SARAC II

Quality Criteria for the Safety Assessment of Cars
Based on Real-World Crashes

Study of the relationship between injury outcomes in police reported crash data and crash barrier test results in Europe and Australia

Report of Sub-Task 2.1/2.2

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Report of Sub-Tasks 2.1 and 2.2

Study of the relationship between injury outcomes in police reported crash data and crash barrier test results in Europe and Australia

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Title and Subtitle

Study of the relationship between injury outcomes in police reported crash data and crash barrier test results in Europe and Australia

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Abstract

The sub-task uses police reported crash data from Great Britain, France and Germany to estimate injury risk and injury severity measures for European vehicles. The relationship between these measures and EuroNCAP test results is evaluated for vehicles tested under the EuroNCAP test program prior to the commencement of the study. In addition, the correlation between EuroNCAP protocol test results and injury outcome in real crash data from Australia and New Zealand was investigated. Sub-task 2.2 extends the analysis of subtask 2.1 by focusing on front impact and side impact police reported crashes. This sub-task aims to evaluate the relationship between EuroNCAP test results and injury outcome in police reported crashes for each of these crash types in Great Britain, France and Australia and New Zealand. Results from each country point to improving average vehicle crashworthiness with increasing EuroNCAP star rating.

Keywords

NEW CAR ASSESSMENT PROGRAM (NCAP), CRASH BARRIER, VEHICLE TESTS, REAL-WORLD DATA, CRASHWORTHINESS, VEHICLE OCCUPANTS, INJURIES, QUALITY SYSTEMS

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EXECUTIVE SUMMARY

The broad aim of sub-task 2.1 of the SARAC II project was to update a pilot study of the relationship between EuroNCAP test results and injury outcome in police reported crashes in Great Britain and France carried out in SARAC I (Newstead et al, 2001). The sub-task uses updated police reported crash data from Great Britain and France and newly obtained police reported crash data from Germany to estimate injury risk and injury severity measures for European vehicles. The relationship between these measures and EuroNCAP test results was then evaluated for vehicles tested under the EuroNCAP test program prior to the commencement of the study. In addition, the correlation between EuroNCAP protocol test results and injury outcome in real crash data from Australia and New Zealand was investigated.

SARAC II sub-task 2.2 extends the analysis of subtask 2.1 by focusing on front impact and side impact police reported crashes. This sub-task aims to evaluate the relationship between EuroNCAP test results and injury outcome in police reported crashes for each of these crash types in Great Britain, France and Australia and New Zealand. Crash configuration information was unavailable in sufficient detail to enable similar analysis of the German data.

DATA SOURCES

EuroNCAP Test Results

The EuroNCAP Executive supplied EuroNCAP data for use in this study covering all tests completed up to mid 2003. Results supplied from the EuroNCAP program covered the three main test procedures comprising the program. These were the 64km/h 40% offset barrier test, the 50km/h side impact test using 950kg mobile barrier and the pedestrian impact test incorporating leg form to bumper test and head form to bonnet test. Where conducted, the results of the side impact pole test were also supplied. For details of the pole test, see EuroNCAP(2003). Full details of the other EuroNCAP test procedures and protocols are described in Williams (1997). Test results were available for a total of 138 different vehicle models. This is an increase of 73 vehicle models from the time of the pilot study (SARAC I).

Australian ANCAP Test Results

Since 1999, the ANCAP program has adopted a vehicle test and scoring procedure fully harmonised with the EuroNCAP program. The ANCAP data for use in this study using the EuroNCAP protocol was supplied by Michael Paine of Vehicle Design and Research Australia with permission of the Australian NCAP Program Steering Committee. As for EuroNCAP, the ANCAP program uses three main test procedures for vehicle occupant and pedestrian protection assessment; the 64km/h 40% offset barrier test, the 50km/h side impact test using 950kg mobile barrier and the pedestrian impact test incorporating leg form to bumper test and head form to bonnet test. Where a suitable head protection device is incorporated in the vehicle and at the request of the manufacture, a side impact pole test is also carried out. Reflecting the harmonisation of the programs, scoring of the test outcomes in ANCAP is also identical to EuroNCAP.

British Real Crash Data

The STATS19 database covering all crashes in Great Britain reported to Police over the period 1993 to 1998 was supplied by the UK Department for Transport (DfT – formerly the Department of Environment, Transport, and the Regions) for use in the pilot study conducted in SARAC I. Full details of that data are provided in Newstead et al, 2001. Additional data, for use in the current project, sub-tasks 2.1 and 2.2, covering police reported crashes in Great Britain for the period 1999 to 2001 was provided by the UK Department for Transport (DfT) in the same format as the earlier data.

Generally, only crashes involving injury are reported to police in Great Britain. Considering the combined data set from 1993 to 2001, and after selecting passenger cars only, complete information for the required variables (driver age, driver sex, junction type, point of impact and speed limit of the crash site) was available for 1,635,296 crashes. Estimation of injury risk using the DfT and Newstead methods considered 973,613 and 546,984 two-car crashes respectively. A total of 775,972 injured drivers were available for analysis of which 159,306 were involved in single vehicle crashes and 616,666 were involved in two-car crashes.

Crashed vehicles with primary impact to specific areas of the vehicle could be identified in the British data using the "1st Point of Impact" variable in the vehicle section of the database. Selecting from the final data set described above, 551,841 and 383,033 crashes were available for use in the estimation of driver injury risk for front impact crashes using the DfT and Newstead methods respectively. Estimation of the injury severity measure for front impact crashes involved the analysis of 411,691 cases. For side impact crashes 129,639 and 66,198 crashes were available for use in the estimation of driver injury risk using the DfT and Newstead methods respectively. Injury severity was estimated from 137,433 injured drivers.

Vehicle models for comparison with EuroNCAP test results were identified in the British crash data through use of the detailed make and model codes appearing in the British data.

French Real Crash Data

In France, every road accident in which at least one road user received medical treatment is investigated by the police and included in a national database managed by the Ministry of Transportation. The Laboratory of Accidentology and Biomechanics PSA (LAB) in France supplied an extract of the data for use in this project. The data covered accidents occurring from 1993 to 2001 not involving a two-wheeler or pedestrian and including drivers or right front passengers of private cars whose injury outcome is known. Considering the final data set for crashes occurring between 1993 and 2001, 610,118 two-car and single vehicle crashes were identified that contained complete information concerning the variables required for analysis. Estimation of injury risk using the DfT and Newstead methods considered 424,753 and 280,603 two-car crashes respectively. Estimation of injury severity using the MUARC severity measure considered a total of 379,557 injured drivers of which 98,249 were involved in single vehicle crashes and 281,308 were involved in two-car crashes.

Crashed vehicles with primary impact to specific areas of the vehicle could be identified in the French data using the “Point of Initial Impact” variable in the database. Selecting from the final data set described above, 312,945 and 224,732 crashes were available for use in the estimation of driver injury risk for front impact crashes using the DfT and Newstead methods respectively. Estimation of the injury severity measure for front impact crashes involved the analysis of 272,965 cases. For side impact crashes 35,297 and 17,792 crashes were available for use in the estimation of driver injury risk using the DfT and Newstead methods respectively. Injury severity was estimated from 33,253 cases in which driver injury was sustained.

Vehicle models for comparison with EuroNCAP test results were identified in the French crash data through use of the available make and model codes appearing in the data. The data supplied for SARAC I (1993-1998) contained only broad vehicle model classifications. However, the more recent data contains sufficient detail to enable the identification of equivalent EuroNCAP tested models in the French data with a precision much closer to that available when using the British data.

German Real Crash Data

In Germany, every road accident attended by the police must be reported and is recorded in a database held at the German Federal Statistical Office. There are no strict injury criteria for inclusion in the database and accidents involving material damage or slight personal injuries are included where the accident was reported to the police. A copy of this database for the period 1998 to 2002 was supplied to MUARC for use in this study.

Considering the complete data set for crashes occurring between 1998 and 2002, 804,589 two-car and single vehicle crashes were identified and contained complete information concerning the variables required for analysis. Estimation of injury risk using the DfT and Newstead methods considered 364,939 and 221,132 two-car crashes respectively. Estimation of injury severity considered a total of 273,421 injured drivers involved in either single vehicle or two-car crashes. Information on the primary point of impact on the vehicles was not sufficient to identify front and side impact crashes with certainty. Therefore, analysis of these crash types could not be conducted using the German data.

Vehicle models for comparison with EuroNCAP test results were identified in the German crash data using a method developed by the BAST on the basis of the “HSN” and “TSN” variables describing vehicle make and model that were available in the data.

Finnish Real Crash Data

Finnish insurance data was supplied for use in this study by Helsinki University of Technology. However, there was insufficient data to enable the estimation of vehicle safety ratings with sufficient accuracy for meaningful analysis.

Australian and New Zealand Real Crash Data

Data from four states of Australia and the whole of New Zealand were combined to produce the Australia and New Zealand make and model specific crashworthiness ratings of Newstead et al (2004). The ratings covered drivers of cars, station wagons, four-wheel drive vehicles, passenger vans, and light commercial vehicles manufactured during 1982-2002 and crashing in the Australian states of Victoria and New South Wales during 1987-2002 or the Australian states Queensland and Western Australia during 1991-2002 and in New Zealand during 1991-2002.

Estimation of injury risk using the MUARC method considered 1,070,369 crashes that had complete information for the required variables. Estimation of injury severity using the MUARC severity measure considered 251,269 drivers injured in a crash during 1987-2002. Selecting from the final data set described above, 140,184 crashes were available for use in the estimation of driver injury risk for front impact crashes using the MUARC method. Estimation of the injury severity measure for front impact crashes involved the analysis of 75,478 cases. Injury risk in side impact crashes was estimated using 15,605 cases whilst injury severity in these crashes was estimated from 11,459 injured drivers.

Vehicle model details in the Australian and New Zealand data were identified using a process of VIN decoding.

Comparison of the European Data Sets

There were a number of fundamental differences between the French, British and German data sources, the most important of which is the segregation of injury levels coded in the reported data. The British data divides injured occupants into those severely injured (hospital admissions and other serious outcomes) and those with minor injuries. In the French data, injured occupants are classified into two groups defined as those staying less than 7 days in hospital and those staying 7 or more days in hospital. Clearly, these injury definitions are incomparable between the two data systems. Detailed criteria for the classification of injuries in the German data have not been provided.

Another apparent difference between the British, French and German databases is the comparative number of vehicle occupants involved in injury crashes that fall into each injury severity level (Table 1).

Table 1. Comparison of British and French Data Injury Level Codes (All Crash Types).

British Injury Level	% of Injured Drivers at Level	French Injury Level	% of Injured Drivers at Level	German Injury Level	% of Injured Drivers at Level
Fatal (death < 30 days after crash)	0.4	Killed (death <7 days after crash)	3.0	Killed	0.3
Severely Injured (including any hospital admission and other serious outcomes)	4.7	Severely Injured (>6 Days in hospital)	11.6	Severely Injured	5.3
Slight Injury (injured but not severely)	42.4	Slightly Injured (<7 days in hospital)	47.6	Slightly Injured	28.4
Total Injured	47.5	**Total Injured**	62.2	**Total Injured**	34
No Injury	52.5	Uninjured	37.8	Uninjured	66

As a result of the inconsistencies in defining injury severity levels, crash reporting and the differing level of specificity relating to vehicle model identification in the British, French and German databases, parallel rather than combined analysis of the three data sources has been conducted. This approach was also adopted in SARAC 1. Similar outcomes from analysis of the three data sources would serve to confirm the results obtained whilst differences in analysis outcomes could be investigated in the context of the differences noted above.

METHODS

Vehicle Safety Measures Based on Real Crashes

The real crash measure estimated is the risk of serious injury (including death) to a vehicle driver given involvement in a crash where at least one person was injured. It is computed as a product of two components, the first being the risk of driver injury given involvement in an injury crash, the second being a risk of serious injury given that some level of injury to the driver was sustained. Separate sets of real crash measures were estimated based on all crash types, frontal impact crashes and crashes to the near (driver's) side of the vehicle. This approach to representing real crash outcomes has been used successfully in previous studies correlating real crashes with NCAP-style barrier crash test results from Australia and the USA.

Two methods of estimating real crash injury risk are used in this study. The first injury risk measure is a modified version of that used by the DfT to estimate vehicle passive safety ratings in the UK and is based on the analysis of crashes between two light passenger vehicles. The second measure of injury risk, denoted the Newstead method, has also been estimated for the three crash groupings considered (all crash types, front impact and side impact crashes) and is described in detail in the SARAC I sub-task 1.6 and 3.4 project reports. It stems from considering the same 2-car crash outcomes on which the DfT injury risk measure is estimated. The injury severity measure is similar to that used by the Monash University Accident Research Centre in producing vehicle safety ratings in Australia and is based on the analysis of both multi vehicle and single vehicle crash outcomes. Both components were estimated using logistic regression analysis, adjusting for the influence of driver sex and age, point of impact on the vehicle, road junction type, and speed limit or level of urbanisation, along with first and higher order interactions between these factors. In addition, estimates of injury severity were adjusted for the number of vehicles involved in the crash. When the two components were multiplied, they represented the risk of serious injury to drivers, a measure commonly used internationally for rating cars in terms of their crashworthiness.

Methods of Comparing Real Crash Injury Measures with EuroNCAP Scores

Preliminary analysis has focused on examining the average crashworthiness ratings derived from the police reported data of vehicles within each overall star-rating category assigned by the EuroNCAP test program. Lie and Tingvall (2000) have used this approach to make basic comparisons of real crash outcomes in Sweden with EuroNCAP test results. Comparison was made for each crash type considered in the real crash data with specific comparisons between the frontal crash ratings and the offset frontal EuroNCAP test results and the side impact crash ratings and side impact test EuroNCAP score. Previous work has highlighted the relationship between vehicle mass and real crash outcome, with vehicles of higher mass generally having better real crash ratings. In contrast, the EuroNCAP score is purported to be independent of vehicle mass. Therefore, analysis including vehicle mass as an extra predictive term in the logistic regression has been conducted to remove the effect of vehicle mass from the analysis.

As well as examining the average injury outcome in police reported crashes within each EuroNCAP star rating, comparisons have also been made on a vehicle by vehicle basis. Comparisons on this basis were made graphically with the underlying EuroNCAP score from which the overall star ratings is derived plotted against the crashworthiness ratings calculated from the police reported data. Comparisons have been made for all crash types as well as for frontal and side impact crashes.

RESULTS

Analysis in this sub-task has generated a large number of results across a number of jurisdictions. These include estimates of crashworthiness, injury risk and injury severity calculated using two methods of safety rating. Comparison of the EuroNCAP overall scores, front impact and side impact scores with safety ratings estimated for all crashes, front impact and side impact crashes only have also been made for both European and Australasian jurisdictions. The role of vehicle mass in determining the level of association between the two ratings systems has also been investigated. Given the large volume of results available, only those most relevant to the aims of the study and those most representative of the true relationship between EuroNCAP test scores and injury outcome in police crash reports are presented below.

Real Crash Based Ratings for EuroNCAP Tested Vehicle Models

Of the 138 EuroNCAP crash tested vehicle models available for use in this study, there were 70, 54 and 23 vehicles with sufficient British real crash data from all crash types, frontal impact crashes and side impact crashes respectively to be included in the analysis. To illustrate the contents of the estimated vehicle ratings, Table 2 below presents the ratings estimated by applying the DfT method to police reported crash data for all crash types in Great Britain.

Table 2. Estimated vehicle secondary safety ratings estimated using the DfT method and applied to British police reported crash data for all crash types.

ALL CRASH TYPES (DfT Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating**	**Estimated Injury Risk**	**Estimated Injury Severity**	**Lower 95% CI CWR**	**Upper 95% CI CWR**	**Range of CI**	**CWR Coeffi-cient of Variation**
	All Model Average	**6.79**	**63.34**	**10.72**				
1	Fiat Punto 55S	7.68	71.29	10.77	6.53	9.02	2.49	0.32
2	Ford Fiesta 1.25 LX 16V	7.43	68.39	10.87	6.75	8.18	1.43	0.19
3	Nissan Micra 1.0L	10.22	71.69	14.26	8.91	11.74	2.83	0.28
4	Renault Clio 1.2RL	8.29	70.40	11.78	5.92	11.61	5.69	0.69
5	Rover 100	9.70	71.92	13.48	8.50	11.06	2.57	0.26
6	Vauxhall Corsa 1.2LS	7.37	65.98	11.16	5.12	10.59	5.47	0.74
7	Volkswagen Polo 1.4L	7.42	67.96	10.92	6.32	8.72	2.40	0.32
8	Audi A4 1.8	6.16	55.06	11.18	4.31	8.81	4.50	0.73
9	BMW 316i	6.14	55.35	11.10	5.32	7.10	1.78	0.29
10	Citroen Xantia 1.8i Dimension	5.62	55.58	10.11	4.57	6.92	2.35	0.42
11	Ford Mondeo 1.8LX	6.38	60.30	10.57	5.56	7.31	1.75	0.27
12	Mercedes C180 Classic	3.07	56.92	5.40	1.83	5.15	3.32	1.08
13	Nissan Primera 1.6GX	7.35	62.75	11.71	5.65	9.56	3.92	0.53
14	Peugeot 406 1.8LX	5.72	54.07	10.57	4.75	6.88	2.12	0.37
15	Renault Laguna 2.0RT	5.51	60.69	9.07	4.24	7.16	2.92	0.53
16	Rover 620 Si	6.05	58.89	10.27	4.79	7.64	2.86	0.47
17	Saab 900 2.0i	5.96	47.98	12.43	3.42	10.39	6.96	1.17
18	Vauxhall Vectra 1.8iLS	7.08	59.89	11.82	6.26	8.00	1.75	0.25
19	Volkswagen Passat 1.6L (LHD)	8.42	55.12	15.27	5.54	12.78	7.24	0.86
20	Audi A3 1.6	5.84	60.74	9.62	3.45	9.89	6.44	1.10
21	Citroen Xsara 1.4i (LHD)	6.57	65.69	10.00	4.33	9.98	5.65	0.86
22	Daewoo Lanos 1.4SE (LHD)	7.66	66.08	11.59	5.28	11.11	5.83	0.76
23	Fiat Brava 1.4S	6.83	65.84	10.38	5.56	8.40	2.83	0.41
24	Honda Civic 1.4i	9.02	65.04	13.87	7.79	10.46	2.67	0.30
25	Hyundai Accent 1.3GLS (LHD)	9.28	75.40	12.30	6.47	13.30	6.83	0.74
27	Peugeot 306 1.6GLX	8.36	67.09	12.47	7.31	9.57	2.26	0.27
28	Renault Megane 1.6RT (LHD)	6.71	66.45	10.09	5.52	8.16	2.64	0.39
29	Suzuki Baleno 1.6GLX (LHD)	7.74	67.51	11.46	4.82	12.42	7.61	0.98
30	Toyota Corolla 1.3 Sportif (LHD)	8.24	65.33	12.62	6.14	11.08	4.95	0.60
31	Volkswagen Golf 1.4 (LHD)	8.06	64.37	12.53	4.58	14.21	9.63	1.19
32	Audi A6 2.4 (LHD)	3.53	54.09	6.53	1.61	7.75	6.14	1.74
33	BMW 520i (LHD)	6.46	50.32	12.84	4.42	9.46	5.04	0.78
34	Mercedes E200 [redacted]	[redacted]	52.83	11.59	3.58	10.47	6.89	1.13

38	Volvo S70 2.0/2.5 10V (LHD)	6.35	56.02	11.34	2.92	13.83	10.91	1.72
39	Ford Focus 1.6 (LHD)	6.19	60.86	10.17	5.10	7.52	2.43	0.39
40	Mercedes A140 Classic (LHD)	9.12	66.93	13.63	5.57	14.93	9.36	1.03
41	Vauxhall Astra 1.6i Envoy	7.84	69.55	11.27	6.81	9.03	2.22	0.28
42	Ford Escort 1.6 LX	7.33	66.29	11.05	6.71	7.99	1.28	0.17
43	Nissan Almera 1.4GX	6.50	66.36	9.80	4.41	9.59	5.18	0.80
47	Nissan Serena 1.6 (LHD)	8.56	63.51	13.49	4.43	16.56	12.13	1.42
48	Volkswagen Sharan TDI (LHD)	5.43	54.25	10.00	2.65	11.09	8.43	1.55
56	Vauxhall Corsa 1.0 12v Club	7.41	69.69	10.64	6.20	8.86	2.66	0.36
59	Honda Accord 1.8iLS	1.89	63.20	2.99	0.49	7.34	6.86	3.63
61	Saab 9-3 2.0 (LHD)	4.94	45.78	10.79	2.39	10.21	7.82	1.58
63	Ford Ka 1.3 (LHD)	7.81	68.86	11.34	6.62	9.20	2.58	0.33
64	Volvo S40 1.8	4.38	62.10	7.06	2.58	7.44	4.87	1.11
65	Toyota Avensis 1.6S	5.83	63.46	9.18	4.15	8.18	4.03	0.69
66	Citroen Saxo 1.1 SX (LHD)	8.03	75.58	10.63	7.07	9.12	2.05	0.26
67	Daewoo Matiz SE+ RHD	13.75	78.38	17.54	9.99	18.92	8.93	0.65
69	Fiat Seicento	8.98	76.30	11.77	5.80	13.90	8.10	0.90
70	Ford Fiesta 1.25 Zetec	8.01	70.72	11.32	6.53	9.82	3.29	0.41
71	Nissan Micra L 1.0 (RHD)	11.26	73.04	15.41	7.25	17.47	10.22	0.91
72	Peugeot 206 1.3 XR Presence (LHD)	7.54	69.60	10.83	5.85	9.71	3.87	0.51
73	Renault Clio 1.2 RTE (LHD)	5.87	68.76	8.53	4.35	7.91	3.57	0.61
74	Rover 25 1.4i (RHD)	7.66	72.72	10.53	5.06	11.57	6.51	0.85
77	Toyota Yaris 1.0 Terra (LHD)	8.03	71.99	11.16	5.09	12.67	7.58	0.94
78	Volkswagen Polo 1.4 (LHD)	7.35	67.11	10.95	4.81	11.23	6.42	0.87
81	Nissan Almera Hatch	5.72	64.02	8.93	3.04	10.75	7.70	1.35
84	BMW 316i (LHD)	6.20	61.30	10.11	4.51	8.50	3.99	0.64
89	Peugeot 406 (LHD)	6.42	56.03	11.46	4.60	8.97	4.38	0.68
91	Rover 75 1.8 (RHD)	3.85	48.05	8.02	1.63	9.13	7.50	1.95
93	Vauxhall/Opel Vectra 1.8 (LHD)	7.64	58.52	13.05	6.08	9.60	3.52	0.46
94	Volkswagon Passat 1.9 Tdi (LHD)	5.45	56.43	9.66	3.72	7.99	4.28	0.78
96	Citroen Picasso 1.6 LX (LHD)	6.65	61.45	10.82	2.89	15.31	12.42	1.87
102	Renault Scenic 1.4 (LHD)	5.97	66.54	8.98	3.38	10.55	7.17	1.20
112	Mazda MX-5 1.6 LHD	9.33	66.41	14.05	6.27	13.90	7.63	0.82
115	Jeep Cherokee 2.5 TD Limited (LHD)	4.20	41.66	10.09	2.12	8.36	6.24	1.48
136	Vauxhall/Opel Corsa 1.2 Comfort (LHD)	6.55	65.53	9.99	3.48	12.31	8.82	1.35

Considering the French real crash data, there were 36, 31 and 5 vehicle models with sufficient real crash data from all crash types, frontal impact crashes and side impact crashes respectively to be included in the analysis. The German crash data supplied provided sufficient data to estimate ratings for the performance of 53 vehicles across all crash types. There was insufficient point of impact information in the German data to enable estimation of ratings for front or side impact crashes only. Finally, there was sufficient Australian and New Zealand real crash data from all crash types, frontal impact crashes and side impact crashes to estimate ratings for 35, 17 and 6 vehicles respectively.

Comparison of Average Real Crash Safety Ratings and Overall EuroNCAP Star Ratings

Logistic Regression Analysis

In this study the overall EuroNCAP score and corresponding star rating are calculated based on the driver dummy measurements in the EuroNCAP test only to ensure compatibility with the real crash ratings that relate to driver injury outcome only. Average real crash outcomes in all crash types have been estimated within each EuroNCAP star rating category in each of the European jurisdictions and Australia and New Zealand and for each of the real crash outcome measures. Table 2 shows average crashworthiness for all vehicle models within each EuroNCAP overall star rating category with sufficient real data to be included in the German analysis.

Table 2. Crashworthiness estimates (DfT method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Crashworthiness Ratings (DfT method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**12.17%**	**11.89%**	**10.08%**		**12.70%**	**12.46%**	**9.19%**
LCL		11.81%	11.51%	9.70%		12.33%	12.08%	8.86%
UCL		12.54%	12.28%	10.47%		13.08%	12.86%	9.54%

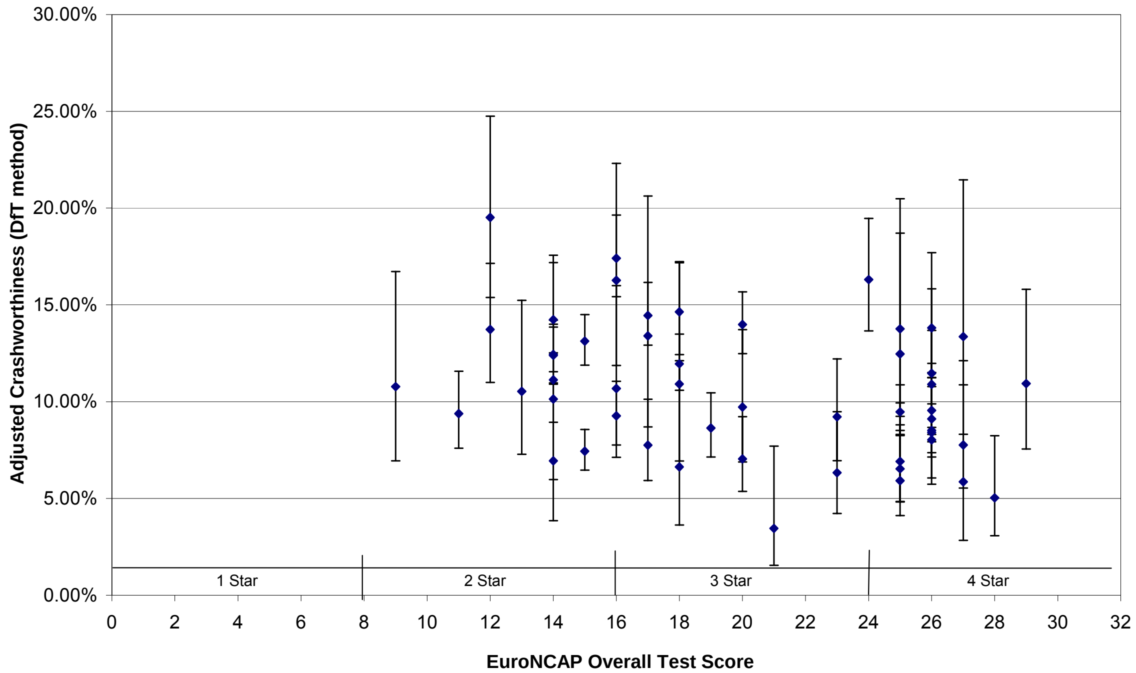
In the German data the average crashworthiness for the 4 star rated cars is significantly better than that of both the 2 and 3-star rated cars which are not significantly different from each other. Similarly, in the French results, the average crashworthiness of 3 and 4 star rated cars are both statistically significantly lower than that of 2 star rated cars but are not statistically significantly different from each other. The British results show the average crashworthiness of the 2, 3 and 4 star rated vehicles is significantly better than the one star rated vehicle with four star vehicles having the best average crashworthiness.

Trends in average crashworthiness and its component measures by EuroNCAP overall star rating derived from the Australian and New Zealand crash data were very different from those measured using the European data sources. No association between average crashworthiness, injury risk or injury severity and EuroNCAP overall star ratings was observed in the Australian and New Zealand data comparisons. There are a number of possible causes for the different outcomes in the Australian and New Zealand analysis, however the exact reasons for the differences are difficult to isolate.

Graphical Analysis

Figure 1 below shows overall EuroNCAP scores plotted against crashworthiness estimated from all crash types in the German data. Plotting overall EuroNCAP scores against estimated crashworthiness, injury risk and injury severity using data from the other jurisdictions considered in this study demonstrated very similar trends.

Figure 1. Overall EuroNCAP test score vs. German real crash crashworthiness based on all crash types (DfT Method)



There is evidence of significant differences in the police reported crash measures between vehicle models within the same EuroNCAP star rating and between vehicle models with almost the same overall EuroNCAP rating score from which the star ratings are derived. This is demonstrated by the non-overlapping confidence limits on the police reported crash measures between pairs of vehicles within the same overall star rating category. These results are consistent across the three European jurisdictions examined and across all measures of injury outcome based on police reported crash data.

This result suggests there are other factors, apart from those summarised in the overall EuroNCAP score that are determining injury outcomes as reported by police. These other factors are also different from those that have already been compensated for in the estimation of the police reported crash based ratings, such as driver age and sex and speed limit at the crash location.

Whilst differences exist in the results by jurisdiction and according to the real crash measure being considered, analysis of the European data sources tends to support some common conclusions when examining average real crash outcome by EuroNCAP star rating. Results from each country point to improving average vehicle crashworthiness with increasing EuroNCAP star rating. Analysis of the component measures of the crashworthiness metric shows this result stems from an association between average injury severity and overall EuroNCAP star rating and not the injury risk component of the crashworthiness measure. However, there remains significant variation in the measures of injury outcome in real crashes for specific vehicles within each EuroNCAP score category. Therefore, a vehicle with a low crashworthiness or injury severity estimate does not always perform well in EuroNCAP testing and vice versa. This observation is consistent across the results for all countries considered in the study.

Results by Crash Configuration

Due to a lack of information on the point of vehicle impact in the German data, no ratings for specific impact types could be calculated from this data. Subsequently, comparisons by specific crash configurations are focused on the frontal impact results for the French and British data and the side impact results for the British data only.

Comparison of average crashworthiness ratings based on frontal impact crashes within EuroNCAP offset frontal impact star rating categories showed no trends. This was the case when examining either the average crashworthiness rating or its injury risk or injury severity components. For illustrative purposes this is shown in Table 3 below for estimates of crashworthiness based on British data. Similar results were achieved using French data.

Table 3. Average frontal impact crashworthiness and 95% confidence limits by EuroNCAP frontal impact star rating categories: with and without mass adjustment.

Crashworthiness Ratings (DfT method)								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**7.30%**	**7.45%**	**7.63%**	**7.71%**	**7.46%**	**7.91%**	**7.31%**	**7.41%**
LCL	6.99%	7.15%	7.26%	7.18%	7.14%	7.61%	6.96%	6.91%
UCL	7.63%	7.77%	8.02%	8.27%	7.79%	8.23%	7.68%	7.96%

Overall, these results suggest there is little if any association between the results of the EuroNCAP offset frontal impact test and injury outcomes to drivers in frontal crashes reported to police as measured by crashworthiness estimated using the DfT and Newstead methods.

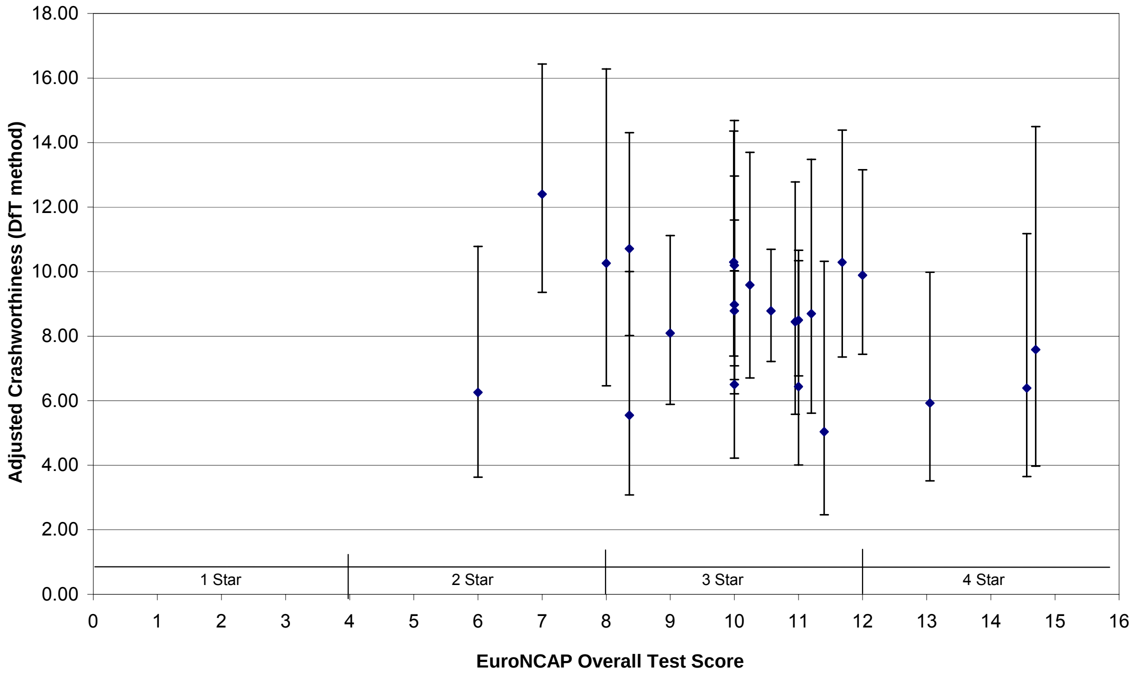
In contrast to the frontal impact test, a strong association between average crashworthiness in side impact crashes and the side impact EuroNCAP score was observed in the British data (Table 4). There were relatively few vehicle models with sufficient side impact data to be reliably rated in the French and Australian and New Zealand data and to be meaningfully analysed against EuroNCAP frontal and side impact scores.

Table 4. Average side impact crashworthiness and 95% confidence limits by EuroNCAP side impact star rating categories: with and without mass adjustment.

Crashworthiness Ratings (DfT method)								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**10.68%**	**9.09%**	**6.89%**		**10.81%**	**9.14%**	**6.77%**
LCL		9.33%	8.20%	5.80%		9.45%	8.25%	5.71%
UCL		12.20%	10.06%	8.15%		12.33%	10.11%	8.00%

Interpreting the point estimates of the analysis revealed an approximate 20% drop in average side impact serious injury risk measured from the police reported data with every increase in EuroNCAP side impact star rating category. Analysis of results shows the association with the side impact crashworthiness rating stems largely from the association between average side impact injury severity and side impact EuroNCAP rating. However, comparisons between side impact crashworthiness ratings and side impact EuroNCAP scores on a vehicle by vehicle basis shows significant dispersion suggesting that a high EuroNCAP score is not associated with good side impact crashworthiness and vice versa for all vehicle models (Figure 2).

Figure 2. Side Impact EuroNCAP test score v Adjusted side impact crashworthiness estimated using British data (DfT method)



DISCUSSION

In many aspects, the results of this study hold many similarities to the results of the Pilot study of Newstead et al (2001) carried out under Phase I of the SARAC research program. However, in comparison to Phase I of the SARAC research program, this study is based on much larger quantities of police reported crash data from a wider range of countries with results based on the analysis of up to 70 EuroNCAP tested vehicle models. As such this study provides a much more definitive assessment of the relationship between EuroNCAP test scores and injury outcomes recorded in police reported crash data. The results of this study are also consistent with results of other similar studies comparing real crash outcomes and the results of crash barrier test programs conducted world-wide.

In drawing conclusions from this type of analysis it is interesting to revisit the philosophy of the EuroNCAP program. According to those involved in EuroNCAP, the principal purpose of the program is to apply pressure to vehicle manufacturers to improve the safety design and specification of vehicles. Reflecting the aims of the program, the scoring system for EuroNCAP is not designed to necessarily represent an injury risk outcome scale. Instead, the various test measurements are weighted according to how highly it is desired to influence manufacturers on each aspect of vehicle design. Recognising the nature of the EuroNCAP scoring process, a linear relationship between injury outcomes in real world crashes and the EuroNCAP score would not necessarily be expected. However, given the aim of EuroNCAP is to improve vehicle safety generally, a general association between improving crashworthiness and higher EuroNCAP scores would be expected. Considering the analysis of real crash outcomes as the most suitable way of assessing the effectiveness of the EuroNCAP program in meeting its aims, results of this study confirm this general association with average real crash outcomes being better in vehicles with higher EuroNCAP scores than in ones with low scores. Results also confirm that this association is non-linear as expected.

Interpreted in this way, results of analysis in this study confirm that the design priorities for vehicle safety encouraged by the EuroNCAP scoring process are leading to improved real world crash performance on average. Importantly, comparison of the French and British analysis results in particular, suggest that improvement is greatest in the higher severity real world crashes. However, the results of comparison on a vehicle by vehicle basis also show that achieving these design priorities does not always lead to a safer vehicle. This result suggests that EuroNCAP is not necessarily encapsulating all the factors required to ensure good safety performance in a vehicle. Alternately, it is allowing vehicles to score well on a combination of factors that have relatively low effectiveness in improving real world safety. Whether the EuroNCAP test process can or should be modified to overcome this to some degree remains to be determined.

A lack of absolute consistency between EuroNCAP ratings and crashes based on real world data on a vehicle by vehicle basis is only problematic if ratings from the two systems are presented side by side for consumer information. Fortunately this is rarely possible because of the nature of the ratings. Ratings based on real world data typically lag those published by EuroNCAP by many years as real world crash experience accumulates by which time the EuroNCAP test protocol has often been modified and is not directly comparable.

As noted, EuroNCAP is seen as a tool for driving safety change in vehicle design and providing information to consumers on relative safety at the time of vehicle release. In contrast, vehicle safety ratings based on real world data are seen as a tool to evaluate the long term safety of vehicles in the full range of real world circumstances. As shown by this study, real world ratings also provide a means to assess whether EuroNCAP testing is achieving its stated aims in improving vehicle safety and to help fine tune the program in future. Viewed as such, both ratings systems have a defined and non-conflicting role in advancing vehicle safety.

CONCLUSIONS

This study has been able to quantify the relationship between injury outcomes in real world crashes reported to police and estimates of relative vehicle safety derived from the EuroNCAP vehicle crash barrier test program. The measure of real world injury outcome used has been the risk of death or serious injury given crash involvement calculated as a product of the risk of injury given crash involvement and the risk of death or serious injury given an injury was sustained. The crashworthiness measure, as well as its component risk measures based on all crash configurations, has been compared with the overall EuroNCAP score. Real world crash outcomes for frontal and driver side impacts have also been compared with the EuroNCAP offset and side impact test component scores. Police reported crash data from Great Britain, France, Germany, Finland, Australia and New Zealand was analysed. Due to the much larger quantities of real world data available for analysis, up to 70 EuroNCAP tested vehicle models have been considered in the comparisons meaning results from this study are more definitive than those obtained in the preceding SARAC 1 pilot study.

Results of analysis of the European data sources support some common conclusions when examining average real crash outcome by EuroNCAP star rating. Results from each country point to improving average vehicle crashworthiness with increasing EuroNCAP star rating. Analysis of the component measures of the crashworthiness metric shows this result stems from an association between average injury severity and overall EuroNCAP star rating and not the injury risk component of the crashworthiness measure. Measured associations between EuroNCAP score and real world injury severity were strongest and most consistent in both the French and German data. The French data in particular uses a much higher severity definition for serious injury compared to the British data, requiring drivers to be hospitalised for more than 6 days. The strong association between the French definition and EuroNCAP results suggests EuroNCAP may be reflecting the likelihood of these more serious injury outcomes.

No association between average crashworthiness, injury risk or injury severity and EuroNCAP overall star ratings was observed in the Australian and New Zealand data comparisons. This may have been a result of fewer vehicles being available for analysis, the range of vehicle models analysed being vastly different to those represented in the European data sources, differences in the injury outcome coding in the Australasian data or a combination of all these factors

Examination of the relationship between overall EuroNCAP test score and injury outcome on an individual vehicle basis adds a further dimension to the interpretation of the relationship. They show that whilst there is and association between average vehicle crashworthiness and EuroNCAP score outcome, there is significant variation in the measures of injury outcome in real crashes for specific vehicles within each EuroNCAP score category. It shows that a vehicle with good average real world crash outcomes does not always perform well in EuroNCAP testing and vice versa. This observation is consistent across the results for all countries considered in the study.

Comparison of average crashworthiness ratings based on frontal impact crashes within EuroNCAP offset frontal impact star rating categories showed no trends. The results suggest there is little if any association between the results of the EuroNCAP offset frontal impact test and real world injury outcomes to drivers in frontal crashes. In contrast, a strong association between average crashworthiness in side impact crashes and the side impact EuroNCAP score was observed. Interpreting the point estimates of the analysis revealed an approximate 20% drop in average side impact serious injury risk measured from the police reported data with every increase in EuroNCAP side impact star rating category. Like the comparisons based on all crash types, comparisons between side impact crashworthiness ratings and side impact EuroNCAP scores on a vehicle by vehicle basis showed ratings were not always consistent on a vehicle by vehicle basis. The results of this study are consistent with the results of the Pilot study carried out under Phase I of the SARAC research program and other similar studies comparing real crash outcomes and the results of crash barrier test programs conducted world-wide.

EuroNCAP's principal aim is to apply pressure to vehicle manufacturers to improve the safety design and specification of vehicles. Leverage to achieve this end is gained by publishing the results for broad consumer scrutiny. Reflecting the aims of the program, the scoring system for EuroNCAP is not designed to necessarily represent an injury risk outcome scale. Results of this study confirm this general association with average real crash outcomes being better in vehicles with higher EuroNCAP scores than in ones with low scores. Results also confirm that this association is non-linear as expected. As such the study confirms that the design priorities for vehicle safety encouraged by the EuroNCAP scoring process are leading to improved real world crash performance on average. However, the results of comparison on a vehicle by vehicle basis also show that achieving these design priorities does not always lead to a safer vehicle.

Finally, this study shows that comparison with real world ratings provide a means to assess whether EuroNCAP testing is achieving its stated aims in improving vehicle safety and to help fine tune the program in the future. Noting their respective strengths, both EuroNCAP and real world ratings systems have defined and non-conflicting roles in advancing vehicle safety.

FUTURE RESEARCH DIRECTIONS

The work completed in this sub-task of the SARAC 2 project and detailed in this report has pointed to a number of areas of future research that should be considered. They are as follows.

- The EuroNCAP test program is constantly evolving to encourage manufacturers to meet more rigorous standards of vehicle safety performance and to include the latest safety technology. These evolutionary changes to EuroNCAP need to be evaluated specifically to ensure they are effective in improving average vehicle safety in real world crashes. Periodic evaluation of EuroNCAP using the general approach taken in this study is recommended and considered vital to ensure this high profile program continues to meet its target of improving vehicle safety performance.

- One of the limitations of the research presented in this report was the inability to combine the data from each of the jurisdictions for combined analysis. It is recommended that research be undertaken to investigate establishing a standardised European crash data recording protocol. Part of the research should investigate the most suitable measure of severe injury outcome (for example hospital admission) that can be accurately and consistently coded by police.

- More in-depth comparisons of the relationship between real world crash outcomes and EuroNCAP test scores would have been possible if a greater range of injury severity measures were available than just those recorded in the police data. It is recommended that research be conducted in Europe on investigating the availability of other injury outcome data such as insurance claims data and hospital records and the potential for linking these records with police crash data reports on a wide scale. The resulting combined data would also be a powerful resource for a broad range of detailed vehicle safety research in Europe.

1 Introduction

This report describes the analysis undertaken for sub-tasks 2.1 and 2.2 of the second phase of the project *Quality Criteria for the Safety Assessment of Cars based on Real-World Crashes* carried out by the Safety Rating Advisory Committee (SARAC) for the European Commission. The broad aim of sub-task 2.1 of the SARAC II project was to update a pilot study of the relationship between EuroNCAP test results and injury outcome in police reported crashes in Great Britain and France carried out in SARAC I (Newstead et al, 2001). The sub-task uses updated police reported crash data from Great Britain and France and newly obtained police reported crash data from Germany to estimate injury risk and injury severity measures for European vehicles. The relationship between these measures and EuroNCAP test results are then evaluated for vehicles tested under the EuroNCAP test program prior to the commencement of the study. The analysis of the police reported crash data and EuroNCAP results follows the general approach developed in the SARAC I, sub-task 2.2, pilot study. In addition, the correlation between EuroNCAP protocol test results and injury outcome in real crash data from Australia and New Zealand (Newstead et al, 2004) was investigated.

SARAC II sub-task 2.2 extends the analysis of subtask 2.1 by focusing on front impact and side impact police reported crashes. This sub-task aims to evaluate the relationship between EuroNCAP test results and injury outcome in police reported crashes for each of these crash types in Great Britain, France and combined Australia and New Zealand. Crash configuration information was unavailable in sufficient detail to enable similar analysis of the German data. The sub-task updates and adds to earlier analysis of this type conducted in SARAC I (Newstead et al, 2001) and follows the framework established in sub-task 2.1.

2 Data Sources

2.1 Background

The data selected for use in sub-tasks 2.1 and 2.2 are based on considerations set out in detail in Newstead et al (2001) and Cameron, Newstead and Oppe (2000). A brief summary of these considerations and the data follows.

In Europe, the largest databases on crashes reported to police available for analysis are those from France, Great Britain and Germany. However, at the time of SARAC I, data in the required form including information on the point of impact of crash involved vehicles was available for France and Great Britain only. Data from Germany has now become available and as such the analysis undertaken in this study has been extended to include analysis of extended data form France and Great Britain as well as data from Germany. As in SARAC I, sufficient information on vehicle make and model was available within each databases to enable analysis. However, the level of identification of vehicle make and model was greater in the British and German databases than in the French database.

Additional crash data files covering the years 1999 to 2001 required to update the analysis conducted in SARAC I sub-task 2.2 were provided by the LAB in France and the United Kingdom Department for Transport respectively with appropriate common file structure and contents for compatibility with data provided for SARAC I. The German police reported crash data was provided by the German Federal Statistical Office for the years 1998 to 2002.

The Australian and New Zealand real crash data covering the years 1987 to 2002 as used in Newstead et al (2004) was the source of data used in this study. Vehicle make and model information was available and while not all data from jurisdictions comprising the database had a variable coded for point of impact there was sufficient data to enable analysis.

In addition to these data sources, Finnish insurance data was available for analysis. However, there was insufficient data to conduct a full analysis. A full description of the Finnish data source and the limited analysis conducted is provided in Appendix J.

2.2 EuroNCAP Tested Results

2.2.1 Europe

The EuroNCAP Executive supplied EuroNCAP data for use in this study covering all test results published under the EuroNCAP program up until the time of the study. Data from EuroNCAP tests phases 1 to 7+ were supplied for SARAC 1 and again used here. For this update, data from EuroNCAP test phases 8 to 11 were also obtained and integrated with the previous data. The combined data covered EuroNCAP tests completed up to mid 2003, the commencement date for this study.

Results supplied from the EuroNCAP program covered the three main test procedures comprising the program. These were the 64km/h 40% offset barrier test, the 50km/h side impact test using 950kg mobile barrier and the pedestrian impact test incorporating leg form to bumper test and head form to bonnet test. Where conducted, the results of the side impact pole test were also supplied. For details of the pole test, see

EuroNCAP(2003). Full details of the other EuroNCAP test procedures and protocols are described in Williams (1997).

Table 1 details the vehicle models for which EuroNCAP test results were available. The vehicle make, model description and model year of the tested vehicle are provided and an index number has been assigned to each vehicle for reference purposes in the rest of the study. Test results were available for a total of 138 different vehicle models. This is an increase of 73 vehicle models from the time of the pilot study (SARAC I).

Table 1.Vehicle makes/models covered by the EuroNCAP program at the time of study

Index	Make	Model	Model Year
1	Fiat	Punto 55S	1996
2	Ford	Fiesta 1.25 LX 16V	1996
3	Nissan	Micra 1.0L	1996
4	Renault	Clio 1.2RL	1996
5	Rover	100	1996
6	Vauxhall	Corsa 1.2LS	1996
7	Volkswagen	Polo 1.4L	1996
8	Audi	A4 1.8	1997
9	BMW	316i	1997
10	Citroen	Xantia 1.8i Dimension	1997
11	Ford	Mondeo 1.8LX	1997
12	Mercedes	C180 Classic	1997
13	Nissan	Primera 1.6GX	1996
14	Peugeot	406 1.8LX	1997
15	Renault	Laguna 2.0RT	1997
16	Rover	620 Si	1997
17	Saab	900 2.0i	1997
18	Vauxhall	Vectra 1.8iLS	1997
19	Volkswagen	Passat 1.6L (LHD)	1997
20	Audi	A3 1.6	1997
21	Citroen	Xsara 1.4i (LHD)	1998
22	Daewoo	Lanos 1.4SE (LHD)	1998
23	Fiat	Brava 1.4S	1998
24	Honda	Civic 1.4i	1998
25	Hyundai	Accent 1.3GLS (LHD)	1998
26	Mitsubishi	Lancer GLX (LHD)	1997
27	Peugeot	306 1.6GLX	1997
28	Renault	Megane 1.6RT (LHD)	1998
29	Suzuki	Baleno 1.6GLX (LHD)	1998
30	Toyota	Corolla 1.3 Sportif (LHD)	1998
31	Volkswagen	Golf 1.4 (LHD)	1998
32	Audi	A6 2.4 (LHD)	1998
33	BMW	520i (LHD)	1998
34	Mercedes	E200 Classic (LHD)	1998
35	Toyota	Camry 2.2 (LHD)	1998
36	Saab	9-5 2.0 (LHD)	1998
37	Vauxhall	Omega 2.0GI/GLS (LHD)	1998
38	Volvo	S70 2.0/2.5 10V (LHD)	1998
39	Ford	Focus 1.6 (LHD)	1999
40	Mercedes	A140 Classic (LHD)	1999
41	Vauxhall	Astra 1.6i Envoy	1999
42	Ford	Escort 1.6 LX	1989
43	Nissan	Almera 1.4GX	1999

Index	Make	Model	Model Year
44	Renault	Espace 2.0RTE (LHD)	1998 & 1999
45	Toyota	Picnic 2.0GS	1999
46	Peugeot	806 2.0 (LHD)	1999
47	Nissan	Serena 1.6 (LHD)	1999
48	Volkswagen	Sharan TDI (LHD)	1999
49	Mitsubishi	Space Wagon 2.4 GDI GLX	1999
50	Vauxhall	Sintra 2.2 GLS	1998
51	Chrysler	Voyager 2.5TD (LHD)	1999
52	Fiat	Punto S60 1.2 (LHD)	1999
53	Volkswagen	Lupo 1.0 (LHD)	1999
54	MCC	Smart (LHD)	1999
55	Hyundai	Atoz GLS (LHD)	1999
56	Vauxhall	Corsa 1.0 12v Club	1999
57	Honda	Logo (LHD)	1999
58	Lancia	Ypsilon Elefantino (LHD)	1999
59	Honda	Accord 1.8iLS	1999
60	Volkswagen	Beetle 2.0 (LHD)	1999
61	Saab	9-3 2.0 (LHD)	1999
62	Volvo	S80 2.4 (LHD)	2000
63	Ford	Ka 1.3 (LHD)	2000
64	Volvo	S40 1.8	1997
65	Toyota	Avensis 1.6S	1998
66	Citroen	Saxo 1.1 SX (LHD)	2000
67	Daewoo	Matiz SE+ RHD	1999, 2000
68	Daihatsu	Sirion M100LS (LHD)	2000
69	Fiat	Seicento	2000
70	Ford	Fiesta 1.25 Zetec	2000
71	Nissan	Micra L 1.0 (RHD)	2000
72	Peugeot	206 1.3 XR Presence (LHD)	2000
73	Renault	Clio 1.2 RTE (LHD)	2000
74	Rover	25 1.4i (RHD)	2000/2001
75	Seat	Ibiza 1.4 Stella (LHD)	2000
76	Skoda	Fabia 1.4 Classic (LHD)	2000
77	Toyota	Yaris 1.0 Terra (LHD)	2000
78	Volkswagen	Polo 1.4 (LHD)	2000
79	Alfa Romeo	147 1.6 (LHD)	2001
80	Honda	Civic 1.4 S (LHD)	2001
81	Nissan	Almera Hatch	2001
82	Peugeot	307 (LHD)	2001
83	Audi	A4 2.0 (LHD)	2001
84	BMW	316i (LHD)	2000/2001
85	Citroen	C5 1.8i 16v SX (LHD)	2001
86	Hyundai	Elantra 1.6 GLS (LHD)	2001
87	Mercedes-Benz	C180 (LHD)	2001
88	Mitsubishi	Carisma 1.8 Comfort (LHD)	2001
89	Peugeot	406 (LHD)	2001
90	Renault	Laguna II 1.8 16v (LHD)	2001
91	Rover	75 1.8 (RHD)	2000/2001
92	Skoda	Octavia 1.9 Tdi Ambiente	2001
93	Vauxhall/Opel	Vectra 1.8 (LHD)	2001
94	Volkswagon	Passat 1.9 Tdi (LHD)	2001
95	Volvo	S60 (LHD)	2001
96	Citroen	Picasso 1.6 LX (LHD)	2001
97	Fiat	Multipla JTD ELX (RHD)	2001
98	Honda	Stream 1.7 SE VTEC (RHD)	2001
99	Mazda	Premacy 1.8 Comfort (LHD)	2001

Index	Make	Model	Model Year
100	Mitsubishi	(Colt) Space Star 1.3 Family	2001
101	Nissan	Almera Tino 1.8 Luxury	2001
102	Renault	Scenic 1.4 (LHD)	2001
103	Vauxhall/Opel	Zafira 1.8 (RHD)	2001
104	Peugeot	806 2.0 (LHD)	1999
105	Mercedes	M-Class ML270 (LHD)	2002
106	Suzuki	Grand Vitara 2.7ltr XL-7	2002
107	Chrysler	PT Cruiser 2.0ltr (LHD)	2002
108	Audi	A2 1.4 (LHD)	2002
109	BMW	Mini Cooper 1.6 (LHD)	2002
110	Peugeot	607 2.2 Hdi (LHD)	2002
111	Honda	S2000 (LHD)	2002
112	Mazda	MX-5 1.6 LHD	2002
113	Mercedes-Benz	SLK 200 Kompressor (LHD)	2002
114	Range Rover	(RHD)	2002
115	Jeep Cherokee	2.5 TD Limited (LHD)	2002
116	Vauxhall/Opel	Frontera 2.2 DTL 16v RHD	2002
117	Honda	CR-V 2.0 SE (RHD)	2002
118	Mercedes	E-Class 220CDi Elegance	2003
119	Renault	Vel Satis 2.2DCi (LHD)	2003
120	Citroen	C3 SX 1.4 Essence (LHD)	2003
121	Ford	Fiesta 1.4 Trend (RHD)	2003
122	Seat	Ibiza Stella 1.2 (LHD)	2003
123	Toyota	Corrolla 1.4 Terra (RHD)	2003
124	Saab	9-3 2.0ltr (LHD)	2003
125	Nissan	Primera 1.8 (LHD)	2003
126	Subaru	Legacy Outback 2.5 (RHD)	2003
127	Hyundai	Santa Fe 2.0 GRD (LHD)	2003
128	Land Rover	Freelander GS K1.8ltr petrol	2003
129	Nissan	X-Trail 2.0ltr (LHD)	2003
130	Mercedes	Vaneo 170 Cdi (LHD)	2003
131	Peugeot	807 2.0 Hdi (LHD)	2003
132	Vauxhall/Opel	Vectra 1.8 SE (LHD)	2002
133	Proton	Impian 1.6 GX (RHD)	2002
134	Jaguar	X-Type 2.0 (LHD)	2002
135	Renault	Megane II 1.6 16v (LHD)	2003
136	Vauxhall/Opel	Corsa 1.2 Comfort (LHD)	2002
137	Volkswagen	Polo 1.2 (LHD)	2002
138	Ford	Mondeo 1.8 LX (RHD)	2002

For each vehicle tested under the EuroNCAP program, a number of different measures obtained from the barrier tests were supplied. A summary of the measures supplied is given in Table 2. Basic measures supplied include those taken directly from the instrumented dummy during the test, functions of the dummy measures and score modifiers derived from dummy dynamics and vehicle deformation or failure characteristics. From these, summary measures are derived for each body region of the dummy in each test configuration, for each test configuration as a whole and for the offset and side impact tests combined. The summary measures are shown in bold font in Table 2. In addition to the dummy-based measurements, static deformation measurements taken from each vehicle after the offset test have been provided. These are all given as a measure of displacement in millimetres.

A full description of each raw dummy measure and the derivation of the summary measures can be found in Hobbs et al (1999). In the offset frontal barrier test, instrumented dummies are placed in both the driver and front passenger seats. For the purposes of this project, only the driver dummy measures have been considered because analysis of the real crash data has focused on driver injury outcomes only. Reflecting this, the overall score and corresponding star rating of each vehicle has been re-calculated based on only the driver dummy offset test readings. For some vehicle models, where the overall star rating was influenced by the passenger dummy reading in the offset test, the overall score and star rating used in this study will be different to that published by EuroNCAP. Only a driver dummy is used in the side impact tests, including the pole test.

EuroNCAP introduced a pole test in later years of the program. Submitting a vehicle model to the pole test is optional at the request of the vehicle manufacturer provided the vehicle has a side impact head protection device fitted, such as a curtain airbag. A small number of the EuroNCAP tested vehicles models with sufficient real data to be considered in this study were submitted for the pole test. Because not all vehicles, and not even all eligible vehicles, are submitted for the pole test, there was some concern as to whether this study should include the pole test outcome in a vehicle's overall test score. It was decided to conduct separate analyses both including and not including the results of the pole test where available.

Overall scores for latter EuroNCAP vehicle tests could also have points included for the vehicle having a seatbelt reminder system fitted. A maximum of three bonus point are awarded for this feature. Again, not all vehicles in Table 1 were assessed for the fitment of seat belt reminder systems. Of those vehicles in Table 1 that were assessed, very few were awarded points for the system. Consequently, it was decided not to include points for seat belt reminder systems in the EuroNCAP scores analysed in this study.

Table 2.EuroNCAP crash test measures

Offset Frontal Crash Test Results	Side Impact Crash Test Results	Static Deformation Measurements from Offset Frontal Test
HEAD	**HEAD**	**STEERING WHEEL**
Peak acceleration – g	Peak Resultant acceleration – g	Fore/aft displacement - mm
HIC36	HIC36	Vertical displacement - mm
3 msec exceedence – g	3 msec exceedence – g	Lateral displacement - mm

Offset Frontal Crash Test Results	Side Impact Crash Test Results	Static Deformation Measurements from Offset Frontal Test
Unstable contact (-1)	*Side Impact Pole Test (+2)*	**BRAKE PEDAL**
Head bottoming out (-1)	HIC36	Vertical displacement - mm
Steering wheel displacement (-1)	Resultant Acc. 3 ms exceedence	Horizontal displacement - mm
Head assessment	Incorrect Airbag Deployment	**A PILLAR**
NECK	**Head assessment**	Waistline displacement - mm
Shear - kN	**CHEST**	**DOOR APERTURE**
duration of exceedence - ms	Top Rib Compression - mm	Waist level collapse - mm
Tension - kN	Top Rib Viscous Criterion - m/s	Sill level collapse - mm
duration of exceedence - ms	**Top rib assessment**	
Extension - Nm	Mid. Rib Compression - mm	
Neck assessment	Mid. Rib Viscous Criterion - m/s	
Head and Neck assessment	**Middle rib assessment**	
CHEST	Bot. Rib Compression - mm	
Compression - mm	Bot. Rib Viscous Criterion - m/s	
viscous criterion - m/s	**Bottom rib assessment**	
Steering wheel contact (-1)	**Chest assessment**	
A-Pillar displacement (-1,2)	**ABDOMEN**	
Latch/Hinge failure, facia rail detached (-1)	Peak lateral force - kN	
Unstable passenger compartment (-1)	**Abdomen assessment**	
Shoulder belt load - kN	**PELVIS**	
Chest assessment	Pubic Symphysis force - kN	
KNEE, FEMUR and HIP	**Pelvis assessment**	
Left Femur Force - kN	**SUMMARY**	
duration of exceedence - ms	**Head assessment**	
Left Knee Slide - mm	**Chest assessment**	
Variable contact (-1)	**Abdomen assessment**	
Localised load (-1)	**Pelvis assessment**	
Left Knee, Femur & Hip assessment	**TOTAL SIDE**	
Right Femur Force – kN	**Pole Assessment**	
duration of exceedence – ms	**TOTAL SIDE + POLE**	
Right Knee Slide – mm	**OVERALL FRONT AND SIDE**	
Variable contact (-1)	**OVERALL FRONT AND SIDE + POLE**	
Localised load (-1)	**ROUNDED OVERALL SCORE**	
Right Knee, Femur & Hip assessment	**ROUNDED OVERALL SCORE +**	

Offset Frontal Crash Test Results	Side Impact Crash Test Results	Static Deformation Measurements from Offset Frontal Test
	POLE	
Knee, Femur and Hip assessment		
LOWER LEG		
Left axial force – kN		
Left Upper Tibia Index		
Left Lower Tibia Index		
Brake pedal vertical (-1)		
Left Lower Leg assessment		
Right axial force – kN		
Right Upper Tibia Index		
Right Lower Tibia Index		
Brake pedal vertical (-1)		
Right Lower Leg assessment		
FOOT and ANKLE		
Brake pedal horizontal displacement - mm		
Footwell displacement		
Footwell rupture (-1)		
Foot and ankle assessment		
Leg and Foot assessment		
SUMMARY		
Head and Neck assessment		
Chest assessment		
Knee, Femur and Hip assessment		
Leg and Foot assessment		
TOTAL DRIVER FRONTAL		

2.2.2 Australian ANCAP Test Results

Since 1999, the ANCAP program has adopted a vehicle test and scoring procedure fully harmonised with the EuroNCAP program. In fact, for vehicles tested under the EuroNCAP program that are also available for sale in similar specification in Australia, the EuroNCAP test results are published by ANCAP. The ANCAP data for use in this study using the EuroNCAP protocol was supplied by Michael Paine of Vehicle Design and Research Australia with permission of the Australian NCAP Program Steering Committee.

As for EuroNCAP, the ANCAP program uses three main test procedures for vehicle occupant and pedestrian protection assessment; the 64km/h 40% offset barrier test, the 50km/h side impact test using 950kg mobile barrier and the pedestrian impact test incorporating leg form to bumper test and head form to bonnet test. Where a suitable head protection device is incorporated in the vehicle and at the request of the manufacture, a side impact pole test is also carried out. Reflecting the harmonisation of the programs, scoring of the test outcomes in ANCAP is also identical to EuroNCAP.

Table 3 lists the vehicle models for which ANCAP test results were available that had sufficient real crash experience to be considered in the study. Appendix A provides detail on the ANCAP tested vehicle models used to match to vehicle models in the combined Australian and New Zealand crash data. Table 3 provides the vehicle make, model description and model year range of the tested vehicles included in the study. For reference purposes an index number has been assigned to each vehicle matched to vehicles in the combined Australian and New Zealand crash database. The same index number assigned to EuroNCAP tested vehicles has been used when applicable (i.e. when ANCAP had made use of the EuroNCAP test results for a vehicle available in Australia). Index numbers 139 to 154 have been assigned to ANCAP tested vehicles matched to vehicles in the combined Australian and New Zealand crash database where sufficient crash data was available for the vehicle to be included in the analysis.

Table 3. EuroNCAP protocol tested vehicle makes/models covered by the ANCAP program at the time of study.

Index	Make	Model	Year Range
18	Vauxhall	Vectra (E)	1997 to 2002
22	Daewoo	Lanos (E) 5D	1997 to 2003
26	Mitsubishi	Lancer (LHD)	1997 to 2003
27	Peugeot	306 (E)	1997 to 2000
30	Toyota	Corolla (LHD)	1998 to 2001
35	Toyota	Camry	2000 to 2002
41	Vauxhall	Astra (E)	1997 on
56	Holden	Barina City	2001 on
68	Daihatsu	Sirion	Mid 2000 on
77	Toyota	Yaris	2000 to 2002(AU)
126	Subaru	Liberty	1999 to 2003
139	Daewoo	Leganza	1999 to 2003
140	Daewoo	Nubira	1999 on
141	Ford	Falcon	2000 to 2002
142	Ford	Falcon Ute	2001 to 2003
143	Holden	Commodore VX	2000 to 2002
144	Holden	Rodeo	1999 to 2002
145	Hyundai	Accent	2000 on
146	Hyundai	Sonata	1999 to 2000
147	Mazda	121	2000 to 2003
148	Mazda	323	1999 to mid 2002
149	Mazda	Bravo	1999
150	Mitsubishi	Magna	Aug 2001 to 2003
151	Nissan	Pulsar	2000 on

Index	Make	Model	Year Range
152	Toyota	Avalon	2001 on
153	Toyota	Hilux_2wd	Sep 2001 to 2003
154	Volkswagon	Polo(E)	1996 to 1999

As the Australian NCAP program is fully harmonised with EuroNCAP, the measures obtained from the barrier tests under each program are the same and are given in Table 2.

2.3 British Real Crash data

The STATS19 database covering all crashes in Great Britain reported to Police over the period 1993 to 1998 was supplied by the UK Department for Transport (DfT – formerly the Department of Environment, Transport, and the Regions) for use in the pilot study conducted in SARAC I. Full details of that data are provided in Newstead et al, 2001. Additional data, for use in the current project, sub-tasks 2.1 and 2.2, covering police reported crashes in Great Britain for the period 1999 to 2001 was provided by the UK Department for Transport (DfT) in the same format as the earlier data.

Some key features of the British database are worth noting. All road accidents involving human death or personal injury occurring on the highway ('road' in Scotland) and in which one or more vehicles are involved are required to be reported to the police within 30 days of occurrence. All fatal or injury accidents on public roads involving at least one mechanically propelled vehicle should be reported by the public to police unless insurance documents, name and address, and evidence of vehicle ownership and registration are exchanged between drivers. Crashes falling outside the base reporting definition, including those not involving human injury, do not appear in the data. In addition, it is possible that all injury accidents are not reported to police.

Driver injury level is coded in the British data using a three level scale found in the "Severity of Casualty" variable in the casualty section of the database. These levels are:

- **(1) Fatal:** includes cases where death occurs in less than 30 days as a result of the accident
- **(2) Serious:** includes fractures, internal injury, severe cuts, crushing, burns, concussion, severe shock requiring hospital treatment, detention in hospital as an in-patient immediately or at a later date, injuries from the crash resulting in death 30 days or more after the crash
- **(3) Slight:** including sprains or whiplash not necessarily requiring medical treatment, bruises, slight cuts, slight shock requiring roadside attention.

Drivers with no coded casualty information were assumed to be uninjured. Full details of the database (STATS19) can be found in DETR (2000).

Considering the combined data set from 1993 to 2001, and after selecting passenger cars only, complete information for the required variables (driver age, driver sex, junction type, point of impact and speed limit of the crash site) was available for 1,635,296 crashes. Crashes involving one light passenger vehicle colliding with another were identified in these data and used in the estimation of injury risk. Estimation of injury risk using the DfT and Newstead methods, detailed below, considered 973,613 and 546,984 two-car crashes respectively. Estimation of injury severity using the MUARC severity measure considered injured drivers involved in either single vehicle or two-car crashes. A total of 775,972 injured drivers were available for analysis of which 159,306 were involved in single vehicle crashes and 616,666 were involved two-car crashes.

The selection criteria applied to the initial analyses of crashes of all types (in SARAC I, sub-task 2.2) were also utilised in this analysis. EuroNCAP tested vehicles were selected where at least 80 drivers were involved in two-car crashes and at least 20 drivers were injured in single and two-car crashes combined.

Crashed vehicles with primary impact to specific areas of the vehicle could be identified in the British data using the "1st Point of Impact" variable in the vehicle section of the database. Two specific primary impact points were relevant to the study for comparison with the EuroNCAP offset frontal and side impact test results. These were impacts to the front of the vehicle and impacts to the driver's side of the vehicle, selected by the "1 Front" and "3 Offside" codes respectively in the "1st Point of Impact" variable.

Selecting from the final data set described above, 551,841 and 383,033 crashes were available for use in the estimation of driver injury risk for front impact crashes using the DfT and Newstead methods respectively. Estimation of the injury severity measure for front impact crashes involved the analysis of 411,691 cases.

Driver side impact crashes were identified as those crashes coded as offside within the point of impact variable. Cases for analysis of driver side impact crashes were selected on the basis that there were more than 80 involved drivers and more than 20 injured drivers involved in off side impact crashes. The injury risk using the DfT method was estimated using 129,639 cases, while 66,198 cases were contained in the file used to estimate injury risk via the Newstead method. Injury severity was estimated from 137,433 injured drivers.

2.3.1 Identification of Vehicle Models in the British Data

Vehicle model details are coded in two numerical fields in the British crash database, one representing the make of the vehicle and the other the specific vehicle model details. A codebook identifying the vehicle makes and models represented by each code level was supplied by the DfT. Vehicle model codes recorded in the British database were typically very specific, often giving detail about trim level, engine option and often transmission type. For example

- Vauxhall/Opel Astra Club 16V Auto
- Peugeot 106 XN Zest 3

No information on the vehicle identification number (VIN) was available so selection of vehicle models from the crash data for comparison with EuroNCAP test result had to be carried out on the basis of the available make and model coding and descriptions. In addition to the make and model codes in the British data, the year and month of first registration of the vehicle were used to identify the relevant vehicle for comparison. Month of first registration was considered the best proxy for the month of vehicle manufacture (which was not available in the crash data) although it is acknowledged that some vehicles will sit in holding yards after manufacture for some time before sale. In this case, the month of first registration will be some time after the month of manufacture and there will be some chance of misclassification of the vehicle in terms of its model identification. Because the year of manufacture is also used along with reasonably specific details on model information, it is estimated that the proportion of misclassified vehicles will be relatively small in the total volume of data.

Information on general vehicle model specifications was obtained from a number of sources. The UK publication “WhatCar? Used Car Price Guide” (WhatCar? 2000) was used to identify dates of model introduction in Great Britain along with the specification of safety equipment fitted to each model variant and changes in those specifications over the model life. This information was augmented through online information from the Parker’s Guide web site (www.parkers.co.uk). In addition, information and comment on vehicle specification was obtained directly from the DfT staff and from participating vehicle manufacturers in SARAC.

2.4 French Real Crash Data

In France, every road accident in which at least one road user received medical treatment is investigated by the police and included in a national database managed by the Ministry of Transportation. The LAB in France has a copy of this database and supplied an extract of the data for use in the pilot study conducted in phase one of the SARAC project. Full details of that data are provided in Newstead et al, 2001. Additional data, for use here in sub-tasks 2.1 and 2.2, covering police reported crashes in France for the period 1999 to 2001 was provided by the LAB in the same format as the earlier data. Consistent with the earlier data supplied only those cases meeting the following criteria were provided:

- No two wheelers involved;
- Only drivers or right front passengers of private cars whose injury severity is known;
- All types of collisions and obstacles.

Driver injury level is coded in a variable in the French data using a four level scale. These levels are:

- **(1) Uninjured:** no medical treatment
- **(2) Killed:** death within seven days of the crash
- **(3)Severely Injured:** more than 6 days in hospital
- **(4) Slight Injury:**

multiple impacts, 0 – unknown. Impacts to the front of the vehicle were selected as codes 1, 2 and 3 whilst impacts to the driver's side of the vehicle were selected by code 8.

Information on 312,945 two-car crashes was available for use in the estimation of injury risk for front impact crashes using the DfT method. Estimation of injury risk using the Newstead method considered 224,732 crashes. Injury severity was estimated using the MUARC severity measure on the basis of 272,965 injured drivers involved in either single vehicle or two-car crashes. These records were used for the estimation of injury severity in real front impact crashes, as detailed in Section 3.1 below.

After selection of driver side impact crashes, 35,297 cases were available for the estimation of injury risk using the DfT method and 17,792 cases were used in the estimation of injury risk using the Newstead method. The injury severity file contained 33,253 cases in which a driver injury was sustained. These records were used for the estimation of injury severity in real side impact crashes, as detailed in Section 3.1 below.

2.4.1 Identification of Vehicle Models in the French Crash Data

Like the British database, VIN was not available for model identification in the French crash data. Selection of vehicle models from the crash data for comparison with EuroNCAP test result was carried out on the basis of make and model coding and descriptions provided in the crash data. Further, the year of manufacture of the vehicle was used to identify the relevant vehicle for comparison.

A review of the actual descriptions of vehicle model types in the French data supplied for SARAC I revealed a resolution on the description much less than found in the British data. Generally, only the broad model classification was given in the data with no detail on the trim level, engine option or transmission type. For example, a typical make model code was given as "Peugeot 106" with no more detail available. This problem has been rectified somewhat in the 1999-2001 French data with more detailed vehicle model information being available. This has allowed identification of equivalent EuroNCAP tested models in the French data, particularly in the latter data, with a precision much closer to that available when using the British data.

In addition to the problems with vehicle model identification described above, there is apparently no readily available French publication equivalent to the British "WhatCar?" publication that gives details of vehicle model release dates and equipment specifications. Whilst some information was available directly for the EuroNCAP publications and through SARAC participants, it generally had to be assumed that model release dates and specifications in France were similar to those in Great Britain.

2.5 German Real Crash Data

In Germany, every road accident attended by the police must be reported and is recorded in a database held at the German Federal Statistical Office. There are no strict injury criteria for inclusion in the database and accidents involving material damage or slight personal injuries are included where the accident was reported to the police. A copy of this database for the period 1998 to 2002 was supplied to MUARC for use in this study.

