PRE-CRASH FACTORS ASSOCIATED WITH NATURE AND OUTCOME OF INJURIES FROM ROAD TRAFFIC ACCIDENTS IN MAKUENI COUNTY, KENYA

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Abstract: Injuries constitute one of the priority health problems in the world that lead to the loss of several million lives and cause nonfatal injuries to millions of people globally.The objective of the study was to determine the pre-crash factors associated with the nature and outcomes of injuries in traffic accidents in Makueni County. This would provide evidence for the development of policies and programmes in emergency medical services. The Mixed method approach and cross-sectional study design was employed. Data was collected from 427 First Responders and 474 patients. Universal sampling was employed for all the consecutive First Responders who assisted people inflicted with Injuries conveyed to six hospitals in Makueni. Quantitative data analysis was through Statistical Package for Social Scientists version 25 while qualitative data was through descriptive and analytical reports. Study findings indicate a significant relationship between Outcomes of injuries with use of personal protective device, education level of casualties, location of health facility, time the accident occurred andthe weather during the accident. The study recommends regular community members' sensitization and training on pre-hospital emergency care for road traffic related casualties. Sensitization should prioritize issues such as use of personal protective equipment to reduce morbidity and mortality with emphasis to the most affected such as the males.

Keywords: Pre-crash, Road Traffic Accidents, Road Traffic Injuries, Nature and Outcomes of Injuries.

1. Background

Injuries constitute one of the priority health problems in the world and require urgent attention. Majority of these injuries belong to the unintentional category of which the main proportions are the road traffic injuries. They are among the leading cause of death across all age groups globally and constitute a pandemic. They lead to the loss of over 1.2 million lives and cause nonfatal injuries to about 50 million people all over the world annually. About 90 percent of the road traffic deaths and injuries are borne by Low and Middle-income countries. If proper interventions are not instituted, deaths due to road traffic accidents will escalate to 1.9 million annually by 2020. Projections indicate that traffic related injuries are likely to become the seventh leading cause of death by 2030. Road accidents cost most countries 1-3 percent of their gross national product and hence exert pressure to the limited resources. A significant breakthrough may be realized if the severely injured people receive life sustaining care promptly [1;2].

The risk of road traffic death varies considerably by region. The highest rates have been recorded in the African region (26.6/100,000) [1]. In Kenya, these injuries have significantly contributed to hospital admissions and mortality. They account for about 28 percent of all the injuries sustained and are the 9th leading cause of mortality here [3].

Inversely, the European region has recorded rates below the global average (9.3/100,000 population versus the global rate of 17.4/100,000). A large disparity has also been noted within particular regions. Rates in some of the high-income countries in the Western Pacific region such as Australia are among the lowest globally while some the regions in middle-income countries have rates above the global average rate of 24/100,000. Disparities in economic development that has resulted in increased motorization and construction of road infrastructure without a matching investment in institutional capacity nor adequate interventions to cope with the changes resulting to an increase in road traffic related fatalities [1].

2. Materials and Methods

The researcher applied the mixed methods approach and cross-sectional study design to conduct the study between 17/10/2019 and 15/5/2020. The researcher adopted the explanatory sequential strategy followed by the qualitative component of the study. The sample size was worked out as (using the formula by Fisher *et al.*[4] and about 423 First Responders who assisted 474 persons inflicted with road traffic injuries who were managed in Six Hospitals along Nairobi-Mombasa road, Makindu-Wote-Machakos road and Tawa-Masii road were selected for this study. The responders were matched with each person inflicted with injuries who came for treatment in Makueni, Tawa, Makindu, Sultan Hamud, Kibwezi and Mtitoandei Hospitals.

Formula n = z^2pq/d^2 [5].

Where:

- n = desired sample size (where population is greater than 10,000)
- Z = the standard normal deviate set at 1.96 which corresponds to the 95 percent confidence level.
- P = the proportion in the target population estimates to have a particular characteristic (50 percent)
- q = 1.0 – p
- d = degree of accuracy desired, set at .05.

