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Research

Geospatial Distribution of Pedestrian Injuries and Associated Factors in the Greater Kampala Metropolitan Area, Uganda

Frederick Oporia[1,&], Nazarius Mbona Tumwesigye[2], John Bosco Isunju[1], Rebecca Nuwematsiko[1], Abdulgafoor Mahmood Bachani[3], Angela Nakanwagi Kisakye[4,5], Mary Nakafeero[2], Qingfeng Li[3], Fiston Muneza[2], George Kiwanuka[4], Nino Paichadze[6], Olive Kobusingye[1]

[1]Department of Disease Control and Environmental Health, Makerere University School of Public Health, Kampala Uganda, [2]Department of Epidemiology and Biostatistics, Makerere University School of Public Health, Kampala Uganda, [3]Department of International Health and Johns Hopkins International Injury Research Unit, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA, [4]Department of Health Policy, Planning and Management, Makerere University School of Public Health, Kampala Uganda, [5]African Field Epidemiology Network (AFENET), Kampala, Uganda, [6]Department of Global Health, Milken Institute School of Public Health, the George Washington University, Washington, DC, USA

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&CORRESPONDING AUTHOR
Frederick Oporia, Makerere University School of Public Health, College of Health Sciences, New Mulago Hill Hospital Complex, P.O Box 7072, Kampala, Uganda.
Email: foporia@musph.ac.ug

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ABSTRACT

Background: Road traffic injuries (RTIs) are the leading cause of death among 15-29-year olds, of which 22% are pedestrians. In Uganda, pedestrians constitute 43% of RTIs. Over 52% of these injuries occur in Greater Kampala Metropolitan Area (GKMA). However, information on geospatial distribution of RTIs involving pedestrians and associated factors is scanty. We established the geospatial distribution of pedestrian injuries and associated factors in GKMA, Uganda. **Methods:** We conducted a mixed methods cross sectional study in three districts of GKMA. We used a structured questionnaire to interview 332 injured pedestrians at ten purposively selected health facilities from May to July 2017. We used a modified Australian Walkability Audit Tool to assess road characteristics and videography to capture road user behaviour at reported injury sites. Injury location (outcome) was categorized into three locations according to primary land use: residential areas, commercial/business areas and bar & entertainment areas. The injury hotspots were then mapped out using Quantum Geographic Information System (QGIS). Multinomial logistic regression was used to identify factors associated with injury location and adjusted prevalence ratios (APR) reported at 95% confidence interval. **Results:** Males represented 66.5% (221/332) of the sample. Pedestrian injuries were most prevalent among 15-29-year olds (45.5%, 151/332). Most (47.2%, 157/332) injuries occurred in commercial and business areas. Namasuba-Zana (13%, 43/332) followed by Nakawa-Kireka on Jinja road (9.7%, 32/332) had the highest number of injuries. Presence of speed humps was protective (APR=0.13, 95%CI 0.01-0.93). However, zebra crossings (APR=6.41, 95% CI: 1.14-36.08) and clear traffic (APR=6.39, 95%CI: 2.75-14.82) were associated with high prevalence of pedestrian injuries. **Conclusion:** Presence of speed humps was safer for pedestrians but zebra crossings and clear traffic had more than 6-fold risk for injuries. Findings suggest that constructing speed humps on the roads in busy areas and sensitizing motorists to respect zebra crossings could reduce pedestrian injuries.

Background

Globally, 1.3 million people die on the world´s roads every year, out of which 22% are pedestrians [1]. Road traffic injuries (RTIs) are the number one cause of death among 15-29 year olds; and over 90% of these are disproportionately distributed in low- and middle-income countries (LMICs) [2]. Traditionally, most roads in LMICs are designed in the perspective of motor vehicle occupants with little attention paid to pedestrian safety [3]. Intersections, stadiums, commercial areas, residential areas and bars or entertainment centres are candidate locations of pedestrian RTIs [4, 5]. Factors that increase risk of pedestrian injuries are: crossing the road, walking on highways, high population density, marked crosswalks and ignoring designated pedestrian pathways [6-12]. However, separation of pedestrian pathway from the driveway and presence of speed humps are safer for pedestrians [13-15].

In Uganda, just as noted in other studies, [16, 17] increased motorization [18] coupled with increase in human population in greater Kampala metropolitan area (GKMA) [19] has resulted in rising numbers of RTIs among pedestrians. In 2014, Uganda Police reported about 18,686 RTIs in the country, out of which 52% occurred in GKMA [20]. Most injuries (43%) were among pedestrians, with 3-4 injuries occurring daily [20, 21]. Given that 19.7% of Ugandan population lives below the poverty line of USD 2.5 [22], these injuries lead to high socio-economic burden. Some injuries require long-term hospitalization, costing between USD 300-369 in treatment alone, with high likelihood of temporary or permanent disability, and at worst may be fatal [23].

Interventions such as expansion and improvement of roads and creation of walkways on some roads have done little to curb the rising number of pedestrian RTIs in GKMA [24]. Available studies only focused on documenting and characterising RTIs by nature and severity [21, 23, 25, 26]. Information on geospatial distribution of RTIs involving pedestrians and associated factors in GKMA is scanty, hence hindering targeted interventions. We described the geospatial distribution of pedestrian RTIs and associated factors in the GKMA so as to inform government efforts on targeted interventions to improve the walking environs and reduce pedestrian RTIs.

