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M.K. Akama, BDS, MDS, Lecturer, M.L. Chindia, BDS, MSc, FFDRCSI, Associate Professor, Department of Oral and Maxillofacial Surgery, F.G. Macigo, BDS, MPH, Senior Lecturer, Department of Periodontology/Community and Preventive Dentistry and S.W. Guthua, BDS, MMed Sc, COMS, FIAOMS, Professor, Department of Oral and Maxillofacial Surgery, School of Dental Sciences, University of Nairobi, P.O. Box 19676-00202, Nairobi, Kenya

Request for reprints to: Dr. M.K. Akama, Department of Oral and Maxillofacial Surgery, School of Dental Sciences, University of Nairobi, P.O. Box 19676-00202, Nairobi, Kenya

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M.K. AKAMA, M.L. CHINDIA, F.G. MACIGO and S.W. GUTHUA

ABSTRACT

Background: **Road Traffic Accidents (RTAs) are a major cause of morbidity and mortality in Kenya. Victims may suffer multiple injuries including maxillofacial injuries. In most developing countries RTAs are the leading cause of maxillofacial injuries. In an attempt to reduce RTAs, the government of Kenya has enacted a legislation requiring mandatory fitting of speed governors and safety belts by passenger service vehicles.**

Objective: **To describe the characteristics and pattern of maxillofacial and associated injuries sustained in road traffic accidents.**

Design: **A cross-sectional study.**

Setting: **Kenyatta National Hospital (KNH).**

Subjects: **All patients involved in RTAs brought to casualty and the dental department of KNH as well as accident victims admitted to the KNH mortuary over a four- month period from September 2004 to December 2004.**

Results: **Four hundred and thirteen (85.7%) had non-fatal injuries whereas 69 (14.3%) had sustained fatal injuries. Males in the 21-30-year age group were the most affected. Most accidents occurred during weekends with pedestrians being the leading casualties in 59.5% and 71.4% of non-fatal and fatal cases respectively. Most accidents were caused by passenger service vehicles (*matatus*) which were responsible for 62% and 40.6% of non-fatal and fatal injuries respectively. Non-use of safety belts was reported in 56.6% of the cases who suffered non-fatal injuries. In the non-fatal category 89.6% of the casualties had soft tissue injuries (STIs) involving the craniofacial region with facial cuts being the majority (69.2%). Two hundred and seventy three (66.1%) incidents of other STIs than those of the head region were noted, the lower limbs accounting for 45.4% of these. Only 5.1% of the casualties with non-fatal injuries had fractures involving the maxillofacial skeleton. Skeletal injuries other than those involving the maxillofacial region were found in 142 (34.1%) incidents. In the fatal category head injury alone was the leading cause of death accounting for 37.7% of the cases followed by head and chest injuries combined which were responsible for 13% of the cases.**

Conclusion: **Injuries to the maxillofacial skeleton appear to be uncommon in this series. Pedestrians in their third decade of life are most affected with passenger service vehicles being responsible in the majority of the cases.**

Recommendations: **Interventional programmes targeting pedestrians and those in the third and fourth decades of life should be enacted.**

INTRODUCTION

Road Traffic Accidents (RTAs) constitute a major cause of morbidity and mortality in Kenya. At independence in 1963, the number of accidents recorded by police were 3,578 with 4,784 casualties among whom 548 died and 4,236 were injured. The situation continued to worsen and by 2002 the number of reported accidents had risen to 13,418 with 28,774 casualties among whom 2,782 were killed and 25,992 were injured (1). This gives a rate of nine people killed and 87 people injured per 100,000 people compared to six people killed and 42 people injured per 100,000 people at independence in 1963. This implies that the rate of accidents has been way above that of the population growth. A survey done for the period 1983–1990 involving 12,615 fatally injured victims of RTAs revealed that most of them (90%) were aged 16 years and above (2) and were, therefore, within the most economically active segment of society. Regarding gender distribution, males were more involved in RTAs than females for reasons that are not yet evident. Similar findings have been noted in Nigeria (3) where males (37.5%) in the 21–30-year age range were the most involved.