Then the sample size was:

$n = (1.96)^2(.50)\ (.50)/(.05)^2$
n = 384

The calculated size was increased by 10 percent to ensure that the minimum sample is not affected by non-responses. Hence the final sample size was:

- 10 percent of 384=39
- 39 +384=423

The care provided during the pre-hospital phase and the outcome of the injuries sustained were confirmed from the First Responders, the patients and the medical records in various hospitals along the major roads in Makueni County where the casualties were transferred for definitive care.

The data obtained was analyzed through Statistical Package for Social Scientist (SPSS Version 25). Frequency tables and charts were used in presentation of findings. Cross tabulation was used to compare variables. Bivariate analysis explored the association between two variables. Principal component analysis was conducted on the significant variables in bivariate analysis. Multivariate analysis conducted was on various variables significantly associated with the dependent variable in bivariate analysis and those which loaded in the principal component analysis. The statistical tests that were applied include chi-square, correlation and multinomial logistic regression.

3. Results

3.1.1 Demographic and Socio-economic Characteristics of First Casualties: Table 1 shows that the highest number of patients with severe outcomes at the time of disposition was recorded amongst the males (19.4%), those above 30 years (18.2%) and those who had attained secondary level of education (20.4%).

Statistical tests depicted a significant ($P< 0.05$) relationship between gender, marital status, and educational level with outcome of injuries. There was a moderate association between education of the responder and that of the casualties (r=0.176). However, there was no significant (P >0.05) relationship noted between age, religion and outcome of injuries.

Table 1: Demographic and Socio-Economic Characteristics of Casualties

Variables and values	Outcome at disposition			Total (N%)	χ2	df	P-value
	Mild (n%)	Moderate (n%)	Severe (n%)				
Gender (n=427)							
Male	205(66.3)	44(14.2)	60(19.4)	309(100)	7.218	2	0.03*
Female	94(79.7)	10(8.5)	14(11.9)	118(100)			
Total	**299(70)**	**54(12.6)**	**74(17.3)**	**427(100)**			
Age (n=424)							
< 30 Years	169(72.8)	27(11.6)	36(15.5)	232(100)	1.339	2	0.512
≥ 30 Years	130(67.7)	27(14.1)	35(18.2)	192(100)			
Current marital status (n=424)							
Others	154(77.4)	11(5.5)	34(17.1)	199(100)	17.833	2	0.001*
Married	145(64.4)	43(19.1)	37(16.4)	225(100)			
Religion (n=424)							
None and Others	16(66.7)	1(4.2)	7(29.2)	24(100)	3.999	4	0.406
Catholic	112(71.8)	20(12.8)	24(15.4)	156(100)			
Protestants	171(70)	33(13.5)	40(16.4)	244(100)			
Education (n=424)							
None and Primary	92(81.4)	6(5.3)	15(13.3)	113(100)	19.815	4	0.001*
Secondary	116(69.5)	17(10.2)	34(20.4)	167(100)			
Post-secondary	91(63.2)	31(21.5)	22(15.3)	144(100)			
Main occupation (n=424)							
Farmer	27(73)	3(8.1)	7(18.9)	37(100)	17.762	6	0.006*
Business	69(64.5)	18(16.8)	20(18.7)	107(100)			
Employed	94(67.1)	27(19.3)	19(13.6)	140(100)			
Unemployed	109(77.9)	6(4.3)	25(17.9)	140(100)			
Total	**299(70.5)**	**54(12.7)**	**71(16.7)**	**424(100)**			

Note: **significant p< 0.05*

3.1.2 Physical Injuries and Characteristics of Casualties

Study findings in Table 2 indicate that fractures were higher among the males (31.7%), those below 30 years (30.2%) and those who had consumed alcohol prior to the accident (32%). Statistical tests indicate a significant relationship (p< 0.05) between deep cuts with gender, marital status and alcohol consumption. There was a significant association between fractures with gender.

