and maintenance—were also incorporated, recognizing that structural conditions may either facilitate or hinder compliance regardless of perceived sanctions.

In essence, the study was designed to empirically assess whether deterrence theory alone is sufficient to explain compliance behavior or whether these additional factors provide stronger or complementary explanatory power. By doing so, the research moves beyond the assumptions of deterrence theory and contributes to a more comprehensive understanding of road safety protocols compliance among commercial drivers in the Hohoe municipality of Ghana.

Materials and methods

Study design and population

The study adopted descriptive cross-sectional study design (41) to investigate factors influencing compliance with road safety protocols by commercial drivers in the Hohoe municipality of Ghana, targeting only commercial drivers (see Table 1). Thus, we targeted professionally-licensed drivers, who operates a vehicle for public transport, carrying passengers and/or goods, organized under unions such as the Ghana Private Road Transport Union (GPRTU), the Progressive Transport Owners Association (PROTOA), Global Millennium Transport Association (GMTA), and Co-operative Transport Union (CO-OP) (42). The population of commercial (professional) drivers in Hohoe, the municipal capital was 395 in 2023. Using the census sampling method, all the drivers (395) were estimated to be included in this study. Actually, all participants 395 (100% response rate) responded to the research instruments and their data were used in this research.

TABLE 1 Number of drivers in the various transport unions at Hohoe.

Transport unions	Number of members
GPRTU	250
PROTOA	36
CO-OP	58
GMTA	51
Total	395

Source: fieldwork (2023).

Study setting

This study is justified in Hohoe (a municipal capital) in the Volta Region of Ghana due to the town's strategic role as a commercial and transportation hub connecting several districts and neighboring regions (43). Hohoe experiences high volumes of commercial vehicle movement, including buses, minibuses, taxis, and cargo vehicles, which increases exposure to road safety risks and makes driver compliance with road safety protocols a critical public safety concern (44). The road network in and around Hohoe comprises a mix of urban roads, highways, and feeder roads, many of which are characterized by varying road conditions, limited signage, and sections prone to congestion and environmental challenges (45). These conditions create an appropriate context for examining how road, environmental, and vehicle-related factors influence compliance with road safety protocols by commercial drivers. Studying this setting allows for a realistic assessment of compliance behavior under diverse and sometimes challenging driving conditions (46). Additionally, Hohoe reflects the broader characteristics of many mid-sized towns in Ghana, where commercial transport is dominant and enforcement resources are often limited (47). Conducting the study in Hohoe will therefore provide findings that are not only locally relevant but also transferable to similar towns across the Volta region and Ghana as a whole.

Measures

Independent variables (IVs)

In this study, the IVs were socio-demographic characteristics, human factors, vehicle factors, environmental factors, and road factors. Apart from the socio-demographic characteristics, the rest of the IVs including (human factors, vehicle factors, environmental factors, and road factors) were themselves indicators for measurement. The dependent variable (DV) was compliance with road safety protocols, measured on a dichotomous scale: "Yes" coded as 1 and "No" coded as 0. A value of 1 indicated that the respondent observed compliance, while a value of 0 indicated non-compliance. Compliance was assessed using self-reported responses.

The study used a questionnaire, which was developed specifically for this study based on literature and standardized instruments used by other researchers in previous studies (22, 48). This questionnaire was divided into five sections. Section 1 consisted of socio-demographic characteristics of the participants. Some of the items in this section included: What is your age in complete years? How many are you in the family? What religion are you affiliated to? Section 2 covered items on human factors. The item in this section was which human factors do you think can affect compliance with road safety protocols? Section 3 referred to vehicle factors. The item in this section was which vehicle factors can affect compliance with road safety protocols? Section 4 focused on items on

environmental factors. The item in this section was which environmental factors do you think can affect compliance with road safety protocols? While the last section covered items on road factors. The item in this section was which road factors do you think can affect compliance with road safety protocols? All the items were multiple choice in nature. Cronbach alpha reliability test was conducted on the data to ascertain its acceptability for analysis. Cronbach alpha coefficient of 0.60 was obtained which was an indication that the data were acceptable for analysis. This was supported by Griethuijsen et al. (49) rule of thumb that a Cronbach's alpha of 0.60–0.70 is acceptable and that data is good for analysis.

