MONASH University
Accident Research Centre

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Data analysis to investigate the injury profile of near-side, side impact crashes: a comparison of injury risk between pole and vehicle-vehicle impacts

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WP29 Informal Group on Development of Pole side impact GTR.

Department of Transportation, Washington, DC

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Overview of analysis

Two datasets used:

1. Transport Accident Commission of Victoria Claims File
   - no-fault insurer = claims dataset from 1999-2010
   - linked dataset – claim information, police report, road agency, hospital data (injury, procedures)
   - ICD-9 / 10 injury data, converted to AIS using US NTDB as the basis
2. Australian National Crash In-depth Study (ANCIS)
   – protocols compatible with NASS-CDS
   – operational since 2000
   – 974 cases to date

Analysis of mass ('claims') dataset

Dataset definition: any claim made and accepted by the no-fault insurer

Inclusion criteria

- Model year 2000 + (ADR72 compliant / ECE95)
- Initial point of impact: front or rear side passenger door
- Collision partner: tree / pole & other vehicles

Exclusion criteria

- Impact point of front, front / rear side corner, rear, rollovers
- Collisions with 'other' types of partners (animals etc...)

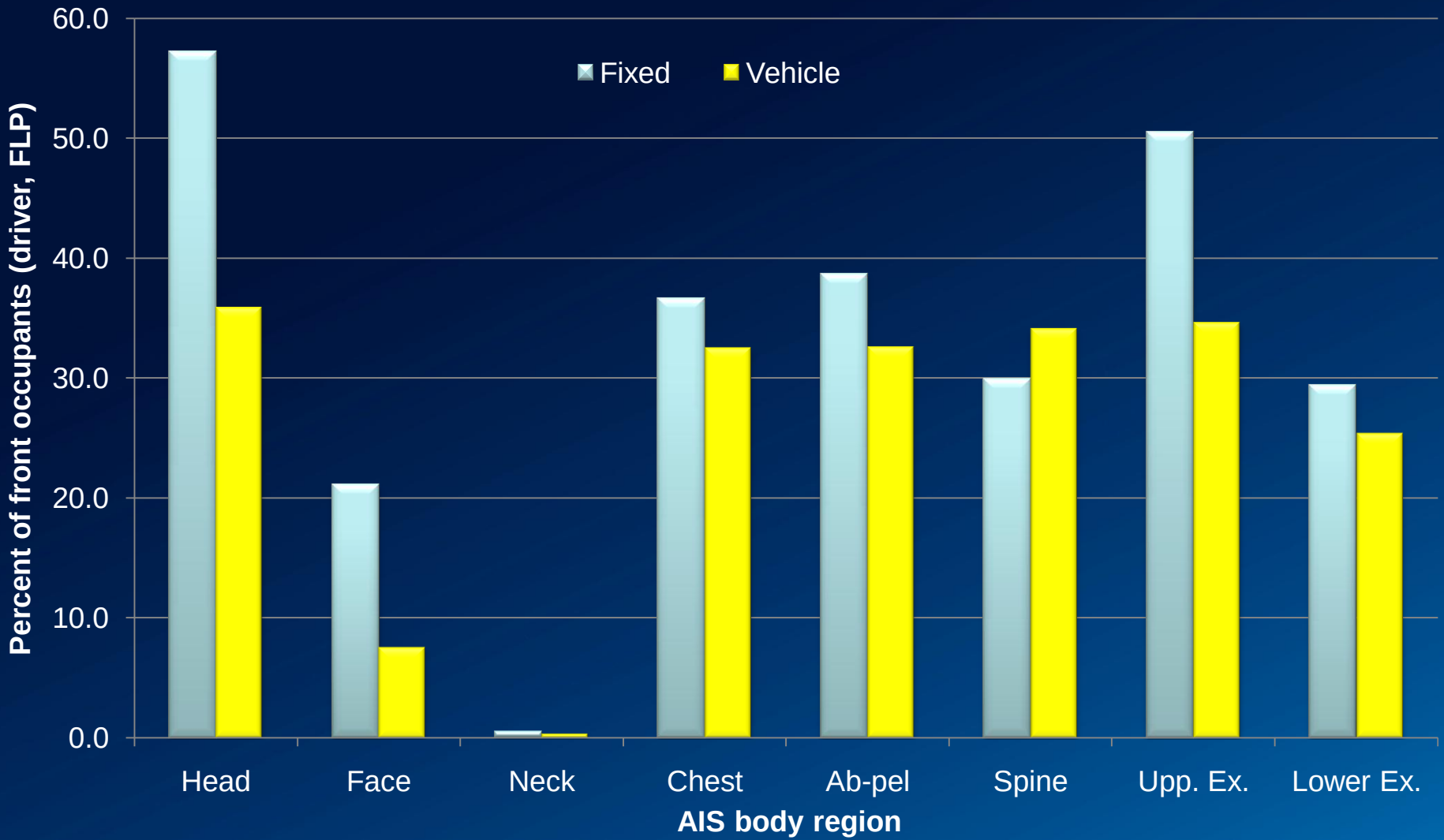
Number of injured persons by crash type

ADR vehicle class	Near-side impacts				Far-side impact			
	Front occupants		Rear occupants		Front occupants		Rear occupants	
	Object	Vehicle	Object	Vehicle	Object	Vehicle	Object	Vehicle
Passenger vehicles								
MA	194	794	20	86	117	434	16	63
Sports Utility vehicles								
MC	4	20	2	3	4	21	1	3
Light commercial vehicles (NA)								
NA	9	19	0	2	5	13	2	2

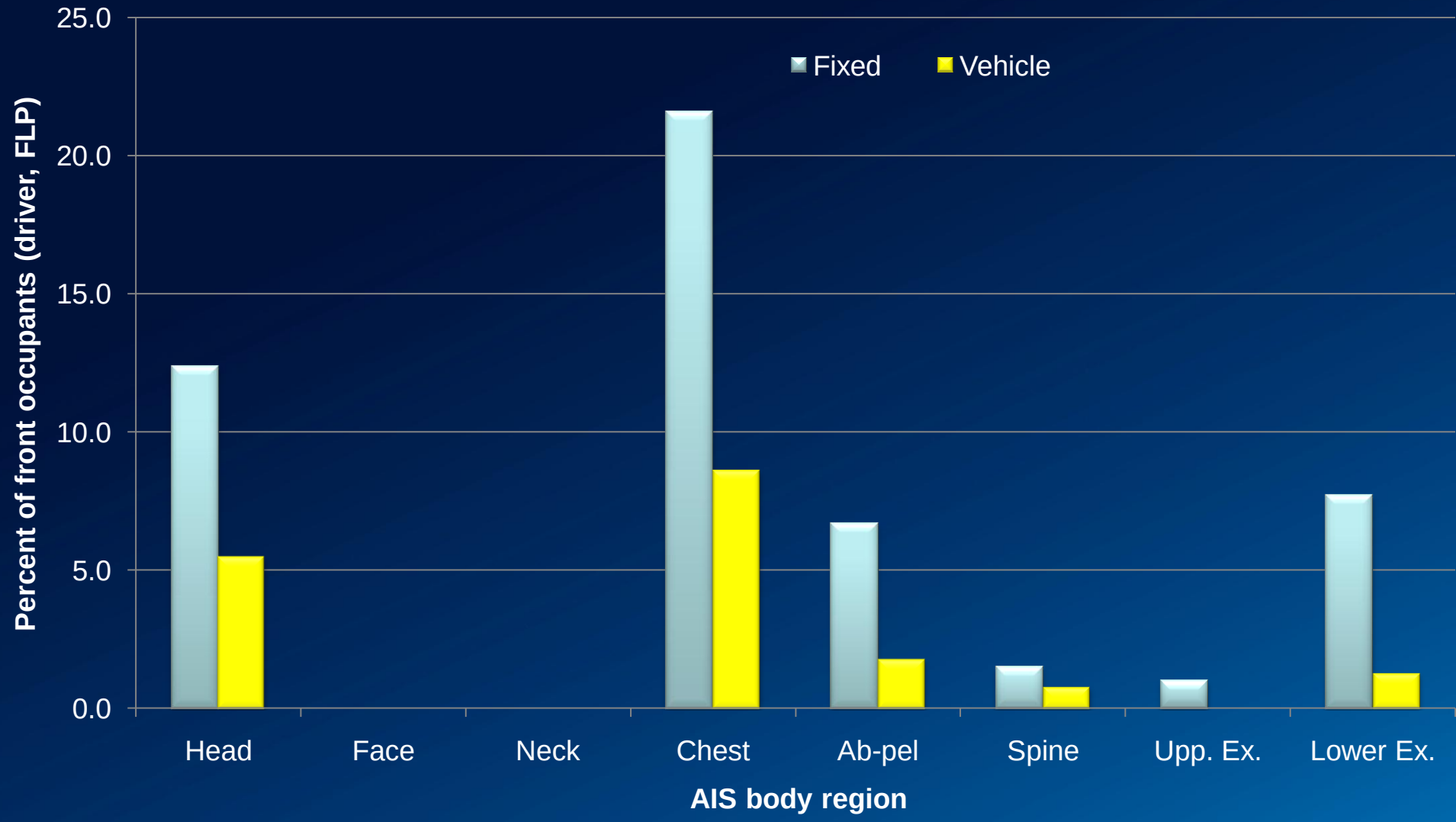
Class MA vehicles – near side impact, injury by body region, severity and collision partner

	AIS 1 +		AIS3+	
AIS body region	**Fixed**	**Vehicle**	**Fixed**	**Vehicle**
Head*	57% (111)	36% (285)	12% (24)	5.5% (44)
Face	21% (41)	8% (60)		
Neck	0.5% (1)	0.4% (3)		
Chest*	37% (71)	32% (258)	22% (42)	9% (68)
Abdomen-pelvis	39% (75)	33% (259)	7% (13)	2% (14)
Spine	30% (58)	34% (271)	1.5% (3)	1% (6)
Upper extremity	51% (98)	35% (275)	1% (2)	
Lower extremity	29% (57)	25% (202)	8% (15)	1% (10)

Injury by body region, severity and collision partner



AIS3+ injury by body region, severity and collision partner



Observed injury risk – crash sample comparability

Parameter	Object impact (tree / pole) (n=214)	Vehicle-vehicle collision (n=880)
% male	65%	33%
Age		
0-9	0.9	1.6%
10-15	2.3	3%
16-64	93.5	79.3%
65+*	3.3	15.5%
Side airbag deployment	3.7%	4.9%
Speed zone		
<=50km/h	16.4%	22.8%
60-75 km/h*	35.5%	50.1%
80-90 km/h	14.0%	14.8%
>=100km/h*	33.2%	11.3%

Imperative to adjust for sample differences – done in a logistic regression model

Near side: Head injury AIS 1+

Head AIS1+	Group	Referent	OR	P>|z|	LCL	UCL
Collision Partner	**Fixed**	***Vehicle***	**2.28**	**<0.001**	**1.67**	**3.12**
Occupant Position	Front	*Rear*	0.74	0.2	0.48	1.12
Speed zone	60-75	*<=50*	0.77	0.1	0.56	1.05
	80-90	*<=50*	0.81	0.3	0.54	1.23
	>=100	*<=50*	0.80	0.3	0.52	1.21

Odds of AIS1+ head injury in a pole impact is 1.92 times greater than a vehicle-vehicle near side impact crash, adjusted for occupant position and speed zone

Average adjusted probability: *Pole: 0.68 (95th % CI: 0.55-0.78)*
Vehicle: 0.48 (95th % CI: 0.37-0.60)

Near side: Head injury AIS3+

Head AIS3+	Group	Referent	OR	P>|z|	LCL	UCL
Collision Partner	**Fixed**	***Vehicle***	**1.92**	**0.02**	**1.12**	**3.27**
Occupant Position	Front	*Rear*	1.38	0.5	0.54	3.54
Speed zone	60-75	*<=50*	0.95	0.9	0.48	1.88
	80-90	*<=50*	1.35	0.5	0.60	3.05
	>=100	*<=50*	1.99	0.07	0.94	4.18

Odds of AIS3+ head injury in a pole impact is 1.92 times greater than a vehicle-vehicle near side impact crash, adjusted for occupant position and speed zone

Average adjusted probability: *Pole: 0.07 (95th % CI: 0.02-0.18)*
Vehicle: 0.04 (95th % CI: 0.01-0.09)