Methods

Study area

The study was conducted in the GKMA. The GKMA is composed of three divisions: Kampala South, North and East [18]. It is the most populated region of Uganda with over four million people [19]. The road network covers over 619 km in length, excluding 700 km of minor access roads and 174 km of new roads [18, 27]. These roads are characterized by, in some places, total lack of street lights and unmarked crossing sites. There is also an invasion of narrow pedestrian walkways by motorists, in addition to risky pedestrian behaviour.

Sample size and sampling procedures

Quantitative data

We determined the sample size using the formula expressed by Kish Leslie [28, 29] for cross-sectional studies on categorical outcomes. The standard normal deviate at 95% level of confidence, estimated prevalence of 39.4% [30] and a 5% precision was considered, which led to a sample size of 367 injured pedestrians. We interviewed the study participants from ten purposively selected health facilities in GKMA including five hospitals, four medical clinics and one level IV health center. Selection of health facilities was based on proximity to major busy roads and services offered by the facility, such as x-ray and CT scan. These facilities were assumed to be more likely to be the first to receive RTI victims.

The level IV health center and clinics were included in order to capture even non-severe injuries. Injured pedestrians were consecutively selected during the three months: May, June and July 2017. Pedestrians who were injured on roads in GKMA and sought medical care from the selected health facilities were included and we excluded those who were not able to respond or complete the interview due to severity of injury or deteriorating health condition and those who declined to participate in the study. Traffic Police Officers, District Physical Planners, District Civil Engineers and officials from Uganda National Roads Authority (UNRA) were purposively selected as key informants.

Variables

The outcome variable was the geographical location of pedestrian injury occurrence. These were categorized into three types according to primary land use: residential areas, commercial and business areas and bars and entertainment areas. The reference category (base outcome) was residential areas. Primary land use was determined by observing the most prominent or dominant activities and features around the injury site and corroborated with the information obtained from the physical planning department of GKMA, in regard to land use of the area. Predictor variables included demographic characteristics of injured pedestrian, speed humps, road design and signalization and volume of motor traffic among others.

Data collection procedures and tools

Spatial and attribute data

Both spatial and attribute data were collected. We used a structured questionnaire to interview injured pedestrians from selected health facilities to obtain information on when and where the crash occurred, activity done when crash occurred, mechanism of injury and other individual factors. Respondents were recruited both from outpatient and inpatient departments of the selected health facilities. Two health care providers who were employed in the respective selected health facilities were trained in data collection; at least one of them was always at the health facility throughout the study period. Where the pedestrian was not able to recall the location of injury, the person who brought him/her to the hospital was interviewed. The locations (96%, 319/332) were corroborated by an informal inquiry from the people who were found around or living near the injury site whether they knew when and where a person was knocked by either a motorcycle or other vehicle. Geographic coordinates of injury sites were obtained using Google maps. . Administrative boundary shape files for the GKMA were obtained from Kampala Capital City Authority (KCCA). These coordinates were projected in universal transverse Mercator (UTM) zone 36N and world geodetic system (WGS) 84 datum. Where the patient reported a prominent feature around the injury site, Google Earth street view with 2015 imagery was used to obtain the coordinates, and thereafter a road audit done around the reported injury site. The 2015 imagery was the most recent imagery of the sites.

Attribute data were collected during the road audit using a context-modified Australian Walkability Audit Tool [31]. This tool was used to collect data such as primary land use of the area, volume of traffic, presence of crossing facilities and number of lanes to be crossed among others. A 5-minute manual count of vehicles was done to establish the volume of traffic around the injury site. Manual counting was chosen because it has been found easier, convenient and reliable [32]. A one-minute video clip was also taken to record the common road user behaviour around the injury site. In situations where it was not possible to visit the injury site on the same day the injury occurred, the field officer responsible for road audits went to the site within 48 hours and did the audit at around the same time when the injury was reported. The time observation was used as a proxy to mimic similar traffic and weather conditions at the reported injury site. However, days of the week were not taken into consideration in this study. At the health facility, the study participants were interviewed using a structured questionnaire to obtain information such as place and time of injury, activity done at the time of injury among others. To minimize recall bias, participants were interviewed within 72 hours from the time they reported to the health facility. The possible delays from the time of injury to time of reporting to health facility were not considered in this study. Only pedestrians who were injured on roads in GKMA and sought treatment from the selected health facilities during the study period were interviewed.

Quality assurance and control

Two healthcare providers (at the level of medical Clinical Officer or Registered Nurse) from each selected health facility were recruited as Research Assistants and trained on how to obtain informed consent and collect data. The study tool originally in English was translated to Luganda, (local language) then reverse translated and compared with the original to see if content had changed. Data were cleaned as the entries were made on a daily basis to ensure completeness, with minor edits that did not change the variables of interest. Updates were given on a daily basis on number of patients received from each participating health facility. During the overlay process of the spatial data, all the geographic coordinates fell within the study area.

Data analysis

Quantitative data

Quantitative data were entered in EpiData 3.0 [33] and exported to STATA 14 [34] statistical software for analysis. In the univariate analysis, the mean and standard deviation were calculated for continuous variables. Age was categorised during analysis, according to WHO categorization for injuries [2, 35]. Given that the outcome had three categories, and since ordering was not important in these categories, multinomial logistic regression (mlogit) was considered most appropriate. The mlogit model was run with 'residential areas′ category as the reference category. Variables that were below 20% level of significance at bivariable analysis as well as known factors from previous studies were included in the multivariable model. Data from the road audit were included in the model and the non-significant ones were dropped. Forward stepwise statistical model building procedure was used and the goodness of fit was tested using the Chi square and the log likelihood statistics. Test of significance was determined at 5% alpha level.

