

Road Traffic Injury on Rural Roads in Tanzania: Measuring the Effectiveness of a Road Safety Program

KAREN ZIMMERMAN¹, DEEPANI JINADASA¹, BERTHA MAEGGA², and ALEJANDRO GUERRERO³

¹*Amend, Dar es Salaam, Tanzania*

²*Tanzania Public Health Association, Dar es Salaam, Tanzania*

³*Intertrauma Medical Consulting, New York, New York*

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Objective: Road traffic injuries (RTIs) are a major public health burden, especially in low- and middle-income countries. There is limited data on RTIs in low-volume, rural African settings. This study attempted to survey all individuals living in households within 200 m of two low-volume rural roads in Tanzania and to collect data on RTIs.

Methods: Local communities and users of the Bago to Talawanda road (intervention site) and Kikaro to Mihuga road (control site) were targeted and received an intensive program of road safety measures tailored using the crash characteristics of the baseline sample. Demographic data on all household members were collected, and those individuals who suffered an RTI in the previous 3 months had comprehensive information collected about the crash characteristics and the socioeconomic impact. The follow-up data collection occurred nine months after the baseline data were collected.

Results: The majority of crashes that caused an RTI involved a motorcycle (71%) and the majority of victims were male (82%) with an average age of 27. Injuries to the legs (55%) were most common and the average length of time away from normal activity was 27 (± 33) days. RTI incidence at the intervention site increased during the course of the study (incidence before vs. incidence after) and was unchanged in the community control (incidence before vs. incidence after).

Conclusion: The incidence of RTIs in the low-volume rural setting is unacceptably high and most commonly associated with motorcycles. The change in incidence is unreliable due to logistic restraints of the project and more research is needed to quantify the impact of various RTI prevention strategies in this setting. This study provides insight into road traffic injuries on low-volume rural roads, areas where very little research has been captured. Additionally, it provides a replicable study design for those interested in collecting similar data on low-volume rural roads.

Keywords: road safety, road traffic injuries, low-volume roads, Tanzania, rural communities

Introduction

Road traffic injuries (RTIs) and correlated deaths are a major public health concern, particularly in low- and middle-income countries. Low- and middle-income countries account for the majority of road traffic deaths, with young males and vulnerable road users especially affected (World Health Organization 2013). With predictions that road traffic injuries and deaths are on the rise and trends suggesting that by 2030 road traffic deaths will move to the fifth leading cause of death (World Health Organization 2013), it is important that all aspects of this public health issue are understood.

By 2050, the population of the continent of Africa is predicted to grow substantially (United Nations 2004). Along with this growth, motorization is expected to increase. The African region already has the highest road traffic fatality rate

(World Health Organization 2013) and with more vehicles, there will be a greater risk of injury and death, unless proper measures are taken to improve road safety.

Though literature is available about RTIs in urban areas, characteristics and incidence in rural regions are not as well quantified. In order for national strategies and policies to accurately include rural communities, RTIs in these areas should be better understood. This study sought to quantify the scope of RTIs along 2 low-volume roads in Tanzania. In addition to determining the scope of RTIs, a road safety intervention was implemented along the study roads and follow-up data were collected to see the impact of such a program in injury patterns.

Methods

Study Area

Data were collected along the length of two rural roads in the Bagamoyo District of Tanzania, approximately 100 km

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Address correspondence to Karen Zimmerman, Amend, P.O. Box 152, New York, NY 10101. E-mail: kzimmerman@amend.org

northwest of Dar es Salaam, the commercial capital. The intervention site was the Bago to Talawanda road (Figure 1, see online supplement), which runs from Bago village through three other small villages and settlements to Talawanda village. Bago has a population of approximately 3,000 people and is situated on a major regional highway. The road was being upgraded from unpaved to paved during the time of this research. Talawanda has a population of around 6,500 people and has a weekly market that attracts people from nearby villages.

The Bago to Talawanda road is approximately 20 km in length, passing through a rolling landscape with gentle hills and long bends. A few short sections have been paved, but most of the length of the road is unpaved. Farming is the predominant economic activity, mostly at a subsistence level. Crops include cotton, maize, sesame, sunflowers, pineapples, and oranges. Long stretches of the road, between villages, are bordered on both sides by agricultural land. Many households keep livestock, such as goats and chickens.