Near side: Chest injury AIS1+

Chest AIS1+ Group		Referent	OR	P>|z|	LCL	UCL
Collision Partner	**Fixed**	***Vehicle***	**1.14**	**0.4**	**0.82**	**1.58**
Occupant Position	Front	*Rear*	1.40	0.2	0.88	2.24
Speed zone	60-75	*<=50*	0.98	0.9	0.71	1.37
	80-90	*<=50*	1.02	0.9	0.66	1.57
	>=100	*<=50*	1.21	0.4	0.79	1.81

No difference in AIS 1+ chest injury risk

Average adjusted probability: Pole: 0.28 (95th % CI: 0.18-0.41)
Vehicle: 0.25 (95th % CI: 0.17-0.36)

Near side: Chest injury AIS3+

Head AIS3+	Group	Referent	OR	P>|z|	LCL	UCL
Collision Partner	**Fixed**	***Vehicle***	**2.57**	≤0.01	1.68	3.91
Occupant Position	Front	*Rear*	1.01	0.9	0.52	1.96
Speed zone	60-75	*<=50*	1.42	0.2	0.80	2.52
	80-90	*<=50*	1.97	0.05	1.00	3.87
	>=100	*<=50*	2.09	0.03	1.09	4.01

Odds of AIS3+ chest injury in a pole impact is 2.6 times greater than a vehicle-vehicle near side impact crash, adjusted for occupant position and speed zone

Average adjusted probability: *Pole: 0.14 (95th % CI: 0.07-0.28)*
Vehicle: 0.06 (95th % CI: 0.03-0.12)

Near side: Abdomen – pelvis injury AIS1+

A/P AIS3+	Group	Referent	OR	P>|z|	LCL	UCL
Collision Partner	**Fixed**	***Vehicle***	**1.19**	**0.28**	**0.86**	**1.65**
Occupant Position	Front	*Rear*	1.19	0.46	0.76	1.86
Speed zone	60-75	*<=50*	1.10	0.59	0.78	1.53
	80-90	*<=50*	1.52	0.05	0.99	2.32
	>=100	*<=50*	1.39	0.13	0.90	2.12

Odds of AIS1+ A/P injury in a pole impact is 1.92 times greater than a vehicle-vehicle near side impact crash, adjusted for occupant position and speed zone

Average adjusted probability: *Pole: 0.30 (95th % CI: 0.19-0.43)*
Vehicle: 0.26 (95th % CI: 0.18-0.37)

Near side: Abdomen – pelvis injury AIS3+

A/P AIS3+	Group	Referent	OR	P>|z|	LCL	UCL
Collision Partner	**Fixed**	***Vehicle***	**3.64**	**<0.001**	**1.72**	**7.71**
Occupant Position	Front	*Rear*	0.52	0.2	0.19	1.41
Speed zone	60-75	*<=50*	1.47	0.5	0.53	4.09
	80-90	*<=50*	1.09	0.9	0.29	4.16
	>=100	*<=50*	1.14	0.8	0.33	3.91

Odds of AIS3+ A//P injury in a pole impact is 3.64 times greater than a vehicle-vehicle near side impact crash, adjusted for occupant position and speed zone

Average adjusted probability: *Pole: 0.09 (95th % CI: 0.03-0.27)*
Vehicle: 0.03 (95th % CI: 0.01-0.09)

Near side: Lower extremity injury AIS1+

LEX AIS1+	Group	Referent	OR	P>|z|	LCL	UCL
Collision Partner	**Fixed**	***Vehicle***	1.41	0.05	1.01	1.98
Occupant Position	Front	*Rear*	0.98	0.94	0.61	1.57
Speed zone	60-75	*<=50*	0.96	0.82	0.68	1.36
	80-90	*<=50*	0.75	0.23	0.47	1.20
	>=100	*<=50*	0.97	0.90	0.62	1.53

Odds of AIS1+ Lower Ex. injury in a pole impact is 1.41 times greater than a vehicle-vehicle near side impact crash, adjusted for position and speed zone

Average adjusted probability: *Pole: 0.33 (95th % CI: 0.22-0.47)*
Vehicle: 0.26 (95th % CI: 0.17-0.37)

Near side: Lower extremity injury AIS3+

LEX AIS3+	Group	Referent	OR	P>|z|	LCL	UCL
Collision Partner	**Fixed**	***Vehicle***	**7.41**	**<0.001**	**3.35**	**16.36**
Occupant Position	Front	*Rear*	0.63	0.4	0.21	1.90
Speed zone	60-75	*<=50*	1.77	0.3	0.57	5.47
	80-90	*<=50*	0.98	1.0	0.21	4.53
	>=100	*<=50*	1.36	0.6	0.38	4.91

Odds of AIS3+ lower extremity injury in a pole impact is 7.4 times greater than a vehicle-vehicle near side impact crash, adjusted for position and speed zone

Average adjusted probability: *Pole: 0.09 (95th % CI: 0.02-0.29)*
Vehicle: 0.01 (95th % CI: 0.003-0.05)

Summary – probability table (MA, near, front occupants)

Region / Severity	Pole / tree Adj. Prob. (95th% CI)	Vehicle Adj. Prob. (95th% CI)
Head AIS1+	0.68 (0.55-0.78)	0.48 (0.37-0.60)
Head AIS3+	0.07 (0.01-0.09)	0.04 (0.01-0.09)
Chest AIS1+	0.28 (0.18-0.41)	0.25 (0.17-0.36)
Chest AIS3+	0.14 (0.07-0.28)	0.06 (0.03-0.12)
Abdomen-Pelvis AIS1+	0.30 (0.19-0.43)	0.26 (0.18-0.37)
Abdomen-Pelvis AIS3+	0.09 (0.03-0.27)	0.03 (0.01-0.09)
Lower extremity AIS1+	0.33 (0.22-0.47)	0.26 (0.17-0.37)
Lower extremity AIS3+	0.09 (0.02-0.29)	0.01 (0.003-0.05)

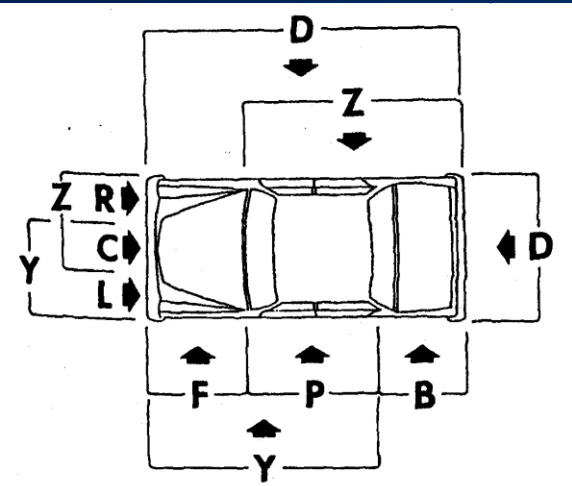
Analysis of in-depth dataset: Australian National Crash In-depth Study (ANCIS)

- protocols compatible with NASS-CDS
- operational since 2000
- 974 cases to date = 81 per inclusion / exclusion criteria below

Inclusion

- MY2000+
- CDC damage zones
  - > D - DISTRIBUTED
  - > P - SIDE CENTRE, LEFT OR RIGHT
  - > Y = F+P
  - > Z =B+P
- Driver and FLP
- Belted

Exclusion: Rollover crashes



Location	Classification
Distributed—side or end	D
Left—front or rear	L
Center—front or rear	C
Right—front or rear	R
Side front—left or right	F
Side center section—left or right	P
Side rear—left or right	B
Side or end—F + P or L + C	Y
Side or end—B + P or R + C	Z

Case characteristics

Characteristic		ALL INJURY SEVERITY		AIS 3+	
		Vehicle (N=42)	Tree / Pole (N=16)	Vehicle (n=22, 52.4%)	Tree/pole (n=11; 68%)
Position					
	Driver	31 (73.8%)	8 (50%)	17 (77.3%)	6 (54.5%)
	Front left passenger	11 (26.2%)	8 (50%)	5 (22.7%)	5 (45.5%)
	Number of occupants	*42 (100%)*	*16 (100%)*	*22 (100%)*	*11*
Age* (years)					
	Mean (SD), years	46.8 (16.4)	32.8 (15.1)	53.8 (14.4)	30.3 (15.8)
	Mean - 95th% CL	41.71-51.96	24.70 - 40.8	47.4-60.2	19.6-40.9
	Median, years	46	28.5	51.5	24
	Min/Max	13-84	16-64	34-84	16-64
Sex					
	Male	21 (50%)	14 (87.5%)	12 (54.5%)	10 (91%)
	Female	21 (50%)	2 (12.5%)	10 (45.5%)	1 (9%)

Characteristic	ALL INJURY SEVERITY		AIS 3+	
	Vehicle (N=42)	Tree / Pole (N=16)	Vehicle (n=22, 52.4%)	Tree/pole (n=11, 68%)
Weight (weight) (kg)				
Mean (SD), years	72.7 (18.6)	77.6 (17.6)	72.6 (15.9)	73.9 (10.1)
Mean - 95th% CL	66.7-78.6	68.2-87.0	65.5-79.5	67.1-80.7
Median, kg	67.5	75	67	75
Min/Max	51-140	50-115	51-103	50-85
Height (height) (cm)				
Mean (SD), years	170.7 (10.4)	178.9 (10.2)	170.4 (9.7)	181.3 (9.6)
Mean - 95th% CL	167.5-174.0	173.43-184.3	166.1-174.7	174.8-187.7
Median (cm)	172	182	170	183
Min/Max	150-191	158-200	155-191	160-200
BMI				
Mean (SD), years	24.7 (4.6)	24.2 (5.1)	24.8 (3.6)	22.5 (2.6)
Mean - 95th% CL	23.3-26.2	21.5-26.9	23.2-26.4	20.7-24.2
Median (cm)	24	23.8	24.5	23
Min/Max	16.1-40.9	18.2-37.0	19.0-30.1	18.2-25.8
BMI - CATEGORY				
<20, underweight	6 (14.3%)	3 (18.8%)	2 (9.1%)	3 (27.3%)
20-25, normal weight	19 (45.2%)	8 (50%)	11 (50%)	6 (54.5%)
>25 overweight	17 (40.5%)	5 (31.3%)	9 (40.9%)	2 (18.2%)

Characteristic	ALL INJURY SEVERITY		AIS 3+	
	Vehicle (N=42)	Tree / Pole (N=16)	Vehicle (n=22, 52.4%)	Tree/pole (n=11, 68%)
Vehicle Class				
Small	16 (38.1%)	3 (18.8%)	11 (50%)	2 (18.2%)
Medium	4 (9.5%)	3 (18.8%)	2 (9.1%)	2 (18.2%)
Large	22 (52.4%)	10 (62.5%)	9 (40.9%)	7 (63.6%)
Side airbag				
Side airbag - deployed	9 (21.4%)	1 (6.3%)	5 (22.7%)	-
EBS				
Mean (SD) KM/H	25.4 (7.4)	33.1 (11.8)	26.6 (7.4)	34.9 (11.9)
Mean - 95th% CL	23.1-27.7	26.8-39.4	23.3-29.9	26.9-42.9
Median, KM/H	26	29.5	26.8	31.1
Min/Max	12.2-40.0	18-57.0	13-39	23-57

	ALL INJURY SEVERITY		AIS 3+	
Characteristic	Vehicle (N=42)	Tree / Pole (N=16)	Vehicle (n=22, 52.4%)	Tree/pole (n=11, 68%)
Impact distribution				
D – DISTRIBUTED	3 (7.1%)	-	3 (13.6%)	
P - SIDE CENTRE, LEFT OR RIGHT	19 (45.2%)	12 (75%)	10 (45.5%)	9 (81.8%)
Y = F+P	17 (40.5%)	4 (25%)	8 (36.4%)	2 (18.2%)
Z =B+P	3 (7.1%)	-	1 (4.5%)	
Crush - maximum				
Mean (SD) mm	331.6 (109.5)	560 (231.5)	329.1 (123.2)	621.82 (245.5)
Mean - 95th% CL	297.5-365.8	436.6-683.4)	274.4-383.7	456.8-786.8)
Median, mm	330	520	320	560
Min/Max	140-600	290-1010	140-600	300-1010

