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Analysis of road traffic accidents and implications for road safety: Evidence from a public transportation system in a non-Western Setting

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Abstract

Road traffic accident is a global public health concern that claims both lives and properties running into millions of dollars each year. However, within Africa, there are sparse studies that have examined the distribution of road crashes by type of road traffic accident, how the various types of accidents are related and their relations to risk-taking behaviour. This study sought to fill in those empirical gaps. A sample of 226 commercial vehicle drivers in Ghana were drawn for this study. Pearson correlation coefficient and multiple standard regression were used to analyse the data. Results showed that sideswipes when moving in the same or opposite directions, head/rear end collision and accident with animals were the commonest road traffic accidents. Again, accident with fixed object, sideswipe in opposite direction and collision with vehicle left on road were among the road traffic accident highly associated with high frequency of driver risk-taking behaviour. However, most of the risky driver behaviours were found not to directly contribute personal RTAs (RTAs involving the drivers themselves) but may create unsafe road environment. Contrary to the intuitive view that risky driver behaviours increased the risk of RTAs of a person involved in such behaviours, it is safe to say that the increased risk of RTAs appears to be an issue for other road users other than the person displaying the risky behaviours. These findings suggest that interventions to reduce road traffic accident in Ghana should target the most occurring road traffic accident through public safety education.

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Introduction

Movement of goods and services as well as people is a key driver of economic activities that generates the needed resources or income for governments to support their developmental projects. Road transportation is important in that it facilitates access to jobs, market, education, recreation, and healthcare (World Health Organization [WHO], 2009). However, the rise in road transportation has placed a considerable burden on the road users (drivers, pedestrians, cyclists, passengers, and a host of others) in terms of road traffic accidents (RTA), making RTA a global public health problem. WHO (2018) has documented that road traffic accidents were the eighth (8th) leading cause of death worldwide and projects it to be the fifth (5th) leading cause of death globally by 2030 (WHO, 2009). It is estimated that over 1.25 million deaths occur as a result of road traffic accidents each year while between 20 and 50 million non-fatal road traffic injuries occur annually worldwide (WHO, 2009, 2013a, 2015). Road traffic fatalities were estimated to be 1.35 million in 2016 (WHO, 2018).

RTA has been captured among the targets for Sustainable Development Goal 3 (Osborn et al., 2015; Stepping & Rippin, 2015). Two of the targets are relevant here, namely: *Goals 3.6* and *3.4.* The *Goal 3.6* requires governments around the world to halve deaths and injuries from RTAs by 2020 whereas the *Goal 3.4* enjoins governments to reduce by one-third pre-mature mortality from non-communicable diseases through prevention and treatment, and promote mental health and wellbeing (Osborn et al., 2015; Stepping & Rippin, 2015).

WHO (2009, 2018) reports that over 90% of global deaths due to road traffic accidents occur mostly in low and middle-income countries (LAMIC) even though these countries tend to have less than half of the world's registered vehicles. However, recent estimates suggest that RTA-related deaths in middle-income countries are thrice as high as in high-income countries (WHO, 2018). It has also been documented that nearly 62% of world's road traffic accidents occur in ten (10) countries, namely (in descending order): India, China, the USA, Russian Federation, Brazil, Iran, Mexico, Indonesia, South Africa and Egypt. On the other hand, the top ten (10) countries for fatal road traffic accidents include China, India, Nigeria, the USA, Pakistan, Indonesia, Russian Federation, Brazil, Egypt and Ethiopia. In addition, considering all continents, Africa is reported to have the highest fatality rate of road traffic accidents (WHO, 2013a, 2015, 2016, 2018).

Africa is said to be one of the least motorized regions in the world. Yet, it suffers the highest rates of road traffic accident and fatalities. WHO (2018) reports that the number of vehicles per 1000 persons in Africa stands at 46.6 yet has fatality rate of 26.6 per 100,000 as opposed to vehicle ownership rate of 510.3 vehicles per 1000 and fatality rate of 9.6 per 100,000 people in Europe. Some researchers, such as Tarimo (2012), have reported that road traffic mortality rate in LAMIC, including sub-Saharan Africa, is estimated to be approximately 20 per 100,000 compared to the estimated 10.3 per

100,000 in High Income Countries. In Kenya, for instance, road traffic accident accounts for between 45% and 60% of all admissions to surgical wards (WHO, 2009).

It is worth noting that Nigeria, Ethiopia, South Africa, and Sudan are reported to account for half the road injury death toll of sub-Saharan Africa (Bhalla et al., 2014). Pedestrians, cyclists, and passengers are also said to be the most vulnerable road users with a high risk of road traffic mortality (Bhalla et al., 2014; Tarimo, 2012). Bhalla et al. (2014) also estimate road traffic injuries to be the 7th and 13th leading cause of death in males and females respectively in sub-Saharan Africa. Sadly, young adults (aged between 15 and 44 years) have a higher share of deaths due to road traffic injuries; WHO (2013b) reports that this age group suffers 62% of all deaths due to road traffic accident.

