Referral conditions for severe road traffic injuries and their influence on the occurrence of hospital deaths in Benin

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Abstract

Road traffic accidents are the leading cause of death by trauma. Delays in in first aid due, inter alia, to the long time to transfer traffic accident victims to hospital and the lack of pre-hospital emergency care, contribute to the increase in hospital mortality. This study aims to analyse the referral conditions for severe road traffic injuries and to assess their effect on the occurrence of hospital deaths in Benin. This is an analytical prospective cohort study conducted in road accident victims with a severe injury. Four groups of factors were studied: referral conditions, sociodemographic and victim-specific characteristics, factors related to the accident environment, and factors related to health services. A top-down binary stepwise logistic regression was the basis for the analyses. Nine point eight percent of severe trauma patients died after hospital admission (7.0-13.5). Associated factors were referral time greater than 1 hour (RR=5.7 [1.5-20.9]), transport to hospital by ambulance (RR=4.8 [1.3-17.3]) and by the police or fire department (RR=7.4 [1.8-29.7]), not wearing protective equipment (RR=4.5 [1.4-15.0]), head injuries (RR=34.8 [8.7-139.6]), and no upper extremity injuries (RR=20.1 [2.3-177.1]). To reduce the risk of hospital death in severe road traffic injuries, it is important to ensure rapid and medicalized referral of severe trauma patients in Benin.

Introduction

Road traffic accidents are the leading cause of trauma seen in hospitals in several African countries.[1,2] They are the leading cause of death by trauma,[3,4] but their in-hospital mortality varies from country to country, ranging from 0.6% to 17.5%.[2,5-9] In Benin, these accidents represent about one third of all traumas.[10]

In low-income countries, the organization of referral and pre-hospital care is still insufficient, which means that very few trauma patients transported to emergency departments receive pre-hospital care.[4,11-13] This is compounded by the limited resources of the injured to meet the costs of care, which affects both the time to care and the quality of care, resulting in complications or death.[14,15] Delays in first aid, due to prolonged delays in transferring patients to hospital or lack of pre-hospital emergency care, have contributed to the increase in-hospital mortality .[3,4,16-18] Several other factors contribute to in-hospital trauma deaths including trauma severity score,[3,9,18,19] low systolic blood pressure on admission,[8,9] Glasgow Coma Scale,[8,9,20] head injuries,[21] intracerebral haemorrhage,[20] presence of multiple trauma injuries[18] and patient age.[8,9,18,20] Non-use of safety equipment, such as helmets, seat belts and airbags,[16,18,22,23] speeding,[24] driving under the influence of alcohol or any psychoactive substance,[21,25,26] means of travel used, and position in the car were found to be factors associated with severity and mortality in trauma patients.[16,20,21] In Benin, in-hospital mortality among these trauma patients is poorly documented, especially for trauma patients with severe injuries who are at greater risk of death. Identification of the factors associated with the occurrence of these deaths would contribute to improving the management system. This study aims to analyse the referral conditions for severe road traffic injuries and to assess their effect on the occurrence of hospital deaths in Benin.

Materials and Methods

Ethical considerations

This study is part of a doctoral thesis. The thesis project is submitted to the ethics committee of the University of Parakou in Benin (Ref 0180/CLERB-UP/P/SP/R/SA of July 04, 2019). The free and informed written consent of all subjects included in the study was obtained. All patients are recruited after a written informed consent. Data was treated confidentially.

Type of study and population

This is a prospective cohort study. The target population is 336 severe road traffic injuries with a Maximum Abbreviated Injury Score (MAIS≥3) selected from a cohort of road accident victims named the TraumAR cohort. It was constituted by recruiting patients in five hospitals (two in the north and three in the south of Benin).

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Availability of data and materials: All data generated or analyzed during this study are included in this published article.

Ethics approval and consent to participate: The free and informed written consent of all subjects included in the study was obtained. All patients are recruited after a written informed consent. Data was treated confidentially.

Informed consent: The manuscript does not contain any individual person's data in any form.

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Recruitment took place from July 01, 2019 to January 31, 2020. Each patient enrolled was subjected to a questionnaire, allowing prospective collection of data on general information, risk factors for accidents, severity factors, clinical, paraclinical and therapeutic details, follow-up information and their progress. The severity of lesions was assessed with the AIS score using the AIS 2005 dictionary updated in 2008.[27] The description of the lesions provided in the TraumAR database was used to determine the AIS. Subjects included in this study were those with motor vehicle accident trauma enrolled in the TraumAR cohort who had a MAIS≥3. Subjects were subsequently classified according to their referral times. Excluded from this study were subjects with MAIS≥3 for whom information concerning death after arrival at the hospital or the referral time was not provided.