Data collection procedure

Ethical approval for the study was obtained from the Research Ethics Committee of the University of Health and Allied Sciences (UHAS-REC A. [018] 21-22). The questionnaire was translated into Ewe a dialect widely spoken in the study location to ensure inclusivity for participants who were not fluent in the English language. Data collection was conducted over a 2-week period, between the first 3 weeks of February, 2023 with the help of four research assistants (RAs). These RAs were recruited and trained to ensure standardized administration of the instruments. Before a participant took part in the study, a written informed consent was taken thus, after they were briefed of the purpose of the study, voluntary nature of the study, their right to withdraw at any point without a penalty, and the confidentiality of their responses. Participants were also assured of their anonymity, therefore, information that could identify individual driver was not collected. Data collection was conducted through direct engagement with all identified drivers at lorry stations, terminals, and operational routes within the municipality. Multiple visits and flexible data collection schedules were employed to ensure full coverage and to minimize non-response. No financial or material incentives were offered to participants.

Data processing and analysis

Data collected from participants in the field were cleaned and edited. Items that requested multiple responses as well as categorical responses were systematically coded by assigning numerical values to each response category, thereby facilitating efficient data entry and analysis using the Statistical Package for the Social Sciences (SPSS) version 27. This approach ensured consistency in data handling and enabled the application of appropriate statistical techniques for the analysis. Data were screened to ensure accuracy before analysis using frequency, and scatter plot. Frequency distribution, chi-square test, and binary logistic regression were used to analyze the data. The frequency distribution was used to summarize participants' responses into proportions. The Pearson's chi-square test was used to test the hypotheses postulated in the study, either to accept or reject the null hypotheses. The binary logistic regression was used to determine the predictive effect of the IVs on DV. Significance level was determined with a p-value of 0.05 (5%). This standard serves as a balance between minimizing false positives and detecting real effects (50, 51).

Results and discussion

Socio-demographic characteristics of study participants

The study comprised 395 commercial drivers, 23.3% ($n = 92$) were 50–59 years, 16.5% ($n = 65$) were either 20–29 or 40–49 years, nearly, sixty-two percent ($n = 244$) were Christians, 11.1% ($n = 44$) were traditionalist. About third ($n = 131$) had five and above member household, 16.5% ($n = 65$) had 2-member household. More than half ($n = 219$) had operated for 6 years and above, while 5.8% ($n = 23$) had operated for less than a year (See Table 2).

Descriptive results

A total of 395 commercial drivers responded to the question on road safety protocols. The majority 88.9% ($n = 351$) observed compliance, while 11% ($n = 44$) did not (See Table 3). With respect to human factors leading to compliance, 32.7% ($n = 129$)

TABLE 2 Socio-demographic characteristics of study participants.

Variable	Frequency	Percentage
Socio-demographic factors		
Age		
20–29	65	16.5
30–39	84	21.3
40–49	65	16.5
50–59	92	23.3
60+	89	22.5
Religion		
Christianity	244	61.8
Islamic	107	27.1
Traditional	44	11.1
Household size		
2	65	16.5
3	88	22.3
4	111	28.1
5+	131	33.2
Years of driving		
<1 year	23	5.8
1 year	46	11.6
2–5 years	107	27.1
6+ years	219	55.4
Total	395	100.0

Source: fieldwork (2023).

TABLE 3 Descriptive results.

