Non-Ankle Lower Extremity Fractures [NALEF] in Frontal Crashes: Bio-Mechanical Interactions of Driver Height, Vehicle Type, Seatbelt Use and Crash Delta-V

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PURPOSE

To determine the role of occupant and vehicle characteristics on Non-Ankle Lower Extremity Fractures (NALEF). We excluded ankle fractures from the analysis. Ankle fractures have been addressed heavily in many studies and the mechanism of injury has been well established.

The independent variables tested are:

1) Driver height
2) Vehicle type
3) Seatbelt use
4) Crash Delta-V (Change in velocity)

METHODS

Retrospective analysis of:

1. Crash Injury Research and Engineering Network (236 cases)

2. National Automotive Sampling System (823 cases)

METHODS

Inclusion Criteria:

- Drivers aged ≥ 16 years
- Frontal vehicle crash (PDOF 11 to 1 O'clock)
- Injuries with Abbreviated Injury Scale (AIS)* of ≥ 2
- Vehicle model year 1996 to 2004
- Vehicle type: Passenger Cars
  Sports Utility Vehicles (SUV)/Light Trucks

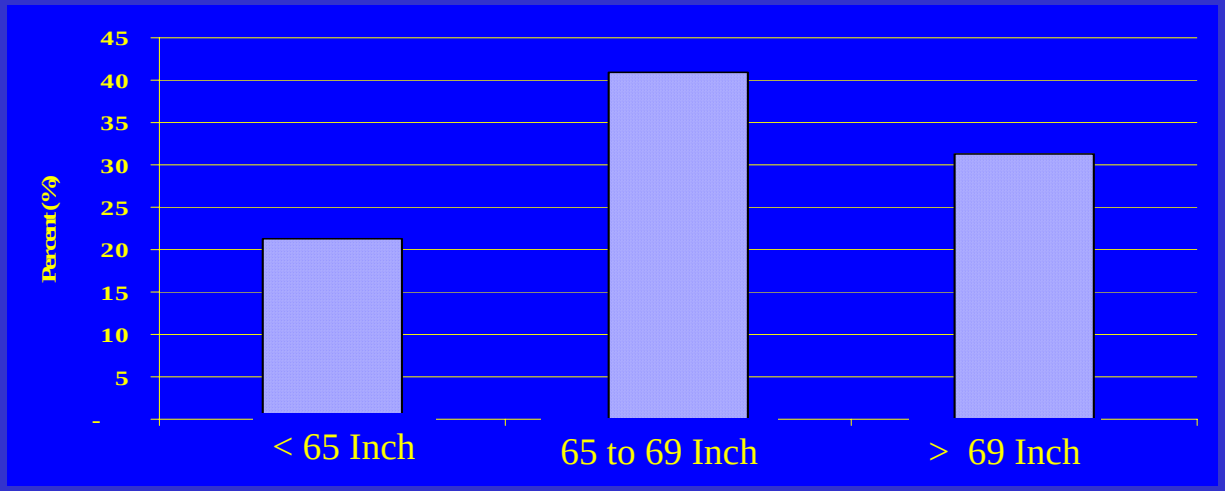
Exclusion Criteria

Rollovers, fires, ejection, more than one impact and injuries with unknown AIS

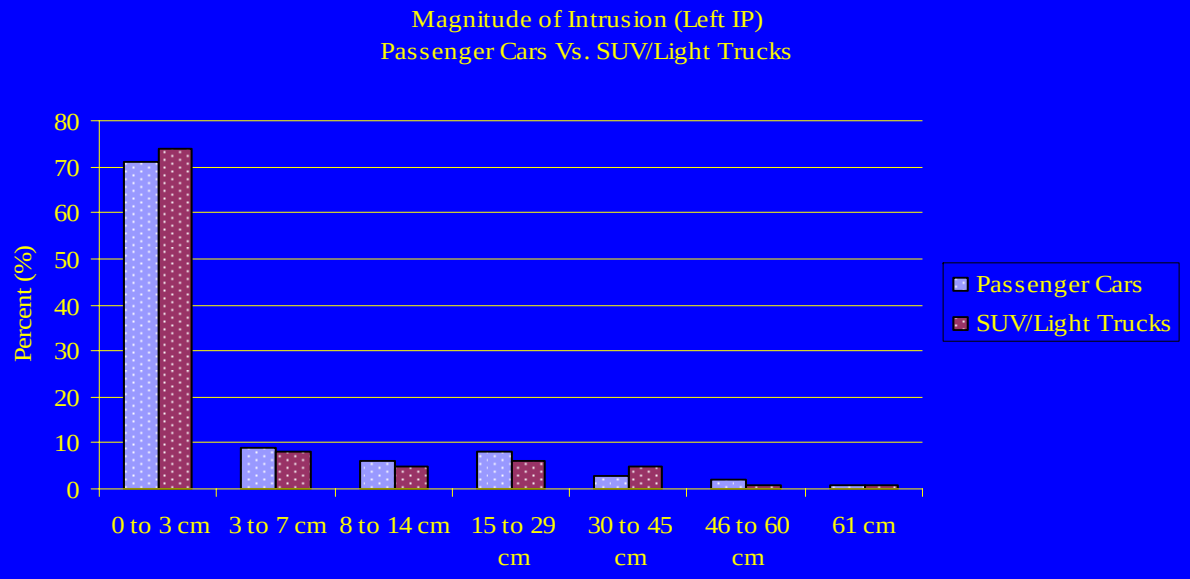
In this study, Driver Heights were grouped according to the 5th, 50th and 95th Hybrid III dummies

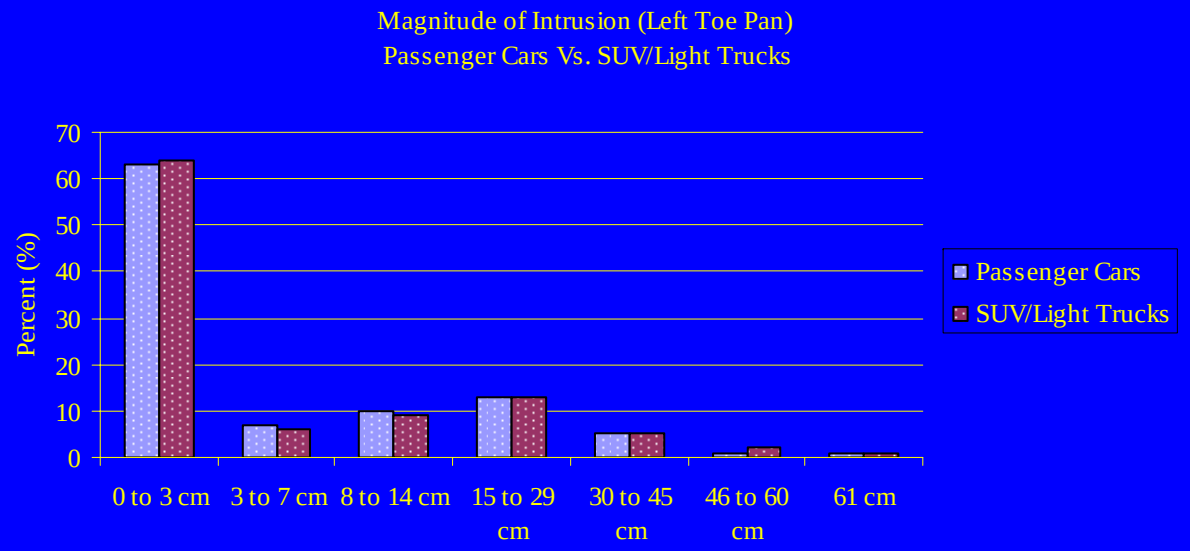
Dummy Height	cm	inch
Hybrid III 5th percentile female	152	59.8
Hybrid III 50th percentile male dummy	168	66.1
Hybrid III 95th percentile	188	74

Height Distribution for Cases Included in the Study



INTRUSION





There was no significant difference in the magnitude of intrusion of left instrument panel (IP) & left toe pan between passenger cars & SUV/Light Trucks.

Passenger Cars
vs.
SUV/Light Trucks

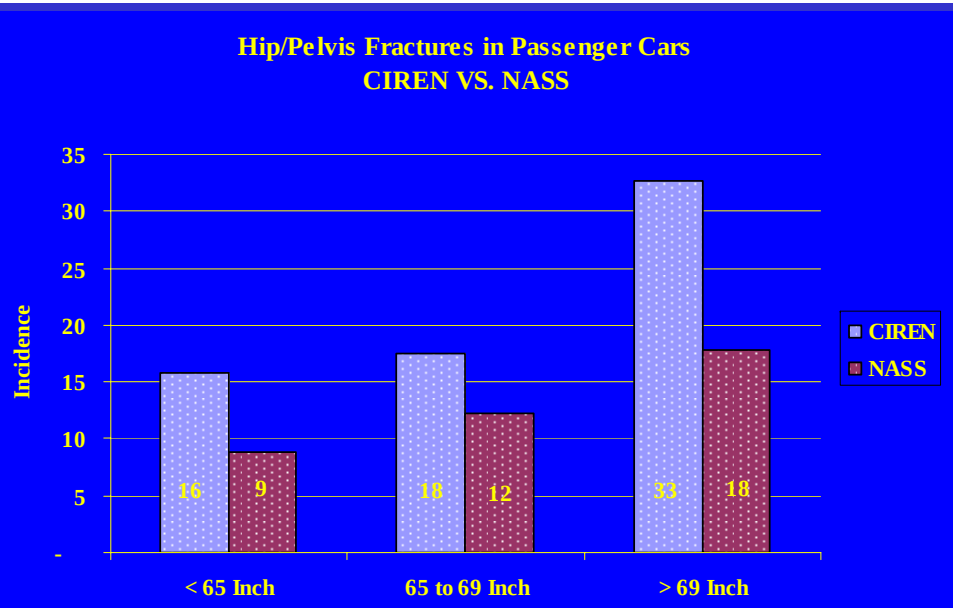
Intruded Part	Odds Ratio	P-Value
Left IP*/KB^	1.15	0.32
Left Toe Pan	1.01	0.99