Table 2: Association between Physical Injuries and Characteristics of Casualties

Variable and values	Category	Frequency	Percent	Physical Injuries							
				Cut-superficial	Cut-deep	Fracture	Sprain/strain	Dislocation	Multiple injuries	Concussion -loss of consciousness	Internal injury
Gender (n=427)	Male	309	72.4	124(40.1)	114(36.9)	98(31.7)	60(19.4)	57(18.4)	30(9.7)	23(7.4)	14(4.5)
	Female	118	27.6	50(42.4)	20(16.9)	26(22)	32(27.1)	25(21.2)	10(8.5)	9(7.6)	3(2.5)

	Chi-square ;df; P-value			0.178; df1;0.673	15.773; df;1;0.001*	3.388; df 1;0.05*	2.99;df 1; 0.08	0.413; df 1;0.52	0.153; df;1;0.696	0.004;df1;0.949	0.883;df; 1;0.347
Age (424)	< 30	232	54.7	100(43.1)	81(34.9)	70(30.2)	44(19)	46(19.8)	19(8.2)	17(7.3)	11(4.7)
	≥ 30	192	45.3	74(38.5)	51(26.6)	53(27.6)	48(25)	36(18.8)	19(9.9)	15(7.8)	6(3.1)
	Chi-square; df; P-value			0.904; df 1;0.342	3.417; df 1;0.065	0.336; df 1; 0.562	2.252; df 1;0.133	0.078; df 1;0.779	0.375; df 1;0.540	0.035;df 1;0.850	.713' df1; 0.398
Marital status (424)	Other	199	46.9	98(49.2)	72(36.2)	52(26.1)	43(21.6)	44(22.1)	10(5)	14(7)	7(3.5)
	Married	225	53.1	76(33.8)	60(26.7)	71(31.6)	49(21.8)	38(16.9)	28(12.4)	18(8)	10(4.4)
	Chi-square; df; P-value			10.443 ;df 1; 0.001*	4.459; df 1; 0.03*	1.508; df 1;0.219	0.002; df 1;0.966	1.846; df 1;0.174	7.125; df 1; 0.007*	0.141;df 1;0.707	0.236;df 1;0.827
Religion (424)	None and others	24	5.7	11(45.8)	14(58.3)	3(12.5)	3(12.5)	5(20.8)	3(12.5)	5(20.8)	1(4.2)
	Catholic	156	36.8	64(41)	40(25.6)	47(30.1)	31(19.9)	26(16.7)	7(4.5)	12(7.7)	7(4.5)
	Protestants	244	57.5	99(40.6)	78(32)	73(29.9)	58(23.8)	51(20.9)	28(11.5)	15(6.1)	9(3.7)
	Chi-square; df; P-value			0.250; df 2; 0.883	10.556; df 2 ;0.005*	3.369; df 2; 0.186	2.12; df 2 ;0.347	1.13; df 2; 0.568	6.086; df 2; 0.048*	6.761 ;df 2;0.03*	0.159; df 2; 0.923
Education level (424)	None and Primary	113	26.7	42(37.2)	36(31.9)	32(28.3)	39(34.5)	34(30.1)	4(3.5)	6(5.3)	3(2.7)
	Secondary	167	39.4	79(47.3)	53(31.7)	45(26.9)	26(15.6)	23(13.8)	14(8.4)	16(9.6)	8(4.8)
	Post-secondary	144	34	53(36.8)	43(30)	46(31.9)	27(18.8)	25(17.4)	20(13.9)	10(6.9)	6(4.2)
	Chi-square; df; P-value			4.476; df 2;0.107	0.165; df 2;0.921	0.974; df 2;0.615	15.352 ;df 2;0.001*	12.049 ;df 2;0.002*	8.425; df 2;0.015*	1.876;df 2;0.391	0.813;df 2;0.666
Main occupation (424)	Farmer	37	8.7	12(32.4)	10(27)	9(24.3)	8(21.6)	7(18.9)	3(8.1)	2(5.4)	2(5.4)
	Business	107	25.2	34(31.8)	32(29.9)	38(35.5)	22(20.6)	22(20.6)	14(13.1)	11(10.3)	4(3.7)
	Employed	140	33	61(43.6)	51(36.4)	41(29.3)	28(20)	20(14.3)	13(9.3)	8(5.7)	4(2.9)
	Unemployed	140	33	67(47.9)	39(27.9)	35(25)	34(24.3)	33(23.6)	8(5.7)	11(7.8)	7(5)
	Chi-square;			7.988; df	2.898; df	3.691; df	0.871; df	4.006; df	4.089; df	2.082;df 3;0.556	1.048;df

