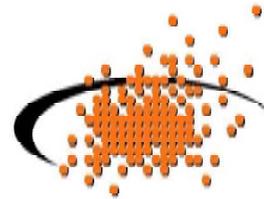


# DAIMLERCHRYSLER



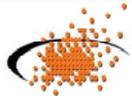
*CUSTOMER RESEARCH CENTER*



## **Customer study: Shingled head restraints**

Patrick Riedemann (MB-technology)  
GR/VER

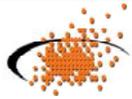
**March 2007**



## Basic situation

- If the rear seating positions are not occupied, for rear view it is favourable to remove the head restraints quick and easy out of the field of view.
- „Standard“ head restraints bother the folding of the rear seat bench.
- A so called „shingled“ head restraint was developed, which allows an easy adjustment of the head restraint into the portion of the seat back (see photo on the right).
- Advantages: Head restraint can be easy pushed out of the field of view and rear seat can be folded without removal of head restraints.
- Problem: If there is a passenger in the rear, he must recognise this none-use position and adjust the head restraint upwards to reduce the risk of injury in a rear end collision.

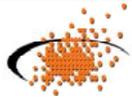




# Current legislation

## Objective of customer study

- FMVSS 202a currently requires non-use position for rear seats only, if one of the following conditions is met:
  - Automatic return when occupied by a 5th percentile female
  - Forward or rearward rotation of at least 60°
- Additional „discomfort metric“ criteria under discussion for GTR head restraints
- Criteria for NHTSA to accept „discomfort metric“: 80% of rear seat occupants must recognise the non-use position and re-adjust the head restraint spontaneously (within the first 5 minutes of driving).
- Objective of the customer study is to find out, if the Mercedes-Benz „shingled“ head restraints, which fulfill the „discomfort metric“ criteria, can meet the 80% criteria.
- Additionally there shall be made a comparison between the „shingle“-type and the foldable head restraints, which are allowed in the current FMVSS 202a



# Formulation of the problem

- There are two alternative „shingled“ head restraint concepts:
  - Standard (series in M-Class)
  - Prototype: Extended (goes more into the portion of seat back when adjusted in non-use position)
- For comparison a classic foldable concept (E-Class wagon) is tested
- Based on a sufficient spot check it shall be determined the percentage of people, which adjust the head restint upwards spontaneously.
- It shall be investigated if this percentage is differing in dependence of the head restraint concept.

„shingled“ head restraint (series M-Class)

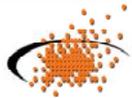


Prototype: „shingled“ head restraint „extended“



Foldable head restraint (series E-Class wagon)





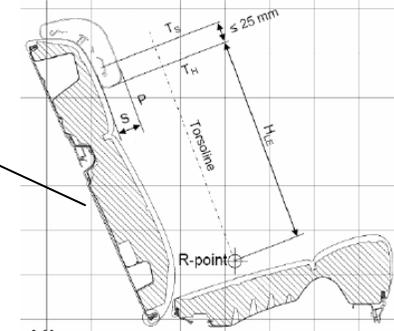
# 3 vehicles with 3 different head restraints

M-Class 1  
(type 164)



„shingled“ head restraint (series):  
 $s = 40 \text{ mm}$   
 $H_{LE} = 460 \text{ mm}$

According to GTR proposal: „discomfort metric“



M-Class 2  
(type 164)



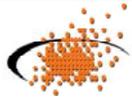
Prototype:  
„shingled“ head restraint „extended“:  
 $s = 40 \text{ mm}$   
 $H_{LE} = 430 \text{ mm}$

E-Class wagon  
(type 211)



Foldable head restraint (series)

According to FMVSS 202a, §4.4 (non-use position):  
„... rotating forward or rearward by not less than 60 degrees ...“



# Procedure



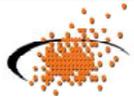
Each candidate is driving as a rear seat passenger successively in each of the three vehicles.

