

ORIGINAL RESEARCH ARTICLE

Truck drivers' behaviour on road traffic crash involvement: A structural equation modeling approach

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ABSTRACT

Truck drivers significantly enhance global economic development due to the varying and bulk freight transport from one end to another. However, their involvement in road traffic crashes usually results in significant losses of lives and properties. There are sparse studies on the influence of driving behaviours of truck drivers on road traffic crashes, especially in developing countries like Nigeria. A total of 880 commercial truck drivers participated and completed the driver behaviour questionnaire. The structural equation modeling approach was used in the analysis to examine the influence of truck drivers' behaviours on crash involvement in Nigeria. The results showed that driving violations, driving errors, and inattention errors were significantly associated with road traffic crash involvement, while positive driving behaviour was negatively significant. The analysis further revealed a significant relationship between crash involvement and sociodemographic factors, notably age and driving experience, whereas no significant association was observed with educational background. The findings suggest crash involvement among truck drivers can be reduced by addressing violation, error, and inattention, while positive behaviours should be encouraged through training programs and policy formulations.

Keywords: drivers behaviour; road traffic crash; sociodemographic; structural equation modeling; truck drivers

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1. Introduction

Trucking business has continued to boost the global economy through seamless freight transport. This is making the truck industry sustain relevance in many nations. In the US, about 10 million tons of freight worth over 12 billion dollars were transported by trucks^[1]. Similarly, an increase in freight transport through trucks has been recorded in Nigeria^[2]. This consequently affects the road infrastructure, which can cause road traffic crashes.

The cause of road traffic crashes has been attributed to humans, the environment, and mechanical faults. The major cause has been identified as human behaviour like speeding, drunk driving, and lack of driving experience^[3]. Commercial drivers are more involved in road traffic crashes (RTC) than private drivers because of their driving frequency and the quest to meet targets. In Nigeria, over 50% of truck drivers were reportedly involved in crash injuries at least once in their profession^[4]. This is expected as the weight and size of trucks impact their driving behaviour^[5]. While most studies have focused on

commercial drivers' behaviour, truck drivers' behaviour's influence on crash involvement has not been critically explored. Specifically, truck drivers in Nigeria are known to be more concerned about their enumeration making them double-dealing about their vehicles' condition, thus resulting in unscrupulous deals with roadside mechanics when there is a fault with their vehicle^[6]. This is a matter that poses a danger to other road users as faults with vehicle results in a breakdown in the middle of the road, causing congestion, sometimes fire outbreaks and even the falling of trucks. Furthermore, fatigue and sleepiness are practices peculiar and prevalent among commercial drivers in Nigeria due to workload^[6]; which often causes sleeping while driving and high chances of RTC involvement.

1.1. Influence of driving behaviour on road traffic crashes

Several studies have examined the influence of truck driving behaviour (violation, error, inattention, and positive driving behaviour) on crash involvement. The study by Rezapour et al.^[7] has attributed truck driver violations to road traffic crashes. This could be as a result of their size and weight increasing their chances of violations^[8]. Previous studies have also found a significant influence of driving errors on road traffic crashes among truck drivers^[9-12]. Based on the findings by Mehdizadeh et al.^[13] had driving errors among truck drivers increases the chances of RTCs. Furthermore, truck drivers' inattention has also been linked to crashes, as reported in the findings by Pulugurtha et al.^[14] and Alimo et al.^[15] that inattention significantly influenced traffic crashes among truck drivers. Positive driving behaviour among drivers also revealed the creation of a conducive driving environment, thus enhancing safety^[5,16]. Therefore, it is vital to examine the influence of specific driving behaviours among truck drivers considering their enormous contribution to RTCs^[7,17].

1.2. Influence of sociodemographic factors on road traffic crashes

The impact of truck drivers' sociodemographic factors (like age, driving experience, and education level) on traffic crashes have varying views among researchers. Specifically, among commercial drivers, errors and violations were less associated with older professional drivers of heavy cargo^[18]. Also, an increase in drivers' age reveals a downward trend of crash involvement among truck drivers^[19]. Similarly, Han and Zhao^[5] and Guého et al.^[20] agree that violations decrease as drivers age increase. However, Maslač et al.^[16] found no influence of age on professional drivers' behaviour. This disparity is important to be explored among Nigerian truck drivers.