Variable	Frequency	Percentage
Comply with road safety protocols		
Yes	351	88.9
No	44	11.1
Human factors		
Drivers behavior	111	28.1
Drivers skills and experience	67	17.0
Psychological factors	88	22.3
Physical and mental conditions	129	32.7
Vehicle factors		
Vehicle conditions	153	38.7
Vehicle type	131	33.2
Tire Condition	111	28.1
Environmental factors		
Road conditions	176	44.6
Time of day	131	33.2
Lighting conditions	88	22.3
Road factors		
Road design: sharp curves, narrow lanes, or inadequate signage	110	27.8
Traffic volume	153	38.7
Road construction and maintenance	132	33.4
Total	395	100.0

Source: fieldwork (2023).

reported physical and mental conditions, 17.0% ($n = 67$) indicated drivers' skills and experience. Regarding vehicle factors, 39% ($n = 153$) reported vehicle conditions, while 28% ($n = 111$) indicated tire condition. Among environmental factors, about 45% ($n = 176$) reported road conditions, while 22.3% ($n = 88$) indicated lighting conditions. Concerning road factors, about 39% ($n = 153$) reported traffic volume, while about 28% ($n = 110$) indicated road design: sharp curves, narrow lanes, and/or inadequate signage (See Table 3).

Bivariate results

Table 4 presents Pearson's chi-square test of independence results on the relationships between each independent variable and drivers' compliance. Statistically significant relationship was found between age [$\chi^2 = 58.634$, $p < 0.001$] and drivers' compliance. Data indicated that all drivers aged 20–29, 30–39, and 40–49 years (100.0%) observed compliance. Majority of drivers aged 50–59 (75.0%) observed compliance compared to25.0% who did not. More than seventy per cent aged 60 and above observed compliance compared to 23.6% who did not.

There was a statistically significant relationship between religion [$\chi^2 = 14.025$, $p < 0.001$] and drivers' compliance. The data revealed that about 91% of Christian drivers observed compliance compared to 9.4% who did not. Also, 80.4% of Muslim drivers observed compliance compared to 19.6% who did not. All the traditional drivers (100.0%) observed compliance.

Household size showed positive association with compliance [$\chi^2 = 79.757$, $p < 0.001$]. The data indicated that 68% of drivers with two-member household observed compliance compared to 32.3% who did not. Nearly 74% of drivers with three-member household observed compliance compared to 26.1% who did not. Further, all drivers (100.0%) with four-member households and all those with five and above member households observed compliance.

Statistically significant relationship was found between years of driving [$\chi^2 = 39.793$, $p < 0.001$] and drivers' compliance. The data indicated that drivers with experiences ranging between (less than 1, 1, and 2–5 years) all (100.0%) observed compliance. Additionally, about 80% of drivers with 6 and above driving experience observed compliance compared to 20.1% who did not.

Human factors showed significant positive association with compliance [$\chi^2 = 33.168$, $p < 0.001$]. The data indicated that drivers who reported drivers' own behavior, 79.3% observed compliance compared to 20.7% who did not. Also, drivers who indicated drivers' own skills and experience, those who indicated psychological factors, and those who indicated physical and mental conditions, all (100.0%), respectively, observed compliance.

There was statistically significant relationship between vehicle factors [$\chi^2 = 32.641$, $p < 0.001$] and commercial vehicle drivers' compliance. The data revealed that drivers who reported vehicle conditions, all (100.0%) observed compliance. Further, drivers who indicated vehicle type, 84.0% observed compliance compared to 16.0% who did not. Furthermore, drivers who reported tire condition, 79.3% observed compliance compared to 20.7% who did not.

Statistically significant relationship was found between environmental factors [$\chi^2 = 99.787$, $p < 0.001$] and commercial vehicle drivers' compliance. The data revealed that drivers who reported road conditions, and those who reported lightning conditions, all (100.0%), respectively, observed compliance. Also, drivers who reported time of day, 66.4% observed compliance compared to 33.6% who did not.

Statistically significant relationship was found between road factors [$\chi^2 = 20.091$, $p < 0.001$] and commercial vehicle drivers' compliance. The data indicated that drivers who reported road design: sharp curves, narrow lanes, or inadequate signage, all (100.0%) observed compliance. Also, drivers who indicated traffic volume, 86.3% observed compliance compared to 13.7% who did not. Further, drivers who reported road construction and maintenance, 82.6% observed compliance compared to 17.4% who did not (See Table 4).