Each trip lasts approx. 10 – 15 minutes.

Vp 1	Foldable head restraint	Shingled head rest series	Shingled head rest extended
Vp 2	Shingled head rest extended	Foldable head restraint	Shingled head rest series
Vp 3	Shingled head rest series	Shingled head rest extended	Foldable head restraint
Vp 4	Foldable head restraint	Shingled head rest series	Shingled head rest extended
Vp 5	Shingled head rest extended	Foldable head restraint	Shingled head rest series
Vp 6	Shingled head rest series	Shingled head rest extended	Foldable head restraint
Vp 7	Foldable head restraint	Shingled head rest series	Shingled head rest extended

etc. ...

To control sequence effects, the sequence was permuted (each possible sequence appears with the same rate in the whole test).



# Success criteria

- Success criteria: Head restraint is adjusted spontaneously (without request) within the first 5 minutes after starting the trip (controlled by the testing manager)

## Foldable head restraint

Starting position



Success criteria:  
head restraint  
folded upwards



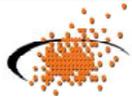
## „Shingled“ head restraint

Starting position



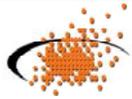
Success criteria:  
Adjusted at least  
to first nod (use  
position)





## „Fake“- formulation of problem

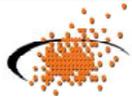
- To be sure, that the re-adjustment of the head restraint really happens spontaneously and not by the requesting character of the study, the real objective of the study has to be concealed.
- The candidates were told another, pretended objective of the study (fake instruction), which deviates from the real objective.
- In Germany customer research with fake instructions are legally allowed
- It has to be avoided, that the candidates concentrate too much on the pretended objective of the fake instruction and thereby are distracted too much to re-adjust the head restraint, although they would have done it otherwise.
- Pretended (fake) objective of this study: Driving comfort for rear seat occupants; evaluation of shock-absorber setting of the suspension.



## Fake-Instruction

- Testing manager at the beginning of investigation: *„The test is about comfort in rear seats. By a selectable change of the shock-absorber setting of the suspension, the comfort in the rear seats can be improved. Therefore three different systems were developed, which are installed in the three vehicles. We would like to know from you, to what extent the comfort changes in your feeling, when we change the adjustemnt of the shock-absorber.“*
- To avoid that people concentrate too much on pretended objective: *„First we give you the possibility to accustom to the vehicle and we will switch on the system later. So for a start you do not need to look after something special.“*
- In the vehicle there is a blind switch visible for the candidate, which is operated by the test manager after 5 minutes driving. No more after the critical 5 minutes the new pretended system is activated.
- After each trip: Review of the pretended comfort system by means of a short questionnaire.

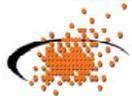




## Interview after test trip

- After the cycle of all three vehicles, the candidates were clarified about the real intention of the investigation.
- None of the candidates was annoyed afterwards.
- After this a questionnaire about the real intention of the investigation, the head restraint, was handed out.
- Content of the questionnaire:
  - Questions about the person: Age, body height
  - Review of the 3 head restraint concepts regarding handling, comfort and styling
  - Normal habit: yearly travelled kilometers, frequency as rear passenger, frequency of changing vehicles, how often is the head restraint raised up?



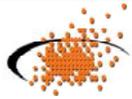


## Description of sampling

- DC-employee: Raising up the head restraint basically depends on habit, exigence of safety and body height, which means that it is largely independent from the vehicle brand, therefore internal candidates could be used.
- Body height: Special attention was payed on the distribution of body heights of the sample which largely corresponds with the distribution of the population.