Spatial analysis

Spatial and attribute data were processed using Microsoft Office Excel program and uploaded into Quantum Geographical Information System (QGIS) software version 2.16 [36]. In order to facilitate quick processing and analysis, the coordinate system was transformed to a projected coordinate system with X, Y coordinates in metres. Neighbourhood analysis was done to ascertain patterns of occurrence of incidences within defined neighbourhoods such as administrative boundaries for purposes of visualization of injury hotspots. Heat maps were generated to visualize clusters of count data points. Part of the vector data was converted to raster data so as to produce the heat maps. The maps were generated by creating distance buffer zones around a defined radius of data points and assigning density values to resulting raster pixels.

On the heat map generated, pedestrian injury concentrations are represented by different colour gradients based on intensity of occurrence. The lighter colours represent areas with fewer incidences of injuries whereas the darker colours represent more incidences. However, there were some areas in the outskirts of the CBD that had some high concentrations of pedestrian injuries, especially around busy trading centers/townships (Figure 2andFigure 3). The unit of concentration of pedestrian RTIs is shown on the legend of the figures; which represent number of pedestrian RTIs that increase as the intensity increases. A distance of 50 metres radius for each of the data points was taken based on acceleration and deceleration models of motor vehicle kinetics, where a motor vehicle moving at 80 kph requires about 45-50 metres to stop [37]

Qualitative data

Qualitative data were obtained sequentially (after identifying pedestrian injury sites). A key informant interview (KII) guide was used to obtain expert opinion from nine purposively selected key informants. This was because they were the only available potential respondents in the study area. The key informants included road engineers, physical planners, traffic police and officials from the National Road Safety Council (NRSC). The informants were asked for their opinions on why pedestrian RTIs were particularly more common at the identified locations as compared to other places, and if they had any possible remedies for the reduction of these RTIs. Unified coding and thematic analysis was done [38]. The audio files were listened to by one trained research assistant and the Principal Investigator and transcribed verbatim. This was compared with the hand written notes from the interview. The codes were entered into Atlas.ti version 6.0 [39]. The themes were then identified from the codes using the compare and contrast method [40].

Ethical considerations

Approval was obtained from the Higher Degrees Research Ethics Committee (HDREC) of Makerere University School of Public Health, with clearance from the Uganda National Council for Science and Technology. Informed consent was obtained from every study participant. In circumstances where the injured pedestrian was a minor, consent was obtained from the immediate care taker, after which the minor assented to the study. Confidentiality was maintained by ensuring that no personal identifiers were recorded. Patients were interviewed after they had received medical attention and were medically stabilized.

Results

Background characteristics of injured pedestrians in the GKMA

In this study, a response rate of 90.4% (332/367) was achieved. The 9.6% (35/367) pedestrians were excluded due to severity of injury and therefore inability to participate in the interview. Results show that males represented 66.5%, (221/332) of the sample. The mean age of the study participants (±SD) was 28.5 (±12.3) years. Injuries were most prevalent among 15-29-year olds (45.5%, 151/332). More pedestrians were knocked by a motorcycle (51%, 169/332) compared to motor vehicle (49%, 163/332) (**Table 1**). More than half of the victims (53.9%, 179/332) sustained injuries in lower limbs (**Table 2**); and the largest proportion (59%, 197/332) were knocked while they were walking by the roadside. Most pedestrian RTIs occurred during lunch hours of 12:00 pm to 2:59 pm, (20.4%, 68/332), (**Figure 1**), and nearly an equal number occurred during the two rush hour periods between 6:00am to 8:59am, (18.7%, 62/332) and 6:00pm to 8:59pm, (19.6%, 65/332). In the three months during which the study was conducted, most injuries were reported in June (55.7%, 185/332), followed by May (33.1%, 110/332) and July had the least pedestrian RTIs, 11.1% (37/332).

Geographical location of pedestrian RTIs in the GKMA

Pedestrian injuries were concentrated around the central business district (CBD) of Kampala but relatively reduced as distance increased away from the center to the outskirts. Kampala city had most (59%, 197/332) pedestrian injuries, as represented by red dots on **Figure 2**. The largest proportion of pedestrian RTIs (47.3%, 157/332) occurred in commercial/business areas, followed by bars/entertainment areas (35.2%, 117/332) whereas residential areas had 17.5% (58/332). It was noted that pedestrian injuries were concentrated in Nakawa and Kireka along Kampala-Jinja road and Namasuba, Zana and Kajjansi along Kampala-Entebbe road It should be noted that Jinja is the second largest city in the country while Entebbe has an international airport and the roads to the two places are among the busiest.