The influence of the driving experience is expected to enhance the safety consciousness among drivers. However, there appear to be divergent findings as Guého et al.^[21] found truck driving experience to significantly influence RTC, which deviates from the study by Giroto et al.^[22] where truck drivers' experience was inversely related to crashes among the truck drivers. Furthermore, driver education has been found to influence RTC among truck drivers. This was revealed by Mehdizadeh et al.^[18] and de Sousa and Rossi^[23] highlight the influence of driver education on RTCs. Also, Han and Zhao^[5] and Guého et al.^[20] demonstrated that professional drivers with higher education rarely fall victim to driving violations, which was consistent with the findings of de Sousa and Rossi^[23]. Nevertheless, this was not consistent with the findings of Batool and Carsten^[24] and Hussain et al.^[25], who found that the level of education is not a determining factor for risky driving behaviour. In Nigeria, a low level of education among truck drivers has been found to negatively affect the assimilation of on-the-job training, which is dangerous to the safety of other road users and properties^[26]. This necessitates a study on sociodemographic impacts among Nigerian commercial drivers. Most existing studies have used the traditional statistical method to examine the influence of driving behaviour, which often results in biased conclusions. Also, assessing the positive driving behaviour among commercial drivers has not been critically examined.

This study uses the structural equation approach to bridge the existing gap by examining the influence of truck drivers' behaviour and socio-demographics on traffic crash involvement. As far as the authors know, no study has investigated the influence of truck drivers' specific driving behaviour and socio-demographics on

traffic crash involvement using the SEM in Nigeria. Therefore, the study hypothesizes that:

- H1: A significant relationship exists between driving violations and road traffic crashes among truck drivers.
- H2: A significant relationship exists between driving errors and road traffic crashes among truck drivers.
- H3: A significant relationship exists between inattention errors and road traffic crashes among truck drivers.
- H4: A negative significant relationship exists between positive driving behaviour and road traffic crashes among truck drivers.
- H5: There is a significant relationship between truck drivers' age and road traffic crashes.
- H6: A significant relationship exists between driving experience and road traffic crashes.
- H7: A significant relationship exists between truck drivers' educational level and road traffic crashes.

2. Materials and method

2.1. Methodology

This study used purposive sampling to collect data from 880 truck drivers who voluntarily participated in the survey. The study gathered data through a driver behaviour questionnaire (DBQ)-based data collection method conducted from May 2022 to September 2022, and consent was sought from the officer in charge of truck stations and drivers. Before the survey, the purpose of the study was disclosed to the respondents, and data anonymity was assured. The questionnaire was distributed to those willing to participate in the study, and the meaning of items was explained to the illiterate drivers without permitting discussion with other respondents.

The DBQ, which comprises the sociodemographic of the drivers, crash history, and driving behaviours (risky and positive driving behaviours) used for this survey, is the reviewed version of the professional driver behaviour questionnaire from previous studies^[5,18,27]. It was combined, checked for repetition, and categorised based on the respective driving behaviour that applies to the Nigerian context. The wording from the previous DBQ was also reworded for clarity to the proposed respondents. The pilot study with 45 respondents, which was done before the full-scale study, comprised both the face(content) validity and the reliability assessment of the scale. A team of experts from transport institutions and universities was consulted for the content validity of the DBQ to give it face value. Their comments were based on adopting simplified sentences and words to make it understandable and reduce biased responses. Furthermore, the internal consistency of the scale was assessed by assessing the reliable Cronbach alpha (>0.7). The validity of the pilot scale was also examined through convergent and discriminant validity, all with acceptable thresholds of >0.5 and <0.9 , respectively. After the pilot study, one item was deleted due to limited comprehension from the truck drivers, and the 30-Item DBQ was used for the full study.

2.2. Statistical analysis

2.2.1. Descriptive analysis

The descriptive statistics for socio-demographics and DBQ items were processed by SPSS statistics 27. In the descriptive analysis, the percentage distribution, mean, and standard deviations of the items in the DBQ were estimated.

2.2.2. Model analysis

The SmartPLS4 was used in analysing the SEM (measurement and structural model)—the measurement model aid in assessing the composite reliability, convergent, and discriminant validity. Composite reliability indicates the reliability of the items in the scale and is considered reliable for value >0.7 . The convergent validity ensures the items in the scale converge to explain their respective constructs and the criterion is average

variance extracted (AVE)>0.5. The discriminant validity is assessed in ascertaining the latent variables, which also represent distinct and unique constructs. It must have Heterotrait Monotrait ratio (HTMT) <0.9 for it to be acceptably discriminant; otherwise, the latent variables will be said to have multi-collinearity issues.