Methodology

From the TraumAR database, successive filters selected all subjects meeting the inclusion criteria (Figure 1). Non-consenting subjects, subjects with a MAIS less than three or not filled in, and observations that did not include details of living or dead status were successively removed.

Study variables

The dependent variable was outcome (deceased or not). This was the condition of the trauma patient at hospital discharge or at the end of the cohort set-up for those still in hospital. The independent variables consisted of four groups: i) referral conditions (referral time, mode of transport to hospital, care during transfer); ii) sociodemographic and specific characteristics of the victim (age, sex, marital status, employment status, possession of health insurance, sources of funding for care, type of user, position on the motorcycle or in the car, wearing of protective equipment, number and location of injuries); iii) factors related to the accident environment (time of day, type of road, weather conditions, road conditions); iv) factors related to the health services (hospital of enrolment, entry service, qualification of the health worker, immediate first aid).

Data processing and analysis

Stata 15 software was used for data processing and analysis. Potential risk factors with missing values exceeding 20% of all observations in this study (body mass index, industry, total cost of care) were eliminated. The referral time was calculated from the dates and times of the accident and of first contact with the nursing staff at the hospital.

The Chi-square statistical test or Fisher's exact test was used for comparison of proportions. Due to the distribution of quantitative variables, non-parametric tests (Kruskal-Wallis test) were used for comparisons of means. Interactions between some variables were sought by referring to literature data (wearing protective equipment and head injuries, referral time and mode of transport). A sensitivity analysis of the referral time was performed.

Modelling was done to assess the association between the independent variables and the dependent variable using a binary logistic regression. The option chosen was a top-down stepwise explanatory model. The variables entered into the initial multiple model were those with a p-value≤0.1 on univariate analysis between the dependent variable and the independent variables. In the final model, collinearity between variables was sought. The adequacy of the final model was checked with the Hosmer-Lemeshow test as well as its specification (linktest). The model was adequate with a p-value>0.05.

Results

Among the severe trauma patients, 9.8% died after hospital admission. All deaths occurred within 0 to 24 days of hospital arrival with a median survival time of 1.2 days (0.4-4.1).

Referral conditions and death

The median time to referral was longer in deceased subjects at 3.0 hours (1.2-36.2) compared with 1.3 hours (0.8-3.8) in non-deceased subjects. An analysis of the sensitivity of the referral time shows that when the referral time increased, the risk of death also increased. Indeed, for the different time classes, subjects who were referred earlier were less likely to die. However, the proportion of deaths was lowest in the first hour (Figure 2). Severe trauma patients who arrived at the hospital within the first hour after the accident represented 37.8% of the

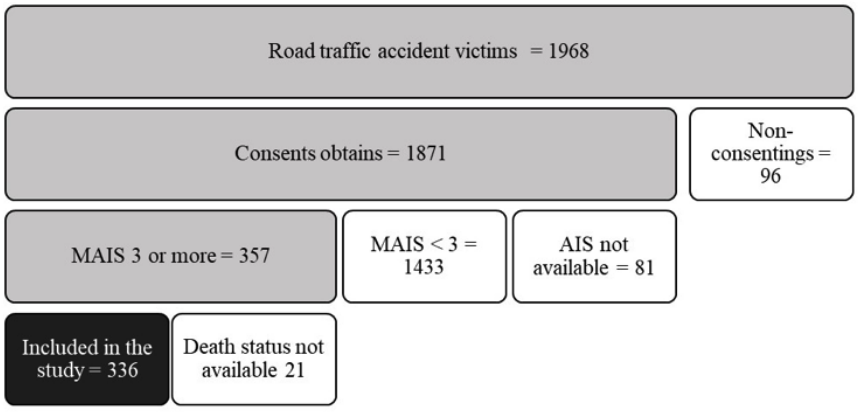

Figure 1. Selection process for subjects in the TraumAR database (non-eligible records have a white background.