(See also attached backup: Distribution of body heights)

	number	∅ body height [cm]	age
total	79	175,9	36,6
women	28	165,9	34,6
men	51	181,7	37,6

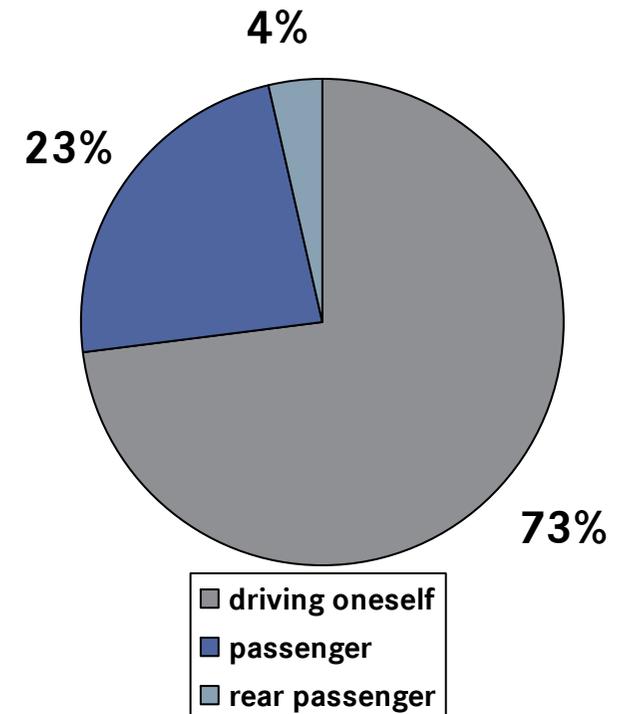
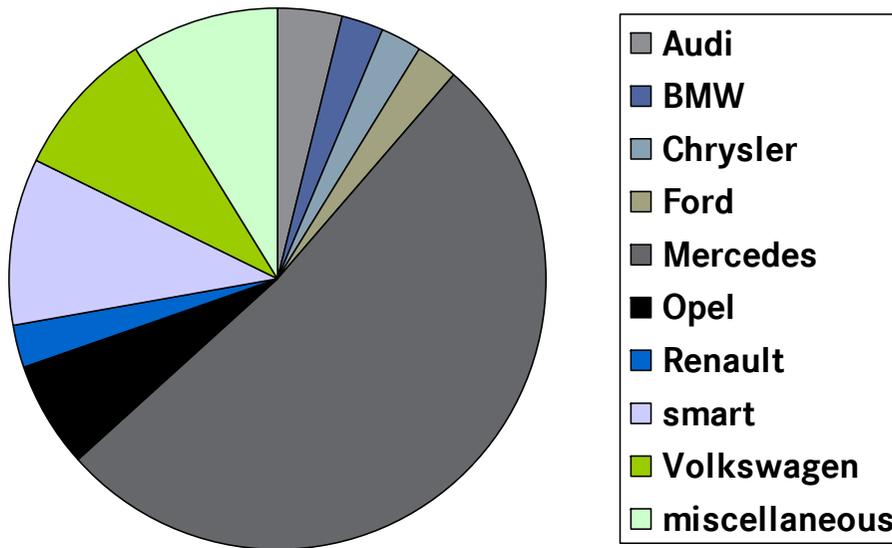


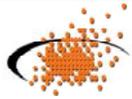
# Description of sampling Driving habit

Number of driven kilometers per year (average)	Standard deviation
23.800 km	13.100 km

*How often are you driving yourself, are you passenger, are you rear seat passenger?*

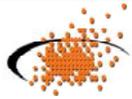
Own vehicle





## Statistical covering of results

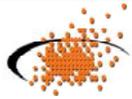
- When can the general NHTSA criteria (80% of rear seat passenger must adjust the head restraint spontaneously within 5 minutes) be regarded as fulfilled?
- It is not sufficient, if the investigation sample shows a rate of 80%. For investigations of this kind it has to be counted on measuring mistakes. When repeated under same conditions, the test may also result in a quote of e.g. 75%.
- To be sure that the result did not appear by chance (e.g. by measuring mistake), the investigation must reach a rate clearly higher than 80%.
- Results of such investigations are regarded as statistically assured, if the probability of error is less than 5% (or 1% as more stringent criteria).