Discussion

The present study examined the associations between socio-demographic, human, environmental, vehicle, and road-related factors and commercial drivers' compliance with road safety protocols. The chi-square analysis revealed significant associations between socio-demographic, human, environmental, vehicle as well as road factors and commercial drivers'

TABLE 4 Bivariate results.

Variable	No (%)	Yes (%)	Total *n* (%)	χ^2	*p*-value
Age				58.634	<0.001
20–29	0.0	100.0	65 (100.0)		
30–39	0.0	100.0	84 (100.0)		
40–49	0.0	100.0	65 (100.0)		
50–59	25.0	75.0	92 (100.0)		
60+	23.6	76.4	89 (100.0)		
Religion				14.025	<0.001
Christianity	9.4	90.6	244 (100.0)		
Islamic	19.6	80.4	107 (100.0)		
Traditional	0.0	100.0	44 (100.0)		
Household size				79.757	<0.001
2	32.3	67.7	65 (100.0)		
3	26.1	73.9	88 (100.0)		
4	0.0	100.0	111 (100.0)		
5+	0.0	100.0	131 (100.0)		
Years of driving				39.793	<0.001
<1 year	0.0	100.0	23 (100.0)		
1 year	0.0	100.0	46 (100.0)		
2–5 years	0.0	100.0	107 (100.0)		
6+ years	20.1	79.9	219 (100.0)		
Human factors				33.168	<0.001
Drivers behavior	20.7	79.3	111 (100.0)		
Drivers skills and experience	0.0	100.0	67 (100.0)		
Psychological factors	0.0	100.0	88 (100.0)		
Physical and mental conditions	16.3	83.7	129 (100.0)		
Vehicle factors				32.641	<0.001
Vehicle conditions	0.0	100.0	153 (100.0)		
Vehicle type	16.0	84.0	131 (100.0)		
Tire Condition	20.7	79.3	111 (100.0)		
Environmental factors	99.787	<0.001			
Road conditions	0.0	100.0	176 (100.0)		
Time of day	33.6	66.4	131 (100.0)		
Lighting conditions	0.0	100.0	88 (100.0)		
Road factors				20.091	<0.001
Road design: sharp curves, narrow lanes, or inadequate signage	0.0	100.0	110 (100.0)		
Traffic volume	13.7	86.3	153 (100.0)		
Road construction and maintenance	17.4	82.6	132 (100.0)		

Row percentages in parenthesis, significant at 0.05, χ^2 = Chi-square, No, non-compliance; Yes, compliance. Source: fieldwork (2023).

compliance with road safety protocols. This suggests that drivers' compliance with road safety protocols is not uniform but varies according to these multiple dimensions. The observed association between socio-demographic variables specifically (age, religion, household size, and years of driving) and compliance aligns with prior studies, which found that younger drivers and those with less years of driving are more prone to risky driving behaviors (52–54). The chi-square results in the present study support this pattern, suggesting that targeted interventions might need to consider these demographic differences when designing safety campaigns or training programs.

Significant associations were found between compliance with road safety protocols and human factors, such as drivers'

behavior, drivers' skills and experience, psychological factors, as well as physical and mental conditions. This highlights the behavioral dimension of road safety compliance. Previous studies have reported that drivers' personal attitudes and behaviors directly influence compliance (55, 56). The current findings reinforce the importance of integrating behavioral strategies—such as awareness programs or fatigue management training—into safety interventions.

The association between environmental factors including (road conditions, time of day, and lighting conditions) and compliance echoes findings from Gu et al. (57), who demonstrated that adverse weather and poor visibility reduce compliance with road safety protocols. This finding emphasizes that environmental hazards interact with driver behavior, underscoring the need for context-sensitive safety measures, such as stricter enforcement or adaptive road infrastructure during high-risk conditions.

Vehicle-related factors, including vehicle conditions, vehicle type, and tire condition, were also significantly associated with compliance. This finding corroborates previous a study, which reported that poorly maintained vehicles are linked to higher rates of non-compliance (22). This finding underscore that supports initiatives must focus on regular vehicle inspections and mandatory maintenance checks as a means of improving overall compliance.