Various causative factors of RTAs have been identified. These can be categorised into human, vehicle and environmental factors. According to the police records in Kenya, human causes can be attributed to driver errors, pedestrian, pedal cyclist and passenger errors (4). Driver errors, however, pre-dominate and account for a half of all the human causes. For example in the year 2002 there were a total of 10,990 accidents attributed to human causes of which 5,331 were due to driver error (1). These include loosing control, over-speeding, misjudgment and improper overtaking. Alcohol and other substance abuse may impair the driver's judgmental abilities and therefore, directly contribute to these errors. In an effort to reduce RTAs, the government of Kenya through legal notice number 161 made it mandatory for all public service vehicles (PSVs) to be fitted with speed governors and safety belts (4). The legislation came into effect on 2nd November, 2003 and made it compulsory for every PSV including omni-buses, *"matatus"* and private hire vehicles to be equipped and fitted with seat-belts. It further directs that all PSVs and commercial vehicles whose tare weight exceeds 3,048 kgs except taxis and private hire vehicles shall be fitted with a speed governor.

Over the years private salon cars have been the leading vehicles primarily responsible for accidents followed by lorries, buses and taxis put together, and passenger service vehicles with a carrying capacity of between 9-30 people *(matatus)*. For example, in 2002, private salon cars were responsible for 6,931 accidents, lorries, buses and taxis 2,781 and *"matatus" 2,558* accidents (1). Poor vehicle maintenance increases the possibility of RTAs. Pedestrians are the most vulnerable group of road-users injured in RTAs (1). According to the Road Safety Unit of the Ministry of Roads and Public Works (6), 1,152 pedestrians and 1,041 passengers were killed annually for the period 1999 to 2002. An annual average of 2,804 persons were killed for the period 1999 to 2002 and 10,209 people sustained serious injuries which ranged from orthopaedic injuries such as spinal injuries to head injury leading to paralysis.

The incidence of maxillofacial injuries varies with age, region, season, climatic conditions, socio-economic differences, traffic volume and preventive measures taken in different countries (7). Studies done in Kenya (8,9) show the leading causes of maxillofacial skeletal injuries to be interpersonal violence, followed by RTAs. However, data from Nigeria (10) implicate RTAs to be the leading cause. The maxillofacial region is the most exposed part of the body and it is common for it to be involved in trauma resulting from RTAs. It has been variously reported that 20–60% of all the people injured in RTAs had some form of maxillofacial injury (11,12). The forehead has been cited as the most commonly involved site of soft tissue injury while the mandible is the most often fractured facial bone (3). Maxillofacial injuries may directly contribute to the fatal outcome in the fatally injured RTAs victims. A study carried out in Finland involving 84 victims of maxillofacial injuries sustained in RTAs (86% of whom were occupants of motor cars) attributed facial injuries to have been the definitive fatal trauma in 20 cases (13). Injuries in the maxillofacial region may be limited to the face or may be associated with multiple injuries to the chest, head, cervical spine, abdomen and the extremities (14). Knowledge of concomitant injuries in patients with maxillofacial injuries is important in the rapid assessment and treatment planning as well as prevention of further complications. Concomitant injuries that have been

reported include neurological, orthopaedic, chest, abdominal, pulmonary and urological injuries (15). This study describes the pattern and characteristics of RTAs and the associated maxillofacial and concomitant injuries.

MATERIALS AND METHODS

This was a cross- sectional study that included all patients involved in RTAs brought to the casualty and dental departments of KNH, as well as the fatally injured accident victims taken to the KNH mortuary. The study covered a four-month period, from September to December 2004 and involved all age groups. All patients involved in RTAs attended to through the casualty and dental departments, as well as, the fatally injured victims taken to the KNH mortuary during the study period were included. All participants except the fatally injured gave informed consent to participate in the study. Permission to examine the fatally injured was obtained from the Director of KNH. For those aged below 18 years, consent was obtained from their parents or guardians.

Those who did not give consent were excluded from the study. Patients who had life-threatening injuries were first stabilised and interviews were only conducted when it was evident that their lives were out of danger. A specially designed data collection form was used by the investigators to record all relevant information. The information being sought included demographics, case notes from other specialties, radiological investigations and any other laboratory tests done.