Road traffic accident in Ghana

Ghana ranked 25th among 44 African countries on the road traffic deaths rates with 22 deaths per 100,000, placing Ghana among the countries with moderate road traffic deaths among sub-Saharan Africa; global and African regional averages were 18 per 100,000 and 24 per 100,000 respectively (WHO, 2013b). Ghana ranked below countries such as Burundi, Comoros, Kenya, DR Congo, Malawi, and Equatorial Guinea, among others. On the other hand, Ghana fared better than countries such as Nigeria, South Africa, Namibia, Lesotho, Uganda, among others, which even fared poorly against even the regional average (WHO, 2013b).

Total road traffic-related deaths/fatalities stood at 1,856 (year 2006), 2,043 (year 2007), 1,983 (year 2008), 1,237 (year 2009), 1,986 (year 2010) and 2,199 (year 2011) (Afukaar et al., 2008; Hesse & Ofosu, 2014; National Road Safety Authority [NRSA], 2010). Based on the 2014 statistics of 2058 road traffic related deaths in Ghana (Nyamuame et al., 2015), it can be estimated that there is an average of approximately 6 deaths daily in Ghana due to road accidents (by dividing the number of deaths by 365 days). The average incidence of the morbidity and mortality due to road traffic accidents from 1991 to 2011 in Ghana stood at 61.9 per 100,000 and 7.6 per 100 000 respectively (Hesse & Ofosu, 2014).

NRSA (2010) reports that an estimated 1,800 lives are lost in Ghana annually as a result of RTAs with 14,000 injuries from an average of 11,000 RTAs. NRSA (2010) also reports that RTAs cost Ghana 1.6% of her GDP or US$ 288 million in 2009 alone with 42% of the crash victims being pedestrians while 60% of all crash victims are people within the productive age group. Again, Akufaar et al. (2003) estimated out-of-pocket medical payments to be US$100.05 ± US$228.80 for each transport-related injury in urban Ghana compared to US$21.09 ± US$64.31 for each transport-related injury in rural Ghana.

RTA in Ghana is reported to vary by region, age, gender, day of the week and month of the year, type of road user and type of vehicle as well as rural versus urban settings. Between 2005 and 2014, the Greater Accra Region had the highest number of RTAs

followed by Eastern and Central Regions, though the Ashanti Region had the highest mortality and morbidity (Nyamuame et al., 2015). Ghanaian youth are the hardest hit with respect to road traffic accidents and related fatalities and injuries (Afukaar et al., 2003; Hesse & Ofosu, 2014). Thus, Ghanaian youth are most vulnerable to road traffic accident and have the highest risk of death due to road traffic accident.

Ghanaian males tend to be disproportionately involved in road traffic accidents compared to females. Males are noted to take more risk compared to females (Afukaar et al., 2003; Hesse & Ofosu, 2014; Oppong, 2015). Hesse and Ofosu (2014) documented that males accounted for 73.7% of all fatalities resulting from road traffic accidents whereas female fatalities stood at 26.3% during the same period. Afukaar et al. (2003) also found that males accounted for 73.1% and 68% of all fatalities and casualties during the 1994-1998 study periods. Similarly, using a dataset from 2001 to 2011, Amo and Meirmanov (2014) found that 60% and 40% of all road traffic fatalities occurred among males and females respectively.

Though no study has specifically examined level of education as a correlate of road traffic accidents in Ghana. Inferences can be drawn from a few studies. Damsere-Derry et al. (2014) reported that some formal education was associated with a reduced likelihood of drunk-driving relative to drivers without formal education. Further, Damsere-Derry et al. (2014) reported a significant positive relationship between drunk-driving and road traffic injuries. It can, therefore, be inferred that if drunk-driving leads to road traffic injuries and increasing age and some formal education reduces the likelihood for drunk-driving, then the latter are possible predictors of road traffic injuries. Oppong (2021) also has documented evidence to suggest that there is generally low comprehension of road warning signs among commercial vehicle drivers in Ghana.

Given the similarities between education and training (Buckley & Caple, 2006; Werner & DeSimone, 2006), it may also be deduced that drivers who receive formal professional training (from accredited driving schools as opposed to informal apprenticeship) have reduced likelihood for drunk-driving and, therefore, road traffic accidents. Consistent with this relationship, a qualitative study by Teye-Kwadjo et al. (2013) found that too little driver training and irregular acquisition of driver's license, among other factors, are key determinants of dangerous driving in the Manya Krobo District in the Eastern Region of Ghana. Further, Stephens and Ukpere (2011) also found in their Nigerian study that formal driver training and continuous professional development (post-qualification training) of drivers were associated with lower risk of road traffic accident involvement.