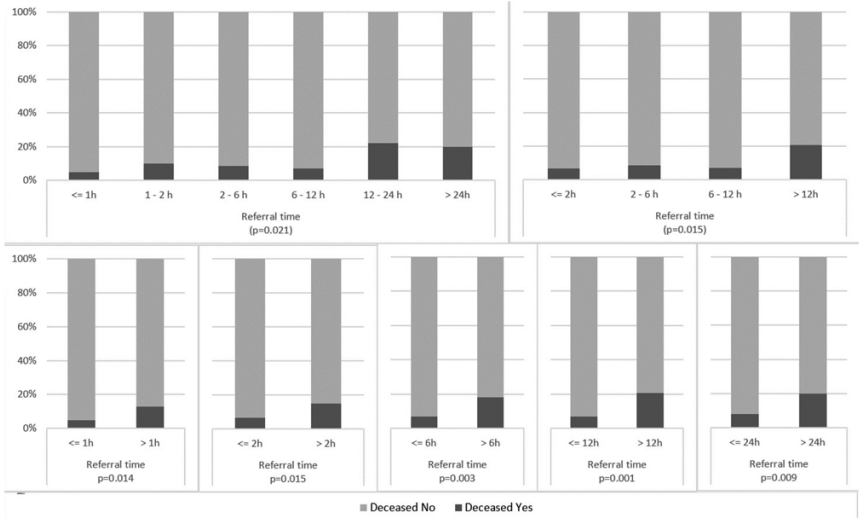

Figure 2. Occurrence of deaths according to referral times.

total. The fire department or the police provided transport to the hospital for 45.6% of the severe trauma patients. The median referral time was longer for those referred by ambulance at 3.0 hours (1.4-23.9) compared with 1.0 hour (0.6-1.7) for those transported by the fire department or police and 1.7 hours (0.9-21.3) for those transported by other means. It was observed that only 17.7% of the subjects referred by ambulance reached the hospital within the first hour, compared with 63.2% for those transported by the fire department and 27.2% for the others. More subjects referred by ambulance died in hospital than those transported by the fire department, the police or by other means.

Of the severe trauma patients seen at the hospital, only 12.0% received care during transport to the hospital. Subjects referred by ambulance received more care (19.1%) than those referred by the fire department or police (10.7%) and by other modes of transport (11.7%), but the difference was not significant. On univariate analysis, referral time and mode of transport to hospital were associated with the occurrence of in-hospital death (Table 1).

Sociodemographic and specific characteristics of the victim

Table 2 shows that 77.7% of the severe trauma victims were male, *i.e.*, a sex ratio of 3.5 males to 1 female. Young people under 25 years of age represented 27.4% of these severe trauma victims, among whom 63.1% were married and 73.8% had a job or professional activity. Only 10.4% of the subjects had health insurance. The patients or their family covered the expenses for hospital care in 69.4% of cases. No sociodemographic variable was associated with the occurrence of death in severe trauma patients.

Two-wheelers were predominant (68.4%). Among all serious injuries, 25.9% were pedestrians and 52.6% were drivers. Thirty-three percent of casualties were non-pedestrians not wearing protective equipment, *i.e.* helmet or seat belt. The number of injuries ranged from 0 to 9 with a single injury in about 57.4% of the subjects. Injuries to the lower limbs were the most frequent (72.9%), followed by injuries to the head and/or face (36.0%), and then to the upper limbs (20.2%). In univariate analysis, injuries to the head and face, spine, lower limbs and upper limbs were associated with death.

Factors related to the environment

The accident occurred during the day for 53.3% of the serious trauma victims. The weather conditions were considered good by 91.2% of the injured. Accidents that occurred on roads in good condition accounted for 80.2% of cases. These factors did not influence the occurrence of death in these subjects with severe trauma (Table 3).

Factors related to health services

The CHUDO received 48.5% of the severe trauma patients and the emergency services 89.2%. Care was judged rapid on arrival at the hospital by 95.2% of the subjects and was provided by a general practitioner in 37.5%. The qualification of the health worker who performed first aid on the patient in hospital was associated with the occurrence of death (Table 3).

Factors associated with death

Factors associated with the occurrence of death in severe trauma patients in the final model were time to referral, mode of transport to hospital, not wearing protective equipment, head injury, and no upper extremity injury (Table 4). Taking into account the wearing of protective equipment, mode of transport to the hospital, and site of injury, subjects referred to the hospital more than 1 hour after the accident were 5.7 times more likely to die than those referred within 1 hour. Taking into account other variables, subjects referred by ambulance were 4.8 times more likely to die than those referred by relatives or witnesses of the accident. Those referred to a hospital by the police or fire department were 7.4 times more likely to die. When adjusting for mode of transport to hospital, time to referral, and head and upper limb injuries, subjects without protective equipment were 4.5 times more likely to die from their accident than those with protective equipment. Controlling for other variables, subjects with head injuries were 34.8 times more likely to die in hospital than those without head injuries. Subjects with upper extremity injuries were less likely to die.