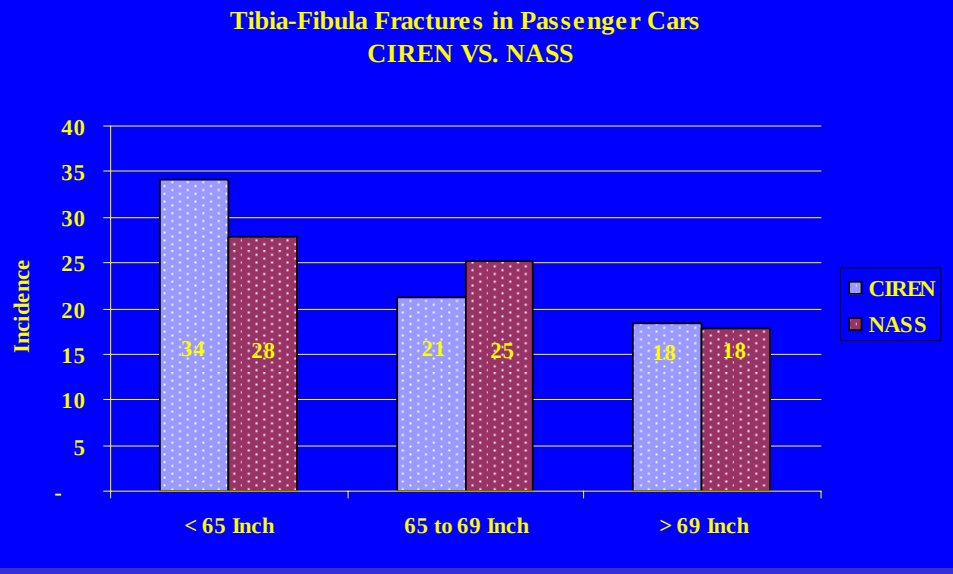
Body Mass Index (BMI)

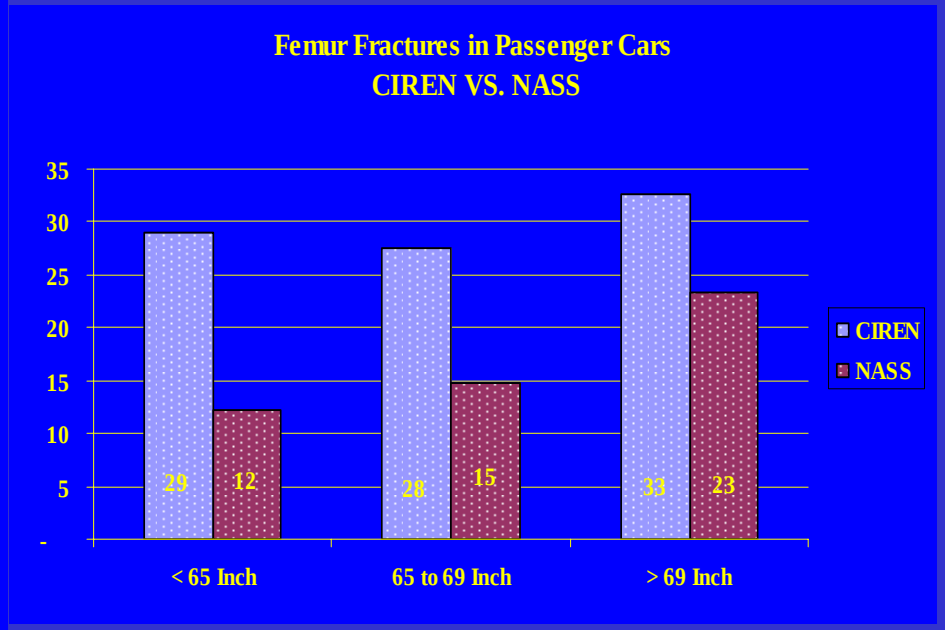
- We examined the relationship between BMI and different NALEF injuries.

- The results did not show any significant relationships between NALEF and BMI.

Comparing to NASS





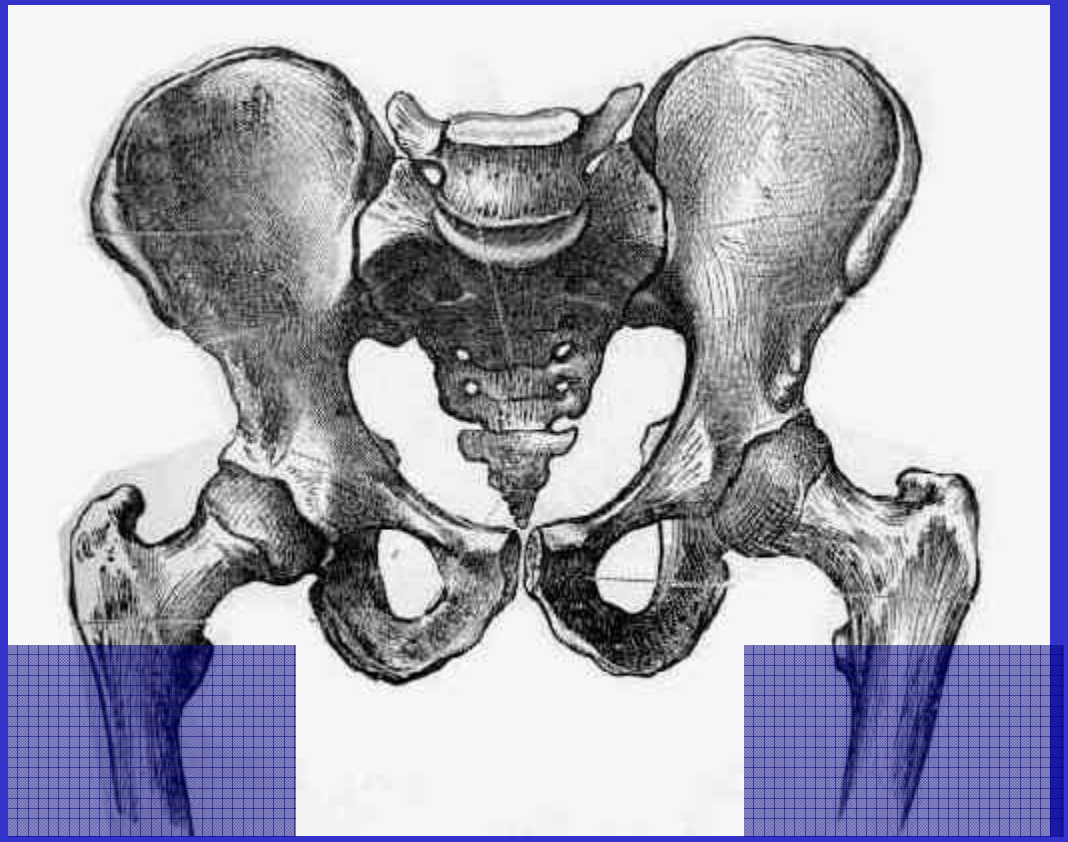


Rationale for Combining NASS & CIREN Data

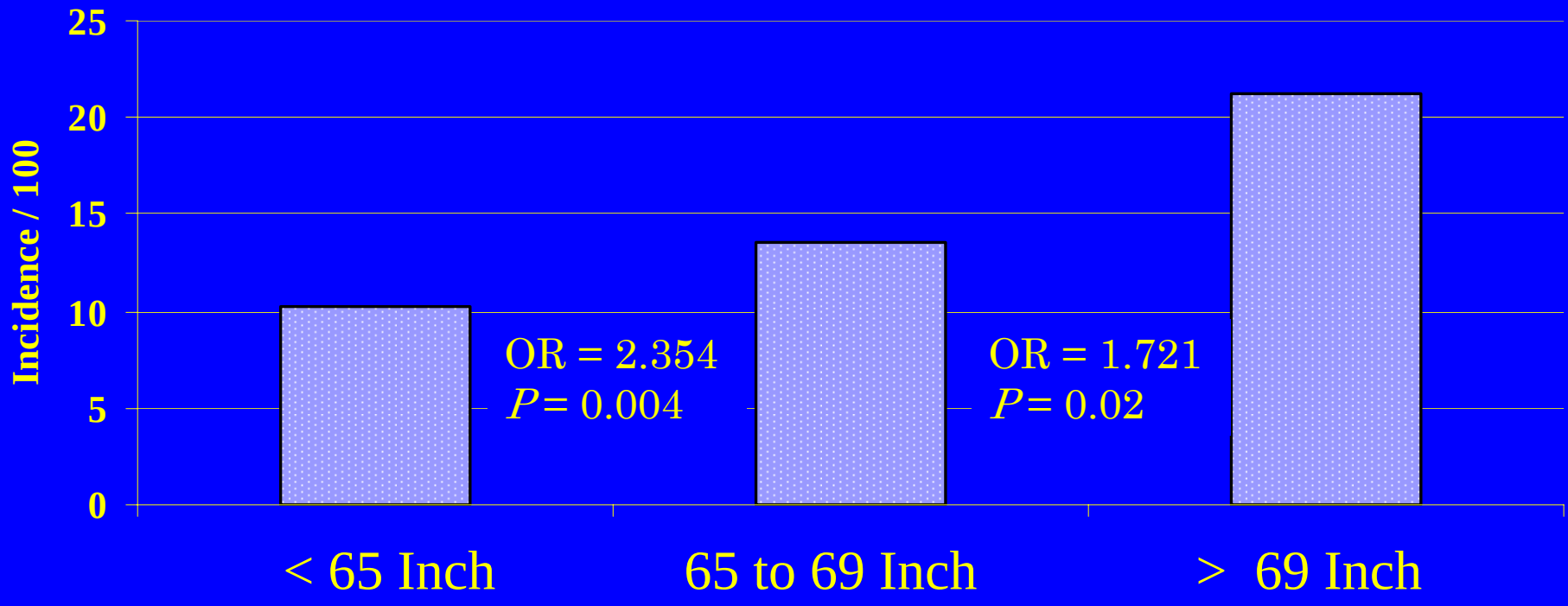
It is a prerequisite of a well-designed study to have a clear statement for data quantity, quality and reliability to increase the power of the study results. Power is the likelihood that a study will detect a true difference of a given magnitude between groups if it actually exists (i.e., a true positive).