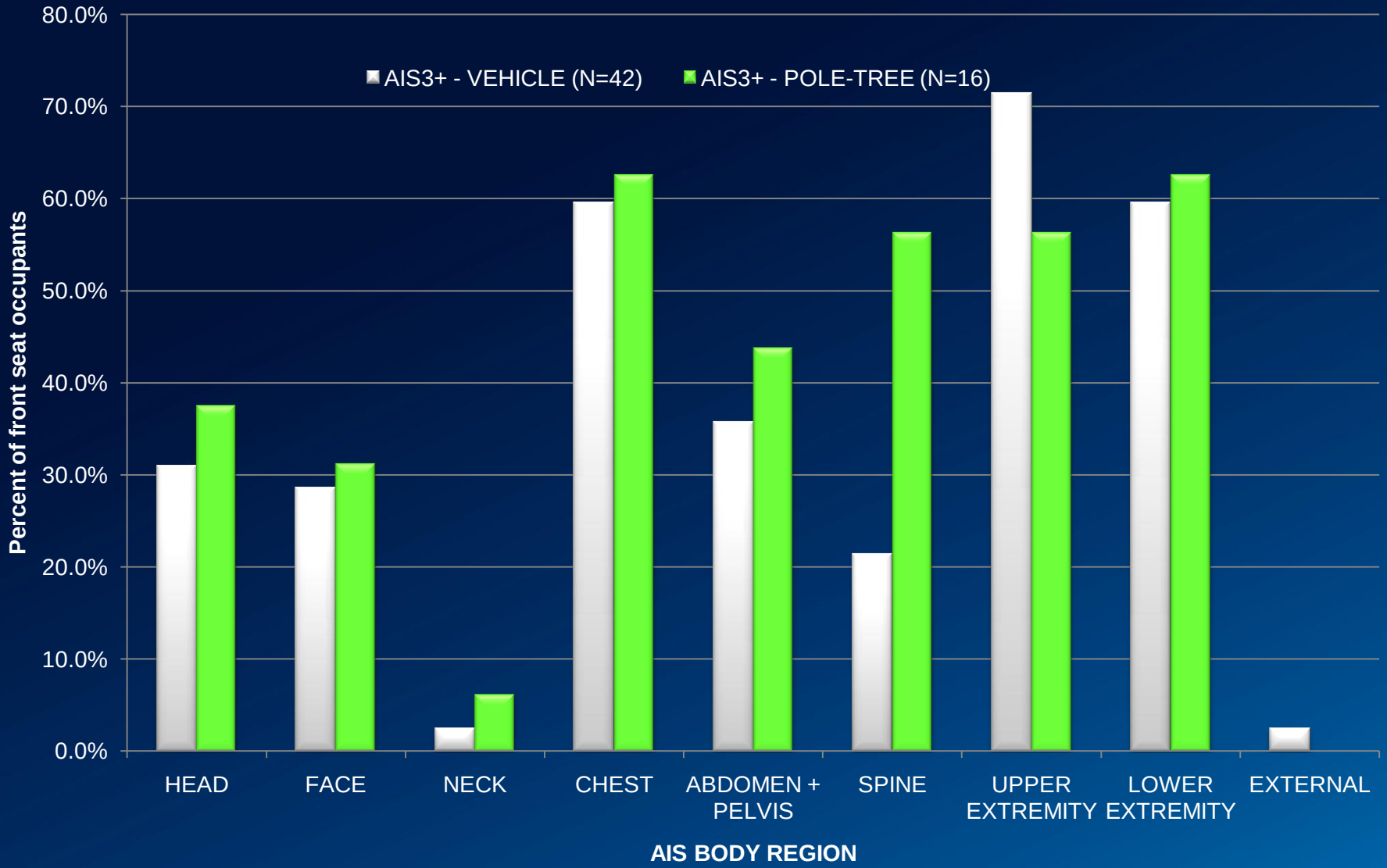
Characteristic	ALL INJURY SEVERITY Vehicle (N=42)	Tree / Pole (N=16)	AIS 3+ Vehicle (n=22, 52.4%)	Tree/pole (n=11, 68%)
Crash characteristics				
Type of crash				
Intersection	22 (52.4%)	-	12 (54.5%)	-
Veh from opposed (incl turn)	9 (21.4%)	-	5 (22.7%)	-
From same direction	1 (2.4%)	-	1 (4.5%)	-
Maneuvreing	4 (9.5%)	-	-	-
Off-path, on straight	5 (11.9%)	11 (68.8%)	3 (13.6%)	8 (72.7%)
Off path, on curve	-	4 (25%)	-	2 (18.2%)
Other / miscellaneous	1 (2.4%)	1 (6.3%)	1 (4.5%)	1 (9.1%)
Speed limit (km/h)				
40	-	-	-	-
50	8 (19%)	-	2 (9.1%)	-
60	22 (52.4%)	6 (37.5%)	14 (63.6%)	3 (27.3%)
70	2 (4.8%)	-	1 (4.5%)	-
80	7 (16.7%)	4 (25%)	3 (13.6%)	4 (36.4%)
90	-	1 (6.3%)	-	1 (9.1%)
100/110	3 (7.1%)	5 (31.3%)	2 (9.1%)	3 (27.3%)

	ALL INJURY SEVERITY		AIS 3+	
Characteristic	Vehicle (N=42)	Tree / Pole (N=16)	Vehicle (n=22, 52.4%)	Tree/pole (n=11, 68%)
MAIS – whole body				
1-Minor	13 (31%)	1 (6.3%)		
2-Moderate	6 (14.3%)	3 (18.8%)		
3=Serious	10 (23.8%)	7 (43.8%)	10 (45.5%)	7 (63.6%)
4=Severe	10 (23.8%)	3 (18.8%)	9 (40.9%)	3 (27.3%)
5=Critical	3 (7.1%)	2 (12.5%)	3 (13.6%)	1 (9.1%)
6=Maximum	-	-	-	-
Injury Severity Score				
Mean (SD)	13.6 (13.2)	21.0 (16.7)	22.3 (11.7)	23.1 (13.1)
Mean - 95th% CL	9.5-17.8	12.1-29.9	17.1-27.6	14.2-31.9
Median	11	15	18	21
Min/Max	1.0 - 51.0	1.0 - 59.0	9.0 to 51.0	10 to 50.0
ISS category				
Major (>15)	17 (40.5%)	8 (50%)	16 (72.7%)	7 (63.6%)

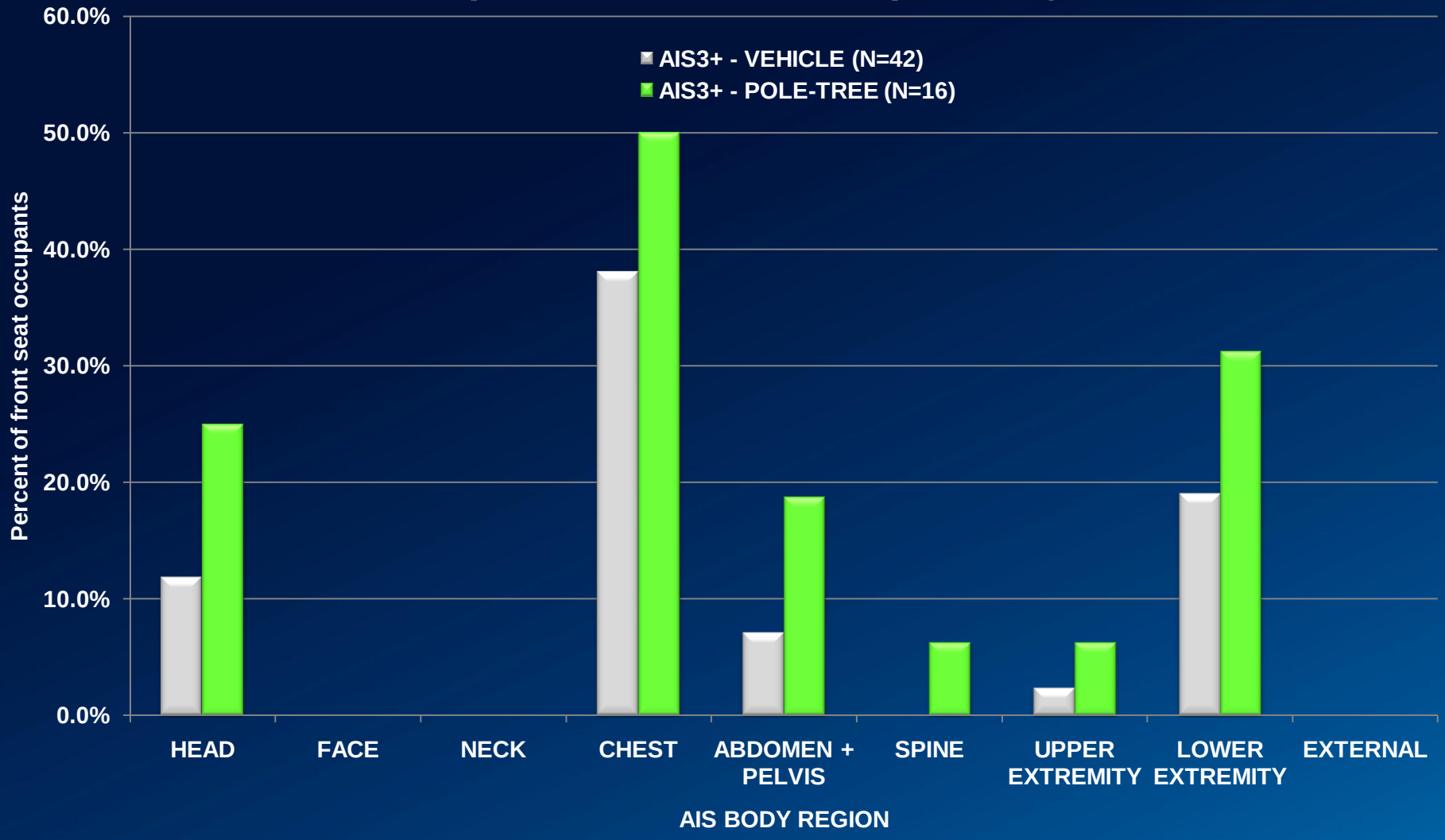
Percent of front occupants injured, by region and severity

AIS BODY REGION	VEHICLE (N=42)	POLE-TREE (N=16)	VEHICLE (N=42)	POLE-TREE (N=16)
	AIS1+	AIS1+	AIS3+	AIS3+
AIS body region				
Head	31.0%	37.5%	11.9%	25.0%
Face	28.6%	31.3%		
Neck	2.4%	6.3%		
Chest	59.5%	62.5%	38.1%	50.0%
Abdomen-pelvis	35.7%	43.8%	7.1%	18.8%
Spine	21.4%	56.3%		6.3%
Upper extremity	71.4%	56.3%	2.4%	6.3%
Lower extremity	59.5%	62.5%	19.0%	31.3%