Discussion

The proportion of in-hospital deaths in our study exceeds the 8.1% observed in the Netherlands[20] and the 1.4% to 7.4% reported in Guinea, Tanzania, Nigeria, Ethiopia and Rwanda.[1,5-8] These differences may be because most of these studies were not restricted to severe trauma patients. The results of our study contrast with routine data from Benin because the 2019 National Health Statistics Yearbook[10] did not report any hospital deaths by road traffic accidents. The reporting system for hospital deaths due to road traffic accidents is not sufficient to capture and track these deaths after admission to hospital, nor does it give a view of the magnitude of the problem or allow for adequate decision-making. The health system should review its collection tools and the training of those involved in order to improve the quality and completeness of routine collection.

Deaths among road accident victims occurred within an average of 3.4 days. Timeliness and quality of care are therefore important in reducing these deaths and involve short referral times, administration of adequate emergency care, medical transfer to hospital, and availability of trained

Table 1. Referral conditions and occurrence of in-hospital deaths among severe trauma patients enrolled in the TraumAR cohort in univariate analysis, Benin, 2020.

Variables	Total number	% or Mean (ET) or Med(Q1 – Q3)	Deceased N (%)	RR (95% CI)	p-value
Referral time		1.4 (0.8 - 5.4)			0.014
One hour or less	127	37.8	6 (4.7)	1	
More than one hour	209	62.2	27 (12.9)	3.0 (1.2–7.5)	
Mode of transport to hospital					0.036
Ambulance	68	20.5	12 (17.7)	3.2 (1.2–8.6)	
Fire department or police	151	45.6	13 (8.6)	1.4 (0.5–3.7)	
Others (relatives or witnesses)	112	33.8	7 (6.3)	1	
Care during transfer					0.241
Yes	42	12.7	6 (14.3)	1.8 (0.7–4.6)	
No	289	87.3	25 (8.6)	1	

personnel to administer first aid.

Sensitivity analysis of the referral time noted that this variable was always associated with the occurrence of death. The categorization into "one hour or less" and "more than one hour" was retained because we believe that severe trauma patients should be referred as soon as possible. The proportion of subjects referred within the first hour after the accident was 37.8%. A similar observation was made in Nigeria, where 48.2% of victims reached the emer-

Table 2. Sociodemographic and specific characteristics of the victim and occurrence of in-hospital deaths among severe trauma patients enrolled in the TraumAR cohort in univariate analysis, Benin, 2020.