# Comparison of head restraints: Adjustment rates

	Head restraint adjusted	Head restraint <u>not</u> adjusted	Probability of error
„shingled“ head restraint (series) 	92%	8%	<5%
„shingled“ head restraint „extended“ 	97%	3%	<1%
Foldable head restraint 	60%	40%	n.s.

The rate of 80% is achieved by both „shingled“ head restraints. The prototype of a „extended shingled“ head restraint exceeds the 80% limit more clearly (probability of error very small). The foldable head restraints clearly fails the 80% rate.



## Explanation of adjustment rates

### „Shingled“ head restraint (series)



- Head restraint in non-use position is felt by almost all candidates in their back.
- To sit comfortable the design of the head restraint constrains the occupant to raise up the head restraint.

### „Shingled“ head restraint (extended)

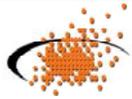


- Head restraint in non-use position is felt by almost all candidates in their back and is regarded disturbing.
- Also smaller occupants are feeling disturbed by the extended „shingled“ head restraint.

### Foldable head restraint



- Folded away head restraint is not recognised (not perceptible)
- Especially small occupants are regarding the folded away head restraint as sufficient for safety, because it already protrudes over the seat back when in non-use position.



# Comparison of head restraints: Adjustment rates and body height

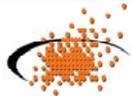
Percentage of adjusted head restraints

	total	small*	large
„shingled“ head restraint (series) 	92%	90%	93%
„shingled“ head restraint „extended“ 	97%	100%	96%
Foldable head restraint 	60%	53%	62%

\* only candidates up to 1,70 m

Smaller people tend to raise up the head restraint less frequently. Anyway the 80% limit is exceeded.

Foldable head restraints protrudes seat back in non-use position; smaller candidates consider this as sufficient protection.

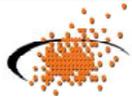


# Comparison of head restraints: Adjustment rates and gender

Percentage of adjusted head restraints

		total	female	male
„shingled“ head restraint (series)		92%	82%	96%
„shingled“ head restraint „extended“		97%	96%	98%
Foldable head restraint		60%	50%	64%

Altogether female candidates adjust all head restraint types less frequently. The 80% limit can not be statistically ensured for the women. The „extended“ version exceeds the 80% limit for all parts of the spot tests significantly.

