

This item was submitted to [Loughborough's Research Repository](#) by the author.
Items in Figshare are protected by copyright, with all rights reserved, unless otherwise indicated.

Why do passengers get hurt when buses don't crash?

PLEASE CITE THE PUBLISHED VERSION

LICENCE

CC BY-NC-ND 4.0

REPOSITORY RECORD

Grant, Rachel, Alan Kirk, and Richard Bird. 2019. "Why Do Passengers Get Hurt When Buses Don't Crash?".
figshare. <https://hdl.handle.net/2134/2178>.

WHY DO PASSENGERS GET HURT WHEN BUSES DON'T CRASH?

Rachel Grant¹, Alan Kirk¹, Richard Bird²

¹Vehicle Safety Research Centre, ²formerly of ICE Ergonomics
Research School in Ergonomics and Human Factors
Loughborough University
Loughborough, Leicestershire, LE11 3UZ. UK

Two major bus safety reports have been completed at the Research School in Ergonomics and Human Factors at Loughborough University. It has become evident during these projects that non-collision incidents are an important part in the injury experience of bus casualties, especially for elderly occupants. By consideration of both national statistics and in-depth cases a picture has been formed of the bus and coach casualty population and the types of incidents in which these people are injured. A brief summary is given of these statistics, along with possible reasons for such a high proportion of casualties occurring in non-collision incidents and recommendations have been made that would lessen the risk of these injuries occurring, through better design and operational changes.

Keywords: Non-collision, DDA, DIPTAC, PSV, Bus, Coach

Introduction

The first study was undertaken on behalf of the Department of Transport, Local Government and the Regions (DTLR) and was entitled the 'Assessment of Passenger Safety in Local Service PSVs'. This study assesses the impact of the Disability Discrimination Act (DDA) and the Disabled Persons Transport Advisory Committee (DIPTAC) regulations on bus travel. The second was a study undertaken for Task 1.1 of the Enhanced Bus and Coach Occupant Safety (ECBOS) project, funded by the European Commission 5th Framework Programme (project no. 1999-RD.11130). 'Real World Bus and Coach Accident Data from Eight European Countries' is a collation of European data that identifies the important issues in bus and coach occupant safety.

Both studies used British national road accident data to investigate bus and coach accidents. Unfortunately there is no way to distinguish between a 'city' bus or coach and a 'touring' bus or coach in the coding. The analysis therefore covers all buses and coaches that have 17 or more seats (regardless of whether or not they are being used in stage operation). (RAGB, 1994 to 1998 and STATS 20).

As part of the study undertaken for the DTLR, physical designs of the current bus fleet were examined during a market review. This provided information on the types of

designs currently in use within the UK and the hazards associated with these designs. A task analysis was undertaken of the actual bus journey from the passenger's point of view. This identified the extent of which passengers would be exposed to any hazards during the journey including such activities as boarding and alighting. As well as investigating the bus design, passenger issues were considered. These included the effects of sensory disabilities; slips, trips and falls; and the characteristics of the bus user population. This work has been used to identify how and why injuries occur.

The casualty population

Passenger casualties on buses and coaches represent 1.4% (644 out of 47,652) of all killed or seriously injured (KSI) casualties in Great Britain. Whilst this percentage is low, and an analysis of exposure indicates that bus travel is one of the safest modes of transport, this study identifies issues that should make local bus transport even safer. Also, as new low floor buses make travel more viable for less physically mobile passengers it is vitally important to make sure that these people are not suffering injuries inside the vehicle which will make the overall proportion of bus casualties higher.

Of these KSI casualties 62.6% occur when the vehicle suffers no impact and 57.1% occur when the passenger is not seated. Overall 48.8% of KSI passenger casualties are not seated and the vehicle does not have a collision. These are large proportions of the bus casualty population. When they do receive an injury, passengers who are not seated at the time are more at risk of receiving a serious or fatal injury (5.5 compared to 10.0%).

Looking at just the non-collision population it is found that 93.9% of all casualties occur on roads with a 30 mph speed limit and 3.6% on 40 mph roads. These roads are defined as built up areas by the UK government. In the data it is not possible to separate local buses and coaches but this high figure in built up / urban areas indicates that the great majority of non-collision incidents occur on local service buses.

