Euro NCAP data - used in this study

Euro NCAP phases 10, 11 and 11+
Total of 39 vehicles, including all categories

Executive Cars: Mercedes-Benz E-Class, Peugeot 607, Renault Vel Satis
Large Family Cars: Jaguar X-Type, Nissan Primera, Proton Impian, Saab 9-3, Subaru Legacy, Toyota Avensis, Opel Vectra
Large SUVs: Range Rover, BMW X5, Hyundai Santa Fe, Jeep Cherokee, Mercedes-Benz M-Class, Suzuki Grand Vitara, Opel Frontera
Mini MPVs: Chrysler PT Cruiser, Mercedes-Benz Vaneo, Opel Meriva
MPVs: Peugeot 807
Roadsters: Audi TT Roadster, Honda S2000, Mazda MX-5, Mercedes-Benz SLK, MG TF
Small Family Cars: Renault Mégane, Toyota Corolla
Small SUVs: Honda CR-V, Land Rover Freelander, Mitsubishi Pajero Pinin, Nissan X-Trail
Superminis: Audi A2, BMW Mini, Citroën C3, Ford Fiesta, SEAT Ibiza, Opel Corsa, Volkswagen Polo.

Note: Euro NCAP selected cars are top selling versions of cars in the European market. These do not necessarily correspond to the best or the worst case of each vehicle model.
Euro NCAP data - used in this study

Euro NCAP phases 10, 11 and 11+; from the introduction of new impact area definition, testing and assessment protocols (January 2002)

Until phase 9

From phase 10

Child Headform:
- free flight test
- mass 2.5 kg
- diameter 130 mm
- impact angle 50°
- impact speed 40 km/h

Adult Headform:
- free flight test
- mass 4.8 kg
- diameter 165 mm
- impact angle 65°
- impact speed 40 km/h

Upper Legform:
- guided test
- test parameters f(BLEH,BL)
- mass 10.5-17.5 kg
- impact angle 10-46°
- impact speed 20-40 km/h

Legform:
- free flight test
- mass 13.4 kg
- impact speed 40 km/h
Euro NCAP data - assessment method

Headform test: HIC
- <1000: (100%)
- 1000 - 1350: (30%)
- >1350: (35%)

Upper Legform test:
- Bending Moment (Nm):<300: (100%)
- 300 - 380: (27%)
- >380: (20%)

- Sum of Forces (kN):<5: (100%)
- 5 - 6: (20%)
- >6: (20%)

Legform test:
- Tibia Deceleration (g's):<150: (100%)
- 150 - 200: (33%)
- >200: (33%)

Knee Shear Displacement (mm):<6: (100%)
- 6 - 7: (17%)
- >7: (17%)

Knee Bending Angle (°):<15: (100%)
- 15 - 20: (33%)
- >20: (33%)

(XX%) indicates difference from red to green in %
Points distribution:
- 2 points green area, 2-0 points yellow area (linear interpolation), 0 points red area

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Euro NCAP data - impact areas

Adult Head Impact Area:
1500 WAL - 2100 WAL

Child Head Impact Area:
1000 WAL - 1500 WAL

Upper Legform:
Bonnet leading edge

Legform:
Bumper reference line
### Euro NCAP data - identification of best performing cars on child headform impact area

<table>
<thead>
<tr>
<th>Model</th>
<th>Child Headform Assessment Sum</th>
<th>Phase</th>
<th>Category</th>
<th>Total Scoring</th>
<th>Total Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEAT Ibiza</td>
<td>6.99</td>
<td>11</td>
<td>Supermini</td>
<td>14 points</td>
<td>2 stars</td>
</tr>
<tr>
<td>Honda CR-V</td>
<td>6.20</td>
<td>10</td>
<td>Small SUV</td>
<td>19 points</td>
<td>3 stars</td>
</tr>
<tr>
<td>Toyota Corolla</td>
<td>6.30</td>
<td>11</td>
<td>Small Family Car</td>
<td>11 points</td>
<td>2 stars</td>
</tr>
</tbody>
</table>

(No. of vehicles with a child headform assessment sum = 0) = 9
(Average no. of points in the child headform assessment sum) = 1.78

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### Identification of differences: Euro NCAP data / EC Directive phase I child headform impact area

**Euro NCAP:**
- Free flight test
- Mass: 2.5 kg
- Diameter: 130 mm
- Angle: 50°
- Speed: 40 km/h
- Impact area: between 1000 WAL - 1500 WAL
- HIC: < 1000 1000 - 1350 1350 - 1550