	df; P-value			3;0.05*	3;0.408	3;0.297	3;0.832	3;0.261	3;0.252		3;0.789
Alcohol prior to accident (424)	Yes	50	11.8	25(50)	25(50)	16(32)	10(20)	10(20)	5(10)	11(22)	3(6)
	No	374	88.2	149(39.8)	107(28.6)	107(28.6)	82(21.9)	72(19.3)	33(88.2)	21(5.6)	14(3.7)
	Chi-square; df; P-value			1.882; df 1;0.170	9.412; df 1;0.002*	.246;df 1;0.619	0.096; df 1; 0.756	0.016; df 1;0.899	0.075; df 1;0.784	16.969;df 1;0.001*	0.548;df 1;0.445

NOTE: *P-value significant (< 0.05); CS = cut-superficial; CD = Cut-deep; F = Fracture; SST = Sprain, strain or twist; D = Dislocation; MI = Multiple injuries; CWLC = Concussion with loss of consciousness; II = Internal Injury;*significant

3.1.3 Association between Physical Injuries with Mechanism of Injury, Number of People Involved in Accident and Use of Personal Protective Device

Table 3 indicates that deep cuts were more common among the 1-3 passenger category (34.1%), other modes of transport other than Motorized vans/cars (38.3%) and those who were not using personal protective devices at the time of accident (33.6%). Fractures were more common among those in the 1-3 passenger category (30.5%), those travelling in motorized vans (34.6%) and those who were not using personal protective devices at the time of accident (31%).

There was a significant relationship (P < 0.05) between fractures, internal injuries with mechanism of injury. There was a weak association between fractures and internal injuries (r=0.024). There was a moderate association between fractures and outcome at entry (r=0.137) as well as outcome at disposition (r=0.161)

Table 3: Association between Physical Injuries with Mechanism of Injury, Number of People Involved in Accident and Use of Personal Protective Device

Variable	Category	Frequency	Percent	Physical Injuries							
				Cut-superficial	Cut-deep	Fracture	Sprain/strain/twist	Dislocation	Multiple injuries	Concussion with loss of consciousness	Internal injury
Number of people involved	1-3.	328	76.8	125(38.1)	112(34.1)	100(30.5)	71(21.6)	68(20.7)	30(9.1)	22(6.7)	11(3.4)
	≥3	99	23.2	49(49.5)	22(22.2)	24(24.2)	21(21.2)	14(14.1)	10(10.1)	10(10.1)	6(6)
	Chi-Square; df; P-value			4.083; df 1;0.04*	5.021; df 1;0.03*	1.439; df 1;0.230	0.008;df 1;0.927	2.129; df 1;0.145	0.082;df1;0.775	1.263;df 1;0.261	1.45;df 1;0.227
Mechanism of Injury	Motorized car/vans	234	54.8	85(36.3)	60(25.6)	81(34.6)	51(21.8)	45(19.2)	23(9.8)	19(8.1)	14(6)
	Others	193	45.2	89(46.1)	74(38.3)	43(22.3)	41(21.2)	37(19.2)	17(8.8)	13(6.7)	3(1.6)
	Chi-Square; df; P-value			4.198; df 1;0.04*	7.923; df 1;0.004*	7.81; df 1;0.005*	0.019;df 1;0.890	0.00; dfq;0.988	0.13;df 1;0.719	0.292;df 1;0.589	5.426;df 1;0.02*
Use of Personal	Yes	61	14.3	19(31.1)	19(31.1)	18(29.5)	13(21.3)	17(27.9)	10(16.4)	5(8.2)	2(3.3)