The structural model assessment precedes the measurement model after the criteria are satisfied. This includes the path coefficient analysis between the latent variables comprising driving behaviour (driving violation, driving errors, inattention error, positive driving behaviour), sociodemographic factors (age, driving experience, educational level), and the crash involvement among the truck drivers. The path coefficient estimates the directional relationship and influence between the latent variables. Importance performance analysis was also examined to indicate the driving behaviours among truck drivers based on importance and performance towards RTC reduction.

3. Results

3.1. Descriptive analysis

The descriptive analysis of the demographic data (**Figure 1**) indicates that there are more male truck drivers than female drivers, while over 60% were married. The educational level of the truck drivers shows that secondary school graduates were dominant while the 31–56 age groups were more. Based on driving experience, more than 60% of the drivers had greater than seven (7) years of driving experience. The crash history indicated that about 61% had been involved in road traffic crashes within the last two years, with rear-end collision as the highest reported (36%) crash severity.

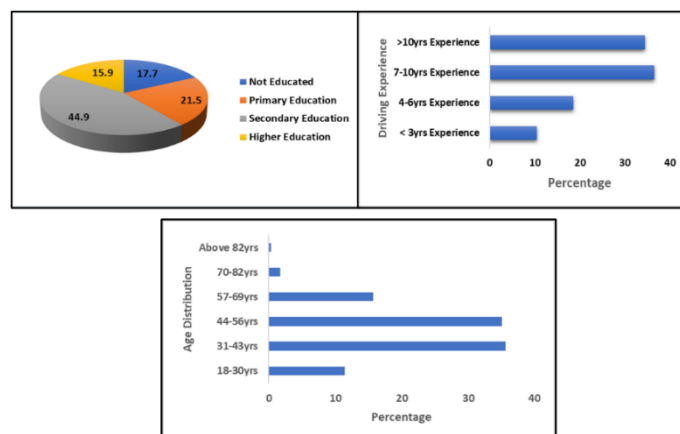


Figure 1. Descriptive statistic of commercial truck drivers: education background; driving experience; age distribution.

The descriptive statistics results of the scale items (**Table 1**) of truck drivers DBQ reveal that the driving behaviour item ‘I keep driving ahead even when traffic light has turned red’ had the highest mean score for driving violations. Inattention errors for the truck drivers had ‘I do forget to turn on the indicator or signal light when turning.’ as most reported while driving error items, ‘I sleep on steering when driving’ had the highest mean score for driving errors.

Table 1. Driving behaviour scale items.

Constructs	Scale items	Questions	Mean (SD)
Driving violations	DVTKD1	I get angry at a certain type of driver and express my anger any way I can, like cursing, angry gestures.	3.12(1.37)
	DVTKD2	I keep driving ahead even when traffic light has turned red.	4.32(0.91)
	DVTKD3	I answer and make calls with phones when driving.	3.21(1.20)
	DVTKD4	I use my horn to show my annoyance to another road user.	3.28(1.14)

Table 1. (Continued).

Constructs	Scale items	Questions	Mean (SD)
Driving violations	DVTKD5	I become angry at another driver and chase them with the intention of showing them how angry I am.	3.79(1.09)
	DVTKD6	I do force my way into the traffic.	3.81(1.12)
	DVTKD7	I take alcohol immediately before or during driving.	3.89(1.20)
	DVTKD8	I overload my vehicle with passenger and goods.	3.80(1.11)
	DVTKD9	I drive with expired driving license.	4.06(1.07)
	DVTKD10	I deliberately disregard the speed limits in the night or very early in the morning.	3.85(1.00)
	DVTKD11	I disregard the speed limit on a residential road.	4.11(1.00)
	DVTKD12	I disregard the speed limit on a freeway or rural highway.	3.60(1.22)
Driving errors	DETKD13	I do not look at the rear-view mirror when changing lanes or merging.	4.07(1.16)
	DETKD14	I underestimate the speed of the overtaking vehicles or the oncoming vehicles when overtaking or swerving left.	3.83(1.16)
	DETKD15	I follow so close to the vehicle ahead that it is hard to apply brake in emergency.	3.98(1.04)
	DETKD16	I sudden break on a wet road or a road with bad conditions.	3.70(1.10)
	DETKD17	I sleep on steering when driving.	4.63(0.75)
	DETKD18	I do not carry out maintenance on my vehicle at the right time.	3.79(1.26)
Inattention errors	IETKD19	I do suddenly apply brake due to failure of the vehicle ahead of me.	3.55(1.24)
	IETKD20	I do drive from the main road to the other street roads without paying attention to pedestrian, bicycle or vehicle.	4.14(1.04)
	IETKD21	I do forget to turn on the indicator or signal light when turning.	4.15(1.25)
	IETKD22	I brake too quickly on a slippery road or when it's raining.	3.72(1.08)
	IETKD23	I do switch on one thing, such as the headlights, when I meant to switch on something else, such as the wipers.	3.94(1.03)
	IETKD24	I realize that I have no clear memory of the road I have been travelling on.	3.99(1.01)
	IETKD25	I do hit something when reversing that I had not previously seen.	3.92(1.08)
Positive driving behaviours	PDTKD26	I like to pay attention and avoid splashing the water to the pedestrians when driving.	2.19(1.30)
	PDTKD27	I do keep the lane clear and do not hinder vehicles behind.	1.95(1.12)
	PDTKD28	I try to avoid indiscriminate use of horn while driving.	2.18(1.23)
	PDTKD29	I ensure not to obstruct other road users while parking by the road.	1.88(1.12)
	PDTKD30	I do keep a safe following distance while driving.	1.95(1.17)