Generally, most of the road traffic accidents in Ghana tend to also occur in the month of November and December and largely on the weekend (Amo & Meirmanov, 2014; Hesse & Ofosu, 2014). In terms of the days, Hesse and Ofosu (2014) reported that the weekends (Saturday and Sunday) accounted for approximately 36.2% and 31.7% of all fatalities in 2010 and 2011 respectively. The trend of road traffic accident in Ghana is noted to also vary by the type of road user and type of vehicle. In particular, pedestrians, car occupants, bus as well as minibus occupants are more likely to be involved in road

traffic accidents than other road users (Afukaar et al., 2003; Amo & Meirmanov, 2014; Hesse & Ofosu, 2014).

However, what appears to have received less attention in the literature is the distribution of road crashes by the various types of road traffic accident in the Ghanaian context. Again, little is known about how the various types of road traffic accidents are related to one another. Similarly, the relationship between the types of road traffic accident and risk-taking behaviour has also received less attention. Therefore, the purpose of this study was to investigate the pattern and frequency of road traffic accidents as well as its relationship with risk-taking behaviour.

Methods

Research design and setting

A cross-sectional study design was employed in this study. This study was carried out among commercial vehicle drivers in the Accra Metropolis in the Greater Accra Region of the Republic of Ghana. These drivers were drawn from four bus terminals at (i) Tudu which is located at the Central Business District of the city of Accra (ii) Kaneshie, (iii) Circle and (iv) Madina. The participants were drawn in such a way that participants operated on inter-regional routes to and from the Capital City of Accra.

Participants and sampling

A cross-sectional survey was carried out comprising a convenience sample of 226 (94.17%) out of the targeted sample size of 240. Questionnaires were administered at bus terminals located at Tudu, Kaneshie, Circle and Madina in Accra, Ghana, with the support of research assistants. These bus terminals were purposively sampled because they serve drivers who ply inter-city and regional routes. The target population for the study was commercial vehicle drivers in Ghana, but the accessible population was commercial vehicle drivers operating in the Accra Metropolis. To ensure that the findings of the study would be generalizable to the target population, drivers operating on interregional routes from Accra to the nine regions at the time of the data collection in 2016 (Ghana now has 16 regions) were sampled. The drivers were all males and had driving experience between 1 and 45 years ($M = 14.76$, $SD = 8.97$). Most of the participants were at least 33 years (153 or 68.3%), had only Junior High/Middle School education (138 or 61.6%), identified themselves as Christians (206 or 92%) and operated a minibus (141 or 62.7%).

Procedure

To begin this study, ethics approval was obtained from the Ethics Committee for the Humanities at the University of Ghana, Legon. At each bus terminal, the drivers were recruited by means of convenience sampling guided by availability and willingness to

participate; the inclusion criteria were that the driver had a valid license and operated between Accra and another regional capital or a major city in the said region. As a result, six drivers were selected for each of the 10 regions; only drivers operating in the Accra Metropolis and its environs were selected for the Greater Accra Region. Thus, in all 60 drivers were recruited at each of the four bus terminals (thus, 24 drivers recruited for each of the 10 regions of Ghana at the time of the data collection). The questionnaire was translated into Akan language, the widely spoken language in Ghana (Agyekum, 2012; Guerini, 2007; Hamzat et al., 2009; Opoku-Amankwa, 2009) through translation and back translation by an Akan language specialist with training and experience in Akan linguistics. As a result, the questionnaire administration was largely done in the Akan language. Of the 240 questionnaires administered, fourteen (14 or 15.83%) were incomplete. For a detailed description of the design, sampling method, ethics approval process, and the data collection procedure used, consult Oppong (2018).

Measures

Road Traffic Accident Frequency (RTAF): A 14-item scale was used to measure road traffic accident frequency. This scale required respondents to indicate the frequency with which they had been involved in 14 different types of road traffic accident in the last 6 months. The scale made use of illustrations or sketches of the accident scenes. This scale was constructed based on the 14 types of road accident reported by Vogel and Bester (2005). In their study, Vogel and Bester (2005) obtained and analysed the road traffic accident database at the Provincial Administration of the Western Cape. This comprised 404 official accident reports filed by the traffic wardens or police following an accident. They reclassified 76 (18.8%) of the accidents and arrived at 14 different types of road traffic accident such as "Head/rear end collision", "Running into each other at right angle: both travelling straight", and "Head-on collision". The use of 6 months as the reference period is consistent with Veazie et al.'s (1994) recommendation that 6 months is the maximum time over which employees should be asked to recall injuries they have sustained with any accuracy. In this study, a visual arts professional sketched the 14 scenarios or scenes depicting each of the 14 types of accident initially created by Vogel and Bester (2005). This was done to ensure easy comprehension by the drivers and to minimize the need for verbal descriptions of the types of accidents in the questionnaire administration process, thereby introducing measurement error. Thus, the sketches helped to reduce the measurement error (see Figure 1 for a sample of the sketches used). A high score of the frequency component means that the respondent has been involved in more accidents over the last 6 month.