Percent of front occupants in near side impacts injured AIS1+

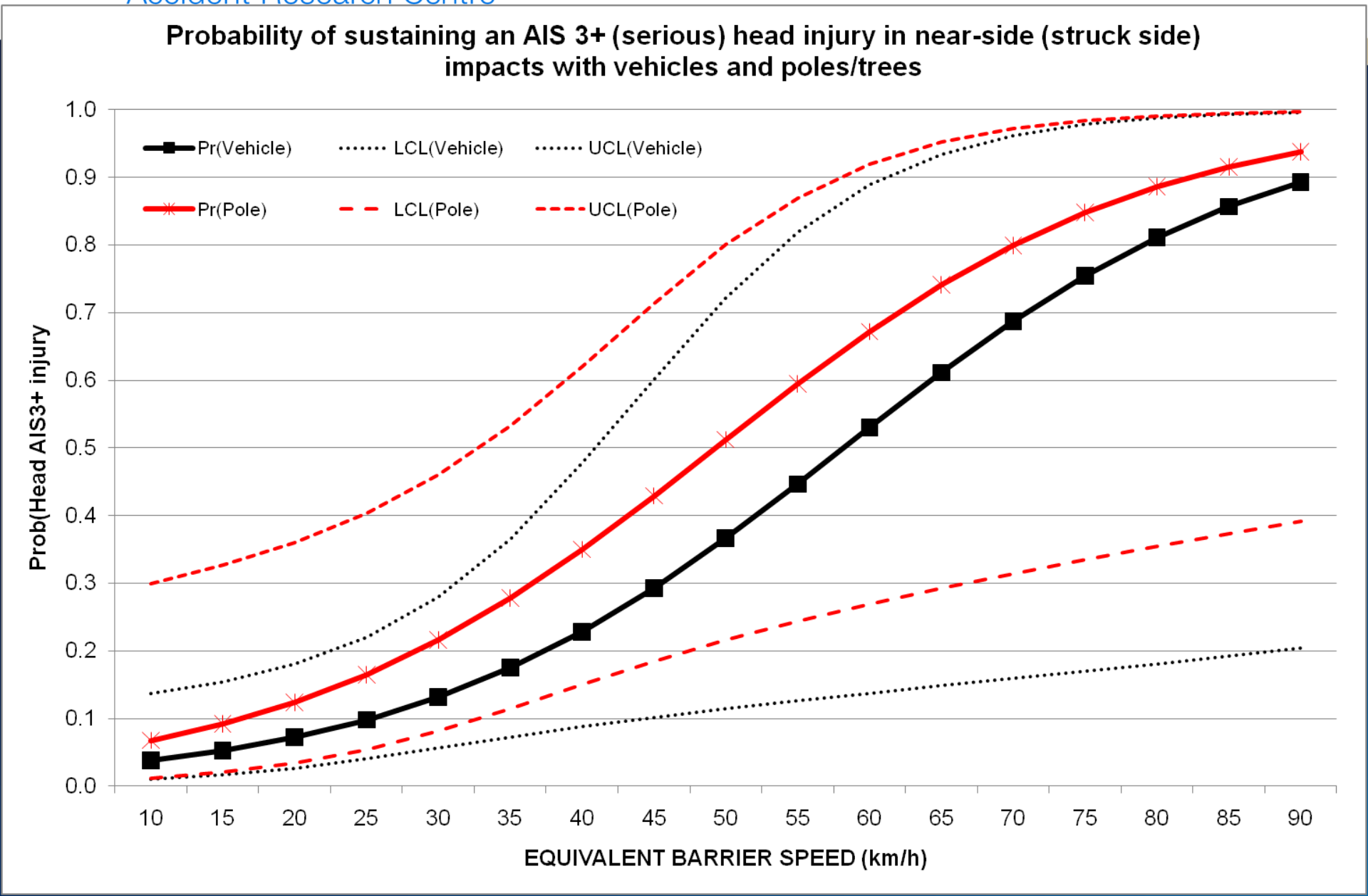


Percent of front occupants in near side impacts injured AIS3+

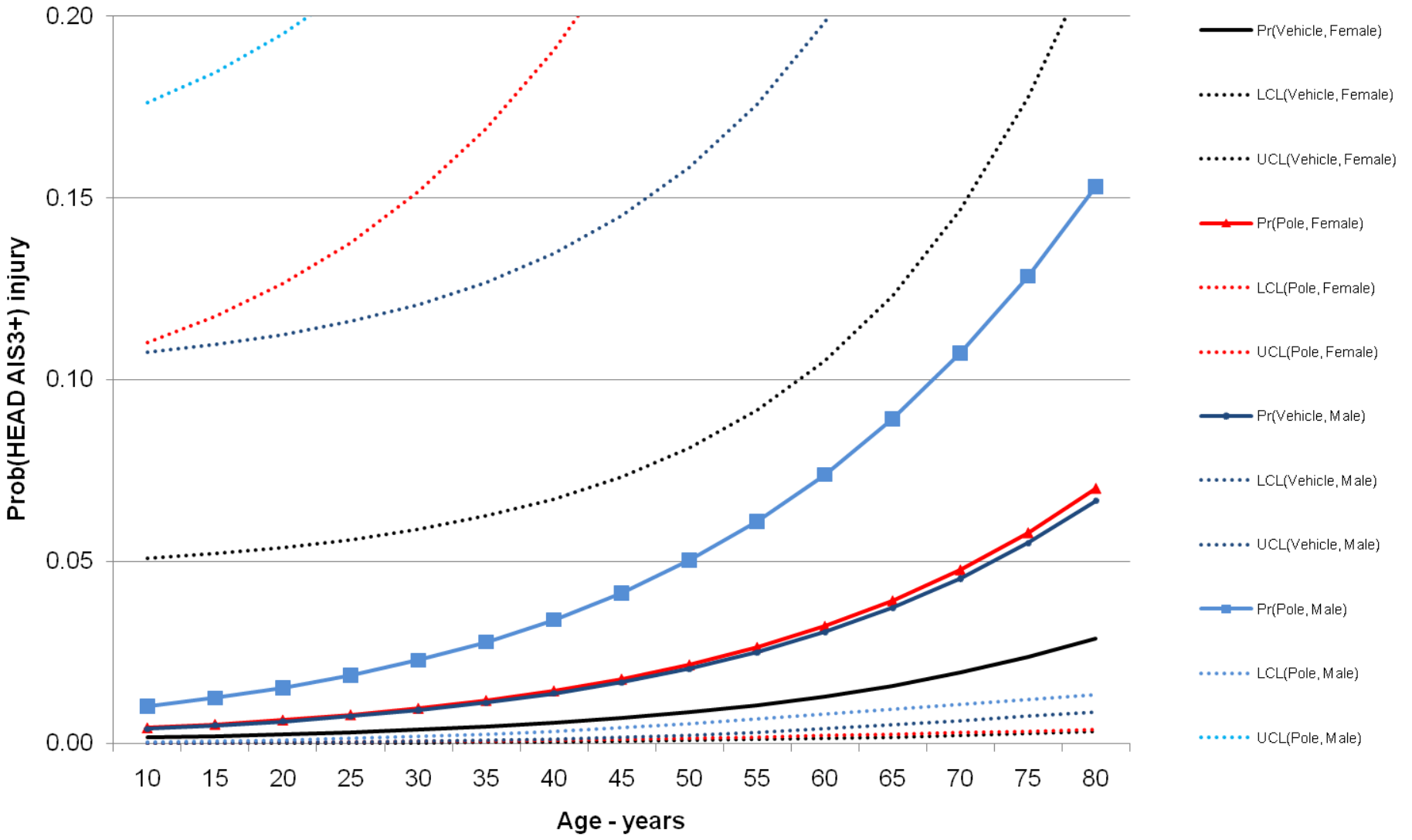


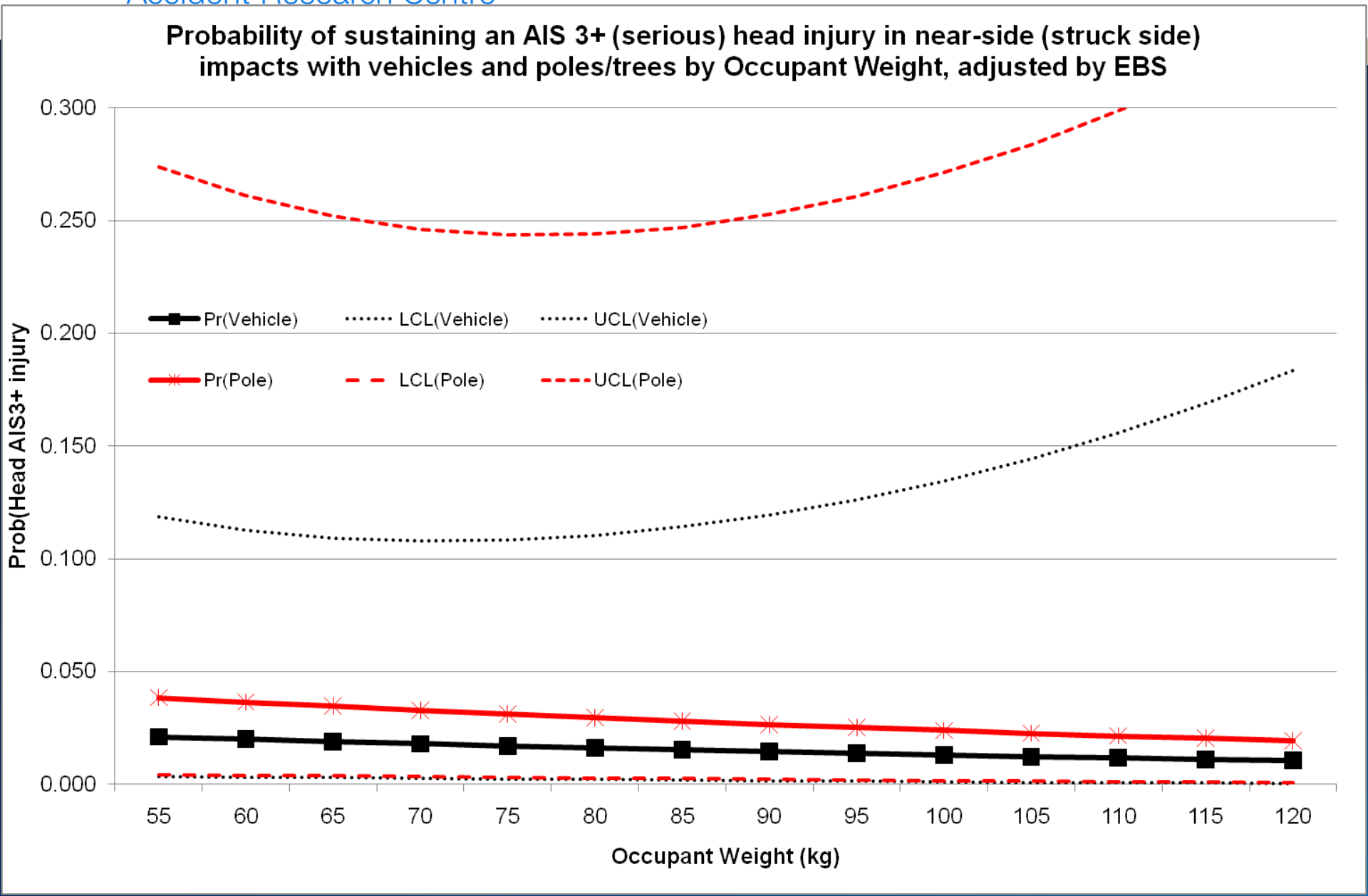
Logistic regression model for Head AIS3+

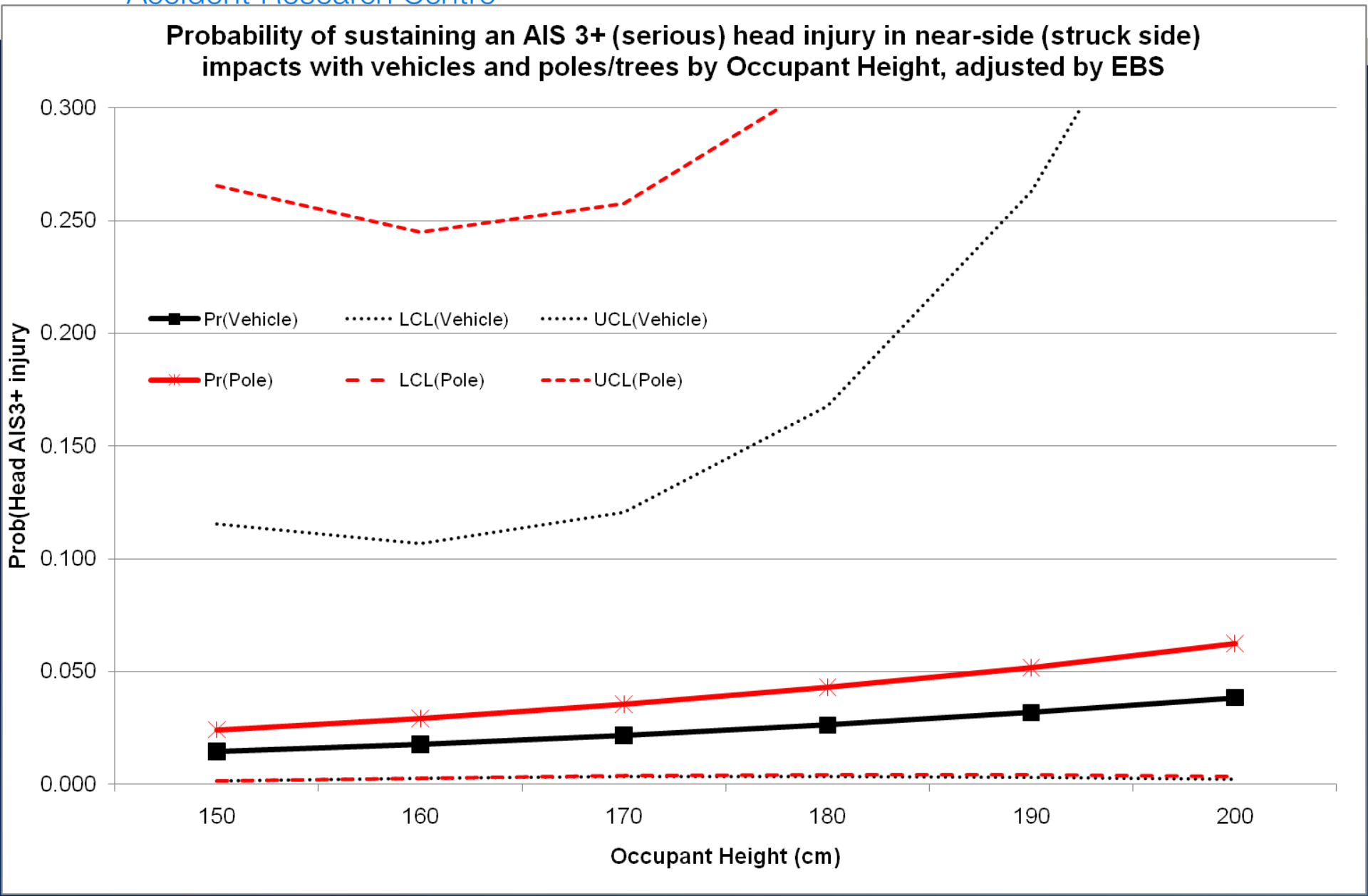
HEAD 3+		Odds Ratio	LCL	UCL	stat sig.
AGE	years	1.04	0.99	1.09	No
Sex	Male cf. Female	2.40	0.40	14.23	No
EBS	km/h	1.08	1.02	1.15	YES
Collision partner	**Pole cf. Veh**	**2.53**	**0.49**	**13.17**	**No**
Impact side	Near cf. Far	2.81	0.40	19.46	No