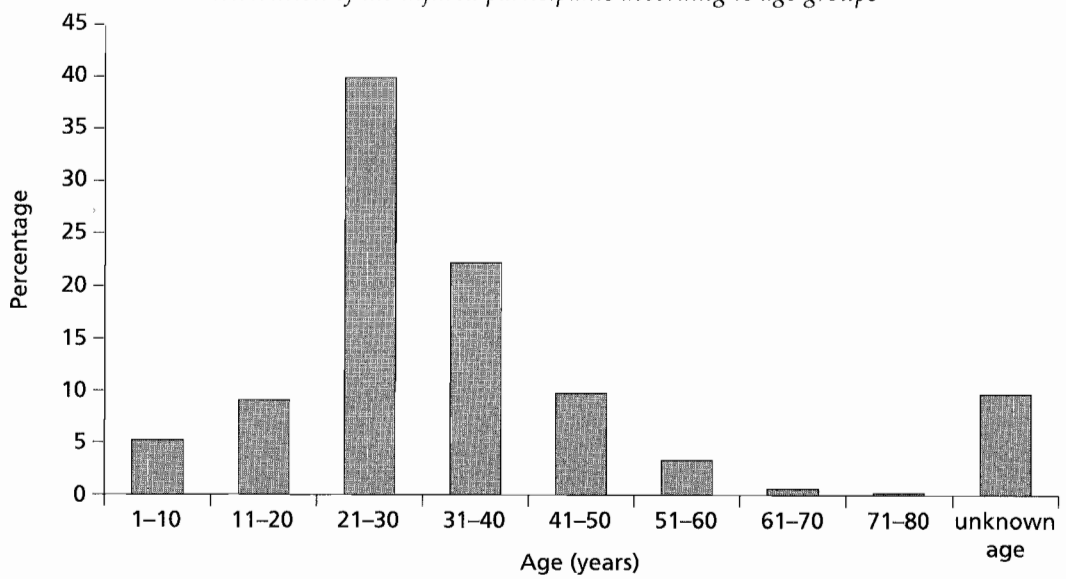
All patients with RTA injuries were examined and the findings documented. Where indicated head injury was scored according to the Glasgow Coma Scale (16). This was done by the investigator who is familiar with the scoring system. For fatalities, autopsy reports were sought to determine the actual cause(s) of death. The victims were examined for general and maxillofacial injuries. Police records were examined for information regarding the circumstances that led to the accidents. Data were analysed using the Statistical Package for Social Sciences (SPSS) version 12 employing relevant statistical tests. This project was approved by the Ethics, Research and Standards Committee of the KNH and the University of Nairobi (Approval No. KNHERC/01/2383).

RESULTS

Demographic characteristics and pattern of RTAs: A total of 482 subjects were examined among whom 413 (85.7%) sustained non-fatal injuries. The males (80.9%) were by far more involved than females (19.1%) giving a male to female ratio of 4:1. While the age range was 1-75 years (mean = 29.65), the 21-30-year age group was the most involved (40%) followed by the 31-40-year age group (22%) as shown in Figure 1. Daytime injuries were recorded in 60.3% of the participants while 39.7% occurred during the night. The incidence of RTAs was highest

Figure 1

Distribution of the injured participants according to age groups



on Fridays (18.5%) but lowest during weekdays with Mondays having the lowest proportion (8.5%) of the total weekly toll. Three hundred and fifty (84.7%) of the participants were first attended to at KNH, the rest were attended to elsewhere then referred to KNH. The proportion of casualties involved in RTAs showed the over-representation of pedestrians. There were 245 (59.4%) pedestrians, 139 (33.7%) passengers, nine (2.2%) cyclists and 20 (4.8) drivers. Most of the accidents were caused by passenger service vehicles which were responsible for 256 (62%) casualties whereas private vehicles were involved in 150 (36.3%) cases. Non-use of safety belts was reported in 90 (56.6%) whereas over-speeding was reported by 120 (29.1%) casualties. Alcohol use by drivers was self-reported in 26 (6.3%) cases, whereas vehicle defects were responsible for 62 (15%) injuries.

Distribution of soft tissue injuries: Three hundred and seventy (89.6%) casualties had soft tissue injuries (STIs) involving the head. Facial cuts accounted for the majority of these injuries 256 (69.2%) whereas injuries to the eye, nose, ear and scalp accounted for the rest. Two hundred and seventy three (66.1%) incidents of STIs involving other parts of the body were noted, among which, the lower limbs accounted for 124 (45.4%), followed by upper limbs 99 (36.3%) and the rest involved the chest and abdomen.

Distribution of skeletal injuries: There were 21(5.1%) casualties with fractures involving the maxillofacial skeleton. The midface was involved in eight cases while a similar number had fractures of the mandible. There were three dentoalveolar fractures, whereas the orbit and nasal bones sustained one fracture each (Table 1).