Factors associated with geographical distribution of pedestrian injuries in the GKMA

The prevalence of pedestrian injuries in commercial and business areas relative to residential areas was 3.79 times higher when traffic was clear (APR=3.79, 95%CI: 1.71-8.38) and 3.57 times higher when a pedestrian had to cross two traffic lanes (APR=3.57, 95%CI: 1.13-11.18). However, in commercial/business areas relative to residential areas, presence of a speed hump/bump or speed table was 85% protective (APR=0.15, 95% CI: 0.02-0.95) (**Table 3**). Comparing bars/entertainment areas to residential areas, the prevalence of pedestrian injuries was 6.39 times higher when traffic was clear (APR=6.39, 95%CI: 2.75-14.82), and 6.41 times higher when there was a zebra crossing (APR=6.41, 95%CI: 1.14-36.08). Similarly, crossing two lanes had a 3.3-fold increase in prevalence of pedestrian injuries in bars and entertainment areas relative to residential areas (APR=3.30, 95%CI: 1.03-10.58).

Perceived correlates of pedestrian RTIs

According to the key informants, absence of speed humps tempts motorists to drive fast, which in turn increases the risk of knocking down pedestrians who may be crossing the road or just walking along by the roadside. This particular correlate was also found to be statistically significant.

"If there were speed humps in these places, there would be no accidents because vehicles would slow down and people can cross easily." (Road Engineer, 2017).

"Entebbe road is a very busy road which does not have any speed humps yet shops are very near the road, drivers drive very fast." (Traffic Police Officer, 2017).

Some key informants attributed the faded zebra crossings that are hardly seen by motorists as one of the reasons for high number of pedestrian RTIs. This was also noted during the road audit, where 60% (n=15) of the available zebra crossings had faded and hardly seen by motorists. One of the key informants said:

"In most busy roads like Entebbe-Kampala road, there are no zebra crossings; those that are available have faded and cannot be seen by speeding drivers", (Physical Planner, KCCA 2017).

Discussion

This study established the geospatial distribution of RTIs involving pedestrians and associated factors in the GKMA. Results show that the largest proportion of pedestrian injuries occurred in commercial and business areas. These areas are characterized by high population density, where pedestrians and motorists share the same non-demarcated narrow roads. It was expected that there is clear demarcation of land use where places are clearly known to be residential, industrial or commercial among others. However, due to poor town and country planning, the reality on the ground reflects a mix of land uses, which increases the risk of pedestrian injuries [16]. These findings are not unique to greater Kampala alone. Other studies have also found that most pedestrian injuries occur in commercial areas [4, 5, 7, 8, 41, 42].

Entebbe-Kampala road and Kampala-Jinja road had the most hotspots for pedestrian injuries. These roads are two of the busiest in Uganda. Particularly Entebbe road is characterized by many bars, night clubs and other entertainment places. It is also the only road that leads to the international airport of Uganda, tempting motorists to drive fast. This puts the unsuspecting pedestrians at a higher risk of being knocked. Similarly, Nakawa-Kireka on Jinja road is characterized by high human population because of the market, two vocational institutes, a university and a taxi park just by the roadside. These roads are highways, and just like many other studies, highways have been found to be generally risky for pedestrians. [4, 9, 14, 30]

Presence of speed calming mechanisms such as speed humps, speed bumps or speed table at the busy places and junctions was protective against pedestrian injuries. This could be because motorists usually slow down at such points, which allows the pedestrians to cross safely. Although in different settings, studies elsewhere have reported similar findings, e.g. in Oakland it was found that speed bumps were associated with reduced odds of pedestrian injuries [15].

Crossing two traffic lanes increased risk of pedestrian injuries. This may be attributed to a common practice of pedestrians crossing the road in two phases by stopping in the middle to wait for the vehicle to pass, which creates panic especially when they are engulfed in the middle of the road by moving vehicles, as also narrated by some injured pedestrians. More number of lanes also means a wider road, which increases the distance the pedestrian has to walk in the middle of the road, compared to crossing one traffic lane which is narrower. The world report on injuries also stresses road design, such as width, as one of the risk factors for pedestrian injuries [43].

Clear traffic was risky for pedestrians. A possible explanation for this is that when there is traffic jam, vehicles are either stationary or moving very slowly. This allows pedestrians to cross the road with less risk of being knocked. However, when there is clear traffic, most motorists are speeding and less likely to stop for pedestrians, thereby exposing them to a higher risk of injury. This finding is similar to the WHO report, which also emphasizes that low traffic and high speed on clear roads increase risks of pedestrian injuries, and conversely high traffic reduces risk of pedestrian injuries [8, 35, 42].

It was intriguing to find out that zebra crossings were strongly associated with high prevalence of pedestrian injuries in this study, yet they are internationally respected pedestrian crossing facilities that every motorist is expected to observe. However, motorists in the GKMA rarely respect zebra crossings [44]. There is also hardly any enforcement of the law regarding respect for zebra crossings. Additionally, there are no speed limits posted at places where zebra crossings are, and some zebra crossings have faded and hardly visible to motorists. This particularly is a weakness of the local government authorities and Uganda National Roads Authority (UNRA). This state of affairs is not limited to GKMA. A matched case control study in Peru found that pedestrian injuries were more likely to occur at pedestrian signalized locations and junctions [10]. However, in Kampala, an earlier study found that presence of a crossing facility such an overpass is protective [25].

During the road walkability audit, it was observed that nearly all the zebra crossings were not raised and painted bright, apart from a few locations where speed humps had been painted at a zebra crossing. However, in some countries, raised zebra crossings and other marked crosswalks have been used and have been found safer [45, 46]. Raised zebra crossings which are painted bright not only forces vehicles traversing across it to slow down, but its elevation also makes it conspicuous and allows pedestrians crossing it to be seen more clearly by a driver [45]. This particularly also emerged several times from many key informants. Although not significantly associated with pedestrian RTIs, it is important to note that most injuries occurred in June as compared to the other months. This may be possibly because of the more rains experienced in this month, which may increase risks of RTIs as noted in some studies [47, 48].