The control site was the Kikaro to Mihuga road (Figure 2, see online supplement), which runs from Kikaro village through five small settlements to Mihuga village. Kikaro has an estimated population of 3,000 people and is situated on a district-level paved road. Mihuga is a small village with a population of around 1,000 people. The Kikaro to Mihuga road is approximately 13 km in length and is similar to the Bago to Talawanda road in that it passes through a rolling landscape with gentle hills and long bends. However, the full length of this road is unpaved. Economic activity along this road is also similar to that along the Bago to Talawanda road, with mostly subsistence farming.

Sampling Strategy

A direct, total population sampling technique was used in selecting households to be interviewed. All households within 200 m of the study roads, along the entire length, were targeted. This technique was chosen to determine the RTI incidence rate among a population of rural road users living in close proximity to a rural road. This targeted population was selected because the extremely low population density of the geographic area and their variable distance from the road was unlikely to provide sufficient RTI data to reasonably allow a generalization to be made that would be valuable for the prevention program to be created.

Study Tools

Household surveys were used to collect the data. A team of project assistants was recruited to collect the before and after data at each of the two study sites. The recruitment technique is described in a previous publication (Guerrero et al. 2011). The survey was administered to members of households living alongside the study road. A distance of 200 m from each study road demarcated the geographical boundary of the study population and all households within this boundary were selected for interviews. In addition, at each end of the study roads, all

households living within 200 m of the junction in all directions were interviewed.

Information on age, sex, and whether an RTI had occurred within the past three months was collected for every member of a household. If an injury had taken place, the project assistants proceeded with a questionnaire to record details of the road crash and the impact of the road crash on the household.

Data Management

Data were managed using Statistical Package for the Social Sciences version 17.0 (SPSS). Demographics were calculated for the denominator and an injury incidence was tabulated. Frequencies and means were calculated for categorical and continuous variables, respectively. If an individual was still recovering from an RTI at the time of interview, the time from the occurrence of the RTI to the day of the interview was recorded as the number of disability days. For the purposes of analysis, children under the age of one were considered one year old.

In order to appreciate the economic impact of the RTIs in this community, disability days were averaged and summed in total and in each age group without regard for severity. Though recall has been found to be variable, all injuries were included to get the broadest description of injury characteristics and circumstances (Mock, Acheampong, Adjei, Koepsell 1999; Mock, Abantanga, Cummings, Koepsell 1999). Fisher's exact test was used for contingency analysis in categorical variables and analysis of variance was used for comparing multiple groups. Significance was taken to be $P < .05$.

Ethical Clearance

The National Institute for Medical Research in Tanzania gave ethical clearance for this study.

Road Safety Intervention

A road safety intervention program was created as a result of the findings during the baseline data collection. Many of the interventions were focused around motorcycle safety, because the injury incidence among motorcycle drivers and passengers was especially high. One hundred motorcyclists were selected to receive a one-week driver training course, all of whom passed and received a license. These motorcyclists also received reflector vests and two helmets each (one for the driver and one for a passenger). Twenty-six motorcyclists also received a back support for their motorcycle.

Two thousand one hundred fifty schoolchildren from five primary schools and one secondary school received reflector enhanced school bags and road safety education. At the same schools, 56 teachers received training in road safety. The road safety education program included instruction such as how to walk safely along a rural road, how to identify safe and dangerous places to cross the road, and how to be seen by other road users. There were 195 adults living along the study road who also received road safety education. One thousand reflective

stickers were distributed to cyclists and pedestrians and 300 calendars displaying road safety messages were distributed to community members.

The community living along Kikaro to Mihuga road received the same road safety interventions immediately after the follow-up data were collected.