Variables	Total number	% or Mean (ET) or Med(Q1 – Q3)	Deceased N (%)	RR (95% CI)	p-value
Sex				0.138	
Female	75	22.3	4 (5.3)	1	
Male	261	77.7	29(11.1)	2.2 (0.7–6.5)	
Age				0.423	
<25 years	92	27.4	9 (9.8)	1.6 (0.5–5.6)	
25-34 years	65	19.3	4 (6.2)	1	
35-44 years	86	25.6	12 (14.0)	2.5 (0.8–8.1)	
45 years and more	93	27.7	8 (8.6)	1.4 (0.4–5.0)	
Marital status					0.227
Single	103	32.2	10 (9.7)	1.3 (0.5–2.9)	
Married	202	63.1	16 (7.9)	2.9 (0.7–11.4)	
Divorced	15	4.7	3 (20.0)	1	
Employment status					0.805
Unemployed	24	7.3	3 (12.5)	1.6 (0.4–7.4)	
Employed	242	73.8	23 (9.5)	1.2 (0.4–3.3)	
In training	62	18.9	5 (8.1)	1	
Possession of health insurance					0.169
Yes	34	10.4	1 (2.9)	1	
No	293	89.6	30 (10.2)	3.8 (0.5–28.5)	
Sources of funding for care					0.727
Own or family funds	218	69.4	19 (8.7)	1.7 (0.4–7.7)	
Other funding	38	12.1	2 (5.3)	1	
Own funds, family and other	58	18.5	4 (6.9)	1.3 (0.2–7.7)	
Type of user					0.429
Two-wheelers	227	68.4	21 (9.3)	1	
Pedestrians	86	25.9	9 (10.5)	1.1 (0.5–2.6)	
Others	19	5.7	0 (0.0)	-	
Position on the motorcycle or in the car					0.779
Driver	172	52.6	15 (8.7)	1	
Passenger	69	21.1	5 (7.3)	0.8 (0.3–2.3)	
NA pedestrians	86	26.3	9 (10.5)	1.2 (0.5–2.9)	
Wearing of protective equipment					0.062
Yes	131	40.4	6 (4.6)	1	
No	107	33.0	14 (13.1)	3.1 (1.2–8.5)	
NA pedestrians	86	26.5	9 (10.5)	2.4 (0.8–7.1)	
Antagonist in the crash					0.360
No antagonist	30	9.2	3 (10.0)	1.3 (0.4–4.7)	
Vehicles	268	82.2	21 (7.8)	2.0 (0.6–6.2)	
Others	28	8.6	4 (14.3)	1	
Number of injuries					0.891
1	193	57.4	18 (9.3)	1	
2	90	26.8	10 (11.1)	1.2 (0.5–2.8)	
3 or plus	53	15.8	5 (9.4)	1.0 (0.4–2.9)	
Head and face injuries					<0.001
Yes	121	36.0	30 (24.8)	23.3 (6.9–78.3)	
No	215	64.0	3 (1.4)	1	
Trunk injuries					0.693
Yes	18	5.4	2 (11.1)	1.2 (0.2–5.3)	
No	318	94.6	31 (9.8)	1	
Spine injuries					0.064
Yes	10	3.0	3 (30.0)	4.2 (1.0–17.2)	
No	326	97.0	30 (9.2)	1	
Lower limbs injuries					<0.001
Yes	245	72.9	11 (4.5)	1	
No	91	27.1	22 (24.2)	6.8 (3.1–14.7)	
Upper limbs injuries					0.033
Yes	68	20.2	2 (2.9)	1	
No	268	79.8	31 (11.6)	4.3 (1.0–18.5)	

Table 3. Factors related to the accident environment and to the health services and occurrence of in-hospital deaths among severe trauma patients enrolled in the TraumAR cohort in univariate analysis, Benin, 2020.

Variables	Total number	% or Mean (ET) or Med(Q1 – Q3)	Deceased N (%)	RR (95% CI)	p-value
Factors related to the accident environment					
Time of day					0.146
Dusk	52	15.7	9 (17.3)	2.6 (1.1–6.6)	
Dawn	14	4.2	2 (14.3)	2.1 (0.4–10.4)	
Day	177	53.3	13 (7.3)	1	
Night	89	26.8	8 (9.0)	1.2 (0.5–3.1)	
Weather conditions					0.332
Good	302	91.2	27 (8.9)	1.6 (0.5–5.0)	
Bad	29	8.8	4 (13.8)	1	
Road conditions					0.379
Good	259	80.2	22 (8.5)	1.2 (0.1–9.7)	
Poor	50	15.5	7 (14.0)	2.1 (0.2–18.8)	
Under construction	14	4.3	1 (7.1)	1	
Type of road					0.524
National Inter-State Road	50	15.4	5 (10.0)	1.4 (0.4–4.3)	
Rural track	24	7.4	4 (16.7)	2.4 (0.7–8.7)	
National road	132	40.6	12 (9.1)	1.2 (0.5–3.0)	
Alleys	119	36.6	9 (7.6)	1	
Factors related to the health services					
Hospital of enrolment					0.198
CHUDB	64	19.1	8 (12.5)	6.3 (0.7–52.1)	
CHUDO	153	45.5	14 (9.2)	4.4 (0.6–34.7)	
CNHU-HKM	74	22.0	10 (13.5)	6.9 (0.8–55.6)	
HZ MENONTIN	45	13.4	1(2.2)	1	
Entry service					0.140
Emergency services	296	89.2	31 (10.5)	4.1 (0.5–30.9)	
Surgery	36	10.8	1 (2.8)	1	
Qualification of the health worker					0.051
General practitioner	125	37.5	14 (11.2)	8.9 (1.2–69.6)	
Surgeon	67	20.1	9 (13.4)	11.0 (1.4–89.5)	
Medical student	69	20.7	9 (13.0)	10.6 (1.3–86.5)	
Nurse or nurse's aide	72	21.6	1 (1.4)	1	
Immediate first aid					0.483
Yes	317	94.9	32 (10.1)	1.8 (0.2–14.0)	
No	17	5.1	1 (5.9)	1	

Table 4. Factors associated with occurrence of in-hospital death among severe trauma patients enrolled in the TraumAR cohort in multivariate analysis, Benin, 2020.