Table 1

Distribution of maxillofacial fractures

Site	No. of casualties
Midface	8
Mandible	8
Dento-alveolar	3
Orbit	1
Isolated nasal bone	1
Total	21

Skeletal injuries to other body regions were found in 142 (34.1%) patients. The lower limbs were more affected with 61(43%) cases followed by the upper limbs 35(24.6%) cases. Thirteen (9.2%) casualties had spinal injuries among which seven were cervical, four were lumbar and two were thoracic. The rest of the injuries involved the pelvis, skull and ribs. Sixty one casualties suffered lower limb fractures among whom pedestrians accounted for more than one half of them (43% or 66.2%) whereas only 12 passengers were involved. Pedestrians were as well leading in fractures of the upper limbs where they accounted for 23 (65.7%) of these fractures. In general, pedestrians were most involved in all types of injuries (Figure 2).

Head injuries: Where indicated head injury was categorised by using the Glasgow Coma Scale (GCS). A total of 29 (7%) patients had suffered head injury based on the GCS assesment. GCS of 13-15 was reported as mild (15 cases), 9-12 as moderate (nine cases) and eight and below as severe (five cases). When head injury was cross-tabulated against type of road user, it was found that pedestrians were injured more often (16 cases) than either passengers (seven cases) or drivers (six cases).

Comparison of RTAs between 2003 and 2004: Data obtained from the Kenya Road Traffic Police Department on RTAs from February to December 2004 was compared to the corresponding months of 2003 . When analysed on a month by month basis, there was a marked reduction of accidents in the first four months (February, March, April and May) following the implementation of the legislation requiring mandatory usage of the safety-belt and fitting of speed governors by public service and commercial vehicles (22). The number of motor vehicle accidents reduced by 2,737 (2.2%) whereas the number of deaths reduced by 753 (25.1%) (Table 2 and 3).

The average number of accidents per month in the year 2003 was 1126.54 whereas that for 2004 was 877.73 . The difference between the two years was significant ($t = 2.421$, $p = 0.036$). For fatal accidents, the average number of fatalities in the year 2003 was 251.45 while in 2004 it was 192.73. This difference was statistically significant ($t = 3.607$, $p = 0.005$).

Figure 2

Distribution of skeletal injuries according to class of road user

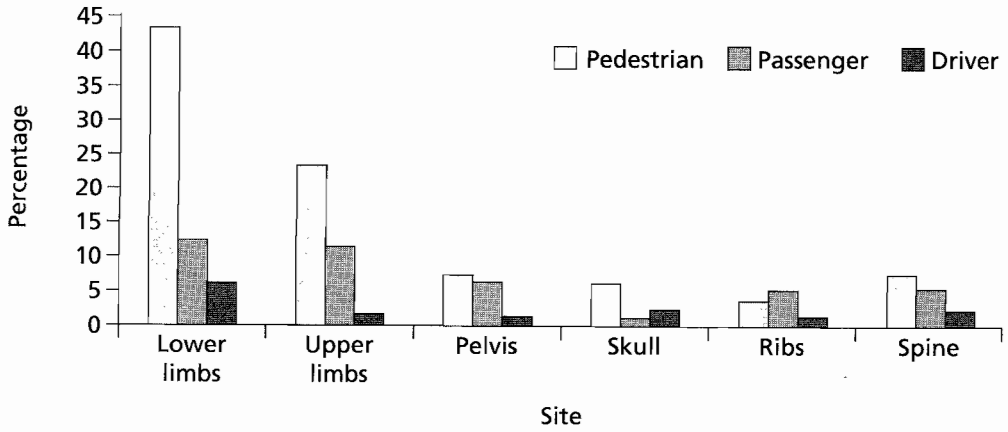


Table 2

Comparison of RTAs between 2003 and 2004

Month	2003	2004	Change	(%) Change
February	1051	350	-701	-66.70
March	1154	520	-634	-55.0
April	1121	404	-717	-64.0
May	1098	460	-638	-58.1
June	1162	1087	-75	-6.5
July	1026	1146	120	11.7
August	1192	1219	27	2.3
September	1180	1107	-73	-6.2
October	1177	1131	-46	-4.0
November	1073	1061	-12	-1.1
December	1158	1170	12	1.0
Total	12392	9655	-2737	-2.2