This study had some limitations; first, spatial correlation was not included in analysis yet it influences interpretation of results in terms of distance. Secondly, information about pedestrians who died at the scene or on the way to a health facility was not included. It is also likely that mostly serious injuries are reported to health facilities, and not all pedestrians who get injured actually report to a health facility, which may have resulted into health care access bias. In the same spirit, it should be noted that only injured pedestrians who reported to the specific selected health facilities and were not seriously injured were included in the study, which may skew the results since the dataset does not include all pedestrian RTIs in the GKMA. Noteworthy is that the study was conducted in a short time (3 months), and therefore may not represent the trends of pedestrian RTIs in other months of the year. However, these months were selected because previous Uganda Police reports that showed more RTIs during the same months; but geospatial distribution was not documented. In this study, we cannot rule out the possibility of recall bias, depending on the severity of the injury. Also, important to note is the wide confidence intervals in some variables may affect the external validity of this study. Road audits that were done on the same day of the injury might have missed out the traffic situation of the area at the time of the injury, since the audit might have been done at a much later time when traffic conditions have changed. We also did not assess the general status of the injured pedestrian for psychosocial factors such as stress, body alcohol content and other factors that could influence road use behaviour.

Further studies are needed to establish the influence of pedestrian-driver alcohol consumption and understanding of road traffic signs. However, the strengths of this study should be noted: the data were collected from pedestrians who were injured during the study period and within 72 hours from the time of injury, which may have minimized some recall bias. Both quantitative and qualitative data were collected, making the study more robust and comprehensive. These results may be generalizable to the three districts of the greater Kampala (Wakiso, Mukono and Kampala), since these districts share many characteristics. A recall period of not more than 72 hours from the time the participant reported to the hospital was considered so as to reduce the recall bias. Medical clinics and lower level health facilities were included so as to capture even the minor injuries.

Conclusion

Results show that crossing a road at a zebra crossing; and having to cross two traffic lanes had a more than 6-fold increase in risk of injury. However, presence of speed humps was protective. From the findings of this study, we suggest the following recommendations: The Ministry of Works and Transport should construct and paint speed humps on roads around Namasuba, Zana, Nakawa and other places that have bars and markets and around zebra crossings. In addition, all zebra crossings should be raised and painted with reflective colours and maintained bright at all times. Concerted efforts are needed to sensitize the public on road safety especially when crossing roads where there is no traffic jam and where there are zebra crossings.

What is known about this topic

- This study involved the establishment of pedestrian RTIs in the greater Kampala metropolitan area, which was already known as reported in the Police annual crime reports to be more common in central Uganda.
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What this study adds

- This study adds a detailed analysis of the geospatial distribution of RTIs involving pedestrians in the GKMA. It also explores the factors that might have contributed to those injuries in the identified hotspots in the GKMA.

Competing interests

Authors have no competing interests to declare.

Authors' contributions

FO: Conceptualized and designed the study and obtained ethical clearance. He was the principal investigator of the study and led in the writing of the drafts of the manuscript and revised the paper for substantial intellectual content. He led the writing of the methods section. RN and ANK: participated in the writing of the draft manuscript and led the writing of the discussion. NMT and MN participated in the review of the draft manuscript and analysis of the quantitative data and interpretation of the statistical results. GK and FM participated in the training of the research assistants and participated in the analysis and writing of the qualitative results. JBI and QL participated in the analysis of the spatial data to generate the heat maps. AMB and NP contributed in scientific editing and critical revision of the manuscript to ensure appropriateness and intellectual content. They also ensured appropriateness of the methods. OK: Gave professional advice on methodology and analysis of data based on her seniority in the field of injury epidemiology. She participated in the review of the draft manuscript and updated on current issues in injury research.

All authors have read and approved the final version of this manuscript.

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Tables and figures

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Table 1: Background characteristics of injured pedestrians in the GKMA	
Variable	**Frequency, N = 332 (%)**
Sex	
Male	221 (66.5)
Female	111 (33.5)
Age in years	**(Mean: 28.5, SD: 12.3)**
0-5	08 (2.4)
6-14	32 (9.6)
15-29	151 (45.5)
30+	141 (42.5)
Occupation	
Pupil (primary school)	35 (10.5)
Student (high school and above)	40 (12.1)
Business	119 (35.8)
Professional	76 (22.9)
Other	62 (18.7)
Education level	
None	44 (13.3)
Primary	113 (34.0)
Secondary	111 (33.4)
Tertiary and above	64 (19.3)
Marital status	
Single	176 (53.0)
Married	140 (42.2)
Divorced	16 (4.8)
Disability before injury	
Yes	11 (3.3)
No	321 (96.7)
Commonest means of transport	
Bicycle	08 (2.4)
Walk	163 (49.1)
Motorcycle	84 (25.3)
Motor vehicle	77 (23.2)
Mechanism of injury	
Knocked by Motor Vehicle	163 (49.0)
Knocked by Motorcycle	169 (51.0)
Month injury occurred	
May	110 (33.1%)
June	185 (55.7%)
July	37 (11.1%)