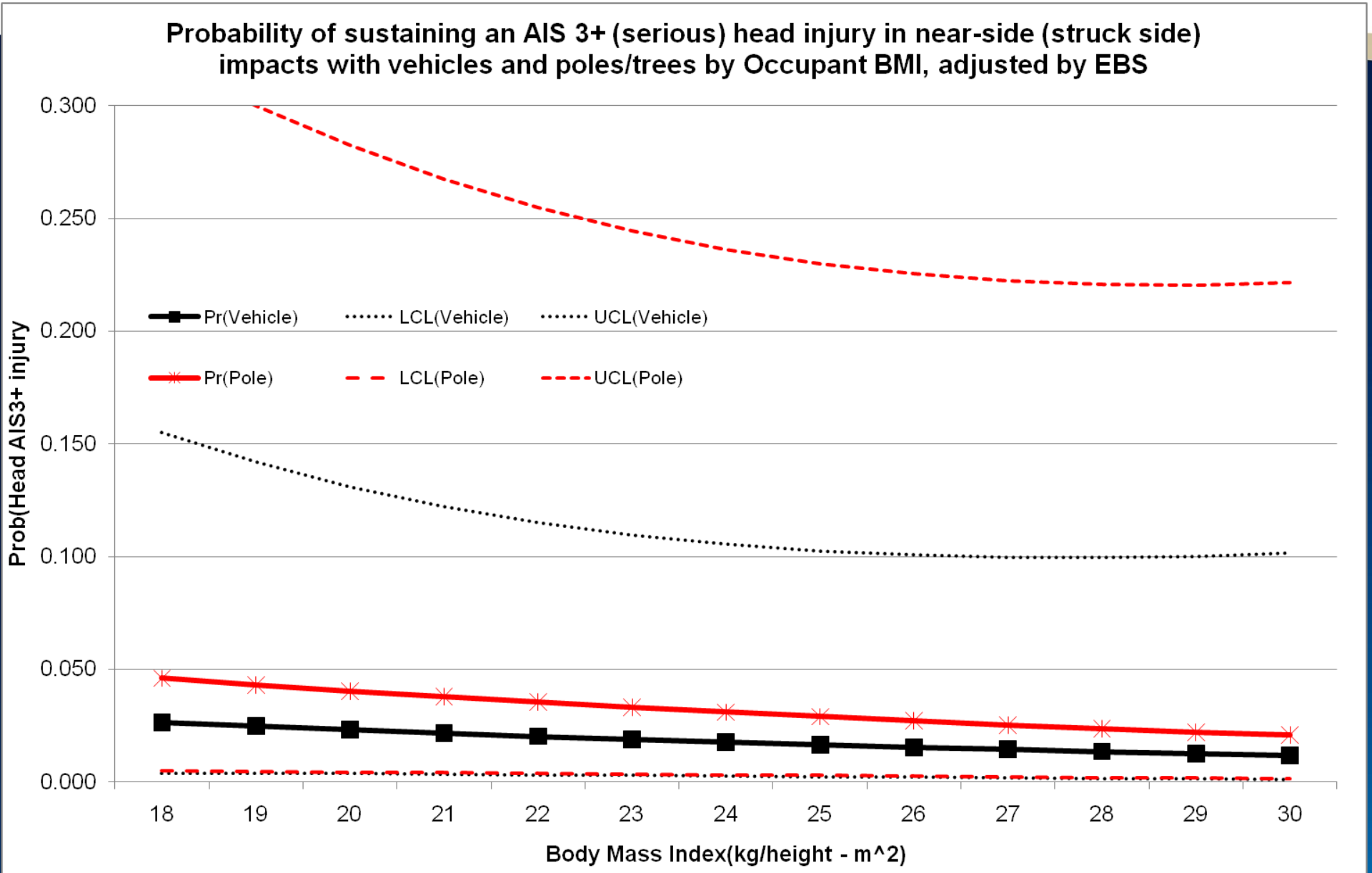

Probability of sustaining an AIS 3+ (serious) head injury in near-side (struck side) impacts with vehicles and poles/trees
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)
Prob(Head AIS3+ injury
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
EQUIVALENT BARRIER SPEED (km/h)

AGE-based Probability of males and females sustaining a Head AIS3+ injury in near-side (struck side) impacts with vehicles and poles/trees



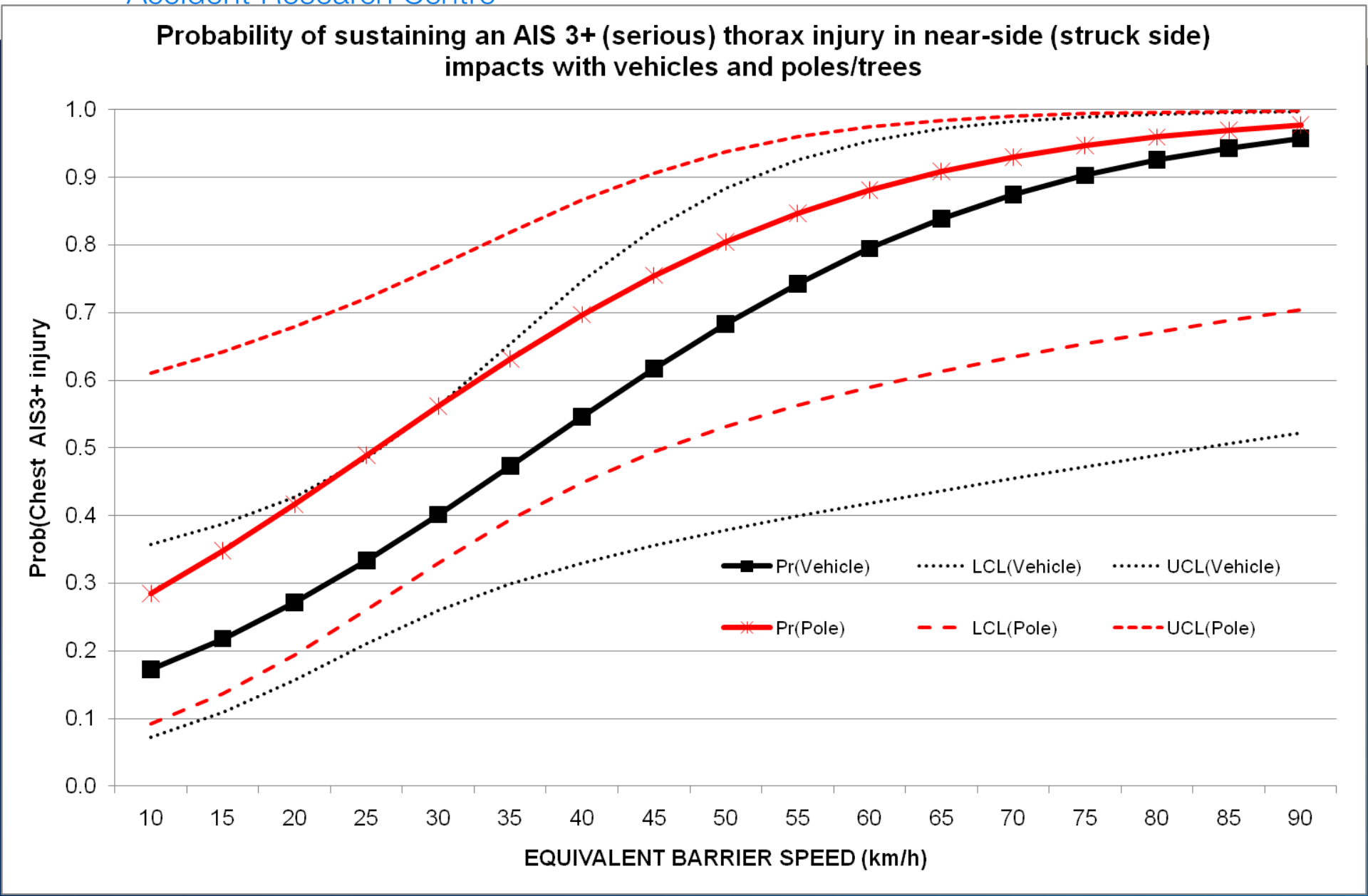

Probability of sustaining an AIS 3+ (serious) head injury in near-side (struck side) impacts with vehicles and poles/trees by Occupant Weight, adjusted by EBS
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Prob(Head AIS3+ injury
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)
55
60
65
70
75
80
85
90
95
100
105
110
115
120
Occupant Weight (kg)


Probability of sustaining an AIS 3+ (serious) head injury in near-side (struck side) impacts with vehicles and poles/trees by Occupant Height, adjusted by EBS
Prob(Head AIS3+ injury
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)
150
160
170
180
190
200
Occupant Height (cm)

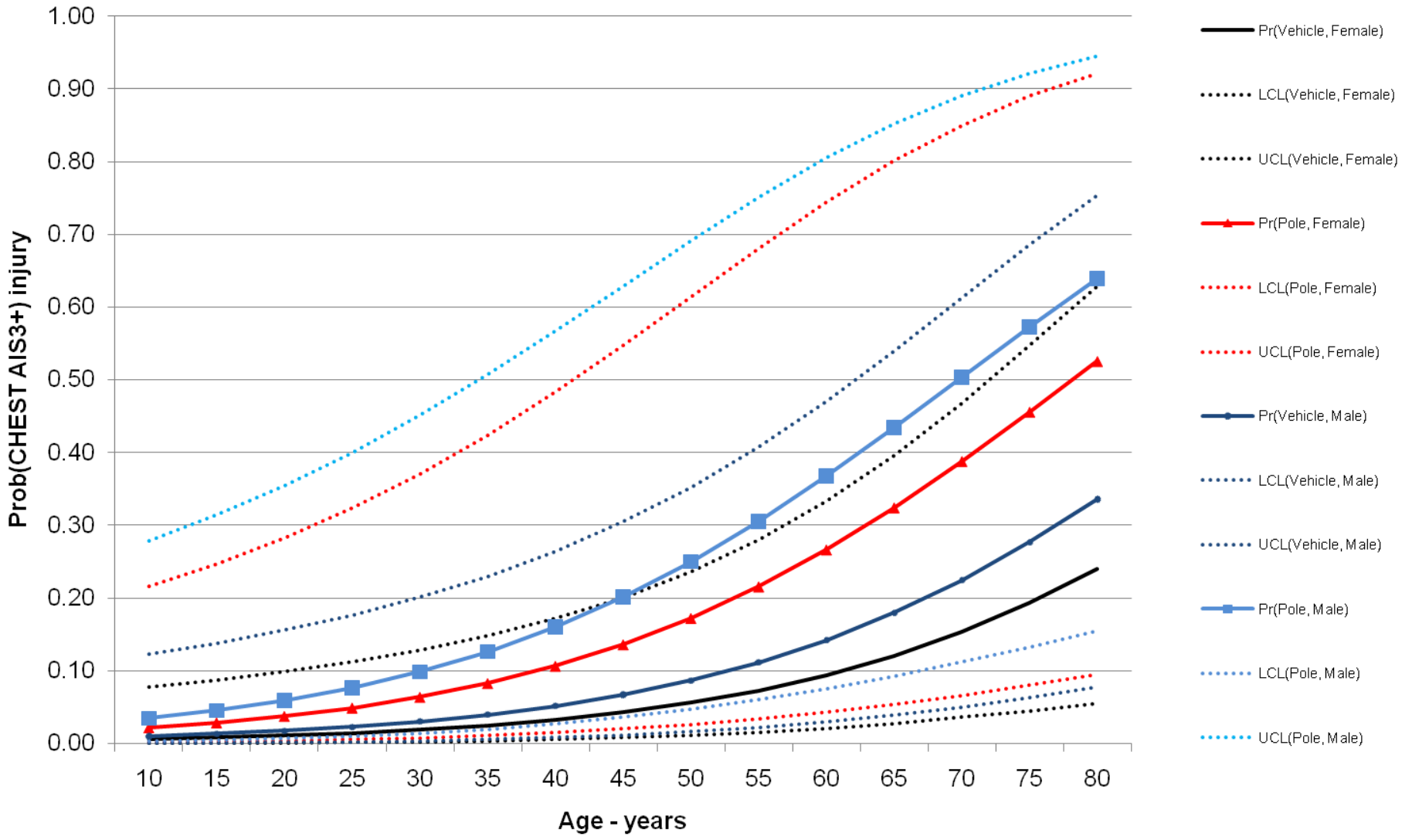

Probability of sustaining an AIS 3+ (serious) head injury in near-side (struck side) impacts with vehicles and poles/trees by Occupant BMI, adjusted by EBS
Prob(Head AIS3+ injury
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)
18
19
20
21
22
23
24
25
26
27
28
29
30
Body Mass Index(kg/height - m^2)

