ORIGINAL ARTICLE

Public road transport crashes in a low income country

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Objective: To assess the safety of government versus non-government public road transportation.
Design: Descriptive study.
Setting: Kandy Municipality Area, Sri Lanka.
Subjects: All road traffic crashes reported to the Kandy Police from 1 October 1998 to 30 September 1999.
Main outcome: Involvement in a road traffic crash reported to the Kandy Police in which a government bus, private bus, or a three-wheeler was involved.
Results: During the study period, 132 government buses, 243 private buses, and 115 three wheelers were involved in 437 police reported road crashes. Of these crashes, eight (1.8%) were fatal and 132 (30.2%) were crashes resulting in injury requiring hospitalization. The majority of road crashes involved vehicle-vehicle interaction (63.4%) and vehicle-pedestrian interaction (17.8%), while the remainder consisted of vehicle-passenger and vehicle-road structure crashes. The research highlights an increased risk associated with travel on privately owned buses (RR = 2.0, 95% CI 1.6 to 2.5) and three wheelers (RR = 2.2, 95% CI 1.7 to 2.8) compared to travel on government buses. The disparity in crash rates between government and privately owned transportation modes can be explained, in part, by fewer safety requirements being imposed on the deregulated public transportation system.
Conclusions: Recommendations are made in order to address the differential in crash rates between public and private vehicle ownership used for public transportation in Sri Lanka.

An estimated 1.2 million road deaths occur annually worldwide, of which the majority occur in middle and low income countries.[1] In addition to these deaths, between 20 million to 50 million people are estimated to be injured or disabled from road crashes each year[2–4] with the impact on the economy of low income countries estimated at 1% to 2% of the country's gross national product per annum.[1]

Sri Lanka, a low income country, is facing a significant health burden due to road traffic crashes. Over a period of 60 years, the absolute number of road traffic crashes has increased 12-fold resulting in 1835 deaths in 1997.[5 6] An old motor vehicle fleet, excessive carriage of passengers (beyond the vehicles design), poor road design and maintenance, and the traffic mix are just some of the factors contributing to the high crash rate in low income countries.

In many low income countries, the only available transportation is public transport. Buses (both government and privately operated) and three-wheelers (or motorized rickshaws) are the predominant mode of public transport for residents in Sri Lanka and although three-wheelers differ in design from buses, in order to assess the safety of available public road transport it was necessary to include both buses and three-wheelers in this study. As alluded to above, buses are either government or privately owned and the three-wheeler is privately owned. The government buses are maintained by the Ministry of Transport and are regulated by rules to supply the public with a safe mode of transport. These include a pre-employment medical examination of drivers, a probationary period of five years with a heavy vehicle license, a three-yearly renewal of the license and medical examinations, a post crash convalescence period following a road traffic crash, and the regular maintenance of the vehicle[7 8]

In 1979, the Sri Lankan government introduced the private bus industry in order to supply the public with an alternate transport system. Private buses operate on the same routes as government buses and passengers tend to board the first bus that arrives. This leads to competition where an individual private bus operator has the opportunity to carry a large share of the passengers on any given route.[9] Usually the driver does not own the bus and the owner can employ any licensed driver.[10]

In contrast, the three-wheeler is a passenger transport vehicle with three wheels and is similar to a scooter/motorcycle for handling characteristics (see fig 1). Three people can sit in the seat situated behind the driver, but up to 5–6 people are often seen travelling as passengers. Without insurance and a revenue license, three-wheeled vehicles cannot be driven on the roads of Sri Lanka. Therefore, similar to other vehicles, all three-wheelers are insured.

The three-wheeler was introduced to the roads of Sri Lanka in 1990 to provide a convenient mode of public transport compared to buses (three-wheelers are fast and provide greater access to urban areas). The situation with three-wheelers is similar to that of private buses—namely, the driver is not the owner and the owner can employ anyone as a driver. As it is a smaller vehicle, often the driver has had little training and usually does not hold a valid license.[11]

Figure 1 The three-wheeler.