protective device	No	274	64.2	117(42.7)	92(33.6)	85(31)	65(23.7)	50(18.2)	23(8.4)	18(6.6)	9(3.3)
	Don't know	92	21.5	38(41.3)	23(25)	21(22.8)	14(15.2)	15(16.3)	7(7.6)	9(9.8)	6(6.5)
	Chi-Square; df; P-value			2.773; df 2;0.249	2,355; df 2;0.308	2.253; df 2;0.324	2.950;df 2;0.229	3.612; df 2;0.164	4.188;df 2;0.123	1.076;df 2;0.583	1,980;df 2;0.372

NOTE:*P-value significant (< 0.05); CS = cut-superficial; CD = Cut-deep; F = Fracture; SST = Sprain, strain or twist; D = Dislocation; MI = Multiple injuries; CWLC = Concussion with loss of consciousness; II = Internal Injury;*significant p< 0.0

3.1.4 Association between Mechanism of Injury, Number of People Involved in an Accident and Use of Personal Protective Device and Outcome of Injuries

The study found that severe outcomes were higher (18.3%) in accidents involving 1-3 people.
The study also revealed that the mechanism of injury with the highest proportion (20.1%) of cases with severe outcomes includes the motorized vehicles as shown in Table 4.

Statistical tests significantly (P<0.05) associated outcome of injuries and use of a protective device during the accident. There was no significant relationship between outcome of injuries with mechanism of injury and number of involved in an accident. There was a strong correlation between the number of people involved an accident and use of personal protective device (r=0.316; P-value: 0.001 < 0.05). A moderate association was noted between use of personal protective device and fractures (r=0.114).

Table 4: Number of People Involved in an Accident, Mechanism of Injury, Use of Personal Protective Device

Variable and Values (n=427)	Outcome at Time of Disposition From the Health Facility			Total (N%)	□2	df	P-value
	Mild (n%)	Moderate (n%)	Severe (n%)				
Number of people involved in accident							
1-3.	225(68.6)	43(13.1)	60(18.3)	328(100)	1.407	2	0.490
≥ 3	74(74.7)	11(11.1)	14(14.1)	99(100)			
What was the mechanism of injury							
Motorized cars/vans	156(66.7)	31(13.2)	47(20.1)	234(100)	3.249	2	0.200
Others	143(74.1)	23(11.9)	27(14)	193(100)			
Use of protective device							
Yes	39(63.9)	11(18)	11(18)	61(100)	27.747	4	0.001*
No	200(73)	19(6.9)	55(20.1)	274(100)			
I don't know	60(65.2)	24(26.1)	8(8.7)	92(100)			
Total	**299(70)**	**54(12.6)**	**74(17.3)**	**427(100)**			

Note: **significant p< 0.05*

3.1.5 Association between Physical Injuries with Time, Weather: Table 5shows that internal injuries (4.8%) were higher when the accident occurred at night. Study findings further indicate that superficial cuts (41.1%), fractures (30.7%), multiple injuries (10.1%) and internal injuries (4.5%) were higher when the accident occurred during dry weather. There was significant relationship (p < 0.05) between time of the day when the accident occurs and dislocations as well as concussions with loss of consciousness.