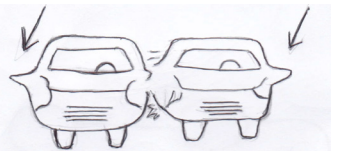
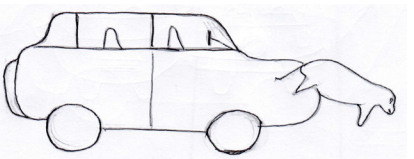
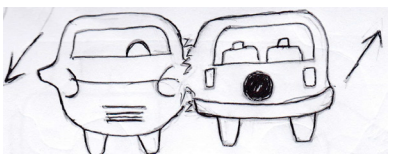
Situation	Sketch
Sideswipe: same direction	
Head/rear end collision	
Accident with animal	
Sideswipe: opposite directions	

Figure 1: A sample of sketches used to represent the Road Traffic Accidents

Risk-taking Behaviour: A 20-item scale was employed to measure the degree of frequency with which the participants engaged in behaviours constituting violations of the road traffic regulations and tenets of defensive driving. High scores on the scale imply more risk-taking behaviours were engaged in by the respondent. Respondents were required to employ the following rating scale to indicate their assessment of their employers' degree of compliance with the existing safety laws: *0 = Never, 1 = Occasionally, 2 = Frequently, and 3 = Always.* Sample items include the following: "Overtaking when prohibited", "Driving without regard for the other road users", and "Failing to stop when signalled by the Police/Traffic warden". This scale was constructed by the researcher through adaptation of the 10-item Traffic Law Violation Questionnaire (TLVQ) developed by Akaateba and Amoh-Gyimah (2013), the 6-item Traffic Accident Risk sub-scale (Cronbach's alpha of 0.806) of the Traffic Risk Perception Scale used by Nordfjærn (2006), and observation of in-traffic behaviour of drivers. As indicated earlier, Akaateba and Amoh-Gyimah (2013) reported a Cronbach's alpha of 0.757. In this study, a Cronbach's alpha of 0**.**89 was reported.

Data analyses

Data were analysed using SPSS v.20. Descriptive statistics was first computed to estimate frequencies with which the participants were involved in RTA as well as to explore the relationships between RTAs and risky driver behaviours. Multiple regression analysis was also performed to estimate the relative influence of risky driver behaviour on RTAs. To increase the confidence in the findings, bootstrapping approach based on 5000 bootstrap samples was utilized. All tests conducted were two-tailed and held statistical significance at $p < .05$.

Results

Frequency of drivers' involvement in RTAs

Descriptive statistics was computed from the data obtained. The frequency of RTAs reported ranged between 0 and 63 with a total of 444 RTAs over the six-month period and a mean of 2.00 RTAs per driver ($SD = 5.16$) or 1.96 RTAs per day over the period. Table 1 presents the frequency with which the drivers reported they have been involved in accidents. Nearly 50% reported that they have not been involved in any accident with one driver reporting having been involved in RTAs 63 times over the period. Again, ten (10) drivers were responsible for 179 RTAs over the period, representing 40.32% of the total number of RTAs reported by the 226 drivers in the period.

Table 1: Frequency of drivers reporting the number of times they have been involved in RTAs

Number of RTAs over the period	Frequency	Percentage
0	112	49.56
1	40	17.70
2	22	9.73
3	16	7.08
4	7	3.10
5	9	3.98
6	10	4.42
7	2	0.88
9	1	0.44
10	1	0.44
11	1	0.44
12	1	0.44
16	1	0.44
17	1	0.44
27	1	0.44
63	1	0.44
Total	226	100.00

The frequency of road traffic accidents reported by the participants are presented in Figure 2. According to the results, most occurring RTA were sideswipes (when moving in the same direction), head/rear end collision, accident with animals, and sideswipes (when moving in opposite direction). The least reported incidence were accident with pedestrians, single vehicle overturned, and accident resulting from vehicles approaching at an angle (one or both turning).