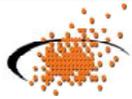


# Which notch was adjusted?

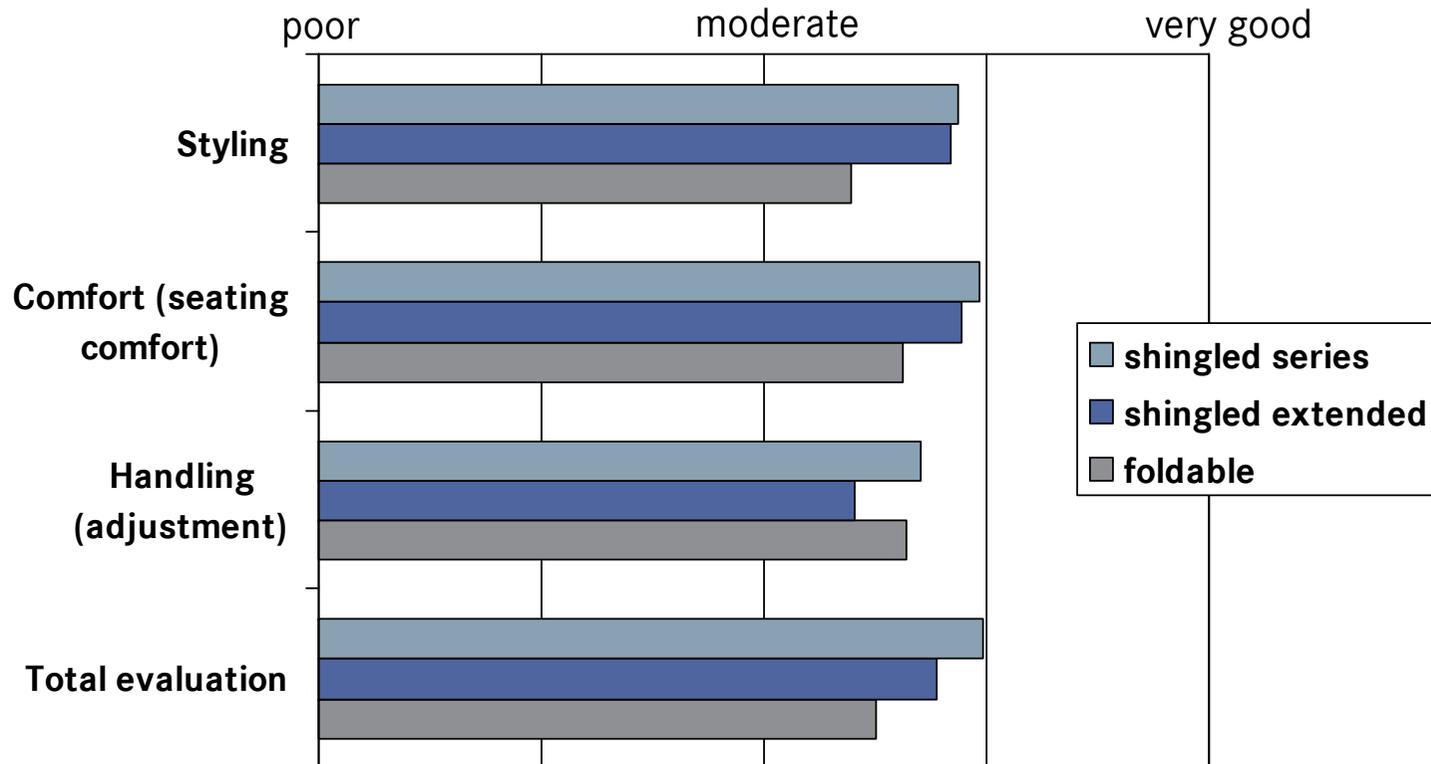
		Total average	Average small*	Average large
„shingled“ head restraint (series)		3,9**	2,4	4,4
„shingled“ head restraint „extended“		3,9**	2,3	4,5
Foldable head restraint		5,2***	3,4	5,6

\* only candidates up to 1,70 m  
 \*\* total number of notches in M-Class: 5  
 \*\*\* total number of notches in E-Class wagon: 8

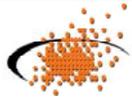
In case of a head restraint adjusted, mostly the height was adjusted correspondingly to the body height.