Table 5: Association between Physical Injuries with Time and Weather

Variable	Category	Frequency	Percent	Physical Injuries							
				Cut-superficial	Cut-deep	Fracture	Sprain/strain/twist	Dislocation	Multiple injuries	Concussion with loss of consciousness	Internal injury
Time of day	Day	262	61.4	108(41.2)	88(33.6)	73(27.9)	64(24.4)	59(22.5)	26(9.9)	13(5)	9(3.4)
	Night	165	38.6	66(40)	46(27.9)	51(30.9)	28(17)	23(13.9)	14(8.5)	19(11.5)	8(4.8)
	Chi-Square; df; P-value			0.063;df 1; 0.803	1.532; df 1;0.216	0.456; df 1; 0.499	3.331;df 1;0.068	4.803;df 1;0.03*	0.247;df 1;0.619	6.272;df 1; 0.012*	0.529'df 1; 0.467
Weather during the accident	Raining	91	21.3	36(39.6)	33(36.3)	21(23.1)	26(28.6)	23(25.3)	6(6.6)	8(8.8)	2(2.2)
	Not raining	336	78.7	138(41.1)	101(30.1)	103(30.7)	66(19.6)	59(17.6)	34(10.1)	24(7.1)	15(4.5)
	Chi-Square; df; P-value			0.068;df 1;0.795	1.280; df 1;0.258	1.995; df 1; 0.158	3.377;df 1;0.066	2.747;df 1;0.09	1.408;df 1;0.305	0.218;df 1;0.596	0.962;df 1;0.327

Note: *CS = cut-superficial; CD = Cut-deep; F = Fracture; SST = Sprain, strain or twist; D = Dislocation; MI = Multiple injuries; CWLC = Concussion with loss of consciousness; II = Internal Injury;*significant p< 0.05*

3.1.6 Health Facility Location

Bivariate analysis was conducted to determine the association between health facility characteristics and nature and outcome of injuries. Almost three quarters (75.2%) the casualties with mild injury outcomes had been involved in an accident more than 5 kilometres away from the health facility. The study further shows that the facilities located in urban setup had the highest number (18.1%) of patients with severe outcomes at the time of disposition. Severe outcomes at the time of disposition were highest (18.9%) among the patients involved in an accident less than 5 Kilometres from the health facility as shown in Table 6.

Statistical tests highlight a significant (P<0.05) relationship, location of health facility, distance to health facility with outcome of injuries. There was a moderate association between the health facility and location of the health facility (r=0.241).

Table 6: Health Facility Location

Variable (n=427)	Outcome at disposition			Total (N%)	$\chi 2$	df	P-value
	Mild (n%)	Moderate (n%)	Severe (n%)				
Location of health facility							
Urban	75(48.4)	52(33.5)	28(18.1)	155(100)	100.405	2	0.001*
Rural	224(82.4)	2(0.7)	46(16.9)	272(100)			
Distance from the health facility							
< 5 Kilometers	117(63.2)	33(17.8)	35(18.9)	185(100)	9.575	2	0.008*
≥5 Kilometers	182(75.2)	21(8.7)	39(16.1)	242(100)			

Note: **significant p< 0.05*

3.1.7 Nature and Outcome of Injuries

Multivariate analysis conducted was on various variables significantly associated with the dependent variable in bivariate analysis and those which loaded in the principal component analysis. Table 7 shows that the patients who did not use Personal Protective Equipment were less likely to be discharged with moderate injury outcome at the time of disposition from the health facility (OR. 0.313 95% CI (0.155 - 0.631); P= 0.001. The casualties without any formal education or those with primary education were less likely to be discharged with moderate injury outcomes at the time of disposition (OR 0.297 95% CI (0.114 - 0.755), P=0.013).

Table 7: Nature and Outcome of Injuries

Variables and Values	Outcome at Disposition (OR, 95%CI, p-value)		
	Mild	**Moderate**	**Severe**
Use of Personal Protective Device			
Yes	1.000	0.766 (0.331-1.77),0.532	1.976 (0.712-5.481),0.191
No	1.000	0.313 (0.155-0.631),0.001*	2.137 (0.941-4.853),0.07
I don't know	1.000	b	b
Education			
None and Primary	1.000	0.297 (0.114 - 0.755), 0.013*	0.603 (0.287 - 1.268), 0.182
Secondary	1.000	0.549 (0.278 - 1.083), 0.084	1.078 (0.58 - 2.0004), 0.832
Post-Secondary	1.000	b	b
Gender			
Male	1.000	1.935 (0.911 - 4.111), 0.086	1.773 (0.936 - 3.580), 0.079
Female	1.000	b	b