Driver injury level is coded in a variable in the German data using a four level scale. These levels are:

- **(1) Killed**
- **(2) Severely Injured**
- **(3) Slightly Injured**
- **(4) Not injured**

Considering the complete data set for crashes occurring between 1998 and 2002, 1,122,685 two-car and single vehicle crashes were identified. Of these, 804,589 contained complete information concerning the variables required for analysis (driver age, driver sex, intersection, location, cost, year of crash). Using this data the vehicle models were selected for inclusion in the analysis on the basis of the number of injured drivers and crash involvements for each of the EuroNCAP tested vehicles. EuroNCAP tested vehicles were selected where at least 100 drivers were involved in two-car crashes and at least 20 drivers were injured in single and two-car crashes combined.

Crashes involving one light passenger vehicle colliding with another were identified in the combined data set and used in the estimation of injury risk. Estimation of injury risk using the DfT and Newstead methods considered 364,939 and 221,132 two-car crashes respectively. Estimation of injury severity using the MUARC severity measure considered injured drivers involved in either single vehicle or two-car crashes. A total of 273,421 injured drivers were available for analysis.

Information on the primary point of impact on the vehicles was not sufficient to identify front and side impact crashes with certainty. Therefore, analysis of these crash types could not be conducted using the German data. A complete description of the German data is available in Hautzinger and Mayer (2004).

2.5.1 Identification of Vehicle Models in the German Data

Like the British and French databases, VIN was not available for model identification in the German crash data. Selection of vehicle models from the crash data for comparison with EuroNCAP test result was carried out on the basis of the "HSN" and "TSN" variables describing vehicle make and model that were available in the data. Using a method developed by the BAST, crash involved vehicles with "HSN" and "TSN" codes corresponding to those EuroNCAP tested vehicles detailed in Appendix A were identified as the relevant vehicles for comparison.

2.6 Australian and New Zealand Real Crash Data

Data from four states of Australia and the whole of New Zealand were combined to produce the Australia and New Zealand make and model specific crashworthiness ratings of Newstead et al (2004). The ratings covered drivers of cars, station wagons, four-wheel drive vehicles, passenger vans, and light commercial vehicles manufactured during 1982-2002 and crashing in the Australian states of Victoria and New South Wales during 1987-2002 or the Australian states Queensland and Western Australia during 1991-2002 and in New Zealand during 1991-2002. The data on the injured drivers analysed to produce the make and model specific vehicle safety ratings covered 383,842 drivers of 1982-2002 model vehicles who were injured in crashes in Victoria or New South Wales during 1987-2002 or in Western Australia, Queensland or New Zealand during 1991-2002. Of these 342,850 had a valid injury severity code, with 40,992 drivers injured in crashes in New South Wales during 1999-2002 excluded because of missing information on injury severity level. Information on the 342,850 injured drivers was used to assess the injury severity of injured drivers of the different makes and models when computing crashworthiness ratings. The information on the 1,504,399 drivers involved in tow-away crashes in New South Wales during 1987-2002 or Western Australia and Queensland during 1991-2002 was used to assess the injury rate of drivers of the different makes and models for computing crashworthiness ratings.

Driver injury level is coded in the combined Australian and New Zealand data using a four level scale. These levels are:

- **(1) Fatal:** includes cases where death occurs in less than 30 days as a result of the accident
- **(2) Serious Injury:** Admitted to hospital
- **(3) Injury:** Injured but not admitted to hospital
- **(4) Not injured:** Uninjured

In the jurisdictions where it was relevant, drivers with no coded casualty information were assumed to be uninjured.

Estimation of injury risk using the MUARC method, detailed below, considered 1,070,369 crashes which had complete information for the required variables (driver age, driver sex, number of vehicles involved, jurisdiction, speed zone of the crash site and year of crash). Estimation of injury severity using the MUARC severity measure considered 251,269 drivers injured in a crash during 1987-2002.

For all analyses, EuroNCAP protocol tested vehicles were selected where at least 100 drivers were involved and at least 20 drivers were injured. This is slightly different to the selection criteria applied in SARAC I, sub-task 2.2 and to the British and French data analysis in this report where 80 involved drivers was the minimum requirement.

Crashed vehicles with primary impact to specific areas of the vehicle could be identified in some jurisdictions in the combined Australian and New Zealand data using either "1st Point of Impact", "1st Impact Type" or "Vehicle Damage Location" variable in the vehicle section of the database. Two specific primary impact points were relevant to the study for comparison with the EuroNCAP protocol offset frontal and side impact test results. These were impacts to the front of the vehicle and impacts to the driver's side of the vehicle.

Selecting from the final data set described above, 140,184 crashes were available for use in the estimation of driver injury risk for front impact crashes using the MUARC method. Estimation of the injury severity measure for front impact crashes involved the analysis of 75,478 cases.

Cases for analysis of driver side impact crashes were selected on the basis that there were more than 100 involved drivers and more than 20 injured drivers involved in off side impact crashes. The injury risk using the MUARC method was estimated using 15,605 cases. Injury severity was estimated from 11,459 injured drivers.

2.6.1 Identification of Vehicle Models in the Australian and New Zealand Data

In some jurisdictions a Vehicle Identification Number (VIN) was decoded to determine the models of light passenger vehicles and in others make and model codes were of sufficient detail to be used, along with year of manufacture to assign vehicle model groupings. Details of the model decoding procedure can be found in Newstead et al (2004).

2.7 Comparison of the European Data Sets

As evident from the description of the French, British and German data sources, there were a number of fundamental differences in the three data systems. The most important fundamental difference is in the segregation of injury levels coded in the reported data. Specifically, the difference lies in the segregation of degree of injury for injured occupants who are not killed. The British data divides injured occupants into those severely injured (hospital admissions and other serious outcomes) and those with minor injuries. In the French data, injured occupants are classified into two groups defined as those staying less than 7 days in hospital and those staying 7 or more days in hospital. Clearly, these injury definitions are incomparable between the two data systems. The LAB advised that there are no variables in the GNPN database that identify hospital admission or other serious injury outcomes to make the French injury classification comparable to that used in Britain. Similarly, in the British data there is no variable indicating admission to, or length of stay in hospital to make the British injury definition comparable with the French definition. Detailed criteria for the classification of injuries in the German data have not been provided.

Another apparent difference in the British, French and German databases is the comparative number of vehicle occupants involved in injury crashes that fall into each injury severity level (

Table 4).

Table 4. Comparison of British, French and German Data Injury Level Codes (All Crash Types).

British Injury Level	% of Injured Drivers at Level	French Injury Level	% of Injured Drivers at Level	German Injury Level	% of Injured Drivers at Level
Fatal (death < 30 days after crash)	0.4	Killed (death <7 days after crash)	3.0	Killed	0.3
Severely Injured (including any hospital admission and other serious outcomes)	4.7	Severely Injured (>6 Days in hospital)	11.6	Severely Injured	5.3
Slight Injury (injured but not severely)	42.4	Slightly Injured (<7 days in hospital)	47.6	Slightly Injured	28.4
Total Injured	47.5	**Total Injured**	62.2	**Total Injured**	34
No Injury	52.5	Uninjured	37.8	Uninjured	66

Although the French have a shorter time frame for death after a crash to be classified as killed, the driver fatality rate per driver in reported crashes is more than 7 times that in the British and German data. Similarly the proportion of French drivers in reported crashes admitted to hospital for more than 6 days is more than double the total rate of serious injury in the British and German data. Overall, the injury rate of reported drivers in the French data is 31% higher than that in the British data. This suggests that either a crash in France is typically far more severe than in Great Britain or that there is substantial under reporting of crashes at the lower injury severity levels in France compared with Great Britain. The later is considered more likely, although the former is possible if factors such as seat belt wearing rates were vastly different between the two countries. The former explanation would also be possible if the exposure to events with high injury risk outcomes, such as travel in zones with high speed limits, was greater in France than Great Britain. The actual reasons for the observed differences remain unknown and are not of primary relevance to this study.

There also appears to be some difference in the proportion of drivers slightly injured and uninjured in German data compared to the British and French data. Possible explanations for this include the under-reporting of slightly injured drivers in Germany.

As a result of the inconsistencies in defining injury severity levels, crash reporting and the differing level of specificity relating to vehicle model identification in the British, French and German databases, parallel rather than combined analysis of the three data sources has been conducted. This approach was also adopted in SARAC 1. Similar outcomes from analysis of the three data sources would serve to confirm the results obtained whilst differences in analysis outcomes could be investigated in the context of the differences noted above.

3 Methods

3.1 Real Crash Based Vehicle Safety Measures

Previous studies of the relationship between real crash outcomes in the US and Australia and vehicle crash barrier test outcomes have measured real crash outcomes by the crashworthiness measure developed by MUARC and described in Newstead et al (1999). The MUARC crashworthiness rating (C) is a measure of the risk of serious injury to a driver of vehicle make/model when it is involved in a crash. It is defined to be the product of two probabilities (Cameron et al. 1992a):

i) the probability that a driver involved in a crash is injured (injury risk), denoted by R;

and

ii) the probability that an injured driver is hospitalised or killed (injury severity), denoted by S.

Hence,

$$C = R \times S.$$

For the estimation of crashworthiness ratings (Newstead et, al, 1999), each of the two components of the crashworthiness rating was obtained by logistic regression modelling techniques. Such techniques are able to simultaneously adjust for the effect of a number of non-vehicle related factors (such as driver age, driver sex, number of vehicles involved, etc.) on probabilities of injury risk and injury severity. Details of the technique are given in Newstead et al (1999) including methods for calculating confidence limits on both of the individual injury risk and severity component estimates as well as crashworthiness ratings. Technical details of the logistic regression procedure can be found in, amongst others, Hosmer & Lemeshow (1989).

Using the British, French, German and Australian and New Zealand data sets described above, the MUARC injury severity measure can be estimated. For Australian and New Zealand data set the MUARC injury risk measure can be estimated. However, calculation of the MUARC risk measure requires complete non-injury crash data which is not available in either the British or French data. The use of alternative injury risk measures was examined in SARAC I sub-task 1.6, and comparisons of the relative outcomes of each method were made. The analysis demonstrated that of the available established methods designed for use on injury only crash databases, the DfT method gave estimates of injury risk closest to those produced by the MUARC method. In addition, real crash based injury risk ratings computed from US data in

SARAC I sub-task 1.6 using the DfT and MUARC methods each had a similar level of correlation with the US crash barrier test results. Therefore in this study, for the British and French data, the DfT method was used to estimate the injury risk component of the crashworthiness ratings for comparison with the EuroNCAP test results. This approach was also adopted for the German data to maintain consistency in the methods applied to European data.

Estimation of the injury risk component of the crashworthiness rating using the DfT method involves identifying crashes between two passenger vehicles in the data. Single vehicle crashes cannot be used in the analysis, as injury in the focus vehicle is a prerequisite to inclusion in an injury crash database. The DfT injury risk measure calculates a conditional probability of driver injury given involvement in a two-car crash where at least one driver was injured. This risk measure is easily computed using logistic regression analysis where the dependent variable is the injury outcome of the driver dichotomised into the categories injured and not injured. Using logistic regression analysis allows the effects of confounding influences on injury outcome external to vehicle design, such as driver and crash characteristics, to be easily controlled. The logistic regression analysis was performed in the statistical computer package SAS using the logistic procedure. It is noted that the estimates of crashworthiness, injury risk and injury severity were calculated by the authors of this report using a modification of the method developed by the DfT. The results of the estimation process should in no way be interpreted as endorsed by the DfT.

A second measure of injury risk, denoted the Newstead method, has also been estimated for the three crash groupings considered (all crash types, front impact and side impact crashes) for the British, French and German data. The Newstead method is described in detail in the SARAC I sub-task 1.6 and 3.4 project reports. It stems from considering the same 2-car crash outcomes on which the DfT injury risk measure is estimated. Essentially, the Newstead injury risk measure is interpreted as a conditional probability of driver injury in the focus vehicle given the driver of the vehicle colliding with the focus vehicle is injured. As for the DfT injury risk measure, the Newstead injury risk measure is easily computed using logistic regression analysis where the dependent variable is the injury outcome of the driver, conditional on the driver of the other vehicle being injured, dichotomised into the categories injured and not injured. The logistic regression analysis was performed in the statistical computer package SAS using the logistic procedure

Procedures for estimation of the severity component of the crashworthiness rating using the MUARC method are well documented in Newstead et al (1999). Estimation of the severity component is unaffected by the lack of non-injury crashes in the database. Following the MUARC method, all crash types, both single and multi-vehicle, are used for estimation of the severity component with adjustment made for the number of vehicles involved in the crash via the logistic regression procedure. Use of single vehicle crashes in the severity analysis was considered justified as this crash type is fully reported in an injury only database with respect to measuring the risk of serious driver injury given any driver injury. It also provides large quantities of data in addition to that available from two vehicle crashes leading to increased accuracy of estimation of the severity index. Experience in producing the Australian crashworthiness ratings (Newstead et al 1999) has shown single vehicle crashes tend to result in more severe injury outcomes than multi vehicle crashes. However, any propensity for greater or lesser involvement in single vehicle crashes than average of a particular vehicle model that might bias the estimated severity index can be controlled using the logistic regression analysis technique.

Following the methods used the SARAC I, sub-task 2.2, study comparing real crash outcomes against vehicle crash barrier test measures, crashworthiness ratings were computed for all crash types as well as for crash types comparable to the barrier test crash configurations. Specific crash types considered were crashes involving a front impact to the focus vehicle and crashes involving a side impact to the driver's side of the focus vehicle. Variables used to select the specific crash types of interest from the real crash databases are described in the Data section above.

3.1.1 Factors Considered in the Logistic Models for Injury Risk and Injury Severity

A number of factors thought to influence the risk of severity of injury to drivers involved in crashes were included in the logistic models in order to obtain estimates of vehicle safety unbiased by these factors. The factors considered in the analysis for injury risk and severity for each of the types of British crashworthiness rating calculated, were:

- **drv_sex:** sex of driver (male, female)
- **drv_age:** age of driver (≤25 years; 26-59 years; ≥60years)
- **spd_lim:** speed limit at the crash location (<40mph; 41-59mph; ≥60mph)
- **junction** junction detail (intersection; non-intersection)
- **poi** first point of impact (did not impact; front; back; offside; nearside)
- **yea** year of crash

In addition, the variable **num_veh** (number of vehicles involved: one vehicle, ≥1 vehicle) was used in the injury severity analysis. Base effects as well as all possible interactions of these variables were included in the logistic regression analyses.

The factors considered in the analysis for both injury risk and injury severity for each of the types of French crashworthiness rating calculated, were:

- **sex:** driver sex (male, female)
- **age:** driver age (≤25 years; 26-59 years; ≥60years)
- **int:** intersection (intersection; non-intersection; other)
- **urb:** urbanisation of location (rural; urban)
- **yea** year of crash

In addition, **nbv:** (number of vehicles involved; one vehicle, ≥1 vehicle) was included in the injury severity analysis. Again, base effects as well as all possible interactions of these variables were included in the logistic regression analyses. Speed limit at the crash site was not available in the French crash data so urbanisation of location was included in the analysis as a proxy for speed limit.

The factors considered in the analysis for both injury risk and injury severity for each of the types of German crashworthiness rating calculated, were:

- **sex:** driver sex (male, female)
- **age:** driver age (<25 years; 25-64 years; ≥65years)
- **int:** intersection (intersection; non-intersection)
- **loc:** location of crash (within built-in areas; outside built-in areas)
- **cost:** cost of vehicle damage in '000 € (<2; 2-2.9; 3-3.9; 4-4.9;5-9.9; 10-14.9; 15-24.9; ≥25)
- **year** year of crash (1998, 1999, …, 2000)

In addition, **nbv:** (number of vehicles involved; one vehicle, ≥1 vehicle) was included in the injury severity analysis. Again, base effects as well as all possible interactions of these variables were included in the logistic regression analyses. Speed limit at the crash site was not available in the German crash data; crash location was included in the analysis as a proxy for speed limit.

The factors considered in the analysis for both injury risk and injury severity for the Australian and New Zealand crashworthiness ratings calculated, were:

- **sex:** driver sex (male, female)
- **age:** driver age (≤25 years; 26-59 years; ≥60 years)

- **speedzone:** speed limit at the crash location (≤75 km/h; ≥80 km/h)
- **nveh:** the number of vehicles involved (one vehicle; >1 vehicle)
- **state:** jurisdiction of crash (Victoria, NSW, QLD, WA, NZ)
- **year:** year of crash (1987, 1988, … ,2002)

These variables were chosen for consideration because they were part of the Victorian, Queensland, New South Wales, Western Australia and New Zealand databases. Other variables were only available from one source and their inclusion would have drastically reduced the number of cases that could have been included in the analysis.

Jurisdiction of crash was a necessary inclusion in the logistic model because each jurisdiction has its own level of general road safety performance that affects injury outcome. Including the jurisdiction factor in the covariate model is necessary to adjust for rating bias towards those vehicle models that are sold and driven more in one jurisdiction than another. There is also some indication of reporting bias by crash severity in some jurisdictions that is also controlled by including the jurisdiction variable in the regression models. Inclusion of a year of crash indicator in the model is necessary to adjust for the different trends in crash severity noted between each of the jurisdictions.

3.2 Methods of comparing crashworthiness ratings with EuroNCAP scores

Preliminary analysis has focused on examining the average crashworthiness ratings derived from the police reported data of vehicles within each overall star-rating category assigned by the EuroNCAP test program. Lie and Tingvall (2000) have used this approach to make basic comparisons of real crash outcomes in Sweden with EuroNCAP test results. Comparison was made for each crash type considered in the real crash data with specific comparisons between the frontal crash ratings and the offset frontal EuroNCAP test results and the side impact crash ratings and side impact test EuroNCAP score.

As well as examining the average injury outcome in police reported crashes within each EuroNCAP star rating, comparisons have also been made on a vehicle by vehicle basis. Comparisons on this basis were made graphically with the underlying EuroNCAP score from which the overall star ratings is derived plotted against the crashworthiness ratings calculated from the police reported data. Comparisons have been made for all crash types as well as frontal and side impact crashes.

4 Results

Before presenting the results of analysis completed for this project, it is worth noting that a number of qualifications on the results presented are relevant. These qualifications are made in detail in the Discussion section below, but the relevant points can be summarised briefly here. They are:

- Real crash data used in this report covers the period up to 2002 at the latest whilst the first EuroNCAP test results were not published until early 1997. This means that sample sizes for some makes/models used in this analysis are small. However, the relative accuracy of the real crash outcomes is reflected in the statistical confidence bounds on the estimates.

- There are fundamental differences in the measures of vehicle safety represented by EuroNCAP and derived from analysis of the real crash data. In addition, there are also clear differences in the range of crash situations and configurations that the two measures being compared represent, beyond those factors that have been made comparable by the study design.

- Classification of injury severity in the real crash data is made on a fairly coarse scale and hence analysis of such data may not be able to differentiate safety performance between vehicles on a level less than the resolution of the scale.

- There could be differences in the characteristics of vehicles examined by EuroNCAP and those dominant in the field data at this stage of data analysis because manufacturers sometimes adapt existing models with running changes before the NCAP test. Every attempt has been made to avoid this limitation by selecting vehicle appearing in the police crash data that best match the specifications of the EuroNCAP tested vehicle based on the information available.

4.1 Identification of EuroNCAP Tested Vehicle Models

As described above, information was supplied in the EuroNCAP publications on tested vehicle make and model whilst information on specifications of vehicles in the British vehicle model fleet was obtained from the “WhatCar?” publications and other sources. Using this information, a vehicle comparison table matching EuroNCAP tested vehicles with comparable models in the British fleet was designed. The vehicle comparison table was circulated amongst the SARAC participants for comment. Replies were received from DfT, Renault-Peugeot-Citroen via LAB, Daimler Chrysler and Ford Europe. Modification of the vehicle matching table was then made incorporating the feedback from the SARAC members. The resulting final matching table is shown in Appendix A. Description of all the fields in the table can also be found in Appendix A.

Whilst the vehicle model matching table in Appendix A has been derived primarily from British data sources, it has also been used to identify EuroNCAP tested vehicle models appearing in the French and German crash data. In some instances, variations in the specification of standard safety equipment in the European vehicle models are noted in Appendix A, however the dates of introduction of the each vehicle model have been presumed to be the same in France and Great Britain. No information to discredit this presumption has been available to date.

4.1.1 EuroNCAP Tested Vehicle Models Identified in the British Crash Data

Using the model comparison table in Appendix A, EuroNCAP tested vehicle model codes were identified in the British model codes supplied by the DfT. The selected model codes were then merged onto the British crash data to identify EuroNCAP tested comparable vehicle models appearing in the crash database.

Table 5 gives the number of involved and injured drivers of EuroNCAP tested vehicles that had sufficient real crash data to be included in the analysis. Past experience in estimating vehicle safety ratings based on real crash data has shown there needs to be a minimum of 80 vehicles of the focus type involved in 2 car injury crashes to ensure successful estimation of the injury risk measures. Similarly, there needs to be at least 20 drivers injured in all crash types involving the focus vehicle (excluding crashes with fixed objects and light goods vehicles) to successfully estimate the injury severity index for that vehicle model. These selection criteria have been applied in this study for identification of vehicle models with sufficient data to be included in the study. The number of cases for all crash types, frontal impact crashes and side impact crashes are shown separately. Vehicle models with empty cells in

Table 5 had insufficient data to be included in the analysis.

Of the 138 EuroNCAP crash tested vehicle models listed in Table 1 there were 70, 54 and 23 vehicles with sufficient real crash data from all crash types, frontal impact crashes and side impact crashes, respectively, to be included in the analysis. The crash data was used to assess the injury risk and severity of the drivers of the different makes and models of EuroNCAP tested vehicles for each crash type.

Table 5. **Number of injured or involved drivers of EuroNCAP crash tested vehicles from 1993 to 2001: British Crash Data.**

Make/model with Crashworthiness Rating based on 1993-2001 crashes and tested in the EuroNCAP program	Euro-NCAP Index	All Crashes		Frontal Impact Crashes		Side Impact Crashes	
		Drivers involved in injury crashes between 2 light cars	Injured drivers in single and 2 light car crashes	Drivers involved in injury crashes between 2 light cars	Injured drivers in single and 2 light car crashes	Drivers involved in injury crashes between 2 light cars	Injured drivers in single and 2 light car crashes
Fiat Punto 55S	1	2522	2099	1377	1048	352	267
Ford Fiesta 1.25 LX 16V	2	8692	7158	4898	3744	1109	805
Nissan Micra 1.0L	3	2361	2069	1258	1057	302	244
Renault Clio 1.2RL	4	330	316	190	188	59	43
Rover 100	5	2665	2337	1419	1195	373	290
Vauxhall Corsa 1.2LS	6	349	309	177	150	44	31
Volkswagen Polo 1.4L	7	2332	1986	1209	954	318	243
Audi A4 1.8	8	495	333	262	145	61	43
BMW 316i	9	2757	2194	1460	1020	329	190
Citroen Xantia 1.8i Dimension	10	1703	1056	1010	533	199	117
Ford Mondeo 1.8LX	11	4169	2810	2258	1361	535	320
Mercedes C180 Classic	12	457	316	225	128	67	43
Nissan Primera 1.6GX	13	746	568	405	280	100	62
Peugeot 406 1.8LX	14	2135	1318	1291	700	249	128
Renault Laguna 2.0RT	15	1088	753	657	408	121	78
Rover 620 Si	16	1448	920	809	395	167	115
Saab 900 2.0i	17	189	122	97	49	28	17
Vauxhall Vectra 1.8iLS	18	4207	3060	2265	1507	547	339
Volkswagen Passat 1.6L LHD	19	312	189	150	82	49	28
Audi A3 1.6	20	242	189	123	98	41	25
Citroen Xsara 1.4i LHD	21	278	247	165	140	35	24
Daewoo Lanos 1.4SE LHD	22	368	306	175	139	58	44
Fiat Brava 1.4S	23	1500	1168	863	625	235	167
Honda Civic 1.4i	24	2166	1714	1178	862	288	185
Hyundai Accent 1.3GLS LHD	25	345	296	191	155	55	45
Peugeot 306 1.6GLX	27	2708	2291	1543	1253	321	220
Renault Megane 1.6RT LHD	28	1518	1271	828	652	233	167
Suzuki Baleno 1.6GLX LHD	29	210	182	111	93	30	20
Toyota Corolla 1.3 Sportif LHD	30	590	466	301	212	82	59

Volkswagen Golf 1.4 LHD	31	148	117	84	60	18	12
Audi A6 2.4 LHD	32	165	107	82	50	28	20
BMW 520i LHD	33	357	235	181	98	51	27
Mercedes E200 Classic LHD	34	183	125	96	62	24	11
Saab 9-5 2.0 LHD	36	103	54	54	28	16	8
Vauxhall Omega 2.0Gl/GLS LHD	37	1014	700	540	345	132	74
Volvo S70 2.0/2.5 10V LHD	38	107	61	47	31	15	9
Ford Focus 1.6 LHD	39	1816	1327	1046	713	224	135
Mercedes A140 Classic LHD	40	199	151	101	79	38	24
Vauxhall Astra 1.6i Envoy	41	3104	2403	1794	1327	366	249
Ford Escort 1.6 LX	42	12038	9167	6655	4620	1505	1012
Nissan Almera 1.4GX	43	415	319	252	183	60	40
Nissan Serena 1.6 LHD	47	120	85	64	41	20	14
Volkswagen Sharan TDI LHD	48	167	101	93	48	24	14
Vauxhall Corsa 1.0 12v Club	56	1785	1617	939	819	223	165
Honda Accord 1.8iLS	59	112	88	54	42	20	12
Saab 9-3 2.0 LHD	61	138	82	80	43	22	10
Ford Ka 1.3 LHD	63	2006	1843	1051	934	294	230
Volvo S40 1.8	64	372	267	182	111	39	25
Toyota Avensis 1.6S	65	620	458	310	206	84	54
Citroen Saxo 1.1 SX LHD	66	3090	3158	1804	1807	402	330
Daewoo Matiz SE+ RHD	67	310	293	145	129	43	37
Fiat Seicento	69	255	236	134	125	35	28
Ford Fiesta 1.25 Zetec	70	1158	1053	666	594	136	102
Nissan Micra L 1.0 RHD	71	165	144	108	91	22	20
Peugeot 206 1.3 XR Presence LHD	72	825	750	418	362	105	79
Renault Clio 1.2 RTE LHD	73	721	658	425	364	97	80
Rover 25 1.4i RHD	74	280	252	165	141	37	30
Toyota Yaris 1.0 Terra LHD	77	251	223	122	108	35	25
Volkswagen Polo 1.4 LHD	78	269	248	130	122	42	35
Nissan Almera Hatch	81	176	141	94	71	20	17
BMW 316i LHD	84	471	416	241	197	62	41
Peugeot 406 LHD	89	540	356	284	181	68	40
Rover 75 1.8 RHD	91	136	77	66	32	26	10
Vauxhall/Opel Vectra 1.8 LHD	93	1088	762	548	351	145	83
Volkswagon Passat 1.9 Tdi LHD	94	533	346	268	163	58	37
Citroen Picasso 1.6 LX	96	105	77	40	27	24	19

LHD							
Renault Scenic 1.4 LHD	102	239	193	102	75	36	27
Mazda MX-5 1.6 LHD	112	191	196	94	82	26	21
Jeep Cherokee 2.5 TD Limited LHD	115	159	93	90	48	16	7
Vauxhall/Opel Corsa 1.2 Comfort LHD	136	141	125	66	62	20	16
Total number of vehicle models		**70**		**54**		**23**	

4.1.2 EuroNCAP Tested Vehicle Models Identified in the French Crash Data

Again, using the model comparison table in Appendix A, EuroNCAP tested vehicle model codes were identified in the French model codes appearing in the French crash data. Table 6 gives the number of involved and injured drivers of EuroNCAP tested vehicles that had sufficient real crash data to be included in the analysis of the French data. Selection criteria of at least 80 vehicles in two-car injury crashes and 20 injured drivers in two-car and single vehicle crashes have been applied to the French data for identification of vehicle models with sufficient data for analysis. The number of cases for all crash types and frontal impact crashes are shown separately. Vehicle models with empty cells in Table 6 had insufficient data to be included in the analysis.

Of the 138 EuroNCAP crash tested vehicles listed in Table 1 there were 36, 31 and 5 vehicle models with sufficient real crash data from all crash types, frontal impact crashes and side impact crashes respectively to be included in the analysis.

Table 6. Number of injured or involved drivers of EuroNCAP crash tested vehicles from 1993 to 2001: French Crash Data.

Make/model with Crashworthiness Rating based on 1993-2001 crashes and tested in the EuroNCAP program	Euro-NCAP Index	All Crashes		Frontal Impact Crashes		Side Impact Crashes	
		Drivers involved in injury crashes between 2 light cars	Injured drivers in single and 2 light car crashes	Drivers involved in injury crashes between 2 light cars	Injured drivers in single and 2 light car crashes	Drivers involved in injury crashes between 2 light cars	Injured drivers in single and 2 light car crashes
Fiat Punto 55S	1	1694	1049	1285	776	121	92
Ford Fiesta 1.25 LX 16V	2	1070	650	764	452		
Nissan Micra 1.0L	3	89	63				
Renault Clio 1.2RL	4	3293	1997	2451	1460	252	177
Vauxhall Corsa 1.2LS	6	746	467	553	339		
Volkswagen Polo 1.4L	7	857	518	613	361		
BMW 316i	9	230	101	163	70		

Citroen Xantia 1.8i Dimension	10	1768	785	1348	573	123	74
Ford Mondeo 1.8LX	11	210	86	145	56		
Mercedes C180 Classic	12	87	30				
Nissan Primera 1.6GX	13	81	37				
Peugeot 406 1.8LX	14	983	392	731	278		
Renault Laguna 2.0RT	15	715	310	545	240		
Vauxhall Vectra 1.8iLS	18	278	116	202	84		
Audi A3 1.6	20	110	51	80	33		
Citroen Xsara 1.4i LHD	21	408	236	290	166		
Fiat Brava 1.4S	23	348	198	268	144		
Honda Civic 1.4i	24	155	74	114	49		
Peugeot 306 1.6GLX	27	1639	862	1203	616	128	74
Renault Megane 1.6RT LHD	28	863	471	622	326		
Ford Focus 1.6 LHD	39	164	86	122	62		
Vauxhall Astra 1.6i Envoy	41	241	122	175	83		
Ford Escort 1.6 LX	42	1122	590	822	434		
Renault Espace 2.0RTE (LHD)	44	228	71	161	52		
Peugeot 806 2.0 (LHD)	46	80	30				
Vauxhall Corsa 1.0 12v Club	56	296	186	214	130		
Ford Ka 1.3 LHD	63	199	122	132	77		
Citroen Saxo 1.1 SX LHD	66	1362	890	986	630	130	102
Ford Fiesta 1.25 Zetec	70	128	82	89	52		
Peugeot 206 1.3 XR Presence LHD	72	318	212	221	150		
Renault Clio 1.2 RTE LHD	73	624	364	451	256		
Volkswagen Polo 1.4 LHD	78	142	89	107	66		
BMW 316i LHD	84	86	34				
Peugeot 406 LHD	89	362	151	270	108		
Volkswagon Passat 1.9 Tdi LHD	94	155	69	107	49		
Renault Scenic 1.4 LHD	102	219	96	140	60		
Total number of vehicle models		**36**		**31**		**5**	

4.1.3 EuroNCAP Tested Vehicle Models Identified in the German Crash Data

Using the model comparison table in Appendix A, EuroNCAP tested vehicle model codes were identified in the German data. Table 7 gives the number of involved and injured drivers of EuroNCAP tested vehicles that had sufficient real crash data to be included in the analysis. Criteria of at least 100 vehicles of the focus type involved in two-car injury crashes. Similarly, criteria of at least 20 injured drivers in two-car and single vehicle crashes involving the focus vehicle has been applied.

Of the 138 EuroNCAP crash tested vehicle models listed in Table 1 there were 53 with sufficient real crash data from all crash types to be included in the analysis.

Table 7. Number of injured or involved drivers of EuroNCAP crash tested vehicles from 1998 to 2000: German Crash Data.

Make/model with Crashworthiness Rating based on 1993-2001 crashes and tested in the EuroNCAP program	Euro-NCAP Index	All Crashes	
		Drivers involved in injury crashes between 2 light cars	Injured drivers in single and 2 light car crashes
Fiat Punto 55S	1	1814	1622
Nissan Micra 1.0L	3	1549	1475
Renault Clio 1.2RL	4	408	402
Vauxhall Corsa 1.2LS	6	3306	3055
Volkswagen Polo 1.4L	7	1865	1791
Audi A4 1.8	8	1189	773
BMW 316i	9	643	547
Citroen Xantia 1.8i Dimension	10	158	107
Ford Mondeo 1.8LX	11	640	394
Mercedes C180 Classic	12	2254	1509
Nissan Primera 1.6GX	13	248	189
Peugeot 406 1.8LX	14	171	110
Renault Laguna 2.0RT	15	133	98
Vauxhall Vectra 1.8iLS	18	1009	726
Volkswagen Passat 1.6L (LHD)	19	721	451
Audi A3 1.6	20	683	530
Fiat Brava 1.4S	23	172	152
Honda Civic 1.4i	24	740	690
Hyundai Accent 1.3GLS (LHD)	25	442	435
Peugeot 306 1.6GLX	27	129	97
Renault Megane 1.6RT (LHD)	28	736	655
Toyota Corolla 1.3 Sportif (LHD)	30	440	356
Volkswagen Golf 1.4 (LHD)	31	1709	1266
Audi A6 2.4 (LHD)	32	339	182
BMW 520i (LHD)	33	530	317
Mercedes E200 Classic (LHD)	34	378	221

Ford Focus 1.6 (LHD)	39	340	245
Mercedes A140 Classic (LHD)	40	482	342
Vauxhall Astra 1.6i Envoy	41	1914	1426
Ford Escort 1.6 LX	42	1973	1535
Nissan Almera 1.4GX	43	575	452
Volkswagen Sharan TDI (LHD)	48	136	76
Vauxhall Sintra 2.2 GLS	50	154	94
Chrysler Voyager 2.5TD (LHD)	51	116	61
Fiat Punto S60 1.2 (LHD)	52	347	291
Volkswagen Lupo 1.0 (LHD)	53	639	540
MCC Smart (LHD)	54	688	709
Vauxhall Corsa 1.0 12v Club	56	1879	1849
Lancia Ypsilon Elefantino (LHD)	58	102	94
Volkswagen Beetle 2.0 (LHD)	60	120	90
Ford Ka 1.3 (LHD)	63	1893	1872
Citroen Saxo 1.1 SX (LHD)	66	156	169
Fiat Seicento	69	324	329
Renault Clio 1.2 RTE (LHD)	73	334	327
Skoda Fabia 1.4 Classic (LHD)	76	114	90
Toyota Yaris 1.0 Terra (LHD)	77	197	191
Volkswagen Polo 1.4 (LHD)	78	247	228
BMW 316i (LHD)	84	245	173
Skoda Octavia 1.9 Tdi Ambiente (LHD)	92	315	207
Volkswagon Passat 1.9 Tdi (LHD)	94	393	219
Mazda MX-5 1.6 LHD	112	109	118
Vauxhall/Opel Corsa 1.2 Comfort (LHD)	136	130	121
Total number of vehicle models		**53**	

4.1.4 EuroNCAP/ANCAP Tested Vehicle Models Identified in the Australian and New Zealand Crash Data

Using the model comparison tables in Appendix A, EuroNCAP and ANCAP tested vehicle model codes were identified in the Australian and New Zealand model codes supplied. The selected model codes were then merged onto the combined Australian and New Zealand crash data to identify EuroNCAP / ANCAP tested comparable vehicle models appearing in the crash database.

Table 8 gives the number of involved and injured drivers of EuroNCAP / ANCAP tested vehicles that had sufficient real crash data to be included in the analysis. With Australian crashworthiness ratings a minimum requirement for inclusion in estimating vehicle safety ratings based on real crash data has been 100 involved drivers of the focus type vehicle and at least 20 drivers injured in the focus crash type and focus vehicle model. These selection criteria have been applied in this study for identification of vehicle models with sufficient data to be included in the study. The number of cases for all crash types, frontal impact crashes and side impact crashes are shown separately. Vehicle models with empty cells in Table 8 had insufficient data to be included in the analysis.

Of the 138 EuroNCAP crash tested vehicle models listed in Table 1 and the 27 ANCAP crash tested vehicles listed in Table 3 there were 35, 17 and 6 vehicles with sufficient real crash data from all crash types, frontal impact crashes and side impact crashes, respectively, to be included in the analysis. The crash data was used to assess the injury risk and severity of the drivers of the different makes and models of EuroNCAP tested vehicles for each crash type.

Table 8. Number of injured or involved drivers of EuroNCAP/ANCAP crash tested vehicles from 1993 to 2001: Australian and New Zealand Crash Data.

Make/model with Crashworthiness Ratings based on 1987- 2002 crashes and tested in EuroNCAP or ANCAP programs	EuroNCAP / ANCAP Index	All Crashes		Frontal Impact Crashes		Side impact Crashes	
		Drivers involved in injury crashes	Injured drivers	Drivers involved in injury crashes	Injured drivers	Drivers involved in injury crashes	Injured drivers
Daihatsu Sirion	68	573	161				
Daewoo Nubira	140	1053	209	97	55		
Daewoo Lanos	22	1849	427	183	111		
Daewoo Leganza	139	287	57				
Ford Mondeo 1.8LX	11	1116	175				
Ford Falcon Ute AU	142	518	69				
Ford Falcon AU	141	6962	1191	721	350	195	152
Holden Rodeo	144	685	152	95	40		
Holden Vectra	18	1236	221	103	72		
Holden Commodore VT/VX	143	13630	2384	1348	714	314	322

Holden Statesman/Caprice WH	41	1312	268	114	63		
Holden Barina SB	56	4003	977	350	196		
Hyundai Accent 1.3GLS (LHD)	25	15582	3782	1383	898	275	321
Hyundai Sonata	146	386	65				
Hyundai Getz	145	1047	242				
Mitsubishi Magna TE/TF/TH/TJ / Verada KE/KF/KH/KJ / Diamante	150	6721	1115	682	427	172	160
Mitsubishi Lancer / Mirage CE	26	7747	1617	572	441	120	153
Ford / Mazda Laser / 323	148	1133	257	121	75		
Mazda 121 Metro / Demio	147	1124	251	121	76		
Ford / Mazda Courier / B-Series	149	346	57				
Mercedes C180 Classic	12	686	96				
Nissan Micra 1.0L	3	568	141				
Nissan Pulsar	151	922	205				
Peugeot 306	27	647	96				
Saab 900 2.0i	17	627	78				
Subaru Liberty / Legacy	126	641	103				
Suzuki Grand Vitara 2.7ltr XL-7 (LHD)	106	961	152				
Suzuki Baleno 1.6GLX (LHD)	29	853	185				
Toyota Corolla	30	2313	461	174	104		
Toyota Camry	35	5891	997	490	250	115	107
Toyota Hilux	153	1796	326	262	88		
Toyota Echo	77	813	199				
Toyota Avalon	152	409	65				
Volvo S70 2.0/2.5 10V (LHD)	38	1075	149	94	36		
Volkswagen Polo	154	288	64				
Total number of vehicle models		**35**		**17**		**6**	

4.2 Vehicle Safety Ratings Estimated From Police Reported Crash Data.

This section details the results of estimation of crashworthiness ratings based on the collected police reported crash data for EuroNCAP vehicle models for all crash types, frontal impact crashes and side impact crashes from the European and Australian and New Zealand databases.

4.2.1 U.K. Data

Injury Risk Analysis

Logistic models of injury risk for each crash type considered were fitted to the data using the logistic procedure of the statistical software package SAS following a modification of the DfT method of analysis. Instead of fitting the main effects of the covariates considered in the model only, as the DfT do in estimating the British vehicle crashworthiness ratings, interactions of first and higher order were also included in the model. To avoid an overly complex final model or one that might become unstable in the estimation procedure, a stepwise approach was used to fit the model. A restriction was imposed on the stepwise procedure that an interaction could only be considered in the model if the main effect terms of the interaction were significant predictors of injury risk. This approach to fitting model interactions has been used successfully by MUARC in estimating the Australian crashworthiness ratings. The approach also gives a greater chance that the fit of the final model to the data will be acceptable.

Table 9 and Table 10 detail the main effects and interactions that were judged to be significant predictors of injury risk through the stepwise logistic modelling approach for each crash type considered. A variable indicating vehicle model was included as a main effect in each of the models and was a significant predictor of injury risk in each case. The "vehicle model" variable had distinct levels representing each of the EuroNCAP tested vehicle models given in

Table 5 in

Table 9. Significant factors in the logistic regression models of injury risk by crash type derived from the British data using the DfT injury risk method.

Significant Model Factors	All Crash Types	Frontal Impacts	Driver Side Impacts
Main Effects	driver age (age), driver sex (sex), junction type (jun), point of impact (poi), speed limit (sl)	driver age (age), driver sex (sex), junction type (jun), speed limit (sl)	driver age (age), driver sex (sex), junction type (jun), speed limit (sl) year of crash (year)
First Order Interactions	poi*sl, age*poi, jun*poi, jun*sl, age*sex, sex*jun, age*jun, sex poi, age*sl, sex*sl	jun*sl, age*jun, sex*jun, age*sex, age*sl	age*sl age*sex age*jun sex*jun
Second Order Interactions	jun*poi*sl, age*jun*poi, age*sex*poi, age*poi*sl, age*jun*sl, sex*jun*sl, age*sex*sl, sex*jun*poi, sex*poi*sl	age*jun*sl	
Third Order Interactions	age*jun*poi*sl, sex*jun*poi*sl		

addition to a further level representing all crashed vehicles in the data not assessed under the EuroNCAP program. Non EuroNCAP tested vehicles were included in the analysis to provide better estimates of the effects of non-vehicle factors, such as driver age and sex, on injury risk. No interaction between the "vehicle model" and other covariates in the model was included, as this would cause difficulty in interpretation of the vehicle model main effect.

Table 10 Significant factors in the logistic regression models of injury risk by crash type derived from the British data using the Newstead injury risk method.

Significant Model Factors	All Crash Types	Frontal Impacts	Driver Side Impacts
Main Effects	driver age (age), driver sex (sex), junction type (jun), point of impact (poi), speed limit (sl)	driver age, driver sex, junction type, speed limit	driver age, driver sex, speed limit, junction type, year of crash
First Order Interactions	jun*poi, jun*sl, age*poi, sex*jun, poi*sl, age*sex, sex*poi, age*sl, age*jun	jun*sl, sex*jun, age*jun, age*sex	sex*jun, age*jun, age*sex, age*sl, jun*sl
Second Order Interactions	jun*poi*sl sex*jun*poi age*sex*poi age*poi*sl age*jun*poi		

Estimated injury risk based on the British crash data for each of the EuroNCAP tested vehicle models considered in logistic models is shown in Appendix B. Separate sets of estimates are shown for each crash type and for each method of analysis used. The injury risk estimates can be interpreted as the risk of injury to the driver of the focus vehicle given involvement in an injury crash for the DfT method and the risk of injury to the driver of the focus vehicle given the other driver was injured in the case of the Newstead method. The average injury risk for drivers of vehicles reported in the British crash data was 0.6333 and 0.3474 calculated using the DfT and Newstead methods respectively.

Injury Severity Analysis

Using the exact approach detailed by MUARC to estimate injury severity from Australian data, injury severity estimates for the EuroNCAP tested vehicles with sufficient data in the British database have been estimated. Following the MUARC approach, logistic models of injury severity for each crash type considered were fitted to the data using the logistic procedure of the statistical software package SAS. Interactions of first and higher order were included in the models using a stepwise approach. The restriction imposed on the stepwise procedure that an interaction could only be considered in the model if the main effect terms of the interaction were significant predictors of injury risk was again used.

Table 11 details the main effects and interactions that were judged to be significant predictors of injury severity through the stepwise logistic modelling approach for each crash type considered. As for injury risk, a variable indicating vehicle model was included as a main effect in each of the models and was a significant predictor of injury risk in each case. The “vehicle model” variable was defined as for the injury risk analysis and treated in the same manner in the model.

Table 11 **Significant factors in the logistic regression models of injury severity by crash type derived from the British data.**

Significant Model Factors	All Crash Types	Frontal Impacts	Driver Side Impacts
Main Effects	driver age (age), driver sex (sex), junction type (jun), no of vehicles (nov), point of impact (poi), speed limit (sl)	driver age, driver sex, junction type, no of vehicles, speed limit	driver age, driver sex, no of vehicles, speed limit, year of crash
First Order Interactions	nov*sl, nov*poi, jun*poi, jun*nov, sex*nov, age*sex, sex*sl, poi*sl, jun*sl, age*jun, sex*jun, age*sl, sex*poi, age*poi, age*nov	nov*sl, jun*nov, sex*nov, age*sex, jun*sl, age*sl, sex*sl, age*nov, sex*jun	nov*sl, sex*nov, age*nov, age*sex, sex*sl,
Second Order Interactions	jun*poi*sl, jun*nov*poi, age*nov*poi, age*jun*poi, jun*nov*sl, sex*jun*sl, sex*jun*nov, age*sex*sl, nov*poi*sl, sex*poi*sl, sex*jun*poi, age*sex*nov	age*sex*sl, jun*nov*sl, sex*jun*sl	sex*nov*sl
Third Order Interactions	jun*nov*poi*sl		

Estimated injury severity based on British crash data for each of the EuroNCAP tested vehicle models considered in logistic models is shown in Appendix B. Separate sets of estimates are shown for each crash type. The injury severity estimates can be interpreted as the risk of severe injury or death to the driver of the focus vehicle given injury in a crash. The average injury risk for drivers of vehicles reported in the British crash data was 0.1072, a similar magnitude to that observed in analysis of Australian and US data.

Crashworthiness Ratings

Crashworthiness ratings for each EuroNCAP tested vehicle with sufficient British crash data for inclusion in the analysis were calculated by taking the product of the estimate injury risk and severity components. Appendix B shows the British crashworthiness rating resulting from multiplication of these two quantities for all crashes, frontal impact crashes, and side impact crashes for both the DfT and Newstead methods of estimating injury risk. Upper and lower confidence limits and confidence limit width for each estimated crashworthiness rating are also given in Appendix B, along with the all model average crashworthiness rating. Confidence limits on the estimated crashworthiness rating were estimated using the method detailed in the MUARC crashworthiness computation by Newstead et al (1999). Appendix B also shows the estimated coefficient of variation of the crashworthiness ratings. Co-efficient of variation is the ratio of the width of the confidence limit to the magnitude of the point estimate and is useful as a scaled measure of rating accuracy.

4.2.2 French Data

Injury Risk Analysis

Estimates of injury risk for the EuroNCAP tested vehicles, with sufficient crash data to be included in the analysis, detailed in Table 6, were obtained using the same methods as for the British data. Analyses were conducted on all crash types, front impact crashes and side impact crashes. Table 12 and Table 13 show the factors that were identified as significant predictors of injury risk in the French data through the stepwise logistic regression procedure used.

Table 12. **Significant factors in the logistic regression models of injury risk (calculated using the DfT method) by crash types derived from the French data.**

Significant Model Factors	All Crash Types	Frontal Impacts	Driver Side Impacts
Main Effects	Driver age (age) Driver sex (sex) Intersection (int) Urbanisation (urb)	Driver age Driver sex Intersection Urbanisation	Driver age Driver sex Intersection Urbanisation
First Order Interactions	age x sex sex x int age x urb sex x urb int x urb age x int	age x sex sex x int age x urb sex x urb int x urb	age x urb sex x urb int x urb
Second Order Interactions	age x sex x int age x int x urb sex x int x urb		

Table 13. **Significant factors in the logistic regression models of injury risk (calculated using the Newstead method) by crash types derived from the French data.**

Significant Model Factors	All Crash Types	Frontal Impacts	Driver Side Impacts
Main Effects	Driver age (age) Driver sex (sex) Intersection (int) Urbanisation (urb)	Driver age Driver sex Intersection Urbanisation	Driver age Driver sex Intersection Urbanisation
First Order Interactions	age x sex sex x int age x urb int x urb age x int	age x sex sex x int age x urb int x urb	age x urb int x urb
Second Order Interactions	age x sex x int age x int x urb		

Estimated injury risk based on the French crash data for each of the EuroNCAP tested vehicle models considered in logistic models is shown in Appendix C. Separate sets of estimates are shown for each crash type. The average injury risk for drivers of vehicles reported in the French crash data was 0.6623 and 0.4888 calculated using the DfT and Newstead methods respectively.

Injury Severity Analysis

Using the same methods as for the British data, estimates of injury severity for the EuroNCAP tested vehicle models with sufficient data were obtained from the French crash data. The significant predictors of injury severity obtained from the stepwise logistic modelling approach are shown in Table 14.

Table 14. Significant factors in the logistic regression models of injury severity by crash types derived from the French data.

Significant Model Factors	All Crash Types	Frontal Impacts	Driver Side Impacts
Main Effects	Driver age (age) Driver sex (sex) Number of vehicles involved (nbv) Intersection (int) Urbanisation (urb) Year of crash (yea)	Driver age Driver sex Number of vehicles involved Intersection Urbanisation Year of crash	Driver age Driver sex Number of vehicles involved Intersection Urbanisation Year of crash
First Order Interactions	age x sex age x nbv sex x nbv age x int sex x int nbv x int age x urb sex x urb nbv x urb int x urb	age x sex age x nbv sex x nbv age x int sex x int nbv x int age x urb sex x urb nbv x urb int x urb	age x int age x urb nbv x urb int x urb age x nbv sex x nbv
Second Order Interactions	age x nbv x int sex x nbv x urb age x int x urb sex x int x urb age x sex x nbv age x nbv x urb	sex x nbv x urb age x int x urb sex x int x urb age x sex x nbv age x nbv x int age x nbv x urb	

Estimated injury severity based on the French crash data for each of the EuroNCAP tested vehicle models considered in logistic models is shown in Appendix C. The average injury severity for drivers of vehicles reported in the French crash data was 0.2342, more than double that of the British data.

Crashworthiness Ratings

Appendix C shows the estimated crashworthiness ratings for all crashes, frontal impact crashes and side impact crashes derived from analysis of the French data computed in the same manner as for the British data. Also shown are the 95% confidence limits, confidence limit width and co-efficient of variation for the crashworthiness ratings. All vehicle models had sufficiently accurate ratings to be included for further analysis.

4.2.3 German Data

Injury Risk Analysis

Logistic models of injury risk for each crash type considered were fitted to the data using the logistic procedure of the statistical software package SAS following the DfT and Newstead methods of analysis described earlier. To avoid an overly complex final model or one that might become unstable in the estimation procedure, a stepwise approach was used to fit the model. A restriction was imposed on the stepwise procedure that an interaction could only be considered in the model if the main effect terms of the interaction were significant predictors of injury risk. The approach gives a greater chance that the fit of the final model to the data will be acceptable.

Table 15 details the main effects and interactions that were judged to be significant predictors of injury risk through the stepwise logistic modelling approach. A variable indicating vehicle model was included as a main effect in each of the models and was a significant predictor of injury risk in each case. The “vehicle model” variable had distinct levels representing each of the EuroNCAP tested vehicle models given in Table 7 in addition to a further level representing all crashed vehicles in the data not assessed under the EuroNCAP program. Non EuroNCAP tested vehicles were included in the analysis to provide better estimates of the effects of non-vehicle factors, such as driver age and sex, on injury risk. No interaction between the “vehicle model” and other covariates in the model was included, as this would cause difficulty in interpretation of the vehicle model main effect.

Table 15 Significant factors in the logistic regression models of injury risk by crash type derived from German data using the DfT and Newstead injury risk methods.

Significant Model Factors	All Crash Types (DfT Method)	All Crash Types (Newstead Method)
Main Effects	driver age (age), driver sex (sex), intersection (int), location of crash (loc) cost of crash (cost) year of crash (year)	driver age (age), driver sex (sex), intersection (int), location of crash (loc) cost of crash (cost) year of crash (year)
First Order Interactions	sex*age, age*int, age*loc, int*loc, age*cost, sex*cost, int*cost, loc*cost	age*loc, sex*loc, int*loc, age*cost, sex*cost, int*cost, loc*cost, loc*year, cost*year
Second Order Interactions	int*loc*cost	

Estimated injury risk based on the German crash data for each of the EuroNCAP tested vehicle models considered in logistic models is shown in Appendix D. The injury risk estimates can be interpreted as the risk of injury to the driver of the focus vehicle given involvement in a tow-away crash. The average injury risk for drivers of vehicles reported in the German crash data was 0.6217.

Injury Severity Analysis

Using the exact approach detailed by MUARC, injury severity estimates for the EuroNCAP tested vehicles with sufficient data in the German database have been estimated. Following the MUARC approach, logistic models of injury severity for each crash type considered were fitted to the data using the logistic procedure of the statistical software package SAS. Interactions of first and higher order were included in the models using a stepwise approach. The restriction imposed on the stepwise procedure that an interaction could only be considered in the model if the main effect terms of the interaction were significant predictors of injury risk was again used.

Table 16 details the main effects and interactions that were judged to be significant predictors of injury severity through the stepwise logistic modelling approach for each crash type considered. As for injury risk, a variable indicating vehicle model was included as a main effect in each of the models and was a significant predictor of injury risk in each case. The “vehicle model” variable was defined as for the injury risk analysis and treated in the same manner in the model.

Table 16 Significant factors in the logistic regression models of injury severity by crash type derived from the German data.

Significant Model Factors	All Crash Types
Main Effects	driver age (age), driver sex (sex), number of vehicles (nbv), location of crash (loc), cost of crash (cost) year of crash (year)
First Order Interactions	age*sex, age*nbv, sex*nbv, age*int, sex*int, veh*int, veh*loc, int*loc, age*cost, sex*cost, nbv*cost, int*cost, loc*cost, int*year, loc*year, cost*year
Second Order Interactions	age*sex*nbv, nbv*int*loc, age*int*cost, nbv*int*cost, nbv*loc*cost, int*loc*cost, int*cost*year

Estimated injury severity based on the German crash data for each of the EuroNCAP tested vehicle models considered in logistic models is shown in Appendix D. Separate sets of estimates are shown for each crash type. The injury severity estimates can be interpreted as the risk of severe injury or death to the driver of the focus vehicle given injury in a tow-away crash. The average injury severity for drivers of vehicles reported in the German crash data was 0.1647.

Crashworthiness Ratings

Crashworthiness ratings for each EuroNCAP tested vehicle with sufficient German crash data for inclusion in the analysis were calculated by taking the product of the estimated injury risk and severity components. Appendix D shows the resulting German crashworthiness rating resulting from multiplication of these two quantities for all crashes for both the DfT and Newstead methods of estimating injury risk. Upper and lower confidence limits and confidence limit width for each estimated crashworthiness rating are also given in Appendix D, along with the all model average crashworthiness rating. Confidence limits on the estimated crashworthiness rating were estimated using the method detailed in the MUARC crashworthiness computation by Newstead et al (1999). Appendix D also shows the estimated coefficient of variation of the crashworthiness ratings. The co-efficient of variation is the ratio of the width of the confidence limit to the magnitude of the point estimate and is useful as a scaled measure of rating accuracy.

4.2.4 Australian and New Zealand Data

Injury Risk Analysis

Logistic models of injury risk for each crash type considered were fitted to the data using the logistic procedure of the statistical software package SAS following the MUARC method of analysis. To avoid an overly complex final model or one that might become unstable in the estimation procedure, a stepwise approach was used to fit the model. A restriction was imposed on the stepwise procedure that an interaction could only be considered in the model if the main effect terms of the interaction were significant predictors of injury risk. The approach gives a greater chance that the fit and interpretation of the final model to the data will be acceptable.

Table 17 details the main effects and interactions that were judged to be significant predictors of injury risk through the stepwise logistic modelling approach for each crash type considered. A variable indicating vehicle model was included as a main effect in each of the models and was a significant predictor of injury risk in each case. The "vehicle model" variable had distinct levels representing the EuroNCAP tested vehicle models included in the analysis in addition to a further level representing all crashed vehicles in the data not assessed under the EuroNCAP program. Non EuroNCAP tested vehicles were included in the analysis to provide better estimates of the effects of non-vehicle factors, such as driver age and sex, on injury risk. No interaction between the "vehicle model" and other covariates in the model was included, as this would cause difficulty in interpretation of the vehicle model main effect.

Table 17 Significant factors in the logistic regression models of injury risk by crash type derived from the combined Australian and New Zealand data using the MUARC injury risk method

Significant Model Factors	All Crash Types	Frontal Impacts	Driver Side Impacts
Main Effects	driver age (age), driver sex (sex), speed limit (speedzone), number of vehicles (nveh), jurisdiction (state), year of crash (year)	driver age (age), driver sex (sex), speed limit (speedzone), number of vehicles (nveh), jurisdiction (state), year of crash (year)	driver age (age), driver sex (sex), speed limit (speedzone), number of vehicles (nveh), year of crash (year)
First Order Interactions	speedzone*nveh, sex*nveh, sex*age, age*nveh, speedzone*age, state*year	speedzone*state, state*ycrash, speedzone*nveh, year*nveh, sex*state, sex*nveh, age*nveh, age*speedzone, age*sex	year*nveh age*sex
Second Order Interactions	age*sex*nveh age*speedzone*nveh		

Estimated injury risk based on the combined Australian and New Zealand crash data for each of the EuroNCAP tested vehicle models considered in logistic models is shown in Appendix E. Separate sets of estimates are shown for each crash type. The injury risk estimates can be interpreted as the risk of injury to the driver of the focus vehicle given involvement in a tow-away crash. The average injury risk for drivers of vehicles reported in the combined Australian and New Zealand crash data was 0.1720.

Injury Severity Analysis

Using the exact approach detailed by MUARC, injury severity estimates for the EuroNCAP tested vehicles with sufficient data in the combined Australian and New Zealand database have been estimated. Following the MUARC approach, logistic models of injury severity for each crash type considered were fitted to the data using the logistic procedure of the statistical software package SAS. Interactions of first and higher order were included in the models using a stepwise approach. The restriction imposed on the stepwise procedure that an interaction could only be considered in the model if the main effect terms of the interaction were significant predictors of injury risk was again used.

Table 18 details the main effects and interactions that were judged to be significant predictors of injury severity through the stepwise logistic modelling approach for each crash type considered. As for injury risk, a variable indicating vehicle model was included as a main effect in each of the models and was a significant predictor of injury risk in each case. The “vehicle model” variable was defined as for the injury risk analysis and treated in the same manner in the model.

Table 18 Significant factors in the logistic regression models of injury severity by crash type derived from the combined Australian and New Zealand data.

Significant Model Factors	All Crash Types	Frontal Impacts	Driver Side Impacts
Main Effects	driver age (age), driver sex (sex), speed limit (speedzone), number of vehicles (nveh), jurisdiction (state), year of crash (year)	driver age (age), driver sex (sex), speed limit (speedzone), number of vehicles (nveh), jurisdiction (state), year of crash (year)	driver age (age), driver sex (sex), speed limit (speedzone), number of vehicles (nveh), jurisdiction (state), year of crash (year)
First Order Interactions	sex*state, speedzone*nveh, sex*age, nveh*state, state*speedzone, speedzone*age, age*state, age*nveh, state*year, speedzone*year	speedzone*nveh speedzone*state state*nveh age*sex state*year speedzone*year age*nveh sex*year age*speedzone sex*state age*state age*year	sex*nveh, speedzone*nveh, sex*state, speedzone*state, state*year, age*sex, year*nveh
Second Order Interactions	Speedzone*nveh*state speedzone*state*year	speedzone*state*nveh age*speedzone*state	

Estimated injury severity based on the combined Australian and New Zealand crash data for each of the EuroNCAP tested vehicle models considered in logistic models is shown in Appendix E. Separate sets of estimates are shown for each crash type. The injury severity estimates can be interpreted as the risk of severe injury or death to the driver of the focus vehicle given injury in a tow-away crash. The average injury severity for drivers of vehicles reported in the combined Australian and New Zealand crash data was 0.2101.

Crashworthiness Ratings

Crashworthiness ratings for each EuroNCAP tested vehicle with sufficient combined Australian and New Zealand crash data for inclusion in the analysis were calculated by taking the product of the estimated injury risk and severity components. Appendix E shows the resulting combined Australian and New Zealand crashworthiness rating resulting from multiplication of these two quantities for all crashes, frontal impact crashes and side impact crashes for the MUARC method of estimating injury risk. Upper and lower confidence limits and confidence limit width for each estimated crashworthiness rating are also given in Appendix E, along with the all model average crashworthiness rating. Confidence limits on the estimated crashworthiness rating were estimated using the method detailed in the MUARC crashworthiness computation by Newstead et al (1999). Appendix E also shows the estimated coefficient of variation of the crashworthiness ratings. The co-efficient of variation is the ratio of the width of the confidence limit to the magnitude of the point estimate and is useful as a scaled measure of rating accuracy.

4.3 Comparison of Real Crash Safety Ratings and Overall EuroNCAP Star Ratings

In comparing EuroNCAP crash test results with real crash outcomes in Sweden, Lie and Tingvall (2000) computed the average real crash injury rates for vehicles grouped within each overall star rating. It was hypothesised that occupants of EuroNCAP tested vehicles with a five star rating should have a lower average risk of serious injury in a real crash than those with only three or two stars. If so, the overall barrier crash performance star rating given to each vehicle from EuroNCAP testing would be broadly representative of relative real crash outcomes. Based on the Swedish data analysed, Lie and Tingvall (2000) indeed found that EuroNCAP tested vehicles rated four stars had a lower average risk serious injury risk in real crashes than those rated three stars. The three star vehicles had a correspondingly lower average risk than vehicles rated two stars. The analysis that follows also considers the relationship between real crash safety ratings and overall EuroNCAP star ratings.

An overall EuroNCAP star rating scale of five categories is used to classify vehicle safety performance based on crash test results. The five star categories are derived from an equal mix of the results of both the offset frontal and side impact EuroNCAP test components plus the pole test and seat belt reminder assessment. In this study the overall EuroNCAP score and corresponding star rating are calculated based on the driver dummy measurements in the EuroNCAP test only to ensure compatibility with the real crash rating that relate to driver injury outcome only. In contrast, the official scores published by EuroNCAP consider both the driver and front passenger dummy scores in the offset frontal barrier test. It is also noted that the EuroNCAP overall scores used here do not include the pole test result or the seat belt reminder points for reasons given previously. However, analysis conducted using EuroNCAP overall scores including the pole test produced similar results.

In the following material, driver injury outcome ratings derived from police reported crashes are often referred to as real crash ratings for the purpose of differentiating these ratings from the EuroNCAP test scores. This is in no way meant to imply that the EuroNCAP test does not involve physically crashing a vehicle. It refers to the difference between the real world setting of the police reported crash versus the controlled laboratory setting of the EuroNCAP test.

4.3.1 British Safety Ratings and Overall EuroNCAP Star Ratings

The following series of figures show overall EuroNCAP scores plotted against, respectively, injury risk, injury severity and crashworthiness estimated from all crash types in the British data. Individual EuroNCAP scores are grouped according to the corresponding star rating and 95 per cent confidence limits are placed on the estimates of real crash measures. Similar plots are provided in Appendix F for front and side impact crashes.

Figure 1. Overall EuroNCAPtest score vs. British real crash injury risk based on all crash types (DfT Method).

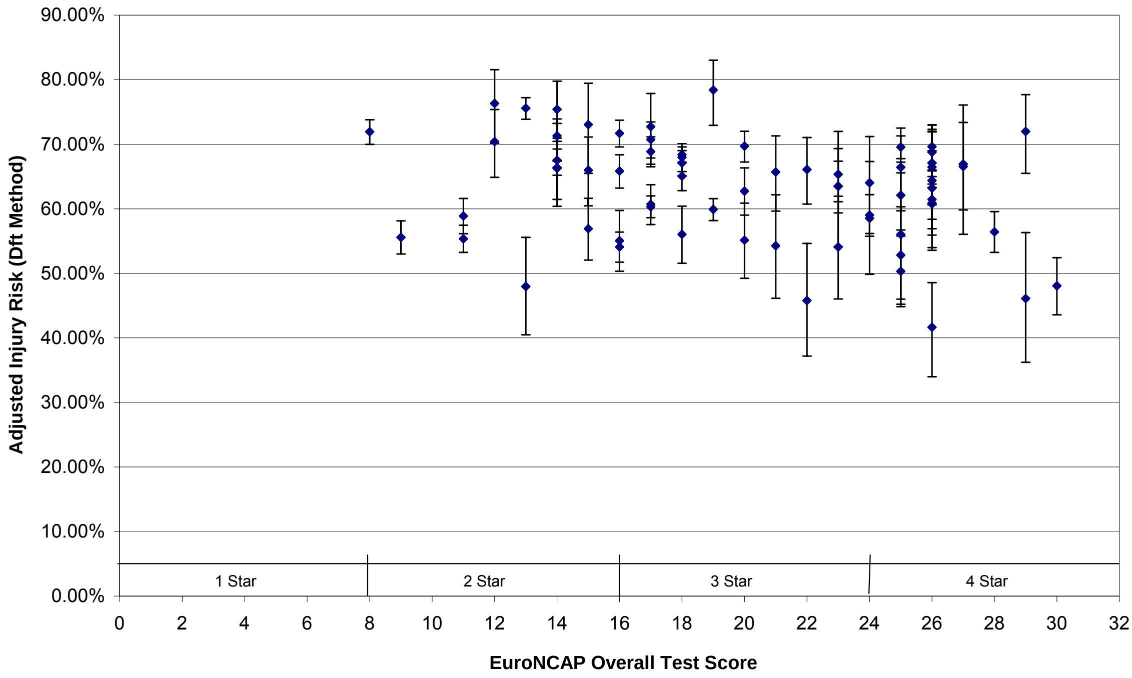


Figure 2. Overall EuroNCAP test score vs. British real crash injury risk based on all crash types (Newstead Method).

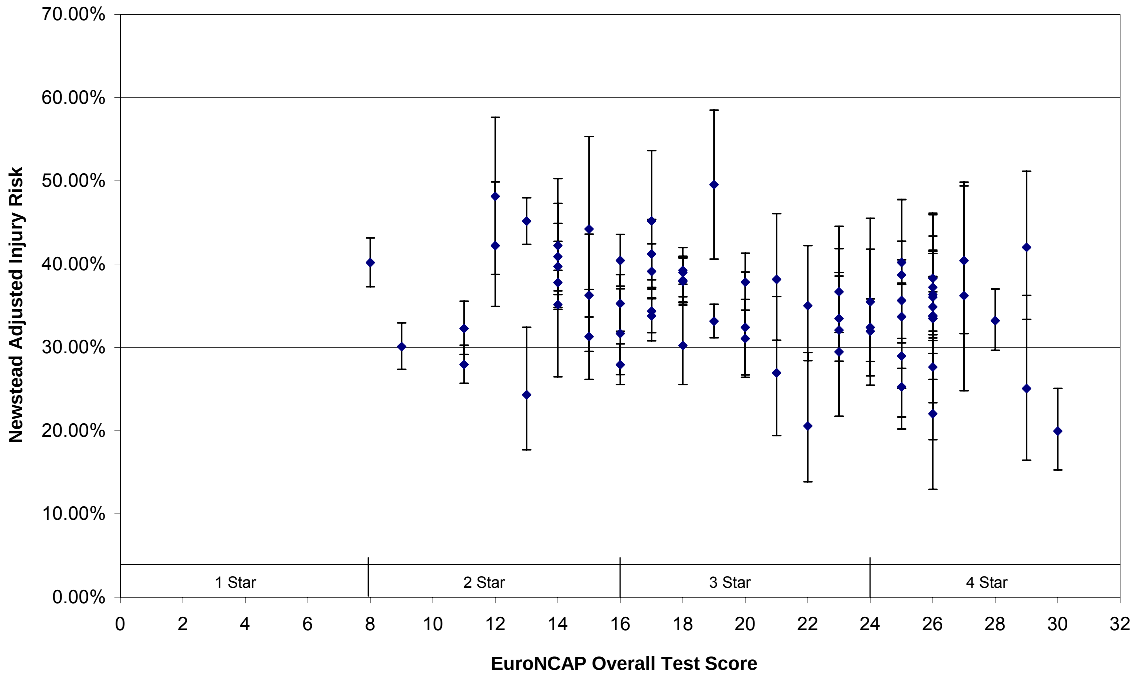


Figure 3. **Overall EuroNCAP test score vs. British real crash injury severity based on all crash types.**

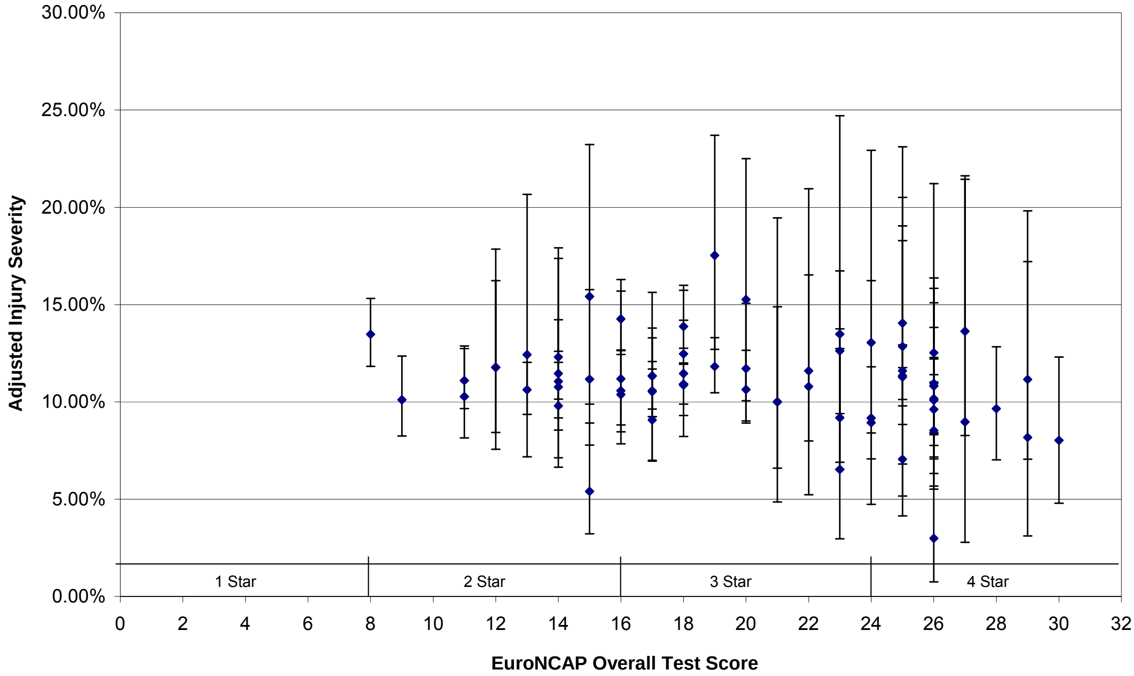


Figure 4. **Overall EuroNCAP test score vs. British real crash crashworthiness based on all crash types (DfT Method).**

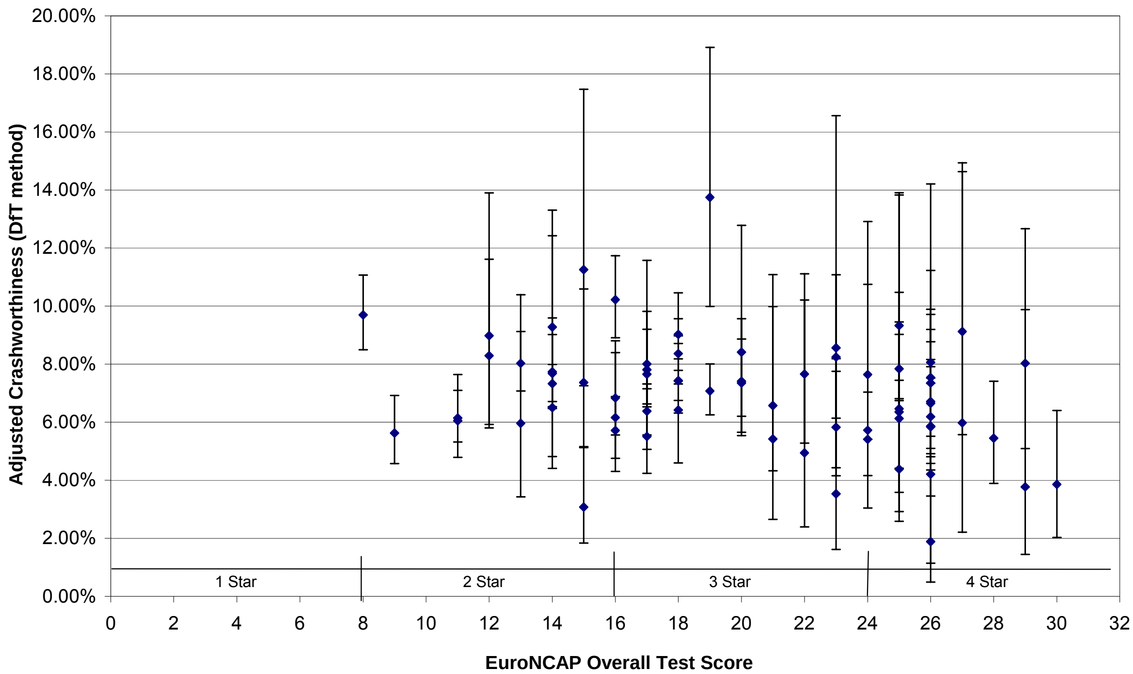
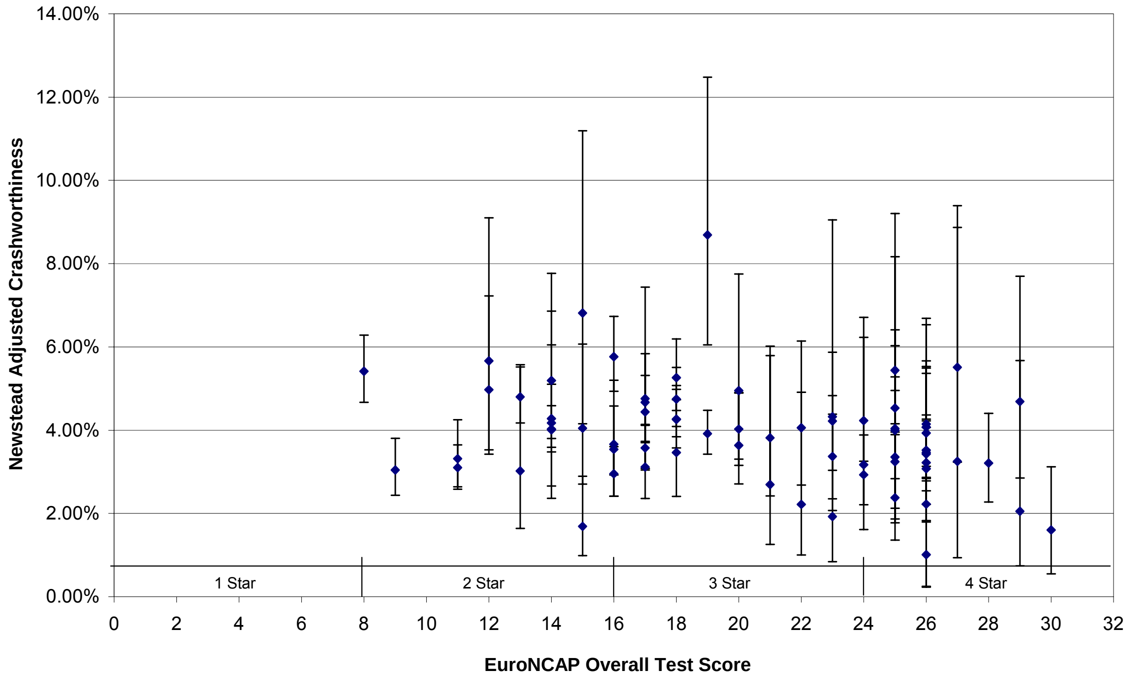


Figure 5. Overall EuroNCAP test score vs. British real crash crashworthiness based on all crash types (Newstead Method).