Table 2: Injury characteristics of the pedestrians in the GKMA		
Variable	**Frequency, N = 332**	**(%)**
Body part injured		
Head	24	(7.3)
Upper limb	31	(9.4)
Lower limb	179	(53.9)
Multiple parts	58	(17.4)
Others	40	(12.0)
Nature of injury		
Cut	13	(3.9)
Laceration	24	(7.2)
Bruise	167	(50.3)
Fracture	117	(35.2)
Other	11	(3.3)

Table 3: Factors associated with pedestrian RTIs at bars and entertainment areas versus residential areas from the mlogit model				
Variable	**Location**		**Crude PR (95% CI)**	**Adjusted PR (95% CI)**
	Bars & entertainment areas (%)	**Residential areas (%)** (Base outcome)		
Sex				
Female	41 (70.6)	17 (29.4)	1.0	
Male	76 (64.9)	41 (35.1)	1.30 (0.65-2.57)	1.81 (0.81-4.04)
Age in years				
0-5	4 (57.2)	3 (42.8)	1.0	
6-14	12 (63.2)	7 (36.8)	1.28 (0.22-7.49)	1.23 (0.13-11.68)
15-29	50 (71.5)	20 (28.5)	1.87 (0.38-9.14)	1.71 (0.23-12.71)
30+	51 (64.5)	28 (35.5)	1.36 (0.28-6.54)	1.38 (0.19-10.10)
Volume of traffic at injury site				
Traffic jam	84 (83.2)	17 (16.8)	1.0	
Clear traffic	33 (44.6)	41 (55.4)	6.14 (3.06-12.29)	6.39 (2.75-14.82)**
Road type at injury site				
Access road	77 (74.7)	26 (25.3)	1.0	
Highway	40 (55.6)	32 (44.4)	2.36 (1.33-4.90)¶	1.73 (0.79-3.76)
Mechanism to slow down traffic				
None	90 (65.2)	48 (34.8)	1.0	
Speed humps	2 (33.3)	4 (66.7)	0.26 (0.04-1.50)	0.13 (0.01-0.93)*
Roundabouts	5 (71.5)	2 (28.5)	1.33 (0.24-7.13)	0.98 (0.15-6.11)
Others	20 (83.3)	4 (16.7)	2.67 (0.86-8.24)	3.28 (0.79-13.62)
Number of lanes to be crossed				
>two lanes	34 (77.3)	10 (22.7)	1.0	
One lane	1 (11.1)	8 (88.9)	0.03 (0.01-0.33)¶	0.39 (0.02-6.29)
Two lanes	82 (67.2)	40 (32.8)	0.60 (0.27-1.34)	3.57 (1.13-11.18)*
Zebra crossing provided				
No	24 (92.3)	2 (7.7)	1.0	
Yes	93 (62.4)	56 (37.6)	7.22 (1.64-31.74)¶	6.41 (1.14-36.08)*
Variable	**Commercial/business areas (%)**	**Residential areas (%)** (Base outcome)	**Crude PR (95% CI)**	**Adjusted PR (95% CI)**
Sex				

Table 3: Factors associated with pedestrian RTIs at bars and entertainment areas versus residential areas from the mlogit model				
Variable	**Location**		**Crude PR (95% CI)**	**Adjusted PR (95% CI)**
	Bars & entertainment areas (%)	**Residential areas (%)** (Base outcome)		
Female	53 (75.7)	17 (24.3)	1.0	
Male	104 (71.7)	41 (28.3)	1.22 (0.63-2.36)	1.78 (0.83-3.78)
Age in years				
0-5	1 (25.0)	3 (75.0)	1.0	1.0
6-14	13 (65.0)	7 (35.0)	5.57 (0.48-64.08)	5.97 (0.37-49.76)
15-29	81 (80.1)	20 (19.9)	12.15(1.19-123.07)	12.08 (0.89-163.43)
30+	62 (68.9)	28 (31.1)	6.64 (0.66-66.70)	7.64 (0.57-102.30)
Volume of traffic at injury site				
Heavy traffic	90 (84.2)	17 (15.8)	1.0	
Clear traffic	67 (62.1)	41 (37.9)	3.23 (1.69-6.20)¶	3.79 (1.71-8.38)**
Road type at injury site				
Access road	92 (77.9)	26 (22.1)	1.0	
Highway	65 (67.0)	32 (33.0)	1.74 (0.97-3.30)	1.50 (0.71-3.09)
Mechanism to slow down traffic				
None	130 (73.0)	48 (27.0)	1.0	
Speed humps	3 (42.8)	4 (57.2)	0.27 (0.05-1.28)	0.15 (0.02-0.95)*
Roundabouts	13 (86.7)	2 (13.3)	2.40 (0.52-11.02)	2.52 (0.48-13.28)
Others	11 (73.3)	4 (26.7)	1.01 (0.30-3.34)	1.45 (0.33-6.25)
Number of lanes to be crossed				
>two lanes	29 (74.4)	10 (25.6)	1.0	
One lane	3 (27.3)	8 (72.7)	0.12 (0.02-0.58)¶	0.85 (0.12-6.03)
Two lanes	125 (75.8)	40 (24.2)	1.08 (0.48-2.40)	3.57 (1.13-11.18)*
Zebra crossing provided				
No	18 (90.0)	2 (10.0)	1.0	
Yes	139 (71.2)	56 (28.8)	3.62 (0.81-16.14)	3.94 (0.70-22.17)
Significant at bivariate analysis, **statistically significant at p=<0.001, * statistically significant at p=0.05. PR- Prevalence Ratio, CI- Confidence Interval.				