Note: *Reference (Mild: Released at Out-patient Department); b = (Parameter set at Zero), *Significant p<0.05*

4. Discussion

4.11 Use of personal protective device

The study shows that about 8.2% the patients were discharged with disabilities. These findings are similar to those of a study in Rwanda found that about 14.9% of the casualties involved in motorcycle injuries were discharged with disabilities. This could be attributed to the fact that majority of the casualties arrived at the hospital more than one hour after injury. The study further noted that the casualties wearing protective gear did not experience severe injuries and hence probably those without protective gear ended up with disabilities [6].

The above findings are in agreement with a study carried out in Urban India to assess factors influencing mortality in the pre-hospital period after road traffic accidents found that 11.3 percent of the 576 survivors lost one or more extremities resulting in permanent disability. About 8 percent of the survivors were unable to care for themselves as a result of severe head injuries. Morbidity and mortality was significantly associated with non-use of protective gear and delays in transfer to the health facility. However, this was a hospital-based study which had several gaps in vital information in areas such as the road and weather conditions which may also impact the outcome of injuries [7].

Similarly, study findings in a descriptive prospective study involving street children under 18 years admitted for trauma at Bugando Medical Centre between 2008 and 2014 indicate that the mortality rate was 13.5 percent. The mortality was significantly associated with severe head injury [8]. Other studies with similar results include a prospective observational study carried out in Urban India to assess factors influencing mortality in the pre-hospital period after road traffic accidents also found that lack of personal protective gear was significantly associated with mortality. The study also noted that increased mortality was significantly associated with lack of pre-hospital emergency care [7]. However, the study did not indicate whether inappropriate pre-hospital care by lay responders would result to positive outcomes.

4.1.2 Gender

The study shows that 0.8% died by the time of disposition from the health facility. All the recorded deaths involved the male casualties. The findings agree with a study in Southern Thailand which found that mortality was 1.8% of all the injuries. Most of the deaths occurred amongst the male casualties [9]. Huge mortality in males can be attributed to exposure due their involvement in driving as an occupation. They also produce the highest number of *boda boda* (motorcycle) riders due to the significant increase of motorcycles in the transport industry. It is also documented that the males are culpable of risky driving behaviours than females. They fail to wear helmets and fasten seat belts and hence predisposing them to head injuries in the event of an accident. The young males were mainly involved due to their involvement in a wide number of activities and hence are at the greatest risk of dying due to traffic related injuries.

The findings are supported by several other studies such the study to establish the economic impact of motorcycles in Kigali, Rwanda which concluded that mortality was highest among the young males. The researcher attributed this to serious injuries involving multiple organs. The researcher further revealed that the casualties who had used personal protective equipment such as the helmet did not sustain severe head injury. The study further found that head injuries were present in 65% of all patient deaths [6].

4.1.3 Location and Distance to Health Facility

The current study shows that more than half (75.2%) of the casualties who ended up with mild outcomes had been involved in an accident more than 5 kilometres away from the health facility. The study further shows that the facilities located in urban setup had the highest number (18.1%) of patients with severe outcomes at the time of disposition.Pre-hospital emergency care interventions can only reduce morbidity and mortality through prompt communication and response by the emergency system. However, prompt response may be greatly influenced by factors divergent from the systems of emergency medical services such as physical inaccessibility due to poor roads or long distances to the health facilities.

The findings on a study conducted to establish the lifesaving effects of hospital proximity in road accidents in Italian municipalities showed that the overall average distance to the nearest hospital was 8.56 kilometres, while the corresponding fatality rate was about 6 deaths per every 100 accidents (6.046). The findings further indicate that an increase by a standard deviation of distance to the nearest hospital (5 kilometres) increases fatality rate by 13.84 percent on the sample average. This translates to a 0.92 additional death for every 100 accidents. However, hospital proximity effects on road-fatality rates can also be affected by poor emergency care and low quality hospitals [10].