Figures 1 to 5 show there is significant variation in the injury measures of each vehicle estimated from police crash data within each overall EuroNCAP score range. This variation is partly a product of the estimation error in each of the police reported crash injury measures, particularly for vehicle models with relatively few records in the crash data, as shown by the 95% confidence limits on the police reported crash estimates. However, there are significant differences in the police reported crash measures between vehicle models within the same EuroNCAP star rating, and even between vehicle models with almost the same overall EuroNCAP rating score from which the star ratings are derived. This is demonstrated by the non-overlapping confidence limits on the police reported crash measures between pairs of vehicles within the same overall star rating category.

This result suggests there are other factors, apart from those summarised in the overall EuroNCAP score that are determining injury outcomes as reported by police. These other factors are also different from those that have already been compensated for in the estimation of the police reported crash based ratings, such as driver age and sex and speed limit at the crash location.

4.3.2 French Safety Ratings and Overall EuroNCAP Star Ratings

As for the British data the relationship between real crash safety ratings and overall EuroNCAP star ratings is explored through the following series of figures that show overall EuroNCAP scores plotted against, respectively, injury risk, injury severity and crashworthiness estimated from all crash types in the French data. Individual EuroNCAP scores are grouped according to the corresponding star rating and 95 per cent confidence limits are placed on the estimates of real crash measures. Similar plots are provided in Appendix G for front and side impact crashes.

Figure 6. Overall EuroNCAP test score vs French real crash injury risk based on all crash types (DfT method)

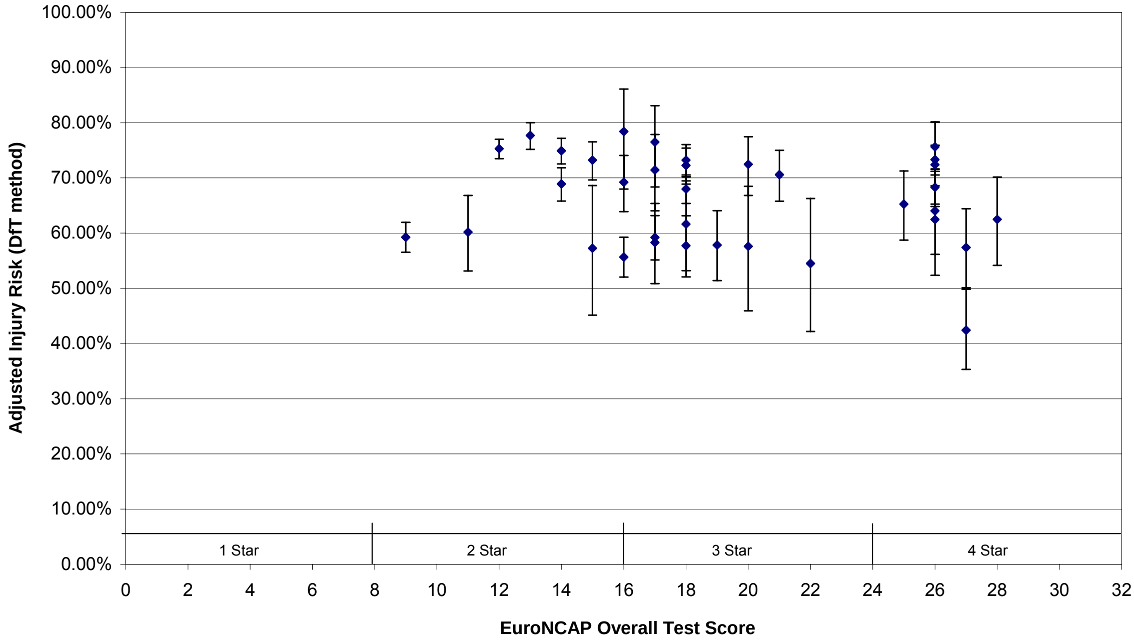


Figure 7. Overall EuroNCAP test score vs French real crash injury risk based on all crash types (Newstead method)

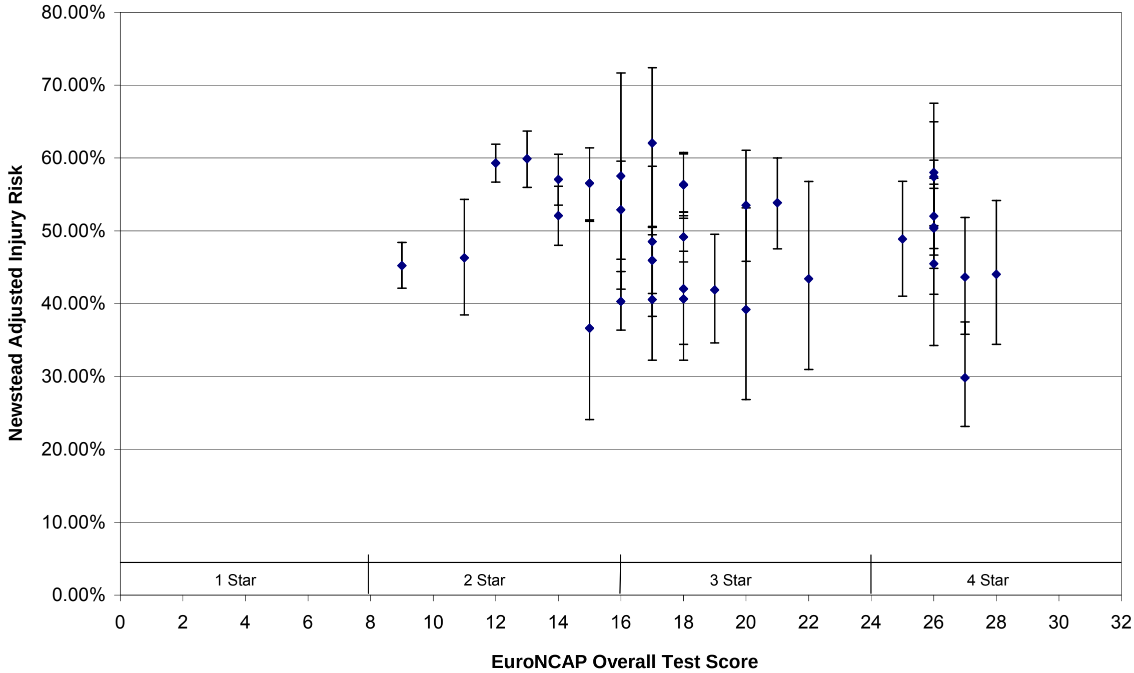


Figure 8. Overall EuroNCAP test score vs French real crash injury severity based on all crash types

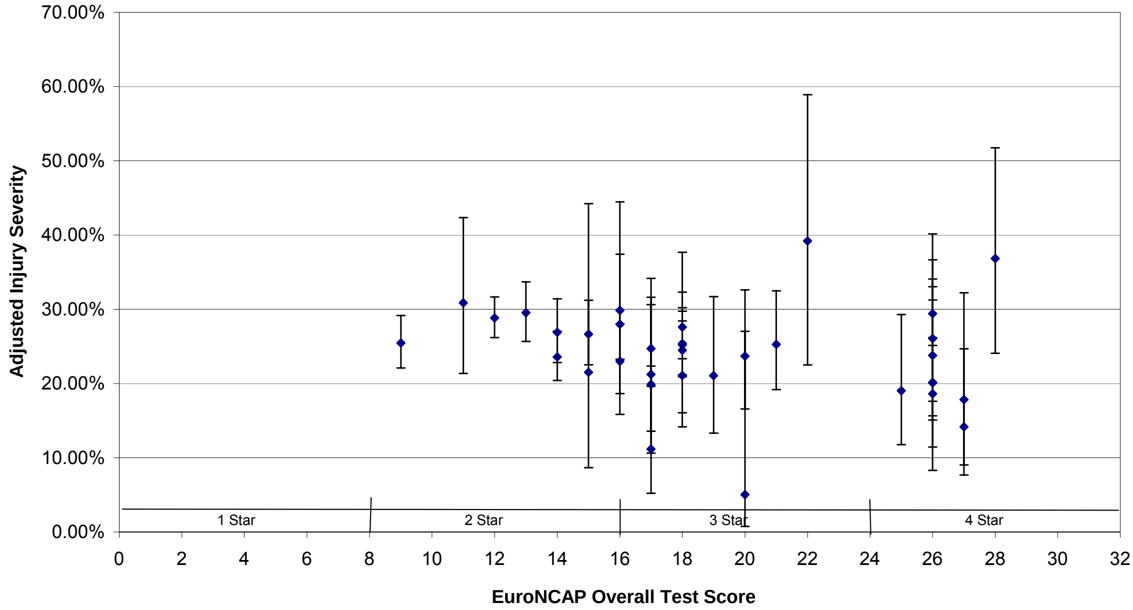


Figure 9. Overall EuroNCAP test score v French real crash crashworthiness based on all crash types (DfT method)

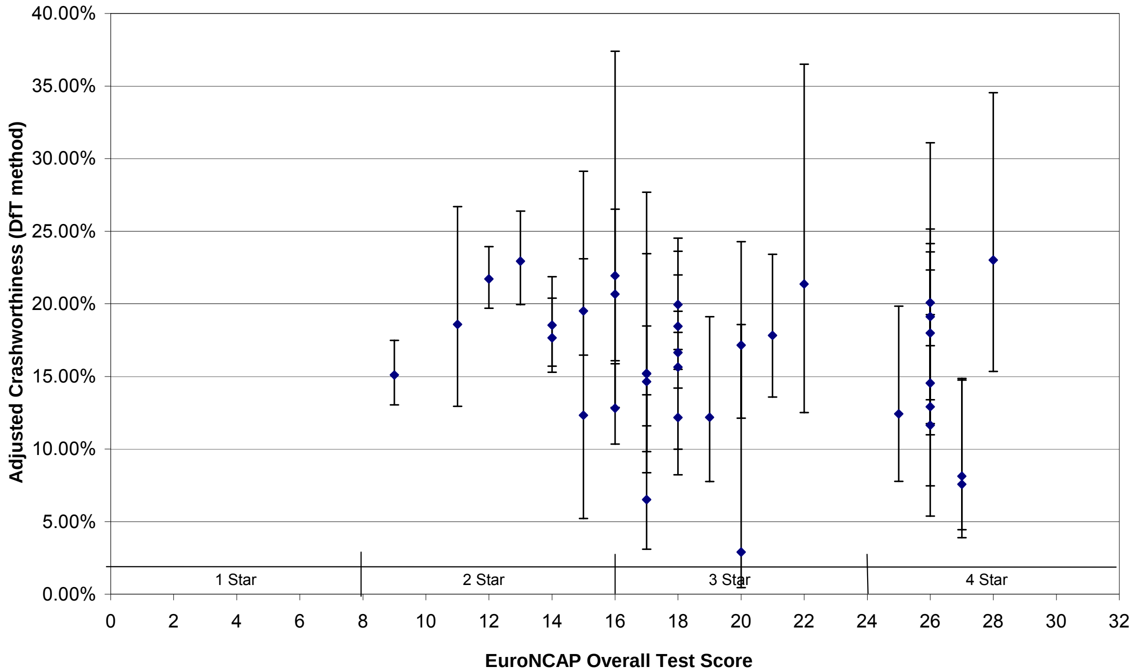
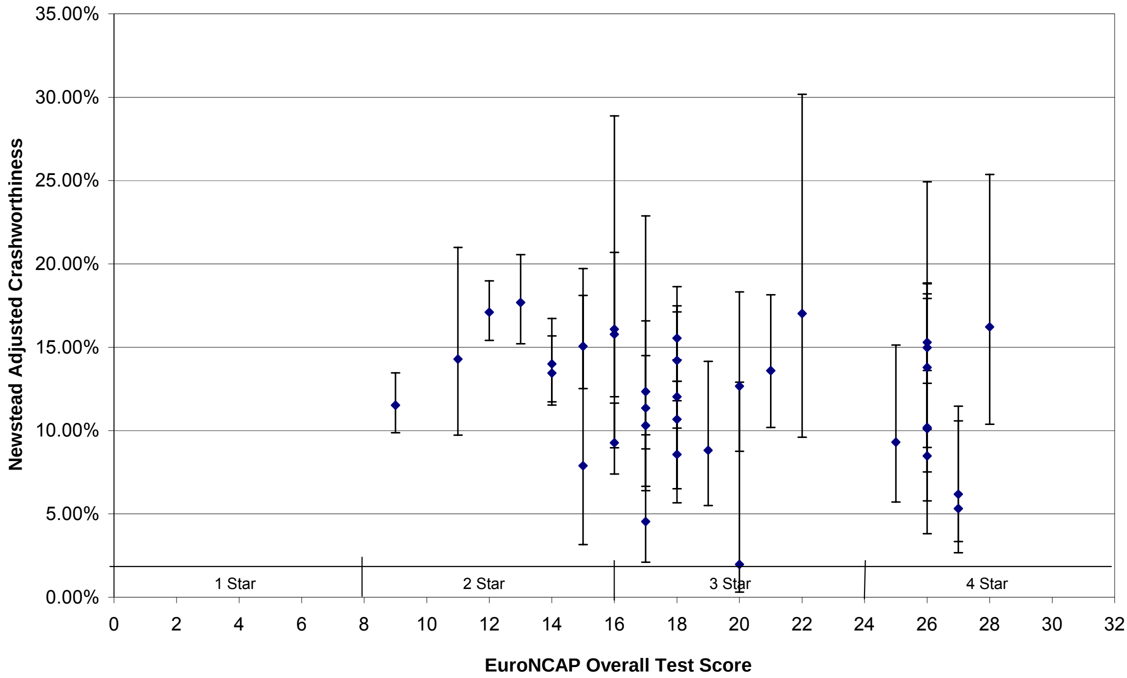


Figure 10. Overall EuroNCAP test score vs French real crash crashworthiness based on all crash types (Newstead method)



As in the analysis of the British data, Figures 6 to 10 show that there is significant variation in the estimated real crash injury measures of each vehicle within each overall EuroNCAP score range. Again, this variation suggests that there are other factors, apart from those summarised in the overall EuroNCAP score that are determining real crash outcomes.

4.3.3 German Safety Ratings and Overall EuroNCAP Star Ratings

The following serious of figures show overall EuroNCAP scores plotted against, respectively, injury risk, injury severity and crashworthiness estimated from all crash types in the German data. Individual EuroNCAP scores are grouped according to the corresponding star rating and 95 per cent confidence limits are placed on the estimates of real crash measures.

Figure 11. **Overall EuroNCAP test score vs. German real crash injury risk based on all crash types (DfT Method)**

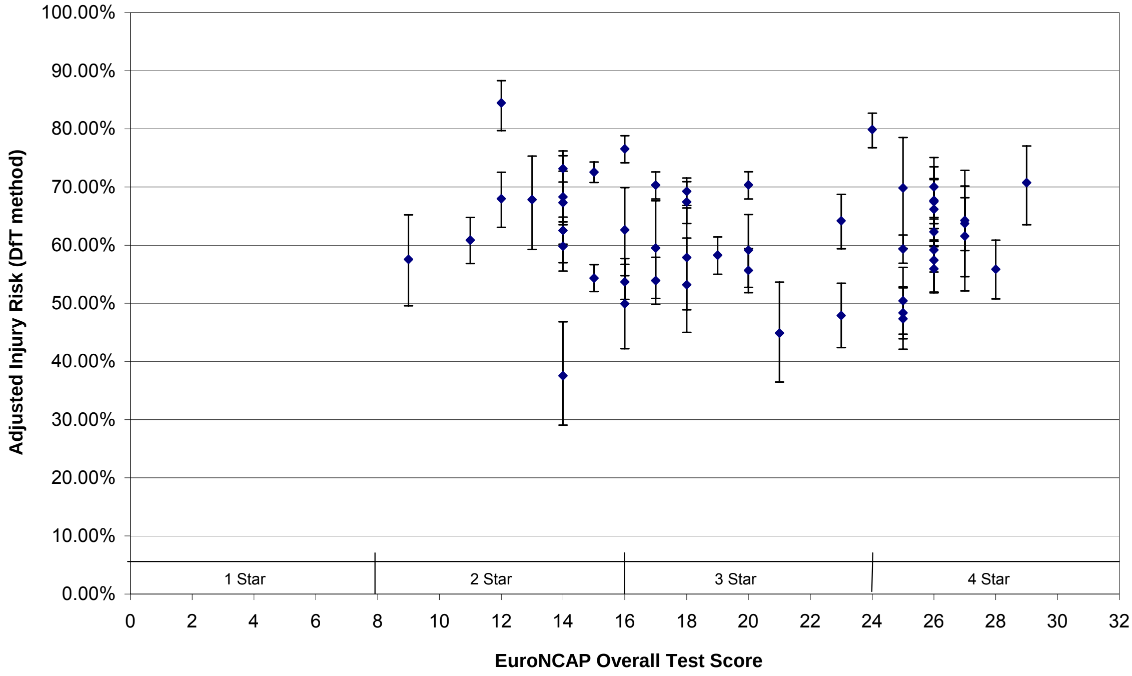


Figure 12. **Overall EuroNCAP test score vs. German real crash injury risk based on all crash types (Newstead Method)**

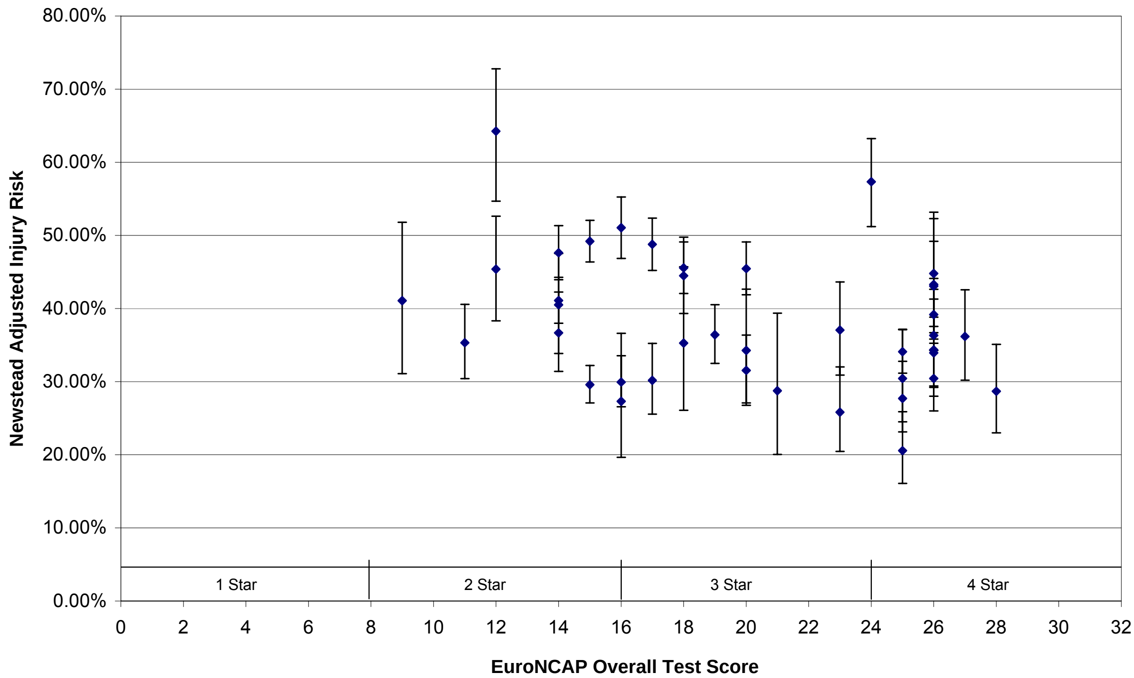


Figure 13. Overall EuroNCAP test score vs. German real crash injury severity based on all crash types

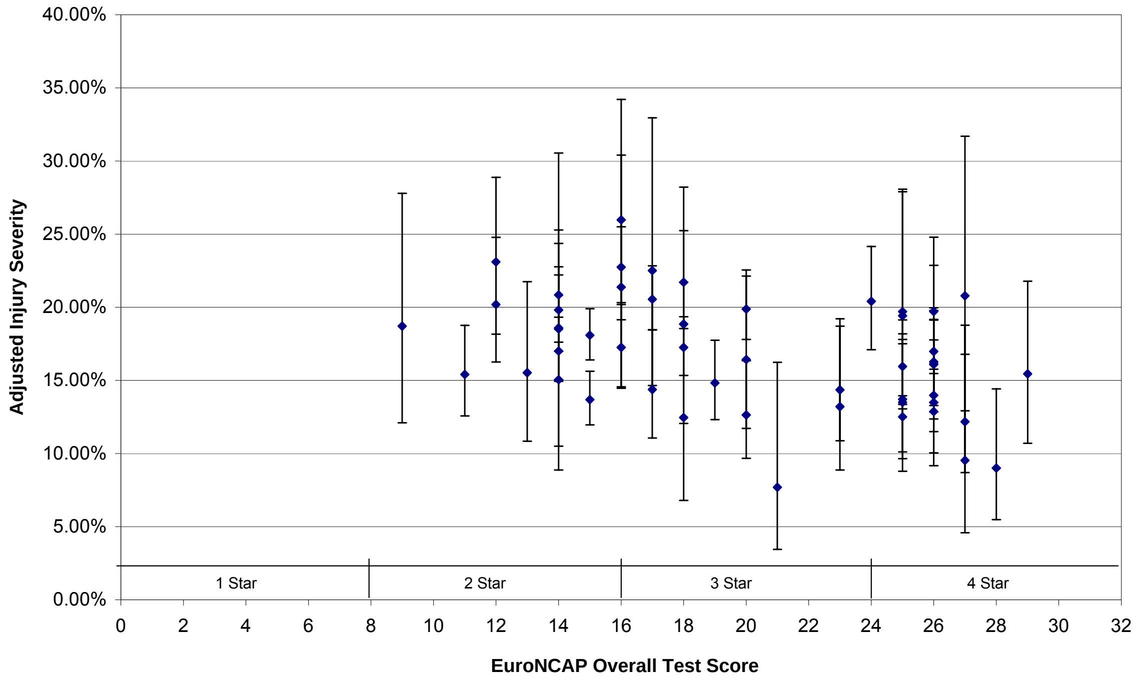


Figure 14. Overall EuroNCAP test score vs. German real crash crashworthiness based on all crash types (DfT Method)

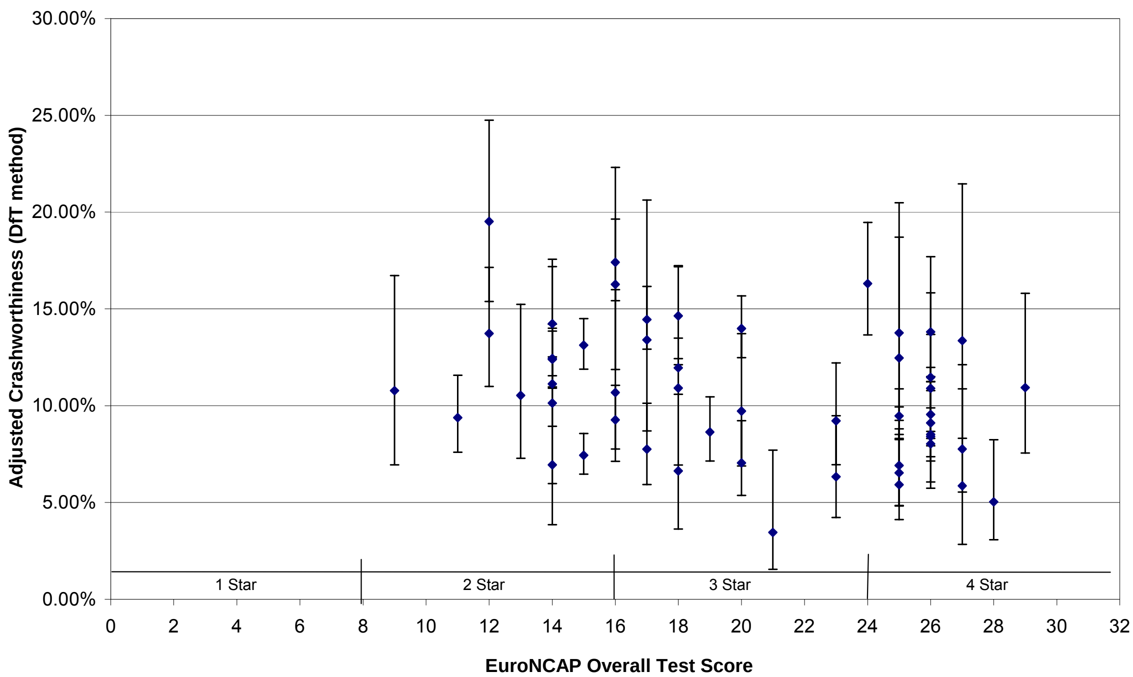
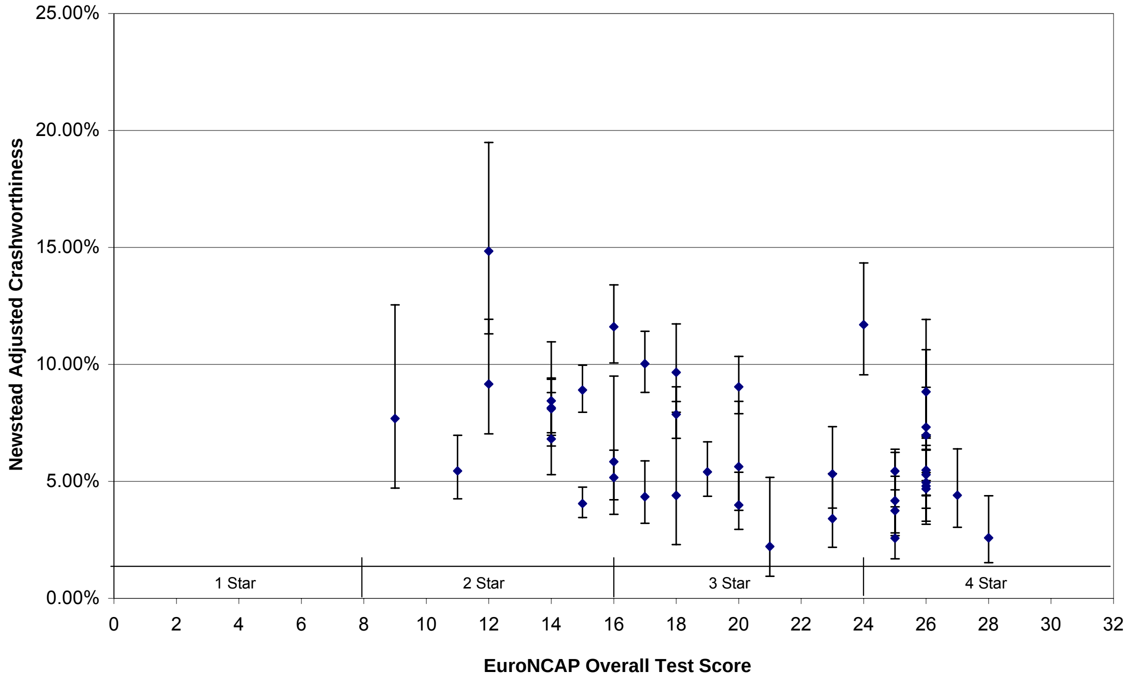


Figure 15. Overall EuroNCAP test score vs. German real crash crashworthiness based on all crash types (Newstead Method)



As in the other European analysis, Figures 11 to 15 show that there is significant variation in the estimated real crash injury measures of each vehicle within each overall EuroNCAP score range.

4.3.4 Australian and New Zealand Safety Ratings and Overall EuroNCAP Star Ratings

The following series of figures show overall EuroNCAP scores plotted against, respectively, injury risk, injury severity and crashworthiness estimated from all crash types in the combined Australian and New Zealand data. Individual EuroNCAP scores are grouped according to the corresponding star rating and 95 per cent confidence limits are placed on the estimates of real crash measures. Similar plots are provided in Appendix H for front and side impact crashes.

Figure 16 **Overall EuroNCAP test score vs. Real Crash Injury Risk Based on All Crash Types**

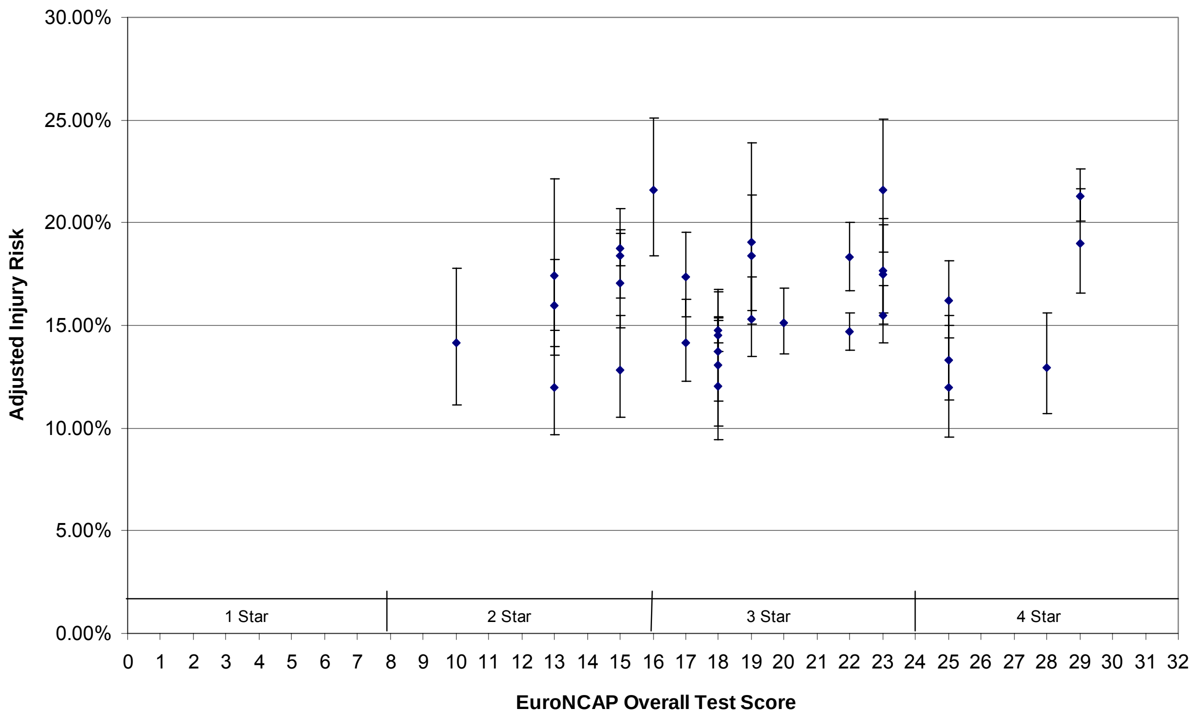


Figure 17 **Overall EuroNCAP test score vs. Real Crash Injury Severity Based on All Crash Types**

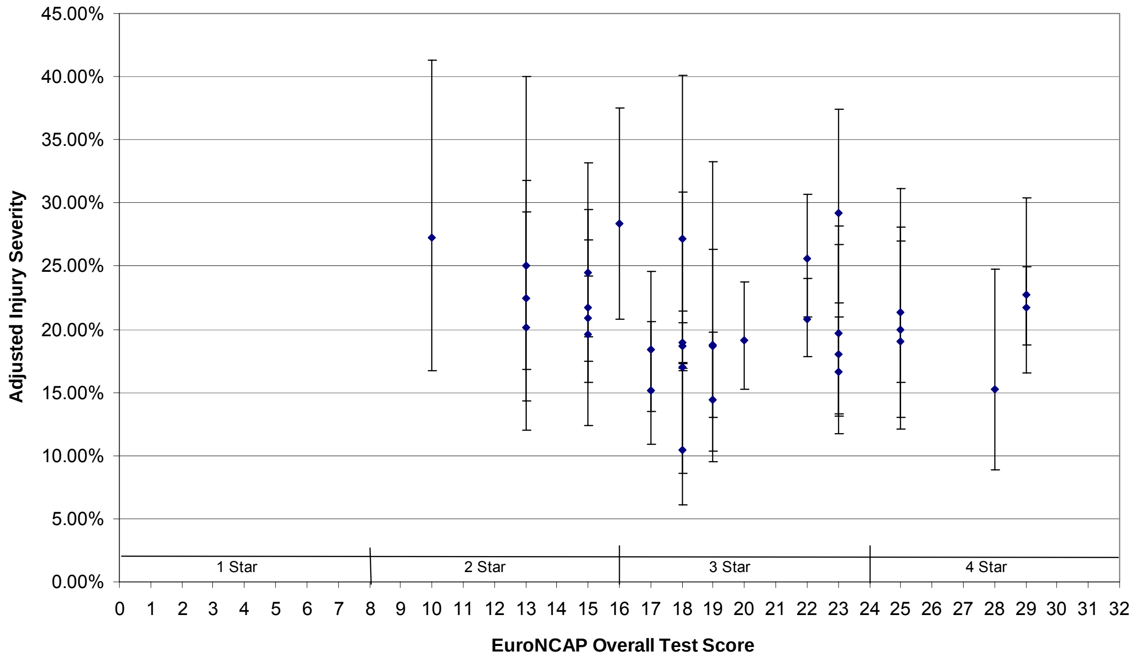
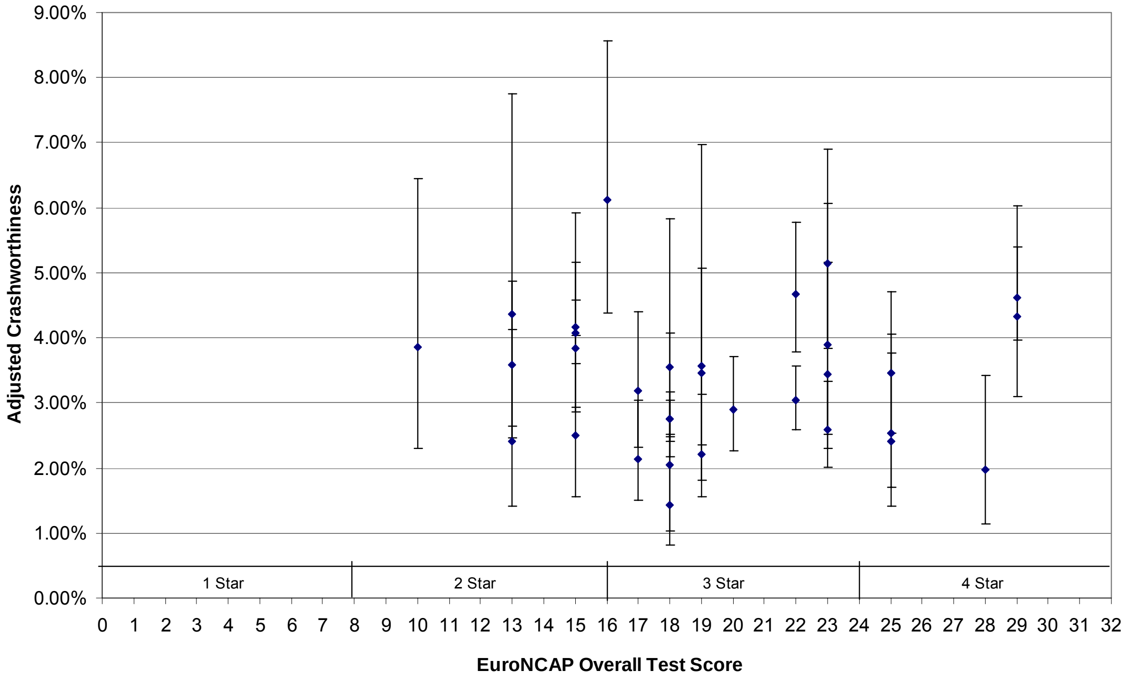


Figure 18 **Overall EuroNCAP test score vs. Real Crash Crashworthiness Based on All Crash Types**



Comparisons in Figures 16 to 18 are consistent with those made on the European data previously in showing significant variation in the estimated real crash injury measures of each vehicle within each overall EuroNCAP score range. Like the previous results, they suggest there are other factors, apart from those summarised in the overall EuroNCAP score that are determining real crash outcomes. These other factors are also different from those that have already been compensated for in the estimation of the real crash based ratings, such as driver age and sex and speed limit at the crash location.

4.4 Logistic Regression Comparison of Real Crash Ratings and Overall EuroNCAP Star Ratings

The above analysis of the relationship between the overall EuroNCAP vehicle star rating and the British, French, German and combined Australian and New Zealand real crash based vehicle safety ratings has been able to identify general relationship trends between the two safety measures. In order to make more definitive statements about the relationship between the two safety measures and the statistical significance of the relationship, a logistic regression framework has been used. Under this framework vehicle safety rating measures derived from real crashes data have been modelled as a function of the EuroNCAP overall star rating.

In the case of the real crash crashworthiness measure, the logistic function fitted is of the following form.

$$\text{logit}(CWR_i) = \alpha + \beta(Euro\ NCAP\ overall\ \ star\ ratings_i)$$ …*(Equation 1)*

where *i* is the vehicle model index and α and β are parameters of the logistic model. Similar equations can be used to model the injury risk and injury severity components of crashworthiness as a function of EuroNCAP overall star rating. No restriction has been placed on the form of the relationship between the star rating categories and the dependent injury outcome variable. It may be expected that a higher star rating would be associated with lower injury risk, severity or crashworthiness in real crashes, or that there will be some monotonic relationship between the barrier test and real crash measures. However, no such restiction has been place upon the analysis in order to maintain objectivity.

The statistical significance of the EuroNCAP star rating as a whole in predicting real crash outcome can be measured by the contribution of the EuroNCAP star rating term in improving the fit of the logistic model. Improvement in the fit of a logistic model by inclusion of an extra predictive term is measured by the change in scaled deviance of the model. The scaled deviance is a statistic based on the likelihood ratio and has a chi-squared distribution with degrees of freedom equal to the number of levels in the categorical factor fitted, minus one. In terms of the EuroNCAP overall star rating being considered here, if the EuroNCAP star rating makes a statistically significant contribution to the fit of the logistic model, this implies that there is a statistically significant difference between average crashworthiness (or injury risk or severity) of at least two of the star rating classes, but not necessarily more than two star rating classes. To assess which pairs of the star rating classes have significantly different average crashworthiness (or injury risk or severity), the confidence limits on the parameter point estimates generated from the logistic modelling procedure must be compared to see if they overlap.

Categorical variables in a logistic model can be parameterised in a number of ways. One way convenient to the interpretation of the effects being studied here is a parameterisation that compares each level of the categorical variable to a comon reference level, often termed a simple parameterisation. The reference level is the aliased level for which no parameter estimate can be made. If the dependent variable being modelled is a probability of injury, as is the case here, the exponent of the parameter estimates associated with each level of a categorical predictor variable can be interpreted as the crashworthiness (injury risk or injury severity) in each category relative to the reference category.

A better method of parameterising the EuroNCAP overall star rating for use in this study is often referred to as the deviance method of parameterisation. Under the deviance method of parameterisation, the average risk in each level of the categorical variable in not compared to that in the aliased category, but is compared to the average injury risk across all observations in the data set being analysed. This method of parameterisation has the advantage that the parameter estimates for each level of the independent categorical variable are not dependant on the category chosen to be aliased. So here for example, the model parameter estimates for EuroNCAP star categories 2, 3 and 4, and importantly the standard errors of these parameter estimates, will be the same regardless of whether star category 1 or star category 5 is chosen to be aliased. An advantage of this method of parameterisation is that, if the aliased parameter category is changed and the model re-estimated, the results of the two model estimates can be used to obtain parameter and standard error estimates for all five levels of the EuroNCAP star rating category. Again, the exponent of the parameter estimates associated with each level of the EuroNCAP star rating variable can be interpreted as the average crashworthiness rating (or injury risk or severity) of vehicles in each star category relative to the average across all star categories. The deviance method of parameterising the EuroNCAP star rating variable has been used in the logistic modells fitted here, with models re-fitted with the aliased category changed to give the parameter estimate for the aliased category in the initial model.

The standard errors for each estimated parameter in the logistic regression produced are used to calculate statistical confidence limits for the estimated relative risks allowing statistical comparison of relative injury risks at each level of the categorical variable. Applied here, this allows us to test the significance of the estimated average crashworthiness (or injury risk or severity) between vehicles in each of the EuroNCAP star categories.

Practical interpretation of the above statistical concepts will be made more clear through presentation of the analysis results below.

In the following sections, logistic regression analysis has been used to assess the relationship between the EuroNCAP overall star ratings and the crashworthiness, injury risk and injury severity ratings estimated from real crash data. Real crash ratings based on all crashes, frontal impact crashes and side impact crashes have been considered separately. Again, because of the differences noted above, parallel analysis has been carried out for real crash ratings estimated on the British, French, German and combined Australian and New Zealand data sets.

4.4.1 The Influence of Vehicle Mass

Prior to conducting analysis using the logistic regression technique the compatibility of the two safety measure must be considered; in particular, the contribution of vehicle mass to both rating systems. Previous work has highlighted the relationship between vehicle mass and real crash outcome with vehicles of higher mass generally having better real crash rating for injury risk, injury severity and crashworthiness (see SARAC I, sub task 2.2). Given the apparent consistency of the 1999-2001 data with that used in the SARAC I analysis, it is expected that the relationship between vehicle mass and real crash safety measures will also be consistent. In contrast, the

EuroNCAP score is purported to be independent of vehicle mass. Therefore, in exploring the relationship between the real crash safety measures and EuroNCAP test scores, the apparent contrasting influence of vehicle mass on the two safety measures must be accounted for.

First, however, the relationship between vehicle mass and real crash outcome safety measures must be confirmed. For this purpose, a logistic regression, estimating the effect of mass on real crash outcome, has been conducted for each of the real crash measures considered for Great Britain, France, Germany and Australia and New Zealand.

British Relationship between Mass and Vehicle Safety Ratings

The fitted logistic regression curves estimating the relationship between vehicle mass and the real crash safety measures described above are plotted on the graphs that follow. The data used here considers all crash types, however, similar graphs for front and side impact crashes are provided in Appendix H.

Figure 19. Adjusted injury risk (DfT method) vs Vehicle mass

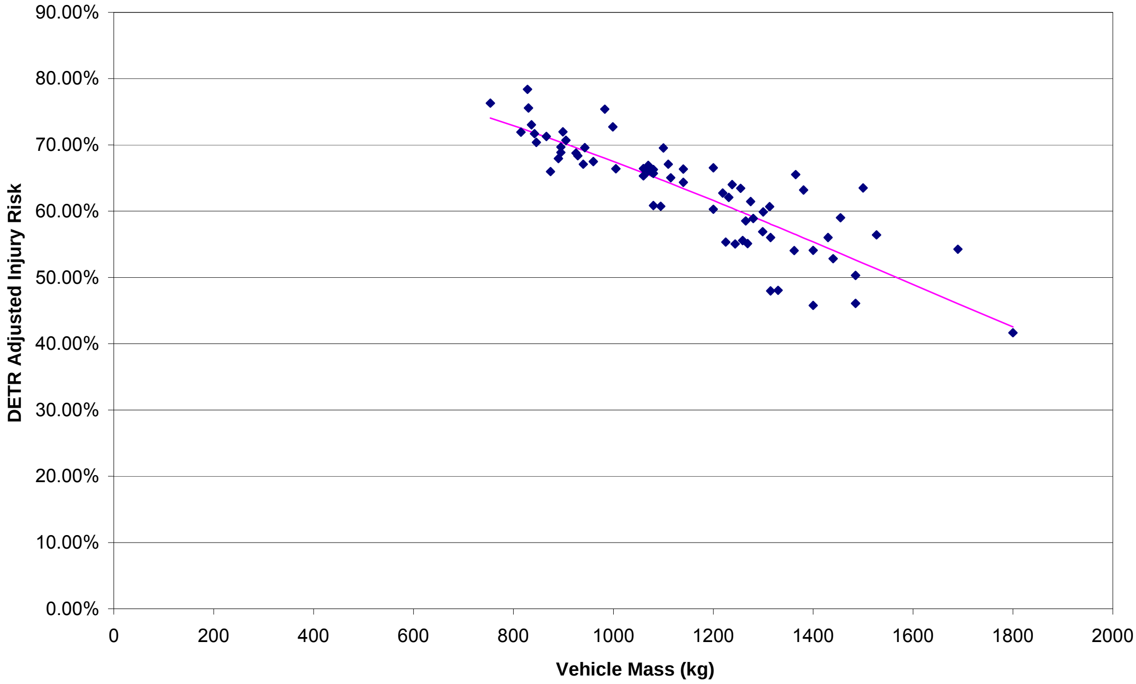


Figure 20. Adjusted injury risk (Newstead method) vs Vehicle mass

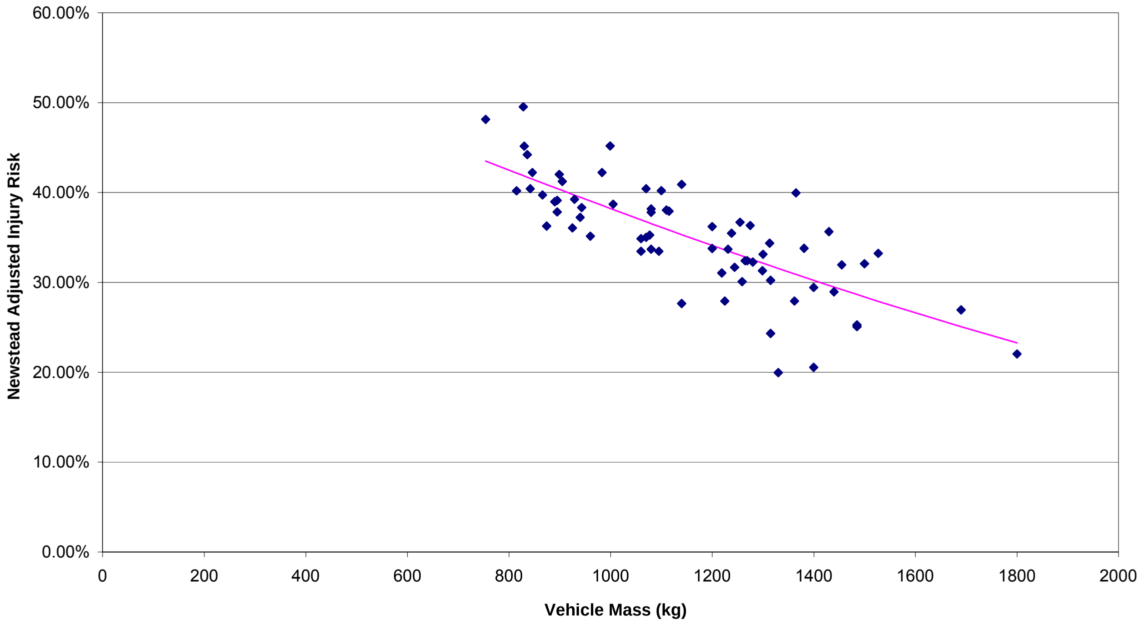


Figure 21. Adjusted injury severity vs Vehicle mass

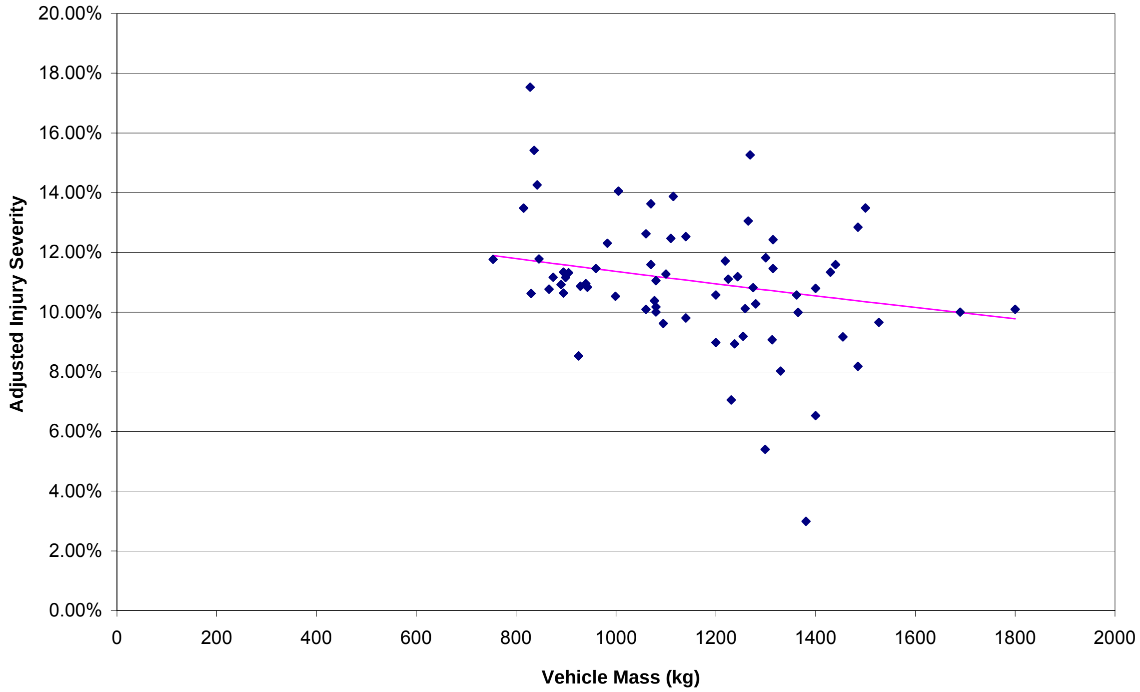


Figure 22. Adjusted crashworthiness (DfT method) vs Vehicle mass

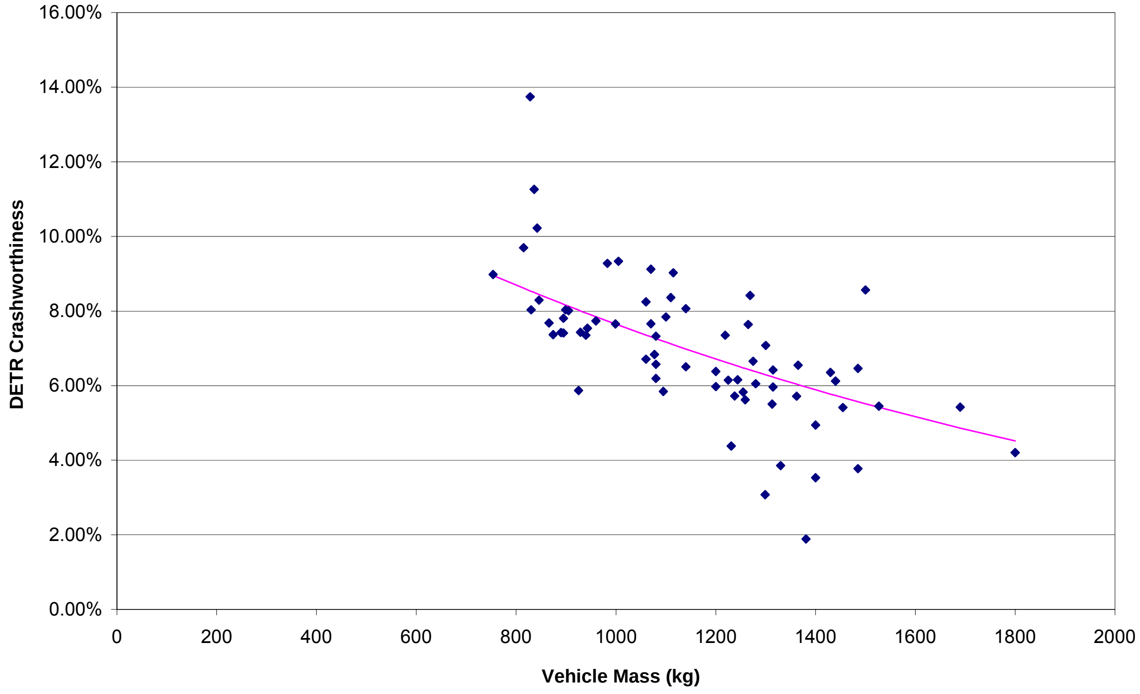
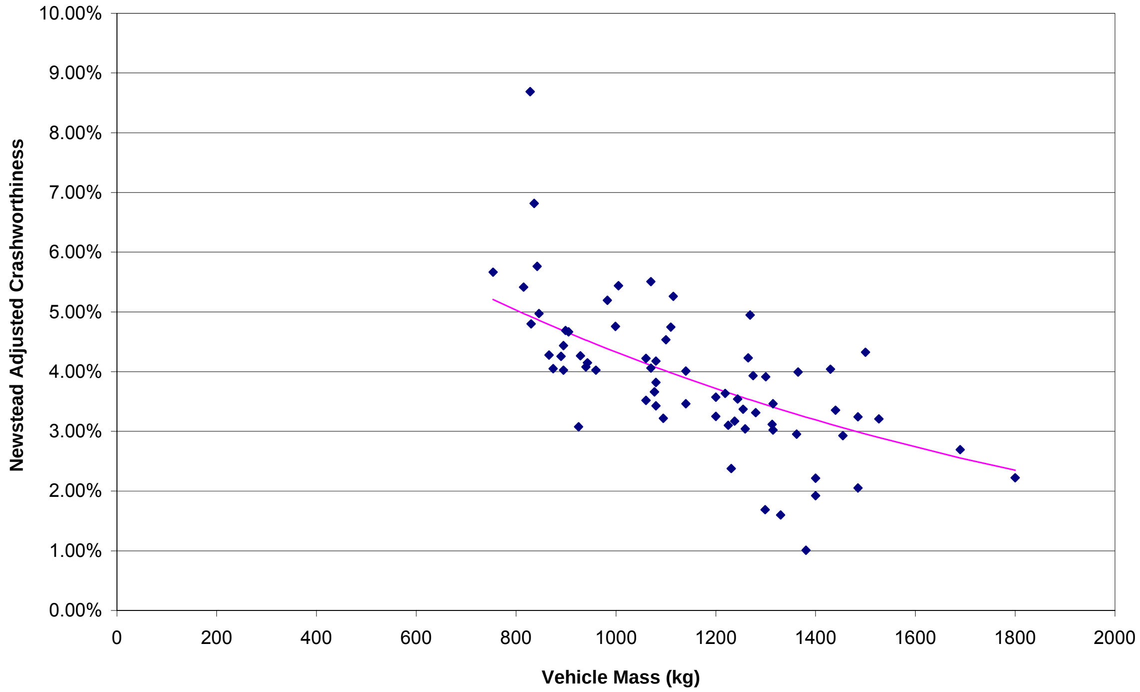


Figure 23. Adjusted crashworthiness (Newstead method) vs Vehicle mass



Figures 19-23 demonstrate a strong relationship between each of the estimated real crash safety measures and vehicle mass, with vehicles of higher mass generally associated with improved safety performance in the real crash safety measures. Further, although not reported here, the coefficient of vehicle mass in each of the regressions calculated was both negative and statistically significant. This confirms that on average, vehicles of higher mass have better real crash ratings.

French Relationship between Mass and Vehicle Safety Ratings

In a similar manner to the above analysis, logistic regression curves estimating the relationship between vehicle mass and real crash safety measure were fitted to the French crash data. These curves are plotted on the graphs that follow. The data used here considers all crash types, however, similar graphs for front and side impact crashes are provided in Appendix H.

Figure 24. Adjusted injury risk (DfT method) vs Vehicle mass

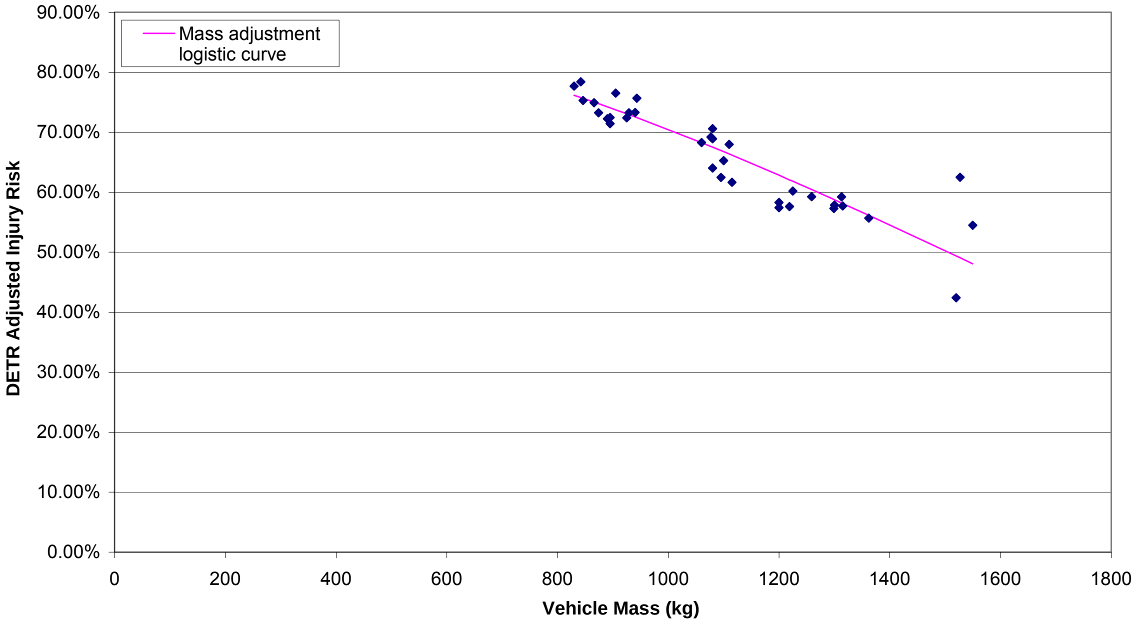


Figure 25. Adjusted injury risk (Newstead method) vs Vehicle mass

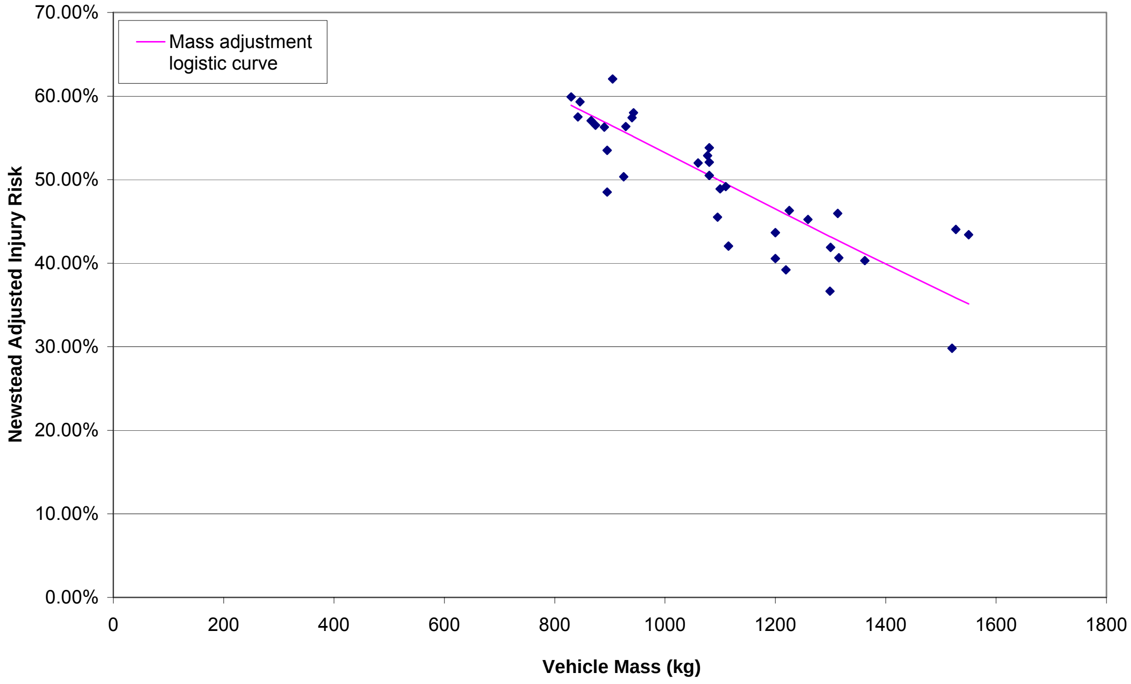


Figure 26. Adjusted injury severity vs Vehicle mass

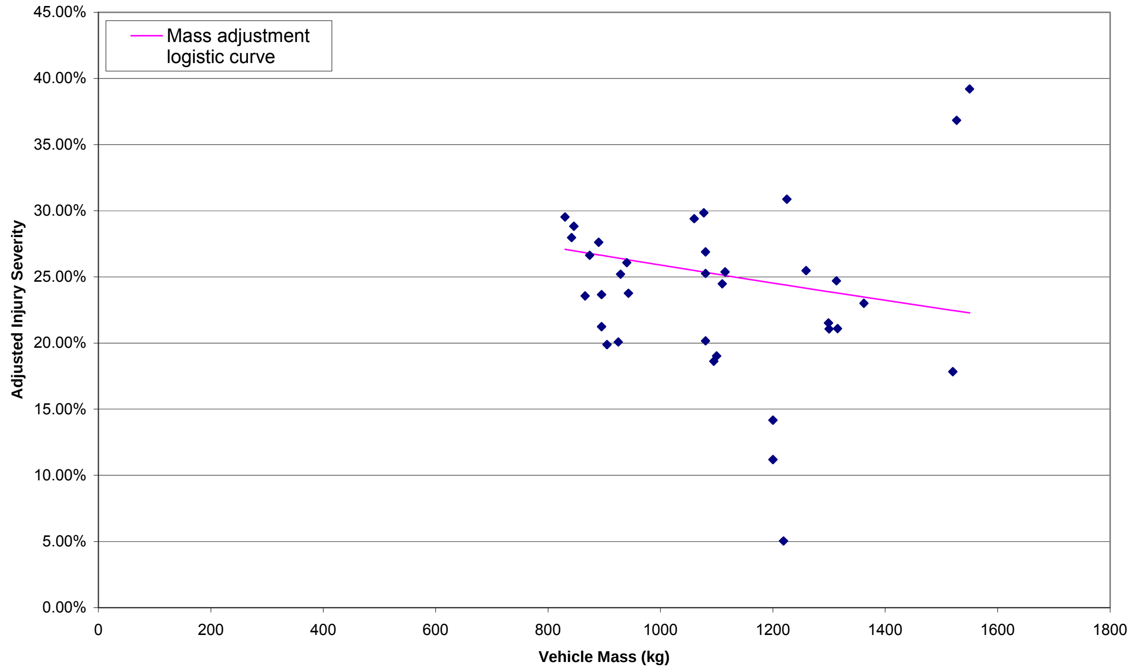


Figure 27. Adjusted crashworthiness (DfT method) vs Vehicle mass

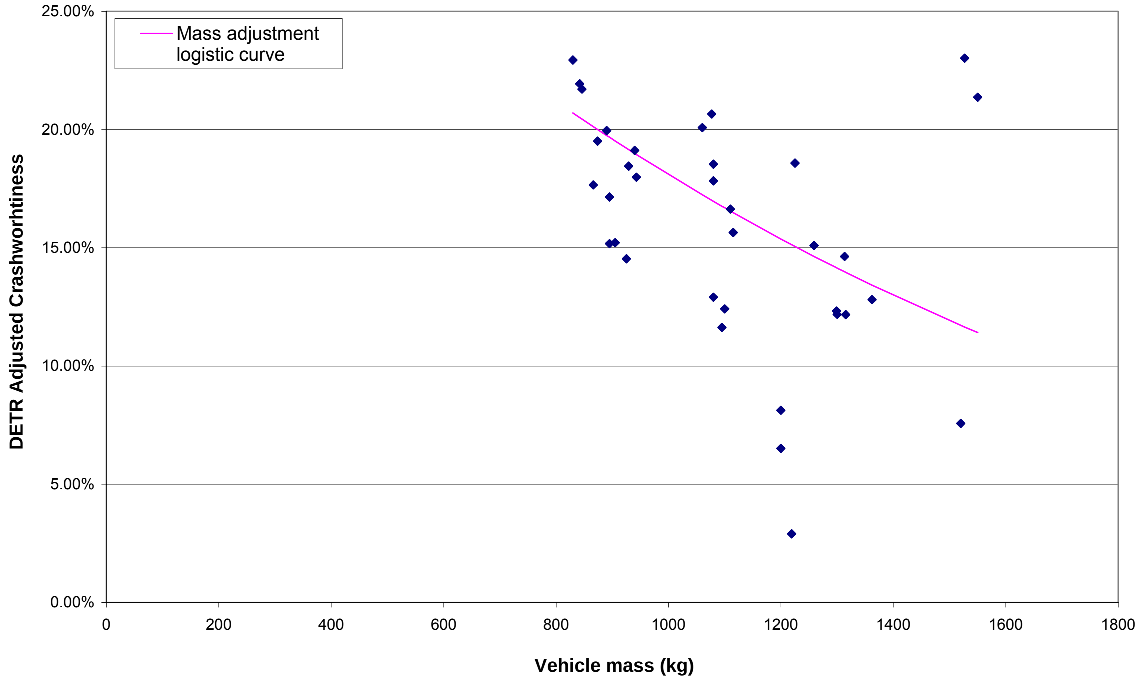
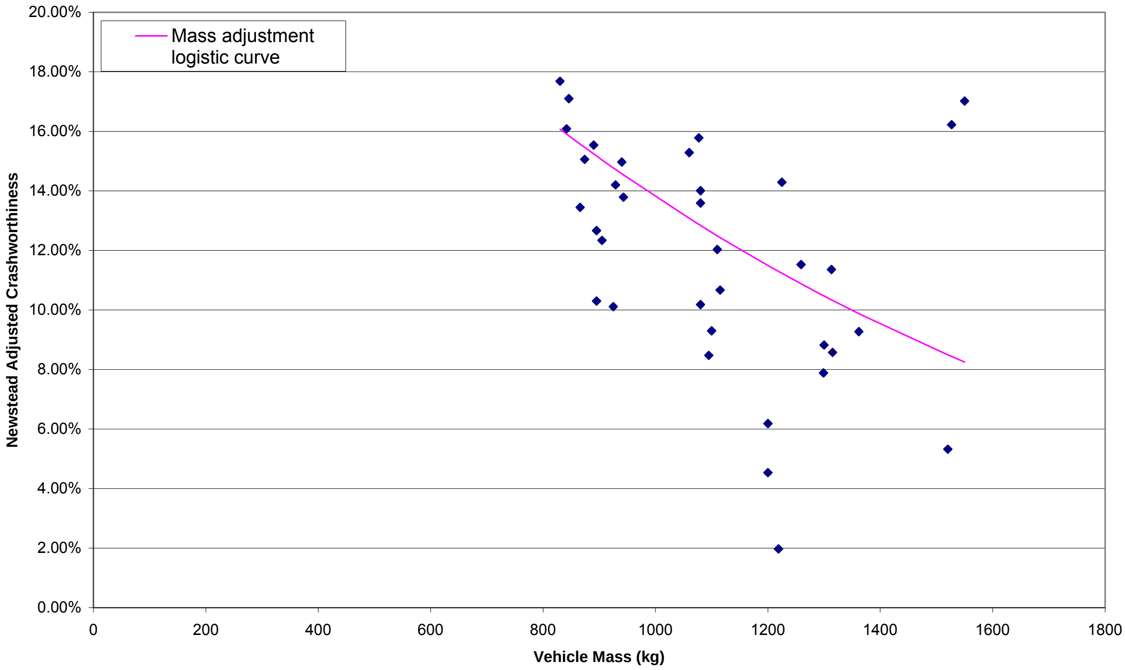


Figure 28. Adjusted crashworthiness (Newstead method) vs Vehicle mass



As for the British data there is evidence of a strong relationship between vehicle mass and performance in the real crash safety ratings with vehicles of greater mass being associated with improved performance in real crash safety measures. The coefficient of vehicle mass in each of the regressions calculated was both negative and statistically significant. Again this confirms that on average, vehicles of higher mass perform better in real crash safety ratings than those with lower mass.

German Relationship between Mass and Vehicle Safety Ratings

The fitted logistic regression curves estimating the relationship between vehicle mass and real crash safety measure for all crash types described above are plotted on the graphs that follow.