3.2. Model results

The measurement model assessment shows the Cronbach alpha and composite reliability were above 0.7, which means the items are reliable. The convergent validity of the latent variables was greater than 0.5 for the positive driving behaviour but less for driving violations, driving errors, and inattention errors. This was improved through the removal of items with lower loadings (<0.6) to improve the convergent validity (AVE). The following items that were deleted for the AVE improvement include Driving Violations (DVTKD1, DVTKD2, DVTKD3, DVTKD4, DVTK5, DVTKD7, DVTKD8, DVTKD9), Driving Errors (DETKD17, DETKD15), Inattention Errors (IETKD19, IETKD20, IETKD24), after which, AVE for driving violation, driving errors, and inattention errors rose to 0.560, 0.560, and 0.522 consistent with the required standard of AVE above 0.5^[28] for convergent validity to be established. Discriminant validity was assessed with Heterotrait-Monotrait (HTMT) ratio, which must be less than 0.9 to be discriminately valid^[29]. The constructs' values, being less than the 0.9 threshold, suggest the criteria for discriminant validity is satisfied.

The structural model assessment was established, and the path coefficient was estimated from the

hypothetical constructs' directional relationship. The results (Table 2; Figure 2) show a significant positive relationship between driving violations, driving errors, and inattention error of truck drivers and their involvement in road traffic crashes. In contrast, positive driving behaviour indicated a significant negative relationship. The sociodemographic factors (age and driving experience) were significantly associated with road crashes, unlike the truck drivers' educational level, which did not show any association.

Table 2. Effect of risky driving constructs on crash involvement for commercial truck drivers.

Structural relationship	Original sample	T statistics	P values
DVTK -> TKDAI	0.171	4.762	0.000
DETK -> TKDAI	0.069	2.704	0.040
IETK -> TKDAI	0.083	2.727	0.023
PDTKD -> TKDAI	-0.144	4.269	0.000
AGTKD -> TKDAI	-0.149	4.497	0.000
DEXTKD -> TKDAI	0.087	2.419	0.016
ELTKD -> TKDAI	-0.027	0.877	0.380

DVTK: Driving Violations; TKDAI: Truck Driver Accident Involvement; DETK: Driving Errors; IETK: Inattention Errors; PDTKD: Positive Driving Behaviour; AGTKD: Age; DEXTKD: Driving Experience; ELTKD: Education Level.

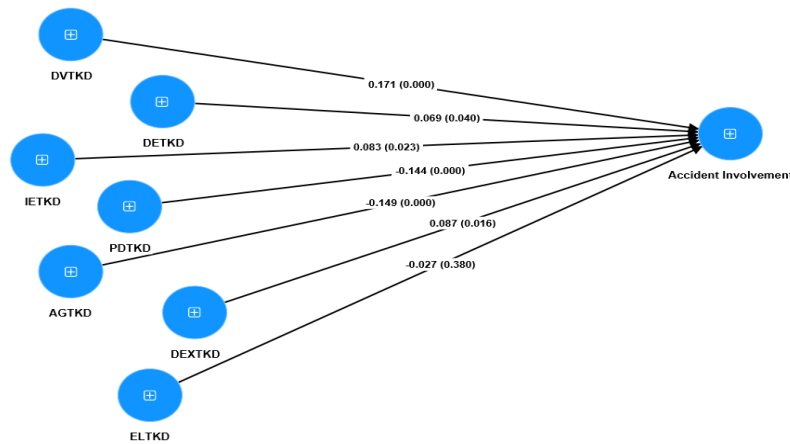


Figure 2. Model of driver behaviour and accident involvement.