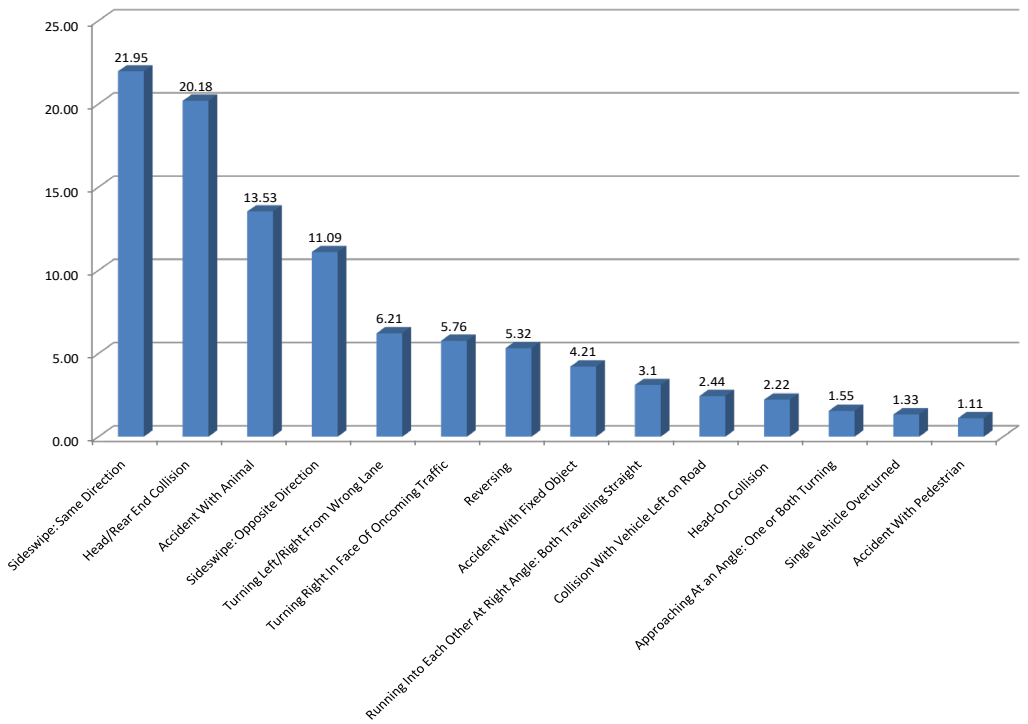


Figure 2: Bar graph distribution of Road Traffic Accidents

Intercorrelations among the Types of RTA Frequency and Risk-Taking Behaviours (RTB)

The intercorrelations among the various types of RTAs and the risk-taking behaviour are presented in Table 2. It was found that total frequency of RTAs was not significantly related to driver risk-taking behaviour ($r = 0.10$, $p > 0.05$). The results further showed that all but RTAs involving single vehicle overturning ($r = 0.06$, $p < 0.05$), running into each other at right angle when both are travelling straight ($r = 0.11$, $p < 0.05$), turning right in the face of oncoming traffic ($r = 0.13$, $p < 0.05$) and approaching at an angle where one or both are turning ($r = 0.08$, $p < 0.05$) were significantly related to the overall

RTA. This means that the involvement in the ten (10) other RTAs increases the total number of RTAs that the person is likely to be involved.

It was also found that involvement in head/rear end collision was positively associated with involvement in sideswipes moving the same direction ($r = .78$, $p < 0.01$), accident with pedestrians ($r = 0.34$, $p < 0.01$), sideswipes moving in the opposite direction ($r = 0.13$, $p < 0.05$), and reversing ($r = 0.78$, $p < 0.01$). Similarly, involvement in sideswipes moving in the same direction was positively correlated accident with pedestrians ($r = 0.40$, $p < 0.01$), sideswipes moving in the opposite direction ($r = 0.40$, $p < 0.01$), collision with vehicle left on the road ($r = 0.17$, $p< 0.01$), head-on collision ($r = 0.29$, $p < 0.01$), and reversing ($r = 0.83$, $p < 0.01$). Accident with animals was also found to be positively correlated with RTA involving a single vehicle overturning ($r = 0.23$, $p < 0.01$). Together, these findings suggest that drivers who are involved in head/rear end collisions, sideswipes (same direction), and accident with animals are also more likely to be involved in other types of RTAs. It is also worth noting that though sideswipes (when moving in the same direction), head/rear end collision, accident with animals, and sideswipes (when moving in opposite direction) had the highest frequency of occurrence, the other types of RTAs should be of concern as well.

It was also found that risk-taking behaviour was positively correlated with accident with fixed object ($r = 0.22$, $p < 0.01$), sideswipe when moving in opposite direction ($r = 0.17$, $p < 0.05$), running into another vehicle at right angle when both are travelling straight ($r = 0.16$, $p < 0.05$), collusion with vehicle left on road ($r = 0.30$, $p < 0.01$), and turning left/right from wrong lane ($r = 0.23$, $p < 0.01$). These findings show that engaging in more risk-taking behaviours increases one's odds of being involved in these types of RTAs. However, these findings also suggest that with the exception of these types of RTAs that correlated positively with risk-taking behaviours, involvement in all the other types of RTA may not be dependent on engaging in risk-taking behaviour. The results suggest that one can, for instance, be involved in sideswipes, accident with pedestrian and head-on collision through no fault of the driver. The implication is that defensive driving and alertness are critical for ensuring safety on roads. This also suggests human error matters in the control of RTA.