Figure 29. Adjusted injury risk (DfT method) vs Vehicle mass

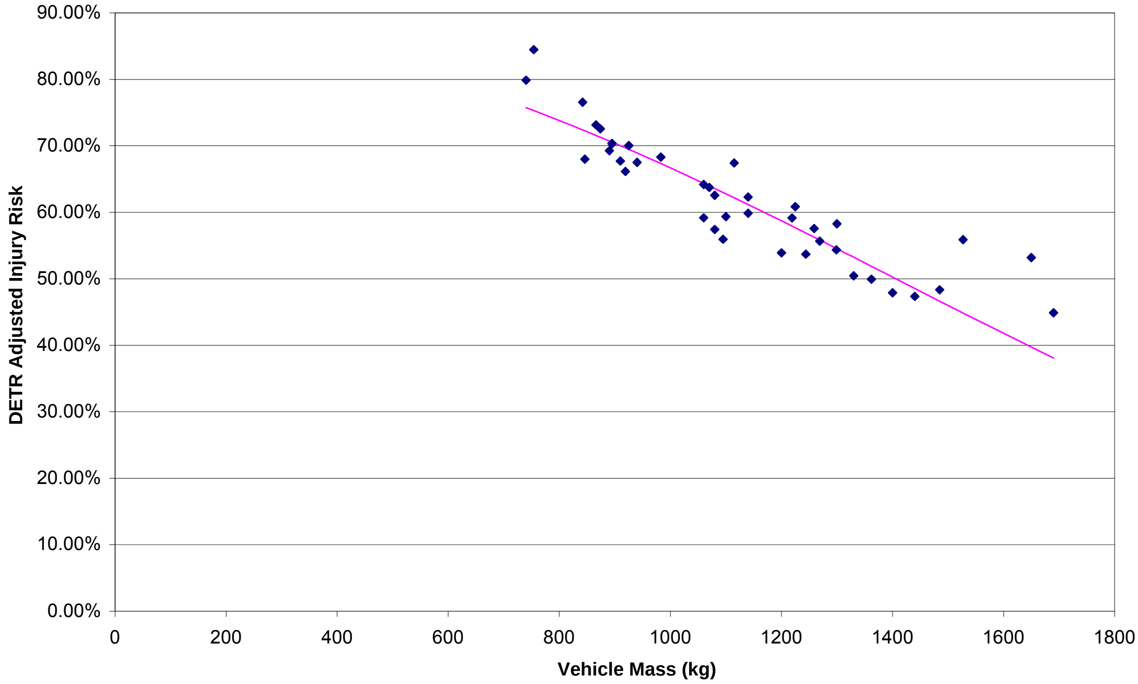


Figure 30. Adjusted injury risk (Newstead method) vs Vehicle mass

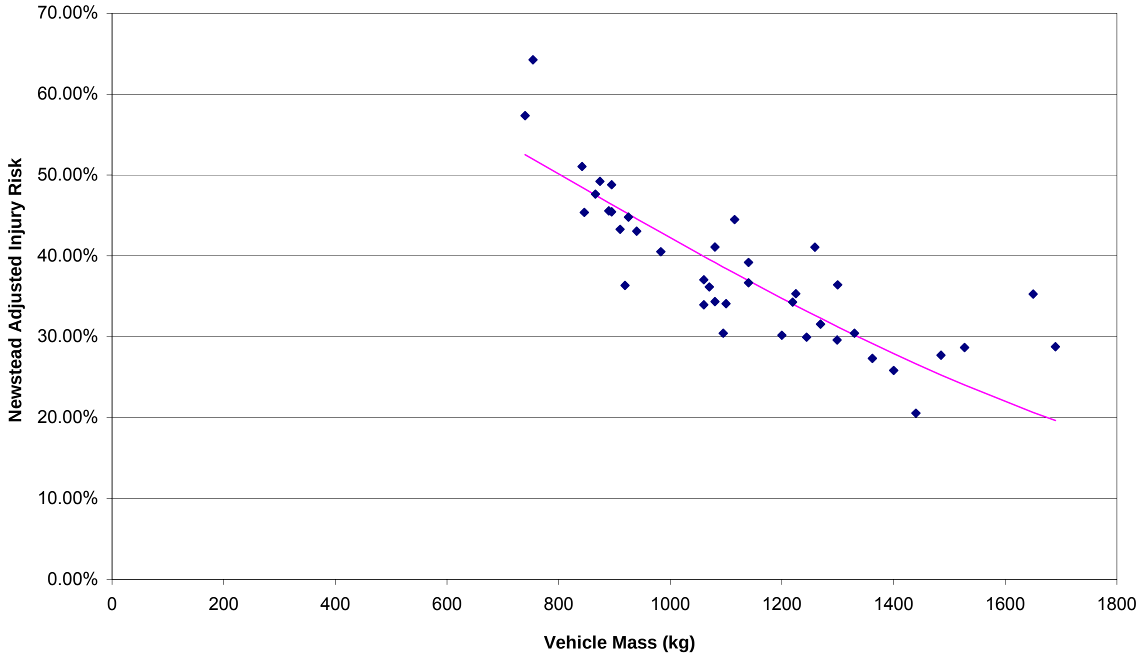


Figure 31. Adjusted injury severity vs Vehicle mass

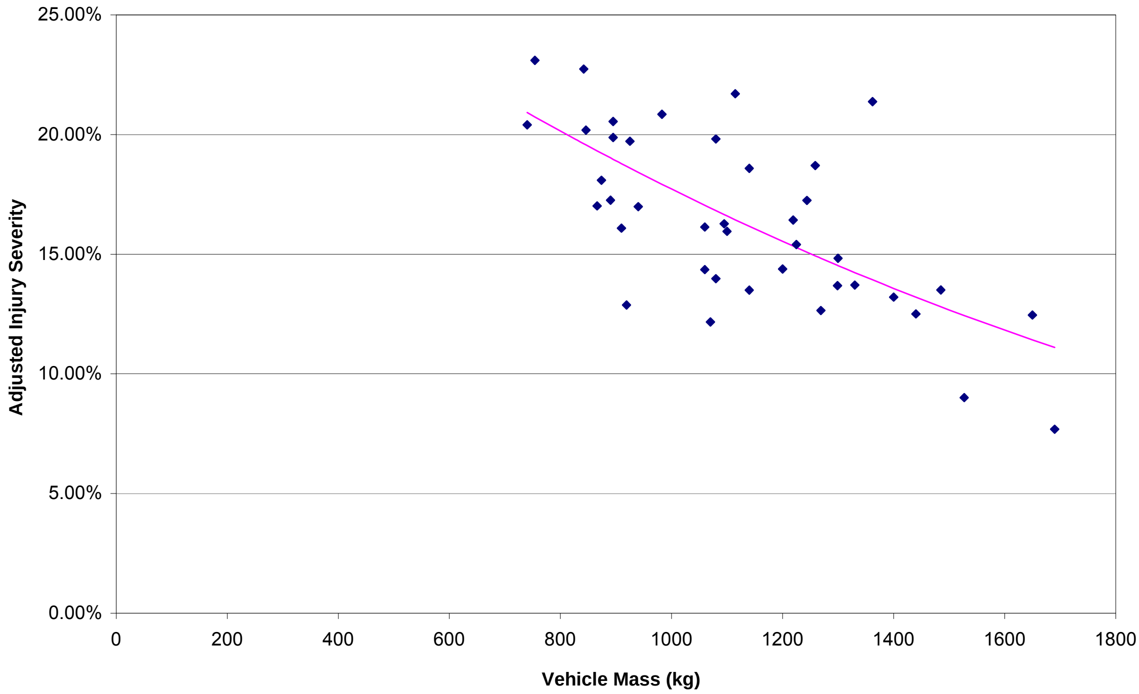


Figure 32. Adjusted crashworthiness (DfT method) vs Vehicle mass

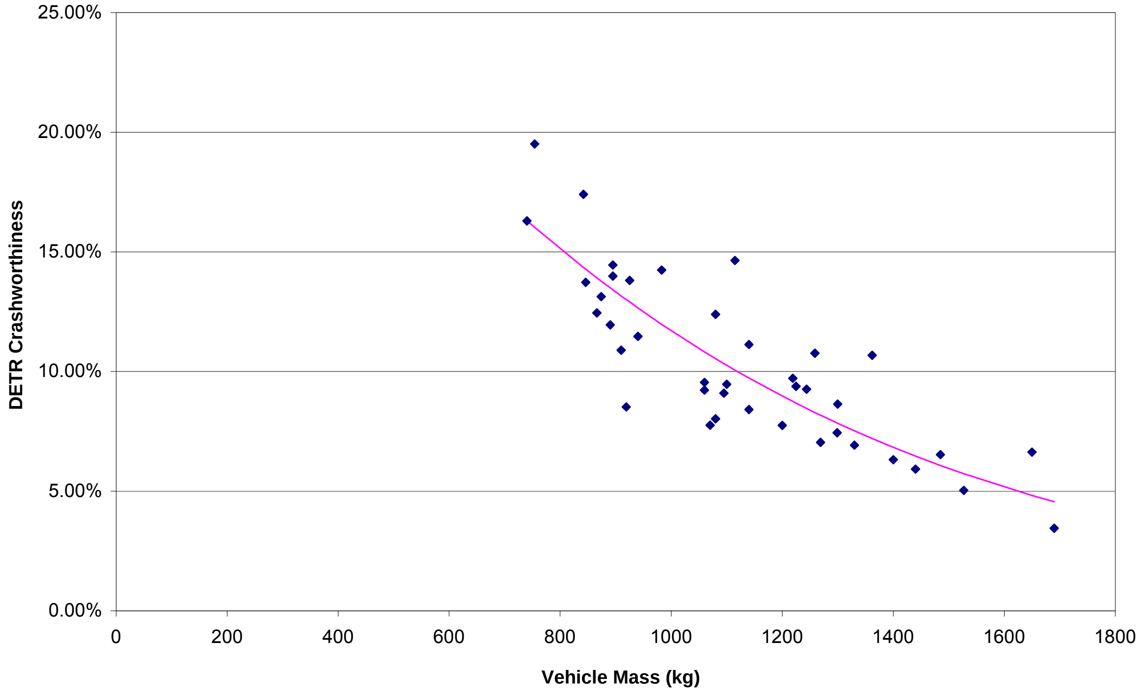
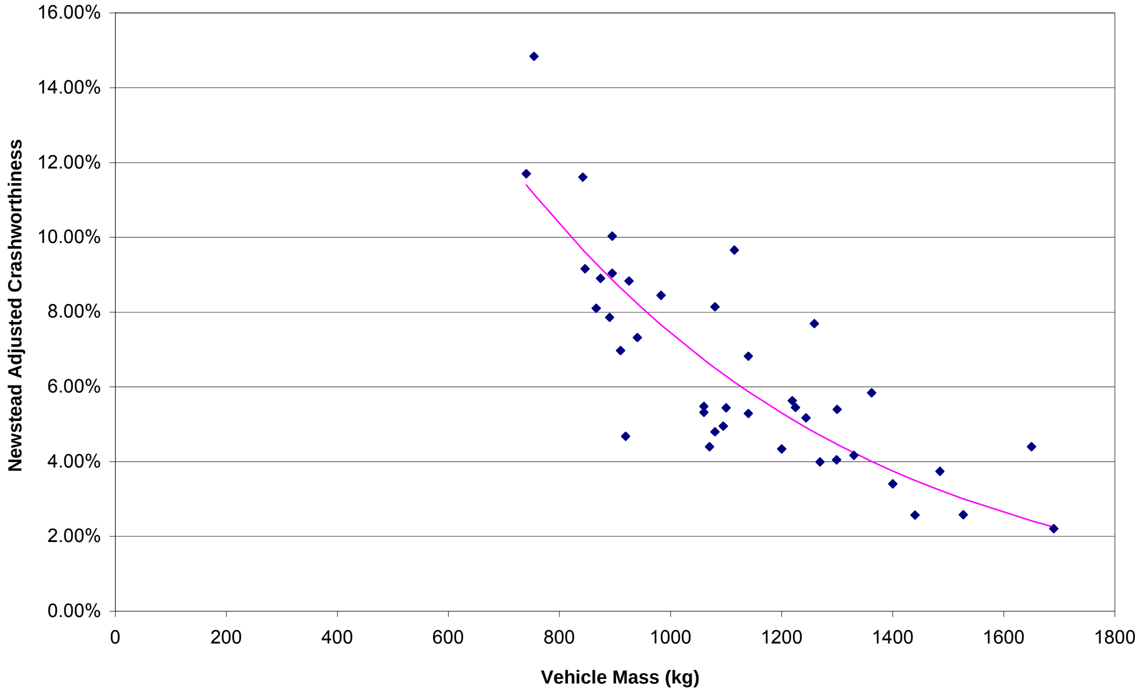


Figure 33. Adjusted crashworthiness (Newstead method) vs Vehicle mass



As for Great Britain and France, there is evidence of a strong relationship between vehicle mass and performance in the real crash safety ratings with vehicles of greater mass being associated with improved performance in real crash safety measures. The coefficient of vehicle mass in each of the regressions calculated was both negative and statistically significant. This confirms that on average, vehicles of higher mass perform better in real crash safety ratings than those with lower mass.

Australian and New Zealand Relationship between Mass and Vehicle Safety Ratings

The fitted logistic regression curves estimating the relationship between vehicle mass and real crash safety measure described above are plotted on the graphs that follow. The data used here considers all crash types. Similar graphs for front and side impact crashes are provided in Appendix H.

Figure 34. Adjusted injury risk vs Vehicle mass

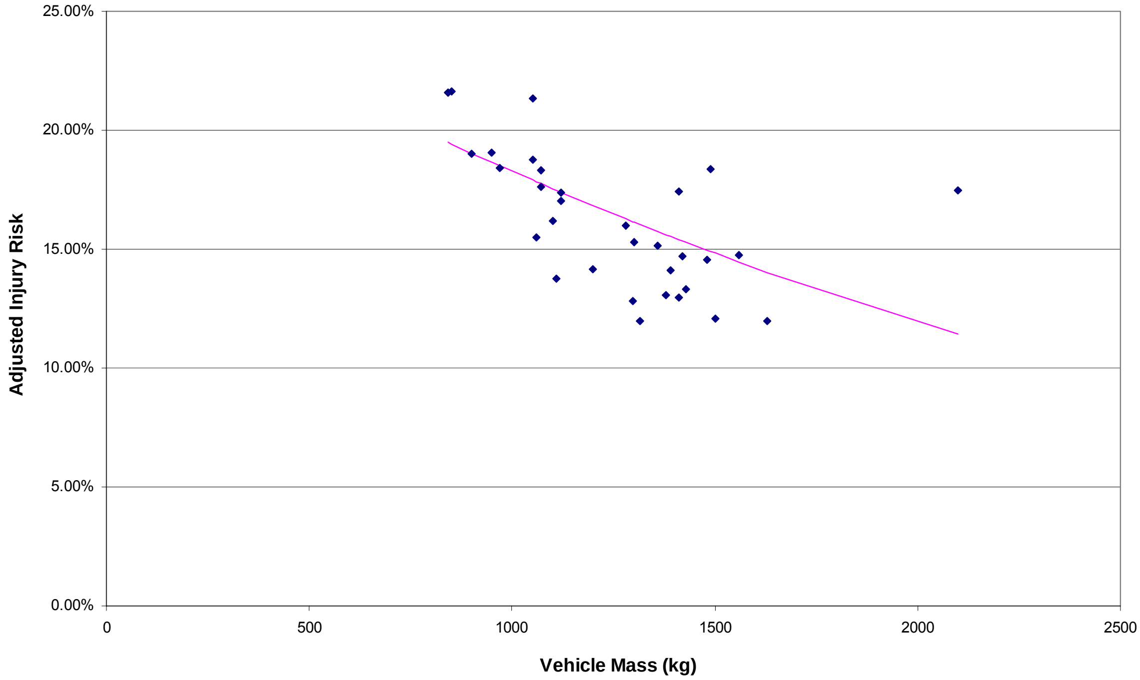
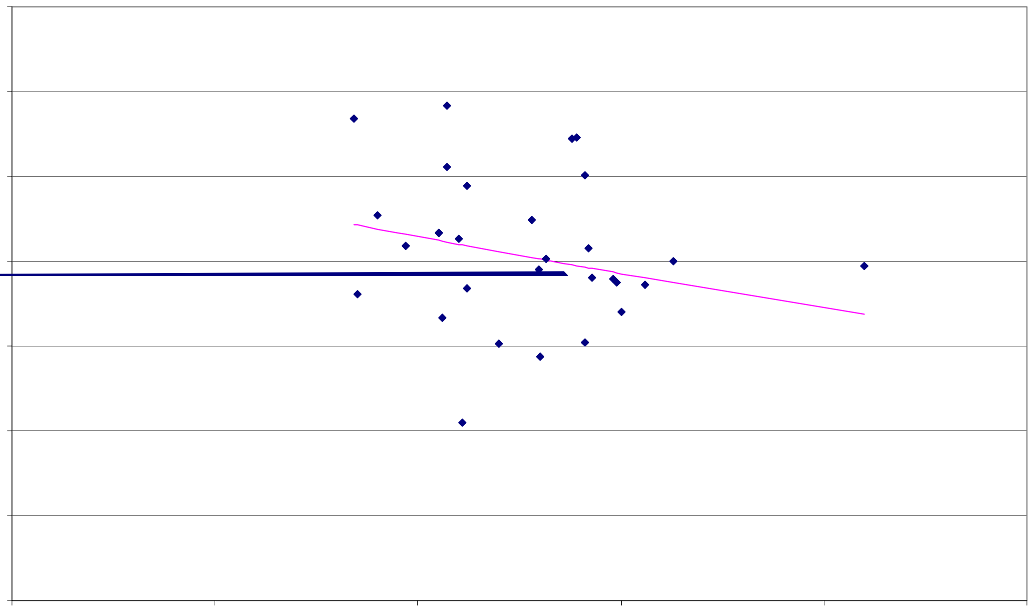


Figure 35. Adjusted injury severity vs Vehicle mass



4.4.2 Logistic Regression Results- All Crash Types

Given the proven relationship between vehicle mass and the real crash safety measures, it is necessary to adjust for vehicle mass when exploring the relationship between these measures and EuroNCAP test scores. To achieve this vehicle mass is included as an extra predictive term in the logistic regression (Equation 1) and operates to remove the effect of mass from the analysis. Analysis was conducted both with and without compensating for mass effects to determine more precisely the relationship between real crash measures and EuroNCAP star ratings. The results are shown in the tables that follow for Great Britain, France, Germany and Australia and New Zealand combined.

Each of the tables presented shows the average real crash measure for all vehicle models within each EuroNCAP overall star rating category with sufficient real crash data to be considered in the study. In addition, the 95% confidence limits for each of the estimates are given to allow comparison of the statistical significance in the average real crash outcome between pairs of EuroNCAP overall star rating categories. The data presented here considers all crash types only.

British Results

Tables 19 and 20 show average real crash outcomes in all crash types estimated within each EuroNCAP star rating category estimated using both the DfT and Newstead methods. Comparison of the point estimates and associated confidence limits provides valuable information on the statistical significance of the relationship between each of the real crash safety measures and EuroNCAP star ratings. Non-overlapping confidence limits across EuroNCAP star rating classes indicate that there is a statistically significant relationship between EuroNCAP star ratings and the real crash safety measures. That is, there are statistically significant differences in average real crash injury outcomes between vehicles in different EuroNCAP star rating categories. In contrast, overlapping confidence limits across EuroNCAP star rating classes indicate that there is no statistically significant difference in average injury outcomes in real crashes for vehicles in each EuroNCAP star rating category.

Table 19. Crashworthiness estimates (DfT method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Crashworthiness Ratings (DfT method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**8.22%**	**7.08%**	**7.28%**	**6.85%**	**9.24%**	**6.92%**	**7.02%**	**6.45%**
LCL	7.67%	6.85%	7.04%	6.55%	8.66%	6.70%	6.79%	6.17%
UCL	8.79%	7.33%	7.52%	7.16%	9.84%	7.16%	7.25%	6.74%

Table 20. **Crashworthiness estimates (Newstead method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.**

Crashworthiness Ratings (Newstead method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**4.48%**	**3.99%**	**4.14%**	**3.86%**	**5.17%**	**3.87%**	**3.96%**	**3.59%**
LCL	4.01%	3.78%	3.93%	3.60%	4.66%	3.68%	3.77%	3.35%
UCL	4.99%	4.20%	4.36%	4.14%	5.73%	4.08%	4.17%	3.84%

Considering the mass adjusted analysis for crashworthiness using the DfT method, vehicles with a 1 star rating have an average crashworthiness significantly worse than higher star rated vehicles and 4 star rated vehicles had an average crashworthiness significantly less than 3 star rated vehicles. However, 2 star rated vehicles had an estimated average crashworthiness rating not statistically significantly different to 3 or 4 star rated models. The analysis of the relationship between the Newstead crashworthiness ratings and EuroNCAP star ratings does not show any statistically significantly difference between the average real crash performances of one, two, three or four star rated vehicles.

Tables 21, 22 and 23 show the corresponding relationships between the average injury risk and injury severity components of the real crash ratings and EuroNCAP star ratings category for the real crash measures estimated using the DfT and Newstead methods. Again, results unadjusted and adjusted for mass effects are given.

Table 21. **Injury risk rating estimates (DfT method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.**

Risk Ratings (DfT method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**64.38%**	**64.95%**	**65.26%**	**66.11%**	**70.51%**	**63.59%**	**63.31%**	**62.99%**
LCL	62.83%	64.27%	64.60%	65.27%	69.15%	62.91%	62.64%	62.15%
UCL	65.90%	65.62%	65.92%	66.94%	71.84%	64.27%	63.97%	63.83%

Table 22. Injury risk rating estimates (Newstead method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Risk Ratings (Newstead method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**34.57%**	**36.17%**	**36.86%**	**36.90%**	**39.32%**	**35.09%**	**35.44%**	**34.70%**
LCL	32.55%	35.26%	35.95%	35.76%	37.26%	34.21%	34.57%	33.62%
UCL	36.65%	37.08%	37.77%	38.06%	41.42%	35.99%	36.32%	35.80%

In relation to injury risk calculated using either the DfT or Newstead method and without adjusting for mass effects, 1 star rated vehicles have statistically significantly lower average injury risk than higher star rated vehicles. However, no statistically significant differences between other EuroNCAP star ratings could be detected on the basis of injury risk. Similarly, no statistically significant differences in real crash performance between vehicles of different star ratings were identified on the basis of the mass adjusted results.

Table 23. Injury severity estimates and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Injury Severity Ratings								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**12.76%**	**10.82%**	**11.10%**	**10.28%**	**13.09%**	**10.77%**	**11.01%**	**10.15%**
LCL	11.78%	10.41%	10.68%	9.75%	12.13%	10.36%	10.60%	9.64%
UCL	13.82%	11.26%	11.54%	10.84%	14.11%	11.20%	11.44%	10.68%

Considering the mass adjusted analysis for injury severity, 1 star rated vehicles had an average injury severity significantly worse than higher star rated vehicles. However, 2 star rated vehicles had an estimated average crashworthiness rating not statistically significantly different to 3 or 4 star rated models.

French Results

Tables 24 to 28 show the comparisons between overall EuroNCAP star rating and average real injury outcome derived from the French police reported crash data. Presentation is the same as for the British data comparisons given above.

Table 24. Crashworthiness estimates (DfT method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Crashworthiness Ratings (DfT method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**19.10%**	**17.57%**	**17.21%**		**20.03%**	**17.19%**	**16.75%**
LCL		18.49%	16.93%	16.43%		19.41%	16.56%	15.99%
UCL		19.73%	18.23%	18.02%		20.66%	17.84%	17.54%

Table 25. Crashworthiness estimates (Newstead method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Crashworthiness Ratings (Newstead method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**14.72%**	**13.31%**	**13.00%**		**15.53%**	**12.99%**	**12.61%**
LCL		14.08%	12.66%	12.20%		14.89%	12.35%	11.85%
UCL		15.38%	14.00%	13.83%		16.19%	13.66%	13.42%

The 95% confidence limits of the crashworthiness estimates calculated using the DfT and Newstead methods (both with and without mass adjustment) for vehicles with 3 and 4 EuroNCAP star ratings overlap. There is no such overlap between EuroNCAP 2 star rated vehicles and 3 or 4 star rated vehicles. That is, there are statistically significantly differences between the average real crash crashworthiness of 3 and 4 star EuroNCAP rated vehicles but not between 2 star and 3 or 4 star rated vehicles

Table 26. Injury risk (DfT method) estimates and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Risk Ratings (DfT method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**68.79%**	**69.01%**	**68.45%**		**70.86%**	**68.09%**	**67.23%**
LCL		67.89%	68.03%	67.24%		70.02%	67.12%	66.02%
UCL		69.68%	69.97%	69.64%		71.68%	69.06%	68.42%

Table 27. Injury risk estimates (Newstead method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Risk Ratings (Newstead method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**52.29%**	**51.58%**	**50.85%**		**54.08%**	**50.76%**	**49.87%**
LCL		51.07%	50.24%	49.21%		52.90%	49.43%	48.26%
UCL		53.51%	52.92%	52.47%		55.26%	52.08%	51.48%

The 95% confidence limits of the mass adjusted estimates using either the DfT or Newstead methods indicate that the EuroNCAP star rating is not associated with a statistically significantly difference between estimated real crash injury risk for 2, 3 or 4 star rated vehicles. When vehicle mass is not considered there is a statistically significant difference between 2 star rated vehicles and 3 and 4 star rated vehicles. However, the EuroNCAP star rating is not associated with a statistically significantly difference between estimated real crash injury risk for 3 and 4 star rated vehicles.

Table 28. Injury severity estimates and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Injury Severity Ratings								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**27.66%**	**25.31%**	**25.10%**		**28.01%**	**25.16%**	**24.92%**
LCL		26.54%	24.12%	23.64%		26.93%	23.99%	23.47%
UCL		28.80%	26.54%	26.62%		29.12%	26.38%	26.42%

The 95% confidence limits of the injury severity estimates (both with and without mass adjustment) for vehicles with 3 and 4 EuroNCAP star ratings overlap. There is no such overlap between EuroNCAP 2 star rated vehicles and 3 or 4 star rated vehicles. That is, the EuroNCAP star rating is not associated with a statistically significantly difference between estimated real crash injury severity for 3 and 4 star rated vehicles.

German Results

Tables 29 to 33 present the same comparisons made for the British and French data between the German real crash measure and EuroNCAP star rating categories.

Table 29. **Crashworthiness estimates (DfT method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.**

Crashworthiness Ratings (DfT method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**12.17%**	**11.89%**	**10.08%**		**12.70%**	**12.46%**	**9.19%**
LCL		11.81%	11.51%	9.70%		12.33%	12.08%	8.86%
UCL		12.54%	12.28%	10.47%		13.08%	12.86%	9.54%

Table 30. **Crashworthiness estimates (Newstead method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.**

Crashworthiness Ratings (Newstead method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**7.76%**	**7.68%**	**6.12%**		**8.17%**	**8.17%**	**5.45%**
LCL		7.42%	7.33%	5.77%		7.82%	7.80%	5.15%
UCL		8.11%	8.05%	6.48%		8.53%	8.55%	5.76%

Considering the mass adjusted analysis for crashworthiness using both the DfT and Newstead methods, 4 star rated vehicles have an average crashworthiness significantly better than lower star rated vehicles. However, 2 star rated vehicles had an estimated average crashworthiness rating not statistically significantly different to 3 star rated models.

Table 31. **Injury risk rating estimates (DfT method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.**

Risk Ratings (DfT method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**65.08%**	**64.97%**	**62.68%**		**66.42%**	**66.09%**	**60.10%**
LCL		64.22%	61.88%	64.39%		65.75%	65.36%	59.30%
UCL		65.71%	63.48%	65.77%		67.08%	66.81%	60.88%

Table 32. Injury risk rating estimates (Newstead method) and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Risk Ratings (Newstead method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**39.94%**	**40.70%**	**36.86%**		**41.03%**	**41.72%**	**34.85%**
LCL		39.00%	39.69%	35.84%		40.10%	40.72%	33.88%
UCL		40.88%	41.72%	37.90%		41.96%	42.73%	35.83%

With respect to injury risk calculated using either the DfT or Newstead method and without adjusting for mass effects, 4 star rated vehicles have statistically significantly lower average injury risk than lower star rated vehicles. However, no statistically significant differences between 2 and 3 star rated vehicles could be detected on the basis of injury risk. The same conclusions can be drawn from the results of the mass adjusted Newstead analysis. After adjusting the DfT method results for mass, it was not possible to statistically significantly differentiate real crash performance on the basis of EuroNCAP star ratings.

Table 33. Injury severity estimates and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Injury Severity Ratings								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**18.41%**	**18.12%**	**15.91%**		**18.78%**	**18.55%**	**15.21%**
LCL		17.79%	17.46%	15.23%		18.16%	17.89%	14.58%
UCL		19.05%	18.80%	16.62%		19.42%	19.23%	15.87%

Considering both the mass adjusted and non-mass adjusted analysis for injury severity, 4 star rated vehicles have an average injury severity significantly better than lower star rated vehicles. However, 2 star rated vehicles had an estimated average injury severity rating not statistically significantly different to 3 star rated models.

Australian and New Zealand Results

Tables 34 to 36 present the final comparisons of average real crash injury outcomes against EuroNCAP star ratings based on the Australian and New Zealand police reported crash data.

Table 34. Crashworthiness estimates and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Crashworthiness Ratings								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**3.46%**	**3.00%**	**3.42%**		**3.67%**	**2.73%**	**3.54%**
LCL		3.23%	2.81%	3.18%		3.44%	2.58%	3.29%
UCL		3.70%	3.20%	3.69%		3.91%	2.88%	3.81%

With or without mass adjustment, 2 star rated vehicles have an average crashworthiness significantly worse than 3 star rated vehicles. However both 2 and 3 star rated vehicles have an estimated average crashworthiness rating not statistically significantly different to 4 star rated models.

Table 35. Injury risk rating estimates and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Injury Risk Ratings								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**16.18%**	**15.55%**	**16.78%**		**16.89%**	**14.52%**	**17.19%**
LCL		15.67%	15.08%	16.20%		16.39%	14.16%	16.61%
UCL		16.71%	16.03%	17.37%		17.40%	14.90%	17.78%

In relation to injury risk calculated using the MUARC method and adjusting for mass effects, 3 star rated vehicles have statistically significantly lower average injury risk than 4 star rated vehicles. However, no statistically significant differences were detected between other EuroNCAP star rating combinations on the basis of injury risk and with mass adjustment. Without adjusting for mass both 2 and 4 star rated vehicles have statistically higher average risk than 3 star rated vehicles.

Table 36. Injury severity estimates and 95% confidence limits across EuroNCAP star rating categories both with and without mass adjustment.

Injury Severity Ratings								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**21.31%**	**18.82%**	**20.21%**		**21.54%**	**18.47%**	**20.36%**
LCL		19.95%	17.63%	18.75%		20.25%	17.50%	18.93%
UCL		22.73%	20.07%	21.74%		22.89%	19.47%	21.86%

Considering the mass adjusted analysis for injury severity, no statistically significant differences were detected between EuroNCAP star rating combinations. Without mass adjustment 2 star rated vehicles have an average injury severity significantly worse than 3 star rated vehicles.

4.4.3 Logistic Regression Results- Front and Side Impact Crashes

As discussed, the analysis of the relationship between EuroNCAP star ratings and real crash safety measures above considered all crash types only. Similar analysis was conducted separately for front and side impact crashes using the British, French and combined Australian and New Zealand data. Front and side impact crashes could not be analysed separately using the German data as there was insufficient crash information to reliably identify these crash types. Furthermore, there were relatively few vehicle models with sufficient side impact data to be reliably rated in the French and Australian and New Zealand data and to be meaningfully analysed against EuroNCAP frontal and side impact scores. Because of this, the primary focus of this analysis is the results derived from the British police reported crash data. Full results of all analyses are presented in Appendices F, G and H for Great Britain, France and combined Australia and New Zealand respectively.

In interpreting the results of the frontal and side impact comparisons, a few notes on the calculation of the EuroNCAP star rating are required. Rather than include the offset frontal or side impact barrier test scores in the logistic model as a continuous variable, each variable has been categorised into four levels. The four levels have been defined in a manner similar to the derivation of the overall EuroNCAP star rating from the total of either the offset frontal or side impact test scores. The four score categories are defined as follows:

- Category 1: $0 \le \text{score} \le 4$
- Category 2: $4 < \text{score} \le 8$

- Category 3: 8 < score ≤ 12
- Category 4: 12 < score ≤ 16

Treating the scores categorically avoids the need to assume a functional form of the relationship between the continuous measure and the real outcome in the logistic regression model.

Key results from the analyses of British police reported crash data in front and side impacts follows.

FRONTAL IMPACT CRASHES

Figure 37 shows the relationship between crashworthiness in frontal impact crashes calculated from the British police reported crash data using the DfT method and the EuroNCAP frontal impact test score. Very little trend is seen in the real crash based ratings with increasing EuroNCAP frontal impact score whilst significant variation is seen in the frontal impact real crash ratings of vehicles with very similar EuroNCAP frontal test scores. Similar relationships were observed when using the Newstead real crash measure and when looking at the injury risk and injury severity components separately. These results can be seen in Appendix F.

Figure 37a **Frontal Impact EuroNCAP test score v Adjusted frontal impact crashworthiness (DfT method)**

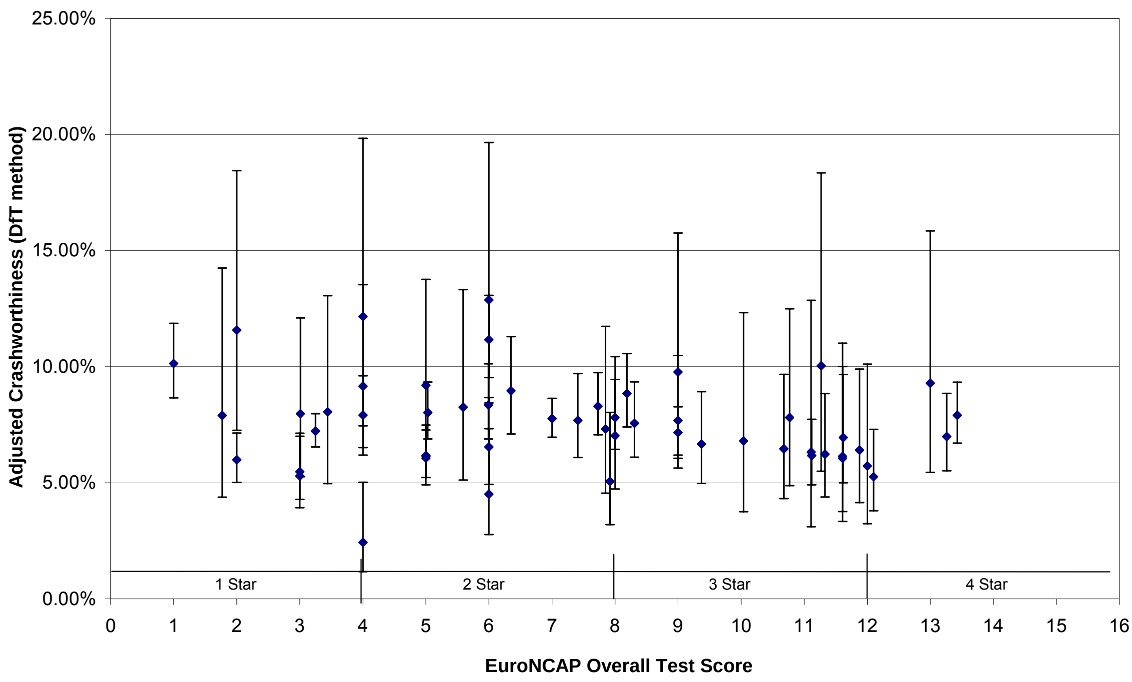


Table 37a shows average frontal impact crashworthiness estimated using the DfT method to calculate injury risk from the British data by EuroNCAP frontal impact star rating category estimated via logistic regression analysis. Reflecting the trends seen in Figure 37a, there is no statistically significant difference in average frontal impact crashworthiness between any of the derived EuroNCAP frontal impact star rating categories in either the mass adjusted or non-mass adjusted results. A similar lack of association was found when using the Newstead method of real crash rating detailed in Appendix F.

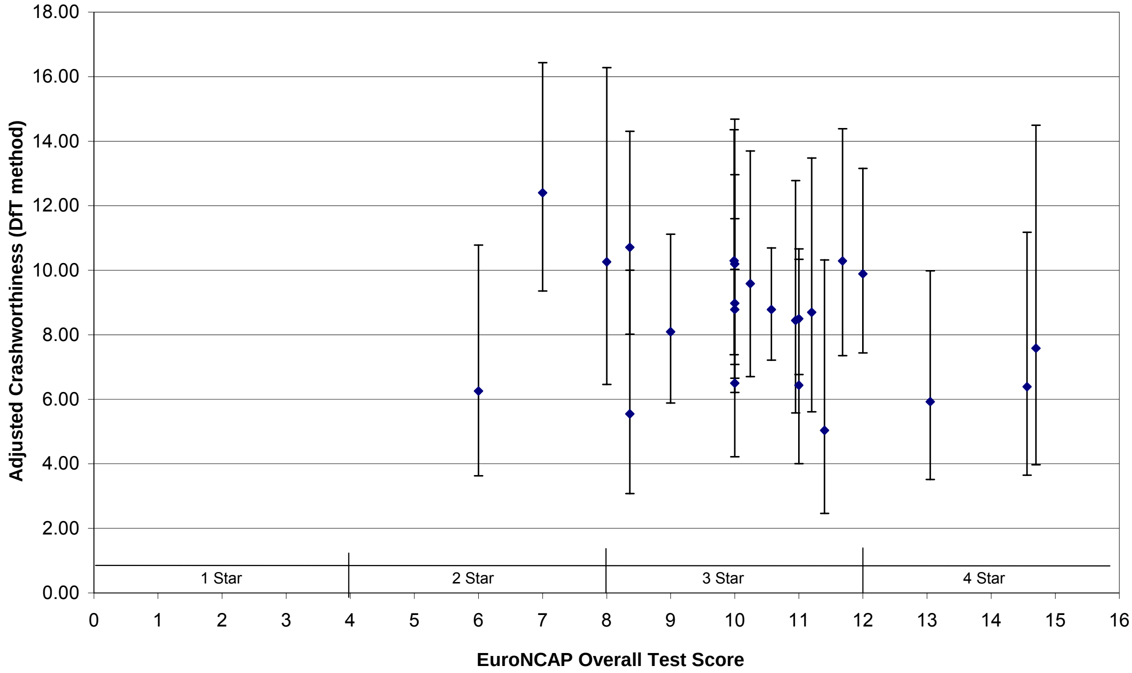
Table 37a. Average frontal impact crashworthiness and 95% confidence limits by EuroNCAP frontal impact star rating categories: with and without mass adjustment.

Crashworthiness Ratings (DfT method)								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**7.30%**	**7.45%**	**7.63%**	**7.71%**	**7.46%**	**7.91%**	**7.31%**	**7.41%**
LCL	6.99%	7.15%	7.26%	7.18%	7.14%	7.61%	6.96%	6.91%
UCL	7.63%	7.77%	8.02%	8.27%	7.79%	8.23%	7.68%	7.96%

SIDE IMPACT CRASHES

Analysis analogous to the frontal impact analysis presented above was also undertaken for side impact crashes. Figure 37b shows the relationship between crashworthiness in side impacts estimated using the DfT method on side impact crashes in the British crash data and the side impact EuroNCAP score. Figure 37b shows some evidence of a trend to improving crashworthiness in real side impact crashes with increasing EuroNCAP score. Like all the previous comparisons, however, there is significant variation in the real crash side impact performance of vehicles with the same or similar EuroNCAP side impact ratings. Interpretation of the trends in Figure 37b should be tempered through noting the relatively wide confidence limits on the real crash side impact ratings for most vehicles. A similar comparison to Figure 37b but using the Newstead measure of crashworthiness yielded a similar relationship.

Figure 37b Side Impact EuroNCAP test score v Adjusted side impact crashworthiness (DfT method)



Results of logistic regression analysis of the average side impact crashworthiness in the British data by derived EuroNCAP side impact star rating both with and without mass adjustment are summarised in Table 37b for crashworthiness estimated using the DfT method. The results reflect the general downward trend seen in Figure 37b with the average side impact crashworthiness reducing with increasing side impact EuroNCAP test score. Average side impact crashworthiness for 4-star side impact rated EuroNCAP vehicles was significantly better than for those vehicles rated 2 or 3 stars whether considering the mass adjusted or non-mass adjusted results.

Table 37b. Average side impact crashworthiness and 95% confidence limits by EuroNCAP side impact star rating categories: with and without mass adjustment.

Crashworthiness Ratings (DfT method)								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**10.68%**	**9.09%**	**6.89%**		**10.81%**	**9.14%**	**6.77%**
LCL		9.33%	8.20%	5.80%		9.45%	8.25%	5.71%
UCL		12.20%	10.06%	8.15%		12.33%	10.11%	8.00%

Similar results to those reported in Table 37b were also found when using the Newstead measure of real rash side impact performance as shown in Appendix F. Evidence of a trend to improving side impact injury outcome in both the injury risk and injury severity components of the real crash based measures was also observed in the results of Appendix F. However, none of the results relating to the risk or severity components in Appendix F were sufficiently accurate to be statistically significant.

5 Discussion

Analysis in this report has focused on comparing vehicle passive safety ratings computed from analysis of driver injury outcomes in crashes reported to police with those generated from the results of crash barrier testing under the EuroNCAP program. Reflecting the injury outcome scales used in police reported crash data, the nominal injury outcome measure calculated from this data has been the risk of driver death or serious injury given involvement in a reported crash. The measure is a product of two probabilities, the first being the risk of sustaining an injury of any level in a crash and the second being the risk of death or serious injury given some injury is sustained. Two methods for calculating the ratings based on police crash reports have been used. The first is a method used for many years by the British Department for Transport to rate relative vehicle secondary safety whilst the second is a new method proposed as part of the SARAC I research to overcome inherent biases identified in the existing methods.

Police reported crash data from five different jurisdictions has been analysed for this project, these being Great Britain, France, Germany, Finland and Australia and New Zealand combined. Due to fundamental differences identified between data from each of the jurisdictions, parallel rather than combined analysis of the data has been undertaken. For each jurisdiction, a set of vehicle safety ratings has been calculated from the available police data and compared independently to the EuroNCAP score for vehicles rated under each system. The hope in making parallel comparisons in this way was that consistency would be observed in the relationships measured in each jurisdiction leading to a robust conclusion about the relationship between injury outcomes in police reported crashes and the ratings produced under the EuroNCAP program.

Comparison of the EuroNCAP scores and police data derived rating systems has been undertaken on a number of levels. In considering ratings based on real crashes, not only the crashworthiness rating, measuring the risk of serious injury or death given involvement in an injury crash, has been calculated but also the component injury risk and injury severity measures that multiply to give the crashworthiness rating. Similarly, not only the overall EuroNCAP barrier test rating has been considered. The results of the offset frontal and side impact tests have been individually compared with crash types of similar configuration in the police data. The role of vehicle mass in determining the level of association between the two ratings systems has also been investigated.

Data from five jurisdictions, rated using two different analysis techniques each incorporating three numerical measures both unadjusted and adjusted for the effects of vehicle mass equates to a large number of results from the study to interpret. The diversity of results presented in this report requires a level of distilling and interpretation before conclusions can be drawn. The following section attempts to distil the most relevant and representative of the results presented. Subsequent sections of the discussion attempt to draw common conclusions from the key results chosen and to discuss the implications of these results in practice.

5.1 Selection of the Most Relevant and Representative Analysis Results

In order to make the task of interpreting the analysis results from this study more manageable, consideration has been given to which of the large number of analysis results is most relevant to the aims of the study and representative of the true relationship between EuroNCAP test scores and injury outcomes in police crash reports. Of specific interest has been to examine the results by country, the different analysis methods used and the role of adjustment for vehicle mass in the comparisons.

5.1.1 Results by Country

As will be discussed later, there are some general consistencies in the measured associations between the police crash based ratings and EuroNCAP scores across the five data sets analysed. However, the level of consistency between results from the different data sets analysed is not as high as hoped, leading to potentially different conclusions from the study depending on which countries analysis results are the focus of interpretation. There are a number of reasons for the observed inconsistencies.

The data sources used and the final data sets analysed differ in a number of practically significant ways. One of the fundamental differences between data sets is in the injury outcome scales defined. In general, four levels of injury outcome are defined in or can be defined from the data from each county falling under the broad descriptors fatal injury, serious injury, minor or slight injury and not injured. Superficially, the definitions appear roughly consistent, however examination of the precise definitions within each country reveal some important differences. For example, in Australia and the Britain, a fatality is recorded for death within 30 days of a crash compared to France where fatalities only include deaths within 7 days of the crash. In Australia a serious injury is defined by hospitalisation whereas in Britain it also includes other non-hospitalised major injury whilst in France it includes only those hospitalised for more than 6 days. In both the German and Finnish police crash data, the exact definitions of each injury severity level were not well articulated so it is unclear how they relate to the other countries.

A further means of checking the comparability between injury outcome levels was to assess the proportion of injured drivers in each category as presented in Table 4. The French data records a much large proportion of drivers as either fatally or seriously injured than does the British or German data which are both relatively similar. The French data also reports higher levels of slight injuries and lower levels of non-injured compared to Britain or Germany whilst Germany reports a much higher proportion of uninjured drivers. Differences in these proportions reflect both the differences in injury severity level definitions as well as possible differences in crash reporting biases related to injury severity. For example, Germany may report more minor crashes than France. To a certain extent, they may also represent different driving environments between the countries.

Differences in injury severity scales and crash reporting biases between countries were the primary reasons for pursuing parallel rather than combined analysis of the police crash data from each country. The differences in definition of injury outcome between countries results in a difference in the interpretation of the meaning of the ratings measure. In France, the crashworthiness measure is the relative risk of death within 7 days of the crash or hospitalisation for more than 6 days given involvement in a reported crash. In contrast, the crashworthiness measure in Britain measures the risk of death within 30 days of the crash, hospitalisation or other serious outcomes given crash involvement.

Not being able to pool data across countries for analysis reduces the amount of total data available for any particular analysis and most likely limits the range of vehicle models with sufficient data for assessment. One positive, however, is that it allows relative comparison of the level of association between the different interpretations of the crashworthiness measures resulting from the data set differences and the EuroNCAP measures. Higher levels of association between EuroNCAP and a particular crashworthiness measure may give some insight into the aspect of real crash outcome reflected by EuroNCAP testing.

Sub-task 2.2 of SARAC I (Newstead et al, 2001), which laid the foundation for the work presented in this study, reported less accurate identification of vehicle makes and models in the French database compared to the British database. Subsequently, less weight was given to the results based on the French data. Discrimination in this way has not been necessary in this study because the French data supplied had much more accurate vehicle make and model information than previously. Identification of vehicle makes and model details was equally as accurate in each of the data sets considered.

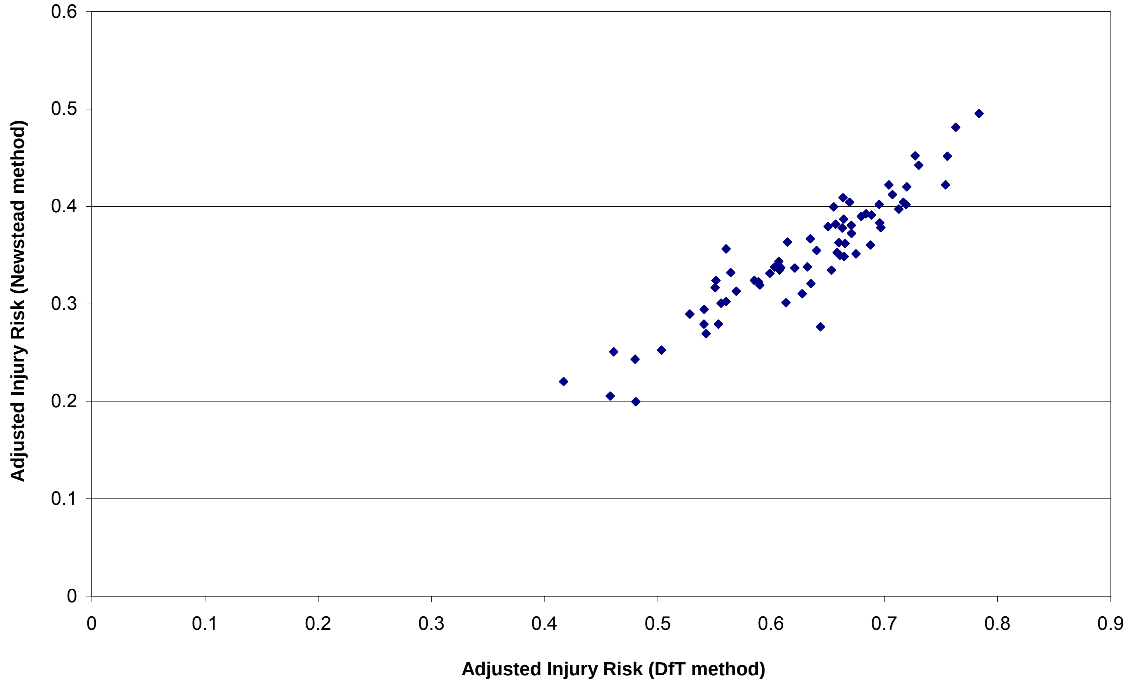
Given there is no clear preference for analysis results from any particular country based on injury severity definition or accuracy of vehicle model details, the next most relevant assessment factor was database size and the range of vehicle models with sufficient data for analysis. Analysis results based on the greatest data quantities and covering the greatest range of vehicle models are most likely to give the most representative measured relationships with EuroNCAP scores. On this basis, results from the three largest European databases, Britain, France and Germany, are preferred. Quantities of data from Finland and the range of vehicles covered were too small to make robust comparisons. Whilst the Australian and New Zealand data covered a reasonable large range of vehicle models, the amount of total data was still significantly less than the large European countries making comparisons based on this data of secondary interest.

5.1.2 Different Rating Methods for Police Data

As noted, analysis in this study has used two methods to calculate injury risk given crash involvement; the DfT and Newstead methods. The purpose in using the two methods was to assess how dependent the relationships measured between injury outcomes in police reported crashes and EuroNCAP scores are on the underlying real crash based measure used. As discussed in SARAC I, Sub-Task 1.6, the primary reason for development of the Newstead method was to overcome the underlying problem of the measure of injury risk developed by the DfT being confounded with the aggressivity of the vehicle. Since the EuroNCAP program is all about measuring relative vehicle crashworthiness and not aggressivity, it seemed that the Newstead real crash measure, which is a more pure measure of crashworthiness, might show potential for a higher level of association with EuroNCAP outcomes.

Empirical investigations in SARAC I, Sub-Task 1.6 showed that, in practice, many of the real crash injury risk measures in common use produced estimates of relative vehicle safety that were relatively consistent. The DfT and Newstead methods were two that showed a high degree of consistency in the estimates they produced. It was not clear from the SARAC I research whether the observed consistency would be observed in all applications of the methods, a further reason for considering both methods in this study. Table 38 below shows the level of correlation between injury risk ratings estimated from both the DfT and Newstead methodology using the British data covering all crash types. It confirms the empirical results observed in SARAC I with a high degree of consistency in ratings from the two methods.

Figure 38 DfT versus Newstead Injury Risk Ratings: British Crash Data, All Crash Types



Examination of the full results in this report also shows the consistency observed in Figure 38 leads to a high degree of similarity in the comparisons between ratings from each method and the EuroNCAP outcomes.

One observation of the ratings estimated by the Newstead method was that they generally had wider confidence limits than those estimated by the DfT methodology. In some cases the number of vehicle models rated was also less. This is a reflection of the smaller quantities of data available for analysis under the Newstead method due to the more limited selection of data analysed compared to the DfT methodology. Given the smaller coverage and relatively higher variation in the Newstead method ratings and their noted consistency with the ratings estimated using the DfT method, results of comparisons using the ratings estimated using the DfT method have been the focus in interpreting the analysis results.

Ratings based on the combined Australian and New Zealand crash data are estimated from both injury and non-injury crash data using the rating methodology proposed by the Monash University Accident Research Centre (MUARC, Newstead et al, 2004). As this data source was the only one including non-injury crashes and hence allowing the direct computation of injury risk given crash involvement, comparisons between the Australian and New Zealand ratings and EuroNCAP scores are a secondary focus in interpreting the analysis outcomes.

5.1.3 The Role of Vehicle Mass

The role of vehicle mass in influencing injury outcome in real crashes has been noted in a number of previous studies (for example, Langwieder and Bulmer, 1994; Viano, 1994). The relationship between vehicle mass and injury outcome in the crashworthiness measures used in this study have also been highlighted in Section 4.4.1 for both the injury risk and, to a lesser degree, injury severity measures as well as the resulting crashworthiness measure.

It is commonly accepted that the results of EuroNCAP style offset frontal impact tests into rigid barriers are independent of vehicle mass. The mass independence is a reflection of the essentially infinite mass ratio of the crash barrier compared to the mass of the vehicle being tested. The relationship between vehicle mass and the side impact EuroNCAP test outcome is less clear since the side impact barrier at 950kg is comparable in weight to the vehicles being tested. Given the finite weight of the mobile side impact barrier, momentum transfer laws suggest that heavier vehicles may have an advantage in the EuroNCAP side impact test through absorbing a lower proportion of the total crash energy.

These considerations suggest mass adjusted real crash ratings are the most appropriate to compare to EuroNCAP offset frontal test scores whilst ratings without mass correction are the most appropriate to compare to the EuroNCAP side impact test results. In comparisons made with overall EuroNCAP scores, mass adjusted ratings are the focus for interpretation reflecting the only partial dependency of the EuroNCAP score on vehicle mass through the side impact test component of the score.

5.1.4 Summary of Results for Interpretation

The above considerations point to the sub-set of results presented that will likely be most representative of the relationship between driver injury outcomes in police reported crashes and the results of EuroNCAP testing. They are:

- Results from those countries with the greatest quantities of police reported data and hence the greatest coverage of EuroNCAP tested cars with sufficient data for meaningful analysis will be most relevant for drawing conclusions from the study. This includes the analysis conducted on British, German and French data with the Australian and New Zealand data results being used as a secondary comparison.

- Results based on ratings calculated from police reported data using the DfT method of rating estimation.

- Comparison of the overall and offset frontal EuroNCAP scores and real crash measures with the effects of vehicle mass removed and side impact EuroNCAP scores and real crash measures including the effects of vehicle mass.

5.2 Summary of Key Analysis Outcomes: Consistencies, Discrepancies and Robustness

Focusing on the key results identified above, a number of general observations about the relationship between EuroNCAP test results and injury outcomes in police reported crashes can be drawn. Reflecting the structure and aims of the study, interpretation of the results of comparisons between the overall EuroNCAP test score and ratings based on police reported crashes of all types have been considered first. Following this is an interpretation of the results of comparing the EuroNCAP component test scores with real crash ratings based on similar crash configurations.

5.2.1 Overall EuroNCAP and Real Crash Ratings from All Crash Types

Table 19 of the Results section shows the relationship between mass adjusted average crashworthiness ratings estimated from the British police reported crash data by overall EuroNCAP star rating. Tables 24 and 29 show the analogous results based on the French and German crash data. Both the French and German results show consistent trends of improving crashworthiness with increasing EuroNCAP star rating across the 2, 3 and 4 star rated cars available for comparison. The statistical significance of the observed trends in these countries is slightly different as demonstrated by comparison of the overlap in 95% confidence intervals on the estimated average crashworthiness. In the French results, the average crashworthiness of 3 and 4 star rated cars are both statistically significantly lower than that of 2 star rated cars but are not statistically significantly different from each other. In the German data the average crashworthiness for the 4 star rated cars is significantly better than that for both the 2 and 3-star rated cars which are not significantly different from each other.

The British data results cover vehicles rated in each of the four star ratings categories although only one vehicle model in the analysis rated 1 star so this result should be treated with some caution. The British results show the average crashworthiness of the 2, 3 and 4 star rated vehicles is significantly better than the one star rated vehicle with four star vehicles having the best average crashworthiness. However, no significant difference or clear trend in the average crashworthiness of 2 and 3 star rated cars was seen in the British data.

Examination of the relationship between the average injury risk and injury severity components of the crashworthiness rating by overall EuroNCAP star rating reveals differences in the relationships observed for the two components. In analysis of each of the major European crash data sets there was essentially no association between average injury risk and overall EuroNCAP star rating. In contrast, the relationships observed between average injury severity and overall star rating were very similar to the relationships observed for the overall crashworthiness rating. This result points to the association observed between the crashworthiness ratings and overall star ratings being driven by the relationship between EuroNCAP score and average driver injury severity in Police reported crashes.

Results of analysis of the European data sources in total seem to generally support some common conclusions when examining average real crash outcome by EuroNCAP star rating. Results from each country point to improving average vehicle crashworthiness with increasing EuroNCAP star rating. Analysis of the component measures of the crashworthiness metric shows this result stems from an association between average injury severity and overall EuroNCAP star rating and not the injury risk component of the crashworthiness measure.

The measured difference in average crashworthiness and injury severity between adjacent overall EuroNCAP star rating categories is not consistent between countries. This may be partly a reflection of the noted differences in injury outcome classification between data for each country. Associations were strongest and most consistent in both the French and German data. The French data in particular uses a much higher severity definition for serious injury requiring drivers to be hospitalised for more than 6 days compared to the British data which includes a number of less severe injury outcomes. The stronger association between the French definition and EuroNCAP results suggests EuroNCAP may be reflecting the likelihood of these more serious injury outcomes.

The relationship between overall EuroNCAP test score and injury severity and crashworthiness on an individual vehicle bases are shown in Figures 3 and 4 for the British data, Figures 8 and 9 for the French data and Figures 13 and 14 for the German data. Results presented in these figures add a further dimension to the interpretation of the relationship between EuroNCAP scores and injury outcomes in police reported crashes. They show that whilst there is and association between average vehicle crashworthiness and EuroNCAP score outcome, there is significant variation in the measures of injury outcome in real crashes for specific vehicles within each EuroNCAP score category. This is demonstrated by the large amount of dispersion in the figures. In a number of cases the 95% confidence limits on estimates for vehicles within the same star rating category do not overlap showing the dispersion is not just a product of the accuracy of the estimates. It is a product of statistically significant differences between the measured real crash safety of vehicles within the same star rating. In other words, a vehicle with a low crashworthiness or injury severity estimate does not always perform well in EuroNCAP testing and vice versa. This observation is consistent across the results for all countries considered in the study.

Results of the vehicle by vehicle comparisons also help to explain the differences in the associations between average crashworthiness or injury severity and overall EuroNCAP score between countries. The range of specific makes and models of EuroNCAP tested vehicles with sufficient representation in the police reported crash data varied from country to country, reflecting the different purchasing preferences of consumers in different countries. Since there are significant differences in crashworthiness and injury severity between vehicles within the same EuroNCAP star ratings, the variation in the comparisons of average crashworthiness and injury severity between countries can be explained to a certain degree by the different makes and models of vehicles over which the averages were taken. Unfortunately, it was no possible to draw a subset of the same vehicle models from the ratings from each country and undertake meaningful analyses due to the limited number of vehicles common to ratings from each county. Doing so would have enabled explicit measurement of the effects of differences in injury outcome scaling between countries on the comparisons with EuroNCAP.

Trends in average crashworthiness and its component measures by EuroNCAP overall star rating derived from the Australian and New Zealand crash data were very different from those measured using the European data sources. No association between average crashworthiness, injury risk or injury severity and EuroNCAP overall star ratings was observed in the Australian and New Zealand data comparisons. This may have been a result of fewer vehicles being available for analysis, the range of vehicle models analysed being vastly different to those represented in the European data sources, differences in the injury outcome coding in the Australian and New Zealand data or a combination of all these factors. Exact reasons for the differences are difficult to isolate. Like the European data sources, crashworthiness ratings by make and model showed statistically significant differences within EuroNCAP star rating categories.

5.2.2 EuroNCAP results by Test Configuration and Real Crash Ratings by Crash Configuration

Due to a lack of impact point on the vehicle in the German data, no ratings for specific impact types could be calculated from this data. In both the Australasian and French data relatively few vehicle models had sufficient data for a side impact crashworthiness rating to be calculated with sufficient precision for further analysis. The range of frontal impact rated vehicle models in the Australian and New Zealand data was also very limited. Subsequently, focus on interpreting results of comparisons by specific crash configurations is on the frontal impact results for the French and British data and the side impact results for only the British data.

Comparison of average crashworthiness ratings based on frontal impact crashes within EuroNCAP offset frontal impact star rating categories showed no trends (Table 37a and appendix G). This was the case when examining either the average crashworthiness rating or its injury risk or injury severity components. The observed lack of association was not due to lack of statistical power in analysis of the crash data with the point estimates of average crashworthiness also showing no defined trend with EuroNCAP score for either the British or French data. There was also a wide range of EuroNCAP offset frontal scores among the vehicle models analysed. Overall, these results suggest there is little if any association between the results of the EuroNCAP offset frontal impact test and injury outcomes to drivers in frontal crashes reported to police as measured by crashworthiness estimated using the DfT and Newstead methods.

In contrast to the frontal impact test, a strong association between average crashworthiness in side impact crashes and the side impact EuroNCAP score was observed in the British data (Table 37b). Vehicles with a 4 star side impact rating had an average side impact crashworthiness rating statistically significantly better than that for 2 or 3 star rated vehicles with the 3 star rated vehicles being marginally statistically significantly better than the 2 star vehicles. Interpreting the point estimates of the analysis revealed an approximate 20% drop in average side impact serious injury risk measured from the police reported data with every increase in EuroNCAP side impact star rating category. Analysis of results in Appendix F shows the association with the side impact crashworthiness rating again stems largely from the association between average side impact injury severity and side impact EuroNCAP rating.

Like the comparisons based on all crash types discussed above, comparisons between side impact crashworthiness ratings and side impact EuroNCAP scores on a vehicle by vehicle basis in Figure 37b shows significant dispersion. In the case of the side impact crashworthiness ratings, however, it is possible that this dispersion is largely due to estimation variance in the ratings with a large degree of overlap observed between rating confidence limits. However, it also suggests that a high EuroNCAP score is not associated with good side impact crashworthiness and vice versa for all vehicle models.

5.3 Comparison with SARAC I Results and Other Studies

In many aspects, the results of this study hold many similarities to the results of the Pilot study of Newstead et al (2001) carried out under Phase I of the SARAC research program. They are also consistent with results of other similar studies comparing real crash outcomes and the results of crash barrier test programs conducted world-wide.

Like the SARAC I study, this study has found an association between the average crashworthiness of vehicles in all crash types and the overall EuroNCAP star rating category. Both studies also identified this association as stemming largely from the injury severity component of the crashworthiness rating. The SARAC I study also reported association between the side impact EuroNCAP ratings and crashworthiness for both all crash types and side impact crashes. Similarly, it found little relationship between EuroNCAP scores and the offset frontal test result. Results in this report support these findings more strongly, a result of greater quantities of police reported crash data on a wider range of vehicle models.

Another important similarity between this study and the SARAC I pilot study is the conclusions drawn from comparing the two ratings systems on a vehicle by vehicle basis. They both identify that, despite the associations measured from average crashworthiness across vehicles, on a vehicle by vehicle basis there is significant variation in crashworthiness between vehicles within the same EuroNCAP star rating category. This is the case when considering ratings from police reported crash data based on both all cash types and for specific impact types. They both conclude that a good EuroNCAP score is not necessarily associated with a good crashworthiness rating based on police reported data.

Similar conclusions have also been drawn from other studies conducted internationally. Lie and Tingvall (2000) confirm the general association between average crashworthiness and EuroNCAP score in a study on Swedish data. Similar studies on data from the USA (Newstead et al, 2003) and Australia (Newstead and Cameron, 1999) also concluded EuroNCAP results had a higher level of association with injury severity measured from Police reported crash data than with the injury risk measure. They also concluded that comparisons on a vehicle by vehicle basis showed a high degree of dispersion away from perfect correlation.

The study of Newstead et al (2001) carried out under Phase I of the SARAC research program was labelled a Pilot since its role was to establish the methodology for comparison and was based on a relatively small sample of EuroNCAP tested vehicles. In comparison, this study is based on much larger quantities of police reported crash data from a wider range of countries with results based on the analysis of up to 70 EuroNCAP vehicle models. As such this study provides a much more definitive assessment of the relationship between EuroNCAP test scores and injury outcomes recorded in police reported crash data.

5.4 Consequences of the Results

Having established the key features of the analysis results, it is next of interest to consider the broader implications of these results. Drawing conclusions from such analysis is always difficult because there are divergent opinions on whether ratings from crash barrier test programs or real world crash data analysis better reflect the most important underlying aspects of relative secondary vehicle safety. Beliefs held on which is the more appropriate rating system will dramatically alter the interpretation of the analysis results.

In arriving at a suitable interpretation, it is interesting to revisit the philosophy of the EuroNCAP program. According to those involved in EuroNCAP, the principal purpose of the program is to apply pressure to vehicle manufacturers to improve the safety design and specification of vehicles. By publishing the results for broad consumer scrutiny, the program achieves maximum leverage to achieve this end. Reflecting the aims of the program, the scoring system for EuroNCAP is not designed to necessarily represent an injury risk outcome scale. Instead, the various test measurements are weighted according to how highly it is desired to influence manufacturers on each aspect of vehicle design. For example, frontal and side impact test results are given equal weight in the overall score reflecting a desire to influence design performance in these two areas equally. In real world crash circumstances, however, front and side impact collisions do not contribute equally to average crash outcomes. Similar comments can be made about the other EuroNCAP score components.

Recognising the nature of the EuroNCAP scoring process, a linear relationship between injury outcomes in real world crashes and the EuroNCAP score would not necessarily be expected. However, given the aim of EuroNCAP is to improve vehicle safety generally, a general association between improving crashworthiness and higher EuroNCAP scores would be expected. Considering the analysis of real crash outcomes as the most suitable way of assessing the effectiveness of the EuroNCAP program in meeting its aims, results of this study confirm this general association with average real crash outcomes being better in vehicles with higher EuroNCAP scores than in ones with low scores. Results also confirm that this association is non-linear as expected.

Interpreted in this way, results of analysis in this study confirm that the design priorities for vehicle safety encouraged by the EuroNCAP scoring process are leading to improved real world crash performance on average. Importantly, comparison of the French and British analysis results, in particular suggest that improvement is greatest in the higher severity real world crashes. However, the results of comparison on a vehicle by vehicle basis also show that achieving these design priorities does not always lead to a safer vehicle. This result suggests that EuroNCAP is not necessarily encapsulating all the factors required to ensure good safety performance in a vehicle. Alternately, it is allowing vehicles to score well on a combination of factors that have relatively low effectiveness in improving real world safety. Whether the EuroNCAP test process can or should be modified to overcome this to some degree remains to be determined.

A lack of absolute consistency between EuroNCAP ratings and crashes based on real world data on a vehicle by vehicle basis is only problematic if ratings from the two systems are presented side by side for consumer information. This is, however rarely possible because of the nature of the ratings. Ratings based on real world data typically lag those published by EuroNCAP by many years as real world crash experience accumulates by which time the EuroNCAP test protocol has often been modified and is not directly comparable.

As noted, EuroNCAP is seen as a tool for driving safety change in vehicle design and providing information to consumers on relative safety at the time of vehicle release. In contrast, crash ratings based on real world data are seen as a tool to evaluate the long term safety of vehicles in the full range of real world circumstances. As shown by this study, real world ratings also provide a means to assess whether EuroNCAP testing is achieving its stated aims in improving vehicle safety and to help fine tune the program in future. Viewed as such, both ratings systems have a defined and non-conflicting role in advancing vehicle safety.

5.5 Future Research Directions

The work completed in this sub-task of the SARAC 2 project and detailed in this report has pointed to a number of areas of future research that should be considered. They are as follows.

- The EuroNCAP test program is constantly evolving to encourage manufacturers to meet more rigorous standards of vehicle safety performance and to include the latest safety technology. Introduction of the side impact pole test and points for seat belt reminder systems are examples of this evolution. The evolutionary changes to EuroNCAP need to be evaluated specifically to ensure they are effective in improving average vehicle safety in real world crashes. This could be achieved through periodic updates of the type of analysis presented in this report. Through the addition of more recent crash data, the updates will cover additional vehicle models as well as providing more precise estimates of real world crash performance for vehicle models studied in this and previous reports. Periodic evaluation of EuroNCAP in general using the approach taken in this study is recommended and considered vital to ensure this high profile program continues to meet its target of improving vehicle safety performance.

- One of the limitations of the research presented in this report was the inability to combine the data from each of the jurisdictions for combined analysis due primarily to inconsistencies in the injury severity level coding of crash involved people. Being able to combine all the data for analysis would have resulted in much more definitive and easily interpreted analysis outcomes. Having a standardised European crash data recording protocol would not only have improved the outcomes of this study but would also represent a powerful tool for use in future European vehicle safety research based on the analysis of police reported crash outcomes. It is recommended that research be undertaken to investigate establishing a standardised European crash data recording protocol. Part of the research should investigate the most suitable measure of severe injury outcome (for example hospital admission) that can be accurately and consistently coded by police. Such a measure would be important for studies such as this where relative injury severity was the key measure related to EuroNCAP score.

- More in-depth comparisons of the relationship between real world crash outcomes and EuroNCAP test scores would have been possible if a greater range of injury severity measures were available than just those recorded in the police data. A greater range of injury severity measures can be explored when more detailed injury outcome measures are collected. An example of a detailed injury outcome measure is the ICD (International Classification for Diseases) coding system typically used for coding hospital admission data and often found in insurance claims data. It is recommended that research be conducted in Europe on investigating the availability of other injury outcome data such as insurance claims data and hospital records and the potential for linking these records with police crash data reports on a wide scale. The resulting combined data would also be a powerful resource for a broad range of detailed vehicle safety research in Europe.

5.6 Assumptions and Limitations

The research results presented in this report are subject to a number of assumptions and limitations. The key assumptions and limitations are listed here.

5.6.1 Assumptions

- Details of the real world crashes analysed were accurately recorded by police particularly with respect to driver injury outcome, age and gender and other crash related non-vehicle variables used in the analysis.

- Information on make and model of vehicle was accurately recorded in the source from which it was obtained (either the police crash reports or the vehicle register).

- There were no other non-vehicle factors apart from those included in the analysis that differed between vehicle make and model dramatically affected injury outcome.

- Factors such as driver age and gender, speed limit, level of urbanisation and number of vehicles involved that were included in the analysis were adequate proxies for crash impact severity that was not available in the real world data.

- There was no systematic bias in crash data reporting or accuracy of recording by vehicle model.

- The forms of the statistical models used to estimate driver injury risk and severity were the most appropriate.

5.6.2 Limitations

- Only one 1-star EuroNCAP tested vehicle had sufficient real world crash experience to be included in the analysis of data from Great Britain. No other jurisdictions had sufficient real world data on 1-star EuroNCAP tested vehicles.

- Due to limited data on real world crashes involving these tests, the EuroNCAP pole test and seat belt reminder score were not explicitly considered in the analysis. No 5-star performing EuroNCAP tested vehicles were available in the analysis.

- Selection of vehicle models for analysis was determined by the popularity of the vehicle and the length of time it has been on sale which is reflected in the amount of cumulative crash data. Furthermore, EuroNCAP only tests a certain number of vehicle makes and models although the most popular vehicles are typically chosen for testing. It is difficult to quantify how this selection bias affects the results obtained.

6 Conclusions

This study has been able to quantify the relationship between injury outcomes in real world crashes reported to police and estimates of relative vehicle safety derived from the EuroNCAP vehicle crash barrier test program. The measure of real world injury outcome used has been the risk of death or serious injury given crash involvement calculated as a product of the risk of injury given crash involvement and the risk of death or serious injury given an injury was sustained. The crashworthiness measure, as well as its component risk measures based on all crash configurations, has been compared with the overall EuroNCAP score. Real world crash outcomes for frontal and driver side impacts have also been compared with the EuroNCAP offset and side impact test component scores. Police reported crash data from Great Britain, France, Germany, Finland, Australia and New Zealand was analysed. Due to the much larger quantities of real world data available for analysis, up to 70 EuroNCAP tested vehicle models have been considered in the comparisons meaning results from this study are more definitive than those obtained in the preceding SARAC 1 pilot study.

Results of analysis of the European data sources support some common conclusions when examining average real crash outcome by EuroNCAP star rating. Results from each country point to improving average vehicle crashworthiness with increasing EuroNCAP star rating. Analysis of the component measures of the crashworthiness metric shows this result stems from an association between average injury severity and overall EuroNCAP star rating and not the injury risk component of the crashworthiness measure. Measured associations between EuroNCAP score and real world injury severity were strongest and most consistent in both the French and German data. The French data in particular uses a much higher severity definition for serious injury compared to the British data requiring drivers to be hospitalised for more than 6 days. The strong association between the French definition and EuroNCAP results suggests EuroNCAP may be reflecting the likelihood of these more serious injury outcomes.

No association between average crashworthiness, injury risk or injury severity and EuroNCAP overall star ratings was observed in the Australian and New Zealand data comparisons. This may have been a result of fewer vehicles being available for analysis, the range of vehicle models analysed being vastly different to those represented in the European data sources, differences in the injury outcome coding in the Australasian data or a combination of all these factors

Examination of the relationship between overall EuroNCAP test score and injury outcome on an individual vehicle basis adds a further dimension to the interpretation of the relationship. They show that whilst there is and association between average vehicle crashworthiness and EuroNCAP score outcome, there is significant variation in the measures of injury outcome in real crashes for specific vehicles within each EuroNCAP score category. It shows that a vehicle with good average real world crash outcomes does not always perform well in EuroNCAP testing and vice versa. This observation is consistent across the results for all countries considered in the study.

Comparison of average crashworthiness ratings based on frontal impact crashes within EuroNCAP offset frontal impact star rating categories showed no trends. The results suggest there is little if any association between the results of the EuroNCAP offset frontal impact test and real world injury outcomes to drivers in frontal crashes. In contrast, a strong association between average crashworthiness in side impact crashes and the side impact EuroNCAP score was observed. Interpreting the point estimates of the analysis revealed an approximate 20% drop in average side impact serious injury risk measured from the police reported data with every increase in EuroNCAP side impact star rating category. Like the comparisons based on all crash types, comparisons between side impact crashworthiness ratings and side impact EuroNCAP scores on a vehicle by vehicle basis showed ratings were not always consistent on a vehicle by vehicle basis. The results of this study are consistent with the results of the Pilot study carried out under Phase I of the SARAC research program and other similar studies comparing real crash outcomes and the results of crash barrier test programs conducted world-wide.

EuroNCAP's principal aim is to apply pressure to vehicle manufacturers to improve the safety design and specification of vehicles. Leverage to achieve this end is gained by publishing the results for broad consumer scrutiny. Reflecting the aims of the program, the scoring system for EuroNCAP is not designed to necessarily represent an injury risk outcome scale. Results of this study confirm this general association with average real crash outcomes being better in vehicles with higher EuroNCAP scores than in ones with low scores. Results also confirm that this association is non-linear as expected. As such the study confirms that the design priorities for vehicle safety encouraged by the EuroNCAP scoring process are leading to improved real world crash performance on average. However, the results of comparison on a vehicle by vehicle basis also show that achieving these design priorities does not always lead to a safer vehicle.

Finally, this study shows that comparison with real world ratings provide a means to assess whether EuroNCAP testing is achieving its stated aims in improving vehicle safety and to help fine tune the program in the future. Noting their respective strengths, both EuroNCAP and real world ratings systems have defined and non-conflicting roles in advancing vehicle safety.