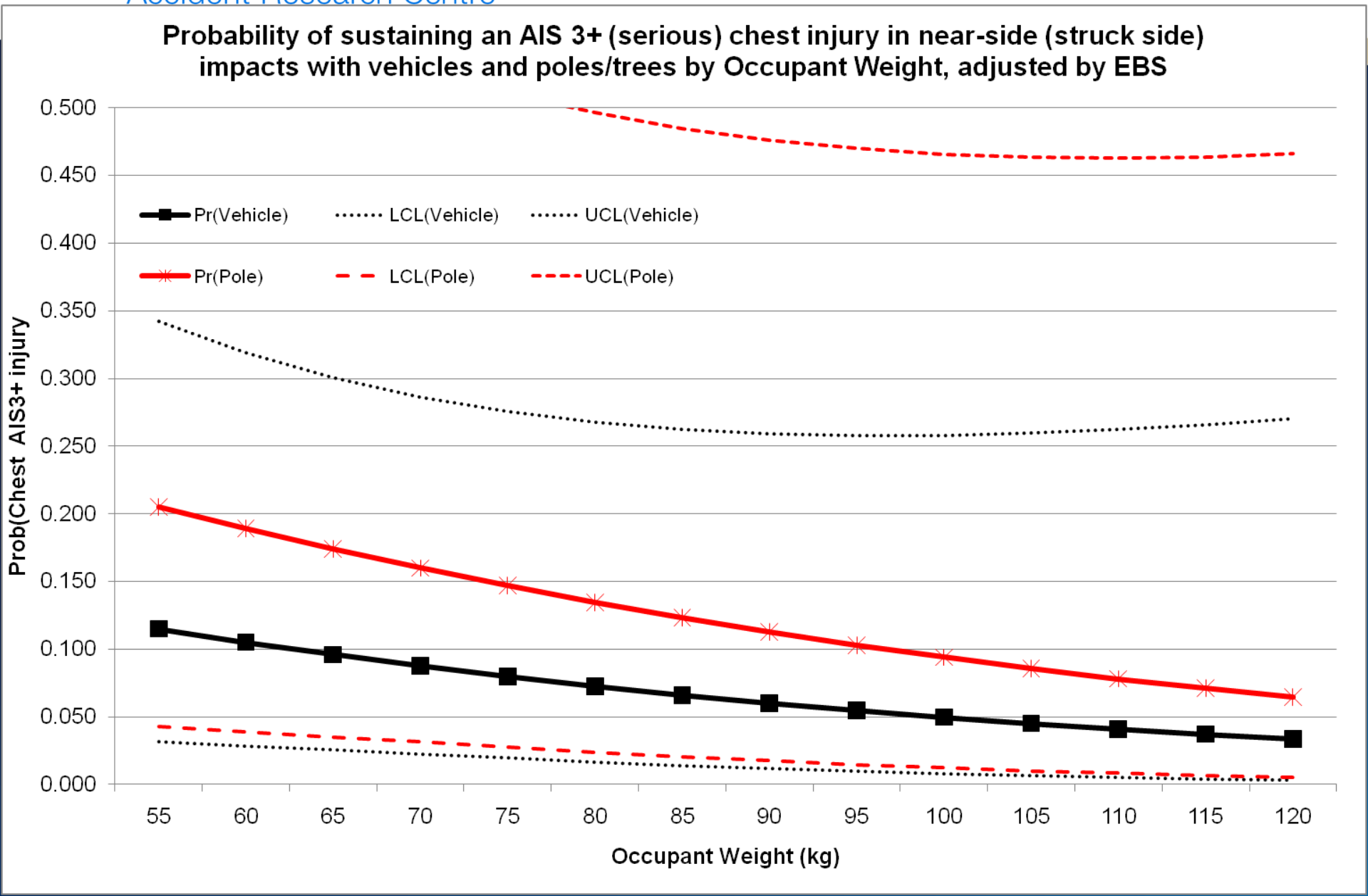
Logistic regression model for Chest AIS3+

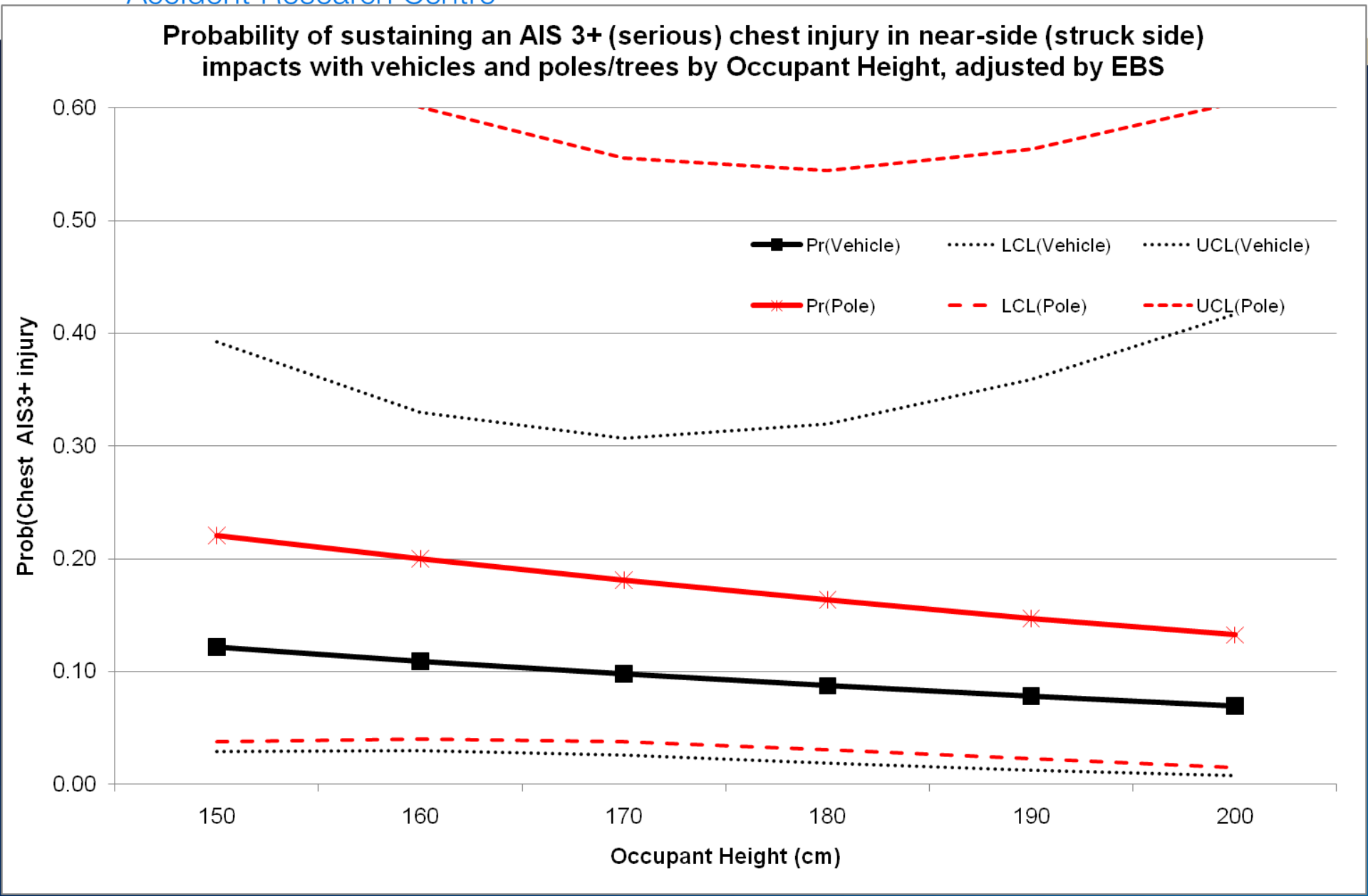
Chest 3+		Odds Ratio	LCL	UCL	stat sig.
AGE	years	1.06	1.02	1.10	YES
Sex	Male cf. Female	1.60	0.49	5.18	No
EBS	km/h	1.08	1.02	1.14	Yes
Collision partner	**Pole cf. Veh**	**3.51**	**0.90**	**13.65**	**Borderline**
Impact side	Near cf. Far	5.89	1.28	27.02	YES

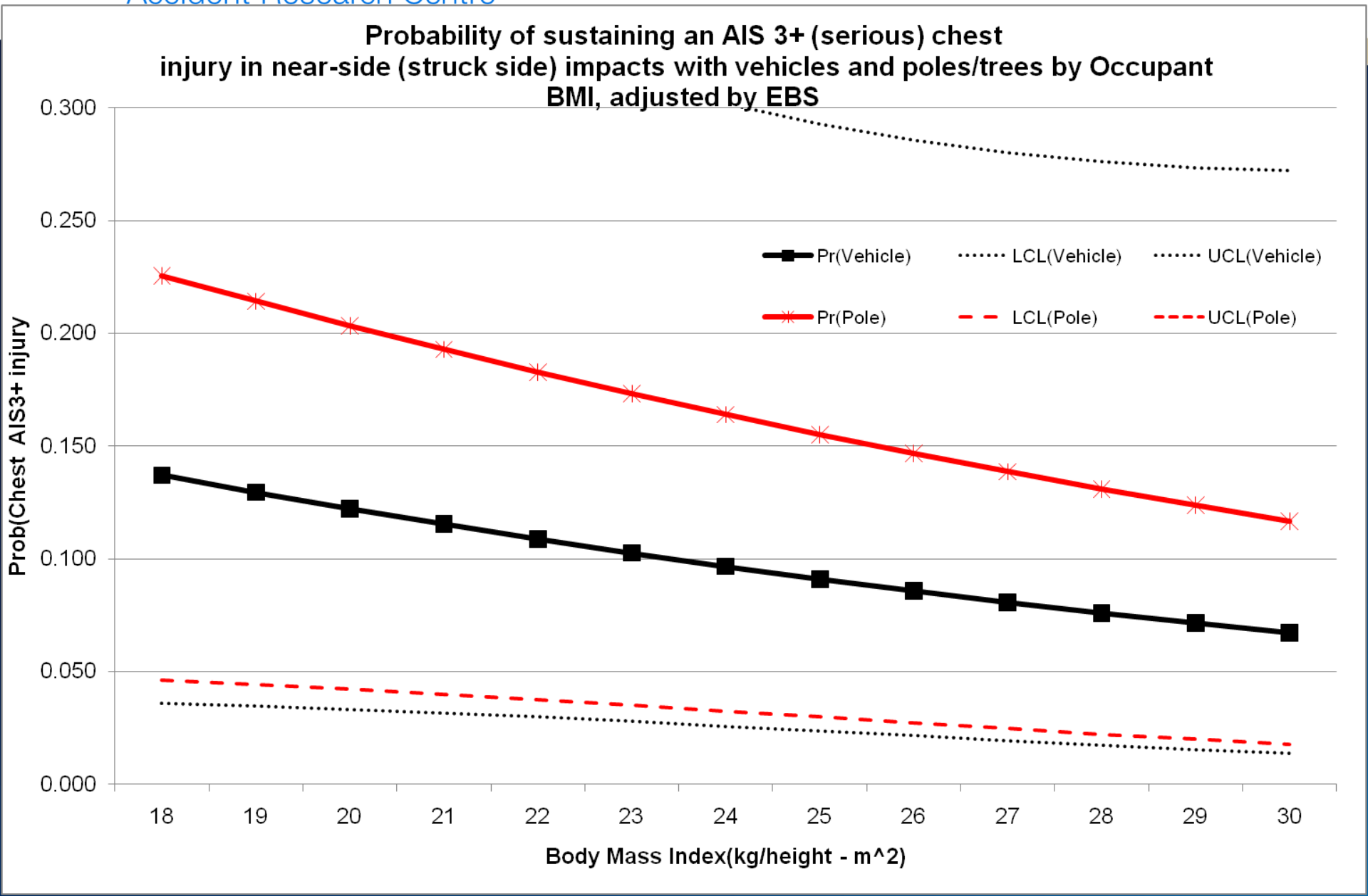

Probability of sustaining an AIS 3+ (serious) thorax injury in near-side (struck side) impacts with vehicles and poles/trees
Prob(Chest AIS3+ injury
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
EQUIVALENT BARRIER SPEED (km/h)
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)