Characteristics	Adjusted RR (95% CI)	p-value
Referral time		0.021
One hour or less	1	
More than one hour	5.7 (1.5–20.9)	
Mode of transport to hospital		0.011
Ambulance	4.8 (1.3–17.3)	
Fire department or police	7.4 (1.8-29.7)	
Others (relatives or witnesses)	1	
Wearing of protective equipment		0.045
Yes	1	
No	4.5 (1.4–15.0)	
NA pedestrians	2.7 (0.8–9.5)	
Head and face injuries		<0.001
Yes	34.8 (8.7–139.6)	
No	1	
Upper limbs injuries		0.008
Yes	1	
No	20.1 (2.3–177.1)	

Pseudo R^2=0.36.

gency room within the first hour after the accident.[11] Longer time to care indicates an inadequate referral system,[28] which is a factor associated with the occurrence of death. Other studies have shown the influence of time to hospital transfer and time to emergency on the occurrence of death.[16-29] In India it was observed that the risk of death was higher when subjects were transported to hospital more than 24 hours after the accident.[16] The highest risk in Tanzania was observed in subjects taken to hospital between 2 and 10 hours after the accident.[18] In Nigeria, on the other hand, the majority of the deceased were seen in the emergency room 6 hours after the accident occurred.[4]

The results of this study show that the police or fire department had transported to hospital 45.6% of victims and ambulance 20.5%. These proportions exceed those observed in Kenya,[12] Ethiopia[8] and Tanzania.[9] The observation made in our study differs from that of a 2018 study in Benin in which the authors noted the presence of firefighters to transport victims in 31% of cases, the presence of the police in 1% of cases, and the near absence of ambulances.[30] Also in Nigeria, ambulances were not found among the means of transporting road traffic accident victims. However, the proportion of subjects transported by the police and fire department (40.4% and 55%) was close to that in our study.[11,31] This study reveals that subjects referred by ambulance and firefighters were more likely to die than those referred by other means. Glèlè-Ahanhanzo *et al.* made a similar observation regarding the occurrence of post-traumatic disabilities.[30] This observation could be explained by the fact that the use of the fire department and ambulances was more frequent for the most serious cases. In addition, the inadequacy of the organization of the referral and ambulances made the referral time longer. In this context, it is understandable that even if the ambulances had adequate materials and human resources for emergency care, the delay in care and the severity of the injuries would negatively influence the outcome. In the case of the fire department and the police, more than 50% of the casualties they managed were referred within the first hour. The negative outcome could be linked to the severity of the accident and the fact that they are not equipped or trained to provide emergency medical care. This situation calls for the establishment of a well-organized, medicalized, and efficient pre-referral system with rapid administration of emergency care to stabilize severe trauma patients and reduce fatalities. The country could consider strengthening the fire department with equipment and training in emergency medical care, and developing the availability of ambulances equipped with qualified human resources in all municipalities.

Few trauma victims received care at the scene of the accident or during transport. The same observation was made in Nigeria, Kenya, Ethiopia and Tanzania.[8,9,11-13] The situation in Benin seemed even better than in these three countries where no trauma patient had received care before admission to hospital.[8,9,11] Inadequate pre-hospital care was not associated with death in severe trauma patients. This factor was, however, found in road traffic accident victims in India.[16] In our study, gender and age were not found to be factors associated with mortality in severe trauma. This contrasts with the results obtained in Guinea, where male sex was associated with the occurrence of hospital deaths in road accident victims.[5] In addition, some authors have noted that age was associated with the occurrence of death in road traffic injuries.[5,8,9,20,32]

Subjects not wearing protective devices were at greater risk of death. In fact, not wearing helmets, seat belts and child restraints increases the risk of serious injury and death.[16,17,22,23] The observation made in our study is that subjects not wearing their protective equipment were 4 times more likely to die than those wearing it. This is consistent with the results obtained in several other countries.[16,22,23,31,33] As in our study, the type of user was not found in multivariate analysis in the Netherlands as a risk factor for death in severe head injuries.[20] However, Naci *et al*. noted that in Africa and in low-income countries, pedestrians were at greater risk of death in road crashes.[34]