Results

The baseline data included a study population of 2,203 and 20 people reporting an RTI, resulting in a nonfatal incidence rate of 3.6 RTIs per 100 person years at Bago to Talawanda road (intervention site) and at Kikaro to Mihuga road (control site) there were 1,343 sampled and 13 people reporting an RTI, resulting in a nonfatal incidence rate of 3.9 per 100 person years. There were 2,027 people surveyed and 28 RTIs reported during the follow-up at Bago to Talawanda road, resulting in a nonfatal incidence rate of 5.5 RTIs per 100 person years and 1,753 individuals surveyed with 21 injuries reported and a nonfatal incidence rate of 4.8 RTIs per 100 person years at Kikaro to Mihuga road (Table 1, see online supplement).

The average age of those injured at baseline at Bago to Talawanda road was 28.3 (± 16.9) and at follow-up the average age was 22.9 (± 12.8). At Kikaro to Mihuga road, the average age at baseline was 24.6 (± 16.1) and at follow-up it was 33.1 (± 21.4).

Children 17 years and under were involved in 25% of all RTIs at the intervention site during the baseline data collection and 28% at follow-up. At the control site, the proportion of children involved in an RTI was the same (38%) in both the baseline and follow-up data.

At both sites and also before and after, males represented the majority of those involved in an RTI. Dirt roads and highways were the most common place for the RTI to occur. The majority of the variables from the 2 groups were found to be similar; however, RTI incidence at the intervention site increased significantly during the course of the study (pre vs. post, $P = .004$) but not in the community control site (pre vs. post, $P = .72$).

Injuries to the legs were most commonly reported in both groups, representing 35% of all injuries at baseline and 68% of all injuries at follow-up at Bago to Talawanda road and 70% of all injuries at Kikaro to Mihuga road at baseline and 48% of all injuries at follow-up (Table 2, see online supplement).

This study found that the most common type of RTIs were those that involved a motorcycle, specifically, those injured while riding a motorcycle, injured while riding a motorcycle taxi, and being hit by a motorcycle taxi. Injuries involving motorcycles represented 71% of all injuries (Table 3, see online supplement).

At the control site, the number and proportion of RTIs involving motorcycles was identified to be higher during the follow-up data collection than during the baseline data collection. The proportion of RTIs involving bicycles was identified to be lower during the follow-up data collection than during the baseline data collection.

The proportion of motorcyclists at the intervention site who were wearing a helmet at the time of the RTI was approx-

imately the same both before (66%) and after (63%) implementation of the intervention. At the control site, the proportion of motorcyclists wearing a helmet when they suffered an RTI was identified to be greater in the follow-up data (63%) than in the baseline data (50%).

At the intervention site and at the control site, the numbers and proportions of RTIs involving 4-wheel motorized vehicles was lower in the follow-up data than in the baseline data, with no RTIs involving 4-wheel motorized vehicles being identified at either site during the follow-up data collection.

At the intervention site, 25% of all RTIs identified during baseline data collection involved pedestrians, and this percentage reduced to 18% for the RTIs identified during the follow-up data collection. At the control site, pedestrians accounted for 46% of RTIs in the baseline data collection and 19% in the follow-up data collection.

Those involved in an RTI sought medical attention over 90% of the time at both baseline and follow-up in both groups and was most commonly provided at a hospital or clinic. In almost all circumstances, money was spent on treatment and income was lost as a result.

Of the 82 victims who were involved in an RTI, 19 (23%) spent one night or more in hospital. The number of RTI victims who spent one or more nights in a hospital decreased at both the intervention and control sites. At the Bago to Talawanda road, the baseline data identified that 35% of RTI victims spent one or more nights in hospital compared to 14% at follow-up. At the Kikaro to Mihuga road, the baseline data identified that 31% of victims spent one or more nights in hospital compared to 19% at follow-up.

Though roadside assistance was provided and medical attention was sought following an RTI, less than 5% at the intervention site and less than half of those injured at the control site filed a police report.

There was one person who had a permanent disability as a result of a crash during the intervention baseline and none reported at follow-up. At the control site one person at both baseline and follow-up had a permanent disability. There were no deaths reported.

At the intervention follow-up, those reporting having received preventative education increased by 38%, whereas at the control site it increased by 26%.