Finally, road-related characteristics (road design: sharp curves, narrow lanes, or inadequate signage, traffic volume, and road construction and maintenance) were significantly linked to driver compliance. This indicates that inadequate road infrastructure may facilitate non-compliant behaviors, consistent with earlier work by Baye (58) which also reported that inadequate or poor road infrastructure can also hinder emergency response and service delivery efforts. This highlights that improving road conditions, signage clarity, and traffic enforcement could directly influence compliance rates among commercial drivers.

The observed compliance rate of 89% among commercial vehicle drivers at Hohoe indicates a substantially high level of adherence to road safety protocols, suggesting effective implementation of road safety protocols and general driver receptivity to road safety protocols. Such a high compliance rate likely reflects the success of combined regulatory enforcement and educational interventions, aligning with behavioral theories that link knowledge, risk perception, and normative influence to adherence behaviors. When compared to previous studies in similar contexts, this finding appears notably lower. For instance, research conducted among commercial drivers in Kumasi and Accra reported compliance rates ranging from 93% to 95.6%, respectively, particularly concerning seatbelt use, adherence to speed limits, and vehicle maintenance (59). Similarly, Felicio et al. (60) found that 99.5% of drivers claimed they stop at red lights, 76.3% slow down at yellow lights, and 98.2% either speed up or maintain speed at green lights. On the contrary, this finding refuted a previous study, which found that 60% of drivers did not obey the stop line at the traffic light and 72% did not fasten their seat belt (61). The higher compliance observed at Hohoe may be attributed to localized factors such as smaller driver networks, more direct enforcement by municipal traffic authorities, or effective community-level education programs, suggesting context-specific interventions can yield measurable improvements in driver behavior. The data also support that the high compliance rate likely contributes to a reduced incidence of road traffic accidents and associated injuries, supporting public health objectives. Further, the finding validates the effectiveness of current road safety interventions at Hohoe, providing an evidence-based rationale for maintaining and potentially scaling similar strategies to other municipalities.

In the present study, 11% of participants were observed exhibiting non-compliance with established road safety protocols. While this proportion represents a minority of the population, it nonetheless has meaningful implications for public safety. Non-compliant behaviors included, but were not limited to, failure to adhere to traffic signals, neglect of seat belt or helmet use, and unsafe driving maneuvers such as speeding or improper lane changes. The finding suggests that although the majority of road users adhere to road safety protocols, a relatively small segment may contribute disproportionately to traffic-related incidents. This observation aligns with prior research indicating that 8.9% of drivers did not comply with road safety protocols (26). Conversely, this finding refuted a study by Tavakkoli et al. (62) which found that only 4.17% of female-drivers had lower compliance with road safety protocols. From a policy perspective, the identification of this 11% cohort highlights the potential value of targeted interventions, such as educational campaigns, enhanced enforcement measures, or behavioral incentive programs, aimed at promoting compliance. Further investigation into the underlying determinants of non-compliance—whether stemming from lack of awareness, deliberate risk-taking, or contextual factors—would provide additional insight to inform effective road safety strategies.

The study found that 23.3% of commercial drivers were aged between 50 and 59 years, indicating a substantial representation of older drivers in the sample. Older drivers often bring extensive driving experience, which can positively influence compliance with road safety protocols. However, age-related declines in vision, reaction time, and physical agility may pose challenges in certain driving situations. This finding refuted a previous study, which found that approximately 59% of bus drivers were aged between 50 and 59 years, with only 12.5% aged 60 years or above, and 28% under age 50 years (63). This suggests that interventions such as periodic refresher courses, health assessments, and ergonomically designed training could help maintain high compliance levels among this age group.

Religious affiliation emerged as another prominent feature, with Christians constituting approximately 62% of the sample. The predominance of Christian drivers may reflect cultural and community norms that emphasize ethical behavior and respect for rules, which could support safer driving habits. Road safety campaigns that incorporate culturally sensitive messaging or involve faith-based organizations may therefore be more effective in promoting adherence to road safety protocols. This finding refuted a previous study, which found that 81.2% of the drivers identified as Christians, while 18.8% were Muslim (64). This finding suggests that few of the drivers are affiliated to different religion (65). The plausible explanation could be that the population of the study setting is dominated by Christianity (66).