Table 1 Severity of the crash by mode of transport

Mode of transport	Fatal	Injury producing	Damage only	Total
Government bus	1	30	101	132
Private bus	5	60	178	243
Three-wheeler	2	42	71	115
Total	8	132	350	490

To date, there has been no research to assess the safety of travel on various public road transportation systems in Sri Lanka. The aim of this study therefore was to assess the safety of government versus non-government modes of public road transportation.

METHODS

The study was conducted in the Kandy Municipality Area. The city of Kandy (located in the Kandy Municipality Area) is located 110 km northeast of the city of Colombo, the capital of Sri Lanka. It is the hill capital of the country and is the administrative center of the Central Province of Sri Lanka which has a population of 201 970.[12 13] In order to claim insurance, all road traffic crashes must be reported to the police within 24 hours.[14] Kandy police interview all victims of road traffic crashes and document information on the social, demographic, and economic aspects of the individual(s) along with a description of the crash, environmental conditions at the time of the crash, vehicular characteristics, and the action of the driver at the time of the crash. The driver's license and the required documents for the vehicle are also reviewed by the police. A blood alcohol test is also conducted depending on the condition of the driver.[11]

Data on all police reported road traffic crashes were collected for the period 1 October 1998 to 30 September 1999 only if a government bus, private bus, or a three-wheeler vehicle was involved in the crash. Crashes where the vehicle was stationary and the driver was not in the vehicle at the time of the crash were excluded from the study.

Comparisons of the means for continuous variables were undertaken using one-way analysis of variance. All p values were two-sided and were considered significant at 0.05 and 95% confidence intervals were calculated using standard errors from the analysis. Analyses were undertaken using STATA statistical software.[15] The incidence rate (IR_i) for a crash was calculated for each of the three transportation modes; government bus, private bus, and the three-wheeler. Data for the numerator c_i—(where i takes the values from 1 to 3; 1 = government bus, 2 = private bus, and 3 = three-wheeler) was obtained from the Kandy police and defined as a crash involving one of the vehicle types that was reported to police during the period 1 October 1998 to 30 September 1999. The denominator for the incidence rate [($T_i = v_i.t_i.d_i$,—where i takes the values from 1 to 3; 1 = government bus, 2 = private bus, and 3 = three-wheeler] was calculated by combining the total number of vehicles (v_i), the number of trips per day (t_i), and the number of days (d_i) per year the vehicle was used.

$$IRi = \frac{ci}{Ti}$$

To determine the number of registered vehicles for each transportation mode, interviews with the managers of the Kandy Bus Company and the Private Bus Transport Unit, with the Central Provincial Council of the Ministry of Transport and Highways, and the President of the Three-Wheeler Driver's Association were conducted. To estimate the number of trips per day and the number of days per year the vehicle was used, a random sample of 25 government bus drivers, private bus drivers, and three-wheeler drivers, respectively, were interviewed.

The risk of a crash for a government bus versus private bus and government bus versus three-wheeler was determined by estimating the risk ratio (RR):

$$RR = \frac{IRi}{IRj}$$

where IR_i is the incidence rate in non-government vehicles, namely a private bus or a three-wheeler, and IRj is the incidence rate in government buses.

The Ethical Review Committee of the General Hospital, Kandy, approved the study. Informed consent was obtained from all participants for personal participation and use of records.