Discussion

RTIs on rural roads contribute to the increasingly significant problem of RTIs. This study supports other sources reporting this problem in rural areas of low- and middle-income countries (Ae-Ngibise et al. 2012; Afukaar et al. 2003; Kobusingye et al. 2001; Moshiro et al. 2005). A Ghanaian study that investigated police data found that 61.2% of road traffic fatalities and 52.3% of injuries occurred on rural roads (Afukaar et al. 2003). Another study found that though there was a lower risk of an RTI among those living in rural areas of Tanzania, they often experienced more serious consequences (Moshiro et al. 2005). A study looking at injury mortality in a rural South Africa setting found that RTIs accounted

for 26% of all injury deaths in adults and were classified as a major cause of death among all injuries (Garrib et al. 2011).

This study showed that RTIs involving a motorcycle were most common. Motorcyclists are classified as vulnerable road users, because they are not as well protected and share the road with high-speed cars and trucks and are therefore at higher risk (Constant and Lagarde 2010; World Health Organization 2013). A population-based study carried out in Nigeria reported that 54% of those injured were riding on a motorcycle at the time of the traffic accident (Labinjo et al. 2009). One systematic review showed that helmet use reduced the risk of fatal injuries by 42% (Constant and Lagarde 2010). In addition to gaining their license, motorcyclists and their passengers should invest in helmets. Interventions that target this specific group in addition to other vulnerable road users should be considered.

As with other studies, men were more likely to both be involved in an RTI and die as a result of an RTI (Ae-Ngibise et al. 2012; Bhalla et al. 2009; Garrib et al. 2011; Jacobs et al. 2000). The average age of men in this study ranged from mid-20s to mid-30s. These findings are consistent with other reports (Afukaar et al. 2003; Labinjo et al. 2009, Mogaka et al. 2011) indicating that RTIs affect a portion of the population that are in their prime of economic productivity. It is reported that these injuries not only affect the economic productivity of males but also drain developing economies (Peden and Hyder 2002).

Though there has been growth in the Tanzanian transportation sector, more attention is needed on this matter (Tanzania National Roads Agency 2011; UNESCO National Commission 2010). Road travel is the most common mode of transportation in Tanzania, though it is estimated that only 7% of the roads are paved (Tanzania National Roads Agency 2011; UNESCO National Commission 2010). In Tanzania's rural areas, road travel involves the use of paths that connect to village and rural district roads. These rural roads have a mix of road users who are competing for space, thus creating a dangerous environment for vulnerable road users (Ministry of Transport 2011).

Though there is no literature providing evidence of a correlation between road safety education of a population and a reduction in injuries, it is widely accepted that road safety education should be included as an integral part of any comprehensive program of road safety measures. As part of this study, education was provided to children on safe use of rural roads and to recipients of road safety materials, such as motorcycle helmets, on why and how to use these materials. The data showed that more people reported receiving preventative education at follow-up than at baseline at the intervention site.

There were several limitations as a result of the methodology and the research environment. Due to project duration constraints, the length of the study was 9 months and therefore the baseline and follow-up data were collected during different months. Baseline data collection occurred during June and July 2012 and follow-up data collection occurred during February and March 2013. Seasonality in road use may have affected the results, because the collection periods were not equivalent and may have been biased by seasonal varia-

tion in travel behavior and climate conditions. The baseline data collection period followed an intense rainy season, which falls in April and May in the Bagamoyo District. The roads may have been slippery and in poor condition during rainy seasons. The intervention community may have also experienced RTI sensitization as a result of the road safety interventions and may have been more likely to recall and report RTIs. The direct total population sampling technique also presents a limitation, because it is difficult to determine whether all households were reached. Though the study team attempted to reach every household within 200 m of the road, the rural characteristics of the sites may have prevented the study team from capturing every household.

In this study, RTIs, especially those involving a motorcycle, were found to be a major public health problem. Bago to Talawanda and Kikaro to Mihuga roads in Tanzania were found to have a high RTI incidence and unique crash characteristics associated with motorcycle use, a long disability time, and predominantly involving working-age males. Interventions should target the taxi drivers and motorcyclists (both taxi and regular drivers) in these communities. The impact of the road safety program cannot be accurately measured because of methodological shortcomings as a result of logistical restraints. More research should be done to accurately quantify the impact of various interventions on RTI incidence and socioeconomic impact.

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Supplemental Material

Supplemental data for this article can be accessed on publisher's website

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