Head injuries increase the risk of death. This factor has also been found in two-wheel users injured in traffic accidents[5,19] and is associated with the occurrence of post-traumatic disability in Benin.[30] The number of injuries was not associated with the occurrence of death in our study. This observation is consistent with that made in Benin in 2018 regarding factors associated with post-traumatic disability.[30] It was observed in our final model that subjects with upper extremity injuries were at lower risk of death. This is because there are no vital organs in the upper extremities. Motorcyclists not wearing helmets accounted for the highest proportion of deaths in this cohort, with pedestrians following in second place. Not wearing a helmet increases the risk of head injury for these riders. This situation calls for decision-makers to rethink actions to reinforce helmet use for two-wheelers and to protect pedestrians. Actions should also be taken to reinforce the use of seat belts.

Limitations

The number of events during the study period was limited to give good precision in the multivariate analysis. Some risk factors for death could not be studied because the data were either not collected or had many missing values (speeding, driving under the influence of alcohol, use of psychoactive substances). The retrospective aspect of some of the questions, which calls on memory, including that of the accident, could create a bias. The quality of the data collection and the short time between the occurrence of the accident and the contact with the trauma patient allowed us to minimize these risks.

Conclusions

Different factors can influence the survival of a severe road accident victim in Benin. The present study confirmed that the time of referral influences the survival of these patients. In addition to this factor, the mode of transport to a hospital, injuries to the head and lack of protective equipment were also found to influence survival. The rapid and adequate care of road accident victims is necessary to improve their survival. The referral system should be strengthened in the country. For this purpose, the fire department could be reinforced with personnel trained in first aid, vehicles and adequate equipment. As for the ambulances, they should be well equipped throughout the country, with a reinforced medical team of emergency doctors available to recover quickly the most critical cases that need urgent medical assistance.

References

1. Sawe HR, Wallis LA, Weber EJ, et al. The burden of trauma in Tanzania: Analysis of prospective trauma registry data at regional hospitals in Tanzania. Injury. 2020;51:2938-45.
2. Adam S, Sama DH, Mouzou T, et al. Emergency admissions in sub Saharan Africa: example of the surgical emergency admissions unit at the Sylvanus Olympio Teaching Hospital of Lome, Togo. Medecine et sante tropicales. 2018;28:327-30.
3. Babalola OR, Oluwadiya K, Vrgoč G, et al. Pattern of emergency room mortality among road traffic crash victims. Injury. 2015;46:S21-S3.
4. Ugare GU, Ndifon W, Bassey IA, et al. Epidemiology of death in the emergency department of a tertiary health