Although only 11.1% of drivers self-identified as traditionalists. This minority may exert a meaningful influence

on workplace culture and operational practices. Traditionalist individuals are often characterized by adherence to established norms, cautious attitudes toward innovation, and preference for conventional approaches to work processes. In the context of commercial driving, this may manifest as resistance to adopting new technologies or updated road safety protocols. Nevertheless, traditionalist drivers may also contribute positively through stability, experience, and consistent adherence to established road safety protocols. The relatively small proportion of traditionalists within the sample suggests that even among older drivers—who constitute a substantial segment of the workforce—attitudes are not uniformly conservative, indicating a nuanced interplay between age, experience, and workplace disposition. This finding implies that some of the drivers do and perceive things in the traditional way (67). This outcome is almost similar to a previous study, which also found that 10.3% of their sample were believers in the African Traditional Religion (68).

The study found that approximately one-third of commercial drivers lived in households with five or more members. Larger household sizes may influence drivers' behavior in several ways. On the one hand, having more dependents could increase a sense of responsibility, motivating safer driving to avoid accidents that could jeopardize family welfare. On the other hand, the economic pressures of supporting a larger household might lead to longer working hours or fatigue, which could compromise road safety. This suggests that interventions aimed at improving compliance with road safety protocols could consider drivers' household contexts. Policies such as fatigue management programs, reasonable scheduling, and economic support could help mitigate risks associated with the pressures of large households. This finding is in line with a previous study, which found that in many regions—particularly sub-Saharan Africa, West Asia, South Asia, and Melanesia—households frequently have five or more members, and in some countries, the average exceeds six (69).

However, the study revealed that 16.5% of the sample resided in two-person households, indicating that a notable proportion of commercial drivers live in smaller domestic arrangements. This household composition may reflect a variety of social and personal factors, including nuclear family structures, partnerships without children, or adult children who have established independent households. Smaller households could influence drivers' domestic responsibilities and time allocation differently compared to larger households, potentially allowing for greater flexibility in managing work-related schedules and reducing the cumulative stress associated with extensive household obligations. This outcome refuted a previous study, which found that the breakdown of household sizes includes: 11.0% lived alone (single-member); 47.2% lived in 2–5 member households (69).

The study found that more than half of the commercial drivers had been in operation for over 6 years. This indicates that the sample included a substantial proportion of experienced drivers, which may have important implications for road safety practices. Drivers with extensive experience are often more familiar with traffic regulations, vehicle handling, and common road hazards, which can enhance compliance with road safety protocols. The high proportion of experienced drivers in this study suggests that interventions aimed at improving road safety might focus less on basic driving skills and more on refresher courses, advanced defensive driving techniques, and continuous education on emerging traffic laws or road safety technologies. Additionally, while experience generally contributes to safer driving, prolonged years on the road can also introduce risks related to fatigue, complacency, or overconfidence. Therefore, programs targeting experienced drivers should balance leveraging their expertise with reinforcing vigilance, updating knowledge of traffic regulations, and mitigating risks associated with complacency or fatigue. Consistent with a previous study, which found that the largest group (37.8%) had between 11 and 20 years of experience, indicating that the majority had well over 6 years behind the wheel (70).

It emerged in the study that a small proportion—5.8%—reported having less than 1 year of driving experience. This emphasizes that less experienced drivers may be less familiar with traffic regulations, vehicle handling, and hazard anticipation, which could increase the likelihood of non-compliance with road safety protocols. Prior studies have consistently shown that novice drivers are more prone to risky driving behaviors and accidents due to limited exposure to real-world driving scenarios (52, 71). The presence of novice drivers in the sample suggests that road safety interventions should be tailored to their level of experience such as structured orientation programs, mentorship with experienced drivers, and targeted safety training could accelerate the development of safe driving habits.