Power is a function of study sample size. The concept of power is extremely important because the lack of it (i.e., the study size is too small) can lead to statistical insignificance in the presence of actual difference (false negative).

Hip/Pelvis

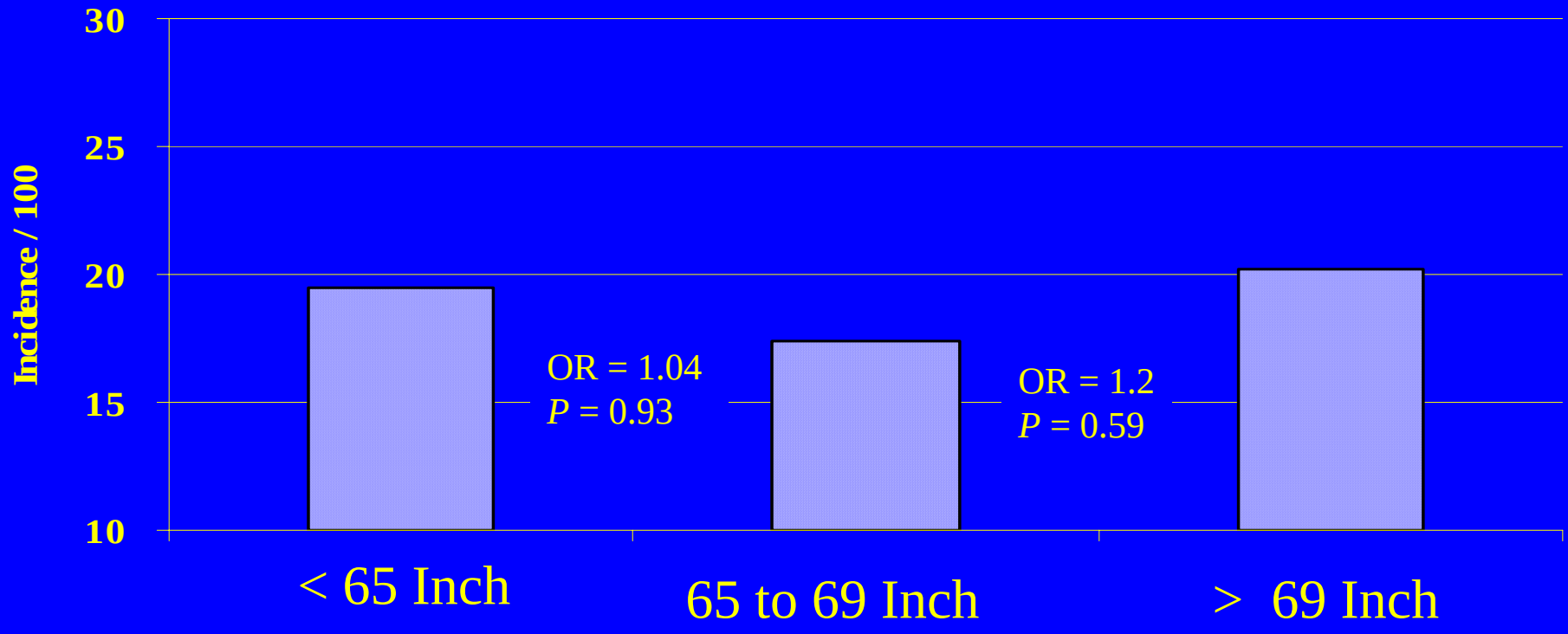


Hip/Pelvis Fractures in Passenger Cars by Driver Height

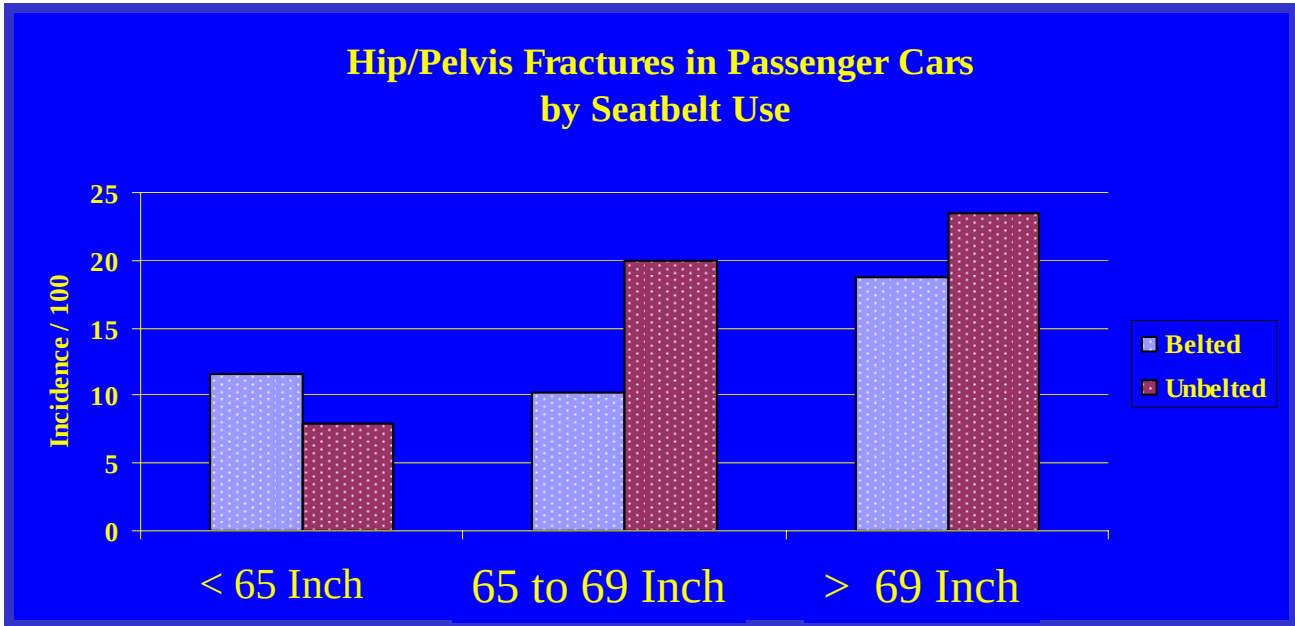


In passenger vehicles, there is a significant positive relationship between driver height and risk of hip/pelvis injuries

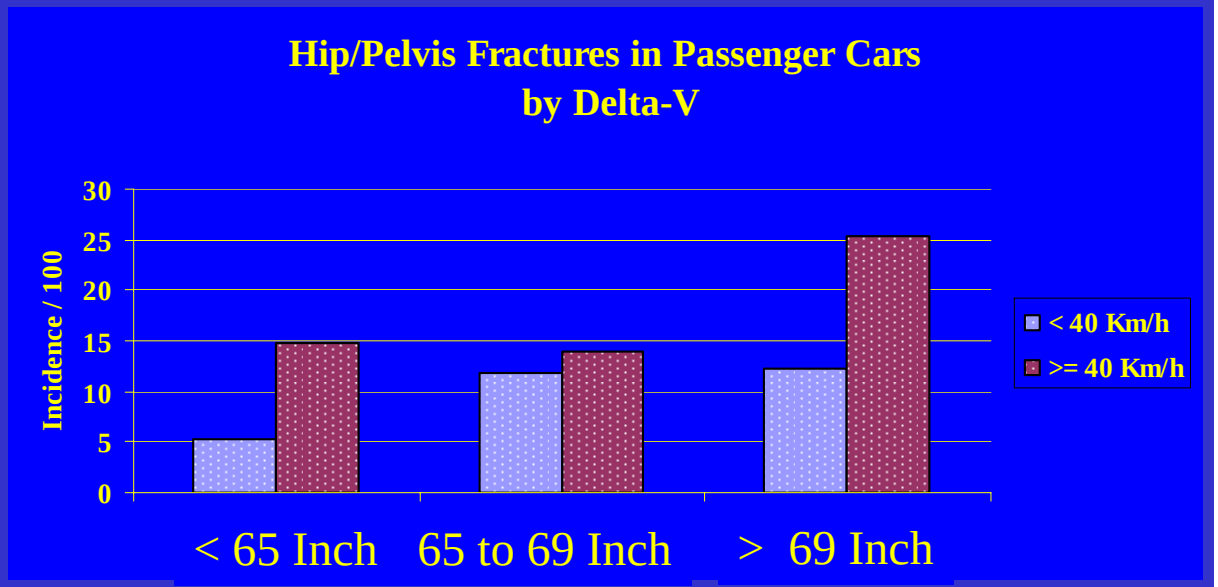
Hip/Pelvis Fractures in SUV/Light Trucks by Driver Height