3.3. Importance performance analysis

The importance-performance analysis (IPMAP) for commercial truck drivers' shows that of all their driving behaviours and sociodemographics, driving violations are the most prominent constructs that will increase RTC by 0.1720 if it increases in performance by one point and has about 72% performance for RTC (Figure 3). It indicates the driving constructs are of the highest importance and have significant high performance in causing RTCs among truck drivers in Nigeria.

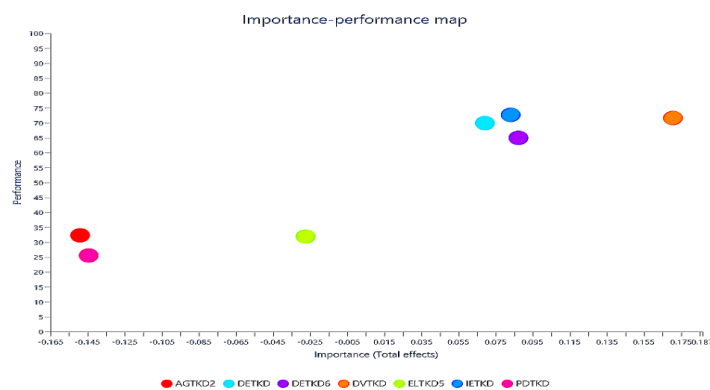


Figure 3. Importance-performance analysis for truck drivers' behaviour.

4. Discussion

The study examined the influence of truck drivers driving behaviour and sociodemographic variable on crash involvement. Driving violations, driving errors, and Inattention errors, which are risky driving behaviours, are positively significant to road traffic crashes, while positive driving behaviour has a negative influence. Also, unlike truck educational background, truck drivers' age and driving experience significantly influenced road traffic crashes,

A significant relationship between the truck driver's violation and crash involvement confirms hypothesis 1, which is the tendency of truck drivers to be involved in RTC due to violations. The indulgence of truck drivers in driving violations could be due to varying factors like risky taking common among truck drivers, which may be because of the size of their vehicles to intimidate other drivers, thus making them violate driving safety, which could result in RTC. Another likely reason for truck drivers' violation may not be unconnected to poor maintenance of truck vehicles, which often cause truck breakdown and brake failures. When the brakes of a truck are poorly maintained, it becomes difficult to avoid crashes near other vehicles, pedestrians, or properties. Also, long driving hours without rest could aggravate driving violations through fatigue. This is why there are stipulated maximum driving hours per day, but they are rarely followed. Repeated disregard for rest due to long hours of driving may be a precursor to RTCs among truck drivers. This is consistent with the study Rezapour et al.^[7] that road traffic crashes involving truck drivers are attributed to violations. This suggests the tendency of commercial truck drivers to be involved in RTCs, as violations can result in more RTCs. Violation could increase with vehicle size^[8].

Driving error among truck drivers significantly influences RTC; thus, hypothesis 2 is supported. Most truck drivers transport cargo, which is usually weighty. Errors can sometimes occur when cargo falls off and threatens other road users. In some cases, the derailment of a trailer due to driver error could also lead to RTC among truck drivers. Some truck driving errors could also be due to the drivers' sleeping, which causes dangerous lane drift. This agrees with the findings of Mehdizadeh et al.^[13] that driving errors among truck drivers increase the chances of RTCs. Also, this study aligns with the results of Naderi et al.^[9], Tabibi et al.^[10], Vahedi et al.^[11], and Varmazyar et al.^[12] that driving errors significantly influence road traffic crashes.

Inattention error influenced RTC among truck drivers significantly, confirming hypothesis 3. This could be preceded by distraction from handheld devices like phones or global positioning devices believed to aid driving. However, they can contribute to making truck drivers distracted, which could lead to RTC. Truck driving could be multi-tasking in which the driver is involved in more than one task or activity simultaneously while driving, like adjusting mirrors, setting controls, road monitoring, and manoeuvring. They have the probability to divert truck drivers' attention. Some other activities that could instigate inattention errors among truck drivers include reading, eating, receiving/making phone calls, or engaging in discussions while driving. They could elevate the propensity of crash involvement among truck drivers. Stress from road congestion, pressure to meet delivery targets, and other health issues affecting a truck driver could also aggravate inattention errors and, consequently, RTC. This is in line with the findings of Pulugurtha et al.^[14] and Alimo et al.^[15], that inattention significantly influenced traffic crashes among truck drivers.