**EC Directive Phase I:**
- Free flight test
- Mass: 3.5 kg
- Diameter: 165 mm
- Angle: 50°
- Speed: 35 km/h
- Impact area according WG17 procedure (Bonnet Rear Reference Line)
- HIC: < 1000 (2/3 of the total area) 1000 - < 2000 (rest of the area)

**D1. Impactor and test speed**
- 2000

**D2. Impact area**
- 2000
Examination of D1:
Euro NCAP data / EC Directive phase I
car headform impact area
D1. Impactor and test speed

Impact energy (Euro NCAP) x 1.07 = Impact energy (EC Directive Phase I)

Using the 3.5 kg impacter the deformation path and possibility of contacting a rigid structure will increase.

If a rigid structure is not contacted, results from the 2.5 kg impacter could be used as a reference to predict results using the 3.5 kg. Differences in HIC maybe around 10%.

Regarding D1. Impactor and test speed
Results of Euro NCAP tests could be used as a reference, taking into account the differences in terms of energy and possibly deformation.

Examination of D2:
Euro NCAP data / EC Directive phase I
child headform impact area
D2. Impact area

Regarding D2. Impact area
An examination of each vehicle model should be done to evaluate the influence of the redefinition of the upper limit of the area (1500 WAL / Bonnet rear reference line)

In the SEAT Ibiza, Euro NCAP impacted zones A2c, A4c, A5d will be included in the phase I child headform impact area.

Based on the results of the adult headform, none of the impacted zones will be below a value of HIC of 1000 when tested with the child headform (3.5 kg)
Interpolation:
Euro NCAP data / EC Directive phase I
child headform impact area

Vehicle 1 - Meets the requirements of phase I regarding child headform impact area - Target
Vehicle 2 - Best Child Headform Assessment Sum (from phase 10, 11 and 11+) - SEAT Ibiza

Euro NCAP data / EC Directive phase I
child headform impact area

Conclusions, child headform impact area:
A methodology has been developed to study Euro NCAP data and determine if the requirements of the EC Directive for phase I would be met. This methodology could be used to exploit more in-depth the available and incoming (phase 12) data and determine trends.

Current vehicles are still far to meet the proposed future legal requirements. Simple design changes on the best scoring vehicles will put them in a situation very close to meet the proposed requirements for phase I.
### Euro NCAP data - identification of best performance legform impact area

<table>
<thead>
<tr>
<th>Model</th>
<th>Legform Assessment Sum</th>
<th>Phase</th>
<th>Category</th>
<th>Total Scoring</th>
<th>Total Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>MG TF</td>
<td>6.84</td>
<td>11+</td>
<td>Roadster</td>
<td>19 points</td>
<td>3 stars</td>
</tr>
<tr>
<td>Honda CR-V</td>
<td>4.54</td>
<td>10</td>
<td>Small SUV</td>
<td>19 points</td>
<td>3 stars</td>
</tr>
<tr>
<td>Nissan X-Trail</td>
<td>2.00</td>
<td>11</td>
<td>Small SUV</td>
<td>10 points</td>
<td>2 stars</td>
</tr>
</tbody>
</table>

(No. of vehicles with a legform assessment sum = 0) = 34 (total sample 39)
(Average no. of points in the legform assessment sum) = 0.37

### Identification of differences:

**Euro NCAP data / EC Directive phase I legform impact area**

*Euro NCAP:*
- free flight test
- WG17 legform
- mass 13.4 kg
- speed 40 km/h
- Bumper reference line
- Tibia Deceleration (g) < 100, 150 - 200, > 200
- Knee Shear Displacement (mm) < 6, 6 - 7, > 7
- Knee Bending Angle (°) < 15, 15 - 20, > 20

*Proposed Directive Phase I:*
- free flight test
- WG17 legform
- mass 13.4 kg
- speed 40 km/h
- Bumper reference line
- Tibia Deceleration (g) < 200
- Knee Shear Displacement (mm) < 6
- Knee Bending Angle (°) < 21

Same test method and impact area. Only differences in assessment method. No need for examining differences.
Euro NCAP data / EC Directive phase I
legform impact area

Two vehicles, MG TF and Honda CR-V, first and second best Legform Assessment Sum (from phase 10, 11 and 11+) are already meeting the requirements of the EC Directive phase I

Conclusions, legform impact area:

Is it possible to use Euro NCAP data to determine if the current vehicle models are meeting the requirements of the EC Directive phase I and WG17

The majority of vehicles are performing very badly. Solutions are available and must be incorporated to vehicles.