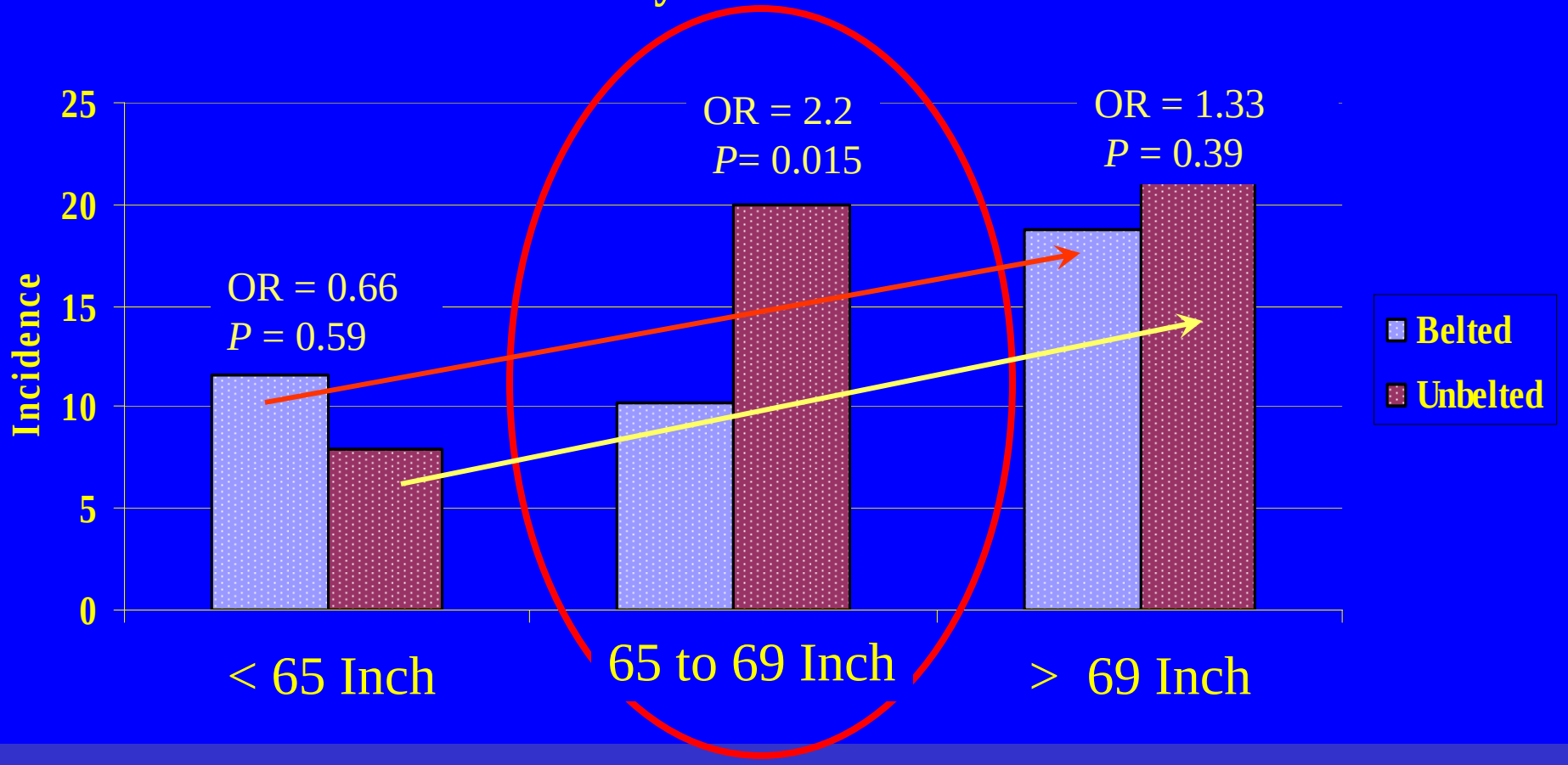
In SUV/Light Trucks, there is not a specific pattern of relationship between driver height and risk of hip/pelvis injuries



In passenger cars, after adding seatbelt use and crash Delta-V as possible confounders, the positive relationship between driver height and risk of hip/pelvis injury did not change

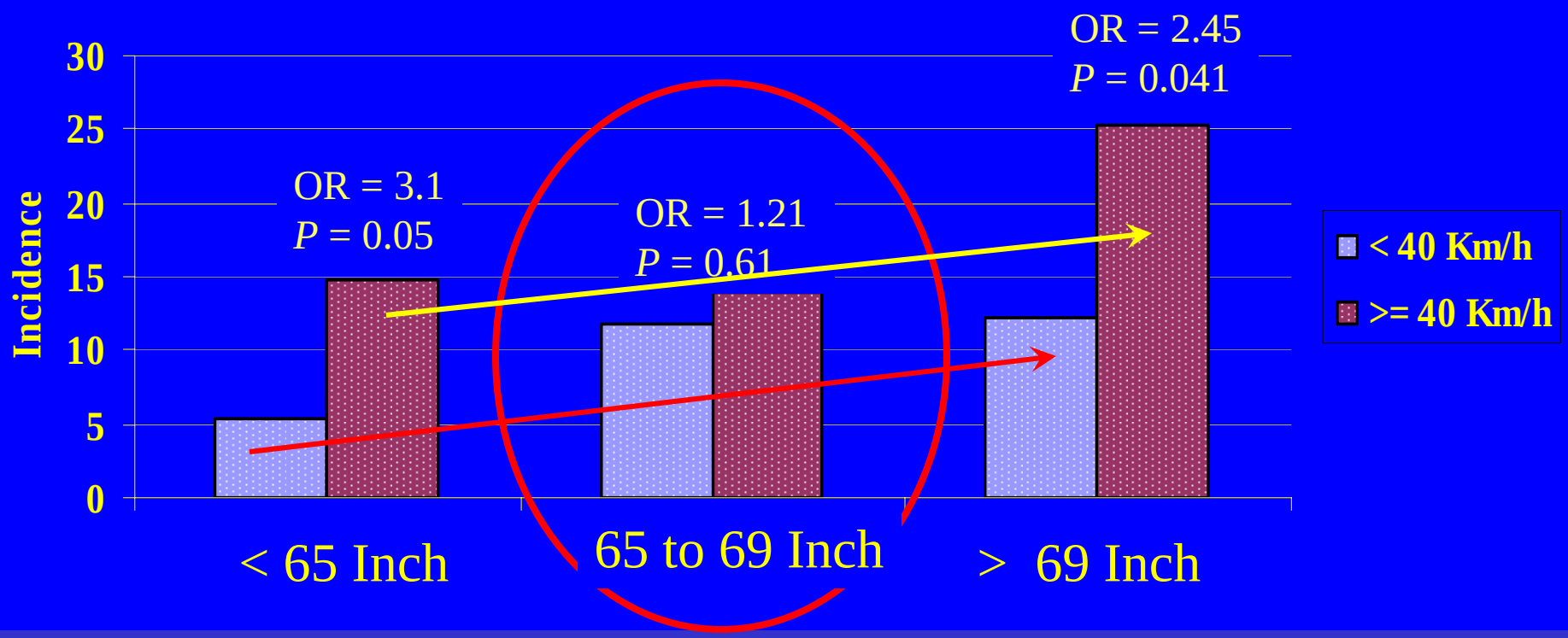


Hip/Pelvis Fractures in Passenger Cars by Seatbelt Use



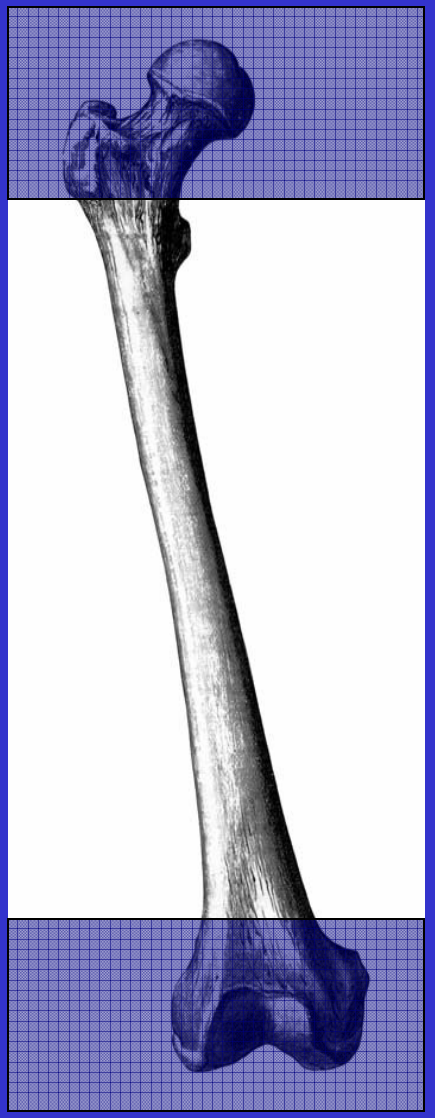
Seatbelt use provided significant protection to the medium height group