Table 3

Comparison of RTA fatalities between 2003 and 2004

Month	2003	2004	Change	(%) Change
February	178	92	-86	-48.3
March	205	71	-134	-65.4
April	253	114	-139	-54.9
May	215	93	-122	-56.7
June	240	209	-31	-12.9
July	258	249	-9	-3.5
August	325	270	-55	-16.9
September	269	225	-44	-16.4
October	262	260	-2	-0.8
November	259	272	13	5.0
December	302	265	-37	-12.1
Total	3004	2251	-753	-25.1

Fatal RTAs: Sixty nine (14.3%) of the 482 casualities were fatally injured. The 21-30-year age group was the most involved (20%) followed by the 31-40 and 41-50- year-old age groups both at 15.7%. The least involved groups were the 61-80-year age group (1.4%) and 0-10-year age group (2.9%). There was a high percentage of those whose age was not known (26.1%), however, all of them were adults. Fifty three males and sixteen females were involved giving a M:F ratio of 3.3:1. Figure 3 depicts the age distribution of the fatally injured patients. Most fatal accidents occurred on the highways (72.5%). Residential areas and the central business district (CBD) had 11.6 and 5.8% respectively. *"Matatus"* and minibuses were the leading cause of fatal accidents, together responsible for 28 (40.6%) of road fatalities. Other vehicles that were involved included 14 saloon cars (20.3%), eight trucks (11.6%), four buses (5.8%), four bicycles (5.8%) and one motorcycle (1.4%). The causative vehicles were not known in eight cases.

Fifty (72.5%) pedestrians were by far more involved than other categories of road users. Only ten passengers and nine drivers were fatally injured.

Length of stay: The duration of stay in hospital ranged from zero to 157 days. Zero day implies that they either were certified dead on arrival or died soon after arrival and this category was the majority comprising of 28 (40.6%) cases. Those who stayed for between one and five days before they died were 25 (36.2%), six to 20 days ten patients, 20 to 33 days three patients. Only three individuals stayed in hospital for more than 90 days before they succumbed to their injuries (Table 4).

Table 4

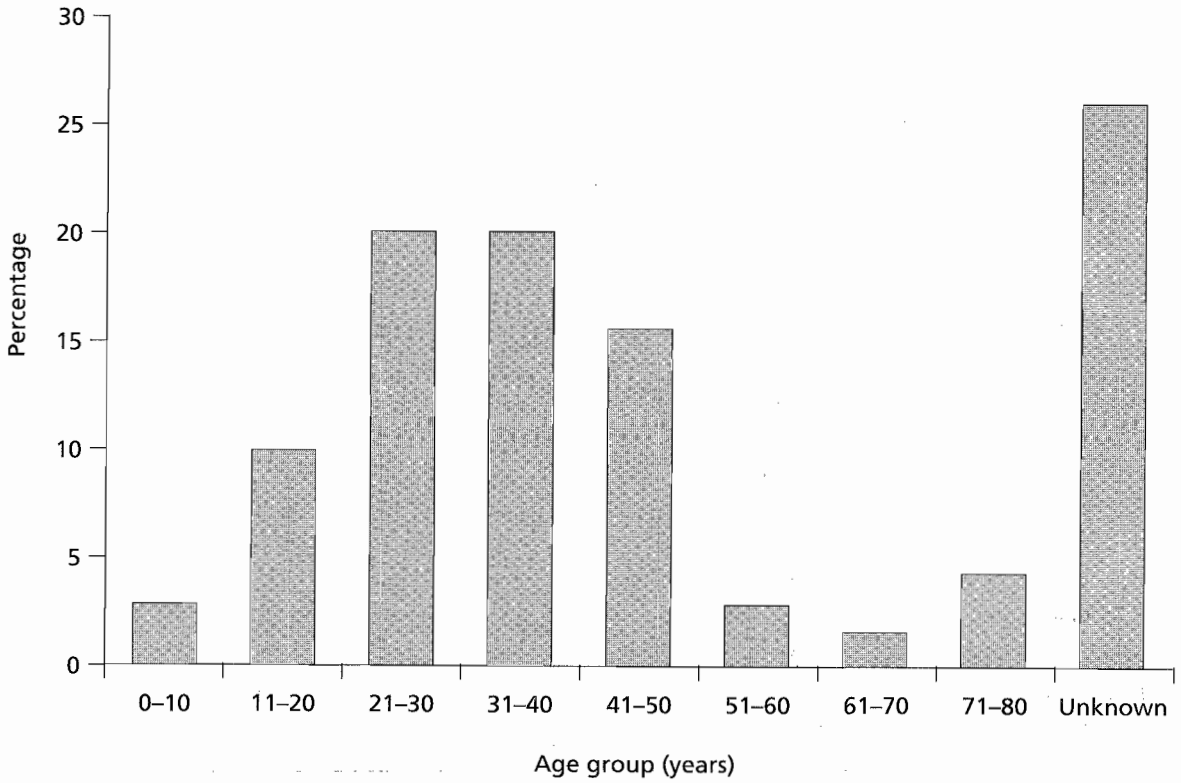
Distribution by number of days spent in hospital (No.=69)