The non-collision casualty population: gender and age

The gender distribution for KSI casualties, injured when no collision takes place, shows that there are over twice as many females (71.6%) as males (28.4%). This is likely to be both a function of greater bus use by females and a lower tolerance to injury. In figure 1 a peak is seen for school age males and there is an obvious increase in numbers amongst elderly females. The mean age for female casualties is 15 years higher than for males.

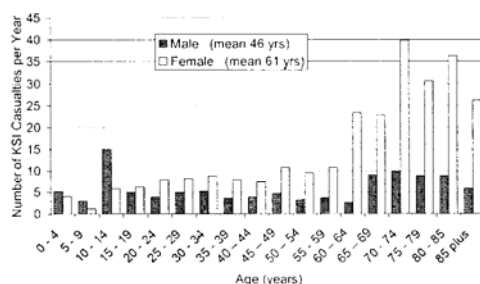


Figure 1. Age and gender distribution

Overall there is a marked increase in the likelihood of a serious or fatal injury to a female occupant as their age increases. Governmental surveys show that generally women travel more on local buses than men for most types of area and age. This goes some way to explaining why women have a much greater representation as bus or coach casualties than men on the database. Overall it is estimated that in the 16 to 59 years old age group women travel 47% further on local buses than men. Women of all ages also make more local bus journeys than men, whilst travelling further, giving higher exposure to injuries that occur whilst standing, boarding or alighting the vehicle, as they get on and off more often.

How and why do these injuries occur?

This work has shown that 63% of all KSI bus passenger casualties are in non-collision incidents with a shift towards elderly female passengers. This section will discuss problems on buses that cause these injuries. Generally it is felt that most of these types of non-collision injury are taking place on local service buses, borne out by 93.9% of these injuries occurring on 30 mph roads. The rest of this paper will therefore concentrate on these vehicles.

Slips, trips and falls on the vehicle

Caused by:

- Slippery floors,
- Weather conditions,
- Uneven floors (fig 2)
- Unexpected or high steps (fig 3),
- Steep slopes,
- Lack of visual cues,
- Physiology in the elderly.



Figure 2



Figure 3

Slips, trips and falls whilst boarding or alighting

Caused by:

- Step to the kerb can be too high,
- Riser steps of different heights,
- Passengers can be encumbered.



Figure 4

Operational issues or heavy braking

Falls can occur from the mechanisms mentioned above but the operation of the vehicle can also initiate a fall on a bus.

Caused by:

Acceleration, vehicle pulls away before passenger reaches seat.

Deceleration, passenger stands to get off bus before bus has come to a halt.

Vehicles sometimes need to turn sharply into and out of recessed bus stops.

Emergency manoeuvres.

Driver issues

In the work carried out for DTLR one operator said 90% of complaints from injured passengers put the blame on the driver, but it is important to recognise workload is high.

Caused by:

High levels of traffic congestion,

Pressure to keep to timetables,

Single operator buses.

Interior design

What are the dangers when a passenger does slip, trip or fall? Why are injuries caused?

These pictures give examples of interior design that can lead to injuries when passengers make contact with internal parts of the bus. These are typical of the bus fleet.

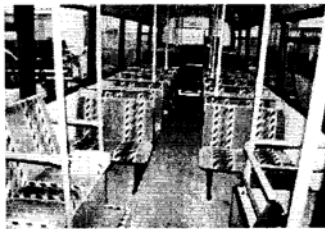


Figure 5

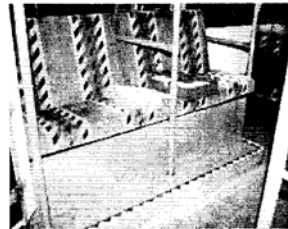


Figure 6

There are unprotected metal grab rails in the areas where seated passengers' heads will naturally fall forward and passengers' upper extremities may hit if they fall over (figures 5 and 6).



Figure 7



Figure 8



Figure 9

Figures 7 and 8 show ticket machines with very hard metal edges that a standing passenger could easily fall forwards and hit, for example, during hard braking. Likewise a boarding passenger could trip and strike the machine. Generally ticket machines, card readers, and bins are not integrated into the design of the bus, they appear to be bolted on afterwards depending upon the requirements of the operator. This inevitably causes them to encroach on the standing area. Also shown is an example of the hard metal joints used for the interior grab bars (figure 9).