Hip/Pelvis Fractures in Passenger Cars by Delta-V

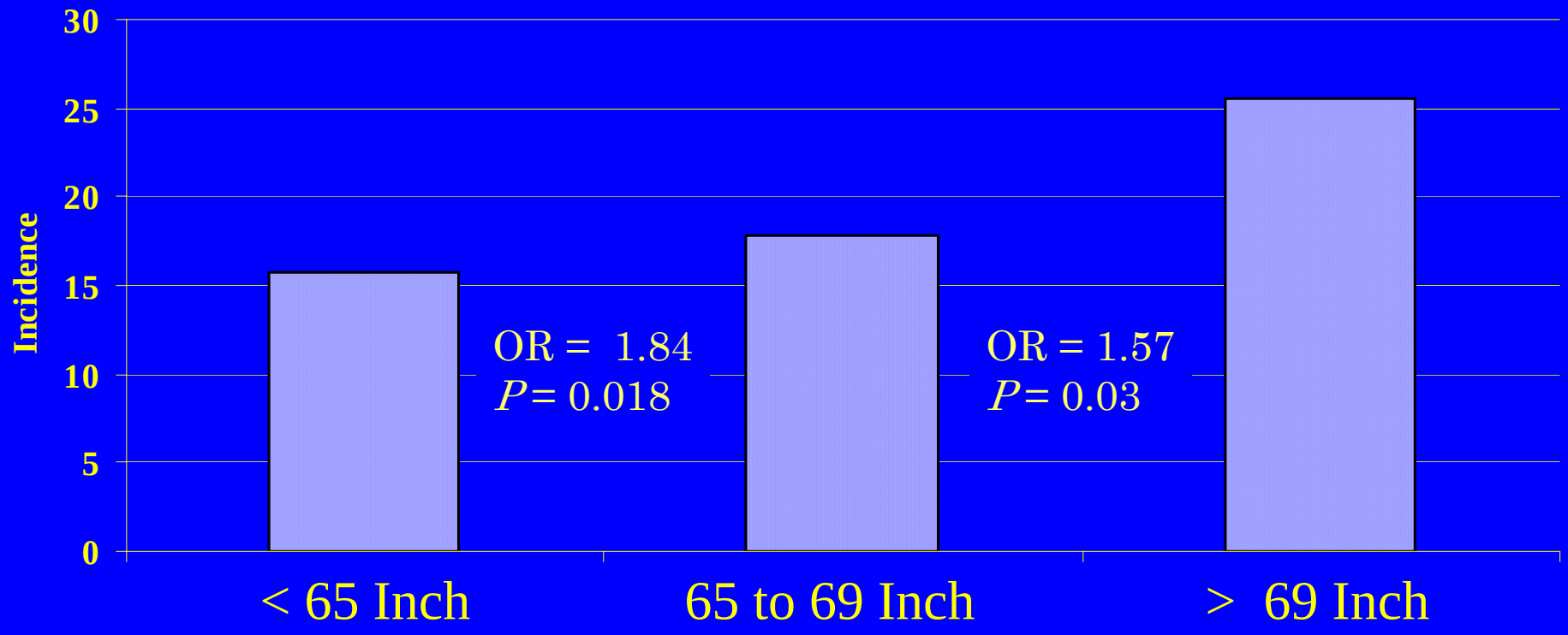


Medium height drivers had a lower risk of hip/pelvis injuries at lower and higher Delta-V

Femur

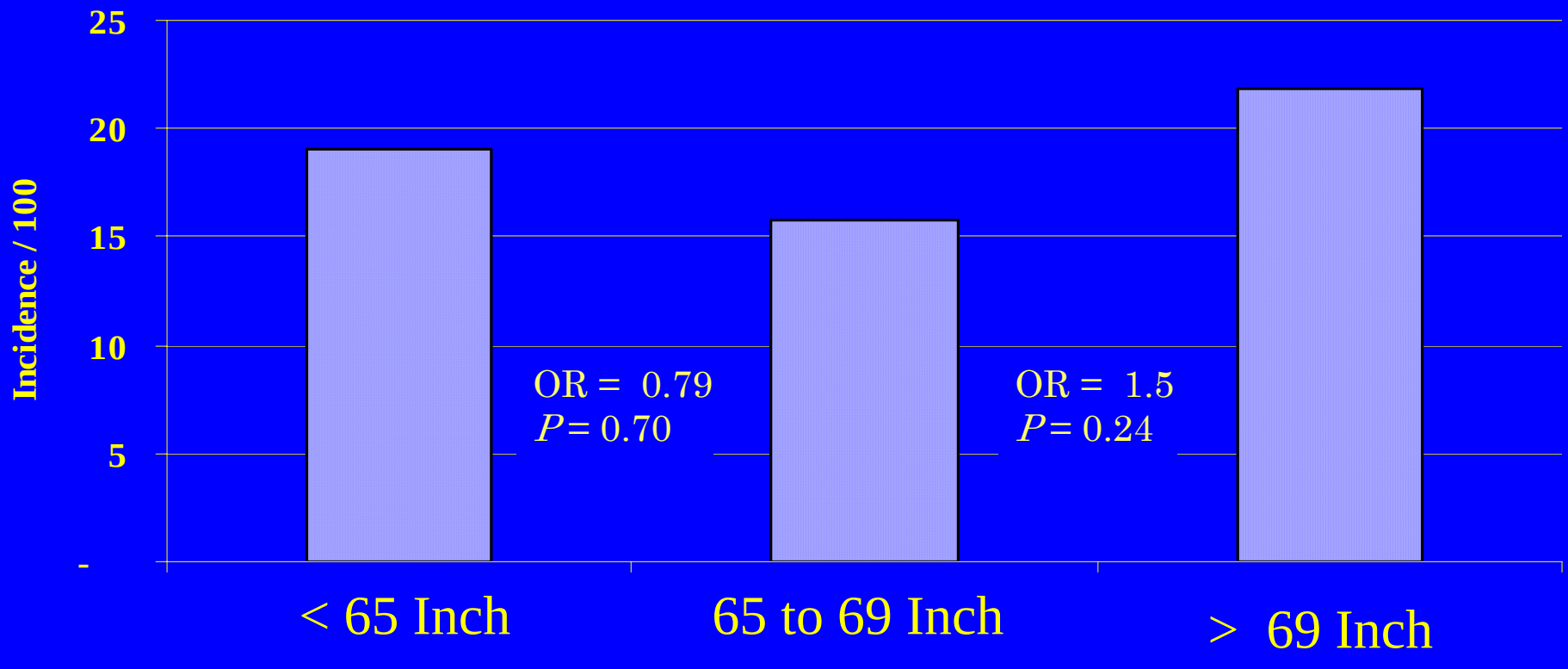


Femur Fractures in Passenger Cars By Driver Height

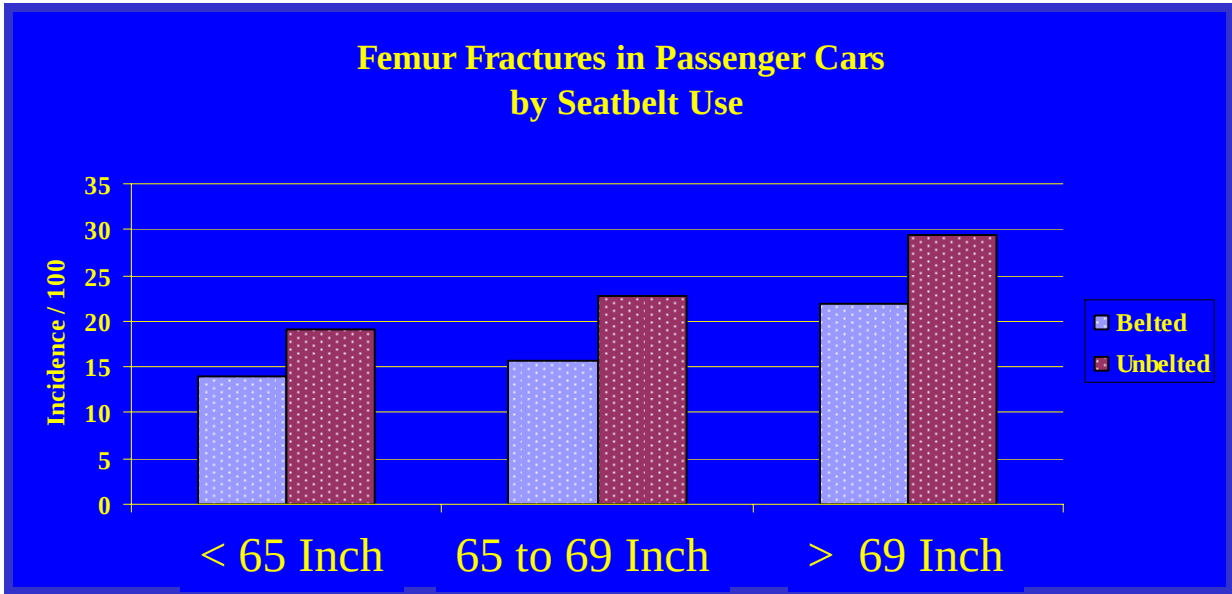


In passenger cars, there is a significant positive relationship between driver height and risk of femur fractures