# Subjective evaluation of the head restraints

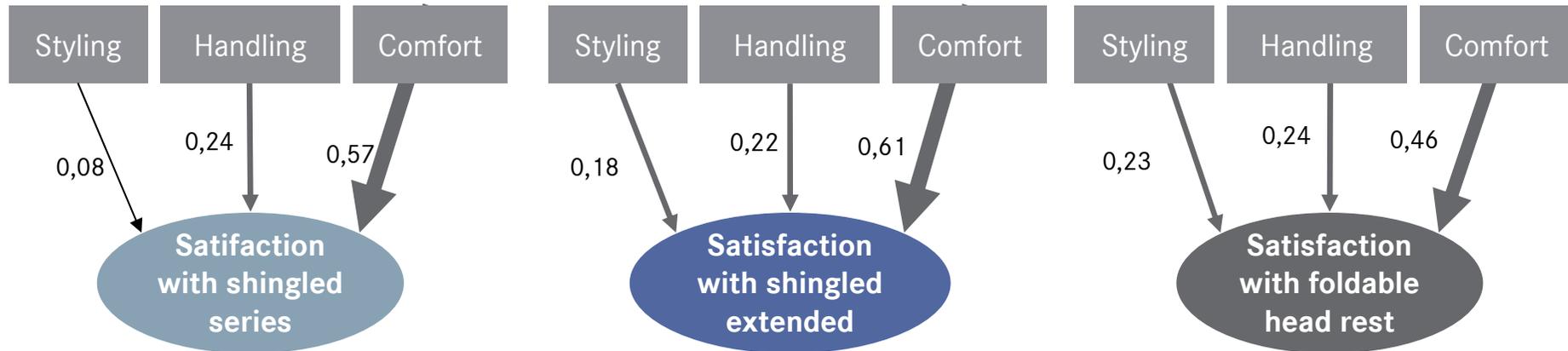


Altogether the series „shingled“ head restraint is evaluated best (statistically significant better as the foldable head restraint). The „extended shingled“ head restraint declines a little bit in handling. Raising up of the head restraint was too tight for many candidates (could have been a prototype problem?).



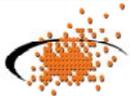
# Wherapon can the subjective evaluation be referred to?

- Which of the factors comfort, handling and styling show the highest correlation with the total satisfaction?
- For answering that question, regression analyses were calculated.

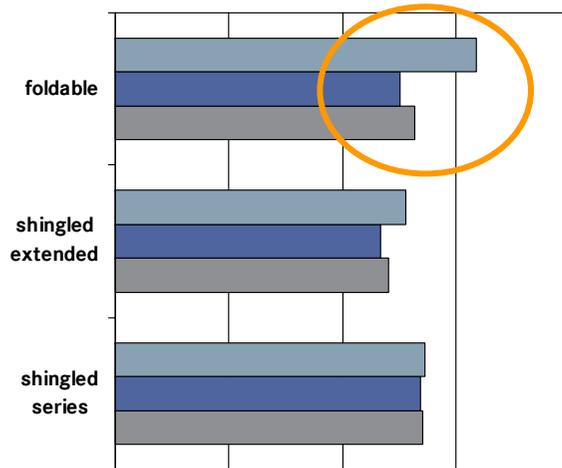


Continuously the highest influence on the total satisfaction with the system has the comfort in the sense of seating comfort.

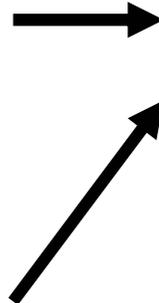
According to the statements of the candidates the most bothering fact for the foldable concept is, that the head restraint is too far behind, so that leaning against the head rest is uncomfortable. The disadvantages of the extended „shingled“ head restraint (see page before) are being marginal reflected in the total satisfaction.



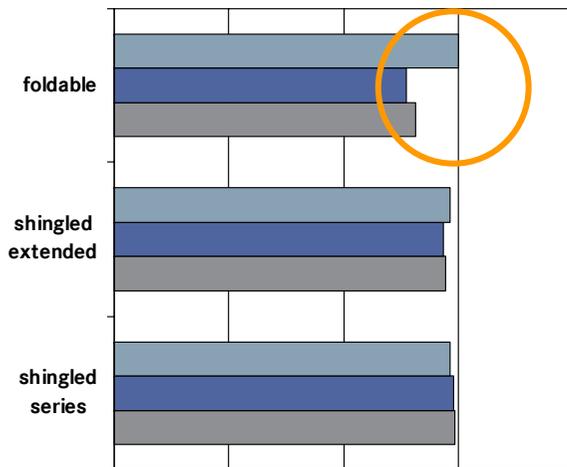
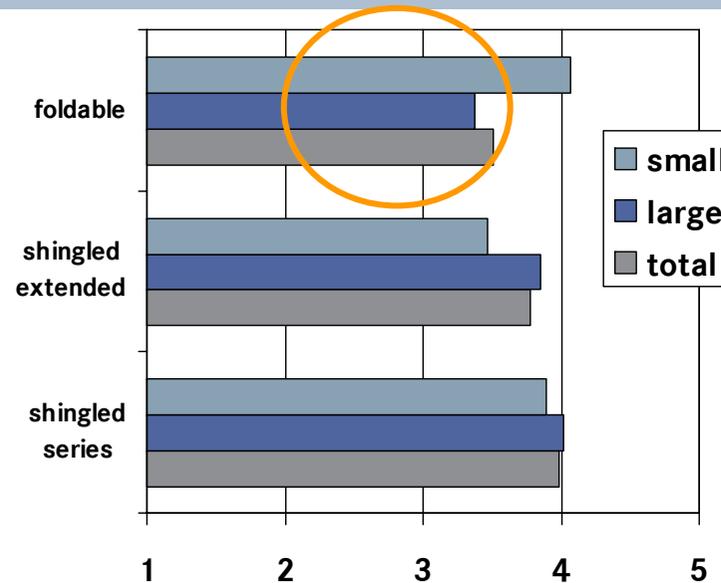
# Subjective evaluation: Varieties by body height?