The study found that 33% of participants reported that human factors, such as physical and mental conditions, can influence compliance with road safety protocols. This highlights the perceived importance of driver well-being in maintaining safe driving behaviors. Physical fatigue, stress, illness, and cognitive impairments are widely recognized as contributors to risky driving, while alertness, mental focus, and good health promote compliance with road safety protocols. Previous studies have shown that human factors significantly affect road safety outcomes. For example, fatigue and stress have been linked to slower reaction times and poor decision-making, increasing the likelihood of accidents (72–74). Conversely, drivers who maintain good physical and mental health are generally more attentive, better able to anticipate hazards, and more likely to follow traffic rules. This finding suggests that interventions aimed at enhancing compliance with road safety protocols should consider the human condition of drivers. Programs that promote rest breaks, stress management, mental health support, and regular medical check-ups could help mitigate risks associated with human factors and improve overall adherence to road safety protocols. This finding refuted a previous study, which found that approximately 25.5% of respondents admitted to driving while feeling sleepy (75). The authors further stressed that sleep disorders such as obstructive sleep apnea (prevalence between 15% and 45% among drivers) and fatigue raise accident risks comparable to those caused by alcohol impairment.

In addition to physical and mental conditions, 17.0% of participants indicated that drivers' skills and experience play a role in compliance with road safety protocols. This emphasizes that beyond health and well-being, the competencies acquired through training and practical driving experience are critical determinants of safe driving behavior. Previous studies have

reported that skill level and accumulated experience influence a driver's ability to anticipate hazards, make quick decisions, and maintain compliance with safety rules (73, 76). Drivers with greater technical proficiency and on-road experience are generally more confident in handling challenging situations, which can reduce risky behaviors and improve adherence to safety protocols. The finding suggests that interventions should not only focus on health and fatigue management but also on developing drivers' skills through continuous training, refresher courses, and mentorship programs. Enhancing skill levels across all drivers, particularly novices, could strengthen compliance with road safety protocols and reduce accident risks.

The study revealed that 39% of participants reported that vehicle conditions influence compliance with road safety protocols. This indicates that drivers recognize the importance of vehicle reliability, maintenance, and safety features in supporting adherence to traffic rules. Well-maintained vehicles with functional brakes, lights, tires, and other safety systems reduce the likelihood of mechanical failure, promote safer driving practices, and can motivate drivers to follow road safety protocols. Previous research has emphasized the link between vehicle conditions and driver behavior. For instance, poorly maintained vehicles have been associated with increased accident risk and non-compliance, while drivers of well-serviced vehicles tend to demonstrate higher adherence to safety measures (73, 77, 78). This finding suggests that policies promoting regular vehicle inspections, mandatory maintenance schedules, and awareness of vehicle safety could enhance compliance among commercial drivers.

The study found that approximately 45% of participants reported that road conditions can influence compliance with road safety protocols. This highlights that the state of infrastructure—such as road quality, signage, lighting, and traffic control measures—plays a critical role in shaping driver behavior. Drivers are more likely to adhere to road safety protocols on well-maintained roads with clear signage, whereas poor road conditions, potholes, or inadequate lighting may challenge safe driving and reduce compliance. Previous studies have demonstrated that road infrastructure affects driver behavior. For example, poorly maintained roads increase accident risk and may encourage drivers to adopt unsafe maneuvers, while clear, well-constructed roads promote safer driving practices (28, 79). This finding suggests that improving road quality, traffic signage, and overall infrastructure could directly enhance compliance with road safety protocols among commercial drivers.

The study also found that 22.3% of drivers reported that lighting conditions influence their compliance with road safety protocols. This indicates that while a minority of participants perceive lighting as a critical factor, it nonetheless plays a role in driver behavior. Poor street lighting or insufficient vehicle lighting can reduce visibility, impair hazard recognition, and increase the risk of accidents, whereas adequate lighting supports safer driving practices. Previous studies indicate that lighting conditions affect driver performance and road safety outcomes. For instance, driving at night or in poorly lit areas has been associated with slower reaction times, reduced hazard perception, and higher accident risk (80–82). Although fewer drivers in this study emphasized lighting as a determinant of compliance, the finding suggests that road safety strategies should not overlook it, especially in regions where night driving is frequent or street lighting is inadequate.