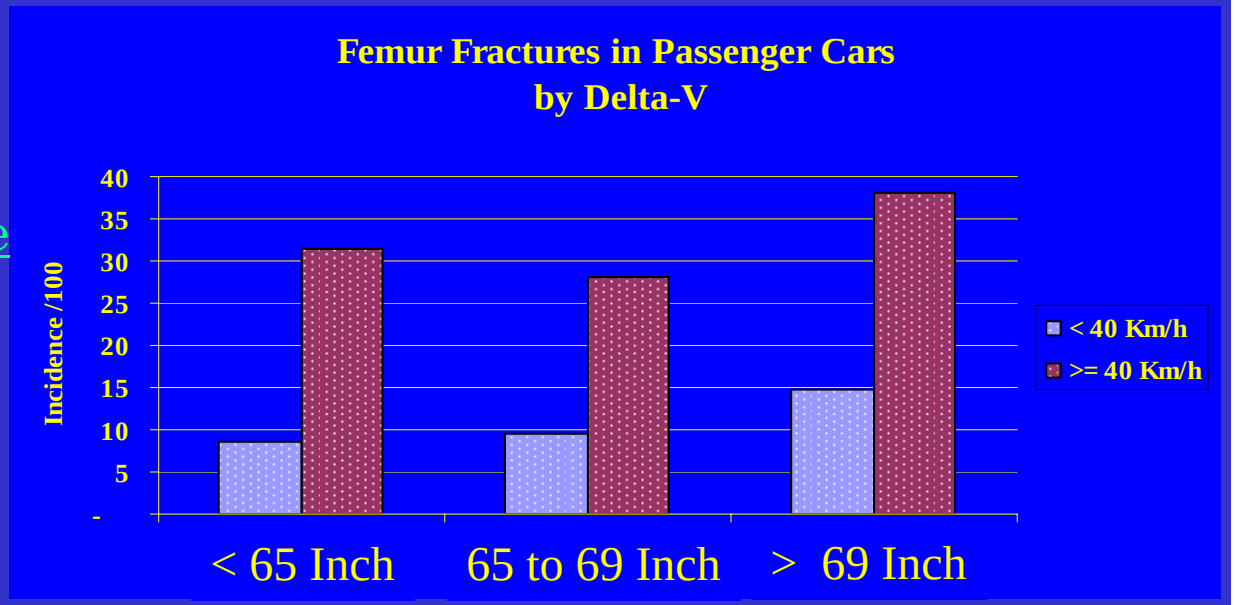
Femur Fractures in SUV/Light Trucks by Driver Height



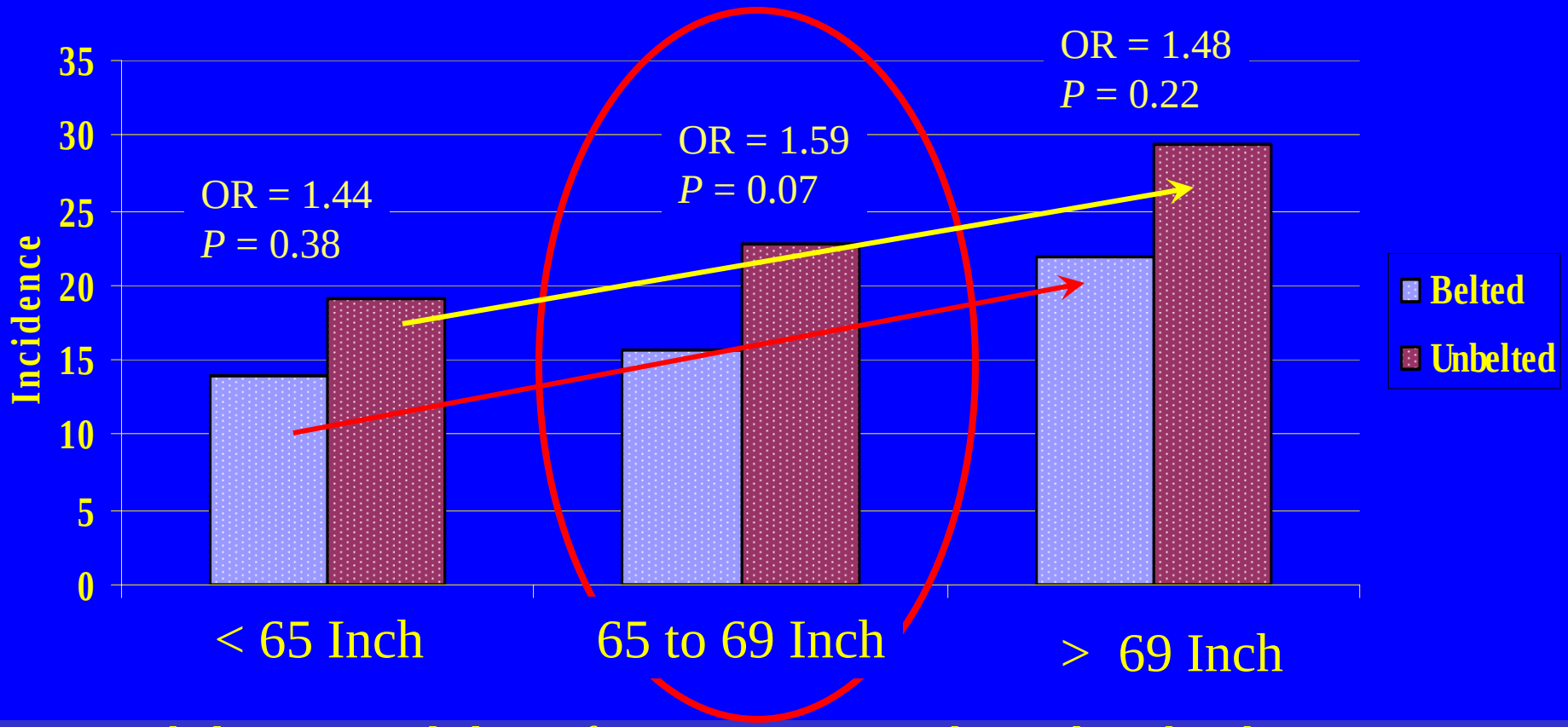
In SUV/Light Trucks, there is no specific pattern of relationship between driver height and risk of femur fractures



In passenger cars, after adding seatbelt use and crash Delta-V as possible con-founders, the positive relationship between driver height and risk of femur fracture did not change

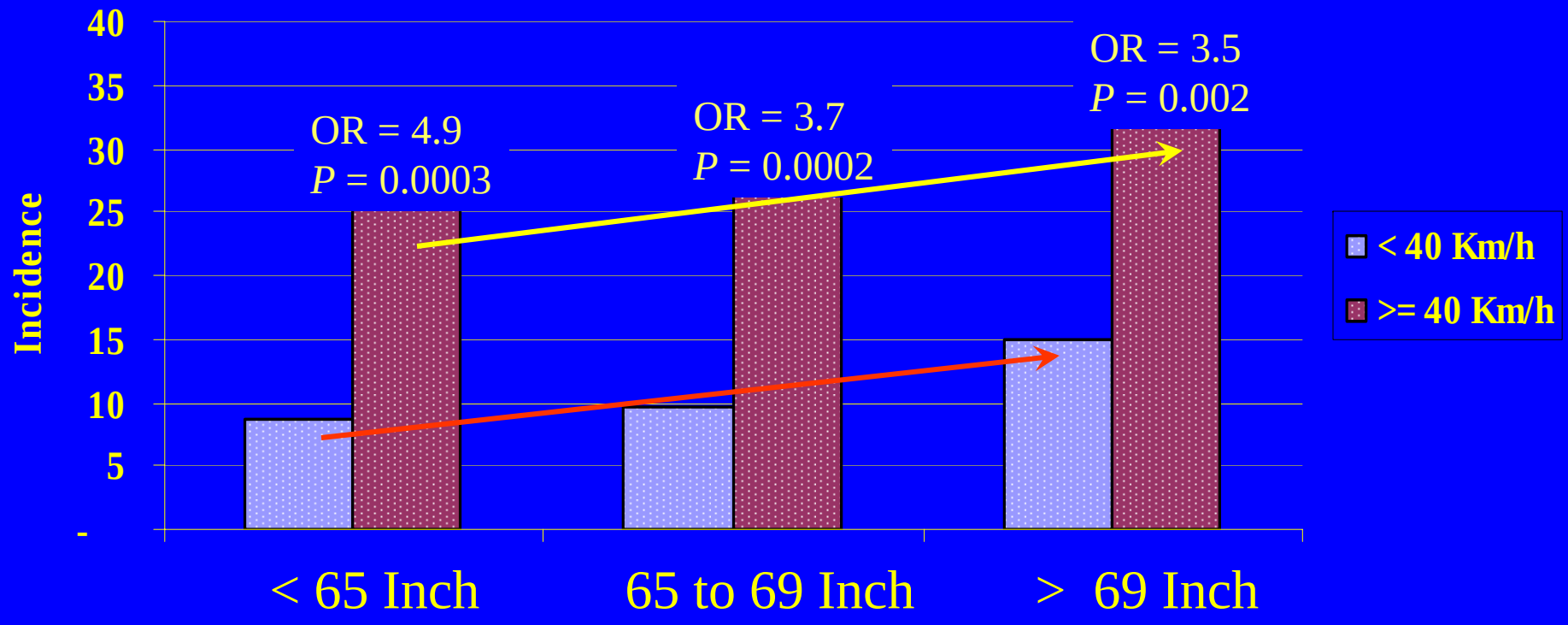


Femur Fractures in Passenger Cars by Seatbelt Use



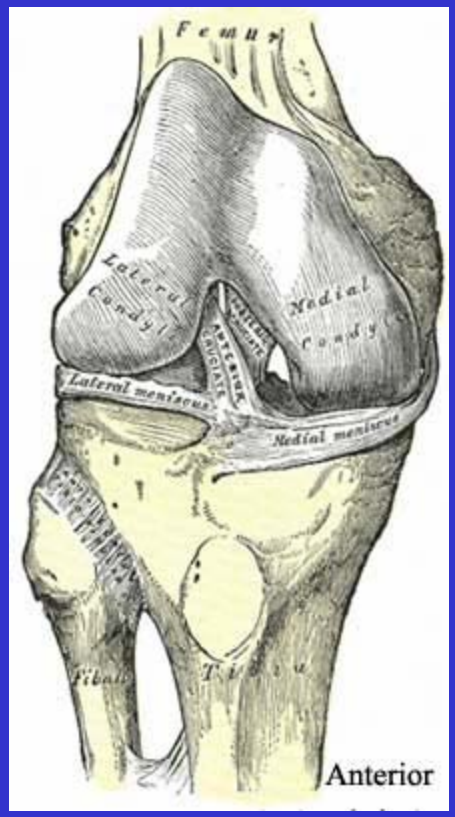
Seatbelt use provided significant protection to the medium height group