RESULTS

During the period of the study, 132 government buses, 243 private buses, and 115 three-wheelers were involved in 437 police recorded road crashes. Of these crashes, eight (1.8%) were fatal and 132 (30.2%) were crashes resulting in injury requiring hospitalization (see table 1). The majority of crashes involved vehicle-vehicle interaction (63.4%) and vehicle-pedestrian interaction (17.8%), while the rest consisted of vehicle-passenger and vehicle-road structure crashes. Only 13 (2.7%) of the drivers of these vehicles were detected to be under the influence of alcohol and only 36 (7.3%) of the motor vehicles involved in the crash were found to have a mechanical defect that may have contributed to the crash. The majority of the crashes (73.7%) occurred during the day and in dry weather conditions (78.7%). All drivers of the vehicles were men. There was a statistically significant difference in the age of the drivers between transportation modes ($F = 42.38$, $df = 2$, $p<0.001$) with government bus drivers significantly older (mean age 38.8 (SD 8.2) years) than the drivers of other transportation modes (private bus mean age 34.8 (SD 10), three-wheeler mean age 27.6 (SD 8.7)). Twenty three percent of three-wheeler drivers involved in a crash did not have a driver's license, while 7.8% of them were detected to be under the influence of alcohol at the time of the crash. The government and private bus drivers had comparatively lower levels of these deficiencies (no license 0.8% and 5.3%, under the influence of alcohol 0.8% and 1.2%, respectively).

Table 2 Incidence rate of crashing by transportation mode

	Government bus	Private bus	Three-wheeler
Incidence rate (per 100 000 trips)	5	10	11
95% CI	4.2 to 5.8	8.7 to 11.3	9 to 13
Risk ratio	1.0	2.0	2.2
95% CI	–	1.6 to 2.5	1.7 to 2.8

There were 790 government buses and 1066 private buses in the Kandy District and two hundred three wheelers in the Kandy Municipality Area during the study period. The average number of trips undertaken by a government bus per week was 66; a private bus 42; whereas for three wheelers, it was 100 trips per week. The incidence rate of crashing varied between the three transportation modes, being five per 100 000 trips for government buses, 10 per 100 000 for private buses, and 11 per 100 000 for three-wheelers, with an increased risk of crashing while travelling on private buses and three-wheelers (see table 2).

DISCUSSION

The aim of the study was to investigate the safety of government versus non-government modes of public road transportation. Until now, no research has investigated the propensity of crashing by mode of transport in Sri Lanka.

The findings highlight a greater risk of crashing when travelling by private bus or three-wheeler compared to travel on government buses, with a twofold greater risk of crashing while travelling in either of these transport modes. Clearly, the risk faced by the commuter when using private rather than public transportation vehicles in the Kandy Municipality Area is greatly increased. Some of this differential is explained by the fact that private buses and three-wheelers can be driven by anyone; the drivers do not receive formal training (with almost one quarter of the drivers not licensed); and do not undergo a medical screening for hearing, sight, and other health conditions, which may directly affect driving performance.[10 11] These driver related factors are of particular concern given that only 7.3% of the crashes reported in this study could be directly attributed to vehicle malfunction (such as faulty brakes or inadequate tyres). Interestingly, vehicle malfunction was higher among private buses and three-wheelers and this may reflect the fact that the maintenance of private public transportation vehicles does not need to meet the same maintenance standards as government vehicles.

Only a few drivers were detected to be under the influence of alcohol at the time of the crash with a greater proportion of three-wheeler drivers detected under the influence of alcohol at the time of crash. Although the proportion of three-wheeler drivers affected by alcohol was greater than public bus drivers (8% *v* 1%) there are significant limitations with the interpretation of the finding. Most importantly, the testing of drivers following a crash is undertaken in an ad hoc manner and is usually only undertaken if the presence of alcohol can be detected and even then, many drivers are still not tested.[11]

With a deregulated public transportation system in Sri Lanka, there is no incentive for private companies or individual operators to make safety a priority. For example, there are almost no government restrictions on driver eligibility or the maintenance of privately operated public transportation vehicles. Furthermore, with incentives paid to drivers who undertake a greater number of trips (in particular, for drivers of three-wheelers), factors such as fatigue and risk taking behaviors are likely to contribute to the overrepresentation of private buses and three-wheelers in road traffic crashes.[11] In contrast, the government bus driver is subjected to regular health screenings, and receives a salary that is not performance based.[7 8]