The study found that approximately 39% of participants reported that traffic volume influences their compliance with road safety protocols. This suggests that drivers are sensitive to the density of traffic on the roads, with heavier traffic potentially prompting increased vigilance and adherence to road safety protocols. Conversely, lighter traffic may create a perception of lower risk, which could lead to more relaxed or risky driving behaviors. Previous research supports the link between traffic volume and driving behavior (83). Studies have shown that high traffic density often encourages cautious driving due to increased interactions with other vehicles and higher perceived risk, whereas low traffic can sometimes lead to speeding or non-compliance with road safety protocols (83, 84). This finding implies that traffic management strategies, including congestion control and awareness campaigns during peak traffic periods, could enhance compliance with road safety protocols.

Implications

Overall, the study findings call for the development of comprehensive, evidence-based road safety policies that integrate behavioral, mechanical, environmental, and infrastructural interventions to enhance compliance among commercial drivers.

Limitations

Although this study has provided significant insights, however, the high level of compliance with road safety protocols (89%) reported may be influenced by self-reporting bias, as drivers may have overreported compliance due to social desirability or fear of sanctions. This may limit the accuracy of the compliance estimates. Again, the use of quantitative methods alone may not have fully captured the contextual and behavioral nuances underlying drivers' compliance with road safety protocols. Therefore, future research should incorporate qualitative approaches to provide deeper insight into the motivations and constraints influencing compliance.

Moreover, the observed limited internal consistency among certain scales measuring the explanatory variables suggests that while these scales were intended to capture specific constructs, the lower-than-ideal reliability indicates that some items may not have fully aligned with the underlying concepts. This may affect the precision of estimates and the strength of inferences drawn from these measures. Future research could address this limitation by refining the items, increasing scale length, or using alternative measurement approaches to ensure more robust reliability.

Our logistic regression analysis did not identify any significant predictors of commercial drivers' compliance with road safety protocols. For all the variables, the upper confidence intervals could not be estimated due to sparse data or small category sizes, and all p-values exceeded the conventional significance threshold ($p > 0.05$). This indicates that the predictors included in the model—socio-demographic, human, vehicle,

environmental, and road-related factors—did not show statistically measurable effects on compliance in this sample. The absence of statistically significant associations in the logistic regression analysis suggests that the variables examined may not exert a strong influence on compliance with road safety protocols among commercial drivers in this study. This finding implies that other unmeasured factors—such as enforcement intensity, individual risk perception, or organizational safety culture—may play a more critical role in shaping compliance behavior. Furthermore, the lack of significant relationships does not provide sufficient empirical evidence to refute deterrence theory; rather, it indicates that the assumptions of the theory remain plausible within this context. Consequently, the results neither confirm nor contradict deterrence theory, but instead highlight the need for further investigation into additional determinants of compliance.

Conclusions

The study findings revealed that multiple factors including vehicle conditions, environmental conditions, road infrastructure, human factors, and driver skills, were significantly related to commercial vehicle drivers' compliance with road safety protocols during the first half of 2022. Therefore, a multi-pronged policy approach that addresses vehicles, roads, environment, human factors, and driver skills is critical for improving road safety protocols compliance among commercial drivers at Hohoe. By targeting both structural and human dimensions of road safety, authorities can reduce traffic violations, prevent accidents, and promote safer transport operations in the Volta region.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Research Ethics Committee of the University of Health and Allied Sciences. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

AA: Conceptualization, Formal analysis, Methodology, Writing – original draft. FA: Resources, Writing – review & editing. ABoak: Writing – review & editing, Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft. TH: Methodology, Writing – original draft, Writing – review & editing. AA-G: Methodology, Writing – original draft, Writing – review & editing. VC-U: Methodology, Writing – original draft, Writing – review & editing, Conceptualization, Supervision.

Funding

The author(s) declared that financial support was not received for this work and/or its publication.

Acknowledgments

Sincerely, we are grateful to the respondents who sacrificed their time to take part in the study and the research assistants for their help during the data collection.

Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declared that generative AI was not used in the creation of this manuscript.

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