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APPENDIX A

SELECTION PROTOCOL FOR IDENTIFYING VEHICLES IN THE BRITISH AND FRENCH REAL CRASH DATA FOR COMPARISON WITH BARRIER TESTED VEHICLES

and

PROTOCOL FOR IDENTIFYING VEHICLES IN THE COMBINED AUSTRALIAN AND NEW ZEALAND REAL CRASH DATA FOR COMPARISON WITH BARRIER TESTED VEHICLES

Index	Make	Model	Body	Test Car Model Year	Test Car Build Date	Model Life	Kerb Weight	Test Phase	Driver Airbag	Passenger Airbag	Side Airbags	ABS	Comments	Variants and Build dates Selected for British Analysis	Notes
1	Fiat	Punto 55S	3 Door Hatch	1996	Nov, Dec 1995	Mar 1994 - May 1997	866	1	Y opt	N opt	N	N	55 discontinued May 97, ELX standard airbag May 1997, SX standard airbag from June 1995	All Punto 55 variants: Mar 94 - May 97	Vehicles with optional driver airbag cannot be identified
2	Ford	Fiesta 1.25 LX 16V	3 Door Hatch	1996	Jan-96	Oct 1995 - Oct 1999	929	1	Y std	N opt	N	N opt	Passenger airbag optional all variants. ABS option on most	All model variants: Oct 1995 - Oct 1999	Vehicles with optional passenger airbag cannot be identified
3	Nissan	Micra 1.0L	3 Door Hatch	1996	Jul, Sept 1995	Jan 1993 - Feb 1998	842	1	Y std	N	N	N opt	Model introduced Jan 1993, airbag introduced Aug 1995 standard all models	All model variants: Aug 1995 - Feb 1998	
4	Renault	Clio 1.2RL	3 Door Hatch	1996	Mar-96	Mar 1991 - April 1998	est 880	1	Y opt	N opt	N	N	Airbag optional all models from June 94, standard on 1.4RT from Sept 1994, Significant structural modifications July 1996	RT models only: July 1996 - Apr 1998	Vehicles with optional passenger airbag cannot be identified
5	Rover	100	3 Door Hatch	1996	Oct-95	Jan 1995 - Oct 1998	815	1	Y opt	N	N	N	Airbag optional on all model variants and fitted to test car	All model variants: Jan 1995 - Oct 1998	Vehicles with optional driver airbag cannot be identified
6	Vauxhall	Corsa 1.2LS	3 Door Hatch	1996	Nov-95	Apr 1993 - Sept 2000	874	1	Y opt	N opt	N (opt UK 1999 on)	N opt	Driver airbag optional from Nov 1993, passenger airbag optional from Aug 1994, st pass airbag CDX Dec 94, driver airbag standard 1.0GLS Jan 98, 1.2GLS Aug 94, 1.4&1.6GLS&SRi Aug 94, 1.4CDX Dec 94, 1.4Sport&GSi Sept 95,	1.2 & 1.4 GLS, SRi, 1.6: Aug 1994 - Sept 2000, Sport & GSi: Sept 1995 - Sept 2000	Vehicles with optional passenger and side airbags cannot be identified
7	Volkswagen	Polo 1.4L	3 Door Hatch	1996	Sep-95	Oct 1994 - Dec 1999	890	1	Y std	N opt	N	N opt	Driver airbag standard on all except 1.0L, Passenger Airbag standard GLX, optional rest, ABS option all but GL	All model variants excluding 1.0L and GLX: Oct 1994 - Dec 1999	Vehicles with optional passenger airbag cannot be identified
8	Audi	A4 1.8	4 Door Sedan	1997	Jan-97	Mar 1995 - Nov 2000	1244	2	Y std	N (opt UK, std Euro)	N opt	Y std	Side airbags optional Oct 1996, passenger airbag and side airbags standard Sept 1997	All model variants: Mar 1995 - Oct 1996	Vehicles with optional passenger airbag cannot be identified
9	BMW	316i	4 Door Sedan	1997	Feb-97	Apr 1991 - Aug 1998	1225	2	Y std	N opt	N opt	Y std	Standard driver airbag from Sept 1993, standard passenger airbag on 318i and above Sept 1993	316i only: Sept 1993 - Aug 1998	Vehicles with optional passenger airbag cannot be identified

10	Citroen	Xantia 1.8i Dimension	5 Door Hatch	1997	Apr-96	July 1993 - Oct 2000	1259	2	Y (std UK, opt Euro)	N opt	N opt	N	ABS standard on VSX, option on all others, driver airbag std all July 94, Dual airbags standard Jan 98, side airbags optional Oct 1998	All model variants: July 1994 - Dec 1997	Vehicles with optional passenger airbag cannot be identified. Euro vehicles with optional driver airbag cannot be identified
11	Ford	Mondeo 1.8LX	5 Door Hatch	1997	Jan-97	Oct 1996 - Sept 2000	1200	2	Y std	N opt	N opt	Y std	ABS opt 1.6 and 1.8 Zetec, driver airbag std all, passenger airbag opt all, side airbags optional GLX, Ghia, std ST-200	All model variants excluding ST-200: Oct 1996 - Sept 2000	Vehicles with optional passenger and side airbags cannot be identified
12	Mercedes	C180 Classic	4 Door Sedan	1997	Jan-97	Oct 1993 - Aug 2000	1299	2	Y std	Y std	Y std	Y std	Driver airbag and ABS std all, Passenger airbag std Aug 95, side airbags std Jun 97	All model variants: Jun 1997 - Aug 2000	
13	Nissan	Primera 1.6GX	5 Door Hatch	1996	Dec 96, Jan 97	Oct 1996 - Aug 1999	1219	2	Y std	N opt	N opt	N opt	ABS std in UK, driver airbag std all	All model variants: Oct 1996 - Aug 1999	Vehicles with optional passenger & side airbags cannot be identified
14	Peugeot	406 1.8LX	4 Door Sedan	1997	Sep-96	Jan 1996 - Feb 1999	1362	2	Y std	Y (std UK, opt Euro)	N	Y std	All features std all models	All model variants excluding coupe: Jan 1996 - Feb 1999	
15	Renault	Laguna 2.0RT	5 Door Hatch	1997	Mar-97	Apr 1994 - Apr 1998	1313	2	Y std	N opt	N	Y opt	ABS std RXE opt rest, driver airbag std RT&RXE Jul 96, passenger airbag std Executive Jul 96, Baccara Jan 96	All model variants excl Executive and Baccara: Jun 1996 - Apr 1998	Vehicles with optional passenger airbag cannot be identified
16	Rover	620 Si	4 Door Sedan	1997	Jul, Aug 1996	Aug 1993 - Jan 1999	1280	2	Y std	N opt	N	Y opt	Driver airbag std all Apr 94, passenger airbag std GSi Ti Apr 94,	All model variants excluding GSi and Ti: April 1994 - Jan 1999	Vehicles with optional passenger airbag cannot be identified
17	Saab	900 2.0i	5 Door Hatch	1997	Nov 96, Feb 97	Oct 1993 - June 1998	1315	2	Y std	Y std	N	Y std	Passenger airbag std on S, XS and Turbo Sept 95, driver airbag all	S, XS and Turbo models: Sept 1995 - Feb 1998	
18	Vauxhall	Vectra 1.8iLS	5 Door Hatch	1997	Aug-96	Oct 1995 - Feb 1999	1300	2	Y std	N opt	N opt	Y std	ABS, driver airbag std all, passenger airbag std CDX, side airbags opt all from MAr 1999	All model variants excluding CDX: Oct 1995 - Feb 1999	Vehicles with optional passenger and side airbags cannot be identified
19	Volkswagen	Passat 1.6L (LHD)	4 Door Sedan	1997	Mar-97	Apr 1997 - Dec 2000	1269	2	Y std	Y std	N opt	Y std	All models ABS dual airbags, side airbags from May 1998	All model variants: Apr 1997 - Apr 1998	
20	Audi	A3 1.6	3 Door Hatch	1997	Oct-97	Sept 1996 - Current	1095	3	Y std	Y std	Y std	Y std	All have ABS, dual airbags, side airbags from Aug 97	All model variants: Aug 1997 onwards	
21	Citroen	Xsara 1.4i	5 Door	1998	Oct 97,	Nov 1997 -	1080	3	Ystd	Y std	Y std	N	All have driver airbag,	All model variants:	

		(LHD)	Hatch		Mar 98	Current							passenger and side airbag all from Oct 98, ABS from Apr 1999	Oct 1998 onwards	
22	Daewoo	Lanos 1.4SE (LHD)	5 Door Hatch	1998	Jul-97	Sept 1997 - Current	1070	3	Y std	N (std UK, opt Euro)	N	N opt	All have driver airbag. Passenger airbag std UK opt Euro. ABS std on SE	All model variants: Sept 1995 onwards	All UK models have passenger airbag, test vehicle did not.
23	Fiat	Brava 1.4S	5 Door Hatch	1998	Feb, Apr 1997	Dec 1995 - Dec 2002	1077	3	Y std	N	N	N opt	All have driver airbag, no passenger airbag, ABS std on 1.8&TD ELX	All model variants: Dec 1995 - Dec 2002	
24	Honda	Civic 1.4i	5 Door Hatch	1998	Sep-97	Apr 1995 - Nov 2000	1115	3	Y std	Y std	N	N	Dual airbags all, ABS on 1.8 & 2.0 only	All model variants: Apr 1995 - Nov 2000	
25	Hyundai	Accent 1.3GLS (LHD)	5 Door Hatch	1998	Jun, Nov 1997	Oct 1994 - Dec 1999	983	3	Y opt	N	N	N	Driver airbag std on 1.3GLS from June 98. Drivers airbag std 1.5, std 1.3SE from Sept 96	1.5: Oct 1994 onwards, 1.3SE: Sept 1996 - Dec 1999	
26	Mitsubishi	Lancer GLX (LHD)	5 Door Sedan	1997	Jan-97	Not for sale in UK	1244	3	Y std	?	?	?		Not sold in UK	
27	Peugeot	306 1.6GLX	5 Door Hatch	1997	May, Jul 1997	Apr 1997 - Mar 2001	1110	3	Y (std UK, Opt Euro)	N	N	N	Driver airbag std all, passenger airbag std GTi6, ABS std XSi & GTi6	All model variants excluding GTi6: Apr 1997 - Mar 2001	Euro vehicle models with optional driver airbag cannot be identified
28	Renault	Megane 1.6RT (LHD)	5 Door Hatch	1998	Jan-98	Apr 1996 - March 1999	1060	3	Y std	N	N	N	Driver airbag std all, passenger airbag std RXE 2.0 16V, 2.0 and 1.9TD, ABS std all May 98	All model variants excluding RXE, scenic and cabriolet: Apr 1996 - Mar 1999	
29	Suzuki	Baleno 1.6GLX (LHD)	4 Door Sedan	1998	Oct, Nov 1997	May 1995 - Dec 2001	960	3	N (std UK, opt Euro)	N (std UK, opt Euro)	N	N	Dual airbags all models UK only	All model variants: May 1995 - Dec 2001	All UK models have driver and passenger airbags, test model did not
30	Toyota	Corolla 1.3 Sportif (LHD)	5 Door Hatch	1998	Nov-97	June 1997 - Dec 2001	1060	3	Y std	N (std UK, opt Euro)	N	N	Dual airbags std all models UK, ABS CD & G6 only	All model variants: Jun 1997 - Dec 2001	All UK models have passenger airbag, test vehicle did not.
31	Volkswagen	Golf 1.4 (LHD)	5 Door Hatch	1998	Jan, Mar 1998	Nov 1997 - Current	1140	3	Y std	Y std	N (std from 21/5/1998)	Y std	All models have dual airbags and ABS	All model variants excludiong cabriolet: Nov 1997 - May 1998	
32	Audi	A6 2.4 (LHD)	4 Door Sedan	1998	Jun-98	May 1997 - Current	1400	4	Y std	Y std	Y std	Y std	Dual front and side airbags and ABS std on all	All model variants: May 1997 onwards	
33	BMW	520i (LHD)	4 Door Sedan	1998	May-98	Apr 1996 - Current	1485	4	Y std	Y std	Y std	Y std	Dual front airbags std Apr 97, side airbags std all Sept 97, ABS std on all Apr 97,	All model variants: Sept 1997 onwards	

34	Mercedes	E200 Classic (LHD)	4 Door Sedan	1998	May, Jul 1998	Oct 1995 - July 1999	1440	4	Y std	Y std	Y std	Y std	Dual front airbags and ABS std on all, side airbags std Sept 97	All model variants: Sept 1997 - July 1999	
35	Toyota	Camry 2.2 (LHD)	4 Door Sedan	1998	Nov-97	Nov 1996 - Dec 2001	1385	4	Y std	Y std	Y std	Y std	Dual front airbags and ABS std on all, side airbags std Nov 97	All model variants: Nov 1997 - Dec 2001	
36	Saab	9-5 2.0 (LHD)	4 Door Sedan	1998	Feb, Mar 1998	Jun 1997 - Aug 2001	1485	4	Y std	Y std	Y std	Y std	Dual front and side airbags and ABS std on all	All model variants excluding cabriolet: Jun 1997 - Aug 2001	
37	Vauxhall	Omega 2.0GI/GLS (LHD)	4 Door Sedan	1998	Sep 97, Jan 98	Apr 1994 - Sept 1999	1455	4	Y std	N opt	N opt	Y std	Driver airbag & ABS std on all, Passenger and side airbags standard CD and CDX option on rest Sept 97	All model variants: Apr 1994 - Sept 1997	Vehicles with optional passenger airbag cannot be identified
38	Volvo	S70 2.0/2.5 10V (LHD)	4 Door Sedan	1998	Jul-98	Dec 1996 - Dec 1999	1430	4	Y std	N opt	Y std	Y std	Driver and side airbags and ABS std on all, passenger airbag optional on all	All model variants: Dec 1996 - Dec 1999	Vehicles with optional passenger airbag cannot be identified
39	Ford	Focus 1.6 (LHD)	5 Door Hatch	1999		Oct 1998 - Current	1080	5	Y std	Y std	N	N opt	Dual airbags std all, ABS 2.0 only, side airbags optional on all but ST-170	All model variants but ST-170: Oct 1998 onwards	Vehicles with optional side airbags cannot be identified
40	Mercedes	A140 Classic (LHD)	5 Door Hatch	1999	Jun-98	Sept 1998 - Current	1070	5	Y std	Y std	N (std UK, opt Euro)	Y std	Dual front airbags and ABS and ESP std on all. Front and rear (outbord) seat belt pretensioners and belt load limiters. Side airbags std except Belgium, Portugal, Ireland	All model variants: Sept 1998 onwards	UK vehicles have side airbags but test vehicle did not
41	Vauxhall	Astra 1.6i Envoy	5 Door Hatch	1999		Feb 1998 - Current	1100	5	Y std	Y std	N opt	N opt	Dual front airbags std all, ABS 1.8 only option others, side airbags CDX only option others	All model variants excluding CDX: Feb 1998 onwards	Vehicles with optional side airbags cannot be identified
42	Ford	Escort 1.6 LX	5 Door Hatch	1989		Jan 1991 - July 2000	1080	5	Y std	N opt	N	N opt	Driver airbag std all Jan 95, ABS 1.8 & 2.0 std Jan 95 option rest, dual airbag option XR3i	All model variants excluding XR3i: Jan 1995 - Jul 2000	
43	Nissan	Almera 1.4GX	5 Door Hatch	1999		Oct 1995 - Dec 2000	1140	5	Y std	N	N	N	Driver airbag std May 97	All model variants: May 1997 - Dec 2000	
44	Renault	Espace 2.0RTE (LHD)	7 Seat Van	1998 & 1999		Apr 1997 - Current	1520	6	Y std	Y std	N (std 2001 on)	Y std	Dual airbags and ABS std all models, Side airbags std form 2001 on	All model variants: Apr 1997 - Dec 2000	
45	Toyota	Picnic 2.0GS	7 Seat Van	1999	Aug-98	Jan 1997 - Current	1450	6	Y std	Y std	N	N opt	Dual airbags all models, ABS std GL, GX, GLS, opt GS	All model variants: Jan 1997 onwards	
46	Peugeot	806 2.0 (LHD)	7 Seat Van	1999	May-99	Oct 1995 -	1550	6	Y std	Y std	N	N	Dual airbags all models, ABS	All model variants:	806 uses same

						Oct 1998						opt	optional all	Oct 1995 - Oct 1998	platform as Citroen Synergie/Evasion, Fiat Ulysse and Lancia Zeta
47	Nissan	Serena 1.6 (LHD)	7 Seat Van	1999	Mar-99	Jan 1993 - Sept 2000	1500	6	Y std	N	N	Y std	Driver airbag std from Jul 96	All model variants: Jul 1996 - Sept 2000	
48	Volkswagen	Sharan TDI (LHD)	7 Seat Van	1999	Mar-99	Sept 1995 - Apr 2000	1690	6	Y std	Y std	N	N opt	Driver airbag std on all, passenger airbag std on all but CL, ABS std on Carat option on all others	All model variants except CL: Sept 1995 - Apr 2000	Sharan uses same platform as Ford Galaxy and Seat Alhambra
49	Mitsubishi	Space Wagon 2.4 GDI GLX (LHD)	7 Seat Van	1999		Oct 1998 - Current	1570	6	Y std	Y std	N opt	Y opt	Driver and passenger airbag std on all, side airbags on GLS only, ABS std on all but GL & Classic	GLS model only: Oct 1998 onwards	
50	Vauxhall	Sintra 2.2 GLS	7 Seat Van	1998		Mar 1997 - Dec 1999	1650	6	Y std	Y std	Y std	Y std	Dual frontal and side airbags and ABS std on all	All model variants: Mar 1997 - Dec 1999	
51	Chrysler	Voyager 2.5TD (LHD)	7 Seat Van	1999		Mar 1997 - Dec 2000	1800	6	Y std	Y std	N	Y std	Dual airbags and ABS std on all	All model variants: Mar 1997 - Dec 2000	
52	Fiat	Punto S60 1.2 (LHD)	3 Door Hatch	1999		Sept 1999 - Current	919	7	Y std	N opt	N opt	N opt	Driver airbag std all, passenger and side airbag option all, ABS std 1.8 16v HGT only. ABS & Pass Airbag std from July 2000	All Punto 60 variants: Sept 1999 - June 2000	Vehicles with optional passenger and side airbags cannot be identified.
53	Volkswagen	Lupo 1.0 (LHD)	3 Door Hatch	1999		Oct 1998 - Current	910	7	Y std	Y std	N opt	N opt	Diver and passenger airbag std on all, side airbags optional on all, ABS std 1.4 Sport, GTi only opt rest	All model variants: Oct 1998 onwards	Vehicles with optional side airbags cannot be identified
54	MCC	Smart (LHD)	2 Door Sedan	1999		July 2000 - Current	740	7	Y std	Y std	N opt	Y std (UK)	Driver and passenger airbags & ABS std all models in UK, side airbags optional	All model variants July 2000 onwards	Vehicles with optional side airbags cannot be identified
55	Hyundai	Atoz GLS (LHD)	5 Door Hatch	1999		May 1998 - Current	865	7	Y std	N	N	N	Driver airbag std in + model, option on base until Sept 1999 when std, passenger airbag & ABS not available	+ Model: May 1998 onwards, Base Sept 1999 Onwards	
56	Vauxhall	Corsa 1.0 12v Club	3 Door Hatch	1999		Apr 1993 - Sept 2000	895	7	Y std	N opt	N	N opt	Driver airbag standard on all 1999 model year onwards. Passenger airbag optional all but CDX where std	All model variants but CDX Sept 1998 onwards	Vehicles with optional passenger airbag cannot be identified
57	Honda	Logo (LHD)	3 Door Hatch	1999		Mar 2000 - Mar 2001	913	7	Y std	N opt (std UK)	N	Y std	Driver airbag and ABS std all, passenger airbag std UK	All model variants: Mar 2000 onwards	Passenger result not relevant for UK
58	Lancia	Ypsilon	3 Door	1999		Not sold in	895	7	Y std	?	?	?		Not sold in UK	

		Elefantino (LHD)	Hatch			UK									
59	Honda	Accord 1.8iLS	4 Door Sedan	1999		Aug 1998 - May 1999	1381	7	Y std	Y std	Y std	Y std	Dual and side airbags and ABS std on all	All model variants: Aug 1998 - May 1999	
60	Volkswagen	Beetle 2.0 (LHD)	2 Door Sedan	1999		Jan 2000 - Current	1228	7+	Y std	Y std	Y std	Y std	Dual and side airbags and ABS std on all	All model variants: Jan 2000 onwards	
61	Saab	9-3 2.0 (LHD)	5 Door Hatch	1999		Mar 1998 - Current	1400	7+	Y std	Y std	Y std	Y std	Dual and side airbags and ABS std on all	All model variants excluding cabriolet: Mar 1998 onwards	
62	Volvo	S80 2.4 (LHD)	4 Door Sedan	2000		May 1998 - Current	1485	7+	Y std	N opt	Y std	Y std	Driver and side airbags and ABS std on all, passenger airbag optional all, side airbags optional from 2001	All model variants: May 1998 - Dec 2000	Vehicles with optional passenger airbag cannot be identified
63	Ford	Ka 1.3 (LHD)	3 Door Hatch	2000		Sept 1996 - Current	895		Y std	N opt	N	N opt	Driver airbag std on all, passenger airbag optional all, side airbags not listed as option in the UK, ABS opt all	All model variants: Sept 1996 onwards	Vehicles with optional passenger airbag cannot be identified
64	Volvo	S40 1.8	4 Door Sedan	1997	Nov-96	May 1996 - Current	1231	2	Y std	N opt	Y std	Y std	Passenger airbag optional on all until Sept 2000 when std	All model variants: May 1996 - Aug 2000	Vehicles with optional passenger airbag cannot be identified
65	Toyota	Avensis 1.6S	4 Door Sedan	1998	Oct, Dec 98	Nov 1997 - Current	1225	2	Y std	Y std	Y std	Y std	Driver, passenger and side airbag, ABS std on all	All model variants: Nov 1997 onwards	
66	Citroen	Saxo 1.1 SX (LHD)	3 Door Hatch	2000		May 1996 - Current	830		Y std	N opt	N opt	N	Drivers airbag, front safety belt pretensioners and load limiters and ISOFIX anchorages (passenger and rear outboard seats). Optional equipment: passenger airbag & side airbags (head & thorax). Passenger airbag std 1.6 VTS	All model variants but 1.6 VTS: May 1996 onwards	Vehicles with optional passenger airbag cannot be identified
67	Daewoo	Matiz SE+ RHD	5 Door Hatch	1999, 2000		Aug 1998 - Current	828		Y std	Y std	N	N opt	Driver and passenger airbags, front belt pretensioners and power assisted steering as standard. Revised rear safety belt buckles are to be fitted from June 2000 production from VIN YC535352.	All model variants: Aug 1998 onwards	
68	Daihatsu	Sirion M100LS (LHD)	3 Door Hatch	2000		Jun 1998 - Current	859		Y std	Y std	N opt	N opt	Dual frontal airbags, front safety belt pretensioners & load limiters and power assisted steering. Optional	All model variants but not + model: Jun 1998 onwards	

													equipment includes side impact airbags & ABS. + model has std side airbags and ABS		
69	Fiat	Seicento	4 Door Hatch	2000		Jun 1998 - Current	754		Y std	N opt	N opt	N opt	2000 model year car features front safety belt pretensioners. Optional equipment includes a driver and passenger airbag, power assisted steering and ABS. Passenger airbag not optional in UK, driver airbag optional on all but citymatic	Citymatic: Jun 1998 onwards.	
70	Ford	Fiesta 1.25 Zetec	3 Door Hatch	2000		Oct 1999 - Sept 2002	905		Y std	N opt	N opt	N opt	2000 model year car features, driver airbag, front safety belt pretensioners and webbing grabbers. Optional equipment on all model variants includes a passenger airbag, side airbags & ABS.	All model variants: Oct 1999 - Sept 2002	Vehicles with optional passenger airbag cannot be identified
71	Nissan	Micra L 1.0 (RHD)	3 Door Hatch	2000		Mar 1998 - Current	836		Y std	N opt	N opt	N opt	Drivers airbag, revised safety belt pretensioners, reinforcements to the structure to improve frontal and side impact performance and ISOFIX fixings to RH rear seat. Optional equipment includes a passenger airbag, side impact airbags & ABS.	July 2000: fitted pass airbag to SE model	Vehicles with optional passenger airbag cannot be identified
72	Peugeot	206 1.3 XR Presence (LHD)	3 Door Hatch	2000		Oct 1998 - Current	943		Y std	Y std	N opt	N opt	The 2000 model year car features dual frontal airbags, front safety belt pretensioners and load limiters & ISOFIX anchorages on the front passenger seat. Optional equipment: side airbags (head & thorax, std in Xsi & GTi) and ABS. Passenger airbag was optional before Sept 1999 in UK	All model variants ut Xsi & GTi: Sept 1999 onwards	Vehicles with optional passenger airbag cannot be identified
73	Renault	Clio 1.2 RTE (LHD)	3 Door Hatch	2000		May 1998 - May 2001	925		Y std	Y std	N opt	N opt	The 2000 model year car features dual frontal airbags, front safety belt pretensioners and load limiters, rear outer belt load limited. Optional	All model variants: Sept 1999 - May 2001	

													equipment includes side airbags & ABS. Passenger airbag was optional in UK before Sept 1999		
74	Rover	25 1.4i (RHD)	3 Door Hatch	2000/2001		Nov 1999 - Current	999		Y std	Y std	N	N opt	Standard equipment on 2001 models includes a driver and passenger airbags and belt load limiters. ABS is optional. Passenger airbag optional in UK on all but 1.6i XL	All model variants: Nov 1999 onwards	Vehicles with optional passenger airbag cannot be identified
75	Seat	Ibiza 1.4 Stella (LHD)	3 Door Hatch	2000		Oct 1999 - Current	977		Y std	N opt	N opt	N opt	The 2000 model year car features front safety belt pre-tensioners as standard across the EU. A driver's airbag is now standard equipment on the Ibiza from 4 September 2000. Optional equipment on Sport and Cupra variants includes side impact airbags and ABS.	All model variants but Sport and Cupra: Oct 1999 onwards	
76	Skoda	Fabia 1.4 Classic (LHD)	5 Door Hatch	2000		Mar 2000 - Current	1077		Y std	N opt	N opt	N opt	The 2000 model year car features a drivers airbag and front safety belt pretensioners; drivers safety belt was load limited & power assisted steering. Optional equipment includes a passenger airbag with load limited safety belt, side impact airbags & ABS. Passenger airbag is std in UK	All model variants: Mar 2000 onwards	Passenger data will not be valid
77	Toyota	Yaris 1.0 Terra (LHD)	3 Door Hatch	2000		Mar 1999 - Current	899		Y std	Ystd	N opt	N opt	The 2000 model year car features dual frontal airbags, front safety belt pretensioners & load limiters. Optional equipment includes side impact airbags & ABS. Passenger airbag is not available on S variant in UK	All model variants but S: Mar 1999 onwards	Vehicles with optional side airbag cannot be identified
78	Volkswagen	Polo 1.4 (LHD)	3 Door Hatch	2000		Jan 2000 - Jan 2002	940		Y std	Y std	N opt	Y std	The 2000 model year car features dual front airbags, front safety belt pretensioners & load limiters and ISOFIX anchorages to the rear seats. Optional equipment includes	All model variants: Jan 2000 - Jan 2002	Vehicles with optional side airbag cannot be identified

													side impact airbags & ABS.		
79	Alfa Romeo	147 1.6 (LHD)	4 Door Hatch	2001		Jan 2000 - Current	1212		Y std	Y std	Y std	Y std	Safety equipment fitted as standard to the 2001 model includes twin front airbags, side airbags and head protection airbags, pre-tensioners and load limiters on the front seat belts, and ABS.	All model variants: Jan 2000 onwards	
80	Honda	Civic 1.4 S (LHD)	5 Door Hatch	2001		Dec 2000 - Current	1160		Y std	Y std	Y std	Y std	Dual frontal airbags, side airbags, front belt pre-tensioners and load limiters, three-point centre rear belt, ISOFIX to rear seat location, ABS, EBD and Brake Assist. Side airbags not in E model variant	All model variants but E: Dec 2000 onwards	
81	Nissan	Almera Hatch	5 Door Hatch	2001		Mar 1999 - Current	1238		Y std	Y std	Y std	Y std	Standard equipment in EU countries includes twin front airbags, side airbags, front belt pre-tensioners and driver belt load limited, ISOFIX fittings in rear outer seats. In UK no passenger airbag on E variant, no side airbag on E and S variants, side airbag optional on Sport variant	All model variants but E, S and Sport: Mar 1999 onwards	
82	Peugeot	307 (LHD)	5 Door Hatch	2001		Apr 2001 - Current	1230		Y std	Y std	Y std	Y std	Equipment on the 2001 model includes dual (smart) frontal airbags, side airbags (thorax) , head protection airbag (curtain), front belt pre-tensioners and load limiters, three-point centre rear belt, ABS, brake assist emergency braking and auto warning. ESP is optional.	All model variants: Apr 2001 onwards	
83	Audi	A4 2.0 (LHD)	4 Door Sedan	2001		Dec 2000 - Current	1370		Y std	Y std	Y std	Y std	Standard equipment includes twin front airbags, side airbags (thorax) and head protecting curtain, front belt pre-tensioners and load limiters on front and rear belts. A 3-point centre rear belt is optional. ABS and ESP are standard.	All model variants: Dec 2000 onwards	

84	BMW	316i (LHD)	4 Door Sedan	2000/2001		Sept 1998 - Sept 2000	1330		Y std	Y std	Y std	Y std	Standard equipment includes dual frontal airbags, side airbags (thorax), head - protecting airbag (tube), front belt pre - tensioners and load limiters, and ABS. A three-point centre rear belt is an option.	All model variants: Sept 1998 - Sept 2000	
85	Citroen	C5 1.8i 16v SX (LHD)	5 Door Hatch	2001		Apr 2001 - Current	1330		Y std	Y std	Y std	Y std	Equipment fitted includes dual (smart) front airbags, side airbags (thorax), head-protecting curtain, front belt pre-tensioners and load limiters, three-point centre rear belt, head restraints for all seats, ABS and brake assist, emergency braking and auto warning system. ESP is optional.	All model variants: Apr 2001 onwards.	
86	Hyundai	Elantra 1.6 GLS (LHD)	4 Door Sedan	2001		Mar 2001 - Current	1265		Y std	Y std	N	Y std	Safety equipment fitted as standard to the 2001 model includes twin front airbags,pre-tensioners and load limiters on the front seat belts. ABS std in UK	All model variants: Mar 2001 onwards.	
87	Mercedes-Benz	C180 (LHD)	4 Door Sedan	2001		Sep 2000 - Current	1455		Y std	Y std	Y std	Y std	Standard equipment includes dual-stage frontal airbags for driver and front passenger, thoracic side airbags, head protection airbag (curtain), belt pre-tensioners and load limiters for front and rear outer seats, has three-point centre belt. Brake Assist, ESP and ABS are also fitted.	All model variants: Sep 2000 onwards.	
88	Mitsubishi	Carisma 1.8 Comfort (LHD)	5 Door Hatch	2001		Aug 1999 - Current	1235		Y std	Y std	N opt	Y std	The 2001 model car features dual frontal airbags, front belt pre-tensioners and load limiters, three-point centre rear safety belt and ABS. Optional equipment includes side airbags (thorax). No side airbag on UK model	All model variants: Aug 1999 onwards.	
89	Peugeot	406 (LHD)	4 Door	2001		Mar 1999 -	1315		Y std	Y std	Y std	Y	Safety equipment fitted as	All model variants:	

			Sedan			Current						std	standard to the 2001 model includes twin (smart) frontal airbags, side airbags (thorax and head) pre-tensioners and load limiters on the front seatbelts, three-point rear centre belt. ABS, brake assist and ESP are options.	Mar 1999 onwards.	
90	Renault	Laguna II 1.8 16v (LHD)	5 Door Hatch	2001		Dec 2000 - Current	1385		Y std	Y std	Y std	Y std	Twin front airbags (dualchamber) are standard, as are thoracic side airbags, head protection airbags (curtain), load limiters for all belts, double pre-tensioner for driver belt, buckle pre-tensioner for front passenger belt, retractor pre-tensioners for rear outer belts, three-point centre belt, and ABS.	All model variants: Dec 2000 onwards.	
91	Rover	75 1.8 (RHD)	4 Door Sedan	2000/2001		Feb 1999 - Current	1330		Y std	Y std	Y std	Y std	It features dual frontal airbags, side airbags (thorax), front belt pre-tensioners and load limiters, all rear belts with pre-tensioners, 3-point centre rear belt, and ABS. A head-protecting side airbag is available as an option.	All model variants: Feb 1999 onwards.	
92	Skoda	Octavia 1.9 Tdi Ambiente (LHD)	5 Door Hatch	2001		Jun 1998 - Current	1330		Y std	N opt	N opt		Safety equipment fitted as standard to the 2001 model includes a driver's airbag and pre-tensioners on the front seat belts. A front passenger-side airbag and side airbags are optional extras. In UK Driver & pass airbags std on all models. Side airbags optional only on 2.0 SLXi, 1.8t SLXi, 1.9 TDi (110bhp) SLX, 2.0 SLXi Estate, 1.8T SLXi Estate and 1.9 TDi (110bhp) SLX Estate.	Classic, GLX and LX models: June 1998 onwards	Passenger data will not be valid
93	Vauxhall/ Opel	Vectra 1.8 (LHD)	5 Door Hatch	2001		Mar 1999 - Current	1265		Y std	Y std	Y std	Y std	Safety equipment fitted as standard to the 2001 model includes twin front airbags,	All model variants: Mar 1999 onwards.	

													side airbags (thorax) pre-tensioners and load limiters on the front seat belts, all belts adjust for height, driver and front passenger active head restraints, brake pedal release system and ABS.		
94	Volkswagon	Passat 1.9 Tdi (LHD)	4 Door Sedan	2001		Apr 1997 - Current	1527		Y std	Y std	Y std	Y std	The 2001 model Passat has twin frontal airbags, side airbags, front belt pre-tensioners and load limiters and ABS. Head airbag curtain and three- point centre rear belt are options at extra cost. Side airbags introduced in May 1998 UK model onwards.	All model variants: May 1998 onwards.	
95	Volvo	S60 (LHD)	4 Door Sedan	2001		Oct 2000 - Current	1425		Y std	N opt	Y std	Y std	Standard equipment on the 2001 model includes driver airbag, side airbags, head protection airbag (curtain), front belt pre-tensioners and load limiters, rear belt load limiters, whiplash protection system (WHIPS) and ABS. A front passenger airbag is optional. Passenger airbag is std in UK	All model variants: Oct 2000 onwards.	Passenger data will not be valid
96	Citroen	Picasso 1.6 LX (LHD)	5-Door MPV	2001		Jun 2000 - Current	1275		Y std	Y std	Y std	Y std	Standard equipment in EU countries includes twin front airbags, side airbags (head and thorax), front belt pre-tensioners and load limiters, plus ABS.	All model variants: Jun 2000 onwards.	
97	Fiat	Multipla JTD ELX (RHD)	5-Door MPV	2001		Dec 1999 - Current	1480		Y std	Y std	N opt	Y std	The 2001 model year features twin frontal airbags, front belt pre-tensioners, three-point rear centre belt and ABS. Side airbags (thorax) are available as an option on all model variants.	All model variants: Dec 1999 onwards.	Vehicles with optional side airbag cannot be identified
98	Honda	Stream 1.7 SE VTEC (RHD)	5-Door MPV	2001		June 2001 - Current	1420		Y std	Y std	Y std	Y std	Equipment fitted includes dual frontal and side airbags (thorax), front belt pre-tensioners and load limiters,	All model variants: June 2001 onwards	

													ABS, EBD and brake assist.		
99	Mazda	Premacy 1.8 Comfort (LHD)	5-Door MPV	2001		Jun 1999 - Current	1250		Y std	Y std	Y std	Y std	Standard equipment across EU markets includes twin front airbags, side airbags (head and thorax) and front belt pre-tensioners.	All model variants: Jun 1999 onwards.	
100	Mitsubishi	(Colt) Space Star 1.3 Family (LHD)	5-Door MPV	2001		Dec 1998 - Current	1155		Y std	Y std	N	N	Standard equipment across EU markets includes twin front airbags and front belt pre-tensioners. In the UK, 1.3i no passenger airbag 1999-2000, 1.8 Gdi & GLS have std side airbag	All model variants but 1.3i & 1.8 GDi: Dec 1998 onwards	
101	Nissan	Almera Tino 1.8 Luxury (LHD)	5-Door MPV	2001		Jul 2000 - Current	1420		Y std	Y std	Y std	Y std	Standard equipment in EU countries includes twin front airbags, side airbags (head and thorax), front belt pre-tensioners and load limiters.Side airbags not available in following models: 1.8 S, 2.0 S, 2.2D S, Twister	All model variants but S & Twister: Jul 2000 onwards.	
102	Renault	Scenic 1.4 (LHD)	5-Door MPV	2001		Aug 1999 - Current	1200		Y std	Y std	Y std	Y std	Standard equipment across EU markets includes twin front airbags, side airbags (thorax and head - protecting curtain) front belt pre-tensioners and load limiters. Rear outboard belts were also load limited.	All model variants: Aug 1999 onwards.	
103	Vauxhall/ Opel	Zafira 1.8 (RHD)	5-Door MPV	2001		Jun 1999 - Current	1390		Y std	Y std	N opt	Y std	The 2001 model features twin frontal airbags, front belt pre-tensioners and load limiters and ABS. In UK side airbags are std on Gsi Turbo only.	All model variants but Gsi Turbo: Jun 1999 onwards.	
104	Peugeot	806 2.0 (LHD)	7-Seat MPV	1999		Nov 1998 - Current	1550		Y std	Y std	N	Y std	1999-model cars have twin frontal airbags, belt pre-tensioners, load limiters and power assisted steering are all fitted as standard wherever sold in EU.	All model variants: Nov 1998 onwards	
105	Mercedes	M-Class ML270 (LHD)	Off-roader	2002		Apr 1998 - Current	2100		Y std	Y std	Y std	N	Twin frontal and side airbags, head-protecting curtain, front belt pre-tensioners and load limiters, ISOFIX anchorages	All model variants: Apr 1998 onwards	

													on the rear outer seats, and a belt reminder for both front seats.		
106	Suzuki	Grand Vitara 2.7ltr XL-7 (LHD)	Off-roader	2002		May 1999 - Current	2100		Y std	Y std	N	N	Driver and passengre front airbags (UK) and front belt pre-tensioners. ISOFIX mountings are provided on the second-row seats.	All model variants: May 1999 onwards	
107	Chrysler	PT Cruiser 2.0ltr (LHD)	5 Door MPV	2002		Jul 2000 - Current	1400		Y std	Y std	Y std	N	Dual frontal and side airbags, head-protecting airbag, front belt pre-tensioners, load limiters and webbing grabbers, ISOFIX points on each rear seat. Side airbags not on Classic in UK.	All model variants but Classic: July 2000 onwards	
108	Audi	A2 1.4 (LHD)	5-Door Hatch	2002		Aug 2000 - Current	910		Y std	Y std	Y std	Y std (UK)	Twin front airbags, side airbags (thorax), front belt pre-tensioners and load limiters, and ISOFIX child restraint mountings on the rear seats.	All model variants: Aug 2000 onwards	
109	BMW	Mini Cooper 1.6 (LHD)	3 Door Hatch	2002		July 2001 - Current	1125		Y std	Y std	Y std	Y std	Dual front airbags, side airbags, front belt pre-tensioners and load limiters, ABS, CBC and EBD. Also has run-flat indicator. Optional equipment includes a head-protecting tube.	All model variants: Jul 2001 onwards	
110	Peugeot	607 2.2 Hdi (LHD)	4 Door Sedan	2002		Jun 2000 - Current	1585		Y std	Y std	Y std	Y std	The '02 model has driver and passenger frontal airbags, side airbags, head-protecting (curtain) airbags, front belt pre-tensioners and load limiters, ABS and ASP.	All model variants: Jun 2000 onwards.	
111	Honda	S2000 (LHD)	2-Seater Roadster	2002		Sep 1999 - Current	1285		Y std	Y std	N	Y std	The 2002 model has dual frontal airbags, belt pre-tensioners and load limiters, and ABS.	All model variants: Sept 1999 onwards	
112	Mazda	MX-5 1.6 LHD	2-Seater Roadster	2002		Apr 1998 - Current	1005		Y std	Y std	N	N	The '02 model has twin frontal airbags, belt pre-tensioners and load limiters as standard.	All model variants: Apr 1998 onwards	
113	Mercedes-Benz	SLK 200 Kompressor (LHD)	2-Seater Roadster	2002		Nov 1996 - Current	1425		Y std	Y std	Y std	Y std	The '02 model year has twin frontal airbags, side airbags (thorax), belt pre-tensioners and load limiters, ABS, ESP	All model variants: Nov 1996 onwards	

													and Brake Assist.		
114	Range Rover	(RHD)	5-Door Off-Roader	2002		Sept 2001 - Current	2540		Y std	Y std	Y std	Y std	Equipment fitted includes dual frontal airbags, side airbags (thorax), head-protecting airbag tube for front passengers, front belt pre-tensioners and load limiters, three-point centre rear belt, ISOFIX mountings on rear seats, and ABS.	All model variants: Sept 2001 onwards	
115	Jeep Cherokee	2.5 TD Limited (LHD)	5-Door Off-Roader	2002		Jun 1996 - Current	1800		Y std	Y std	N	N	The car comes with dual frontal airbags, front belt pre-tensioner and load limiter for the driver and load limiter for the passenger, ISOFIX with top tethers and three-point rear centre belt.	All model variants: Jun 1996 onwards	
116	Vauxhall/ Opel	Frontera 2.2 DTL 16v RHD	5-Door Off-Roader	2002		Oct 1998 - Current	1820		Y std	Y std	N	N opt	The 2002 model year Frontera comes with dual frontal airbags, front belt pre-tensioner and load limiter for the driver and load limiter for the passenger, and a two-point centre rear belt.	All model variants: Oct 1998 onwards	
117	Honda	CR-V 2.0 SE (RHD)	5-Door Off-Roader	2002		Jun 1997 - Current	1497		Y std	Y std	Y std	Y std	Equipment fitted includes dual frontal airbags, side airbags (thorax), front belt pre-tensioners and load limiters, three-point centre rear belt, ISOFIX mountings on rear seats and top tethers.	All model variants Sept 2002 onwards	Will not appear in available crash data
118	Mercedes	E-Class 220CDi Elegance LHD	4 Door Sedan	2003		Sept 2002 - Current	1650		Y std	N (Y std UK)	Y std	Y std	Standard equipment includes dual-stage frontal airbags for driver and front passenger, thoracic side airbags, head protection airbag (curtain), belt pre-tensioners and load limiters for front and rear outer seats, has three-point centre belt. Brake Assist, ESP and ABS are also fitted.	All model variants: Sept 2002 onwards	Will not appear in available crash data
119	Renault	Vel Satis 2.2DCi (LHD)	4 Door Sedan	2003		Sept 2002 - Current	1800		Y std	Y std	Y std	N (Y std UK)	Dual adaptive frontal airbags, dual side airbags, head-protecting curtain, dual front	All model variants: Sept 2002 onwards	Will not appear in available crash data

													belt pre-tensioners and load limiters integrated into the seats, rear outer belt with pre-tensioners and all rear belts with load limiters, ISOFIX anchorages and top tethers to rear outer seats and a belt reminder for the driver		
120	Citroen	C3 SX 1.4 Essence (LHD)	5 Door Hatch	2003		Sept 2002 - Current	1020		Y std	Y std	Y std	N opt	The '03 model year includes driver and passenger frontal and side airbags, front belt pre-tensioners and load limiters. ISOFIX mountings are provided on the rear outer seats. In UK ABS opt LX, std all other variants	All model variants: Sept 2002 onwards	Will not appear in available crash data
121	Ford	Fiesta 1.4 Trend (RHD)	3-Door Hatch	2003		Sept 2002 - Current	1165		Y std	Y std	N	N opt	The car features driver and passenger frontal airbags, front belt pre-tensioners and load limiters. ISOFIX mountings are provided on the rear outer seats. In UK ABS & side airbags optional all model but Ghia where ABS std	All model variants: Sept 2002 onwards	Will not appear in available crash data. Vehicles with optional side airbags cannot be identified
122	Seat	Ibiza Stella 1.2 (LHD)	5 Door Hatch	2003		2002 - Current			Y std	Y std	N	N	The 2003 model features driver and passenger frontal airbags, front belt pre-tensioners and load limiters. ISOFIX mountings are provided on the rear outer seats.		Will not appear in available crash data
123	Toyota	Corrolla 1.4 Terra (RHD)	5 Door Hatch	2003		2002 - Current	1145		Y std	Y std	N	N	Driver and passenger frontal airbags, front belt pre-tensioners, load limiters and webbing grabbers. ISOFIX mountings are provided on the rear outer seats.		Will not appear in available crash data
124	Saab	9-3 2.0ltr (LHD)	4 Door Sedan	2003		2002 - Current	1450		Y std	Y std	Y std	Y std	The '03 model year car includes dual frontal and side airbags, head protection curtains, front belt pre-tensioners and load limiters, a belt reminder system for both front seats and ISOFIX anchor		Will not appear in available crash data

													points on the outer rear seats.		
125	Nissan	Primera 1.8 (LHD)	5 Door Hatch	2003		2002 - Current	1325		Y std	N	Y std	N	Dual frontal and side airbags, head-protecting curtains, front belt pre-tensioners and load limiters, ISOFIX anchorages and top tether for rear outer seats, belt reminder for front passenger.		Will not appear in available crash data
126	Subaru	Legacy Outback 2.5 (RHD)	5-Door Estate	2003		Dec 1998 - Current	1545		Y std	Y std	Y std	Y std	Driver and passenger frontal and side airbags, front belt pre-tensioners and load limiters. ISOFIX mountings are provided on the rear outer seats, 3-point centre rear belt, driver seat belt reminder system and ABS.	All model variants: Dec 1998 onwards	
127	Hyundai	Santa Fe 2.0 GRD (LHD)	Off-roader	2003		Mar 2001 - Current	1785		Y std	Y std	N	N (Y std UK)	Twin frontal airbags, belt pre-tensioners and load limiters on front and outer rear belts, ISOFIX mountings and top tethers on the rear outer seats.	All model variants: Mar 2001 onwards.	
128	Land Rover	Freelander GS K1.8ltr petrol (RHD)	Off-roader	2003		Oct 1997 - Current	1485		Y std	Y std (N opt UK)	N	N	Twin frontal airbags, driver and front passenger belt pre-tensioner and load limiter. In UK 1.8i Base and 'S' have optional passenger airbag	All model variants but S & 1.8i: Oct 1999 onwards	
129	Nissan	X-Trail 2.0ltr (LHD)	5 Door Off-roader	2003		Sept 2001 - Current	1455		Y std	Y std	Y std	N	Dual frontal and side airbags (thorax and head), a belt reminder system for both front seats and ISOFIX anchorages on the rear outer seats.	All model variants: Sept 2001 onwards	
130	Mercedes	Vaneo 170 Cdi (LHD)	5 Door MPV	2003		2002 - Current	1365		Y std	Y std	Y std	N	Driver and passenger frontal and side airbags, belt pre-tensioners for front and rear outer belts, load limiters for front belts, ISOFIX anchorages to rear outer seats. ABS, BAS and ESP		Will not appear in available crash data
131	Peugeot	807 2.0 Hdi (LHD)	MPV	2003		2003 - Current	1700		Y std	Y std	Y std	N	Twin frontal and side airbags, ead-protecting airbags, front belt pre-tensioners and load limiters, 2nd row outer belts with pre-tensioners, ISOFIX		Will not appear in available crash data

													anchorages to rear outer seats, driver belt reminder. Note: The Peugeot 807 is technically identical to the Citroen C8, the Fiat Ulysse and the Lancia Phedra.		
132	Vauxhall/ Opel	Vectra 1.8 SE (LHD)	4 Door Sedan	2002		Mar 1999 - Current	1365		Y std	Y std	Y std	Y std	Standard equipment includes twin frontal airbags, side airbags (thorax) head-protecting airbag (curtain) front and rear outer belt pre-tensioners and load limiters, ABS and active head rests.		Will not appear in available crash data
133	Proton	Impian 1.6 GX (RHD)	4 Door Sedan	2002		Jul 2001 - Current	1230		Y std	Y std	Y std	Y std	The 2002 model year car comes with driver and passenger frontal airbags, side airbags, front belt pre-tensioners and load limiters and a three-point centre rear belt.	All model variants: July 2001 onwards	
134	Jaguar	X-Type 2.0 (LHD)	4 Door Sedan	2002		Feb 2001 - Current	1525		Y std	Y std	Y std	Y std	The new Jaguar X-Type was launched in May 2001 and the 2.0ltr variant released in March 2002. The car features driver and passenger frontal airbags, side airbags (thorax) head protection airbags (curtain), front safety belt pre-tensioners and load limiters, front passenger airbag deactivation system, a three-point centre rear belt and ABS.	All model variants: Feb 2001 onwards	
135	Renault	Megane II 1.6 16v (LHD)	5 Door Hatch	2003		2002 - Current	1175		Y std	Y std	Y std	Y std	It features dual frontal and side airbags, head protecting curtain, front belt pre-tensioners and separate load limiters on the lap and diagonal sections, rear outer belt pre-tensioners and load limiters; ISOFIX anchorages and top tethers on rear outer seats, ISOFIX anchorages on front passenger seat, belt reminder for driver.		Will not appear in available crash data

136	Vauxhall/ Opel	Corsa 1.2 Comfort (LHD)	3 Door Hatch	2002		Oct 2000 - Current	845		Y std	Y std (opt UK)	Y std (opt UK)	N opt	The latest Corsa comes with driver and passenger airbags, side airbags (thorax), front belt pre-tensioners and load limiters and a two-point rear centre belt. In the UK, passenger airbag is std and side airbags optional only on SXi, Elegance and SRi. Passenger airbag is opt on other variants.	SXi, SRi & Elegance: Oct 2000 onwards	Vehicles with optional side airbags cannot be identified
137	Volkswa gen	Polo 1.2 (LHD)	5 Door Hatch	2002		2002 - Current	1055		Y std	Y std	Y std	Y std	Equipment fitted to the 2002 model includes dual front airbags, side airbags (thorax), front belt pre-tensioners and load limiters, two-point centre rear belt and ISOFIX.		Will not appear in available crash data
138	Ford	Mondeo 1.8 LX (RHD)	5 Door Hatch	2002		Oct 2000 - Current	1375		Y std	Y std	Y std	Y std	Modifications introduced from November 2001 include up rated restraint systems (driver airbag and front safety belt pre-tensioners), changes to the steering column and column shroud. Standard equipment includes dual stage frontal airbags, side airbags (thorax), head protecting curtain, front safety belt pre-tensioners and load limiters, 3-point rear centre belt, active head restraints and ABS. EPS is optional.	All model variants: Nov 2001 onwards	

Description of Fields in the Comparison Table:

FIELD	DESCRIPTION
Index	MUARC created variable for use in vehicle model matching and identification in the project analysis process
Make	Test vehicle make as described in EuroNCAP material
Model	Test vehicle model as described in EuroNCAP material
Body	Test vehicle body type as described in EuroNCAP material
Test Car Model Year	Test vehicle model year as given in EuroNCAP material
Test Car Build Date	Test vehicle build date(s) as given in EuroNCAP material
Model Life	Period over which vehicle model broadly equivalent to that tested was sold in the UK (source: UK WhatCar? publications)
Kerb Weight	Test vehicle kerb weight as given in EuroNCAP material (or estimated if indicated by 'est')
Test Phase	EuroNCAP test phase under which vehicle was tested
Driver Airbag	Was a driver front airbag fitted to the test vehicle and was it standard or optional equipment
Passenger Airbag	Was a passenger front airbag fitted to the test vehicle and was it standard or optional equipment
Side Airbags	Was a side airbag system for front passengers fitted to the test vehicle and was it standard or optional equipment
ABS	Was the test vehicle fitted with anti locking brakes and were they standard or optional equipment
Comments	Notes on specification changes on each model variant throughout the vehicle model life (source UK WhatCar? publications)
Variants and build dates	Vehicle model variants and build dates chosen as equivalent to the tested vehicle for comparison in the study. Based on the
Notes	Notes any problems in matching the specifications of the test vehicle with those appearing in the crash data. In particular, when

ANCAP EuroNCAP protocol Tested vehicles

Index	Model Id	Make	Model	Make & Model	Year Range	Airbags	Kerb Mass
18	VECTRA96	VAUXHALL	VECTRA(E)	HOLDEN VECTRA(E)	1997 to 2002	Driver airbag	1300
22	LANOS598	DAEWOO	LANOS(E)5D	DAEWOO LANOS 5DR(E)	1997 to 2003	Driver airbag	1070
26	LANCR98E	MITSUBI	LANCER(LHD)	MITSUBISHI LANCER(LHD)	1997 to 2003	Driver airbag	1050
27	306E97	PEUGEOT	306(E)	PEUGEOT 306(E)	1997 to 2000	Driver airbag	1110
30	COROL98E	TOYOTA	COROLLA(LHD	TOYOTA COROLLA(E)	1998 to 2001	Driver airbag	1060
35	CAMRY01	TOYOTA	CAMRY	TOYOTA CAMRY	2000 to 2002	Driver airbag	1420
41	ASTRA99	VAUXHALL	ASTRA(E)	HOLDEN ASTRA(E)	1997 on	Dual front airbags	1100
56	BARINA01	HOLDEN	BARINA CITY	HOLDEN BARINA CITY	2001 on	Dual front airbags	1050
68	SIRION00	DAIHATS	SIRION	DAIHATSU SIRION	Mid 2000 on	Dual front airbags	850
77	YARIS_00	TOYOTA	YARIS	TOYOTA YARIS/ECHO(LHD)	2000 to 2002(AU)	Dual front airbags	900
126	LIBERTY99	SUBARU	LIBERTY	SUBARU LIBERTY	1999 to 2003	Dual front airbags	1410
139	LEGANZ99	DAEWOO	LEGANZA	DAEWOO LEGANZA	1999 to 2003	Driver airbag	1410
140	NUBIRA99	DAEWOO	NUBIRA	DAEWOO NUBIRA	1999 on	Driver airbag	1280
141	FALCON01	FORD	FALCON	FORD FALCON AU2	2000 to 2002	Dual front airbags	1550
142	FALCU01	FORD	FALCON_UTE	FORD FALCON UTILITY (AU2)	2001 to 2003	Driver airbag	1630
143	COMM01	HOLDEN	COMMODOREVX	HOLDEN COMMODORE VX	2000 to 2002	Driver airbag	1560
144	RODEO01	HOLDEN	RODEO	HOLDEN RODEO (2WD)	1999 to 2002		1490
145	ACCENT00	HYUNDAI	ACCENT	HYUNDAI ACCENT 3 DR	2000 on	Driver airbag	1070
146	SONATA99	HYUNDAI	SONATA	HYUNDAI SONATA	1999 to 2000		1390
147	MZ121_02	MAZDA	121	MAZDA 121	2000 to 2003	Driver airbag	970
148	M323_00	MAZDA	323	MAZDA 323	1999 to mid 2002	Driver airbag	1120
149	BRAVO01	MAZDA	BRAVO	MAZDA BRAVO (2WD)	1999		1380
150	MAGNA00	MITSUBI	MAGNA	MITSUBISHI MAGNA	Aug 2001 to 2003	Driver airbag	1480

151	PULSAR00	NISSAN	PULSAR	NISSAN PULSAR	2000 on	Driver airbag	1120
152	AVALON01	TOYOTA	AVALON	TOYOTA AVALON	2001 on	Dual front airbags	1500
153	HILUX01	TOYOTA	HILUX_2WD	TOYOTA HILUX (2WD)	Sep 2001 to 2003		1360
154	POLO96	VW	POLO(E)	VW POLO(E)	1996 to 1999	Driver airbag	950
	LASER00	FORD	LASER	FORD LASER	1999 to 2002	Driver airbag	1120
	ALF147_01	ALFAROM	147(ELHD)	ALFA ROMEO 147 (LHD)	2000 on	Front+side+head airbags	1212
	AUDA397	AUDI	A3(E)	AUDI A3(E)	1997 to 2003	Front+side airbags	1090
	A3_03	AUDI	A3(E)	AUDI A3(E)	mid 2004 on (AU)	Front+side+head airbags	1340
	AUDI_A401	AUDI	A4(ELHD)	AUDI A4(LHD)	2000 on	Front+side+head airbags	1370
	audi_tt03	AUDI	TT ROADSTER(LHD)	AUDI TT ROADSTER(LHD)	2003 on	Front+side+head airbags	1400
	BMW3_01	BMW	3SERIES(ELHD)	BMW 3-SERIES (LHD)	2000 on	Front+side+head airbags	1330
	MINI	BMW	MINI(LHD)	BMW MINI(LHD)	2002 on	Front+side+head airbags	1130
	X5_03B	BMW	X5(LHD)	BMW X5(LHD)	June 2003 on	Front+side+head airbags	2090
	Z4_04	BMW	Z4(LHD)	BMW Z4(LHD)	2004 on	Front+side airbags	1340
	PTCRUIS02	CHRYSLR	PT_CRUISER(LHD)	CHRYSLER PT_CRUISER(LHD)	2000 on	Front+side+head airbags	1400
	C2_03	CITROEN	C2(LHD)	CITROEN C2(LHD)	2003 on	Front+side airbags	930
	C5_01	CITROEN	C5(ELHD)	CITROEN C5 (LHD)	2001 on	Front+side+head airbags	1330
	kalos03	DAEWOO	KALOS	DAEWOO KALOS	2003 on	Dual front airbags	1080
	ESCAPE03	FORD	ESCAPE	FORD ESCAPE	2001 on	Dual front airbags	1580
	FALCON03	FORD	FALCON BA	FORD FALCON BA	2002 on	Dual front airbags	1690
	FIESTA03	FORD	FIESTA(E)	FORD FIESTA(E)	2003 on	Dual front airbags	1170
	FOCUS99	FORD	FOCUS(LHD)	FORD FOCUS(LHD)	1998 on	Dual front airbags	1080
	KA_00	FORD	KA	FORD KA(LHD)	2000 on	Driver airbag	900
	COMM_UT01	HOLDEN	COMM_UTE	HOLDEN COMM UTILITY (VU2)	Mar 2002 to 2003	Driver airbag	1550
	commvy03	HOLDEN	COMMODORE VY	HOLDEN COMMODORE VY	April 2003 on	Dual front airbags	1570

	CRUZE03	HOLDEN	CRUZE	HOLDEN CRUZE	2003 on	Dual front airbags	1000
	MONARO04	HOLDEN	MONARO	HOLDEN MONARO		Front+side+head airbags	1660
	ZAFIRA01	VAUXHALL	ZAFIRA(E)	HOLDEN ZAFIRA(E)	2001 on	Dual front airbags	1390
	ACCORD03	HONDA	ACCORD(E)	HONDA ACCORD EURO(E)	2003 on	Front+side+head airbags	1390
	crv_02	HONDA	CRV	HONDA CR-V	2002 on	Dual front airbags	1500
	JAZZ03	HONDA	JAZZ	HONDA JAZZ	2003 on	Dual front airbags	1030
	s2000_02	HONDA	S2000(LHD)	HONDA S2000(LHD)	1999 on	Dual front airbags	1290
	ACCENT04	HYUNDAI	ACCENT	HYUNDAI ACCENT	2003 on	Dual front airbags	1110
	ELANTRA01	HYUNDAI	ELANTRA(ELHD)	HYUNDAI ELANTRA (LHD)	2000 on	Dual front airbags	1265
	GETZ03	HYUNDAI	GETZ	HYUNDAI GETZ	2002 on	Driver airbag	1080
	santfe03	HYUNDAI	SANTE FE	HYUNDAI SANTE FE	2002 on	Dual front airbags	1790
	XTYPE03E	JAGUAR	X-TYPE(LHD)	JAGUAR X-TYPE(LHD)	2002 on	Front+side+head airbags	1530
	RIO01	KIA	RIO	KIA RIO	2001 on	Driver airbag	1070
	RIO04	KIA	RIO	KIA RIO	2004 on	Driver airbag	1090
	RANGE02	LROVER	RANGEROVER(E)	LANDROVER RANGE ROVER(E)	2002 on	Front+side+head airbags	2540
	mazda2_03	MAZDA	2 EXCLUSIVE(E)	MAZDA 2 (E)	2003 on	Dual front airbags	1070
	MAZDA3_04	MAZDA	3	MAZDA 3	2004 on	Front+side+head airbags	1200
	mazda6_03	MAZDA	6(LHD)	MAZDA 6 SPORT(LHD)	2003 on	Front+side+head airbags	1370
	626_99	MAZDA	626	MAZDA 626	1998 to 2003	Dual front airbags	1180
	mx5_02	MAZDA	MX5(LHD)	MAZDA MX5(LHD)	2001 on	Dual front airbags	1010
	TRIBUTE02	MAZDA	TRIBUTE	MAZDA TRIBUTE	2001 to 2003	Dual front airbags	1580
	MERC_A99	MERBNZ	A-CLASS(LHD	MERCEDES A-CLASS(LHD)	1998 on	Front+side airbags	1070
	MB_C03A	MERBNZ	C-CLASS	MERCEDES C-CLASS(LHD)	Apr 2004 on (AU)	Front+side+head airbags	1460
	MBNZE98E	MERBNZ	E(ELHD)	MERCEDES E-CLASS(E)	1999 to 2002	Front+side+head airbags	1440
	MB_M02	MERBNZ	M-CLASS(LHD)	MERCEDES M-CLASS(LHD)	2002 on	Front+side+head airbags	2100
	SLK_03	MERBNZ	SLK(LHD)	MERCEDES SLK(LHD)	2002 to 2004	Front+side airbags	1430

	MG_TF03	MG	TF(E)	MG TF(E)	2003 on	Driver airbag	1105
	LANCER03	MITSUBI	LANCER	MITSUBISHI LANCER	2003 on	Dual front airbags	1180
	MAGNA03	MITSUBI	MAGNA	MITSUBISHI MAGNA	2003 on	Front+side airbags	1450
	outland04	MITSUBI	OUTLANDER	MITSUBISHI OUTLANDER	2003 on	Dual front airbags	1550
	PULSAR04	NISSAN	PULSAR	NISSAN PULSAR	2004 on	Dual front airbags	1210
	XTRAIL02	NISSAN	XTRAIL	NISSAN X-TRAIL	2002 on	Dual front airbags	1440
	206_00	PEUGEOT	206	PEUGEOT 206(LHD)	2000 on	Dual front airbags	940
	307_01	PEUGEOT	307(ELHD)	PEUGEOT 307 (LHD)	2001 on	Front+side+head airbags	1230
	P307CC03	PEUGEOT	307 CC(LHD)	PEUGEOT 307 CC(LHD)	2003 on	Front+side+head airbags	1440
	406_01	PEUGEOT	406(LHD)	PEUGEOT 406 (LHD)	2001 on	Front+side+head airbags	1315
	LAGUNA01	RENAULT	LAGUNA(LHD)	RENAULT LAGUNA(LHD)	2001 to 2003	Front+side+head airbags	1390
	LAGUNA03	RENAULT	LAGUNA(LHD)	RENAULT LAGUNA(LHD)	June 2003 on	Front+side+head airbags	1390
	MEGANE03	RENAULT	MEGANE(LHD)	RENAULT MEGANE(LHD)	Dec 2003 on	Front+side+head airbags	1180
	ROVER7599	ROVER	75(E)	ROVER 75(E)	1999 on	Front+side airbags	1330
	9-3C04	SAAB	9-3 CONV(LHD)	SAAB 9-3 CONV(LHD)	2004 on	Front+side+head airbags	1440
	SAAB9303A	SAAB	9-3(LHD)	SAAB 9-3(LHD)	2004 on(AU)	Front+side+head airbags	1450
	SAAB9598	SAAB	9-5(ELHD)	SAAB 9-5(LHD)	1997 to 2001	Front+side+head airbags	1490
	S95_03A	SAAB	9-5(LHD)	SAAB 9-5(LHD)	2004 on(AU)	Front+side+head airbags	1490
	SMART99	MCC	SMART	SMART CITY COUPE	1999 on	Dual front airbags	740
	forest02	SUBARU	FORESTER	SUBARU FORESTER	2002 to Jan 2003	Dual front airbags	1420
	LIBERTY04	SUBARU	LIBERTY	SUBARU LIBERTY	2004 on	Dual front airbags	1440
	OUTBACK04	SUBARU	OUTBACK	SUBARU OUTBACK	2004 on	Dual front airbags	1440
	CAMRY03	TOYOTA	CAMRY	TOYOTA CAMRY	2002 on	Dual front airbags	1450
	COROL02	TOYOTA	COROLLA	TOYOTA COROLLA	2001 on	Driver airbag	1130
	ECHO04	TOYOTA	ECHO	TOYOTA ECHO	2003 on	Driver airbag	930
	PRIUS04	TOYOTA	PRIUS	TOYOTA PRIUS(E)	2004 on	Front+side+head airbags	1300
	rav4_02	TOYOTA	RAV4	TOYOTA RAV4	2002 on	Dual front airbags	1380

	VECTRA01	VAUXHALL	VECTRA(ELHD)	VAUXHALL VECTRA(LHD)	mid 2004 on (AU)	Front+side+head airbags	1365
	S40_E	VOLVO	S40(E)	VOLVO S40(E)	1995 to 2002	Front+side airbags	1230
	S40_04	VOLVO	S40(LHD)	VOLVO S40(LHD)	2004 on	Front+side+head airbags	1370
	S60_01	VOLVO	S60(ELHD)	VOLVO S60 (LHD)	2000 on	Driver+side+head airbags	1425
	S80_E00	VOLVO	S80	VOLVO S80(LHD)	2000 on	Driver+side+head airbags	1485
	XC90_03B	VOLVO	XC90(LHD)	VOLVO XC90(LHD DIESEL)	2003 on	Front+side+head airbags	2120
	BEETL99	VW	BEETLE(E)	VW BEETLE (LHD)	1999 on	Front+side airbags	1230
	GOLF98E	VW	GOLF(LHD)	VW GOLF(LHD)	1998 on	Front+side airbags	1140
	PASSAT01A	VW	PASSAT(LHD)	VW PASSAT(LHD Curtain)	2001 on	Front+side+head airbags	1530
	POLO_00	VW	POLO	VW POLO(LHD)	1999 to 2001	Dual front airbags	940
	POLO02	VW	POLO(LHD)	VW POLO(LHD)	2002 on	Front+side airbags	1060

APPENDIX B

SAFETY RATINGS

ESTIMATED FROM BRITISH REAL CRASH DATA

ALL CRASH TYPES (DfT Method)								
Euro NCAP Index	Vehicle Make/Model	Crash-worthiness Rating	Estimated Injury Risk	Estimated Injury Severity	Lower 95% CI CWR	Upper 95% CI CWR	Range of CI	CWR Coeffi-cient of Variation
	All Model Average	**6.79**	**63.34**	**10.72**				
1	Fiat Punto 55S	7.68	71.29	10.77	6.53	9.02	2.49	0.32
2	Ford Fiesta 1.25 LX 16V	7.43	68.39	10.87	6.75	8.18	1.43	0.19
3	Nissan Micra 1.0L	10.22	71.69	14.26	8.91	11.74	2.83	0.28
4	Renault Clio 1.2RL	8.29	70.40	11.78	5.92	11.61	5.69	0.69
5	Rover 100	9.70	71.92	13.48	8.50	11.06	2.57	0.26
6	Vauxhall Corsa 1.2LS	7.37	65.98	11.16	5.12	10.59	5.47	0.74
7	Volkswagen Polo 1.4L	7.42	67.96	10.92	6.32	8.72	2.40	0.32
8	Audi A4 1.8	6.16	55.06	11.18	4.31	8.81	4.50	0.73
9	BMW 316i	6.14	55.35	11.10	5.32	7.10	1.78	0.29
10	Citroen Xantia 1.8i Dimension	5.62	55.58	10.11	4.57	6.92	2.35	0.42
11	Ford Mondeo 1.8LX	6.38	60.30	10.57	5.56	7.31	1.75	0.27
12	Mercedes C180 Classic	3.07	56.92	5.40	1.83	5.15	3.32	1.08
13	Nissan Primera 1.6GX	7.35	62.75	11.71	5.65	9.56	3.92	0.53
14	Peugeot 406 1.8LX	5.72	54.07	10.57	4.75	6.88	2.12	0.37
15	Renault Laguna 2.0RT	5.51	60.69	9.07	4.24	7.16	2.92	0.53
16	Rover 620 Si	6.05	58.89	10.27	4.79	7.64	2.86	0.47
17	Saab 900 2.0i	5.96	47.98	12.43	3.42	10.39	6.96	1.17
18	Vauxhall Vectra 1.8iLS	7.08	59.89	11.82	6.26	8.00	1.75	0.25
19	Volkswagen Passat 1.6L (LHD)	8.42	55.12	15.27	5.54	12.78	7.24	0.86
20	Audi A3 1.6	5.84	60.74	9.62	3.45	9.89	6.44	1.10
21	Citroen Xsara 1.4i (LHD)	6.57	65.69	10.00	4.33	9.98	5.65	0.86
22	Daewoo Lanos 1.4SE (LHD)	7.66	66.08	11.59	5.28	11.11	5.83	0.76
23	Fiat Brava 1.4S	6.83	65.84	10.38	5.56	8.40	2.83	0.41
24	Honda Civic 1.4i	9.02	65.04	13.87	7.79	10.46	2.67	0.30
25	Hyundai Accent 1.3GLS (LHD)	9.28	75.40	12.30	6.47	13.30	6.83	0.74
27	Peugeot 306 1.6GLX	8.36	67.09	12.47	7.31	9.57	2.26	0.27
28	Renault Megane 1.6RT (LHD)	6.71	66.45	10.09	5.52	8.16	2.64	0.39

29	Suzuki Baleno 1.6GLX (LHD)	7.74	67.51	11.46	4.82	12.42	7.61	0.98
30	Toyota Corolla 1.3 Sportif (LHD)	8.24	65.33	12.62	6.14	11.08	4.95	0.60
31	Volkswagen Golf 1.4 (LHD)	8.06	64.37	12.53	4.58	14.21	9.63	1.19
32	Audi A6 2.4 (LHD)	3.53	54.09	6.53	1.61	7.75	6.14	1.74
33	BMW 520i (LHD)	6.46	50.32	12.84	4.42	9.46	5.04	0.78
34	Mercedes E200 Classic (LHD)	6.12	52.83	11.59	3.58	10.47	6.89	1.13
36	Saab 9-5 2.0 (LHD)	3.77	46.10	8.18	1.44	9.88	8.44	2.24
37	Vauxhall Omega 2.0Gl/GLS (LHD)	5.41	59.02	9.17	4.16	7.03	2.87	0.53
38	Volvo S70 2.0/2.5 10V (LHD)	6.35	56.02	11.34	2.92	13.83	10.91	1.72
39	Ford Focus 1.6 (LHD)	6.19	60.86	10.17	5.10	7.52	2.43	0.39
40	Mercedes A140 Classic (LHD)	9.12	66.93	13.63	5.57	14.93	9.36	1.03
41	Vauxhall Astra 1.6i Envoy	7.84	69.55	11.27	6.81	9.03	2.22	0.28
42	Ford Escort 1.6 LX	7.33	66.29	11.05	6.71	7.99	1.28	0.17
43	Nissan Almera 1.4GX	6.50	66.36	9.80	4.41	9.59	5.18	0.80
47	Nissan Serena 1.6 (LHD)	8.56	63.51	13.49	4.43	16.56	12.13	1.42
48	Volkswagen Sharan TDI (LHD)	5.43	54.25	10.00	2.65	11.09	8.43	1.55
56	Vauxhall Corsa 1.0 12v Club	7.41	69.69	10.64	6.20	8.86	2.66	0.36
59	Honda Accord 1.8iLS	1.89	63.20	2.99	0.49	7.34	6.86	3.63
61	Saab 9-3 2.0 (LHD)	4.94	45.78	10.79	2.39	10.21	7.82	1.58
63	Ford Ka 1.3 (LHD)	7.81	68.86	11.34	6.62	9.20	2.58	0.33
64	Volvo S40 1.8	4.38	62.10	7.06	2.58	7.44	4.87	1.11
65	Toyota Avensis 1.6S	5.83	63.46	9.18	4.15	8.18	4.03	0.69
66	Citroen Saxo 1.1 SX (LHD)	8.03	75.58	10.63	7.07	9.12	2.05	0.26
67	Daewoo Matiz SE+ RHD	13.75	78.38	17.54	9.99	18.92	8.93	0.65
69	Fiat Seicento	8.98	76.30	11.77	5.80	13.90	8.10	0.90
70	Ford Fiesta 1.25 Zetec	8.01	70.72	11.32	6.53	9.82	3.29	0.41
71	Nissan Micra L 1.0 (RHD)	11.26	73.04	15.41	7.25	17.47	10.22	0.91
72	Peugeot 206 1.3 XR Presence (LHD)	7.54	69.60	10.83	5.85	9.71	3.87	0.51
73	Renault Clio 1.2 RTE (LHD)	5.87	68.76	8.53	4.35	7.91	3.57	0.61

74	Rover 25 1.4i (RHD)	7.66	72.72	10.53	5.06	11.57	6.51	0.85
77	Toyota Yaris 1.0 Terra (LHD)	8.03	71.99	11.16	5.09	12.67	7.58	0.94
78	Volkswagen Polo 1.4 (LHD)	7.35	67.11	10.95	4.81	11.23	6.42	0.87
81	Nissan Almera Hatch	5.72	64.02	8.93	3.04	10.75	7.70	1.35
84	BMW 316i (LHD)	6.20	61.30	10.11	4.51	8.50	3.99	0.64
89	Peugeot 406 (LHD)	6.42	56.03	11.46	4.60	8.97	4.38	0.68
91	Rover 75 1.8 (RHD)	3.85	48.05	8.02	1.63	9.13	7.50	1.95
93	Vauxhall/Opel Vectra 1.8 (LHD)	7.64	58.52	13.05	6.08	9.60	3.52	0.46
94	Volkswagon Passat 1.9 Tdi (LHD)	5.45	56.43	9.66	3.72	7.99	4.28	0.78
96	Citroen Picasso 1.6 LX (LHD)	6.65	61.45	10.82	2.89	15.31	12.42	1.87
102	Renault Scenic 1.4 (LHD)	5.97	66.54	8.98	3.38	10.55	7.17	1.20
112	Mazda MX-5 1.6 LHD	9.33	66.41	14.05	6.27	13.90	7.63	0.82
115	Jeep Cherokee 2.5 TD Limited (LHD)	4.20	41.66	10.09	2.12	8.36	6.24	1.48
136	Vauxhall/Opel Corsa 1.2 Comfort (LHD)	6.55	65.53	9.99	3.48	12.31	8.82	1.35

ALL CRASH TYPES (Newstead Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating**	**Estimated Injury Risk**	**Estimated Injury Severity**	**Lower 95% CI CWR**	**Upper 95% CI CWR**	**Range of CI**	**CWR Coeffi-cient of Variation**
	All Model Average	**3.72**	**34.74**	**10.72**				
1	Fiat Punto 55S	4.28	39.73	10.77	3.59	5.10	1.51	0.35
2	Ford Fiesta 1.25 LX 16V	4.27	39.25	10.87	3.85	4.73	0.89	0.21
3	Nissan Micra 1.0L	5.76	40.42	14.26	4.94	6.73	1.80	0.31
4	Renault Clio 1.2RL	4.97	42.22	11.78	3.42	7.23	3.81	0.77
5	Rover 100	5.42	40.18	13.48	4.67	6.28	1.61	0.30
6	Vauxhall Corsa 1.2LS	4.05	36.27	11.16	2.70	6.07	3.36	0.83
7	Volkswagen Polo 1.4L	4.26	38.98	10.92	3.57	5.07	1.50	0.35
8	Audi A4 1.8	3.54	31.67	11.18	2.41	5.20	2.79	0.79
9	BMW 316i	3.10	27.93	11.10	2.64	3.64	1.00	0.32
10	Citroen Xantia 1.8i Dimension	3.04	30.08	10.11	2.43	3.80	1.37	0.45
11	Ford Mondeo 1.8LX	3.57	33.78	10.57	3.08	4.14	1.05	0.30
12	Mercedes C180 Classic	1.69	31.29	5.40	0.99	2.90	1.91	1.13
13	Nissan Primera 1.6GX	3.64	31.05	11.71	2.71	4.89	2.18	0.60
14	Peugeot 406 1.8LX	2.95	27.92	10.57	2.42	3.60	1.19	0.40
15	Renault Laguna 2.0RT	3.12	34.35	9.07	2.36	4.12	1.76	0.56
16	Rover 620 Si	3.31	32.26	10.27	2.58	4.25	1.67	0.50
17	Saab 900 2.0i	3.02	24.32	12.43	1.64	5.57	3.94	1.30
18	Vauxhall Vectra 1.8iLS	3.92	33.13	11.82	3.42	4.48	1.06	0.27
19	Volkswagen Passat 1.6L (LHD)	4.95	32.40	15.27	3.16	7.75	4.60	0.93
20	Audi A3 1.6	3.22	33.46	9.62	1.83	5.67	3.84	1.19
21	Citroen Xsara 1.4i (LHD)	3.82	38.18	10.00	2.42	6.02	3.60	0.94
22	Daewoo Lanos 1.4SE (LHD)	4.06	35.00	11.59	2.68	6.14	3.46	0.85
23	Fiat Brava 1.4S	3.66	35.27	10.38	2.93	4.58	1.65	0.45
24	Honda Civic 1.4i	5.26	37.92	13.87	4.47	6.19	1.71	0.33
25	Hyundai Accent 1.3GLS (LHD)	5.20	42.23	12.30	3.48	7.76	4.29	0.83
27	Peugeot 306 1.6GLX	4.74	38.06	12.47	4.09	5.50	1.41	0.30
28	Renault Megane 1.6RT (LHD)	3.52	34.87	10.09	2.84	4.37	1.53	0.43
29	Suzuki Baleno 1.6GLX	4.03	35.13	11.46	2.36	6.86	4.50	1.12