AGE-based Probability of males and females sustaining a Chest AIS3+ injury in near-side (struck side) impacts with vehicles and poles/trees




Probability of sustaining an AIS 3+ (serious) chest injury in near-side (struck side) impacts with vehicles and poles/trees by Occupant Weight, adjusted by EBS
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)
Prob(Chest AIS3+ injury
0.500
0.450
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
55
60
65
70
75
80
85
90
95
100
105
110
115
120
Occupant Weight (kg)


Probability of sustaining an AIS 3+ (serious) chest injury in near-side (struck side) impacts with vehicles and poles/trees by Occupant Height, adjusted by EBS
Prob(Chest AIS3+ injury
0.60
0.50
0.40
0.30
0.20
0.10
0.00
150
160
170
180
190
200
Occupant Height (cm)
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)


Probability of sustaining an AIS 3+ (serious) chest injury in near-side (struck side) impacts with vehicles and poles/trees by Occupant BMI, adjusted by EBS
Prob(Chest AIS3+ injury
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)
18
19
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21
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29
30
Body Mass Index(kg/height - m^2)

Logistic regression model for Lower Extremity AIS3/4

Lower Extremity AIS3 / AIS4		Odds Ratio	LCL	UCL	stat sig.
AGE	years	1.02	0.97	1.06	No
Sex	Male cf. Female	0.29	0.07	1.25	No
EBS	km/h	1.08	1.01	1.16	YES
Collision partner	**Pole cf. Veh**	**1.78**	**0.34**	**9.41**	**No**
Impact side	Near cf. Far	23.06	1.36	390.26	YES

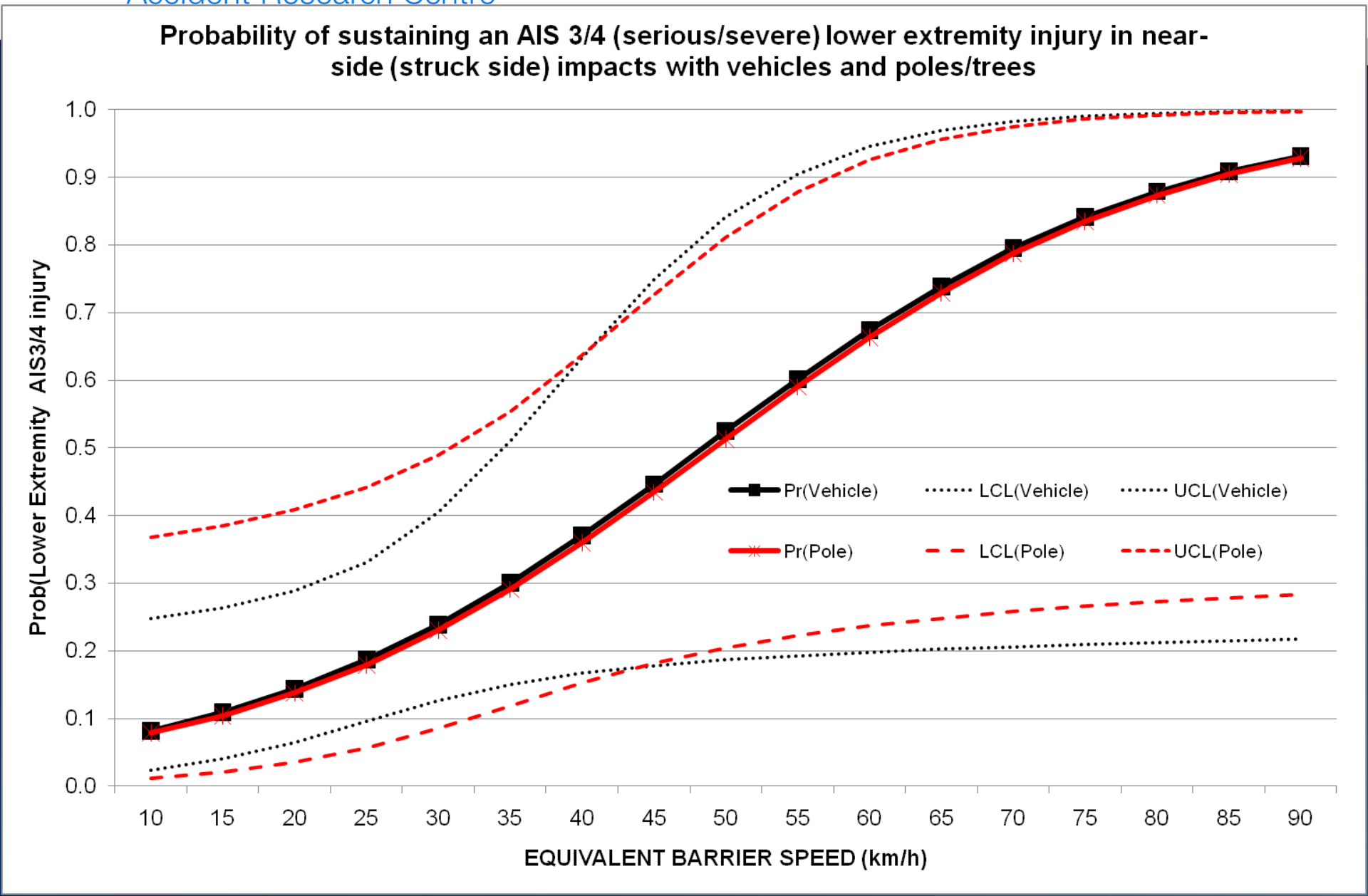
Other factors

Weight

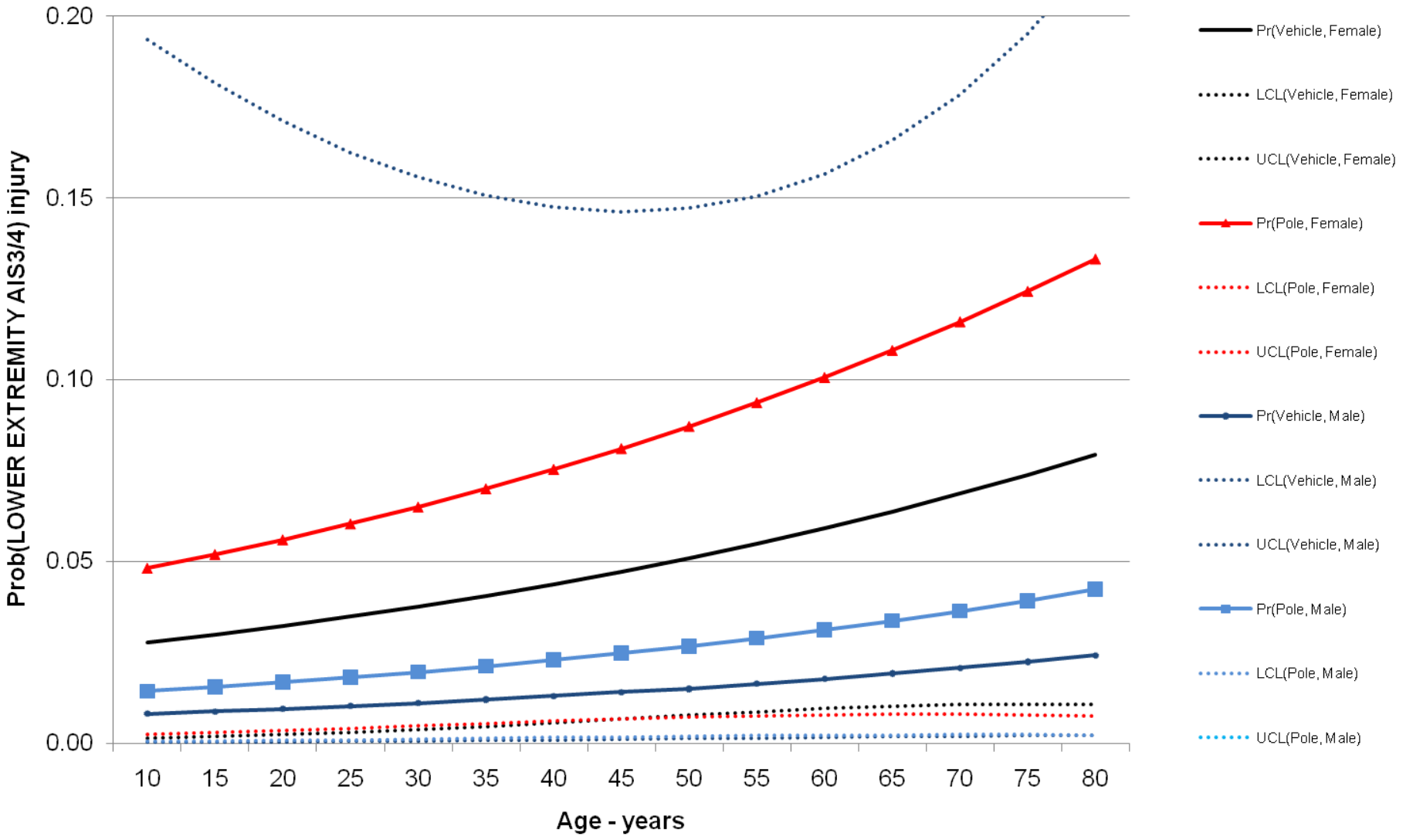
Chest: 1kg increase in weight translates to a 4% lower odds of AIS3+ injury
Head / lower ex: no association with AIS3+