The truck driver's positive driving behaviour negatively influenced their involvement in crashes suggesting that the higher the positive behaviour the truck drivers exhibit, the lesser their involvement in RTC. This confirms hypothesis 4. The findings further imply that truck drivers' accidents can be curtailed by promoting and encouraging positive driving behaviour among them. This can be achieved through training, policy formulation, incentives, and enforcement. The findings are consistent with the findings of Han and Zhao^[5] which state that positive driving reduces risky driving behaviour among professional drivers. It is also in tandem with the results of Maslač et al.^[16] and Han et al.^[30], in which there was a decline in risky driving behaviours due to an increase in positive driving behaviours. This further strengthens the importance of

positive driving behaviour as it creates an atmosphere that curtails risk driving among drivers, especially for commercial drivers who drive long hours with irregular work schedules.

The truck drivers' age significantly relates to their crash involvement, confirming hypothesis 5. The results from this study suggest older commercial truck drivers were more safety conscious. This may be due to the experience they have acquired over the years, which could be aiding them in not handling potentially dangerous driving hazards. The age effect is in line with the study of Sullman et al.^[19], who found that an increase in the age of truck drivers reveals a downward trend in road traffic crashes. Similarly, Sayed et al.^[31] reported crashes to decrease with age increase among drivers. The knowledge of the implication of detrimental effects of a truck collision, especially with other vehicles, is mostly the worst hit in a collision with trucks since a minimum of one life is lost in every truck crash, as found in the study of Umar et al.^[32].

The significant effect of truck drivers driving experience confirms hypothesis 6 that crash involvement of commercial truck drivers is associated with their driving experience. The results suggest that not all experienced drivers have the same driving skills, implying that other factors aside from driving experience could be the cause of road traffic crashes among Nigerian truck drivers. For instance, experienced truck drivers may be susceptible to driving fatigue, which could be a precursor to risky driving behaviour. Our findings deviate from the results of Giroto et al.^[22] where truck drivers' experience was inversely related to crashes among truck drivers.

The educational level of truck drivers is insignificantly associated with crash involvement, thus, hypothesis 7 is not supported. This implies that education's influence on truck drivers may not be responsible for their crash involvement. This may be because education among truck drivers may not be a strong factor that can either avert or lead to a crash. It could be influenced by other factors, primarily culture and environment, especially in Nigeria, a multicultural nation. Our findings are inconsistent with de Sousa and Rossi^[23] and Mehdizadeh et al.^[18] that drivers' education influence RTCs. The disparity could be due to cultural influence on the truck drivers, which could be more likely to impact the driver's behaviour.

The importance-performance analysis further prioritizes the driving behaviour that may require urgent measures among the truck drivers based on the level of importance and performance. Of all the driving behaviours, driving violation need urgent measures to ensure safety and reduce truck drivers' road traffic crashes in Nigeria. This concurs with the study of Rezapour et al.^[7] that violation is a major influencing factor for truck drivers in RTC.

5. Conclusion

The study examined the influence of truck drivers driving behaviours and sociodemographic factors on their involvement in a road traffic crash. A structural equation model analysis revealed that risky driving behaviour (driving violation, driving errors, and inattention errors) influenced RTC positively, unlike their positive driving behaviour, which showed a negative influence. Truck drivers' age and driving experience are associated with RTC, while educational level had no significant relationship. Overall, driving violation requires urgent attention in order of importance and performance on RTC among truck drivers in Nigeria. This study focuses on truck drivers; other categories of drivers could be examined. The use of DBQ may not be free from some elements of bias. However, the anonymity assurance given to the respondents may have reduced the effect. Results from this study will aid transport decision makers, employers, and trainers in formulating training, decisions, and other key issues that are truck driver centred and can help address rising RTC through their driving behaviours.

Author contributions

Conceptualization, OAT; methodology, OAT and SAH; software, OAT; validation, OAT and SAH;

formal analysis, OAT; resources, RM; data curation, OAT; writing—original draft preparation, OAT; writing—review and editing, OAT and SAH; visualization, SAH and NM; supervision, RM; funding acquisition, RM. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare no conflict of interest.

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