Femur Fractures in Passenger Cars by Delta-V

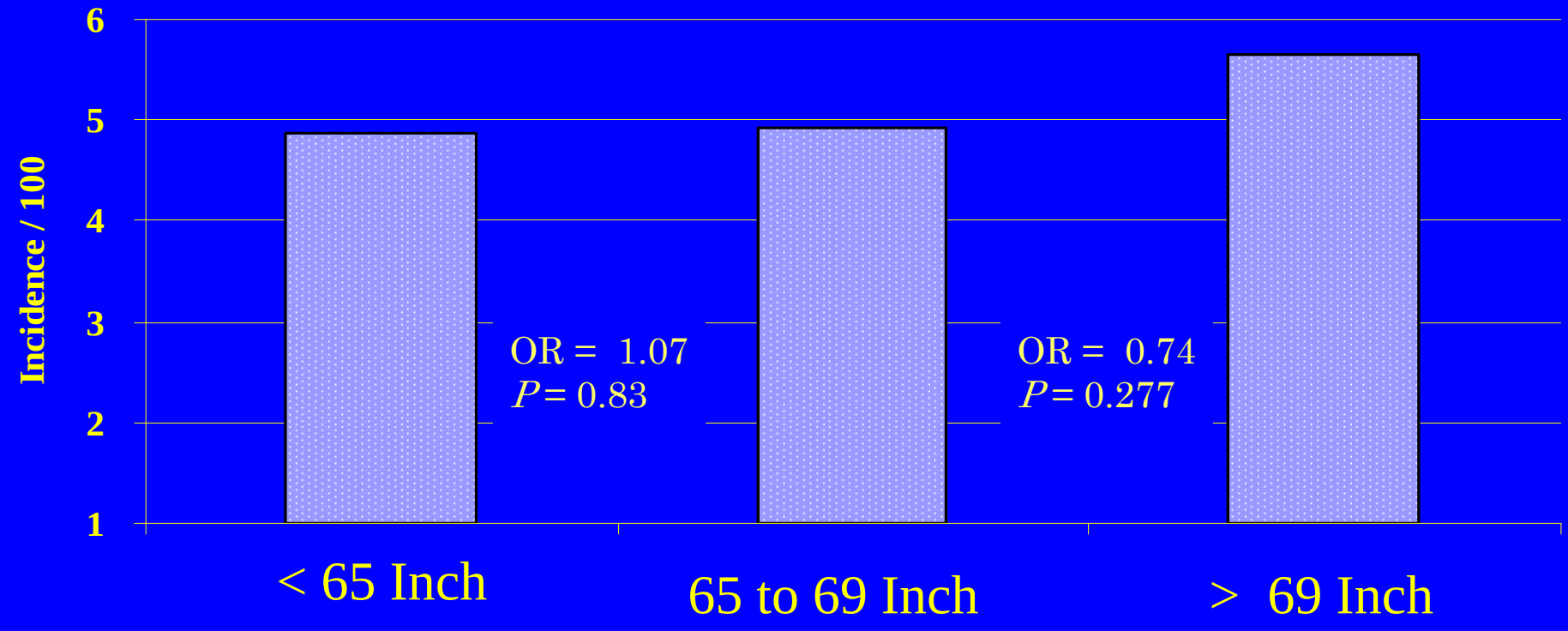


Delta-V increases the risk of femur fractures among the three height groups

Knee/Patella

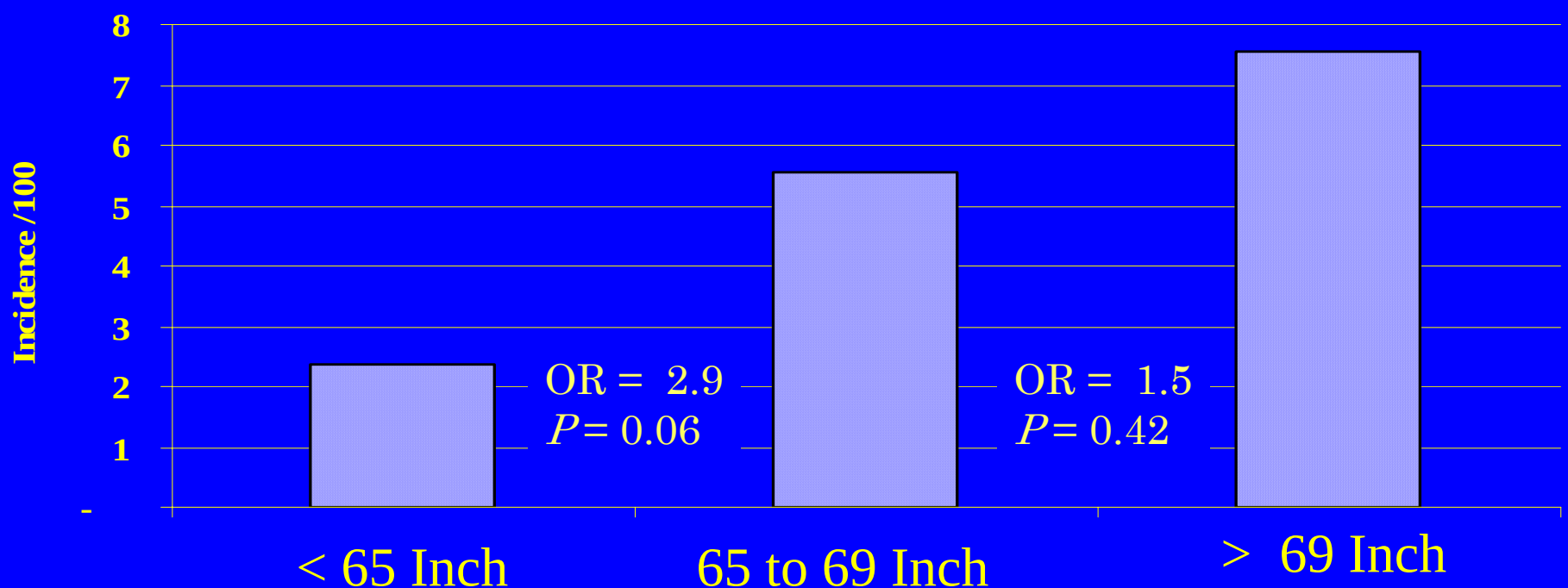


Knee/Patella Fractures in Passenger Cars by Driver Height



In passenger cars, there is not a specific pattern of relationship between driver height and risk of knee/patella injuries

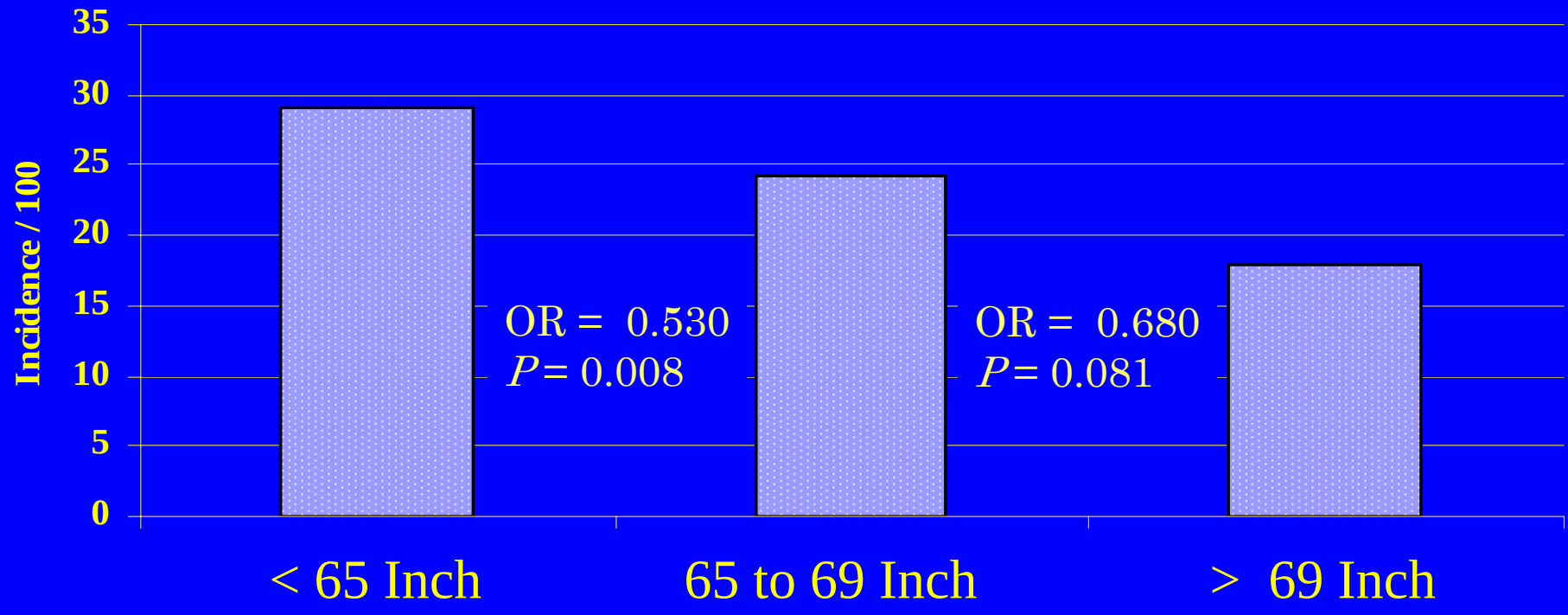
Knee/Patella Fractures in SUV/Light Trucks by Driver Height