centre south-south of Nigeria. African health sciences. 2012;12:530-7.
5. Kourouma K, Delamou A, Lamah L, et al. Frequency, characteristics and hospital outcomes of road traffic accidents and their victims in Guinea: a three-year retrospective study from 2015 to 2017. BMC public health. 2019;19:1022.
6. Madubueze CC, Chukwu CO, Omoke NI, et al. Road traffic injuries as seen in a Nigerian teaching hospital. International orthopaedics. 2011;35: 743-6.
7. Mbanjumucyo G, George N, Kearney A, et al. Epidemiology of injuries and outcomes among trauma patients receiving prehospital care at a tertiary teaching hospital in Kigali, Rwanda. African journal of emergency medicine. 2016;6:191-7.
8. Seid M, Azazh A, Enquselassie F, Yisma E. Injury characteristics and outcome of road traffic accident among victims at Adult Emergency Department of Tikur Anbessa specialized hospital, Addis Ababa, Ethiopia: a prospective hospital based study. BMC emergency medicine. 2015;15:10.
9. Chalya PL, Mabula JB, Dass RM, et al. Injury characteristics and outcome of road traffic crash victims at Bugando Medical Centre in Northwestern Tanzania. Journal of trauma management & outcomes. 2012;6:1.
10. MS. Annuaire des statistiques sanitaires 2019. Benin: Ministère de la Santé; 2020.
11. Solagberu BA, Ofoegbu CK, Abdur-Rahman LO, et al. Pre-hospital care in Nigeria: a country without emergency medical services. Nigerian journal of clinical practice. 2009;12:29-33.
12. Macharia WM, Njeru EK, Muli-Musiime F, Nantulya V. Severe road traffic injuries in Kenya, quality of care and access. African health sciences. 2009;9:118-24.
13. Lucumay NJ, Sawe HR, Mohamed A, et al. Pre-referral stabilization and compliance with WHO guidelines for trauma care among adult patients referred to an urban emergency department of a tertiary referral hospital in Tanzania. BMC emergency medicine. 2019;19:22.
14. Naddumba EK. Musculoskeletal trauma services in Uganda. Clinical orthopaedics and related research. 2008;466:2317-22.
15. Verma V, Singh A, Singh GK, et al. Epidemiology of trauma victims admitted to a level 2 trauma center of North India. International journal of critical illness and injury science. 2017;7:107-12.
16. Chandrasekharan A, Nanavati AJ, Prabhakar S, Prabhakar S. Factors impacting mortality in the pre-hospital period after road traffic accidents in urban India. Trauma monthly. 2016;21.
17. WHO. Global status report on road safety 2018. Geneva: World Health Organisation; 2018.
18. Boniface R, Museru L, Kiloloma O, Munthali V. Factors associated with road traffic injuries in Tanzania. The Pan African medical journal. 2016;23:46.
19. Ankarath S, Giannoudis PV, Barlow I, et al. Injury patterns associated with mortality following motorcycle crashes. Injury. 2002;33:473-7.
20. Leijdesdorff HA, van Dijck JT, Krijnen P, et al. Injury pattern, hospital triage, and mortality of 1250 patients with severe traumatic brain injury caused by road traffic accidents. Journal of neurotrauma. 2014;31:459-65.
21. Wong E, Leong MK, Anantharaman V, et al. Road traffic accident mortality in Singapore. The Journal of emergency medicine. 2002;22:139-46.
22. Brown CVR, Hejl K, Bui E, et al. Risk Factors for Riding and Crashing a Motorcycle Unhelmeted. Journal of Emergency Medicine. 2011;41:441-6.
23. Singleton MD. Differential protective effects of motorcycle helmets against head injury. Traffic injury prevention. 2017;18:387-92.
24. Lin MR, Chang SH, Huang W, et al. Factors associated with severity of motorcycle injuries among young adult riders. Annals of emergency medicine. 2003;41:783-91.
25. Tumwesigye NM, Atuyambe LM, Kobusingye OK. Factors Associated with Injuries among Commercial Motorcyclists: Evidence from a Matched Case Control Study in Kampala City, Uganda. PloS one. 2016;11:e0148511.
26. Mir MU, Khan I, Ahmed B, Abdul Razzak J. Alcohol and marijuana use while driving—an unexpected crash risk in Pakistani commercial drivers: a cross-sectional survey. BMC public health. 2012;12:145.
27. Abbreviated Injury Scale Dictionary 2005 - Update 2008 - Digital
Chicago, USA: AAAM; 2008.
28. Khorasani-Zavareh D, Khankeh HR, Mohammadi R, et al. Post-crash management of road traffic injury victims in Iran. Stakeholders' views on current barriers and potential facilitators. BMC emergency medicine. 2009;9:8.
29. Béavogui K, Koïvogui A, Loua TO, et al. Traumatic Brain Injury Related to Motor Vehicle Accidents in Guinea: Impact of Treatment Delay, Access to Healthcare, and Patient's Financial Capacity on Length of Hospital Stay and In-hospital Mortality. Journal of vascular and interventional neurology. 2015;8:30-8.
30. Glèlè-Ahanhanzo Y, Kpozèhouen A, Paraïso NM, et al. Disability and Related Factors among Road Traffic Accident Victims in Benin: Study from Five Public and Faith-Based Hospitals in Urban and Suburban Areas. 2018;8:226.
31. Ogundele OJ, Ifesanya AO, Adeyanju SA, Ogunlade SO. The impact of seatbelts in limiting the severity of injuries in patients presenting to a university hospital in the developing world. Niger Med J. 2013;54:17-21.
32. Saidi H, Mutiso BK, Ogengo J. Mortality after road traffic crashes in a system with limited trauma data capability. Journal of trauma management & outcomes. 2014;8:4.
33. Baru A, Azazh A, Beza L. Injury severity levels and associated factors among road traffic collision victims referred to emergency departments of selected public hospitals in Addis Ababa, Ethiopia: the study based on the Haddon matrix. BMC emergency medicine. 2019;19:2.
34. Naci H, Chisholm D, Baker TD. Distribution of road traffic deaths by road user group: a global comparison. Injury prevention: journal of the International Society for Child and Adolescent Injury Prevention. 2009;15: 55-9.