	(LHD)							
30	Toyota Corolla 1.3 Sportif (LHD)	4.22	33.45	12.62	3.04	5.87	2.84	0.67
31	Volkswagen Golf 1.4 (LHD)	3.46	27.65	12.53	1.79	6.69	4.90	1.41
32	Audi A6 2.4 (LHD)	1.92	29.44	6.53	0.84	4.38	3.54	1.84
33	BMW 520i (LHD)	3.24	25.25	12.84	2.12	4.95	2.83	0.87
34	Mercedes E200 Classic (LHD)	3.36	28.95	11.59	1.87	6.03	4.16	1.24
36	Saab 9-5 2.0 (LHD)	2.05	25.07	8.18	0.74	5.68	4.93	2.40
37	Vauxhall Omega 2.0Gl/GLS (LHD)	2.93	31.94	9.17	2.21	3.88	1.67	0.57
38	Volvo S70 2.0/2.5 10V (LHD)	4.04	35.63	11.34	1.77	9.21	7.43	1.84
39	Ford Focus 1.6 (LHD)	3.43	33.69	10.17	2.78	4.23	1.45	0.42
40	Mercedes A140 Classic (LHD)	5.51	40.42	13.63	3.23	9.39	6.16	1.12
41	Vauxhall Astra 1.6i Envoy	4.53	40.21	11.27	3.89	5.28	1.39	0.31
42	Ford Escort 1.6 LX	4.18	37.79	11.05	3.80	4.59	0.79	0.19
43	Nissan Almera 1.4GX	4.01	40.90	9.80	2.66	6.05	3.39	0.85
47	Nissan Serena 1.6 (LHD)	4.33	32.08	13.49	2.07	9.05	6.98	1.61
48	Volkswagen Sharan TDI (LHD)	2.69	26.94	10.00	1.25	5.79	4.54	1.68
56	Vauxhall Corsa 1.0 12v Club	4.02	37.83	10.64	3.30	4.90	1.60	0.40
59	Honda Accord 1.8iLS	1.01	33.79	2.99	0.25	4.06	3.81	3.78
61	Saab 9-3 2.0 (LHD)	2.22	20.55	10.79	1.00	4.91	3.91	1.76
63	Ford Ka 1.3 (LHD)	4.44	39.12	11.34	3.70	5.32	1.62	0.36
64	Volvo S40 1.8	2.38	33.69	7.06	1.36	4.15	2.79	1.17
65	Toyota Avensis 1.6S	3.37	36.68	9.18	2.35	4.83	2.48	0.74
66	Citroen Saxo 1.1 SX (LHD)	4.80	45.16	10.63	4.17	5.52	1.35	0.28
67	Daewoo Matiz SE+ RHD	8.69	49.54	17.54	6.05	12.48	6.43	0.74
69	Fiat Seicento	5.66	48.13	11.77	3.53	9.10	5.57	0.98
70	Ford Fiesta 1.25 Zetec	4.67	41.23	11.32	3.73	5.84	2.11	0.45
71	Nissan Micra L 1.0 (RHD)	6.82	44.22	15.41	4.15	11.19	7.04	1.03
72	Peugeot 206 1.3 XR Presence (LHD)	4.15	38.32	10.83	3.14	5.49	2.36	0.57
73	Renault Clio 1.2 RTE (LHD)	3.08	36.05	8.53	2.22	4.26	2.05	0.67

74	Rover 25 1.4i (RHD)	4.76	45.19	10.53	3.04	7.44	4.39	0.92
77	Toyota Yaris 1.0 Terra (LHD)	4.69	42.01	11.16	2.85	7.70	4.85	1.03
78	Volkswagen Polo 1.4 (LHD)	4.08	37.23	10.95	2.54	6.53	3.99	0.98
81	Nissan Almera Hatch	3.17	35.48	8.93	1.61	6.23	4.62	1.46
84	BMW 316i (LHD)	3.04	30.11	10.11	2.12	4.36	2.24	0.73
89	Peugeot 406 (LHD)	3.46	30.22	11.46	2.41	4.98	2.57	0.74
91	Rover 75 1.8 (RHD)	1.60	19.96	8.02	0.63	4.08	3.46	2.16
93	Vauxhall/Opel Vectra 1.8 (LHD)	4.23	32.41	13.05	3.30	5.43	2.13	0.50
94	Volkswagon Passat 1.9 Tdi (LHD)	3.21	33.22	9.66	2.14	4.81	2.66	0.83
96	Citroen Picasso 1.6 LX (LHD)	3.93	36.34	10.82	1.62	9.55	7.93	2.02
102	Renault Scenic 1.4 (LHD)	3.25	36.20	8.98	1.77	5.98	4.21	1.30
112	Mazda MX-5 1.6 LHD	5.44	38.70	14.05	3.45	8.58	5.14	0.94
115	Jeep Cherokee 2.5 TD Limited (LHD)	2.22	22.03	10.09	1.06	4.64	3.58	1.61
136	Vauxhall/Opel Corsa 1.2 Comfort (LHD)	3.99	39.96	9.99	2.03	7.85	5.82	1.46

FRONTAL CRASHES (DfT Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating**	**Estimated Injury Risk**	**Estimated Injury Severity**	**Lower 95% CI CWR**	**Upper 95% CI CWR**	**Range of CI**	**CWR Coeffi-cient of Variation**
	All Model Average	**7.40**	**53.92**	**13.73**				
1	Fiat Punto 55S	7.91	60.52	13.08	6.52	9.60	3.09	0.39
2	Ford Fiesta 1.25 LX 16V	7.76	56.71	13.68	6.97	8.64	1.67	0.22
3	Nissan Micra 1.0L	11.16	61.07	18.28	9.53	13.07	3.54	0.32
4	Renault Clio 1.2RL	9.16	61.52	14.88	6.19	13.53	7.34	0.80
5	Rover 100	10.14	62.34	16.26	8.66	11.87	3.21	0.32
6	Vauxhall Corsa 1.2LS	9.20	53.69	17.13	6.15	13.76	7.61	0.83
7	Volkswagen Polo 1.4L	7.80	56.31	13.85	6.44	9.45	3.01	0.39
8	Audi A4 1.8	4.51	38.38	11.75	2.77	7.33	4.55	1.01
9	BMW 316i	5.99	41.98	14.26	5.02	7.15	2.13	0.36
10	Citroen Xantia 1.8i Dimension	5.48	42.51	12.89	4.28	7.01	2.72	0.50
11	Ford Mondeo 1.8LX	6.17	48.53	12.71	5.23	7.27	2.04	0.33
12	Mercedes C180 Classic	2.43	38.74	6.27	1.17	5.02	3.85	1.59
13	Nissan Primera 1.6GX	7.68	50.51	15.21	5.63	10.48	4.85	0.63
14	Peugeot 406 1.8LX	6.07	43.16	14.05	4.91	7.49	2.58	0.42
15	Renault Laguna 2.0RT	6.54	48.81	13.40	4.94	8.67	3.73	0.57
16	Rover 620 Si	5.29	42.13	12.56	3.92	7.13	3.21	0.61
18	Vauxhall Vectra 1.8iLS	7.16	48.03	14.90	6.19	8.28	2.09	0.29
19	Volkswagen Passat 1.6L (LHD)	9.77	44.46	21.96	6.05	15.76	9.71	0.99
20	Audi A3 1.6	6.80	52.40	12.98	3.75	12.33	8.57	1.26
21	Citroen Xsara 1.4i (LHD)	7.31	54.52	13.41	4.55	11.74	7.19	0.98
22	Daewoo Lanos 1.4SE (LHD)	7.81	55.02	14.19	4.88	12.49	7.61	0.98
23	Fiat Brava 1.4S	7.69	55.07	13.96	6.09	9.71	3.62	0.47
24	Honda Civic 1.4i	8.84	53.48	16.54	7.40	10.57	3.17	0.36
25	Hyundai Accent 1.3GLS (LHD)	8.26	64.15	12.87	5.12	13.32	8.20	0.99
27	Peugeot 306 1.6GLX	8.30	57.24	14.49	7.06	9.74	2.68	0.32
28	Renault Megane 1.6RT (LHD)	6.99	55.63	12.56	5.52	8.85	3.33	0.48
29	Suzuki Baleno 1.6GLX	7.90	59.40	13.30	4.38	14.25	9.87	1.25

	(LHD)							
30	Toyota Corolla 1.3 Sportif (LHD)	6.46	50.17	12.87	4.31	9.67	5.35	0.83
33	BMW 520i (LHD)	6.14	36.10	17.01	3.77	10.01	6.24	1.02
37	Vauxhall Omega 2.0Gl/GLS (LHD)	5.26	48.24	10.90	3.79	7.30	3.50	0.67
39	Ford Focus 1.6 (LHD)	6.16	49.46	12.46	4.91	7.74	2.83	0.46
40	Mercedes A140 Classic (LHD)	10.04	61.49	16.33	5.50	18.35	12.85	1.28
41	Vauxhall Astra 1.6i Envoy	7.91	59.55	13.28	6.70	9.33	2.62	0.33
42	Ford Escort 1.6 LX	7.23	54.34	13.30	6.55	7.98	1.43	0.20
43	Nissan Almera 1.4GX	7.98	56.35	14.15	5.26	12.10	6.84	0.86
56	Vauxhall Corsa 1.0 12v Club	7.56	58.56	12.90	6.11	9.35	3.24	0.43
63	Ford Ka 1.3 (LHD)	8.35	58.25	14.33	6.89	10.12	3.24	0.39
64	Volvo S40 1.8	5.72	47.80	11.97	3.24	10.11	6.88	1.20
65	Toyota Avensis 1.6S	5.06	52.37	9.67	3.19	8.03	4.83	0.96
66	Citroen Saxo 1.1 SX (LHD)	8.02	65.68	12.21	6.89	9.34	2.45	0.31
67	Daewoo Matiz SE+ RHD	12.87	65.93	19.53	8.43	19.65	11.22	0.87
69	Fiat Seicento	11.57	67.34	17.18	7.26	18.44	11.18	0.97
70	Ford Fiesta 1.25 Zetec	8.96	61.19	14.64	7.10	11.30	4.20	0.47
71	Nissan Micra L 1.0 (RHD)	12.16	63.04	19.29	7.45	19.83	12.38	1.02
72	Peugeot 206 1.3 XR Presence (LHD)	6.95	57.86	12.02	5.00	9.66	4.66	0.67
73	Renault Clio 1.2 RTE (LHD)	6.23	56.57	11.02	4.39	8.85	4.46	0.72
74	Rover 25 1.4i (RHD)	8.06	61.43	13.12	4.97	13.06	8.10	1.00
77	Toyota Yaris 1.0 Terra (LHD)	9.29	65.58	14.17	5.44	15.85	10.41	1.12
78	Volkswagen Polo 1.4 (LHD)	6.06	58.39	10.37	3.33	11.01	7.68	1.27
84	BMW 316i (LHD)	5.70	50.44	11.29	3.73	8.69	4.96	0.87
89	Peugeot 406 (LHD)	7.02	47.95	14.65	4.73	10.43	5.71	0.81
93	Vauxhall/Opel Vectra 1.8 (LHD)	6.66	45.47	14.65	4.97	8.92	3.95	0.59
94	Volkswagon Passat 1.9 Tdi (LHD)	6.41	48.19	13.30	4.15	9.90	5.75	0.90
102	Renault Scenic 1.4 (LHD)	6.32	53.45	11.83	3.11	12.85	9.75	1.54

FRONTAL CRASHES (Newstead Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating**	**Estimated Injury Risk**	**Estimated Injury Severity**	**Lower 95% CI CWR**	**Upper 95% CI CWR**	**Range of CI**	**CWR Coeffi-cient of Variation**
	All Model Average	**4.61**	**33.61**	**13.73**				
1	Fiat Punto 55S	4.80	36.69	13.08	3.89	5.92	2.03	0.42
2	Ford Fiesta 1.25 LX 16V	5.02	36.68	13.68	4.47	5.63	1.16	0.23
3	Nissan Micra 1.0L	6.82	37.33	18.28	5.71	8.16	2.45	0.36
4	Renault Clio 1.2RL	5.82	39.08	14.88	3.76	9.01	5.25	0.90
5	Rover 100	6.20	38.14	16.26	5.20	7.39	2.19	0.35
6	Vauxhall Corsa 1.2LS	6.01	35.07	17.13	3.85	9.39	5.54	0.92
7	Volkswagen Polo 1.4L	4.92	35.55	13.85	4.00	6.06	2.06	0.42
8	Audi A4 1.8	2.83	24.07	11.75	1.69	4.74	3.05	1.08
9	BMW 316i	3.39	23.77	14.26	2.78	4.13	1.35	0.40
10	Citroen Xantia 1.8i Dimension	3.47	26.90	12.89	2.67	4.50	1.83	0.53
11	Ford Mondeo 1.8LX	4.01	31.55	12.71	3.37	4.78	1.41	0.35
12	Mercedes C180 Classic	1.48	23.57	6.27	0.69	3.14	2.44	1.66
13	Nissan Primera 1.6GX	4.37	28.74	15.21	3.09	6.19	3.10	0.71
14	Peugeot 406 1.8LX	3.65	25.95	14.05	2.91	4.57	1.66	0.46
15	Renault Laguna 2.0RT	4.23	31.53	13.40	3.13	5.70	2.57	0.61
16	Rover 620 Si	3.27	26.06	12.56	2.39	4.49	2.10	0.64
18	Vauxhall Vectra 1.8iLS	4.42	29.65	14.90	3.77	5.18	1.40	0.32
19	Volkswagen Passat 1.6L (LHD)	6.79	30.92	21.96	4.06	11.35	7.29	1.07
20	Audi A3 1.6	4.43	34.13	12.98	2.34	8.38	6.04	1.36
21	Citroen Xsara 1.4i (LHD)	4.45	33.18	13.41	2.64	7.51	4.87	1.10
22	Daewoo Lanos 1.4SE (LHD)	4.54	32.00	14.19	2.69	7.65	4.96	1.09
23	Fiat Brava 1.4S	4.62	33.13	13.96	3.59	5.96	2.37	0.51
24	Honda Civic 1.4i	5.79	34.99	16.54	4.77	7.02	2.26	0.39
25	Hyundai Accent 1.3GLS (LHD)	4.39	34.10	12.87	2.57	7.50	4.94	1.13
27	Peugeot 306 1.6GLX	5.24	36.12	14.49	4.39	6.24	1.85	0.35
28	Renault Megane 1.6RT (LHD)	3.97	31.58	12.56	3.06	5.14	2.08	0.53
29	Suzuki Baleno 1.6GLX (LHD)	4.41	33.13	13.30	2.27	8.54	6.27	1.42

30	Toyota Corolla 1.3 Sportif (LHD)	3.98	30.91	12.87	2.58	6.14	3.57	0.90
33	BMW 520i (LHD)	3.89	22.86	17.01	2.29	6.62	4.33	1.11
37	Vauxhall Omega 2.0Gl/GLS (LHD)	3.09	28.30	10.90	2.17	4.38	2.21	0.72
39	Ford Focus 1.6 (LHD)	3.86	31.00	12.46	3.03	4.93	1.90	0.49
40	Mercedes A140 Classic (LHD)	7.03	43.03	16.33	3.69	13.37	9.68	1.38
41	Vauxhall Astra 1.6i Envoy	4.90	36.90	13.28	4.10	5.86	1.76	0.36
42	Ford Escort 1.6 LX	4.62	34.78	13.30	4.16	5.14	0.98	0.21
43	Nissan Almera 1.4GX	5.76	40.67	14.15	3.71	8.93	5.22	0.91
56	Vauxhall Corsa 1.0 12v Club	4.68	36.25	12.90	3.71	5.90	2.19	0.47
63	Ford Ka 1.3 (LHD)	5.46	38.10	14.33	4.43	6.73	2.31	0.42
64	Volvo S40 1.8	3.54	29.55	11.97	1.93	6.49	4.56	1.29
65	Toyota Avensis 1.6S	3.25	33.66	9.67	2.00	5.28	3.27	1.01
66	Citroen Saxo 1.1 SX (LHD)	5.26	43.12	12.21	4.46	6.21	1.74	0.33
67	Daewoo Matiz SE+ RHD	9.05	46.33	19.53	5.69	14.39	8.71	0.96
69	Fiat Seicento	7.92	46.11	17.18	4.75	13.23	8.48	1.07
70	Ford Fiesta 1.25 Zetec	5.74	39.18	14.64	4.45	7.40	2.95	0.51
71	Nissan Micra L 1.0 (RHD)	8.23	42.65	19.29	4.76	14.21	9.45	1.15
72	Peugeot 206 1.3 XR Presence (LHD)	4.47	37.16	12.02	3.14	6.36	3.22	0.72
73	Renault Clio 1.2 RTE (LHD)	3.58	32.47	11.02	2.44	5.23	2.79	0.78
74	Rover 25 1.4i (RHD)	5.43	41.42	13.12	3.23	9.14	5.91	1.09
77	Toyota Yaris 1.0 Terra (LHD)	6.20	43.77	14.17	3.48	11.05	7.57	1.22
78	Volkswagen Polo 1.4 (LHD)	4.04	38.96	10.37	2.14	7.64	5.51	1.36
84	BMW 316i (LHD)	3.13	27.72	11.29	1.95	5.02	3.06	0.98
89	Peugeot 406 (LHD)	4.17	28.43	14.65	2.70	6.42	3.72	0.89
93	Vauxhall/Opel Vectra 1.8 (LHD)	4.25	29.02	14.65	3.10	5.82	2.72	0.64
94	Volkswagon Passat 1.9 Tdi (LHD)	4.06	30.52	13.30	2.55	6.46	3.90	0.96
102	Renault Scenic 1.4 (LHD)	3.84	32.50	11.83	1.80	8.22	6.43	1.67

SIDE IMPACT CRASHES (DfT Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating**	**Estimated Injury Risk**	**Estimated Injury Severity**	**Lower 95% CI CWR**	**Upper 95% CI CWR**	**Range of CI**	**CWR Coeffi-cient of Variation**
	All Model Average	**8.18**	**70.30**	**11.63**				
1	Fiat Punto 55S	6.50	74.04	8.78	4.22	10.03	5.81	0.89
2	Ford Fiesta 1.25 LX 16V	8.50	72.66	11.69	6.77	10.66	3.89	0.46
3	Nissan Micra 1.0L	10.19	79.52	12.82	7.08	14.68	7.61	0.75
5	Rover 100	12.40	78.29	15.84	9.36	16.43	7.07	0.57
7	Volkswagen Polo 1.4L	8.98	74.13	12.11	6.22	12.96	6.74	0.75
9	BMW 316i	8.09	59.73	13.55	5.89	11.12	5.24	0.65
10	Citroen Xantia 1.8i Dimension	6.26	63.34	9.88	3.63	10.78	7.15	1.14
11	Ford Mondeo 1.8LX	9.89	65.94	15.00	7.44	13.16	5.72	0.58
14	Peugeot 406 1.8LX	6.44	57.92	11.12	4.01	10.34	6.33	0.98
16	Rover 620 Si	10.26	73.33	13.99	6.46	16.28	9.82	0.96
18	Vauxhall Vectra 1.8iLS	8.78	67.48	13.02	6.65	11.60	4.94	0.56
23	Fiat Brava 1.4S	5.55	71.31	7.78	3.08	10.00	6.92	1.25
24	Honda Civic 1.4i	9.58	65.77	14.57	6.71	13.69	6.98	0.73
27	Peugeot 306 1.6GLX	10.29	70.78	14.55	7.38	14.36	6.97	0.68
28	Renault Megane 1.6RT (LHD)	5.93	72.98	8.12	3.52	9.98	6.47	1.09
37	Vauxhall Omega 2.0GI/GLS (LHD)	5.04	63.65	7.92	2.46	10.32	7.85	1.56
39	Ford Focus 1.6 (LHD)	6.39	62.91	10.16	3.65	11.17	7.52	1.18
41	Vauxhall Astra 1.6i Envoy	10.28	72.55	14.18	7.36	14.38	7.03	0.68
42	Ford Escort 1.6 LX	8.78	70.67	12.43	7.22	10.69	3.48	0.40
56	Vauxhall Corsa 1.0 12v Club	8.70	72.21	12.05	5.61	13.48	7.86	0.90
63	Ford Ka 1.3 (LHD)	8.44	74.37	11.35	5.58	12.78	7.20	0.85
66	Citroen Saxo 1.1 SX (LHD)	10.71	80.74	13.27	8.02	14.31	6.29	0.59
93	Vauxhall/Opel Vectra 1.8 (LHD)	7.59	63.35	11.97	3.97	14.49	10.52	1.39

SIDE IMPACT CRASHES (Newstead Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating**	**Estimated Injury Risk**	**Estimated Injury Severity**	**Lower 95% CI CWR**	**Upper 95% CI CWR**	**Range of CI**	**CWR Coeffi-cient of Variation**
	All Model Average	**4.87**	**41.84**	**11.63**				
1	Fiat Punto 55S	3.93	44.75	8.78	2.47	6.26	3.79	0.96
2	Ford Fiesta 1.25 LX 16V	5.36	45.87	11.69	4.20	6.85	2.65	0.49
3	Nissan Micra 1.0L	6.97	54.33	12.82	4.69	10.33	5.64	0.81
5	Rover 100	7.90	49.87	15.84	5.74	10.86	5.12	0.65
7	Volkswagen Polo 1.4L	5.98	49.35	12.11	4.02	8.88	4.86	0.81
9	BMW 316i	4.04	29.82	13.55	2.77	5.90	3.13	0.78
10	Citroen Xantia 1.8i Dimension	3.26	32.97	9.88	1.79	5.91	4.12	1.26
11	Ford Mondeo 1.8LX	5.84	38.96	15.00	4.27	8.00	3.73	0.64
14	Peugeot 406 1.8LX	3.59	32.26	11.12	2.14	6.00	3.86	1.08
16	Rover 620 Si	7.04	50.30	13.99	4.29	11.55	7.26	1.03
18	Vauxhall Vectra 1.8iLS	5.47	42.05	13.02	4.04	7.41	3.36	0.61
23	Fiat Brava 1.4S	3.42	43.94	7.78	1.84	6.35	4.51	1.32
24	Honda Civic 1.4i	6.25	42.91	14.57	4.24	9.22	4.98	0.80
27	Peugeot 306 1.6GLX	5.72	39.35	14.55	3.91	8.38	4.47	0.78
28	Renault Megane 1.6RT (LHD)	3.55	43.68	8.12	2.03	6.19	4.16	1.17
37	Vauxhall Omega 2.0GI/GLS (LHD)	2.99	37.70	7.92	1.39	6.39	5.00	1.67
39	Ford Focus 1.6 (LHD)	3.83	37.69	10.16	2.12	6.93	4.81	1.26
41	Vauxhall Astra 1.6i Envoy	6.27	44.25	14.18	4.34	9.06	4.72	0.75
42	Ford Escort 1.6 LX	5.52	44.41	12.43	4.47	6.82	2.35	0.43
56	Vauxhall Corsa 1.0 12v Club	4.76	39.56	12.05	2.91	7.81	4.90	1.03
63	Ford Ka 1.3 (LHD)	4.78	42.10	11.35	3.02	7.58	4.56	0.95
66	Citroen Saxo 1.1 SX (LHD)	5.97	44.99	13.27	4.24	8.40	4.17	0.70
93	Vauxhall/Opel Vectra 1.8 (LHD)	4.00	33.40	11.97	1.97	8.12	6.15	1.54

APPENDIX C

SAFETY RATINGS ESTIMATED FROM FRENCH REAL ACCIDENT DATA

ALL CRASH TYPES (DfT Method)								
Euro NCAP Index	Vehicle Make/Model	Crash-worthiness Rating	Estimated Injury Risk	Estimated Injury Severity	Lower 95% CI CWR	Upper 95% CI CWR	Range of CI	CWR Coeffi-cient of Variation
	All Model Average	**15.51**	**66.23**	**23.42**				
1	Fiat Punto 55S	17.66	74.93	23.57	15.29	20.39	5.10	0.29
2	Ford Fiesta 1.25 LX 16V	18.46	73.24	25.20	15.49	21.99	6.50	0.35
3	Nissan Micra 1.0L	21.94	78.40	27.98	12.86	37.40	24.54	1.12
4	Renault Clio 1.2RL	21.72	75.31	28.84	19.70	23.94	4.24	0.20
6	Vauxhall Corsa 1.2LS	19.51	73.23	26.64	16.47	23.11	6.64	0.34
7	Volkswagen Polo 1.4L	19.95	72.26	27.61	16.86	23.62	6.76	0.34
9	BMW 316i	18.58	60.19	30.87	12.94	26.69	13.75	0.74
10	Citroen Xantia 1.8i Dimension	15.10	59.27	25.47	13.04	17.47	4.43	0.29
11	Ford Mondeo 1.8LX	6.52	58.29	11.18	3.09	13.73	10.64	1.63
12	Mercedes C180 Classic	12.33	57.29	21.52	5.22	29.13	23.91	1.94
13	Nissan Primera 1.6GX	2.90	57.61	5.04	0.45	18.57	18.12	6.25
14	Peugeot 406 1.8LX	12.81	55.68	23.01	10.34	15.87	5.53	0.43
15	Renault Laguna 2.0RT	14.64	59.23	24.71	11.60	18.47	6.87	0.47
18	Vauxhall Vectra 1.8iLS	12.19	57.87	21.06	7.77	19.12	11.35	0.93
20	Audi A3 1.6	11.64	62.47	18.63	5.38	25.15	19.77	1.70
21	Citroen Xsara 1.4i (LHD)	17.83	70.60	25.26	13.58	23.41	9.83	0.55
23	Fiat Brava 1.4S	20.66	69.21	29.85	16.09	26.52	10.43	0.50
24	Honda Civic 1.4i	15.65	61.65	25.38	9.98	24.52	14.54	0.93
27	Peugeot 306 1.6GLX	16.64	68.00	24.47	14.20	19.50	5.30	0.32
28	Renault Megane 1.6RT (LHD)	20.08	68.31	29.40	17.11	23.58	6.47	0.32
39	Ford Focus 1.6 (LHD)	12.91	64.02	20.16	7.46	22.32	14.86	1.15
41	Vauxhall Astra 1.6i Envoy	12.42	65.27	19.03	7.77	19.85	12.08	0.97
42	Ford Escort 1.6 LX	18.53	68.92	26.89	15.70	21.87	6.17	0.33
44	Renault Espace 2.0RTE (LHD)	7.57	42.42	17.85	3.89	14.74	10.85	1.43
46	Peugeot 806 2.0 (LHD)	21.37	54.51	39.20	12.51	36.50	23.99	1.12
56	Vauxhall Corsa 1.0 12v Club	17.15	72.46	23.67	12.11	24.28	12.17	0.71
63	Ford Ka 1.3 (LHD)	15.17	71.45	21.24	9.82	23.46	13.64	0.90

66	Citroen Saxo 1.1 SX (LHD)	22.94	77.70	29.53	19.95	26.38	6.43	0.28
70	Ford Fiesta 1.25 Zetec	15.22	76.52	19.89	8.36	27.69	19.33	1.27
72	Peugeot 206 1.3 XR Presence (LHD)	17.98	75.67	23.77	13.39	24.15	10.76	0.60
73	Renault Clio 1.2 RTE (LHD)	14.54	72.40	20.08	10.98	19.25	8.27	0.57
78	Volkswagen Polo 1.4 (LHD)	19.12	73.32	26.08	11.76	31.09	19.33	1.01
84	BMW 316i (LHD)	17.57	55.38	31.72	9.51	32.45	22.94	1.31
89	Peugeot 406 (LHD)	12.17	57.72	21.09	8.22	18.03	9.81	0.81
94	Volkswagon Passat 1.9 Tdi (LHD)	23.02	62.50	36.84	15.34	34.54	19.20	0.83
102	Renault Scenic 1.4 (LHD)	8.13	57.41	14.17	4.45	14.86	10.41	1.28

ALL CRASH TYPES (Newstead Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating**	**Estimated Injury Risk**	**Estimated Injury Severity**	**Lower 95 CI CWR**	**Upper 95 CI CWR**	**Range of CI**	**CWR Coeffi-cient of Variation**
	All Model Average	**11.45**	**48.88**	**23.42**				
1	Fiat Punto 55S	13.45	57.06	23.57	11.54	15.67	4.13	0.31
2	Ford Fiesta 1.25 LX 16V	14.20	56.36	25.20	11.79	17.11	5.32	0.37
3	Nissan Micra 1.0L	16.09	57.51	27.98	8.96	28.88	19.92	1.24
4	Renault Clio 1.2RL	17.10	59.31	28.84	15.41	18.98	3.57	0.21
6	Vauxhall Corsa 1.2LS	15.06	56.52	26.64	12.51	18.11	5.60	0.37
7	Volkswagen Polo 1.4L	15.54	56.29	27.61	12.97	18.63	5.66	0.36
9	BMW 316i	14.29	46.29	30.87	9.73	20.99	11.26	0.79
10	Citroen Xantia 1.8i Dimension	11.52	45.24	25.47	9.87	13.46	3.59	0.31
11	Ford Mondeo 1.8LX	4.54	40.57	11.18	2.11	9.75	7.64	1.68
12	Mercedes C180 Classic	7.89	36.64	21.52	3.15	19.72	16.57	2.10
13	Nissan Primera 1.6GX	1.97	39.20	5.04	0.30	12.90	12.60	6.40
14	Peugeot 406 1.8LX	9.28	40.32	23.01	7.39	11.65	4.26	0.46
15	Renault Laguna 2.0RT	11.36	45.96	24.71	8.90	14.50	5.60	0.49
18	Vauxhall Vectra 1.8iLS	8.82	41.89	21.06	5.50	14.15	8.65	0.98
20	Audi A3 1.6	8.48	45.50	18.63	3.82	18.81	14.99	1.77
21	Citroen Xsara 1.4i (LHD)	13.60	53.83	25.26	10.19	18.15	7.96	0.59
23	Fiat Brava 1.4S	15.78	52.88	29.85	12.04	20.69	8.65	0.55
24	Honda Civic 1.4i	10.67	42.05	25.38	6.51	17.49	10.98	1.03
27	Peugeot 306 1.6GLX	12.03	49.16	24.47	10.16	14.25	4.09	0.34
28	Renault Megane 1.6RT (LHD)	15.29	52.00	29.40	12.84	18.20	5.36	0.35
39	Ford Focus 1.6 (LHD)	10.18	50.51	20.16	5.78	17.93	12.15	1.19
41	Vauxhall Astra 1.6i Envoy	9.30	48.89	19.03	5.72	15.13	9.41	1.01
42	Ford Escort 1.6 LX	14.01	52.08	26.89	11.72	16.73	5.01	0.36
44	Renault Espace 2.0RTE (LHD)	5.32	29.83	17.85	2.68	10.59	7.91	1.49
46	Peugeot 806 2.0 (LHD)	17.02	43.41	39.20	9.60	30.18	20.58	1.21
56	Vauxhall Corsa 1.0 12v Club	12.67	53.52	23.67	8.76	18.32	9.56	0.75
63	Ford Ka 1.3 (LHD)	10.30	48.50	21.24	6.40	16.58	10.18	0.99

66	Citroen Saxo 1.1 SX (LHD)	17.69	59.90	29.53	15.21	20.56	5.35	0.30
70	Ford Fiesta 1.25 Zetec	12.34	62.04	19.89	6.66	22.87	16.21	1.31
72	Peugeot 206 1.3 XR Presence (LHD)	13.79	58.01	23.77	10.08	18.86	8.78	0.64
73	Renault Clio 1.2 RTE (LHD)	10.11	50.34	20.08	7.51	13.61	6.10	0.60
78	Volkswagen Polo 1.4 (LHD)	14.97	57.42	26.08	8.99	24.93	15.94	1.06
84	BMW 316i (LHD)	12.44	39.21	31.72	6.42	24.11	17.69	1.42
89	Peugeot 406 (LHD)	8.57	40.65	21.09	5.68	12.95	7.27	0.85
94	Volkswagon Passat 1.9 Tdi (LHD)	16.22	44.04	36.84	10.38	25.36	14.98	0.92
102	Renault Scenic 1.4 (LHD)	6.18	43.64	14.17	3.33	11.47	8.14	1.32

FRONT IMPACT CRASHES (DfT Method)								
Euro NCAP Index	Vehicle Make/Model	Crash-worthiness Rating	Estimated Injury Risk	Estimated Injury Severity	Lower 95 CI CWR	Upper 95 CI CWR	Range of CI	CWR Coeffi-cient of Variation
	All Model Average	**15.22**	**63.30**	**24.05**				
1	Fiat Punto 55S	17.13	71.81	23.86	14.64	20.04	5.40	0.32
2	Ford Fiesta 1.25 LX 16V	18.73	70.15	26.70	15.48	22.65	7.17	0.38
4	Renault Clio 1.2RL	20.59	72.96	28.22	18.54	22.87	4.33	0.21
6	Vauxhall Corsa 1.2LS	19.96	70.58	28.28	16.59	24.02	7.43	0.37
7	Volkswagen Polo 1.4L	17.03	68.09	25.01	13.87	20.92	7.05	0.41
9	BMW 316i	20.51	57.42	35.72	13.89	30.29	16.40	0.80
10	Citroen Xantia 1.8i Dimension	13.56	55.09	24.61	11.48	16.00	4.52	0.33
11	Ford Mondeo 1.8LX	6.95	54.77	12.69	3.08	15.69	12.61	1.81
14	Peugeot 406 1.8LX	12.45	50.99	24.41	9.79	15.83	6.04	0.49
15	Renault Laguna 2.0RT	14.42	57.34	25.15	11.13	18.69	7.56	0.52
18	Vauxhall Vectra 1.8iLS	9.88	54.91	18.00	5.49	17.78	12.29	1.24
20	Audi A3 1.6	8.34	55.30	15.09	2.99	23.29	20.30	2.43
21	Citroen Xsara 1.4i (LHD)	18.57	68.14	27.25	13.77	25.04	11.27	0.61
23	Fiat Brava 1.4S	17.45	64.97	26.86	12.83	23.74	10.91	0.63
24	Honda Civic 1.4i	15.13	56.12	26.96	9.00	25.42	16.42	1.09
27	Peugeot 306 1.6GLX	15.06	64.15	23.47	12.55	18.06	5.51	0.37
28	Renault Megane 1.6RT (LHD)	19.36	64.08	30.21	16.13	23.22	7.09	0.37
39	Ford Focus 1.6 (LHD)	11.98	62.15	19.28	6.21	23.11	16.90	1.41
41	Vauxhall Astra 1.6i Envoy	12.14	60.65	20.02	7.02	21.00	13.98	1.15
42	Ford Escort 1.6 LX	18.68	67.33	27.75	15.58	22.41	6.83	0.37
44	Renault Espace 2.0RTE (LHD)	8.32	40.60	20.50	4.09	16.94	12.85	1.54
56	Vauxhall Corsa 1.0 12v Club	18.62	69.46	26.81	12.73	27.23	14.50	0.78
63	Ford Ka 1.3 (LHD)	16.57	68.23	24.29	10.13	27.13	17.00	1.03
66	Citroen Saxo 1.1 SX (LHD)	21.29	74.80	28.46	18.12	25.00	6.88	0.32
70	Ford Fiesta 1.25 Zetec	18.39	70.56	26.07	9.97	33.95	23.98	1.30
72	Peugeot 206 1.3 XR Presence (LHD)	16.15	72.66	22.23	11.37	22.95	11.58	0.72
73	Renault Clio 1.2 RTE	15.09	68.35	22.08	11.09	20.52	9.43	0.62

	(LHD)							
78	Volkswagen Polo 1.4 (LHD)	18.89	69.96	27.00	11.03	32.34	21.31	1.13
89	Peugeot 406 (LHD)	11.16	54.28	20.56	6.99	17.83	10.84	0.97
94	Volkswagon Passat 1.9 Tdi (LHD)	18.21	60.41	30.14	10.35	32.03	21.68	1.19
102	Renault Scenic 1.4 (LHD)	7.27	49.41	14.72	3.48	15.20	11.72	1.61

FRONT IMPACT CRASHES (Newstead Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating**	**Estimated Injury Risk**	**Estimated Injury Severity**	**Lower 95 CI CWR**	**Upper 95 CI CWR**	**Range of CI**	**CWR Coeffi-cient of Variation**
	All Model Average	**11.76**	**48.89**	**24.05**				
1	Fiat Punto 55S	13.28	55.68	23.86	11.24	15.70	4.45	0.34
2	Ford Fiesta 1.25 LX 16V	14.88	55.73	26.70	12.16	18.21	6.06	0.41
4	Renault Clio 1.2RL	16.59	58.79	28.22	14.83	18.56	3.73	0.22
6	Vauxhall Corsa 1.2LS	15.72	55.61	28.28	12.86	19.23	6.37	0.41
7	Volkswagen Polo 1.4L	13.73	54.89	25.01	11.05	17.06	6.01	0.44
9	BMW 316i	16.00	44.79	35.72	10.54	24.27	13.73	0.86
10	Citroen Xantia 1.8i Dimension	10.63	43.21	24.61	8.92	12.67	3.74	0.35
11	Ford Mondeo 1.8LX	5.18	40.78	12.69	2.25	11.93	9.68	1.87
14	Peugeot 406 1.8LX	9.57	39.19	24.41	7.43	12.32	4.89	0.51
15	Renault Laguna 2.0RT	11.61	46.17	25.15	8.86	15.21	6.35	0.55
18	Vauxhall Vectra 1.8iLS	7.57	42.03	18.00	4.13	13.86	9.73	1.29
20	Audi A3 1.6	6.08	40.27	15.09	2.12	17.44	15.32	2.52
21	Citroen Xsara 1.4i (LHD)	15.06	55.26	27.25	11.00	20.61	9.61	0.64
23	Fiat Brava 1.4S	13.58	50.55	26.86	9.78	18.86	9.08	0.67
24	Honda Civic 1.4i	10.90	40.43	26.96	6.21	19.13	12.91	1.18
27	Peugeot 306 1.6GLX	11.12	47.38	23.47	9.16	13.49	4.33	0.39
28	Renault Megane 1.6RT (LHD)	15.25	50.47	30.21	12.52	18.56	6.04	0.40
39	Ford Focus 1.6 (LHD)	10.23	53.09	19.28	5.24	19.99	14.75	1.44
41	Vauxhall Astra 1.6i Envoy	9.39	46.91	20.02	5.33	16.55	11.22	1.19
42	Ford Escort 1.6 LX	14.98	54.00	27.75	12.36	18.16	5.80	0.39
44	Renault Espace 2.0RTE (LHD)	6.32	30.82	20.50	3.04	13.11	10.07	1.59
56	Vauxhall Corsa 1.0 12v Club	14.47	53.97	26.81	9.68	21.62	11.93	0.82
63	Ford Ka 1.3 (LHD)	12.42	51.12	24.29	7.32	21.05	13.73	1.11
66	Citroen Saxo 1.1 SX (LHD)	16.78	58.95	28.46	14.12	19.93	5.81	0.35
70	Ford Fiesta 1.25 Zetec	15.20	58.32	26.07	8.05	28.71	20.65	1.36
72	Peugeot 206 1.3 XR Presence (LHD)	12.55	56.44	22.23	8.66	18.19	9.53	0.76
73	Renault Clio 1.2 RTE (LHD)	10.80	48.93	22.08	7.81	14.95	7.14	0.66

78	Volkswagen Polo 1.4 (LHD)	15.02	55.62	27.00	8.55	26.38	17.84	1.19
89	Peugeot 406 (LHD)	8.65	42.09	20.56	5.34	14.03	8.70	1.00
94	Volkswagon Passat 1.9 Tdi (LHD)	12.74	42.27	30.14	6.95	23.37	16.42	1.29
102	Renault Scenic 1.4 (LHD)	5.81	39.50	14.72	2.74	12.33	9.59	1.65

SIDE IMPACT CRASHES (DfT Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating**	**Estimated Injury Risk**	**Estimated Injury Severity**	**Lower 95 CI CWR**	**Upper 95 CI CWR**	**Range of CI**	**CWR Coeffi-cient of Variation**
	All Model Average	**23.24**	**77.67**	**29.92**				
1	Fiat Punto 55S	19.25	84.60	22.75	13.51	27.43	13.92	0.72
4	Renault Clio 1.2RL	24.26	78.08	31.07	19.63	29.97	10.34	0.43
10	Citroen Xantia 1.8i Dimension	21.32	70.12	30.40	15.54	29.24	13.71	0.64
27	Peugeot 306 1.6GLX	21.85	66.25	32.97	15.39	31.00	15.61	0.71
66	Citroen Saxo 1.1 SX (LHD)	23.34	83.76	27.86	17.00	32.04	15.04	0.64

SIDE IMPACT CRASHES (Newstead Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating**	**Estimated Injury Risk**	**Estimated Injury Severity**	**Lower 95 CI CWR**	**Upper 95 CI CWR**	**Range of CI**	**CWR Coeffi-cient of Variation**
	All Model Average	**17.35**	**57.98**	**29.92**				
1	Fiat Punto 55S	15.33	67.40	22.75	10.40	22.62	12.22	0.80
4	Renault Clio 1.2RL	17.75	57.13	31.07	13.78	22.87	9.09	0.51
10	Citroen Xantia 1.8i Dimension	16.52	54.34	30.40	11.59	23.53	11.94	0.72
27	Peugeot 306 1.6GLX	16.75	50.80	32.97	11.39	24.64	13.26	0.79
66	Citroen Saxo 1.1 SX (LHD)	16.79	60.27	27.86	11.55	24.42	12.87	0.77

APPENDIX D

SAFETY RATINGS

ESTIMATED FROM GERMAN REAL CRASH DATA

ALL CRASH TYPES (DfT Method)								
Euro NCAP Index	Vehicle Make/Model	Crash-worthiness Rating %	Estimated Injury Risk %	Estimated Injury Severity %	Lower 95% CI CWR	Upper 95% CI CWR	Range of CI %	CWR Coeffi-cient of Variation
	All Model Average	**6.12**						
1	Fiat Punto 55S	12.45	73.16	17.02	10.90	14.21	3.31	0.27
3	Nissan Micra 1.0L	17.41	76.56	22.74	15.43	19.65	4.22	0.24
4	Renault Clio 1.2RL	13.73	67.99	20.19	11.00	17.14	6.15	0.45
6	Vauxhall Corsa 1.2LS	13.13	72.57	18.09	11.88	14.50	2.62	0.20
7	Volkswagen Polo 1.4L	11.95	69.26	17.26	10.59	13.49	2.90	0.24
8	Audi A4 1.8	9.26	53.70	17.25	7.77	11.05	3.28	0.35
9	BMW 316i	9.38	60.86	15.41	7.60	11.58	3.98	0.42
10	Citroen Xantia 1.8i Dimension	10.77	57.57	18.71	6.94	16.73	9.79	0.91
11	Ford Mondeo 1.8LX	7.75	53.90	14.38	5.93	10.12	4.19	0.54
12	Mercedes C180 Classic	7.44	54.35	13.69	6.47	8.56	2.10	0.28
13	Nissan Primera 1.6GX	9.72	59.15	16.43	6.89	13.72	6.84	0.70
14	Peugeot 406 1.8LX	10.68	49.92	21.38	7.12	16.00	8.87	0.83
15	Renault Laguna 2.0RT	13.40	59.51	22.51	8.70	20.63	11.93	0.89
18	Vauxhall Vectra 1.8iLS	8.64	58.26	14.83	7.14	10.46	3.32	0.38
19	Volkswagen Passat 1.6L (LHD)	7.04	55.67	12.65	5.37	9.23	3.86	0.55
20	Audi A3 1.6	9.10	55.94	16.27	7.37	11.25	3.88	0.43
23	Fiat Brava 1.4S	16.27	62.64	25.98	11.87	22.31	10.45	0.64
24	Honda Civic 1.4i	14.64	67.43	21.71	12.43	17.24	4.80	0.33
25	Hyundai Accent 1.3GLS (LHD)	14.24	68.30	20.85	11.54	17.56	6.02	0.42
27	Peugeot 306 1.6GLX	10.91	57.89	18.85	6.93	17.17	10.24	0.94
28	Renault Megane 1.6RT (LHD)	9.55	59.19	16.14	7.93	11.51	3.58	0.37
30	Toyota Corolla 1.3 Sportif (LHD)	9.22	64.20	14.36	6.96	12.21	5.26	0.57
31	Volkswagen Golf 1.4 (LHD)	8.41	62.29	13.50	7.14	9.89	2.75	0.33
32	Audi A6 2.4 (LHD)	6.32	47.89	13.21	4.22	9.48	5.26	0.83
33	BMW 520i (LHD)	6.53	48.36	13.51	4.85	8.80	3.95	0.61
34	Mercedes E200 Classic (LHD)	5.92	47.36	12.51	4.12	8.52	4.40	0.74
39	Ford Focus 1.6 (LHD)	8.03	57.42	13.98	5.73	11.24	5.51	0.69
40	Mercedes A140 Classic (LHD)	7.76	63.74	12.17	5.54	10.87	5.33	0.69
41	Vauxhall Astra 1.6i Envoy	9.47	59.35	15.96	8.25	10.87	2.63	0.28
42	Ford Escort 1.6 LX	12.39	62.54	19.82	10.97	14.00	3.03	0.24
43	Nissan Almera 1.4GX	11.13	59.85	18.59	8.94	13.86	4.92	0.44
48	Volkswagen Sharan TDI (LHD)	3.45	44.89	7.69	1.55	7.71	6.16	1.78
50	Vauxhall Sintra 2.2 GLS	6.63	53.20	12.46	3.63	12.13	8.50	1.28
51	Chrysler Voyager 2.5TD (LHD)	6.95	37.52	18.52	3.85	12.52	8.67	1.25

52	Fiat Punto S60 1.2 (LHD)	8.52	66.15	12.88	6.06	11.98	5.92	0.70
53	Volkswagen Lupo 1.0 (LHD)	10.89	67.71	16.09	8.67	13.69	5.02	0.46
54	MCC Smart (LHD)	16.30	79.89	20.41	13.66	19.46	5.81	0.36
56	Vauxhall Corsa 1.0 12v Club	13.99	70.35	19.88	12.48	15.67	3.19	0.23
58	Lancia Ypsilon Elefantino (LHD)	10.13	67.31	15.05	5.98	17.18	11.21	1.11
60	Volkswagen Beetle 2.0 (LHD)	5.87	61.55	9.53	2.84	12.12	9.28	1.58
63	Ford Ka 1.3 (LHD)	14.45	70.32	20.55	12.93	16.16	3.24	0.22
66	Citroen Saxo 1.1 SX (LHD)	10.54	67.83	15.53	7.29	15.23	7.94	0.75
69	Fiat Seicento	19.51	84.47	23.10	15.38	24.75	9.37	0.48
73	Renault Clio 1.2 RTE (LHD)	13.81	70.05	19.72	10.78	17.70	6.92	0.50
76	Skoda Fabia 1.4 Classic (LHD)	13.36	64.25	20.79	8.32	21.46	13.14	0.98
77	Toyota Yaris 1.0 Terra (LHD)	10.93	70.74	15.45	7.56	15.81	8.26	0.76
78	Volkswagen Polo 1.4 (LHD)	11.47	67.51	16.99	8.31	15.83	7.52	0.66
84	BMW 316i (LHD)	8.59	55.82	15.39	5.85	12.62	6.77	0.79
92	Skoda Octavia 1.9 Tdi Ambiente (LHD)	6.92	50.45	13.71	4.82	9.94	5.12	0.74
94	Volkswagon Passat 1.9 Tdi (LHD)	5.03	55.88	9.01	3.08	8.24	5.16	1.03
112	Mazda MX-5 1.6 LHD	13.76	69.85	19.70	9.25	20.48	11.23	0.82
136	Vauxhall/Opel Corsa 1.2 Comfort (LHD)	12.47	64.19	19.42	8.31	18.71	10.40	0.83

ALL CRASH TYPES (Newstead Method)								
Euro NCAP Index	**Vehicle Make/Model**	**Crash-worthiness Rating %**	**Estimated Injury Risk %**	**Estimated Injury Severity %**	**Lower 95% CI CWR**	**Upper 95% CI CWR**	**Range of CI %**	**CWR Coeffi-cient of Variation**
	All Model Average	**3.53**						
1	Fiat Punto 55S	8.10	47.63	17.02	6.97	9.42	2.45	0.30
3	Nissan Micra 1.0L	11.61	51.06	22.74	10.06	13.40	3.33	0.29
4	Renault Clio 1.2RL	9.16	45.38	20.19	7.04	11.93	4.89	0.53
6	Vauxhall Corsa 1.2LS	8.90	49.21	18.09	7.96	9.96	2.01	0.23
7	Volkswagen Polo 1.4L	7.86	45.56	17.26	6.84	9.04	2.20	0.28
8	Audi A4 1.8	5.17	29.95	17.25	4.21	6.33	2.12	0.41
9	BMW 316i	5.45	35.33	15.41	4.26	6.97	2.71	0.50
10	Citroen Xantia 1.8i Dimension	7.69	41.07	18.71	4.71	12.54	7.83	1.02
11	Ford Mondeo 1.8LX	4.34	30.18	14.38	3.21	5.87	2.67	0.61
12	Mercedes C180 Classic	4.05	29.59	13.69	3.45	4.75	1.30	0.32
13	Nissan Primera 1.6GX	5.63	34.28	16.43	3.77	8.42	4.66	0.83
14	Peugeot 406 1.8LX	5.84	27.33	21.38	3.59	9.50	5.91	1.01
18	Vauxhall Vectra 1.8iLS	5.40	36.43	14.83	4.36	6.69	2.32	0.43
19	Volkswagen Passat 1.6L (LHD)	3.99	31.55	12.65	2.95	5.39	2.44	0.61
20	Audi A3 1.6	4.95	30.43	16.27	3.85	6.37	2.51	0.51
24	Honda Civic 1.4i	9.66	44.49	21.71	7.96	11.73	3.77	0.39
25	Hyundai Accent 1.3GLS (LHD)	8.45	40.52	20.85	6.51	10.97	4.46	0.53
28	Renault Megane 1.6RT (LHD)	5.48	33.95	16.14	4.38	6.85	2.47	0.45
30	Toyota Corolla 1.3 Sportif (LHD)	5.32	37.05	14.36	3.86	7.34	3.49	0.66
31	Volkswagen Golf 1.4 (LHD)	5.29	39.18	13.50	4.41	6.33	1.92	0.36
32	Audi A6 2.4 (LHD)	3.41	25.82	13.21	2.18	5.33	3.15	0.93
33	BMW 520i (LHD)	3.74	27.71	13.51	2.68	5.22	2.54	0.68
34	Mercedes E200 Classic (LHD)	2.57	20.56	12.51	1.69	3.91	2.22	0.86
39	Ford Focus 1.6 (LHD)	4.80	34.34	13.98	3.29	7.00	3.70	0.77
40	Mercedes A140 Classic (LHD)	4.40	36.17	12.17	3.04	6.39	3.35	0.76
41	Vauxhall Astra 1.6i Envoy	5.44	34.09	15.96	4.64	6.38	1.73	0.32
42	Ford Escort 1.6 LX	8.14	41.10	19.82	7.09	9.36	2.28	0.28
43	Nissan Almera 1.4GX	6.82	36.67	18.59	5.28	8.80	3.52	0.52
48	Volkswagen Sharan TDI (LHD)	2.21	28.77	7.69	0.95	5.17	4.23	1.91
50	Vauxhall Sintra 2.2 GLS	4.40	35.28	12.46	2.30	8.41	6.11	1.39
52	Fiat Punto S60 1.2 (LHD)	4.68	36.35	12.88	3.17	6.92	3.75	0.80
53	Volkswagen Lupo 1.0	6.97	43.29	16.09	5.38	9.02	3.65	0.52

	(LHD)							
54	MCC Smart (LHD)	11.70	57.34	20.41	9.55	14.33	4.78	0.41
56	Vauxhall Corsa 1.0 12v Club	9.04	45.46	19.88	7.90	10.34	2.44	0.27
63	Ford Ka 1.3 (LHD)	10.03	48.79	20.55	8.81	11.41	2.61	0.26
69	Fiat Seicento	14.84	64.25	23.10	11.30	19.49	8.19	0.55
73	Renault Clio 1.2 RTE (LHD)	8.83	44.79	19.72	6.54	11.93	5.39	0.61
78	Volkswagen Polo 1.4 (LHD)	7.32	43.06	16.99	5.03	10.63	5.60	0.77
84	BMW 316i (LHD)	4.13	26.86	15.39	2.61	6.56	3.95	0.96
92	Skoda Octavia 1.9 Tdi Ambiente (LHD)	4.17	30.44	13.71	2.79	6.24	3.44	0.82
94	Volkswagon Passat 1.9 Tdi (LHD)	2.58	28.68	9.01	1.52	4.38	2.86	1.11

APPENDIX E

SAFETY RATINGS ESTIMATED FROM AUSTRALIAN AND NEW ZEALAND REAL CRASH DATA

ALL CRASH TYPES								
Euro NCAP Index	Vehicle Make/Model	Crash-worthiness Rating %	Estimated Injury Risk %	Estimated Injury Severity %	Lower 95% CI CWR	Upper 95% CI CWR	Range of CI %	CWR Coeffi-cient of Variation
	All Model Average	**3.98**						
3	Nissan Micra 1.0L	6.13	21.57	28.40	4.38	8.56	4.18	0.68
11	Ford Mondeo 1.8LX	2.14	14.15	15.12	1.50	3.04	1.54	0.72
12	Mercedes C180 Classic	2.51	12.83	19.54	1.56	4.04	2.49	0.99
17	Saab 900 2.0i	2.41	11.99	20.13	1.41	4.12	2.71	1.12
18	Holden Vectra	2.20	15.31	14.40	1.55	3.12	1.57	0.71
26	Mitsubishi Lancer / Mirage CE	4.07	18.75	21.69	3.60	4.59	0.98	0.24
27	Peugeot 306	1.44	13.75	10.46	0.82	2.52	1.70	1.18
30	Toyota Corolla	2.58	15.50	16.68	2.01	3.33	1.32	0.51
35	Toyota Camry	3.05	14.68	20.75	2.60	3.57	0.98	0.32
38	Volvo S70 2.0/2.5 10V (LHD)	2.53	13.29	19.02	1.70	3.76	2.06	0.81
41	Holden Statesman/Caprice WH	3.46	16.20	21.33	2.53	4.71	2.18	0.63
56	Holden Barina SB	4.62	21.32	21.69	3.96	5.40	1.43	0.31
68	Daihatsu Sirion	3.90	21.62	18.04	2.51	6.06	3.55	0.91
77	Toyota Echo	4.32	19.00	22.74	3.10	6.02	2.92	0.68
106	Suzuki Grand Vitara 2.7ltr XL-7 (LHD)	3.45	17.49	19.71	2.30	5.17	2.87	0.83
126	Subaru Liberty / Legacy	1.97	12.97	15.23	1.14	3.42	2.28	1.15
139	Daewoo Lanos	4.68	18.30	25.56	3.79	5.78	1.99	0.43
140	Daewoo Leganza	4.37	17.42	25.07	2.46	7.75	5.29	1.21
141	Daewoo Nubira	3.59	15.99	22.43	2.64	4.87	2.24	0.62
143	Ford Falcon Ute AU	2.40	12.00	20.00	1.42	4.06	2.65	1.10
144	Holden Commodore VT/VX	2.75	14.73	18.65	2.48	3.04	0.57	0.21
145	Holden Rodeo	3.45	18.39	18.78	2.35	5.07	2.72	0.79
146	Hyundai Getz	5.15	17.65	29.16	3.84	6.89	3.05	0.59
147	Hyundai Sonata	3.86	14.13	27.30	2.31	6.45	4.14	1.07
148	Mazda 121 Metro / Demio	3.84	18.40	20.89	2.87	5.15	2.29	0.59
149	Ford / Mazda Laser / 323	3.19	17.36	18.40	2.32	4.41	2.09	0.65
150	Ford / Mazda Courier / B-Series	3.55	13.06	27.19	2.16	5.82	3.66	1.03
151	Mitsubishi Magna TE/TF/TH/TJ / Verada KE/KF/KH/KJ / Diamante	2.76	14.54	18.95	2.40	3.16	0.76	0.28
152	Nissan Pulsar	4.17	17.05	24.45	2.94	5.91	2.98	0.71
153	Toyota Avalon	2.05	12.06	17.01	1.03	4.08	3.05	1.49
154	Toyota Hilux	2.90	15.13	19.16	2.27	3.71	1.44	0.50
155	Volkswagen Polo	3.56	19.08	18.65	1.82	6.96	5.15	1.45

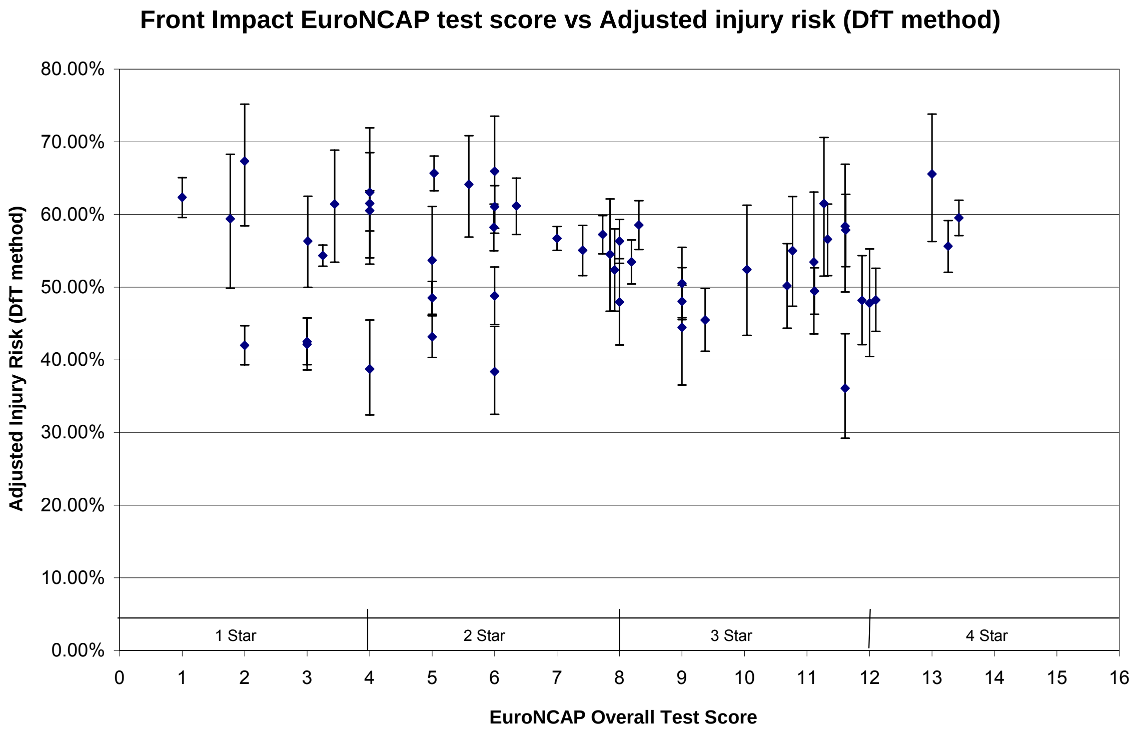
FRONTAL CRASHES								
Euro NCAP Index	Vehicle Make/Model	Crash-worthiness Rating %	Estimated Injury Risk %	Estimated Injury Severity %	Lower 95% CI CWR	Upper 95% CI CWR	Range of CI %	CWR Coeffi-cient of Variation
	All Model Average	**6.71**						
18	Holden Vectra	3.17	20.10	15.76	1.64	6.13	4.49	1.42
26	Mitsubishi Lancer / Mirage CE	6.73	26.21	25.68	5.47	8.28	2.81	0.42
30	Toyota Corolla	3.86	19.98	19.31	2.38	6.24	3.86	1.00
35	Toyota Camry	5.72	19.87	30.95	4.46	7.33	2.87	0.50
38	Volvo S70 2.0/2.5 10V (LHD)	4.36	15.33	28.44	2.15	8.85	6.70	1.54
41	Holden Statesman/Caprice WH	6.40	20.14	31.80	3.91	10.49	6.58	1.03
56	Holden Barina SB	6.73	26.08	25.80	5.06	8.95	3.89	0.58
139	Daewoo Lanos	8.95	26.92	33.25	6.37	12.57	6.19	0.69
141	Daewoo Nubira	5.30	23.30	22.75	2.96	9.50	6.54	1.23
144	Holden Commodore VT/VX	4.08	21.08	19.36	3.41	4.89	1.48	0.36
145	Holden Rodeo	5.13	20.94	24.49	2.71	9.70	6.99	1.36
148	Mazda 121 Metro / Demio	4.86	22.00	22.08	2.91	8.10	5.19	1.07
149	Ford / Mazda Laser / 323	6.30	23.75	26.53	3.89	10.20	6.31	1.00
151	Mitsubishi Magna TE/TF/TH/TJ / Verada KE/KF/KH/KJ / Diamante	4.23	19.11	22.13	3.37	5.31	1.94	0.46
154	Toyota Hilux	6.06%	19.03%	21.90%	3.85%	9.54%	5.69%	0.94

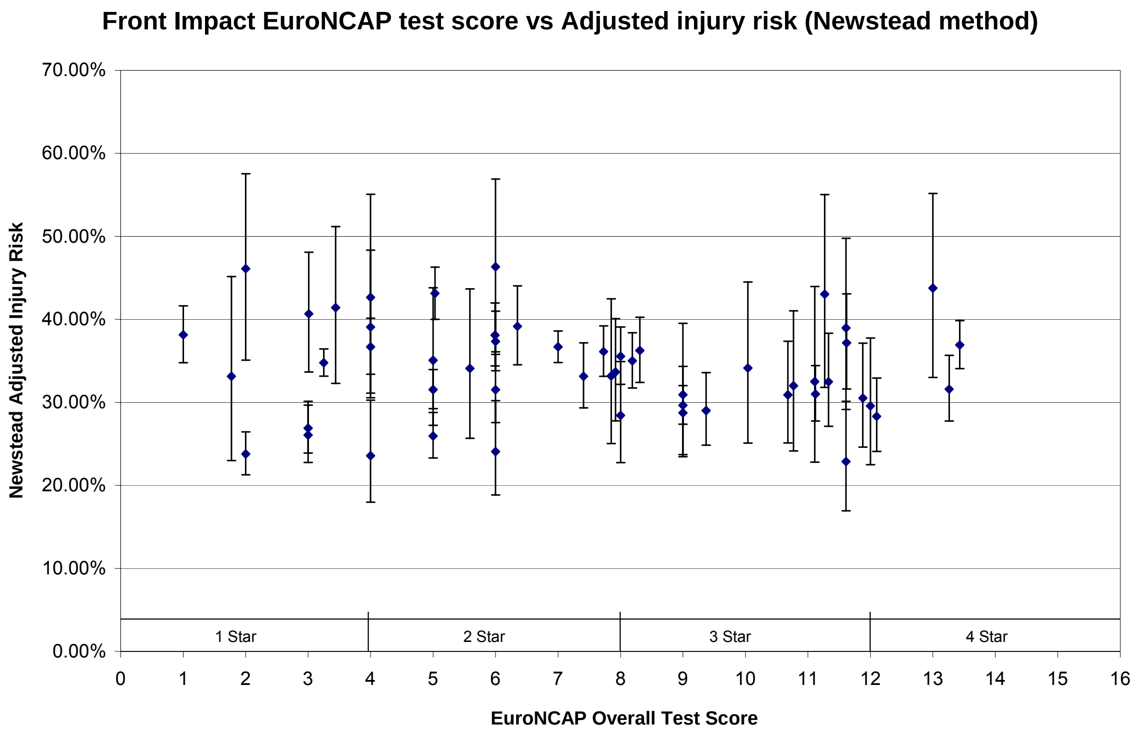
SIDE IMPACT CRASHES								
Euro NCAP Index	Vehicle Make/Model	Crash-worthiness Rating %	Estimated Injury Risk %	Estimated Injury Severity %	Lower 95% CI CWR	Upper 95% CI CWR	Range of CI %	CWR Coeffi-cient of Variation
	All Model Average	**5.75**						
26	Mitsubishi Lancer / Mirage CE	9.00	35.38	25.44	6.36	12.73	6.37	0.71
35	Toyota Camry	4.69	23.68	19.81	2.93	7.51	4.58	0.98
144	Holden Commodore VT/VX	5.84	26.01	22.47	4.47	7.63	3.16	0.54
151	Mitsubishi Magna TE/TF/TH/TJ / Verada KE/KF/KH/KJ / Diamante	3.52	18.74	18.76	2.32	5.34	3.02	0.86

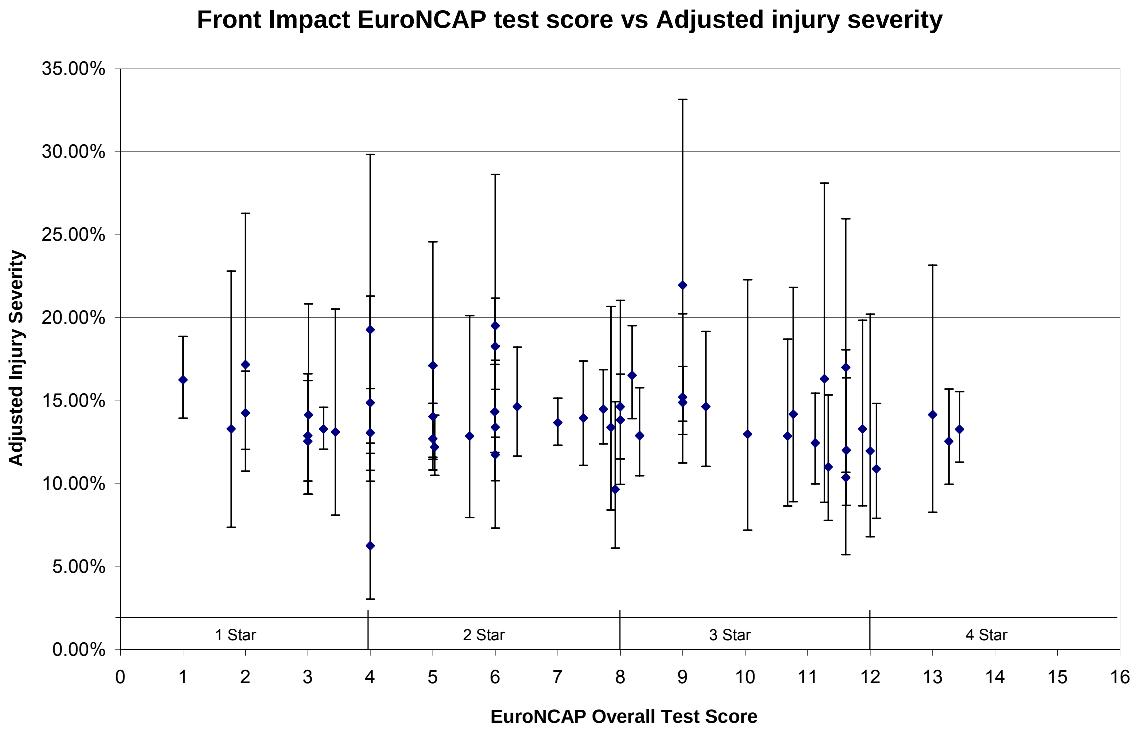
APPENDIX F

RELATIONSHIPS BEWEEN EuroNCAP SCORES BY TEST CONFIGURATION AND REAL CRASH MEASURES DERIVED FROM BRITISH DATA

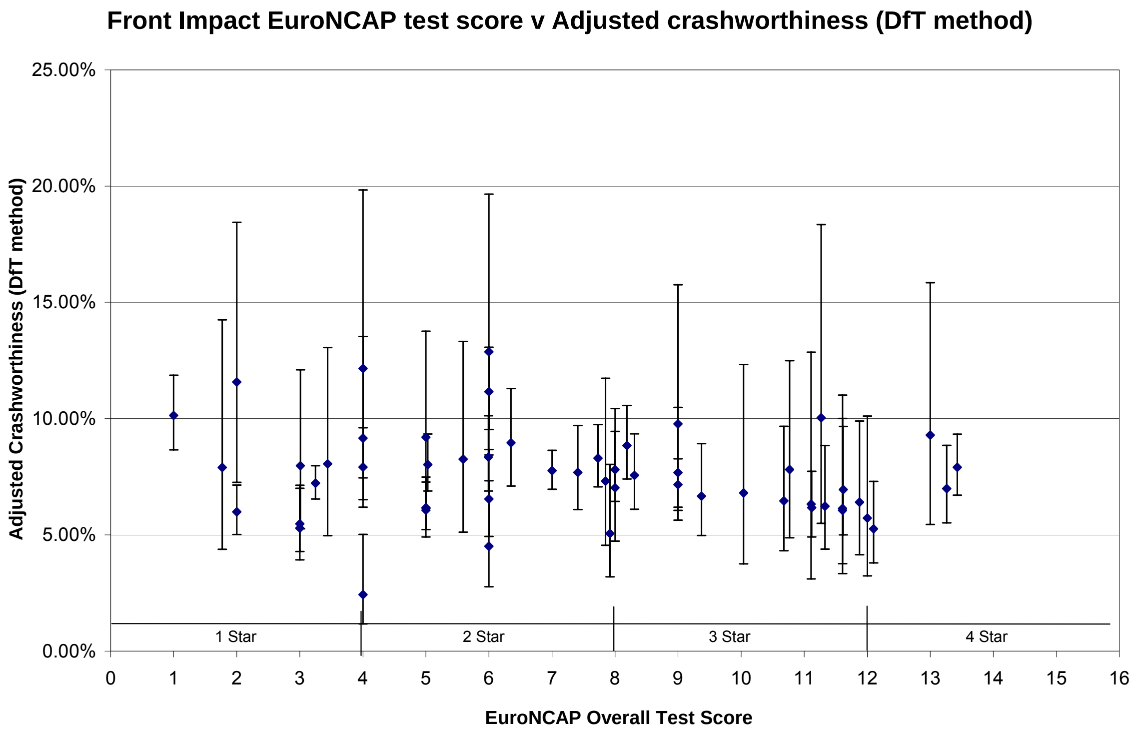
FRONT IMPACT CRASHES- Graphical Analysis



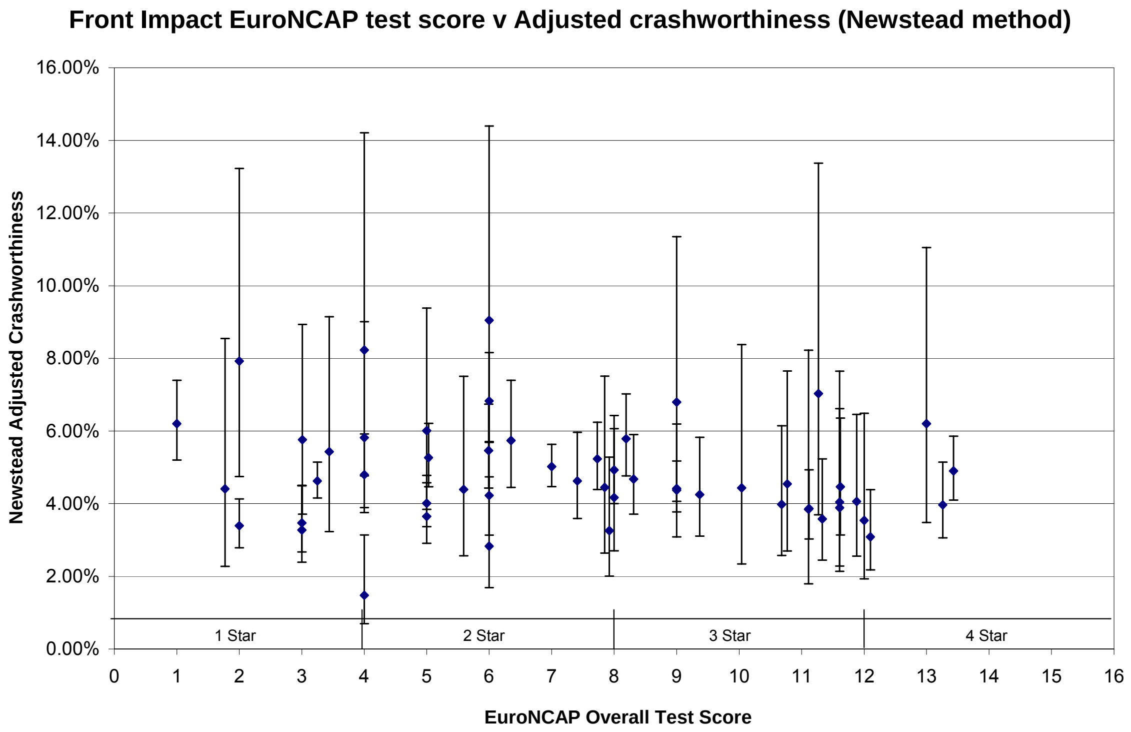




Front Impact EuroNCAP test score vs Adjusted injury severity
Adjusted Injury Severity
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
1 Star
2 Star
3 Star
4 Star
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
EuroNCAP Overall Test Score