This is the first study undertaken to determine the risk of crashing while travelling on public road transportation vehicles in the Kandy Municipality Area. The findings highlight a propensity for private (deregulated) vehicles, namely buses and three-wheelers, to crash compared with government (regulated) public transport. These findings need to be interpreted with caution based on the following limitations. Firstly, it was necessary to estimate the number of trips undertaken on a daily basis in the Kandy Municipality Area. These estimates were generated from a random sample of driver interviews. Due to financial constraints, only 25 interviews per transportation type (n = 3) were undertaken, hence the potential for unreliable estimates. Furthermore, it is likely that the estimates for the number of trips undertaken on a daily basis vary between transport types, with drivers of three-wheelers likely to overestimate their trips (as there was no record to refer to) whereas the estimates from the private and public bus drivers are likely to reflect the true picture as they had a driving schedule to refer to.[11] This disparity was likely to result in differential misclassification of the exposures with the likelihood for overestimation of ''exposures'' among three-wheelers, resulting in an underestimate of the true incidence of road traffic crashes for this transportation mode.

In relation to both the public and private bus populations, it is likely that the number of vehicles at risk of crashing was overestimated. This occurred as it was difficult to determine the number of buses that were not at risk of crashing in the study area, as they predominantly travelled outside of the Kandy District. However, the overestimation of the numerator is likely to lead to an overestimate of the incidence rate and, in turn, lead to a spurious rate ratio estimate. However, we expect that the private and public bus populations have only marginally been overestimated and are therefore unlikely to have changed the interpretation of these findings.

A further point that may have also biased the effect estimates is the fact that the owners of private vehicles discourage the reporting of a crash for various reasons including reduced income, fear of legal action due to deficiencies in the licensing and insurance of their vehicle, and the license status of the driver.[11] Therefore, it is likely that the differential in the risk between private and public transportation crash rates is greater than that reported in this study.

The findings from this research highlight that travel on non-government public transportation vehicles imposes a greater risk (in terms of crash and concomitant injury) for the public compared to government transportation. The differential in crash risk can be explained, in part, by the deregulated nature of the industry. A deregulated market is not necessarily a limitation; however, in this situation where safety is not built into the deregulated market, it poses a public health concern. It is important therefore that governments in low income countries evaluate all aspects of a policy both in relation to the cost efficiencies as well as the safety implications. Clearly, a deregulated market in a low income country has a number of advantages, namely that with an increased supply of vehicles to the market, the public receives a quick and cost efficient mode of transportation. Furthermore, it creates job opportunities. However, when safety is not a feature of this market, an increased risk of crashing and consequent injury has to be expected. Therefore,

Key points

- As motorization continues to increase so too are road related fatalities increasing in Sri Lanka.
- The government has deregulated the public transport industry in order to meet the demand for mobility.
- The findings from this research highlight the increased risk of injury associated with travel on private versus public transportation modes.
- The government needs to introduce preventive strategies to address the differential in crash rates between public and private transportation.

careful evaluation of the advantages and disadvantages of the existing situation is extremely important before making and implementing new public policy.

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LACUNAE

Image chips to stop car crashes

New image-sensing chips for cars from Japanese electronics manufacturer NEC have started shipping, with the intention of preventing collisions with pedestrians and other vehicles. Image detection processors have initially been deployed for facial recognition in security applications. NEC is among the first of the electronics manufacturers to apply image detection to the automotive industry for the prevention of accident. The first of the NEC IMAPCAR image-detection chips will be installed in the soon-to-be-released upmarket Toyota Lexus LS460 sedan. The high cost processors have the capability of detecting people, animals and other cars that are on a collision course with the vehicle and automatically applying the brakes to prevent impact. However, what is not entirely clear is how the technology works in cases where braking is not the best option and swerving is safer. Also unclear is where the technology draws the line between what is an acceptable risk to the occupants of the vehicle by braking hard to avoid hitting say a small animal. NEC aims for its image-detection technology to become the standard for the global automotive industry within the next 10 years (from iTWire, contributed by Barry Pless).