No. of days	Frequency	(%)
0	28	40.6
1-5	25	36.2
6-20	10	14.5
20-33	3	4.3
90-157	3	4.3

Distribution of injuries by anatomical site among the fatally injured: Most of the dead had multiple injuries

Figure 3

Distribution by age of the fatally injured patients



including those to the chest (50 cases), head (46 cases) and the pelvis (13 cases). Injuries to the head region ranged from abrasions to brain evisceration. Forty six (66.7%) victims had injuries to the head region at autopsy. The most common type of injury noted was subdural haemorrhage which was found in 33 (47.8%) cases. Skull fracture was recorded in 20 (29%) victims, brain contusion nine (13.0%), brain laceration seven (10.1%), brain evisceration four (5.8%) and others six (8.7%). Fifteen (21.7%) of the fatally injured had facial injuries all of which were STIs except one involving the mandible and another one involving the maxilla. Neck injuries were found in 17 (24.6%) victims. Cervical bone fracture was the most significant injury noted in this region and it was found in five casualties. The other cervical injuries were mainly minor soft tissue injuries.

Fifty (72.2%) victims sustained injuries to the chest. The most common of this was haemothorax which was found in 22 (31.9%) cases followed by fracture of the ribs which was noted in 21 (30.4%) victims. Injury to the abdomen was found in 42 (60.9%) cases with peritoneal haemorrhage having been the most common 18 (26%) cases. Injury to the viscera was noted in 14 (20.3%) cases, of these eleven (15.9%) developed severe peritoneal infection. Injuries to the lower limbs were more common than those of the upper limbs. Thirty four (49.3%) victims sustained injuries to lower limbs whereas only 19 (27.5%) had upper limb injuries. Fracture of the limbs was the most common injury recorded, 21 (30.4%) involving the lower limbs and nine (13.0%) involving the upper limbs. Thirteen (18.8%) victims had injuries to the pelvis. Pelvic fracture was noted in nine cases whereas pelvic infection occurred in four cases. Severe pelvic haemorrhage occurred in one victim.

Cause of death: The cause of death as indicated in the post-mortem reports ranged from head injury to pulmonary fat embolism (Table 5). Head injury was the predominant cause of death and was identified as the sole cause in 26 (13.7%) cases whereas combined head and chest injuries were responsible for nine (13.0%) deaths. Head and abdominal injuries combined accounted for two deaths as was the case with combined head, chest and lower limb injuries (Table 5).

Table 5

Cause of death

Cause	Frequency	(%)
Head injury	26	37.7
Head and chest injury	9	13.0
Massive haemorrhage	6	8.7
Chest and abdominal injury	6	8.7
Head and abdominal injury	2	2.9
Head, chest and lower limbs	2	2.9
Chest injury	2	2.9
Peritonitis	2	2.9
Abdominal injury	1	1.4
Lower limb	1	1.4
Head and C-spine fracture	1	1.4
Head and lower limbs injury	1	1.4
Others	9	8.4
Total	69	100

DISCUSSION

This study highlights the main features of RTAs in Nairobi with respect to the magnitude and trends, contributing factors, pattern of distribution and the characteristics of casualties involved. The legislation requiring mandatory fitting of speed governors by passenger service and commercial vehicles may have markedly reduced RTAs since the legislation came into effect in February 2004. Within a span of eleven months (February to December 2004) a reduction of accidents by 2.2% and persons killed by 25.1% was achieved. When analysed on a month by month basis, there was a significant reduction of accidents and casualties in the first four months following the implementation of this legislation. Objective assessment of alcohol use by drivers cannot be undertaken by the police as they lack equipment to do so. In the present study a causal relationship between alcohol consumption and RTAs based on self-report is implied.