A prospective study to determine the factors impacting mortality in the pre-hospital period after road traffic accidents in urban India found that 82 percent of the individuals who had accidents within 10 kilometres of the city survived while 18 percent died. The study further indicates that about 292 out of 773 people had accidents above 10 kilometres from the trauma centre. About 38.4 percent of the casualties died while 61.6 percent survived. An accident location above 10 kilometres from the trauma centre was significantly associated with mortality [7]

Study findings in post-crash response arrangements in Australia compared to other high performing road safety Nations indicate that response times are often affected by important factors such as the capacity to identify crash locations in rural and remote areas [11]. Another study conducted to assess the tyranny of distance and rural pre-hospital care in Australia found that ambulance services in rural areas are often volunteer based and with increasing remoteness through the 'tyranny' of distance often results in increased delay in arrival of evacuation services. Although the rural areas in Australia account for only 29 percent of the population, it is burdened with up to 65 percent of the national road fatalities. The mortality rates from trauma in rural areas are four times those of the major cities. This is probably due to lack of specialised services including those provided by emergency specialists. However, the response rate in this study could not be established because it is uncertain how many rural doctors exist in Australia and how many received the questionnaires [12].

4.1.4 Time of the day During the Accident

The highest proportion (74.4%) of casualties discharged with mild injury outcomes had been inflicted with injuries during the day time. However, the highest proportion (22.4%) of severe outcomes was reported among the casualties who experienced injuries at night. These findings agree with a study to identify factors that influence outcome of injuries on Spanish roads and that examined 2355 accidents found that almost a third (30%) of the accidents occurred in the afternoon (12-6pm) and another third (30%) in the morning [13].

Another study that collected secondary data on impact of roadway conditions on severity of 1067 cases involved in accidents in Malaysia between 2008 and 2015 found that environmental factors such as lighting and weather significantly affected severity of accidents. The study further found that, accidents occurred any time of the day and in good weather conditions [14].

A descriptive survey on factor that influence incidence of road traffic accidents along Mombasa-Malaba road found that short hours of day light influences driver's performance hence higher incidents of accidents [15]. Extreme change is a significant hazard for road traffic accidents and affects the driver's performance. Dim or bright light affects the driver's visibility and may result to accidents. A driver can under estimate the speed of oncoming vehicles and hence result to accidents. Severe outcomes may be registered at night because there are fewer staff allocated for night shift as compared to day time. Some of the staff operate on call shifts which sometimes results to delays. On the other hand an increase in injuries during the day time may be explained by the increase in activities during day time.

5. Conclusions

This study sought to determine pre-crash factors associated with outcomes of injuries from road traffic accidents in Makueni County, Kenya. This study concludes that education level of the casualty anduse of personal protective equipment were significantly associated with outcome of injuries. The study recommends regular community members' sensitization and training on pre-hospital emergency care for road traffic related casualties. Sensitization should prioritize issues such as use of personal protective equipment to reduce morbidity and mortality and target the whole population but with emphasis to the most affected such as the males.

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the Mount Kenya University Ethical Review Committee (MKU/ERC/1352: Approval number 756) while National Council for Science and Technology and Innovation (NACOSTI) provided approval for data collection. Permission to collect data from the health facilities was obtained from the County Director of Health Services in Makueni.

The study is not experimental and hence consents for the use of any animal or human data or tissue, "Not applicable".

Consent for publication

Not applicable (The manuscript does not contain data for any individual person)

Data availability statement

The data used to support the findings of this study are available from the corresponding author upon request (Anthony Wambua Mathulu: Corresponding author email:amathulu@gmail.com; mathulu@yahoo.com)

Competing interests

We as authors declare that we have no competing interests.

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Authors' contributions

A.W. M: Conceptualized, analysed and interpreted the data; E.S.S: Read, reviewed and approved the final manuscript; E.M.N: Read, reviewed and approved the final manuscript.

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