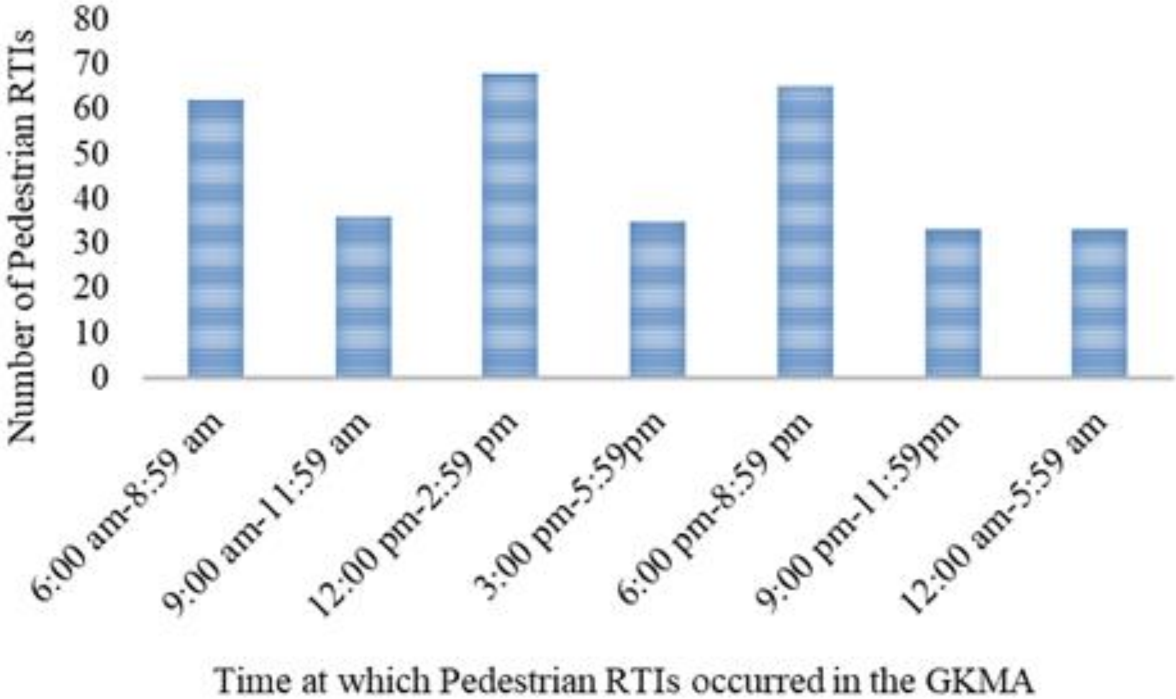

Figure 1: Time at which pedestrians were injured in the GKMA

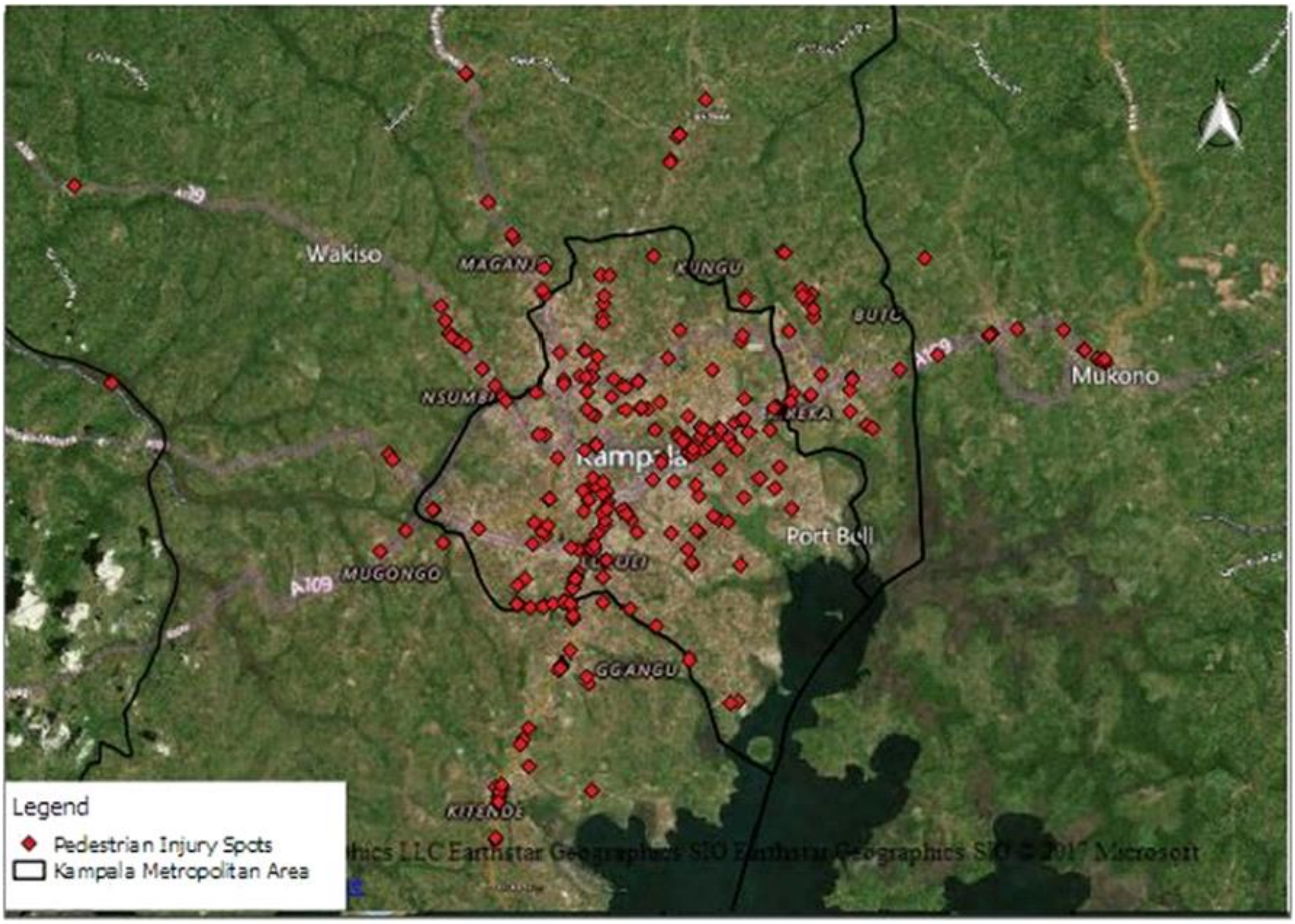