Handling

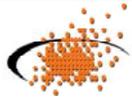


Total satisfaction



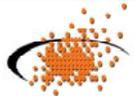
Comfort

The foldable head restraint is evaluated significantly better (probability of error of 5%) from smaller candidates than from larger candidates. This results from the easier handling in the view of the smaller and mostly weaker candidates. But it also results from the better evaluated comfort (smaller candidates could better lean against the foldable head restraint).



## Conclusions

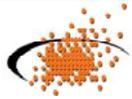
- Both „shingled“ head restraint concepts were adjusted considerable more frequent than the foldable head restraint.
- The 80% limit is exceeded by both „shingled“ head restraint concepts statistically significant.
- In addition the „shingled“ head restraint concepts are regarded as more comfortable.
- The extended „shingled“ head restraint version is the most secure one for all candidates.
- In case the prototype problems (tight handling) are solved, the extended „shingled“ head restraint is the best concept altogether.
- In the sense of the NHTSA 80% criteria the series „shingled“ head restraint is sufficient.



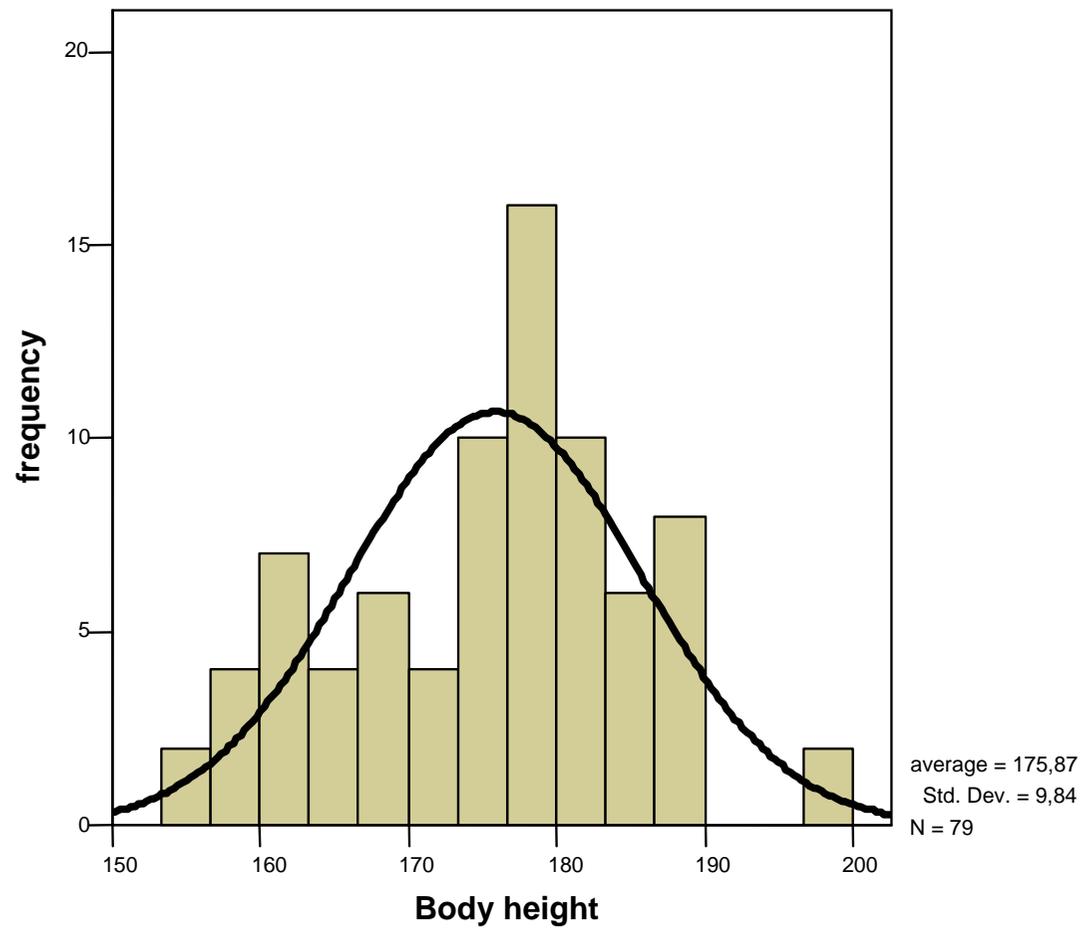
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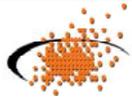
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# Backup