Table 2: The relationship among the various types of RTAs and RTB

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Head/rear end collision															
2	Sideswipe: same direction	.78**														
3	Accident with pedestrian	.33**	.398**													
4	Accident with fixed object	.03	.05	-.04												
5	Single vehicle overturned	.03	-.02	-.03	.04											
6	Sideswipe: opposite direction	.13*	.40**	.03	.12	-.04										
7	Collision with vehicle left on road	.05	.17**	-.03	.17*	-.03	.449**									
8	Running into each other at right angle: both travelling straight	-.02	.00	-.03	.09	.16*	.13*	.27**								
9	Accident with animal	.09	.02	-.01	.09	.23**	.06	.02	-.04							
10	Turning right in face of oncoming traffic	-.03	.07	-.04	.06	.02	.05	-.05	-.02	.01						
11	Head-on collision	.12	.29**	-.02	.08	-.02	.00	-.02	.02	-.01	.11					
12	Turning left/right from wrong lane	.00	.03	.02	.34**	-.04	.15*	.25**	.18**	-.02	.08	.07				
13	Reversing	.78**	.83**	.44**	.07	.01	.21**	.02	.06	.07	.00	.05	.09			
14	Approaching at an angle: one or both turning	.09	.02	-.02	-.03	-.02	.03	-.02	-.02	-.04	-.03	-.01	-.03	-.02		
15	RTA	.83**	.93**	.38**	.18**	.06	.48**	.26**	.11	.21**	.13	.26**	.20**	.84**	.08	
16	RTB	.04	.00	.01	.22**	-.08	.17*	.30**	.16*	-.01	-.05	.04	.23**	-.02	.13	.10

Note:
RTA = Total frequency of Road Traffic Accident; RTB = Risk-taking behaviour
*$p < 0.05$; ** $p < 0.01$; n = 226

Relative Influence of Types of RTB on RTA Frequency

Additional analyses were performed to assess the relative influence of 20 risky driver behaviours on the frequency of RTA by means of multiple regression using the Bias Corrected and accelerated (BCa) option of bootstrapping method with 5000 samples. These risk factors make up the risk-taking behaviour scale. Table 3 presents the results of the multiple regression analysis. Results of the multiple regression analysis reveal that the model did not produce a good fit, $R^2 = 0.045$, $F\,(20, 183) = .436$, $p > .05$. However, only "Turning right while signalling left" $(B = 2.196, p < 0.001)$ did show a significant influence on the frequency of RTAs. Interestingly, it is suggestive that the rest of the risk factors do not directly contribute to the occurrence of accidents. However, bootstrapping-based analysis using 5000 samples provides one of the strongest signals there is as to what can be expected in other studies.

Table 3: Multiple Regression Assessing Impact of Risky Driver Behaviour on RTAs

Risk Factor/Risky driver behaviour	B	BCa Bootstrap[a]			
		Bias	SE B	95% Confidence Interval	
				Lower	Upper
Overtaking when prohibited	-0.002	.028[b]	.346	-.844	.708
Using the mobile phone when driving	-0.768	-.052[b]	.473	-1.737	.002
Failing to comply with a traffic light signal	-0.071	.006[b]	.432	-.688	.768
Getting off the road to bypass a traffic jam	0.128	.071[b]	.522	-.925	1.505
Driving too close to the car in front	0.334	.056[b]	.503	-.686	1.562
Not stopping at pedestrian crossing when pedestrians are waiting to cross	-0.256	.123[b]	1.046	-2.294	2.182
Driving under the influence of alcohol	2.24	.764[b]	3.007	-.827	18.544
Stopping at undesignated areas to pick passengers	0.254	-.106[b]	.759	-.974	1.382
Exceeding the speed limit	0.101	.007[b]	.436	-.669	1.036
Failing to wear the seat belt	-0.074	-.070[b]	.604	-1.297	.869
Looking elsewhere while driving	0.757	-.064[b]	.634	-.234	1.765
Driving without regard for the other road users	0.09	-.022[b]	.828	-1.826	1.631
Poor anticipation of moves by other road users	0.885	.039[b]	.499	-.106	1.987
Parking at undesignated places	0.283	-.078[b]	.684	-.950	1.393
Not signalling before making a turn	-1.397	-.037[b]	1.264	-4.159	.938
Angry with passengers while driving them on board one's vehicle	-0.477	.037[b]	.391	-1.422	.375b
Failing to stop when signaled by the Police/Traffic warden	0.479	-.013[b]	1.047	-1.197	2.491
Changing lanes without signaling	-0.806	.007[b]	1.450	-4.688	1.944
Turning left while signalling right	-1.942	.082[b]	1.860	-5.622[b,c]	1.663
Turning right while signalling left	2.196	.017[b]	.293*	1.649	2.800
R^2		.045			
F		.436			

*p< 0.001

[a] Unless otherwise noted, bootstrap results are based on 5000 bootstrap samples; [b] Based on 3114 samples; [c] Some results could not be computed from jackknife samples, so this confidence interval is computed by the percentile method rather than the BCa method.

Discussion

Results of the analysis on the frequency of road traffic accident indicate that nearly half of the drivers had not been involved in any form of RTA while 10 drivers produced almost 40% of all the RTAs recorded. This appears to say that accident is a low frequency event (Oppong, 2011) and that there may be some drivers who are accident-prone.