Age and gender appear to influence the pattern and probability of accident involvement. Males were by far more involved in RTAs than females. The vulnerability of those in the third decade (21-30 year age group) may be explained by their exposure to a hazardous traffic environment. At this

age people are in the prime of their lives and the economic loss to their families and the country as a whole is immense. Development of more focused interventional programmes targeting these age group is required.

Road traffic accident patients are likely to suffer psychiatric illness relating to injuries or their involvement in motor vehicle accidents thereby reducing their productivity (17). Mayou *et al.* (18) found that psychiatric symptoms and disorders had been frequent after major and less severe RTA injury.

Among road-users, pedestrians were more vulnerable to injury and fatality. This could be explained by the increased number of pedestrians and vehicle volume within the city. Non-observance of road traffic regulations by both pedestrians and motorists could have played a role as well as the lack of special pedestrian facilities such as side-walk lanes and fly-overs at high risk road crossing points. Obviously there is need for greater public awareness on road safety and provision of specialised facilities to pedestrians. It has been established that reducing traffic volume in urban areas could significantly reduce rates of child pedestrian injury (19). This may well apply in Nairobi as the traffic police department records have consistently shown the city to have the highest number of pedestrian casualties as compared to the rest of the country (4). In the present study pedestrians suffered more severe skeletal injuries as compared to other categories of road users. For example, in injuries involving the lower limbs, pedestrians accounted for 66.2% whereas only 18.5% of the passengers suffered such injuries.

It is significant to note that the incidence of STIs to the head region (85.6%) was far much higher than that of the rest of the body (66.1%) bearing in mind that the head region comprises of less than 10% of the total body surface area. Of these injuries, the face alone accounted for 69.2% of them as has been shown elsewhere (20). The high incidence of STIs involving the face may be attributed to the fact that it is one of the most exposed parts of the body. In motor vehicle accident dynamics, during the deceleration phase of the accident, the body is propelled forward by momentum and the face may crash against the dashboard for front seat occupants or against the front seats for back seat occupants. Use of safety seat belts minimises the probability of sustaining such injuries as has been underscored in other studies (13). Orsay *et al* (21) have shown that safety belt wearers had a 60.1% reduction in the severity of injury and a 64.6% decrease in hospital admissions. In the present study there was a high degree of non-use of seat belts (56.6%). The high proportion of casualties with soft tissue facial injuries necessitates the involvement of maxillofacial surgeons in the management of RTAs victims. Surprisingly there were very few fractures involving the maxillofacial region as compared to STIs of the face in the present study. There has been a general observation that the soft tissues cushion the skeleton and therefore when there is extensive injury to the soft tissues, there is little or no injury to the skeleton. Furthermore, it is probable that the force of impact was not sufficient enough to cause skeletal injuries and this could be attributed to the introduction of speed governors although it was difficult to quantify such an effect.

The incidence of head injury (7.0%) was low for reasons that were not apparent. It is possible that the majority of patients who sustained head injury died. The limbs in general were more involved when comparing soft tissue as well as skeletal injuries other than those occurring in the maxillofacial region. Notably the lower limbs sustained more injuries than the upper limbs. The reasons for these require further investigation. Injury to the spine was noted in 9.2% of casualties, the majority of which were cervical. This type of fracture is critical as it can lead to serious consequences if neglected during the primary survey and management of trauma patients.

With regard to fatal RTAs, age and gender appeared to influence the probability of being involved in a fatal RTA as was the case with non-fatal RTAs such that more males were prone to fatal accidents than females. It is not surprising that people between the ages of 21 and 30 years were the most affected as this is the age bracket when people are most active in their lives. It is note worthy that unknown ages among victims may have serious implications in terms of medico-legal issues as well as the calculation of damages for insurance purposes. Just as was the case with non-fatal injuries, pedestrians were the most frequently involved in fatal injuries than other classes of road users. Injuries were reported in almost all anatomical sites with a majority of victims having multiple injuries. The pattern and severity of injuries is significant in the triaging of patients who arrive at the casualty following an accident.

In conclusion, injuries to the maxillofacial skeleton appear to be uncommon in this series. Pedestrians in their third decade of life are most affected with passenger service vehicles being responsible in the majority of the cases.

We recommend interventional programmes targeting pedestrians and those in the third and fourth decades of life should be enacted as well as strict enforcement of traffic laws.

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