Figure 2: Geographical locations of pedestrian RTIs in the GKMA

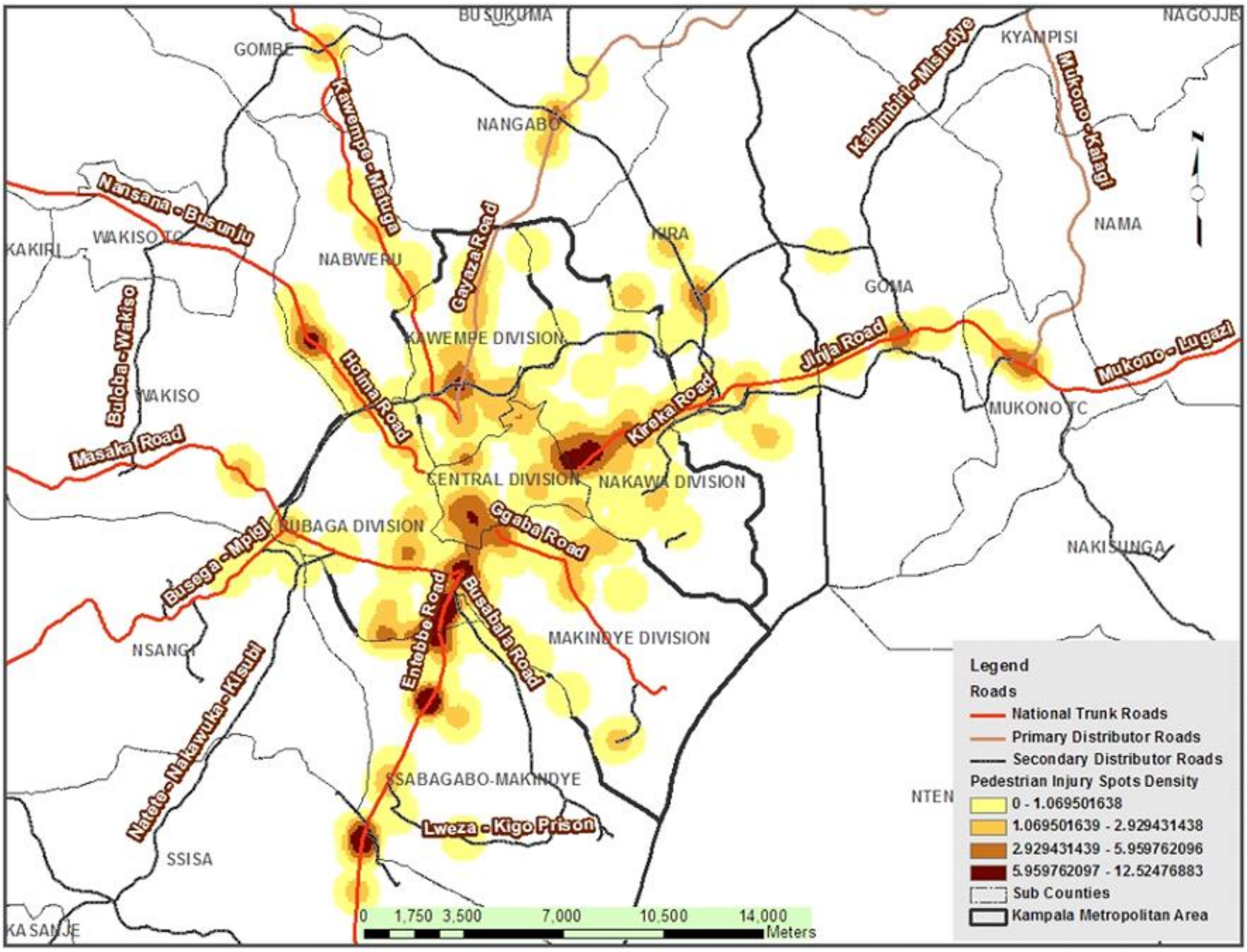

Figure 3: Heat map showing pedestrian injury concentrations in the GKMA