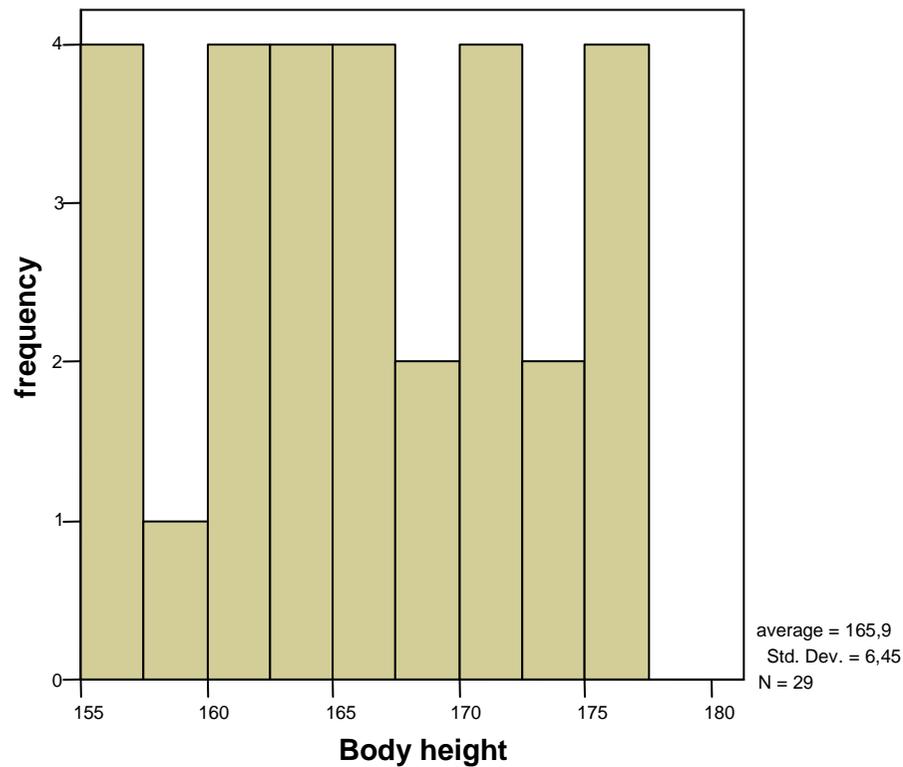
# Total distribution of body heights:





# Distribution of body height dependent to gender:

female



male