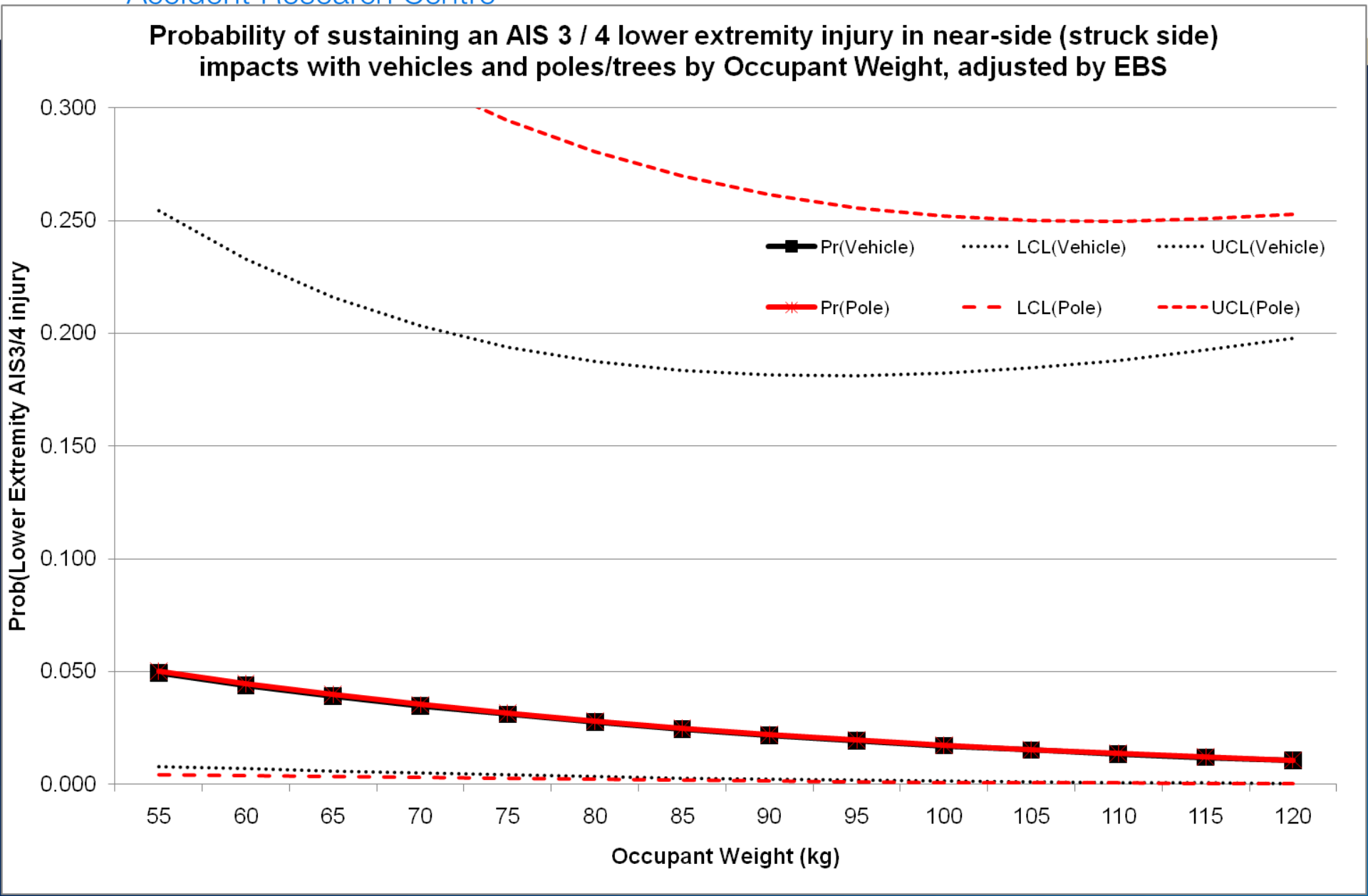
Height - no association with AIS3+ in these cases

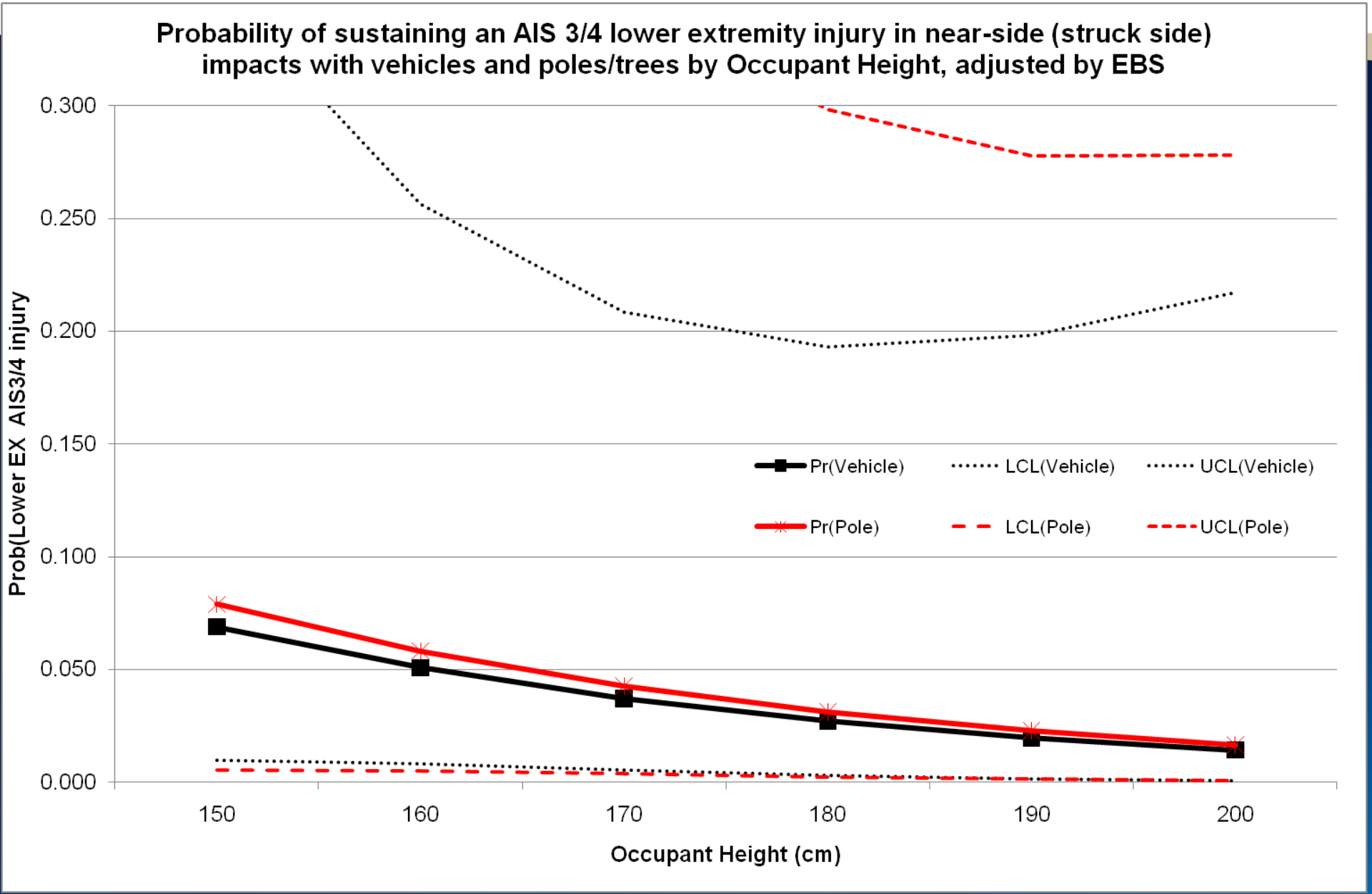
BMI Chest: a 1-point increase in BMI is protective; 14% lower odds of AIS3+

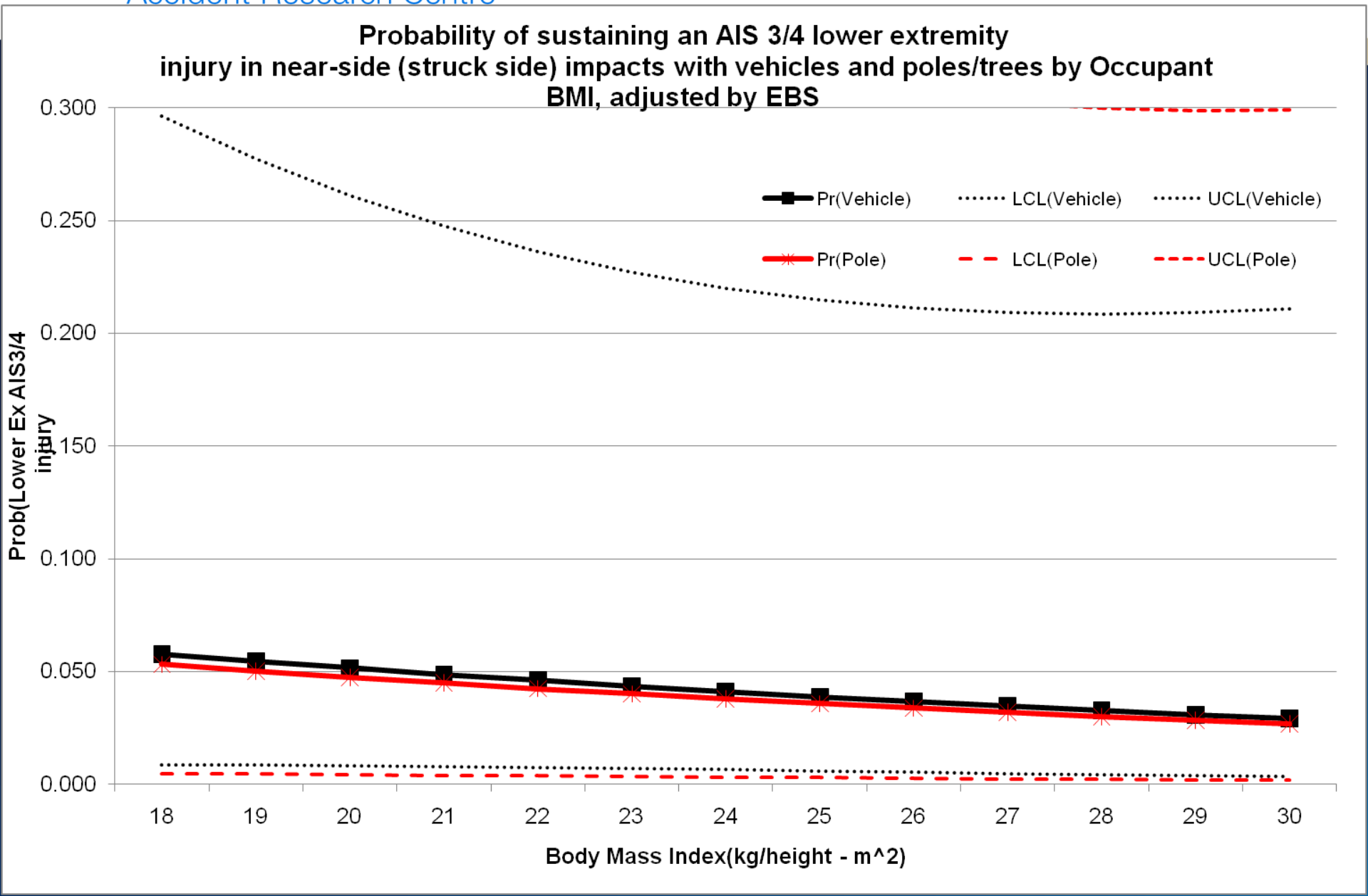

Probability of sustaining an AIS 3/4 (serious/severe) lower extremity injury in near-side (struck side) impacts with vehicles and poles/trees
Prob(Lower Extremity AIS3/4 injury
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
EQUIVALENT BARRIER SPEED (km/h)
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)

AGE-based Probability of males and females sustaining a Lower Extremity AIS3/4 injury in near-side (struck side) impacts with vehicles and poles/trees




Probability of sustaining an AIS 3 / 4 lower extremity injury in near-side (struck side) impacts with vehicles and poles/trees by Occupant Weight, adjusted by EBS
Prob(Lower Extremity AIS3/4 injury
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)
55
60
65
70
75
80
85
90
95
100
105
110
115
120
Occupant Weight (kg)


Probability of sustaining an AIS 3/4 lower extremity injury in near-side (struck side) impacts with vehicles and poles/trees by Occupant Height, adjusted by EBS
Prob(Lower EX AIS3/4 injury
0.300
0.250
0.200
0.150
0.100
0.050
0.000
150
160
170
180
190
200
Occupant Height (cm)
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)


Probability of sustaining an AIS 3/4 lower extremity injury in near-side (struck side) impacts with vehicles and poles/trees by Occupant BMI, adjusted by EBS
Prob(Lower Ex AIS3/4 injury)
0.300
0.250
0.200
0.150
0.100
0.050
0.000
Pr(Vehicle)
LCL(Vehicle)
UCL(Vehicle)
Pr(Pole)
LCL(Pole)
UCL(Pole)
18
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Body Mass Index(kg/height - m^2)

Maximum crash (static) and chest AIS3+

CHEST 3+		OR	LCL	UCL	stat sig.
Crush max.	cm	1.07	1.03	1.12	YES
Age	years	1.08	1.03	1.12	YES
Sex	Male cf. Female	3.51	0.67	18.35	No
Weight	kg	0.95	0.91	1.00	YES
Height	cm	1.02	0.94	1.10	No
Collision partner	Pole cf. Veh	1.44	0.32	6.37	No
Impact side	Near cf. Far	10.44	1.62	67.09	YES

Further steps

- Report on front seat occupants exposed / not exposed to SAB, given NCAP class
- Report on occupants of 5* NCAP vs non-5* vehicles
- Examine crush and intrusion profiles
- Examine impact angle configurations per Gabler, Fildes, Fitzharris (STAPP, 2002) using PDOF
  - 30º Glancing; 60º Angled; 90º Perpendicular; 120º Angled rear; 150º Glancing rear
- Use probabilities linked to mass data to determine community-wide injury distribution
- Overlay effectiveness of countermeasures
- Overlay cost, derive introduction scenarios, and determine likely benefits
- Extend probability analysis in association with data custodians of in-depth and mass casualty datasets