Front Impact EuroNCAP test score v Adjusted crashworthiness (DfT method)
Adjusted Crashworthiness (DfT method)
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
1 Star
2 Star
3 Star
4 Star
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
EuroNCAP Overall Test Score



FRONT IMPACT CRASHES- Regression Analysis

Crashworthiness Ratings (DfT method)								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**7.30%**	**7.45%**	**7.63%**	**7.71%**	**7.46%**	**7.91%**	**7.31%**	**7.41%**
LCL	6.99%	7.15%	7.26%	7.18%	7.14%	7.61%	6.96%	6.91%
UCL	7.63%	7.77%	8.02%	8.27%	7.79%	8.23%	7.68%	7.96%

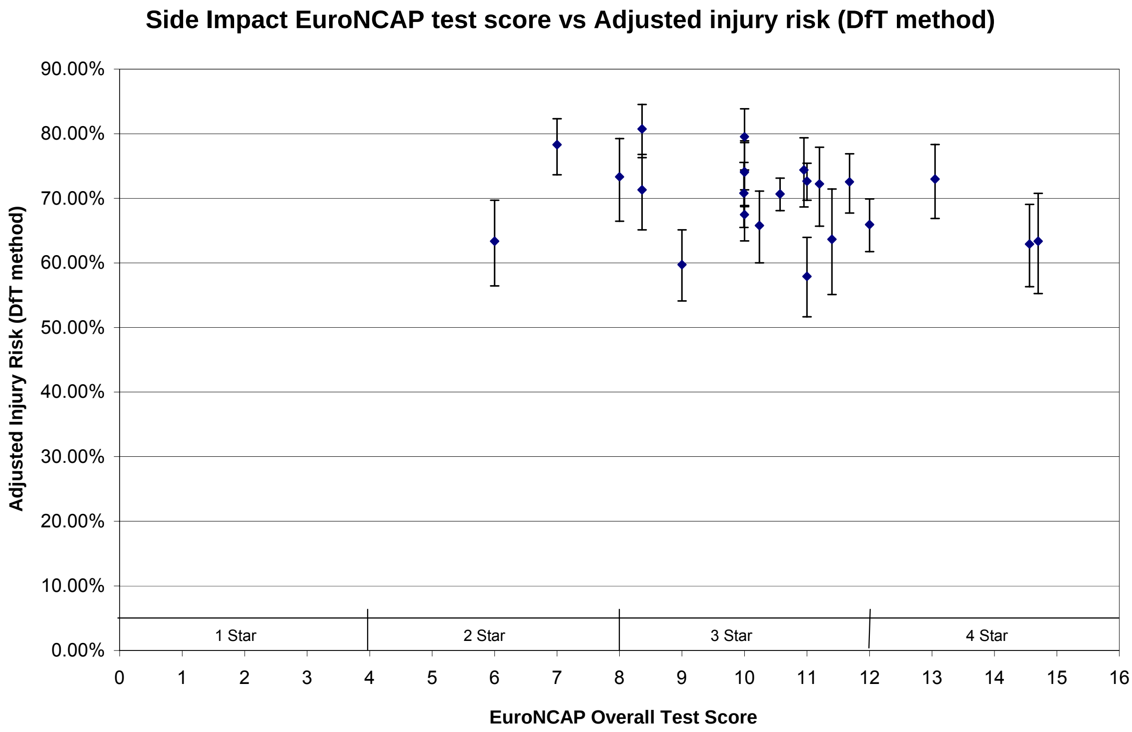
Crashworthiness Ratings (Newstead method)								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**4.58%**	**4.75%**	**4.83%**	**4.70%**	**4.68%**	**5.06%**	**4.62%**	**4.52%**
LCL	4.31%	4.48%	4.50%	4.25%	4.40%	4.78%	4.31%	4.08%
UCL	4.87%	5.03%	5.18%	5.20%	4.98%	5.34%	4.95%	5.00%

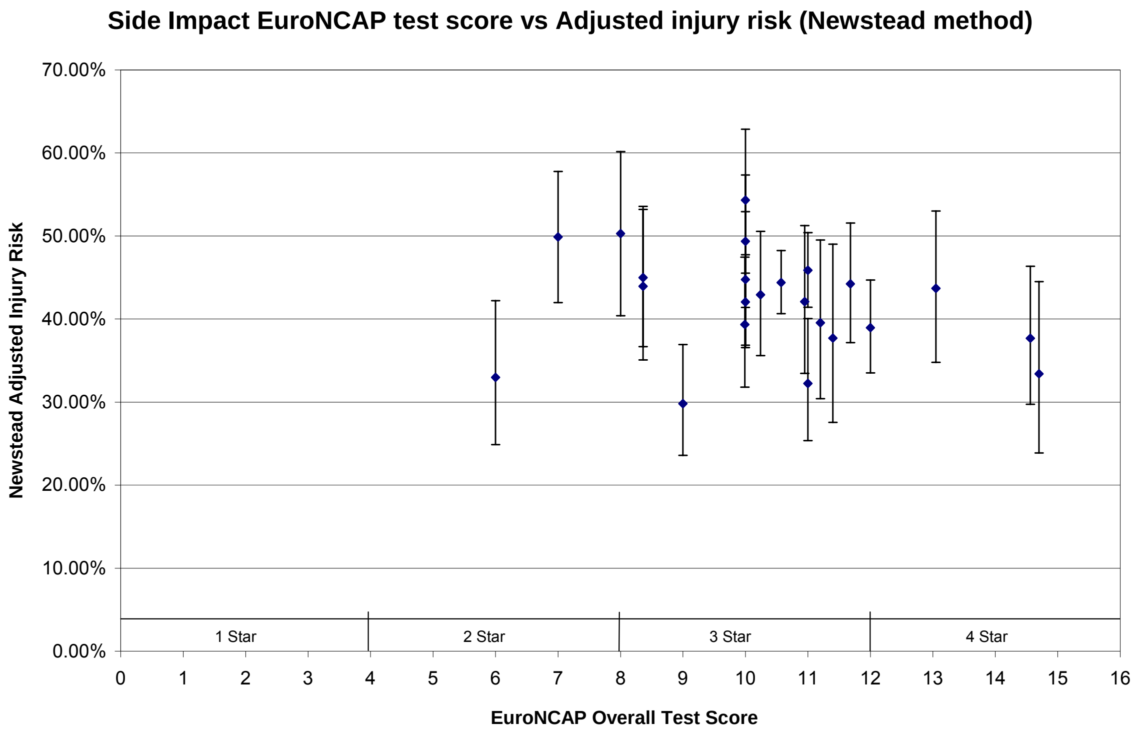
Risk Ratings (DfT method)								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**51.95%**	**52.84%**	**52.91%**	**58.31%**	**52.93%**	**55.34%**	**51.00%**	**56.75%**
LCL	51.12%	52.05%	51.96%	56.98%	52.11%	54.59%	50.07%	55.43%
UCL	52.77%	53.64%	53.86%	59.62%	53.75%	56.10%	51.93%	58.07%

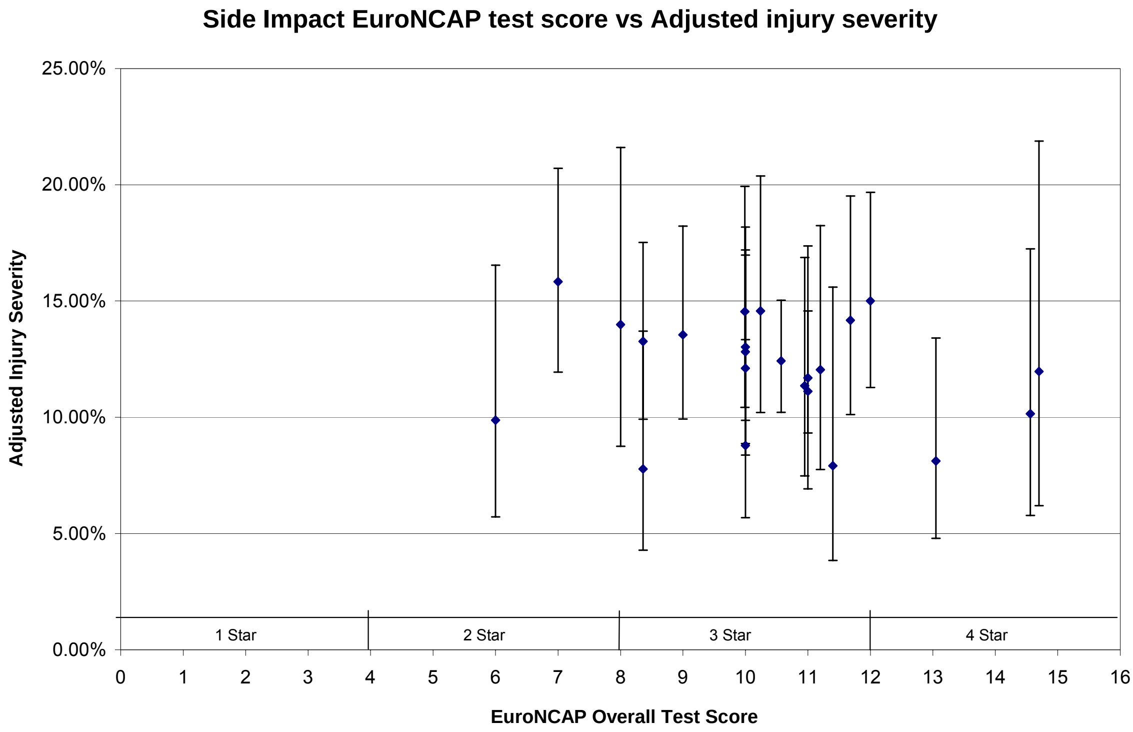
Risk Ratings (Newstead method)								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**32.43%**	**33.47%**	**33.16%**	**35.40%**	**33.01%**	**35.11%**	**31.93%**	**34.42%**
LCL	31.53%	32.59%	32.12%	33.86%	32.11%	34.25%	30.93%	32.91%
UCL	33.35%	34.36%	34.22%	36.97%	33.93%	35.99%	32.95%	35.96%

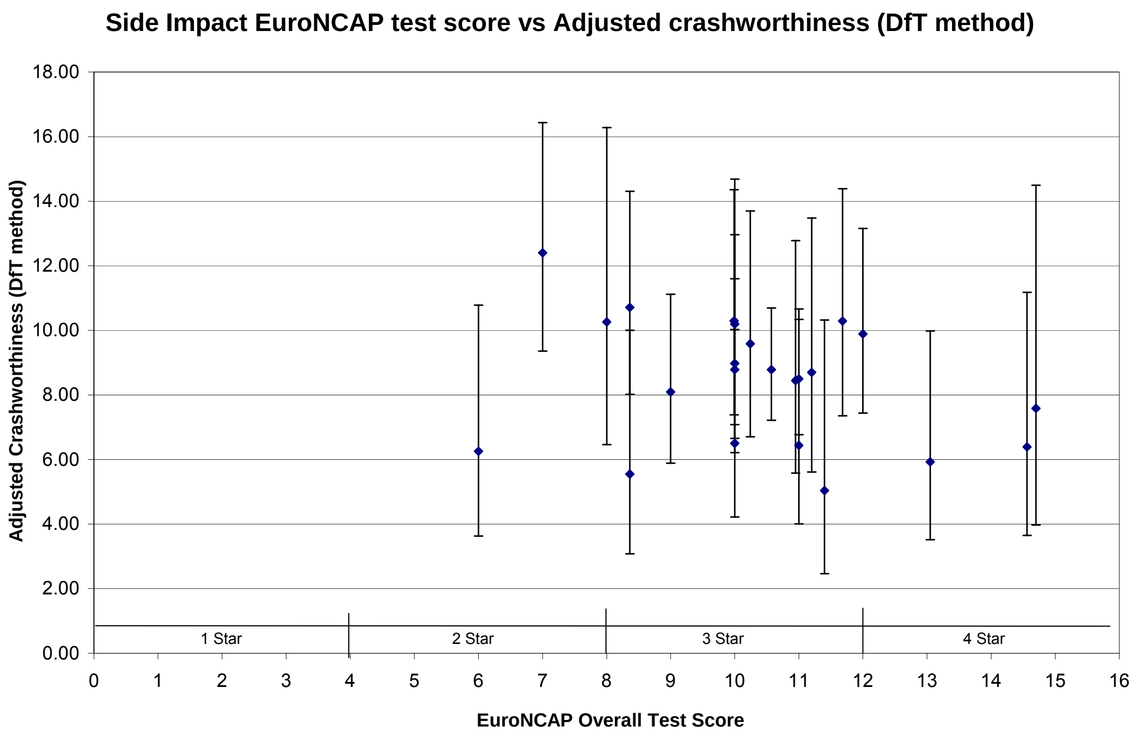
Injury Severity Ratings								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**13.91%**	**14.02%**	**14.37%**	**13.07%**	**13.96%**	**14.16%**	**14.27%**	**12.98%**
LCL	13.28%	13.41%	13.63%	12.09%	13.33%	13.58%	13.55%	12.01%
UCL	14.57%	14.65%	15.13%	14.11%	14.62%	14.76%	15.02%	14.01%

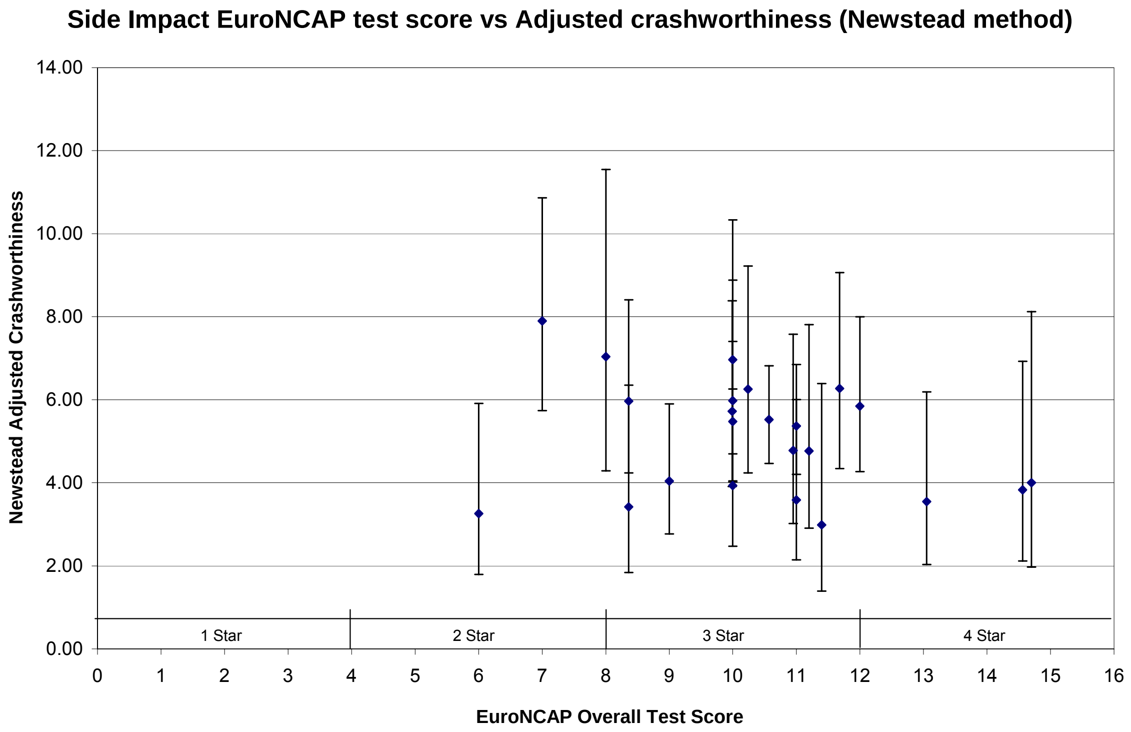
SIDE IMPACT CRASHES- Graphical Analysis






Side Impact EuroNCAP test score vs Adjusted injury severity
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Adjusted Injury Severity
1 Star
2 Star
3 Star
4 Star
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
EuroNCAP Overall Test Score


Side Impact EuroNCAP test score vs Adjusted crashworthiness (DfT method)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Adjusted Crashworthiness (DfT method)
1 Star
2 Star
3 Star
4 Star
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
EuroNCAP Overall Test Score



SIDE IMPACT CRASHES- Regression Analysis

Crashworthiness Ratings (DfT method)								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**10.68%**	**9.09%**	**6.89%**		**10.81%**	**9.14%**	**6.77%**
LCL		9.33%	8.20%	5.80%		9.45%	8.25%	5.71%
UCL		12.20%	10.06%	8.15%		12.33%	10.11%	8.00%

Crashworthiness Ratings (Newstead method)								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**6.71%**	**5.56%**	**4.04%**		**6.81%**	**5.60%**	**3.95%**
LCL		5.45%	4.75%	3.10%		5.54%	4.78%	3.04%
UCL		8.24%	6.51%	5.24%		8.35%	6.55%	5.13%

Risk Ratings (DfT method)								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**72.86%**	**70.55%**	**68.39%**		**73.45%**	**71.01%**	**67.26%**
LCL		70.33%	68.74%	65.58%		70.97%	69.23%	64.41%
UCL		75.25%	72.30%	71.08%		75.79%	72.73%	69.98%

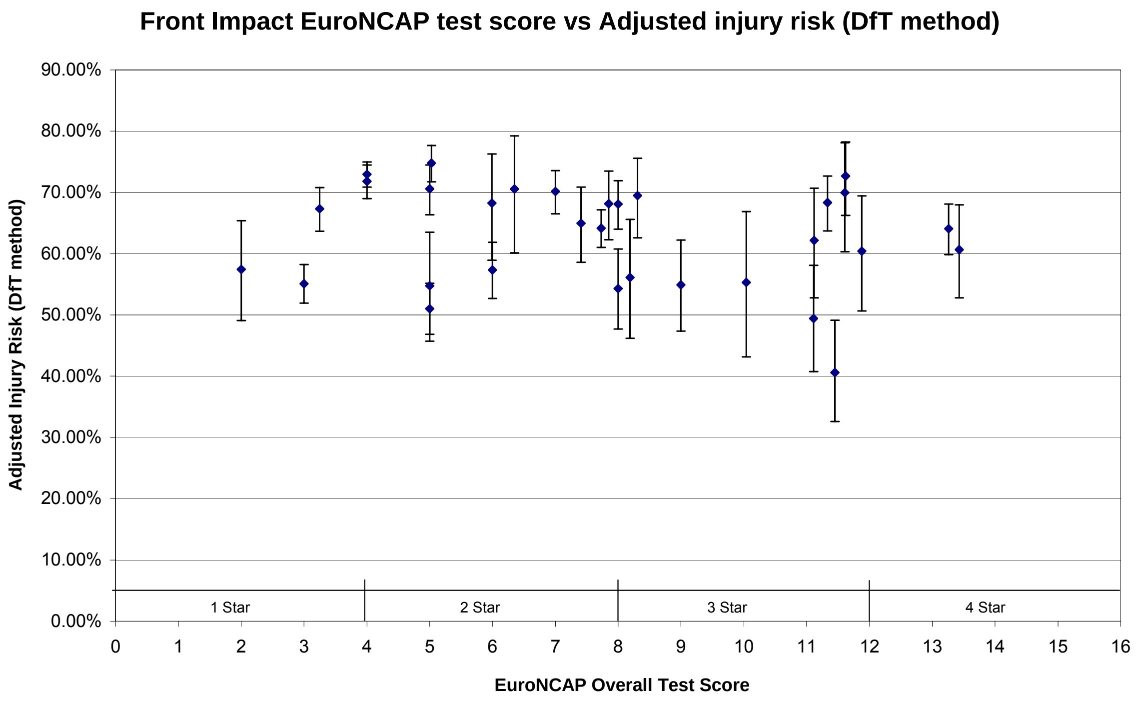
Risk Ratings (Newstead method)								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**44.93%**	**42.94%**	**39.87%**		**45.34%**	**43.23%**	**39.18%**
LCL		41.14%	40.32%	36.05%		41.56%	40.62%	35.41%
UCL		48.78%	45.60%	43.81%		49.17%	45.89%	43.09%

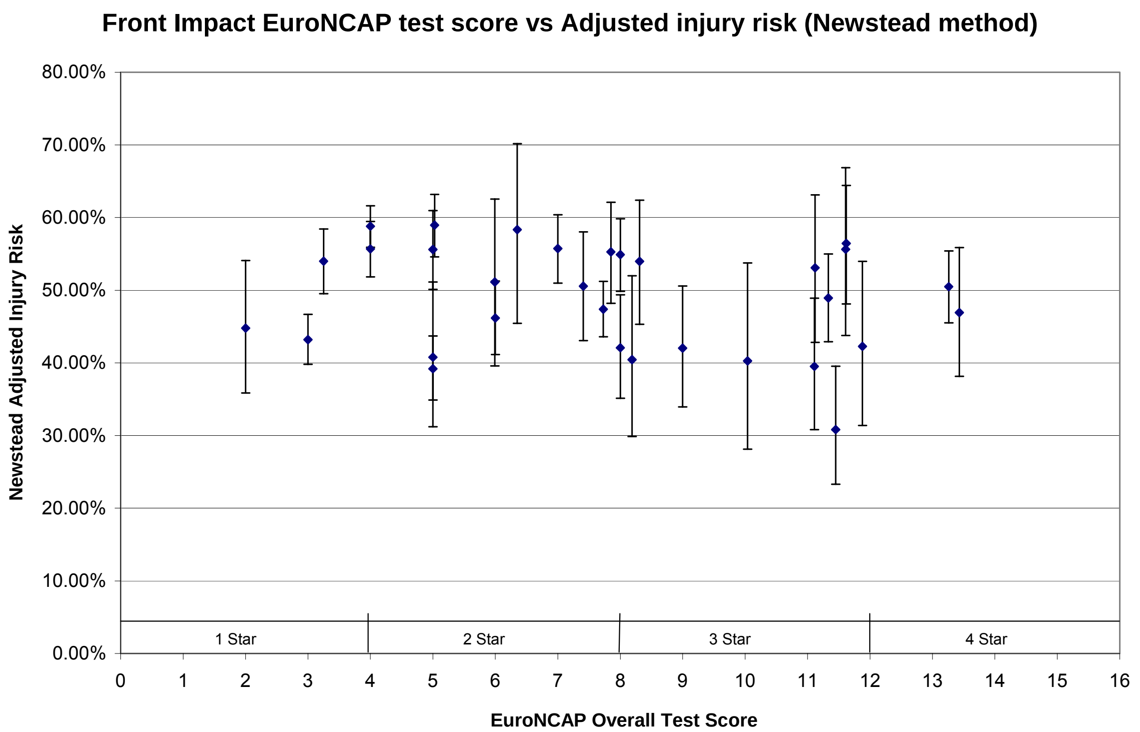
Injury Severity Ratings								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**14.61%**	**12.81%**	**10.00%**		**14.58%**	**12.80%**	**10.04%**
LCL		12.26%	11.22%	8.00%		12.24%	11.21%	8.04%
UCL		17.33%	14.60%	12.43%		17.28%	14.58%	12.46%

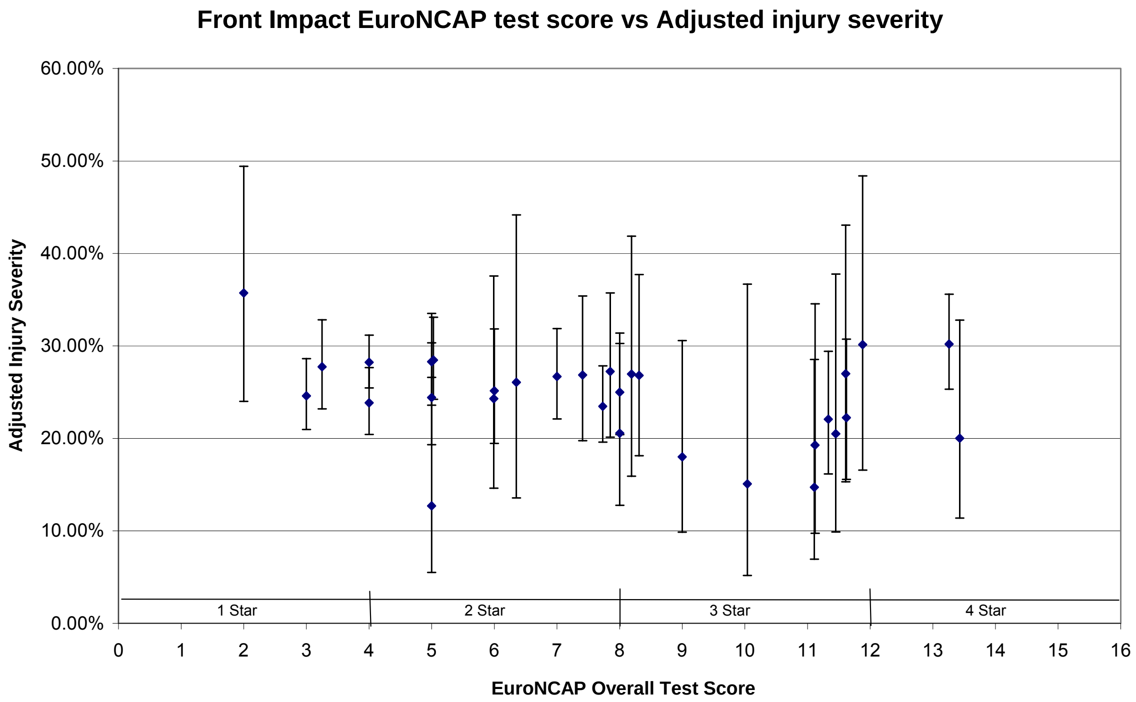
APPENDIX G

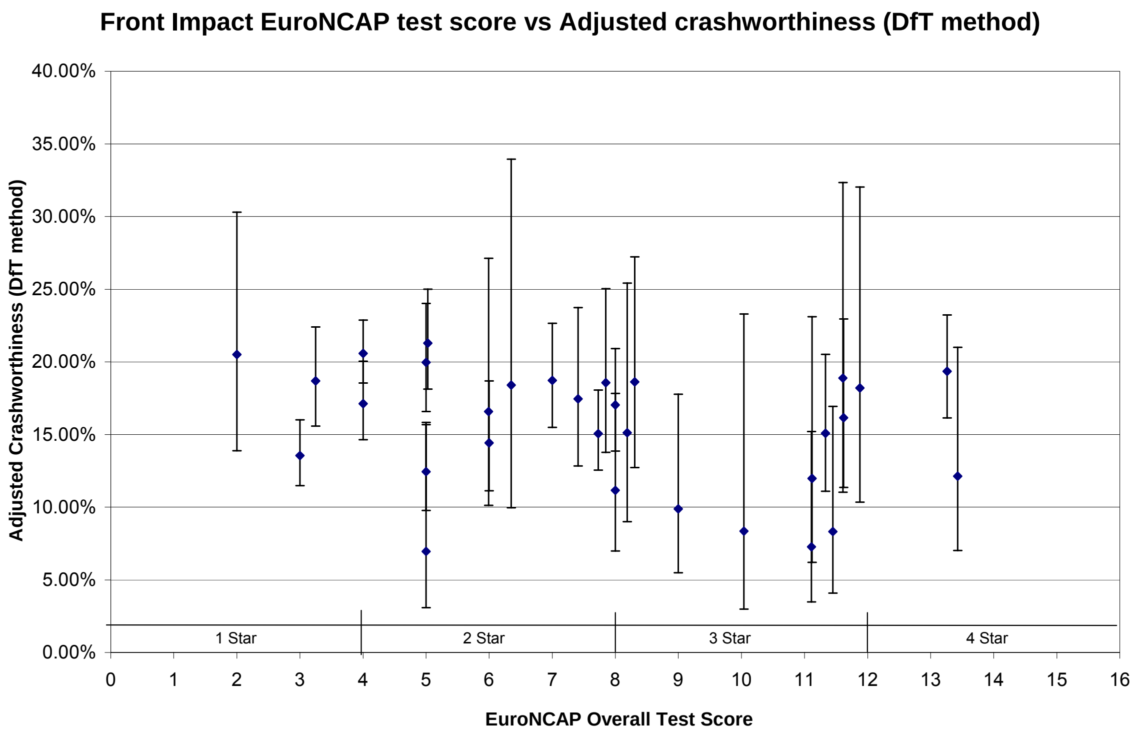
RELATIONSHIPS BEWEEN EuroNCAP SCORES BY TEST CONFIGURATION AND REAL CRASH MEASURES DERIVED FROM FRENCH DATA

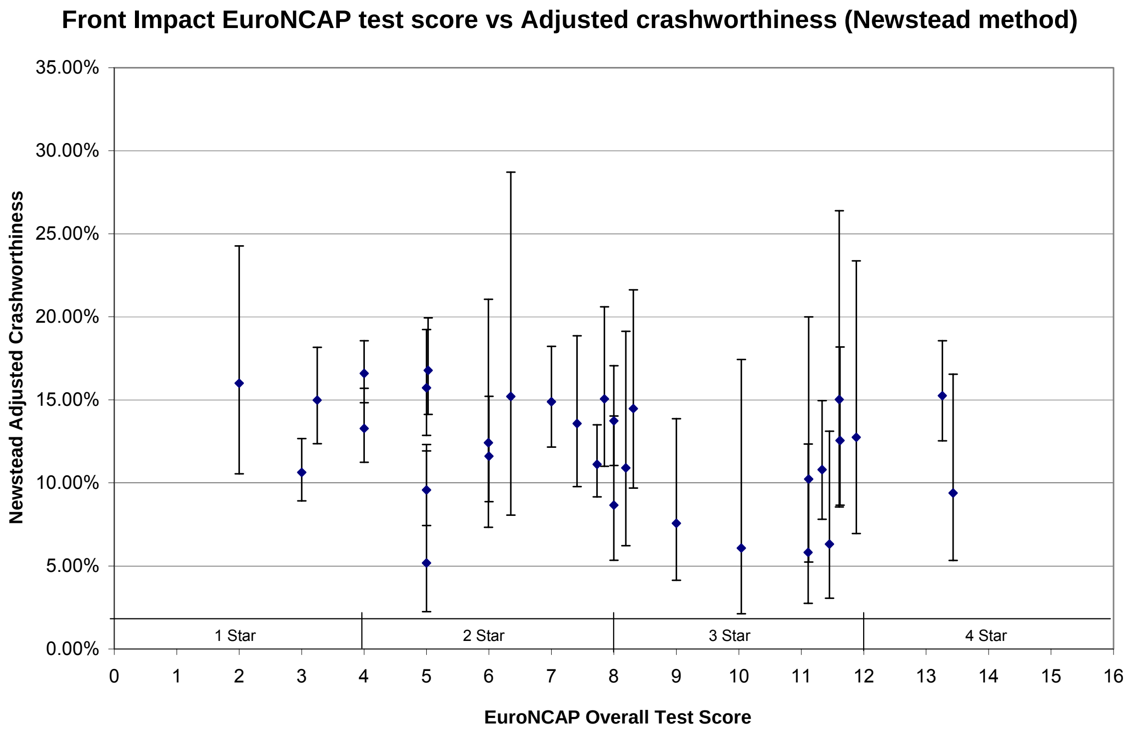
FRONT IMPACT CRASHES- Crash Analysis






Front Impact EuroNCAP test score vs Adjusted injury severity
Adjusted Injury Severity
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
1 Star
2 Star
3 Star
4 Star
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
EuroNCAP Overall Test Score


Front Impact EuroNCAP test score vs Adjusted crashworthiness (DfT method)
Adjusted Crashworthiness (DfT method)
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
1 Star
2 Star
3 Star
4 Star
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
EuroNCAP Overall Test Score



FRONT IMPACT CRASHES- Regression Analysis

Crashworthiness Ratings (DfT method)								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**17.70%**	**17.32%**	**14.92%**	**19.00%**	**18.77%**	**17.36%**	**14.45%**	**18.43%**
LCL	16.83%	16.48%	13.84%	17.34%	17.89%	16.53%	13.40%	16.82%
UCL	18.60%	18.19%	16.08%	20.77%	19.69%	18.24%	15.57%	20.15%

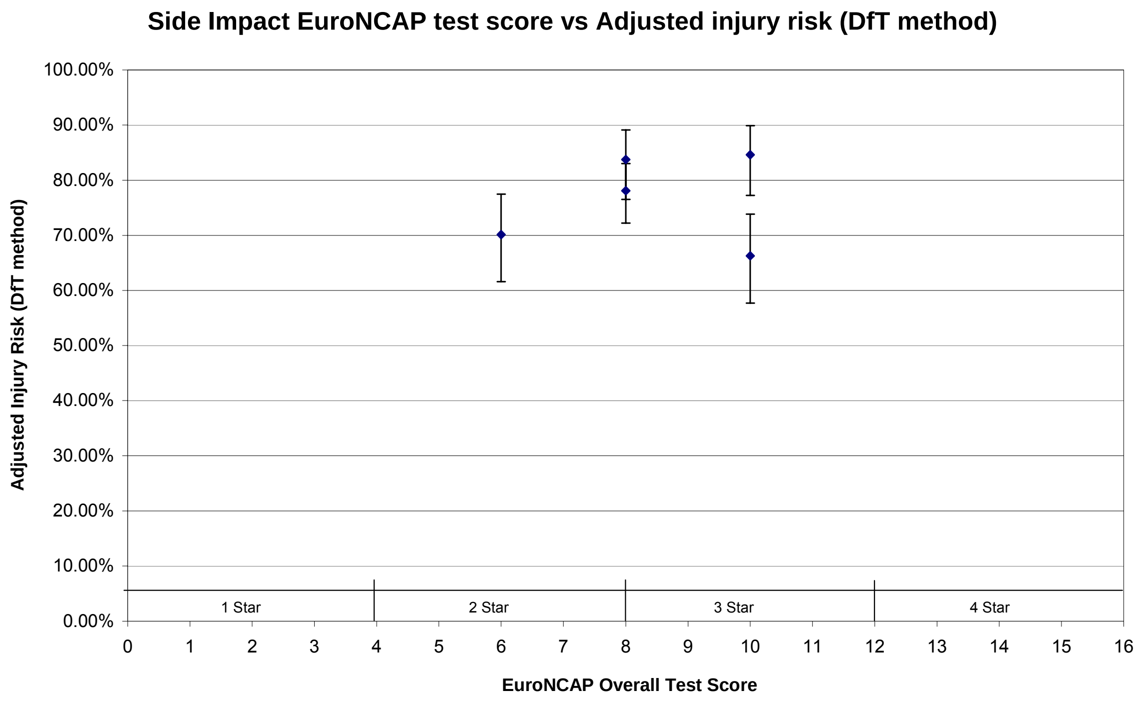
Crashworthiness Ratings (Newstead method)								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**14.12%**	**13.62%**	**11.33%**	**15.07%**	**15.04%**	**13.65%**	**10.94%**	**14.62%**
LCL	13.24%	12.78%	10.27%	13.42%	14.14%	12.80%	9.91%	13.01%
UCL	15.05%	14.51%	12.49%	16.89%	15.99%	14.54%	12.05%	16.38%

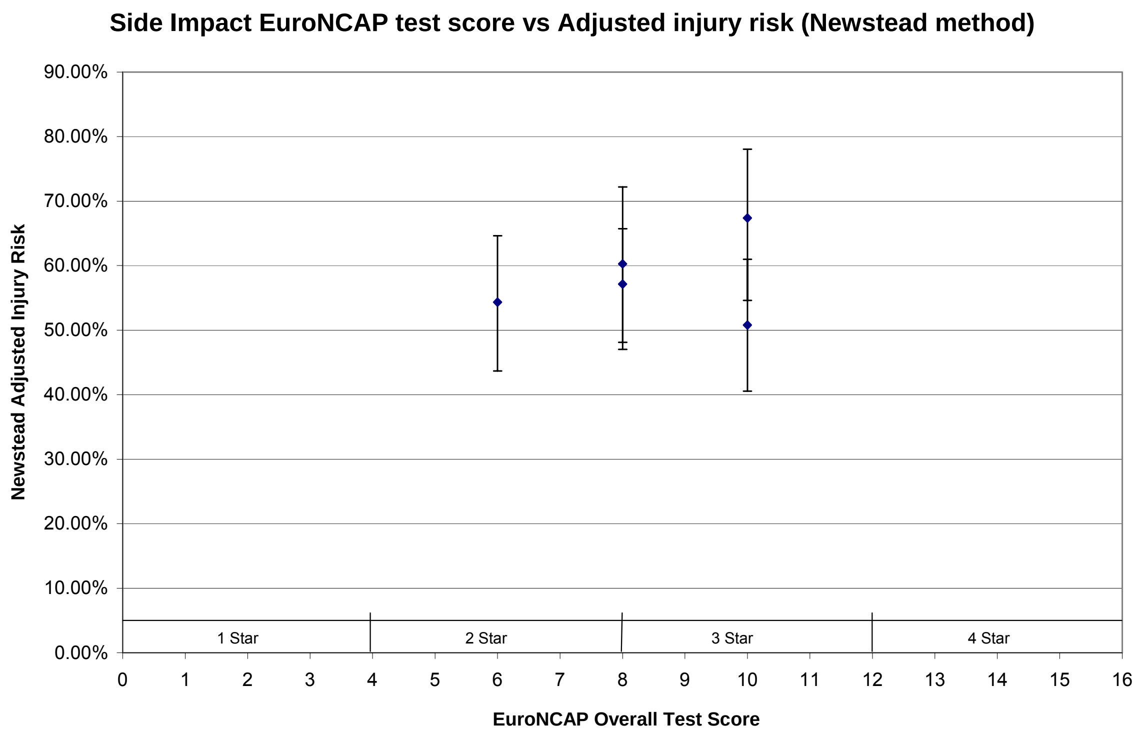
Risk Ratings (DfT method)								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**66.20%**	**66.34%**	**64.80%**	**64.92%**	**68.61%**	**66.17%**	**62.95%**	**64.43%**
LCL	64.81%	65.00%	62.92%	62.33%	67.30%	64.84%	61.07%	61.82%
UCL	67.56%	67.65%	66.64%	67.43%	69.89%	67.47%	64.79%	66.95%

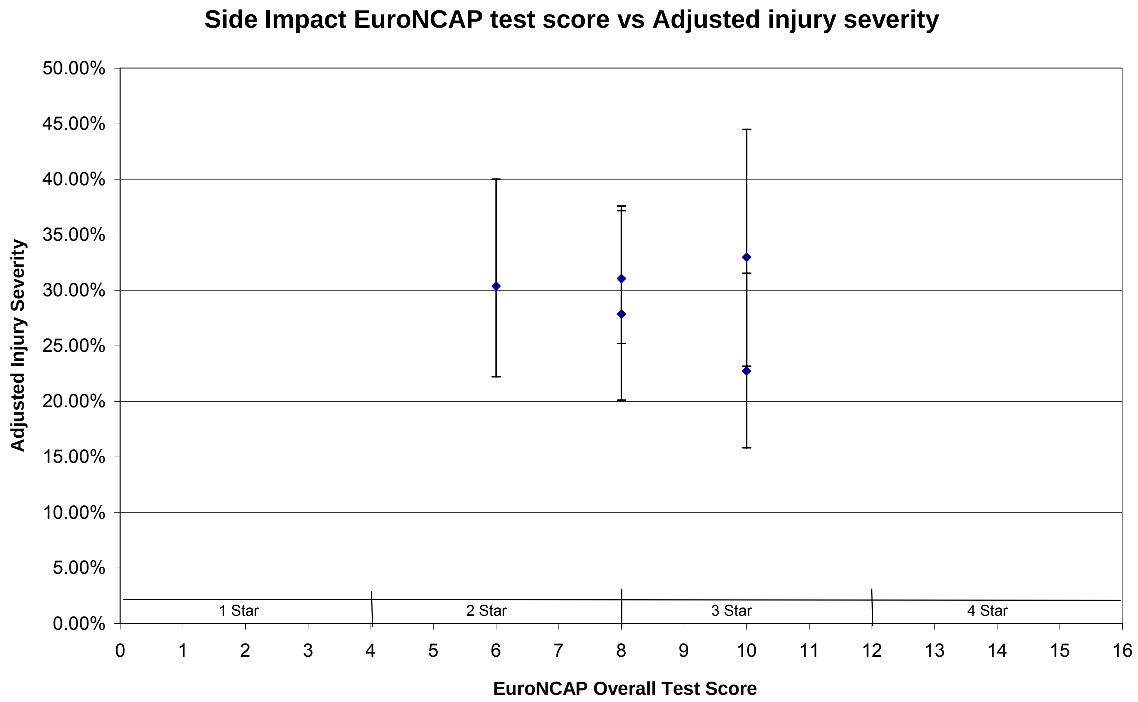
Risk Ratings (Newstead method)								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**52.15%**	**51.56%**	**48.91%**	**50.96%**	**54.19%**	**51.35%**	**47.36%**	**50.68%**
LCL	50.38%	49.85%	46.57%	47.76%	52.46%	49.65%	45.05%	47.48%
UCL	53.91%	53.27%	51.26%	54.16%	55.91%	53.05%	49.68%	53.88%

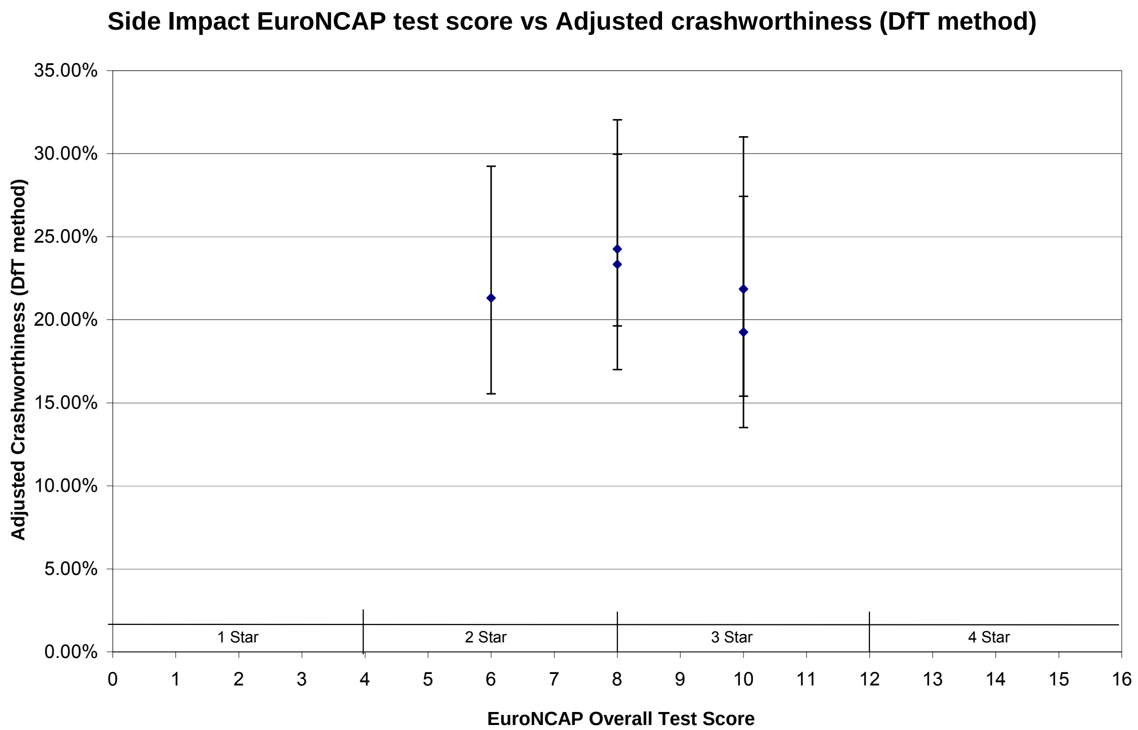
Injury Severity Ratings								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**26.57%**	**25.96%**	**22.84%**	**29.05%**	**27.04%**	**26.00%**	**22.64%**	**28.75%**
LCL	24.98%	24.40%	20.73%	26.01%	25.48%	24.45%	20.54%	25.74%
UCL	28.23%	27.58%	25.10%	32.30%	28.66%	27.62%	24.88%	31.97%

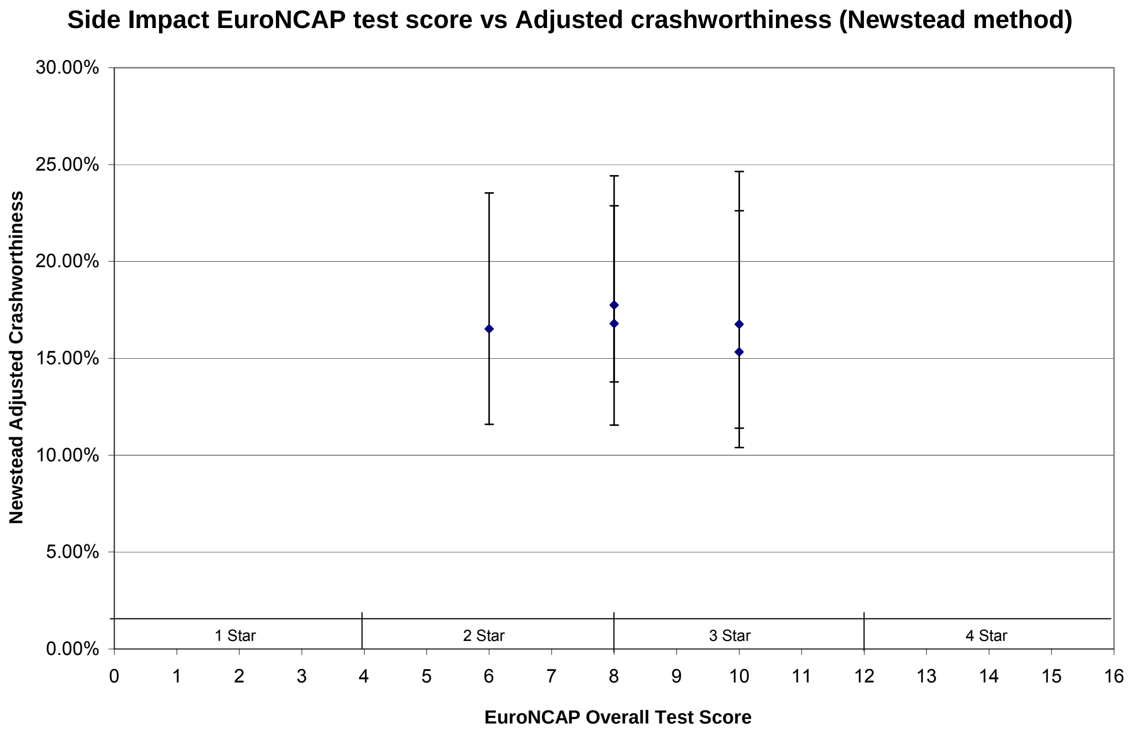
SIDE IMPACT CRASHES- Crash Analysis






Side Impact EuroNCAP test score vs Adjusted injury severity
50.00%
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Adjusted Injury Severity
1 Star
2 Star
3 Star
4 Star
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
EuroNCAP Overall Test Score


Side Impact EuroNCAP test score vs Adjusted crashworthiness (DfT method)
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Adjusted Crashworthiness (DfT method)
1 Star
2 Star
3 Star
4 Star
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
EuroNCAP Overall Test Score



SIDE IMPACT CRASHES- Regression Analysis

Crashworthiness Ratings (DfT method)								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**23.53%**	**21.42%**			**23.42%**	**21.52%**	
LCL		25.54%	23.30%			25.40%	23.40%	
UCL		21.63%	19.65%			21.54%	19.76%	

Crashworthiness Ratings (Newstead method)								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**17.43%**	**16.29%**			**17.40%**	**16.32%**	
LCL		15.37%	14.35%			15.36%	14.39%	
UCL		19.70%	18.44%			19.65%	18.46%	

Risk Ratings (DfT method)								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**76.46%**	**77.72%**			**75.56%**	**78.56%**	
LCL		73.96%	75.31%			73.07%	76.27%	
UCL		78.79%	79.96%			77.90%	80.68%	

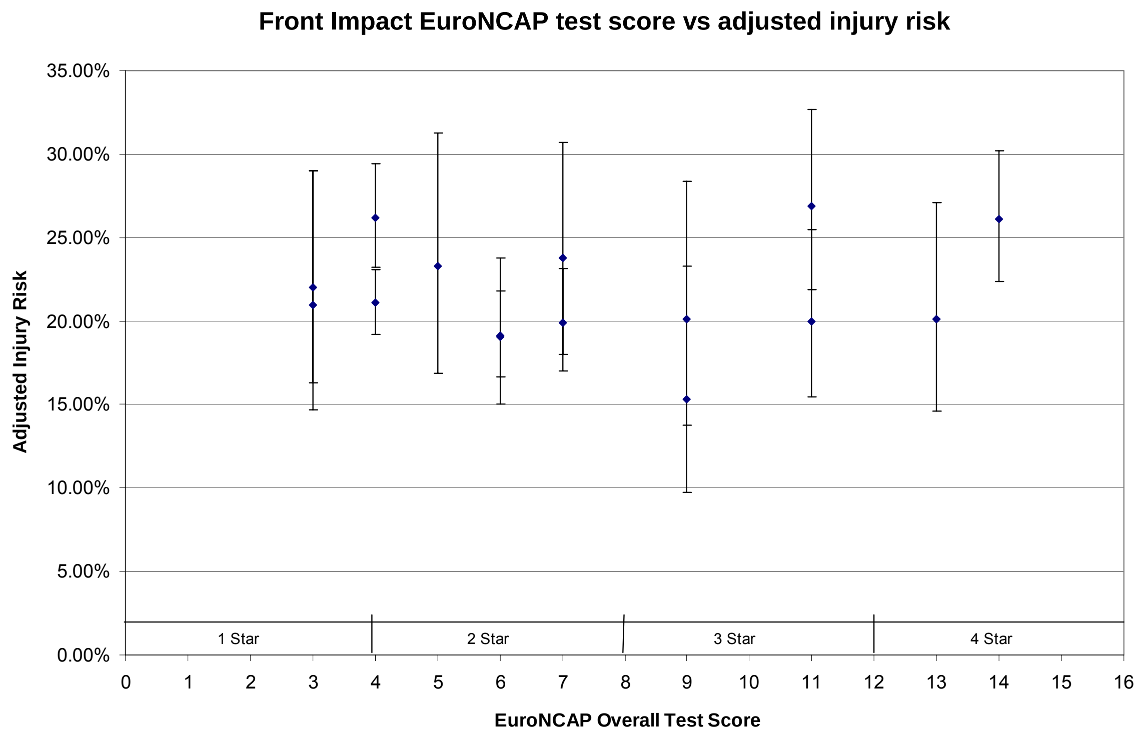
Risk Ratings (Newstead method)								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**56.41%**	**57.92%**			**56.02%**	**58.31%**	
LCL		52.37%	53.91%			52.02%	59.94%	
UCL		60.36%	61.83%			54.35%	62.16%	

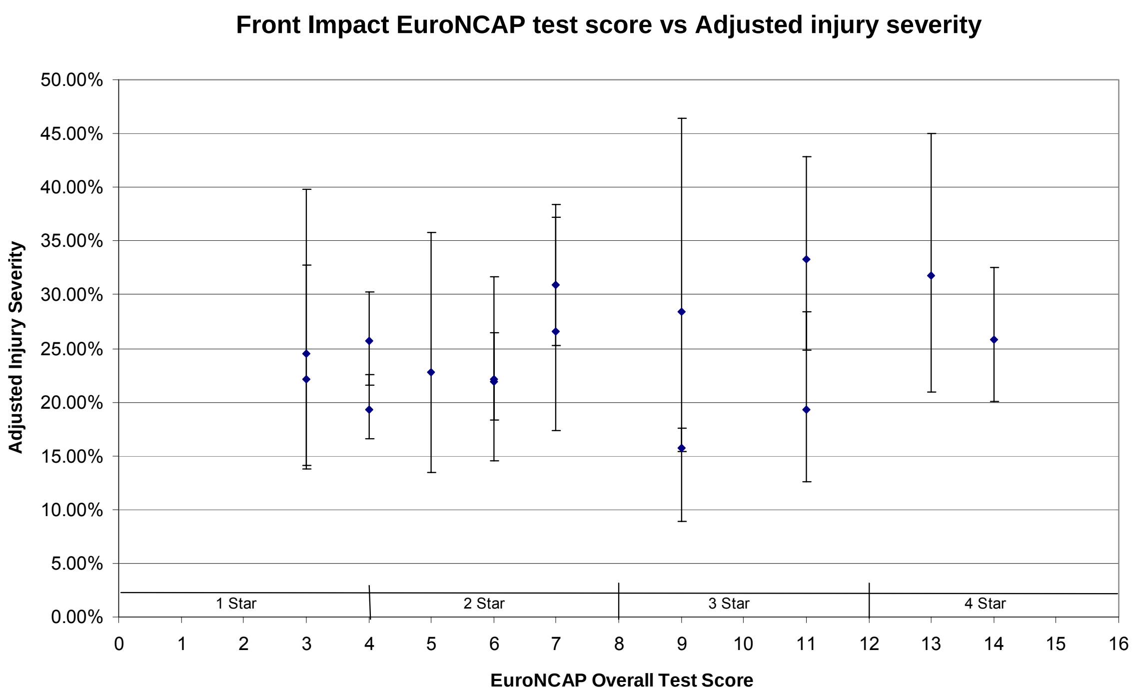
Injury Severity Ratings								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**30.97%**	**27.55%**			**31.09%**	**27.45%**	
LCL		27.39%	24.23%			27.52%	24.15%	
UCL		34.80%	31.14%			34.89%	31.00%	

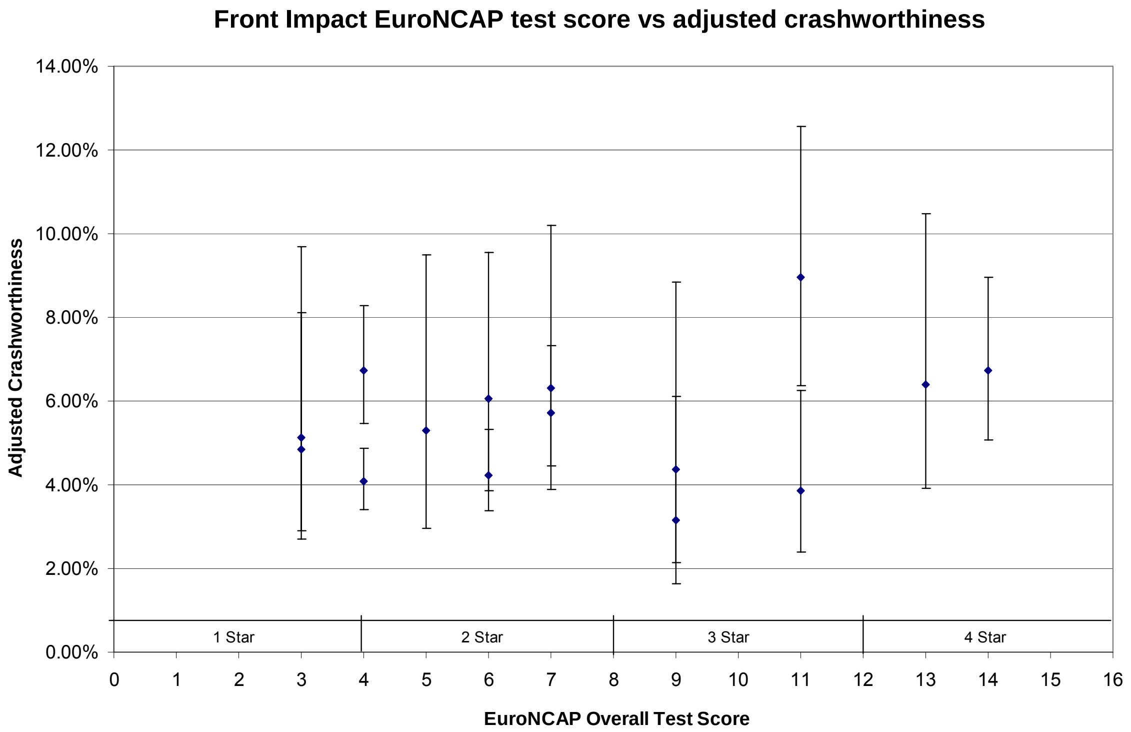
APPENDIX H

RELATIONSHIPS BEWEEN EuroNCAP SCORES BY TEST CONFIGURATION AND REAL CRASH MEASURES DERIVED FROM AUSTRALIAN AND NEW ZEALAND DATA

FRONT IMPACT CRASHES- Crash Analysis







FRONT IMPACT CRASHES- Regression Analysis

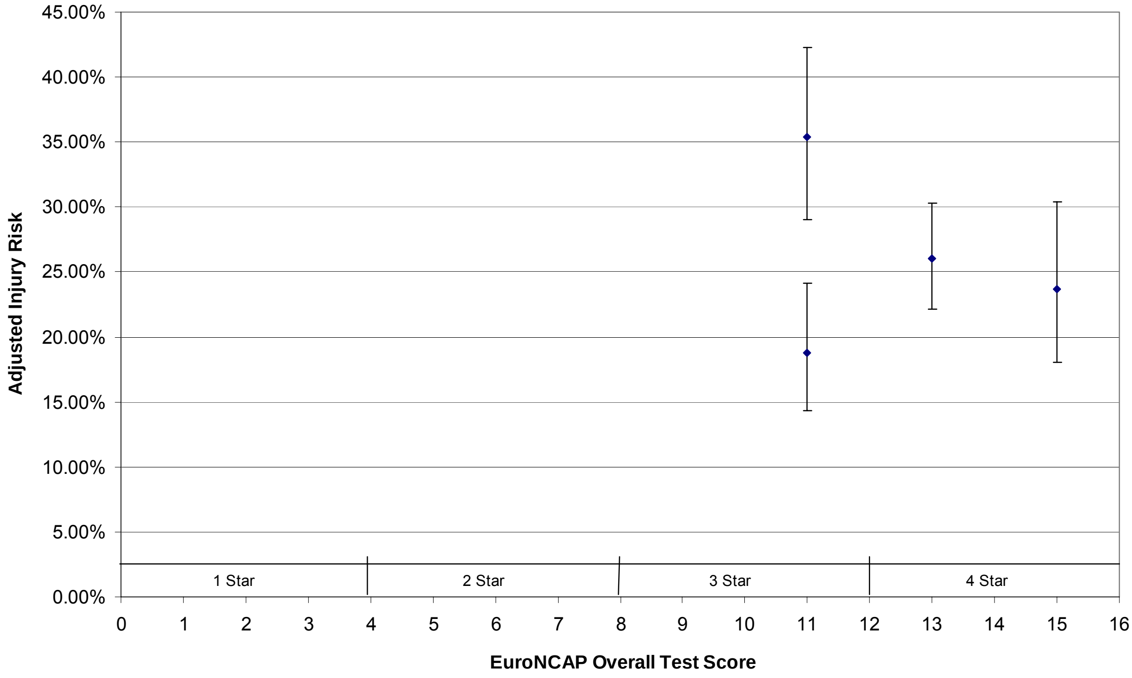
Crashworthiness Ratings								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**5.25%**	**5.67%**	**5.25%**	**5.25%**	**4.82%**	**4.87%**	**5.72%**	**6.11%**
LCL	3.93%	4.01%	3.46%	3.43%	3.64%	3.59%	3.81%	4.11%
UCL	6.98%	7.95%	7.89%	7.96%	6.35%	6.58%	8.50%	8.98%

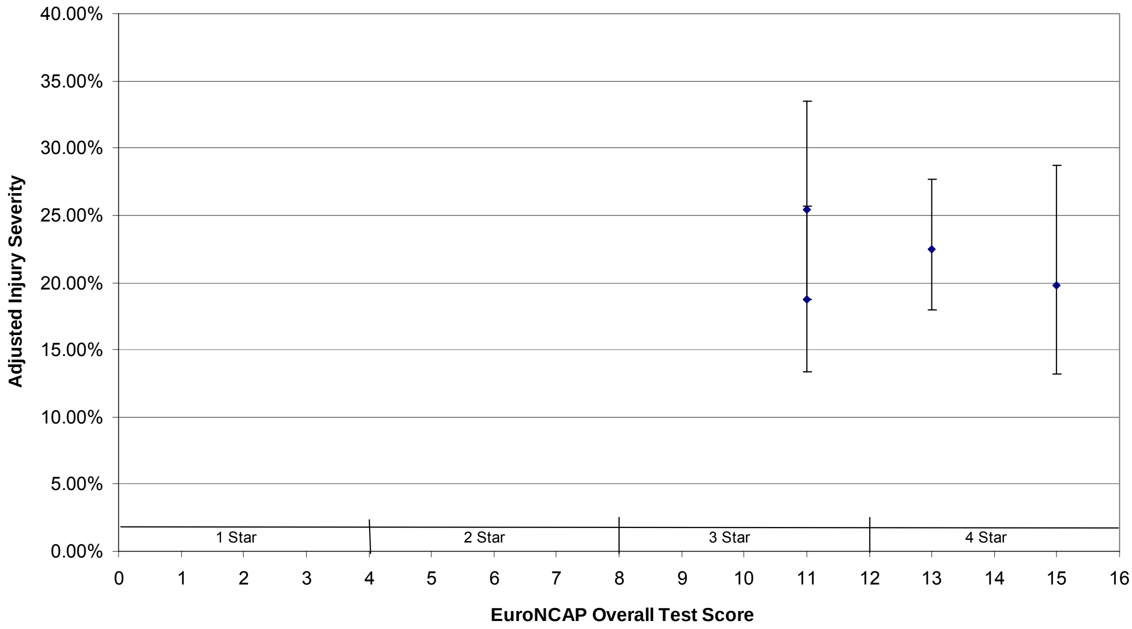
Injury Risk Ratings								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**23.56%**	**21.31%**	**21.57%**	**22.48%**	**22.37%**	**19.80%**	**22.58%**	**24.29%**
LCL	20.13%	17.61%	17.00%	17.68%	19.26%	16.64%	17.95%	19.52%
UCL	27.38%	25.53%	26.96%	28.13%	25.81%	23.39%	27.99%	29.79%

Injury Severity Ratings								
	Front Impact Crashes (with mass adjustment)				Front Impact Crashes (without mass adjustment)			
	Front Impact Star Rating				Front Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate	**21.94%**	**26.30%**	**25.77%**	**25.08%**	**10.32%**	**21.14%**	**26.73%**	**26.90%**
LCL	17.25%	20.20%	18.54%	17.57%	16.73%	19.41%	19.45%	19.46%
UCL	27.47%	33.47%	34.61%	34.46%	26.34%	30.34%	35.53%	35.91%

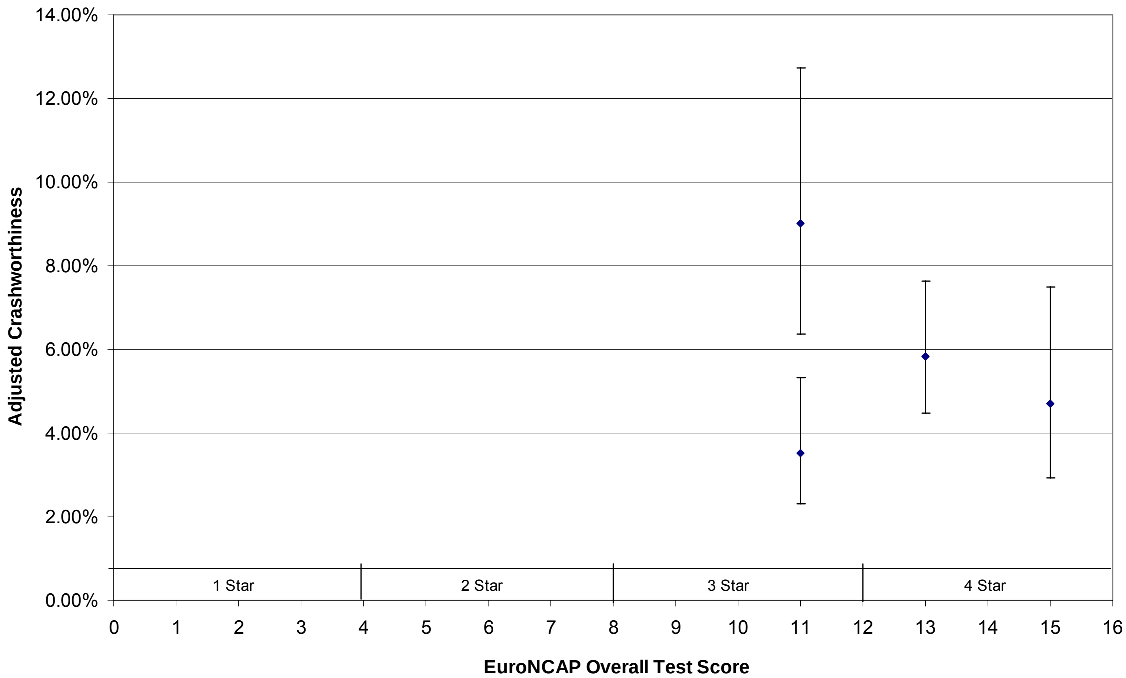
SIDE IMPACT CRASHES- Crash Analysis

Side Impact EuroNCAP test score vs adjusted injury risk





Side Impact EuroNCAP test score vs Adjusted injury severity



Side Impact EuroNCAP test score vs adjusted crashworthiness

SIDE IMPACT CRASHES- Regression Analysis

Crashworthiness Ratings								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate			**4.66%**	**7.24%**			**6.11%**	**5.53%**
LCL			3.48%	5.46%			5.06%	4.57%
UCL			6.20%	9.56%			7.37%	6.68%

Injury Risk Ratings								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate			**22.30%**	**29.75%**			**26.45%**	**25.26%**
LCL			19.08%	25.80%			23.78%	22.68%

UCL			25.90%	34.02%			29.29%	28.03%

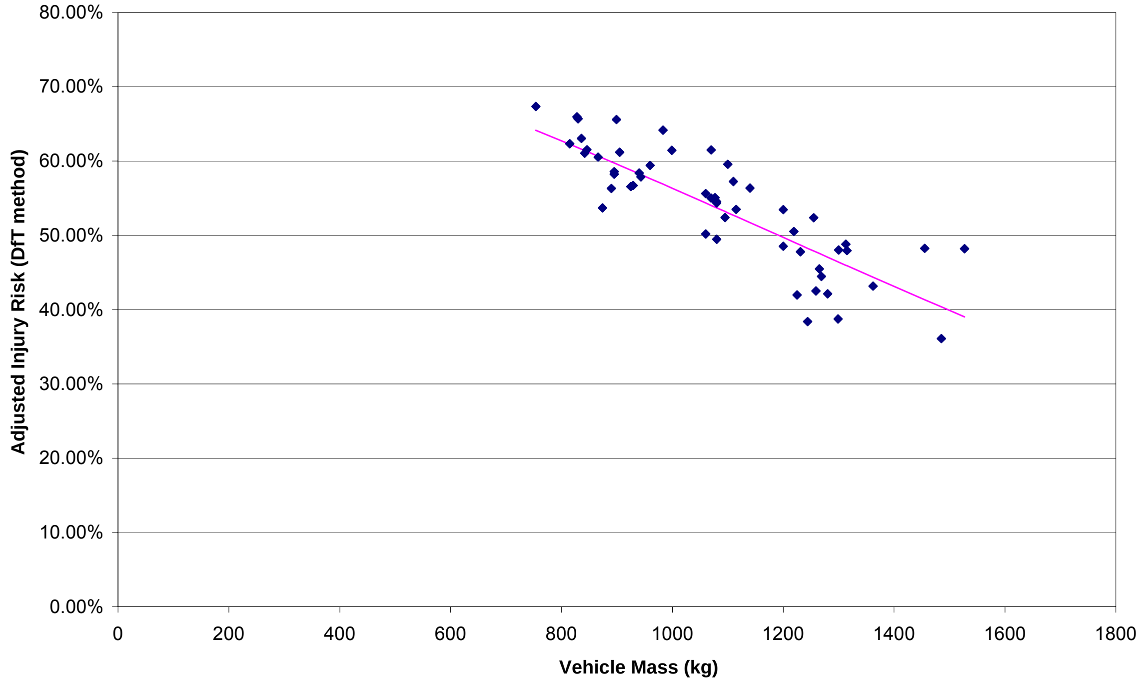
Injury Severity Ratings								
	Side Impact Crashes (with mass adjustment)				Side Impact Crashes (without mass adjustment)			
	Side Impact Star Rating				Side Impact Star Rating			
	1	2	3	4	1	2	3	4
Estimate			**20.45%**	**23.29%**			**22.02%**	**21.65%**
LCL			16.83%	19.29%			19.14%	18.81%
UCL			24.61%	27.82%			25.19%	24.79%

APPENDIX I

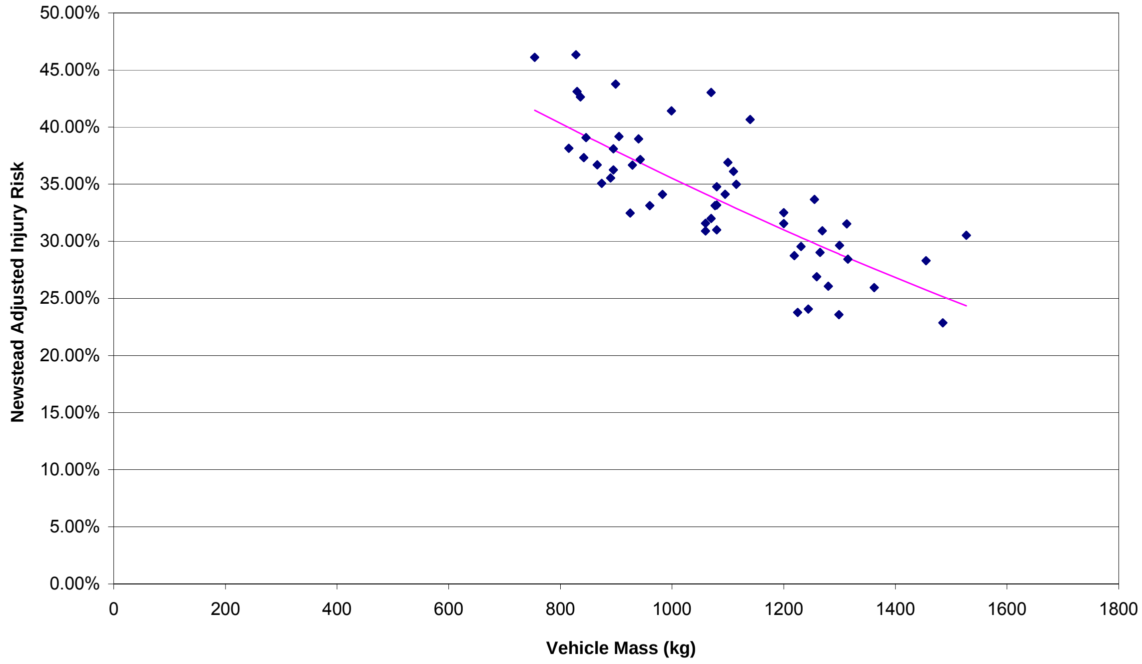
RELATIONSHIPS BEWEEN VEHICLE MASS AND REAL CRASH MEASURES DERIVED FROM BRITISH, FRENCH, AUSTRALIAN AND NEW ZEALAND DATA- FRONT AND SIDE IMPACT CRASHES