It was also found that most occurring RTA were sideswipes (when moving in the same direction), head/rear end collision, accident with animals, and sideswipes (when moving in opposite direction). The nature of these accidents suggests a plethora of causes or risk factors. Taken together, this suggests that the following are potential risk factors: non-enforcement of local government bye-laws which outlaw rearing of domestic animals within urban settlements, poor road infrastructure, impaired attention, poor adjustment of side or driving mirrors (leading to the widening of the driver blind spot or reduction of the visual fields by the sides of the vehicle), impatience of drivers, speeding, and heavy vehicular traffic on Ghanaian roads, particularly in the urban centres. However, it is difficult to know which ones are the common causes of these types of accidents. Such effort will require access to a comprehensive dataset (possibly from Motor Traffic and Transport Department of Ghana Police Service and National Road Safety Authority) in which accidents are recorded with identified causes. This is an exercise beyond the current study.

However, it is possible to speculate that the frequency of sideswipes and head/rear end collisions suggests that (1) heavy vehicular traffic build-ups, (2) impaired attention, (3) impatience, (4) narrow lanes, (5) cutting in wrongfully, (6) tailgating, (7) speeding, and (8) poor adjustment of driving mirrors as potential risk factors or causes. Impatience of drivers during heavy vehicular traffic build-ups may also be implicated. It is important to note that impaired attention could be due to any of the following: distractions (often the fault of the driver for looking at attractions by the roadside instead of concentrating on the driving), fatigue, drunk driving, use of mobile phones while driving, and use of prescribed medication that may impair attention. That speeding, impaired attention (resulting from fatigue and drunk driving) and tailgating may be associated with the types of road traffic accident is consistent with extant literature (Damsere-Derry et al., 2014; Nyamuame et al., 2015). Nyamuame et al. (2015) found over speeding, overloading, wrongful overtaking, and fatigue driving as among the top five causes of road traffic accidents whereas Damsere-Derry et al. (2014) found drunk driving as a cause of road traffic crashes. Indeed, these are risk-taking behaviours and the evidence from this study that risk-taking behaviour influences road traffic accident through perceived risk exposure is additional evidence that over speeding, overloading, wrongful overtaking, and fatigue driving (being driver risk-taking behaviours) have the potential to result in increased frequency of sideswipes and head/rear end collisions.

Tailgating involves keeping an unsafe distance between one's vehicle and the other vehicle in front, usually less than 350cm (3.5m) or 11.48ft (Monteiro et al., 2015).

Indeed, combined with other factors such as impatience, faulty brakes, heavy vehicular traffic build-ups, and impaired attention, tailgating will almost always result in head/rear end collisions. It is equally possible that the aforementioned factors may compel the driver to even tailgate. For instance, impaired attention resulting from the use of mobile phone or distractions may result in a driver driving too close to the vehicle in front without realizing. Similarly, heavy vehicular traffic build-ups can make a driver drive too close to the vehicle in front in order to prevent other drivers from cutting in at the least opportunity. In their study among Batswana drivers, Monteiro et al. (2015) found no significant differences among private vehicle drivers, commercial vehicle drivers, government, and corporate vehicle drivers.

The least reported accidents were accident with pedestrians, single vehicle overturned, and accident resulting from vehicles approaching at an angle (one or both turning). That accident with pedestrians is the least reported among all the accidents is, however, inconsistent with the finding reported by National Road Safety Authority (NRSA, 2010) that 42% of all road traffic accident victims are pedestrians as opposed to the finding in this study that accidents involving hitting pedestrians constituted only 1% of all the accidents reported.

It was also found that not every type of RTA occurs due to engagement in risk-taking behaviour. Specifically, with the exception of accident with fixed object, sideswipe (opposite direction), running into another vehicle at right angle when both are travelling straight, collision with vehicle left on road, and turning left/right from wrong lane, all the other types of RTAs were found to occur without a driver engaging in more risk-taking behaviour. This finding is worrying given the fact that it shows one can get involved in RTA without being at fault. However, this current finding is consistent with results of Clarke's (2006, 2010) study. In a meta-analytic study, Clarke (2006, 2010) reported that safety participation has greater impact on occupational accidents and injuries than safety compliance.

Safety participation and safety compliance are two forms of safety behaviour. Safety compliance results in safe environment for both the one who adheres to safety rules and others in their immediate environment (Clarke, 2006, 2010; Oppong, 2011). This means that when a driver creates unsafe conditions on the road through his or her unsafe actions, it increases the odds of another driver becoming involved in RTAs. There is a need to continue public driver education to encourage all drivers to engage in safe behaviours, which will minimize the likelihood of RTA. Thus, without all drivers engaging in safe behaviours, the road will never be safe for any driver regardless of the person's actual risk-taking behaviour. It also means that most RTAs or accidents in general are due to human error but specifically due to the errors committed by others.