New legislation

Public Service Vehicles Accessibility Regulations legislate on guidelines from the Disability Discrimination Act (DDA), Disabled Persons Transport Advisory Committee (DIPTAC) bus regulations. Under the Public Service Vehicle Accessibility Regulations, which have been in force in the UK since January 2001, the previous guidelines of the Disability Discrimination Act (DDA) have been adopted. These are in line with the European directive on bus safety. Generally these guidelines make access on and off vehicles easier and vehicle interiors safer. They have significant advantages on the ease of access for all passengers but especially the less mobile. New buses will have low floor access, priority seats and crucially space for wheelchairs and push chairs (figure 10). The improved overall design also includes straight stairs on double-deckers (figure 11), better lighting and better visual marking (figure 12).

Examples of new design



Figure 10



Figure 11

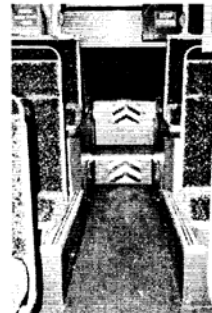


Figure 12

The continuing relevance of non-collision injuries

Even though new legislation has been introduced recently, Great Britain will still have older buses for some time to come and all buses in service will not have to comply until 2015 (coaches, 2020). In fact in 1999 the average age of the public service vehicle fleet in Great Britain was 10 years old, with 10,000 being up to 18 years old. (DETR 1999). Therefore the authors believe it is very important to still consider the access issues raised in this paper as they will affect bus users for at least another 10 years. Also whilst these access regulations generally improve the interior design of the bus, interior contacts must be kept in mind during the vehicle design. In fact an unfortunate by-product of some of these regulations is that the number of seats are reduced, which means that more people may be forced to stand or move upstairs, it is therefore just as relevant to consider falls, especially from bus operation, on these new buses as on older buses.

Conclusions and recommendations

- The majority of killed and seriously injured bus passenger casualties in Great Britain (63%) occur when the vehicle is not involved in a collision.
- It has been found that there is a high proportion of elderly female passengers in this casualty population who, when injured, have an increased risk of serious injury.
- Legislation is changing the design of buses and the authors obviously support those changes which make public transport more widely available. However legislation is improving access for all, enabling more extremes of the population and therefore the less mobile, to travel on buses. These people will be both more susceptible to falls, and to injuries if they fall, whilst on the vehicle. New regulations are in force but they do not place requirements on good operating practice. Also the vehicle fleet includes a large proportion of older vehicles and these new bus designs will not be commonplace for many years to come.

Recommendations

- Regulations have improved access but better interior design is needed, especially around the ticket/driver area and near to the doors to minimise contact injuries. Maintenance procedures should also ensure there is no compromise on safety.
- There should be less pressure on operators and therefore drivers to achieve stricter timetables in mounting congestion at the expense of safety.
- Systems need to be in place to ensure that drivers are aware that a seated passenger wishes to alight at the next stop, and passengers need reassurance that the driver is aware they wish to alight. Bell pushes to achieve this should be in easy reach of all.
- During busy times on busy routes it would be beneficial to have a conductor accompanying the driver, collecting fares, helping passengers (especially with wheelchairs) and dealing with unruly passengers, leaving the driver to concentrate on driving.

References

- Transport Statistics, Department of the Environment, Transport and the Regions, *Road Accidents Great Britain - The Casualty Report*, London, editions 1994 to 1998.
- Technical University Graz, Austria, ECBOS report Task 1.1. www.dsd.at/ecbos.htm
- Transport Statistics, Department of the Environment, Transport and the Regions, *Focus on Public Transport. Great Britain*, London, 1999 edition.
- Transport Statistics, Department of the Environment, Transport and the Regions, *A Bulletin of Public Transport Statistics, Great Britain*, London, 1999 edition.
- Coach and Bus Week Magazine, published by Emap Automotive.
- Reports for Task 1.1 of the Enhanced Bus and Coach Occupant Safety project (European Commission 5th Framework Project no. 1999-RD.11130) www.dsd.at/ecbos.htm
- Vehicle Standards and Engineering, Department of the Environment, Transport and the Regions, *Assessment of Passenger Safety in Local Service PSVs*, London.
- Transport Statistics, Department of the Environment, Transport and the Regions, *STATS 20. Instructions for the Completion of Road Accident Report Form STATS 19*, London.

National (STATS 19) road accident data is collated by the Department of Transport, Local Government and the Regions (DTLR) and supplied to the Vehicle Safety Research Centre in electronic form by the UK Data Archive at Essex University.