FRONT IMPACT CRASHES- Great Britain

Adjusted Injury Risk (DfT method) vs Vehicle Mass

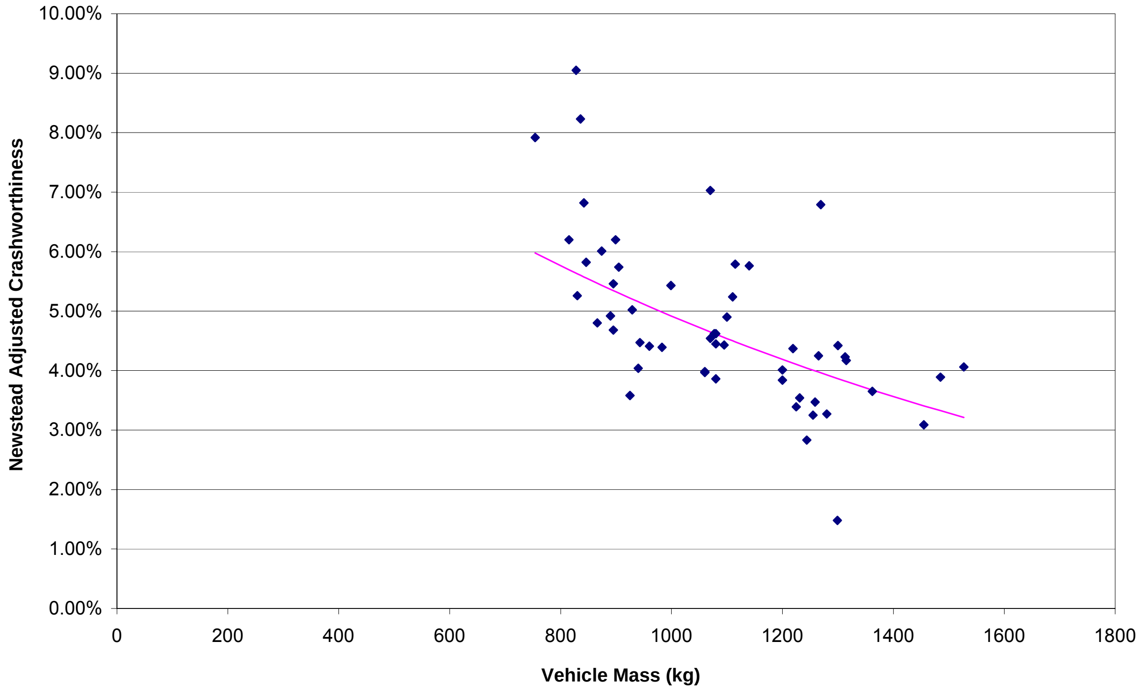


Adjusted Injury Risk (Newstead method) vs Vehicle Mass



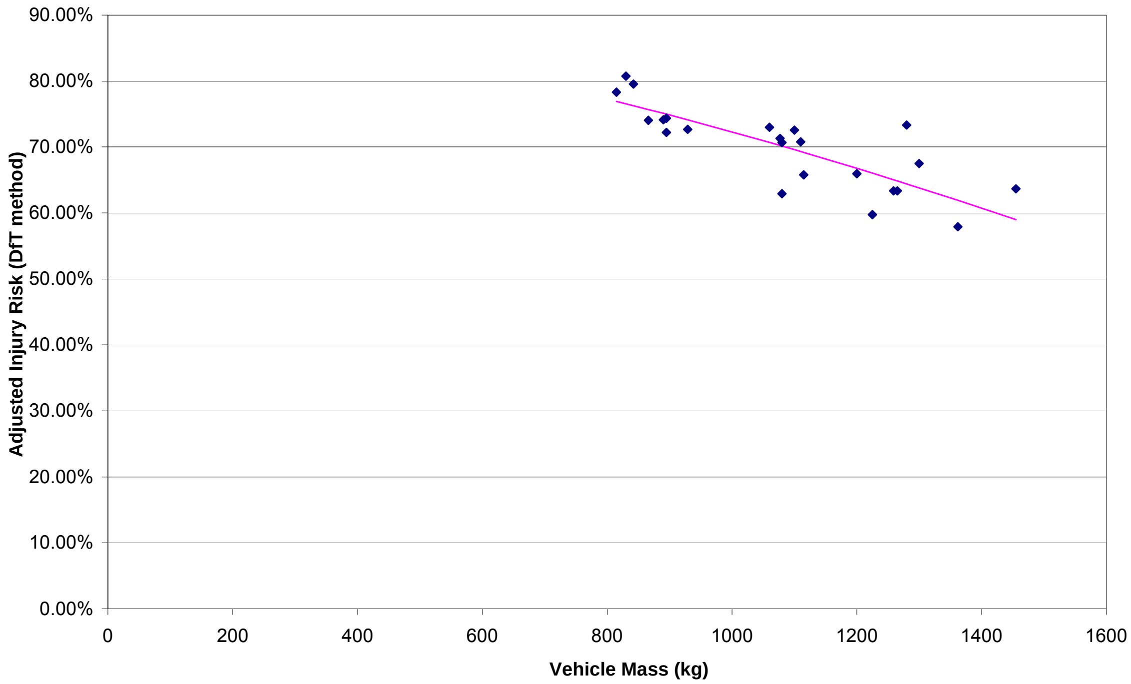
Adjusted Injury Severity vs Vehicle Mass

Adjusted Crashworthiness (Newstead method) vs Vehicle Mass

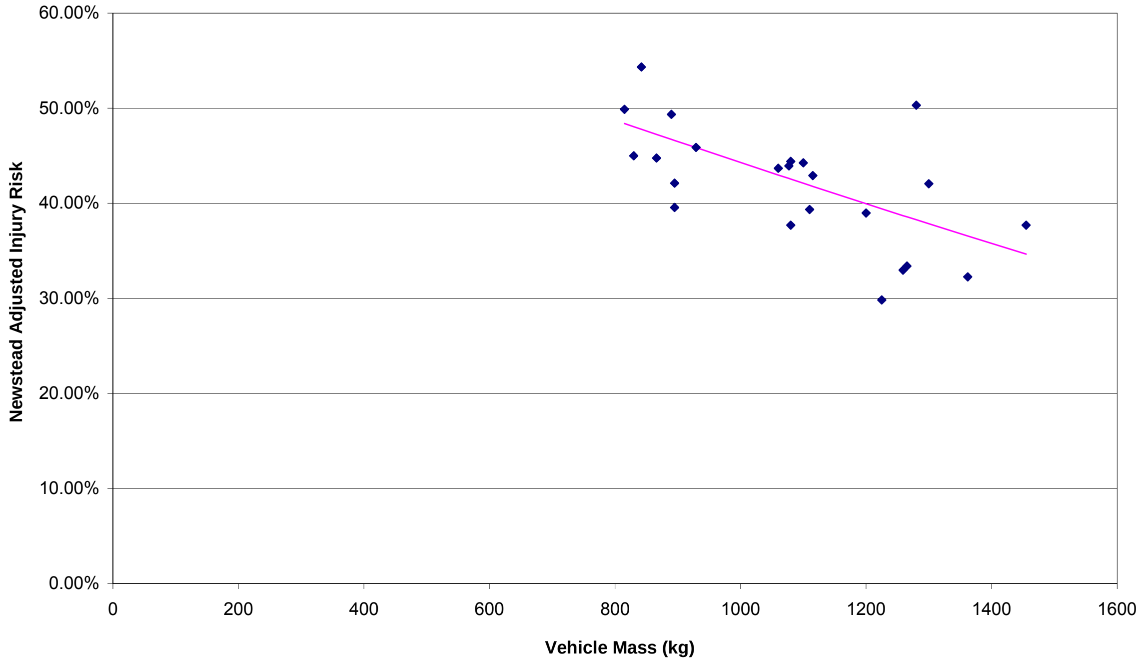


SIDE IMPACT CRASHES- UK

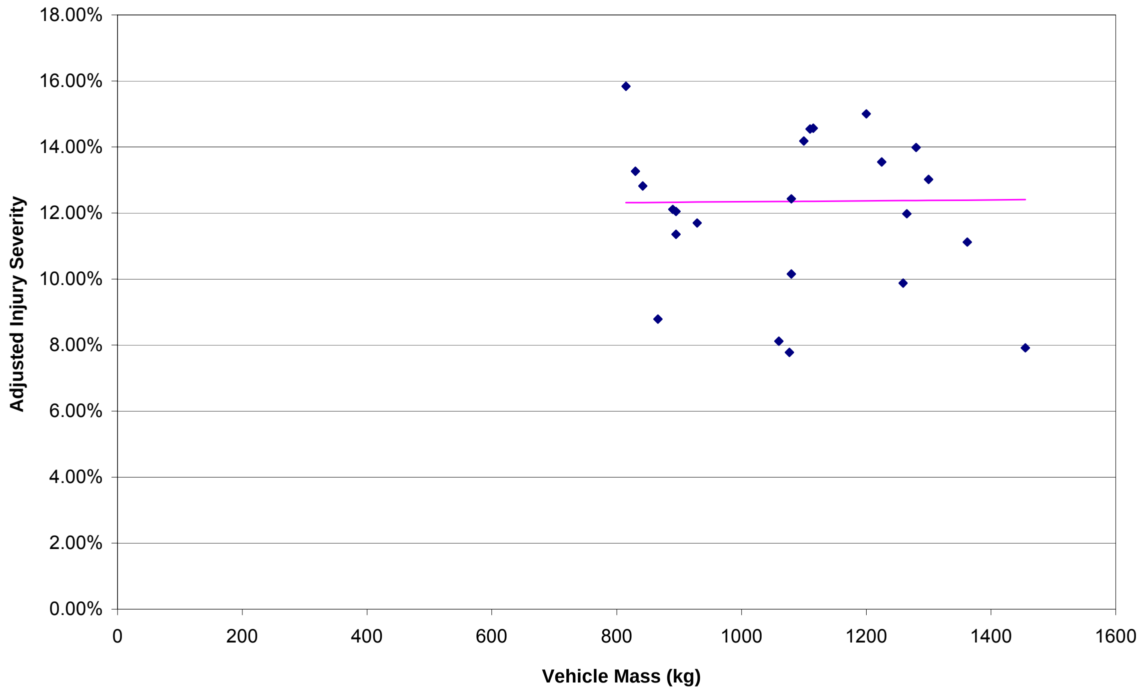
Adjusted Injury Risk (DfT method) vs Vehicle Mass



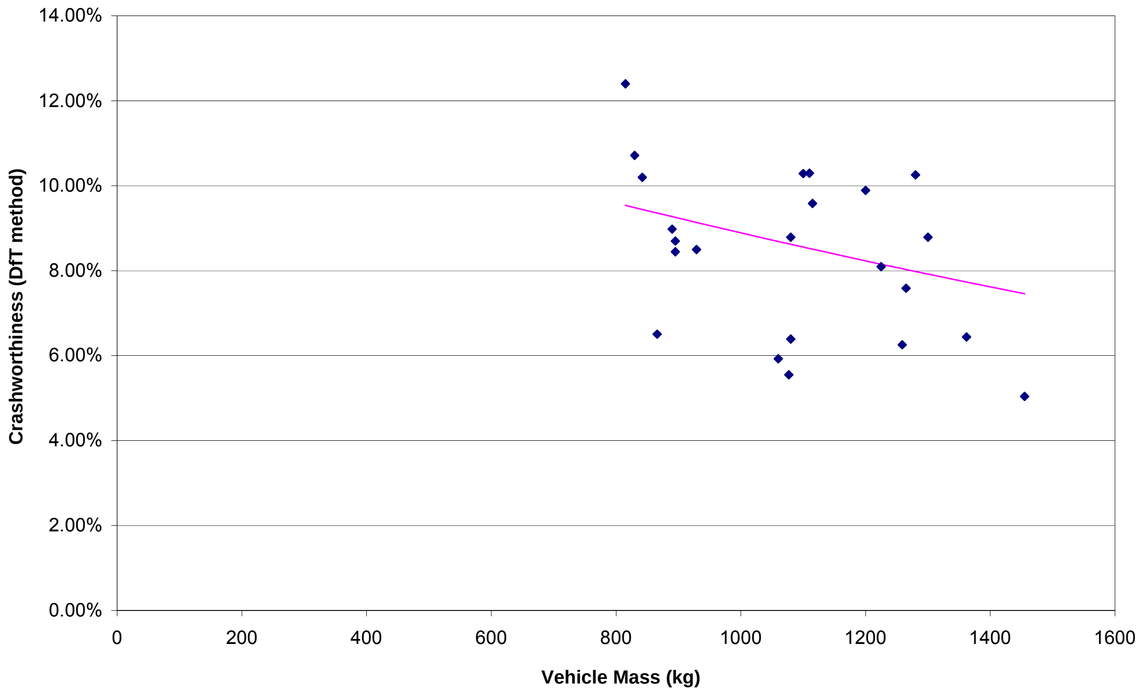
Adjusted Injury Risk (Newstead method) vs Vehicle Mass



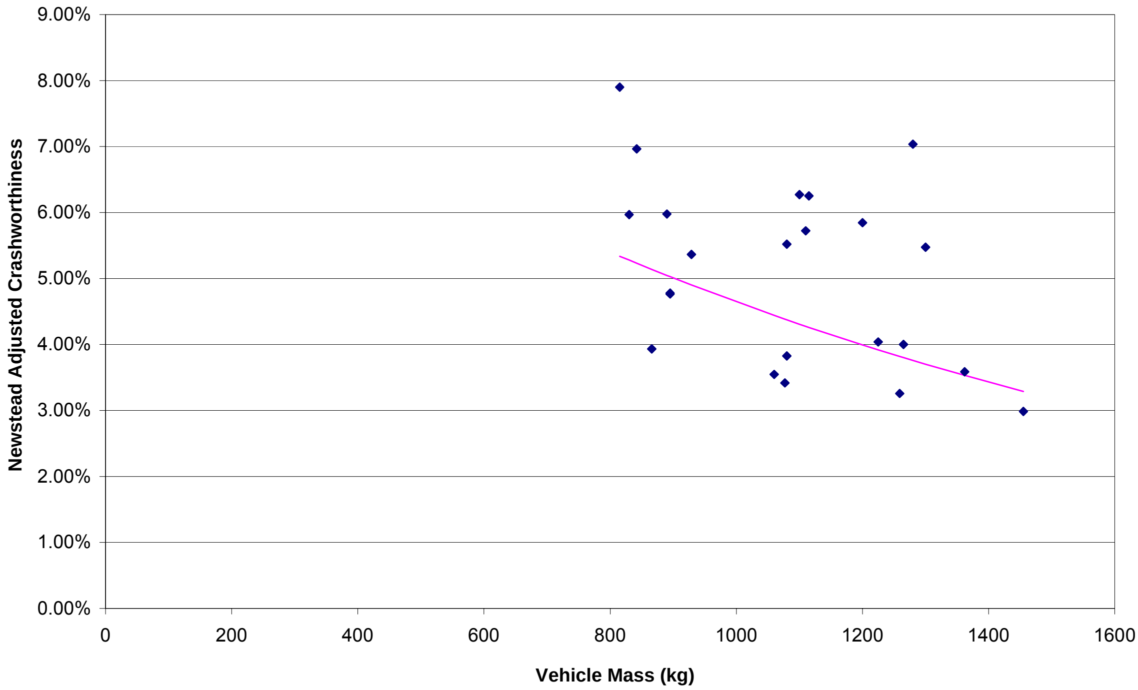
Adjusted Injury Severity vs Vehicle Mass



Adjusted Crashworthiness (DfT method) vs Vehicle Mass

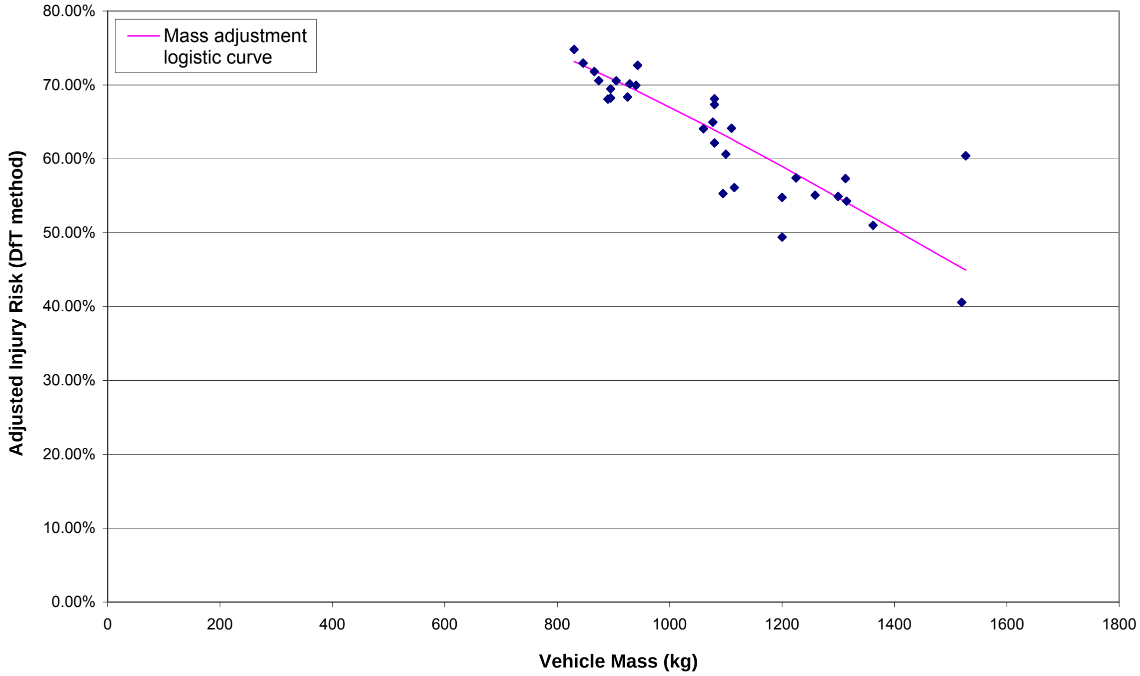


Adjusted Crashworthiness (Newstead method) vs Vehicle Mass

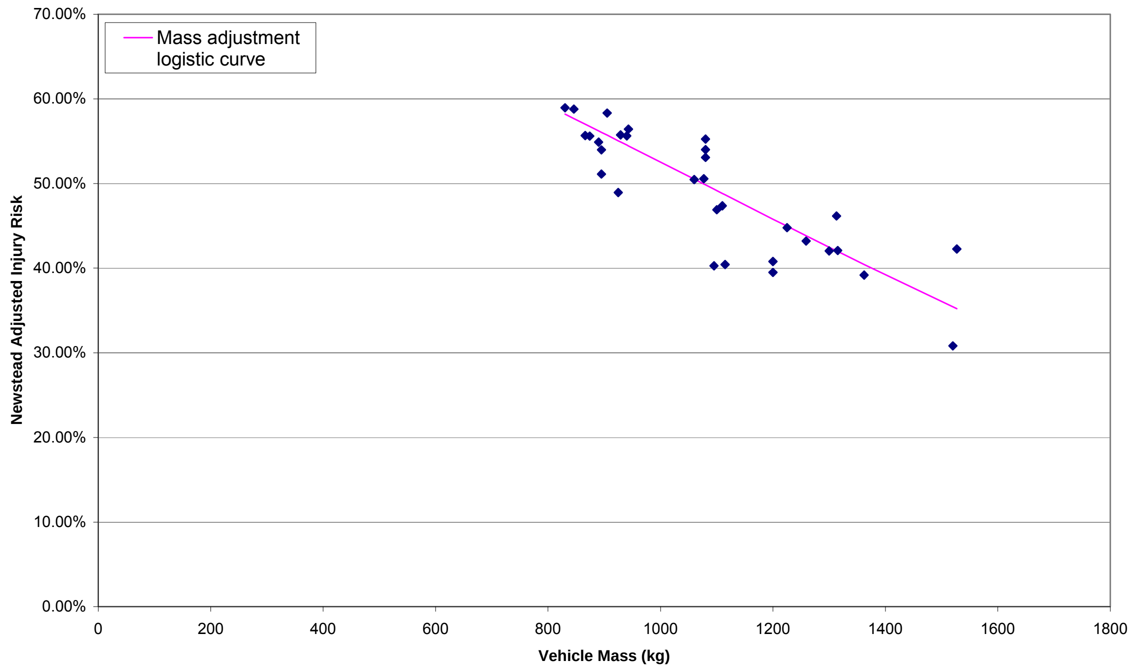


FRONT IMPACT CRASHES- FRANCE

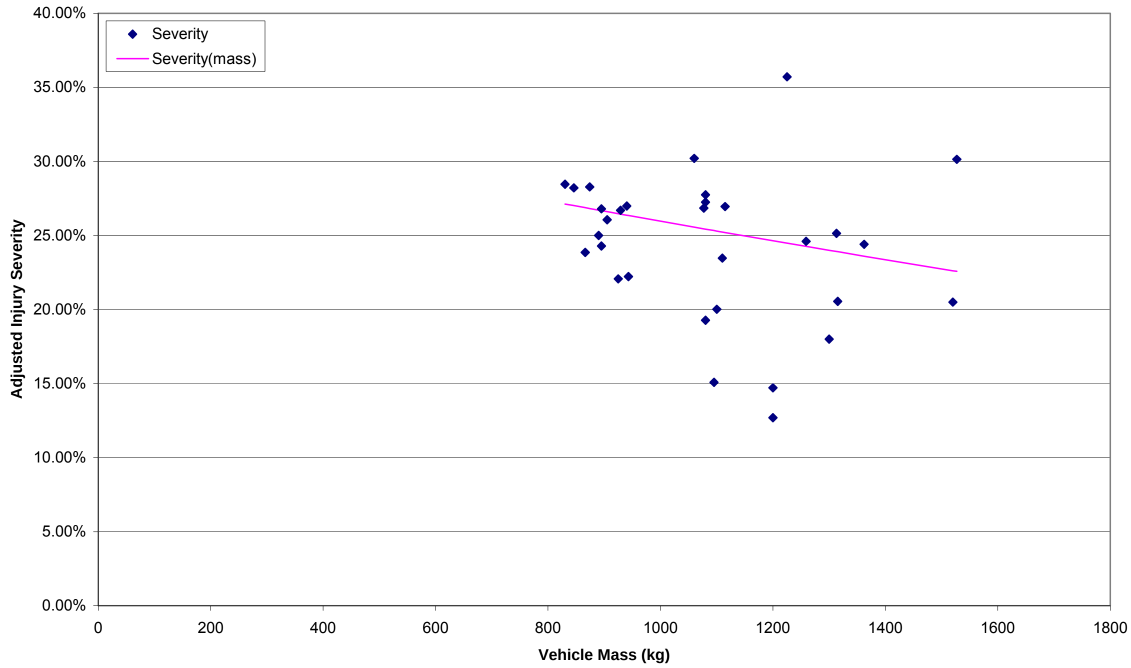
Adjusted Injury Risk (DfT method) vs Vehicle Mass



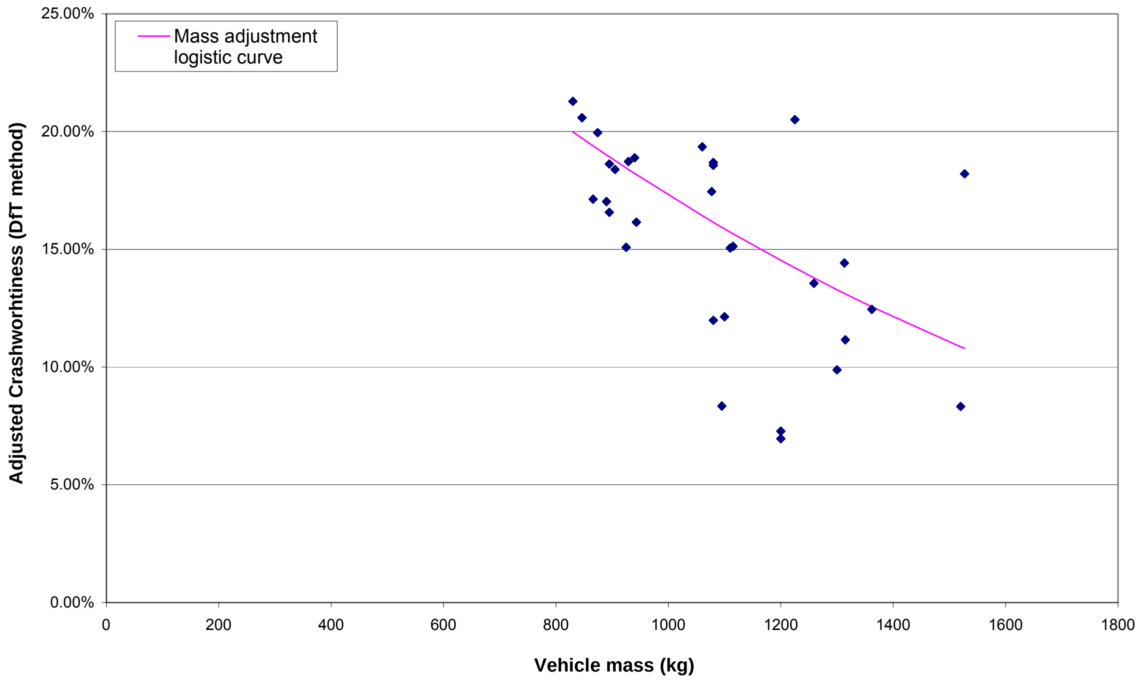
Adjusted Injury Risk (Newstead method) vs Vehicle Mass



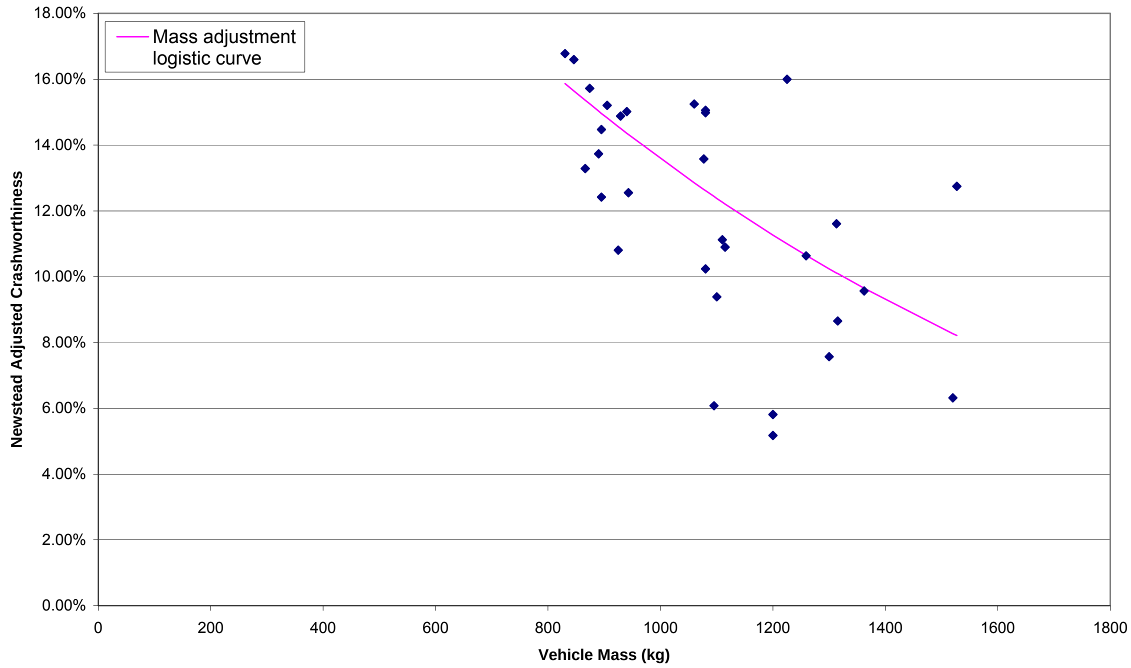
Adjusted Injury Severity vs Vehicle Mass



Adjusted Crashworthiness (DfT method) vs Vehicle Mass

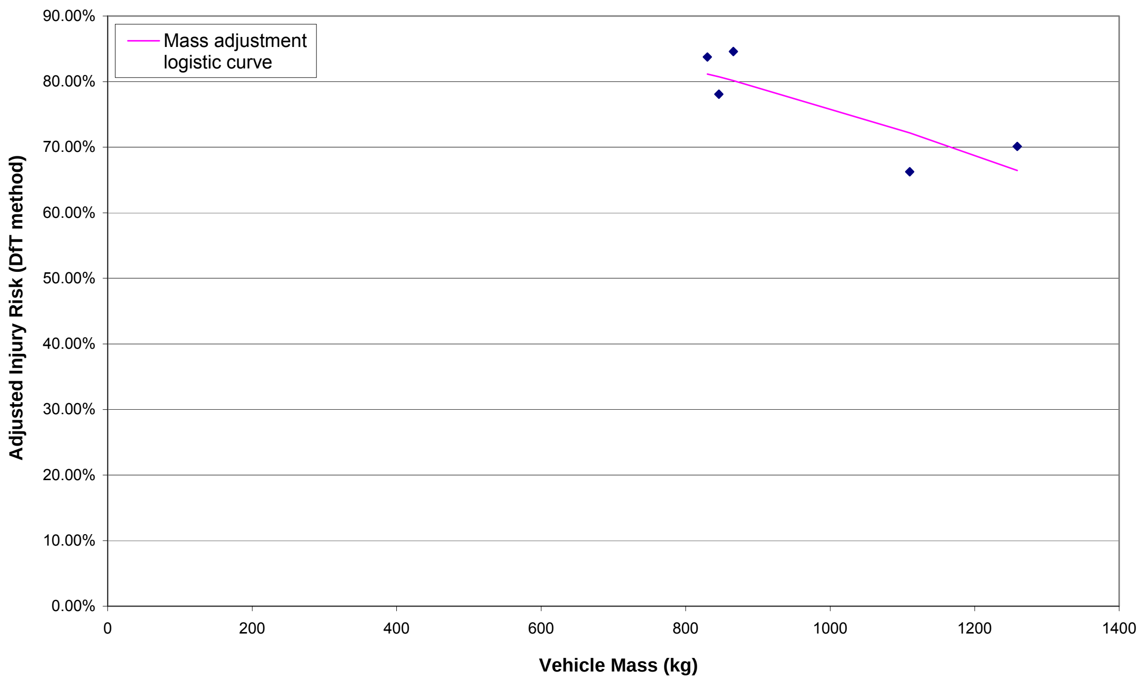


Adjusted Crashworthiness (Newstead method) vs Vehicle Mass

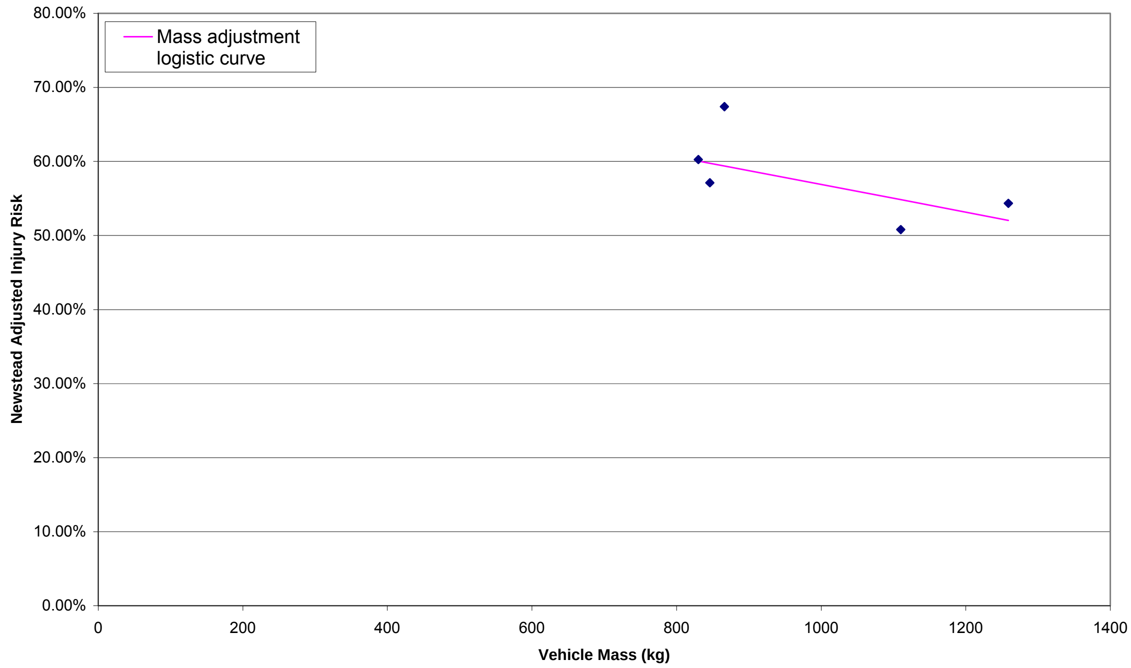


SIDE IMPACT CRASHES- FRANCE

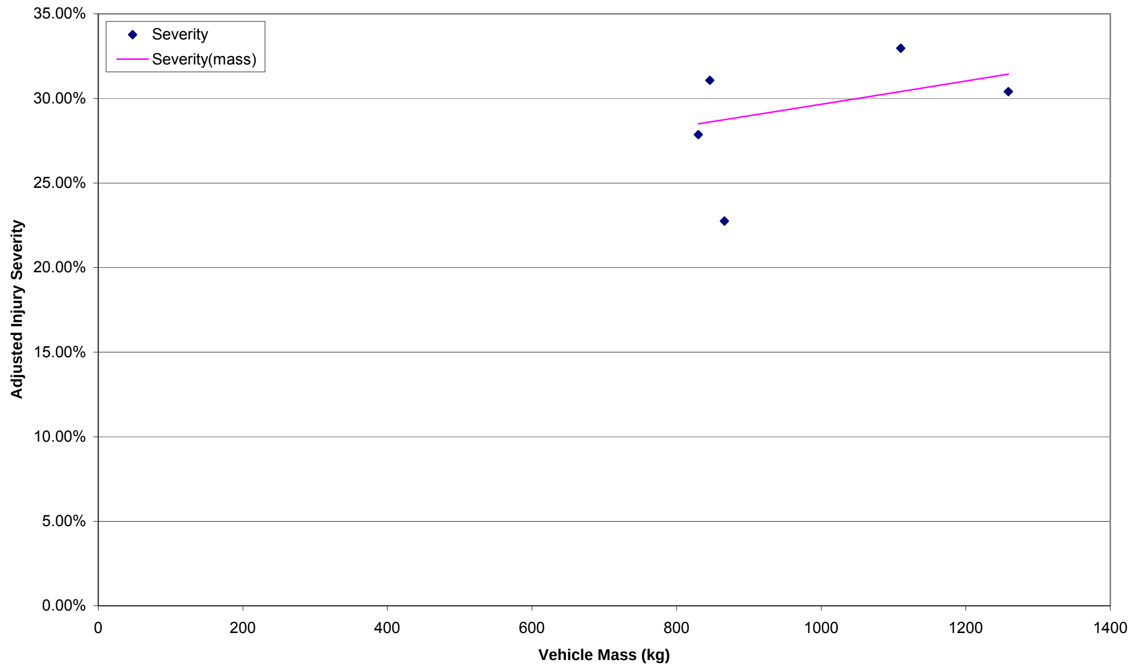
Adjusted Injury Risk (DfT method) vs Vehicle Mass



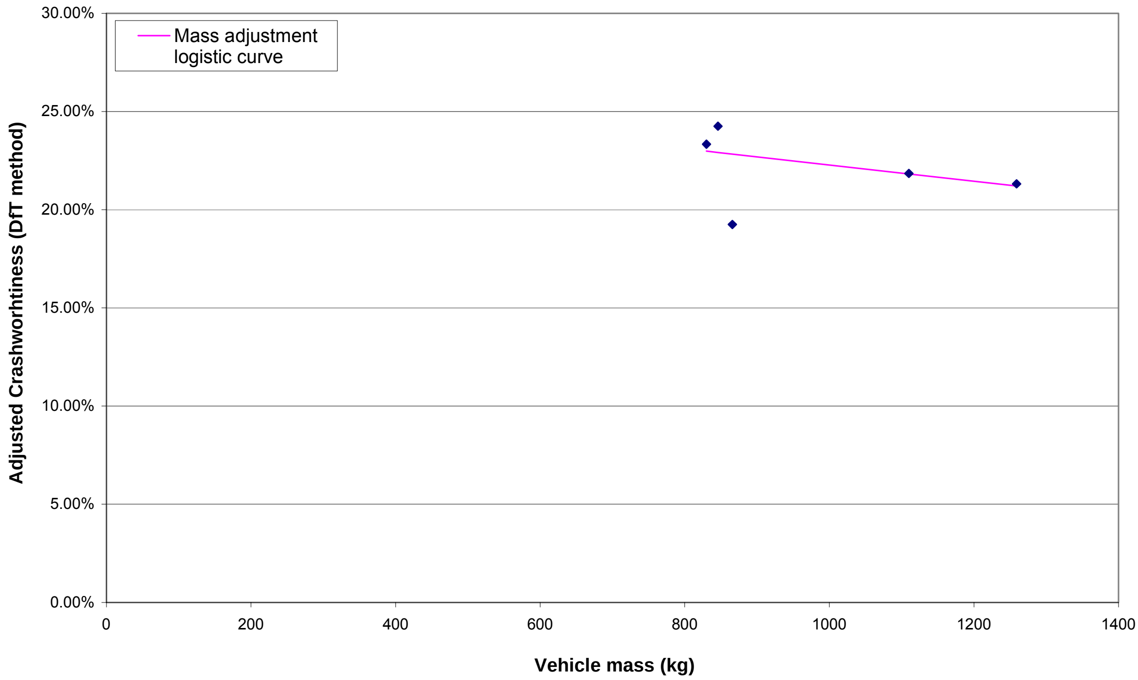
Adjusted Injury Risk (Newstead method) vs Vehicle Mass



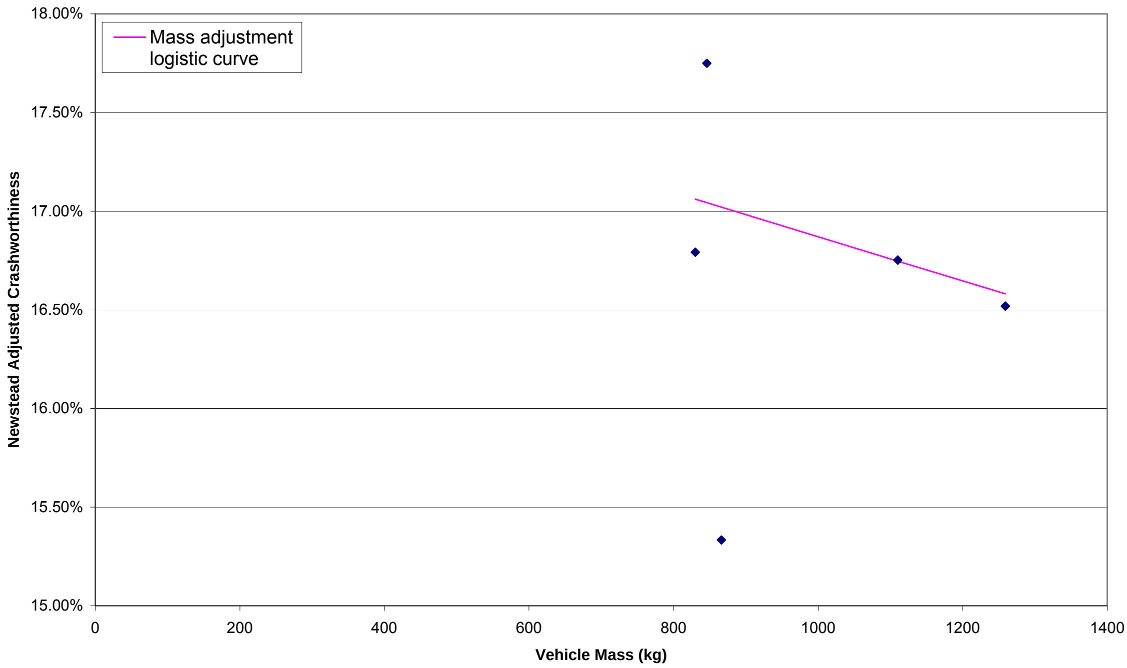
Adjusted Injury Severity vs Vehicle Mass



Adjusted Crashworthiness (DfT method) vs Vehicle Mass

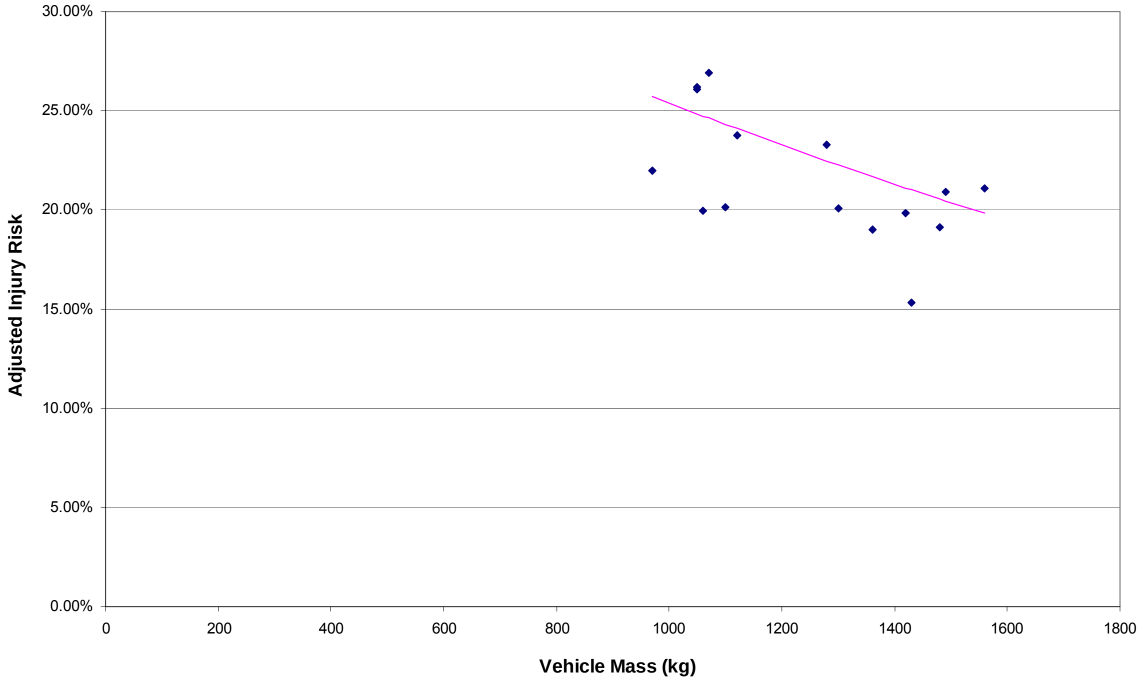


Adjusted Crashworthiness (Newstead method) vs Vehicle Mass

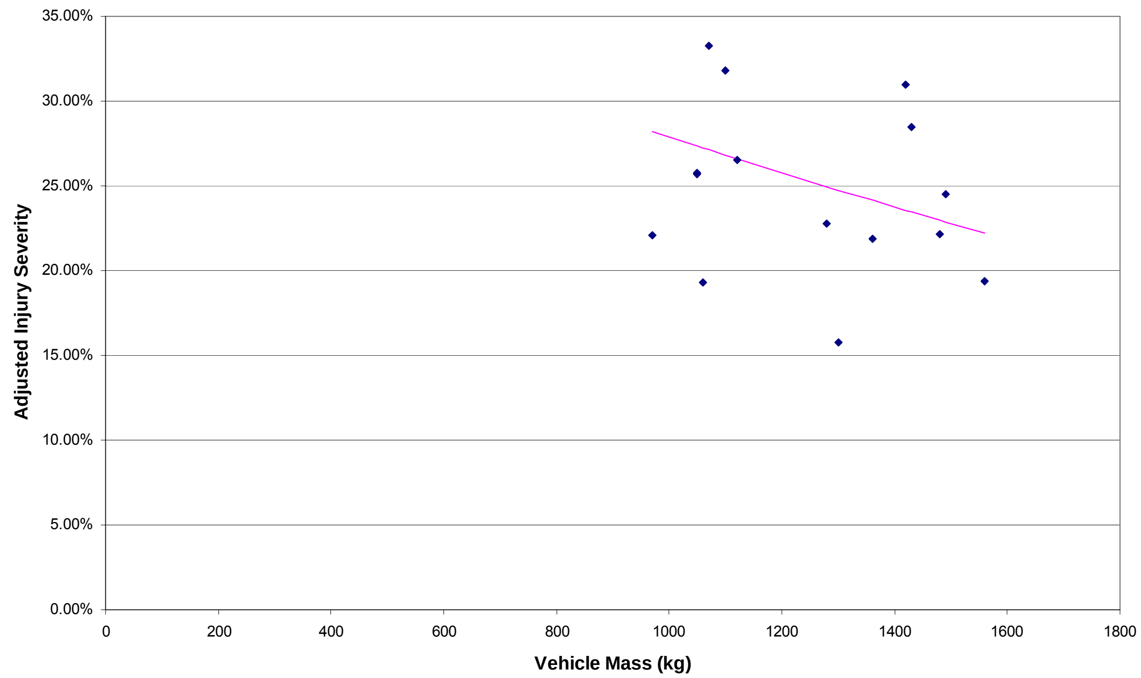


FRONT IMPACT CRASHES- AUSTRALIA AND NEW ZEALAND

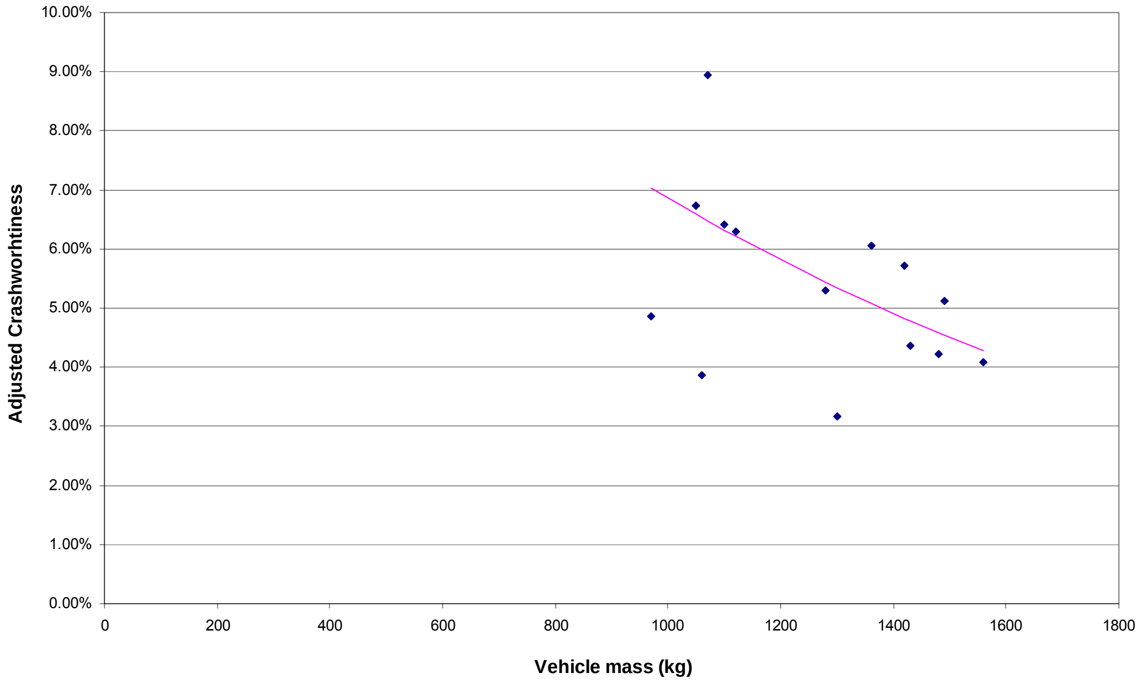
Adjusted Injury Risk vs Vehicle Mass



Adjusted Injury Severity vs Vehicle Mass

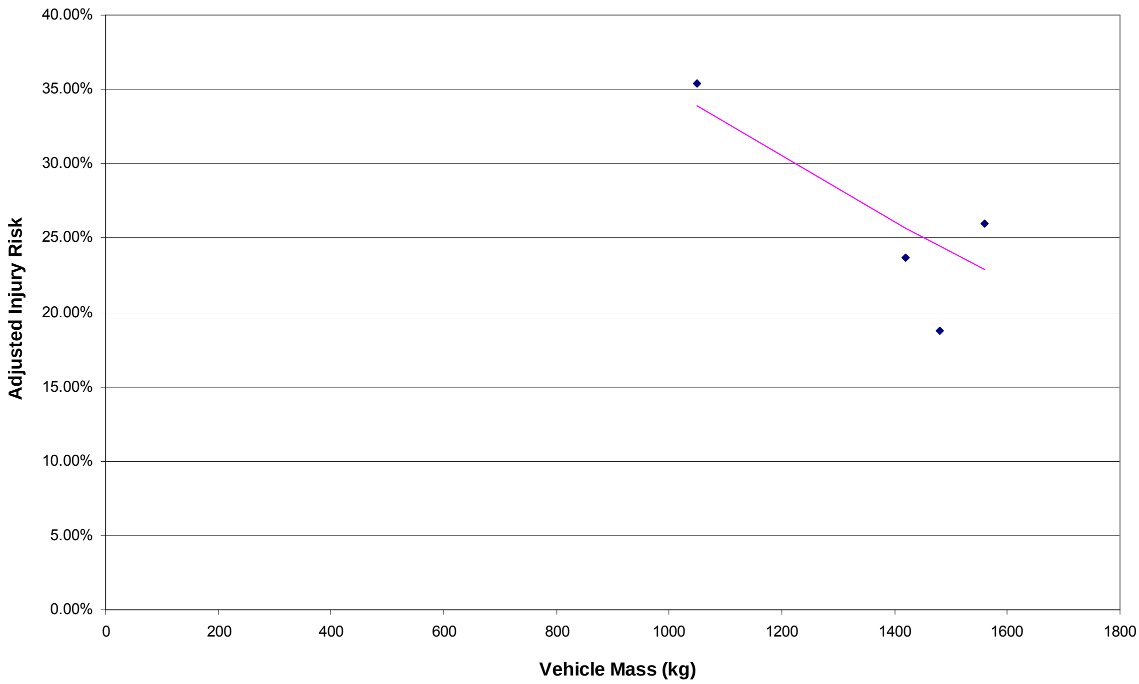


Adjusted Crashworthiness vs Vehicle Mass

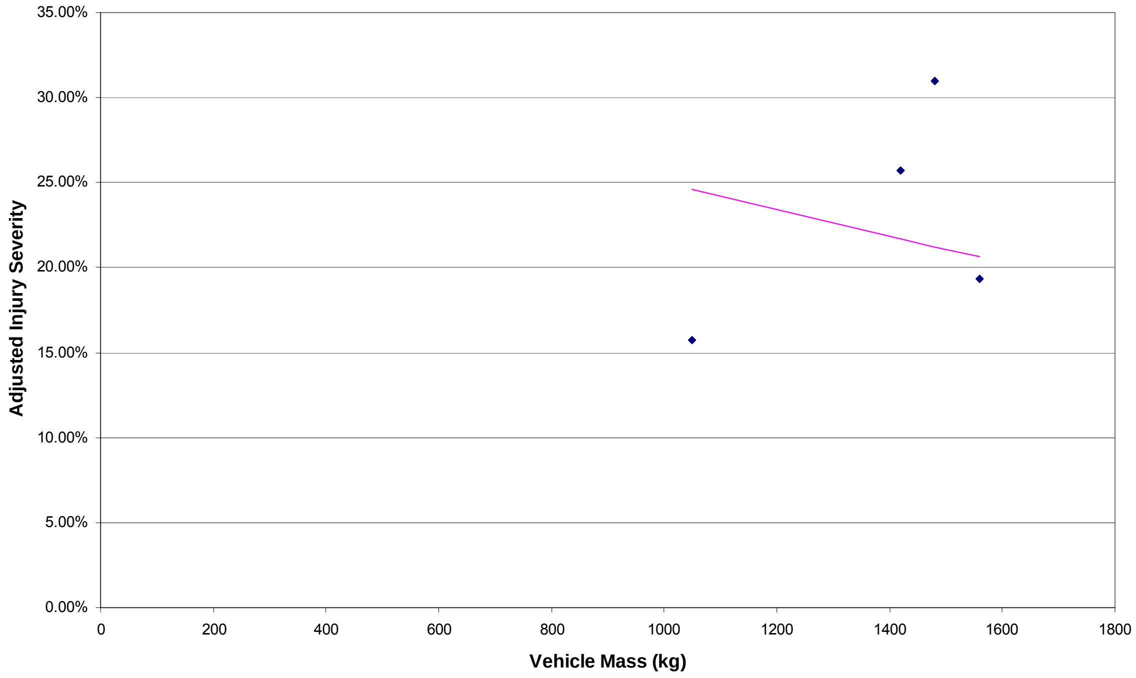


SIDE IMPACT CRASHES- AUSTRALIA AND NEW ZEALAND DATA

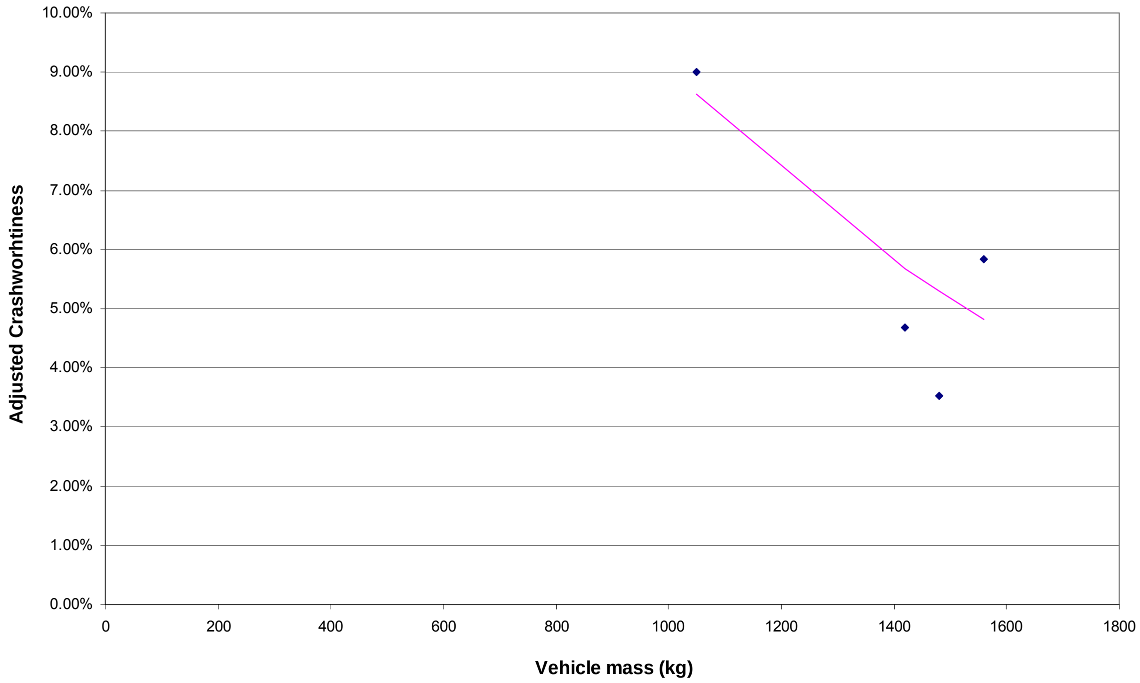
Adjusted Injury Risk vs Vehicle Mass



Adjusted Injury Severity vs Vehicle Mass



Adjusted Crashworthiness vs Vehicle Mass



APPENDIX J

FINNISH CRASH DATA AND ANALYSIS

1 Finnish Real Crash Data

1.1 Data Description

A subset of the Finnish crash data, collected by VALT, was supplied for use in this study by Helsinki University of Technology (HUT). The data included crash based records for all vehicles involved in any single or two-vehicle crash reported to any Finnish insurance company during the period 1994 to 2003. Both injury and non-injury crashes were included in the data. A total of 508,057 single and two-vehicle crash records were recorded in the data of which 348,660 occurred on public roads.

Within each crash record, information was provided on the make and model characteristics of all vehicles involved in the crash. Information on driver characteristics, such as driver age and driver sex, is provided in full for all ‘guilty’ drivers (i.e. those drivers determined to be at fault in the crash) regardless of the level of injury sustained and for ‘non-guilty’ drivers where the driver sustains some injury. Other useful variables included in the crash data were the location of the crash (urban vs rural) and the speed zone of the crash site.

Driver injury level is coded in the Finnish data using a four level scale. These levels are: fatal (includes cases where death occurs in less than 30 days as a result of the accident), serious injury, slight injury and non-injury.

Considering the data set provided, and after selecting those vehicles involved in crashes on public roads only, complete information for the required variables (driver age, driver sex, focus driver injury outcome, opponent driver injury outcome, speed limit at the crash site and urbanisation of the crash site) was available for 252,499 vehicles of which 29,885 were vehicles with makes and models comparable to EuroNCAP tested vehicles.

Vehicle makes and models were selected for inclusion in the analysis where at least 80 drivers were involved in two-car crashes and at least 20 drivers were injured in single and two-car crashes combined. On this basis there was sufficient data to estimate injury risk ratings for 13 individual vehicle makes and models using the DfT method. There was insufficient data to reliably estimate injury severity.

1.2 Identification of Vehicle Models in the Finnish Data

Vehicle model details are coded in the Finnish data in the ‘ TCode’ and ‘VCode’ variables (focus and opposing vehicle model codes respectively) derived from official registration records. Identification of vehicle models compatible with those tested by EuroNCAP was completed by HUT. In addition to the model codes provided in the Finnish data, the first year of registration of the vehicle was available. This variable was used to confirm the compatibility of the Finnish vehicle models with those tested by EuroNCAP.

Table 1. Number of injured or involved drivers of EuroNCAP crash tested vehicles from 1994 to 2001: Finnish Crash Data.

Make/model with Crashworthiness Rating based on 1993-2001 crashes and tested in the EuroNCAP program	Euro-NCAP Index	Drivers involved in injury crashes between 2 light cars	Injured drivers in single and 2 light car crashes
Fiat Punto 55S	1	71	44
Ford Fiesta 1.25 LX 16V	2	49	25
Nissan Micra 1.0L	3	86	58
Renault Clio 1.2RL	4	87	51
Rover 100	5	129	78
Vauxhall Corsa 1.2LS	6	25	9
Volkswagen Polo 1.4L	7	38	21
Audi A4 1.8	8	16	8
BMW 316i	9	65	34
Citroen Xantia 1.8i Dimension	10	59	19
Ford Mondeo 1.8LX	11	73	34
Mercedes C180 Classic	12	81	30
Nissan Primera 1.6GX	13	77	31
Peugeot 406 1.8LX	14	0	0
Renault Laguna 2.0RT	15	20	7
Rover 620 Si	16	54	19
Saab 900 2.0i	17	10	6
Vauxhall Vectra 1.8iLS	18	35	25
Volkswagen Passat 1.6L LHD	19	37	21
Audi A3 1.6	20	20	13
Citroen Xsara 1.4i LHD	21	9	5
Daewoo Lanos 1.4SE LHD	22	42	20
Fiat Brava 1.4S	23	99	59
Honda Civic 1.4i	24	7	4
Hyundai Accent 1.3GLS LHD	25	95	57
Peugeot 306 1.6GLX	27	83	44
Renault Megane 1.6RT LHD	28	4	3
Suzuki Baleno 1.6GLX LHD	29	16	6
Toyota Corolla 1.3 Sportif LHD	30	50	18
Volkswagen Golf 1.4 LHD	31	5	1
Audi A6 2.4 LHD	32	10	4
BMW 520i LHD	33	61	30
Mercedes E200 Classic LHD	34	133	60
Saab 9-5 2.0 LHD	36	250	127
Vauxhall Omega 2.0Gl/GLS LHD	37	120	48
Volvo S70 2.0/2.5 10V LHD	38	4	1
Ford Focus 1.6 LHD	39	0	0
Mercedes A140 Classic LHD	40	1	0
Vauxhall Astra 1.6i Envoy	41	0	0

Ford Escort 1.6 LX	42	0	0
Nissan Almera 1.4GX	43	31	17
Nissan Serena 1.6 LHD	47	97	59
Volkswagen Sharan TDI LHD	48	5	5
Vauxhall Corsa 1.0 12v Club	56	0	0
Honda Accord 1.8iLS	59	19	8
Saab 9-3 2.0 LHD	61	37	27
Ford Ka 1.3 LHD	63	112	53
Volvo S40 1.8	64	20	14
Toyota Avensis 1.6S	65	2	1
Citroen Saxo 1.1 SX LHD	66	28	21
Daewoo Matiz SE+ RHD	67	43	21
Fiat Seicento	69	31	20
Ford Fiesta 1.25 Zetec	70	14	8
Nissan Micra L 1.0 RHD	71	9	5
Peugeot 206 1.3 XR Presence LHD	72	33	19
Renault Clio 1.2 RTE LHD	73	0	0
Rover 25 1.4i RHD	74	3	2
Toyota Yaris 1.0 Terra LHD	77	30	17
Volkswagen Polo 1.4 LHD	78	14	7
Nissan Almera Hatch	81	4	4
BMW 316i LHD	84	14	8
Peugeot 406 LHD	89	11	1
Rover 75 1.8 RHD	91	0	0
Vauxhall/Opel Vectra 1.8 LHD	93	7	3
Volkswagon Passat 1.9 Tdi LHD	94	29	10
Citroen Picasso 1.6 LX LHD	96	5	2
Renault Scenic 1.4 LHD	102	1	0
Mazda MX-5 1.6 LHD	112	23	10
Jeep Cherokee 2.5 TD Limited LHD	115	113	44
Vauxhall/Opel Corsa 1.2 Comfort LHD	136	5	3
Total number of vehicle models with sufficient data for analysis		**13**	

1.3 Method

A detailed description of the methods used in this analysis is provided in section 3.1 of the main report.

A number of factors thought to influence the risk and severity of injury to drivers involved in crashes were included in the logistic models in order to obtain estimates of vehicle safety unbiased by these factors. The factors considered in the analysis for injury risk for the Finnish injury risk ratings were:

Driver age: ≤25 years, 26-59 years, ≥ 60 years

- Driver sex: male, female

- Speed limit at the crash location: ≤ 50km/h, 60-70 km/h, ≥80 km/h
- Urbanisation of crash site: rural, urban
- Year of crash: 1994-2003

Base effects as well as all possible interaction of these variables were included in the logistic regression analyses.

1.4 Results

Logistic models of injury risk were fitted separately to the data using the logistic procedure of the software package SAS. In addition to fitting main effects, interactions of first and higher order were included. To avoid an overly complex final model or one that might become unstable in the estimation procedure, a stepwise approach was used to fit the model, with the restriction that an interaction could only be considered if the main effect terms of the interaction were significant predictors of injury risk. This approach has been used successfully by MUARC in estimating the Australian crashworthiness ratings and gives a greater chance that the fit of the final model to the data will be acceptable.

Table 2 details the main effects and interactions that were judged to be significant predictors of injury risk for all crash types through the stepwise logistic modelling approach. A variable indicating vehicle model was included as a main effect in each of the models and was a significant predictor of injury risk in each case. The "vehicle model" variable had distinct levels representing each of the EuroNCAP tested vehicle models included in the analysis and an additional level representing all crashed vehicles in the data not assessed under the EuroNCAP program. Non-EuroNCAP tested vehicles were included in the analysis to provide better estimates of the effects of non-vehicle factors, such as driver age and sex, on injury risk. No interaction between the "vehicle model" and other covariates in the model was included, as this would cause difficulty in interpretation of the vehicle model main effect.

Table 2. Significant factors in the logistic regression models of injury risk derived from the Finnish data using the DfT injury risk method

Significant Model Factors	All Crash Types
Main Effects	driver age (age), driver sex (sex), urbanisation (urb), speed limit (sl) year of crash (ycrash)
First Order Interactions	age*sex sex*sl sex*ycrash

Table 3 shows the resulting injury risk ratings for all crash types including the all model average injury risk rating. Upper and lower confidence limits for the all crash type injury risk rating are also provided and were calculated using the method detailed in the MUARC crashworthiness computation by Newstead et al (1999). The coefficient of variation of the injury risk rating displayed is the ratio of the width of the confidence limit to the magnitude of the point estimate. It is useful as a scaled measure of rating accuracy.

Table 3. Crashworthiness ratings estimated from Finnish crash data using the DfT method.

ALL CRASH TYPES (DfT Method)						
Euro NCAP Index	**Vehicle Make/Model**	**Estimated Crashworthiness**	**Lower 95 CI CWR**	**Upper 95 CI CWR**	**Range of CI**	**CWR Coefficient of Variation**
	All Model Average	**39.24**				
3	Nissan Micra 1.0L	51.12	40.00	62.13	22.13	0.43
4	Renault Clio 1.2RL	45.24	35.03	55.88	20.85	0.46
7	Volkswagen Polo 1.4L	45.27	36.52	54.31	17.79	0.39
14	Peugeot 406 1.8LX	27.95	19.67	38.07	18.39	0.66
28	Renault Megane 1.6RT LHD	47.66	37.74	57.76	20.02	0.42
30	Toyota Corolla 1.3 Sportif LHD	44.01	34.11	54.41	20.29	0.46
31	Volkswagen Golf 1.4 LHD	40.45	30.49	51.27	20.78	0.51
41	Vauxhall Astra 1.6i Envoy	33.23	25.88	41.50	15.63	0.47
42	Ford Escort 1.6 LX	42.61	36.32	49.16	12.84	0.30
43	Nissan Almera 1.4GX	28.49	21.54	36.63	15.09	0.53
56	Vauxhall Corsa 1.0 12v Club	44.67	34.88	54.90	20.03	0.45
65	Toyota Avensis 1.6S	38.15	29.60	47.49	17.89	0.47
93	Vauxhall/Opel Vectra 1.8 LHD	32.88	24.98	41.88	16.91	0.51

1.5 Finnish Injury Risk Ratings and Overall EuroNCAP Star Ratings

In comparing EuroNCAP crash test results with real crash outcomes in Sweden, Lie and Tingvall (2000) computed the average real crash injury rates for vehicles grouped within each overall star rating. It was hypothesised that occupants of EuroNCAP tested vehicles with a five star rating should have a lower average risk of serious injury in real crashes than those with only three or two stars. If so, the overall barrier crash performance star rating given to each vehicle from EuroNCAP testing would be broadly representative of relative real crash outcomes. Based on the Swedish data analysed, Lie and Tingvall (2000) indeed found that EuroNCAP tested vehicles rated four stars had a lower average risk serious injury risk in real crashes than those rated three stars. The three star vehicles had a correspondingly lower average risk than vehicles rated two stars. The analysis that follows also considers the relationship between real crash safety ratings and overall EuroNCAP star ratings.

An overall EuroNCAP star rating scale of five categories is used to classify vehicle safety performance based on crash test results. The five star categories are derived from the results of both the offset frontal and side impact EuroNCAP test components. In this study the overall EuroNCAP score and corresponding star rating are calculated based on the driver dummy measurements in the EuroNCAP test only to ensure compatibility with the real crash rating that relate to driver injury outcome only. In contrast, the official scores published by EuroNCAP consider both the driver and front passenger dummy scores in the offset frontal barrier test. Also, the EuroNCAP overall scores used here do not include the pole test result. Analysis conducted using EuroNCAP overall scores including the pole test produced similar results.

Figure 1 shows overall EuroNCAP scores plotted against injury risk estimated from the Finnish data. Individual EuroNCAP scores are grouped according to the corresponding star rating and 95 per cent confidence limits are placed on the estimates of real crash measures.

Figure 1. Overall EuroNCAP test score vs. Estimated injury risk

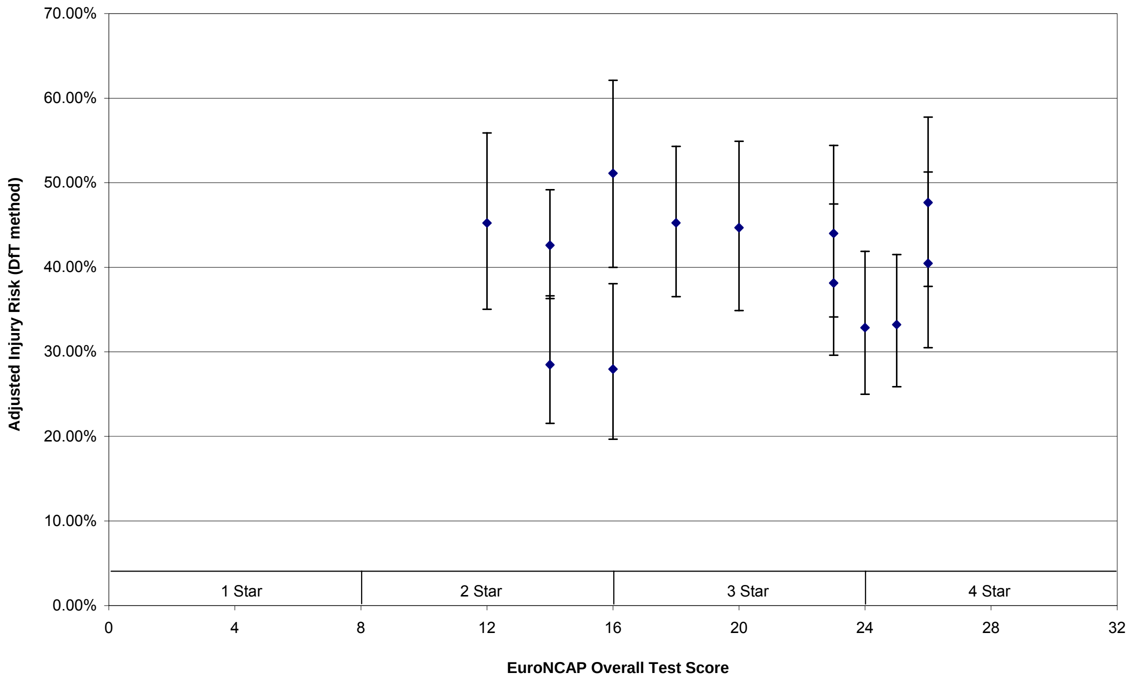


Figure 1 shows significant variation in the estimated injury risk of each vehicle within each overall EuroNCAP score range. This variation is partly a product of the estimation error in the injury risk measure, particularly for vehicle models with relatively few records in the crash data, as shown by the 95% confidence limits. However, there are significant differences in the real crash measure between vehicle models within the same EuroNCAP star rating, and even between vehicle models with almost the same overall EuroNCAP rating score from which the star ratings are derived. This is demonstrated by the non-overlapping confidence limits on the real crash measures between pairs of vehicles within the same overall star rating category.

These results suggest that there are other factors, apart from those summarised in the overall EuroNCAP score that are determining real crash outcomes. These other factors are also different from those that have already been compensated for in the estimation of the real crash based ratings, such as driver age and sex and speed limit at the crash location.

8.1 Logistic regression comparison of real crash ratings and overall EuroNCAP star ratings

The above analysis has identified general relationships between the real crash injury risk ratings and EuroNCAP star ratings. In order to make more definitive statements about the relationships between the two safety measures a logistic regression framework has been used. Vehicle safety rating measures derived from real crash data have been modelled as a function of the EuroNCAP overall star rating.

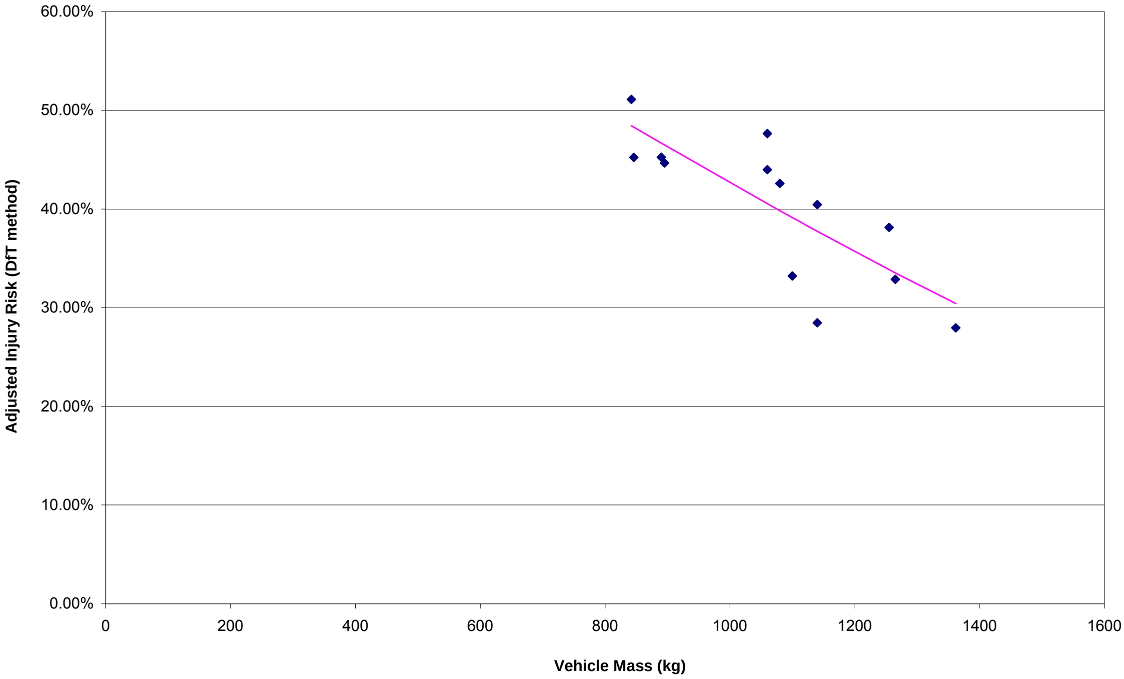
In the case of the real crash crashworthiness measure, the logistic function fitted is of the following form.

$$\mathrm{logit}(CWR_i) = \alpha + \beta(EuroNCAP\,overall\,star\,ratings_i) \quad (1.)$$

where *i* is the vehicle model index and α and β are parameters of the logistic model. It may be expected that a higher star rating would be associated with improved crashworthiness in real crashes, or that there will be some monotonic relationship between the barrier test and real crash measure. However, to maintain objectivity, no restriction has been placed on the form of the relationship between the star rating categories and the dependent injury outcome variable.

Previous work has highlighted the relationship between vehicle mass and real crash outcome with vehicles of higher mass generally having better real crash ratings for injury, risk, injury severity and crashworthiness (see SARAC I). To test this relationship on the current data, a logistic regression, estimating the effect of mass on real crash outcome, has been conducted using the Finnish data. Figure 2 demonstrates a strong relationship between the injury risk measure and vehicle mass, with vehicles of higher mass generally associated with a lower (better) crashworthiness rating.

Figure 2. Adjusted injury risk (DfT method) for all crash types vs Vehicle mass



In contrast to real crash outcomes, the EuroNCAP score is purported to be independent of vehicle mass. Therefore, in exploring the relationship between the real crash safety measures and EuroNCAP test scores, the apparent contrasting influence of vehicle mass on the two safety fit of the logistic model as measured by the change in scaled deviance of the model. If the EuroNCAP star rating makes a statistically significant contribution to the fit of the logistic model, this implies that there is a statistically significant difference between average injury risk of at least two of the star rating classes, but not necessarily more than two star rating classes. To assess which pairs of the star rating classes have significantly different average injury risk, the confidence limits on the parameter point estimates generated from the logistic modelling procedure must be compared to see if they overlap.

Table 4. Injury risk estimates (DfT method) and 95% confidence limits across EuroNCAP star rating categories estimated with and without mass adjustment for all crash types

Injury Risk Ratings (DfT method)								
	All Crash Types (with mass adjustment)				All Crash Types (without mass adjustment)			
	Overall Star Rating				Overall Star Rating			
	1	2	3	4	1	2	3	4
Estimate		**38.98%**	**40.73%**	**40.51%**		**39.56%**	**40.95%**	**39.70%**
LCL		35.61%	37.23%	36.47%		36.21%	37.46%	35.72%
UCL		42.45%	44.33%	44.68%		43.02%	44.53%	43.82%

The analysis demonstrates that it is not possible to differentiate between 2, 3 and 4 star rated vehicles using the injury risk estimates derived from the Finnish data in a statistically significant way.