Further analyses showed that only "Turning right while signalling left" had a significant effect on the frequency of RTAs; all the other risky behaviours failed to show similar relationships with RTAs. This result is consistent with the finding reported in Table 2 in

which overall risk-taking behaviour did not correlate significantly with RTA frequency. Though it is not clear why they showed such an expected relationship, it is possible to speculate that there may be a mediator accounting for why risk-taking behaviour (or human factors) seems to account for most accident (Vogel & Bester, 2005). Thus, this result may be consistent with the current literature that seems to suggest that safety participation has greater impact on occurrence of accident than complying with safety regulations (Clarke, 2006, 2010; Oppong, 2011). This signifies that engaging less in these risky driver behaviours may be some form of safety participation as these are "behaviours that do not directly contribute to an individual's personal safety, but which do help to create an environment that supports safety" (Oppong, 2011, p.22).

Implications for promoting road safety

United Nations Economic Commission for Europe (UNECE, 2008) has presented a *three-dimensional road safety matrix* (comprising road and emergency service infrastructure, vehicles and human dimensions) that offers a systemic approach to road safety management. It was suggested that the commonly occurring road traffic accidents were more likely to be the results of (1) heavy vehicular traffic build-ups, (2) impaired attention, (3) impatience, (4) narrow lanes, (5) cutting in wrongfully, (6) tailgating, (7) speeding, and (8) poor adjustment of driving mirrors. This suggests that lanes should be expanded and marked well all the time (road infrastructure). In addition, public safety education targeting all road users can help address issues relating to impaired attention, vehicular traffic build-ups (by getting traffic wardens to respond quickly to manage spots of vehicular traffic build-ups and repairing the malfunctioning traffic lights), tailgating, speeding, cutting in wrongly, and poor adjustment of driving mirrors (in order to narrow their blind spots and widen their visual fields when driving). These latter concerns relate to the human dimension of the UNECE three-dimensional road safety matrix.

It was also suggested that impaired attention could result from distractions (often the fault of the driver for looking at attractions by the roadside instead of concentrating on the driving), fatigue, drunk driving, use of mobile phones while driving, and use of prescribed medication that may impair attention. Preventive rather than punitive law enforcement will also help address the concerns associated with fatigue, drunk driving, use of mobile phones while driving, and use of prescribed medication. For instance, the law enforcement officers should be able to stop drunk drivers, keep their vehicles at their stations and get them a means of transport to their destination, if possible or get them to rest before such drivers are allowed to continue their journey.

This implies that interventions to reduce road traffic accident in Ghana should target the most occurring road traffic accident through public safety education. These include sideswipes when moving in the same or opposite directions, head/rear end collision, and accident with animals. Even though accident with fixed object, sideswipe in opposite direction and collision with vehicle left on road were not among the most occurring

road traffic accidents, their frequency tends to increase with high frequency of driver risk-taking behaviour. Thus, interventions aimed at encouraging and inducing safe driver behaviours will help to reduce road traffic accident in general.

The finding that only "Turning right while signalling left" may represent the specific case of safety compliance as it directly contributes to the occurrence of accident would also explain why drivers consistently engage in other risky behaviours. As has been found, the other risky behaviours are cases of safety participation which implies failure to engage less in these behaviours would not result in personal accidents. This then makes safety education difficult as organizers of such events are almost always asking drivers to do less of the things; they know from experience that they do not result in personal accident but will generally create safe road environment for other users. It is, therefore, important that public road safety campaigns shift focus from presenting risky driver behaviours as direct causes of RTA to presenting them as contributing generally to unsafe road conditions and also increasing their personal vulnerability to RTAs (risk exposure). This may have the potential of giving the commercial vehicle drivers a new rationale for observing safety behaviours that may not directly contribute to their personal safety.

Direction for future research

Future studies should attempt to obtain comprehensive datasets (possibly from Motor Traffic and Transport Department of Ghana Police Service and National Road Safety Authority) in which accidents are recorded with identified causes. Analysis of these datasets will help identify the reported or recorded causes of road traffic accident. However, distinction needs to be made between what constitutes a 'cause' and a 'risk factor'. Given that a number of the so-called causes of road traffic accident only increases the likelihood of occurrence of accident, it is difficult to simply consider them as causes. Future research should help delineate these concepts neatly as they relate to road safety research. Again, future studies could make use of animation to present the accident situations instead of presenting them as sketches as done in this study. It has been found that some of the several of the risky driver behaviours represent cases of safety participation. As a result, it is important to conduct further research to identify behaviours that represent cases of safety compliance that may be included in public road safety education.

Conclusion

This study provides preliminary evidence that there is a need to unpack the RTBs to really understand its relative influence on RTA. This will pave the way for designing and implementing effective interventions to control the occurrence of RTA in Ghana and elsewhere. Further studies are needed to consolidate these findings and to also explore other related domains which have received less research attention in the road transportation safety.

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