In SUV/Light Trucks, shorter drivers had a the significantly lower risk. Overall, there was no statistically significant pattern of relationship between driver height and risk of knee /patella injury

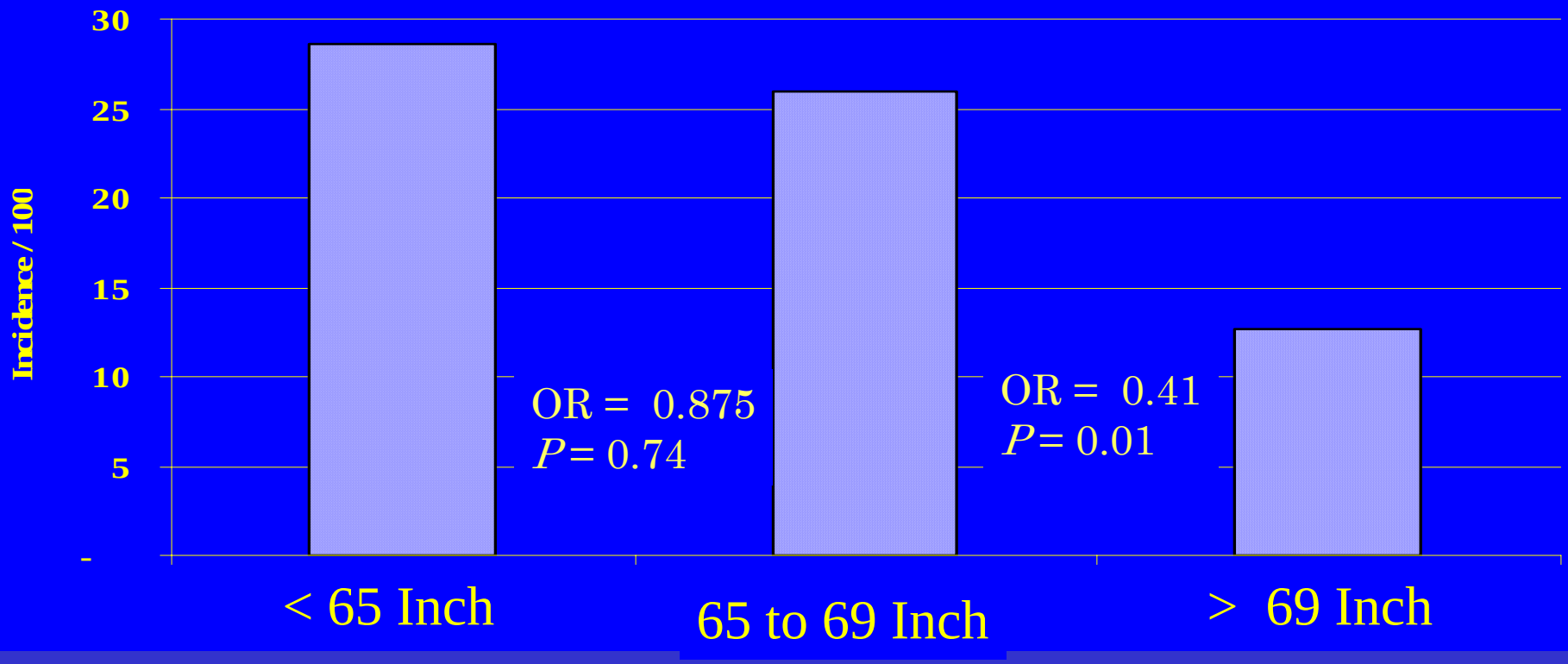
Tibia / Fibula

Tibia/Fibula Fractures in Passenger Cars by Driver Height

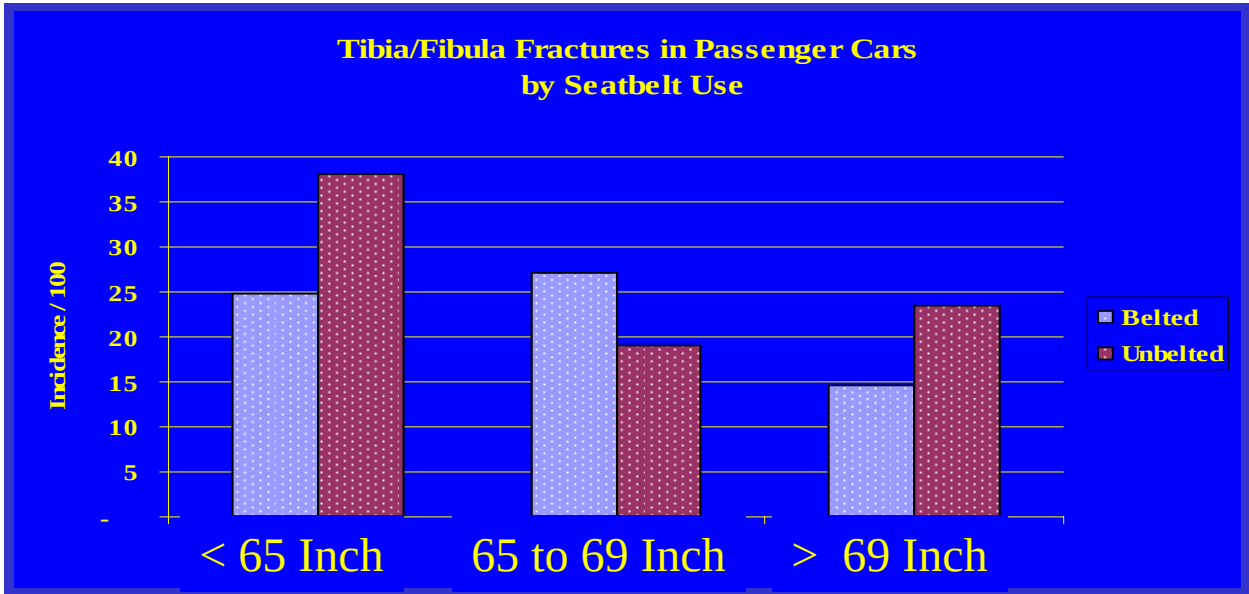


In passenger cars, there is a negative relationship between driver height and risk of tibia/fibula fractures

Tibia/Fibula Fractures in SUV/Light Trucks by Driver Height

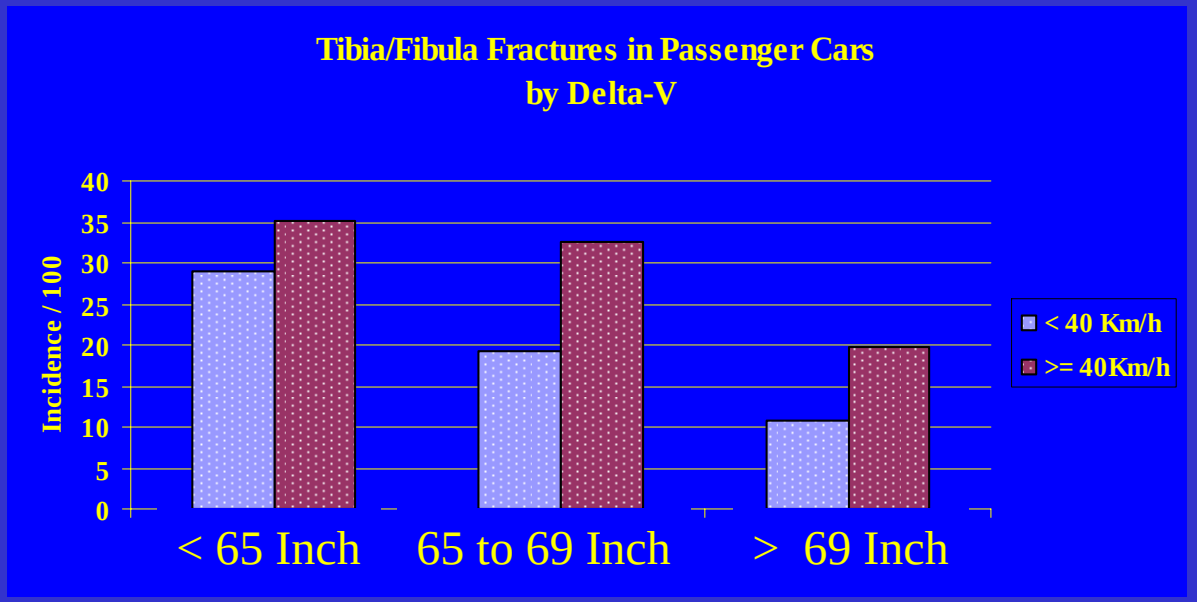


In SUV/Light Trucks, taller drivers had a significantly lower risk. Overall, there was no statistically significant pattern of relationship between driver height and risk of tibia/fibula fractures

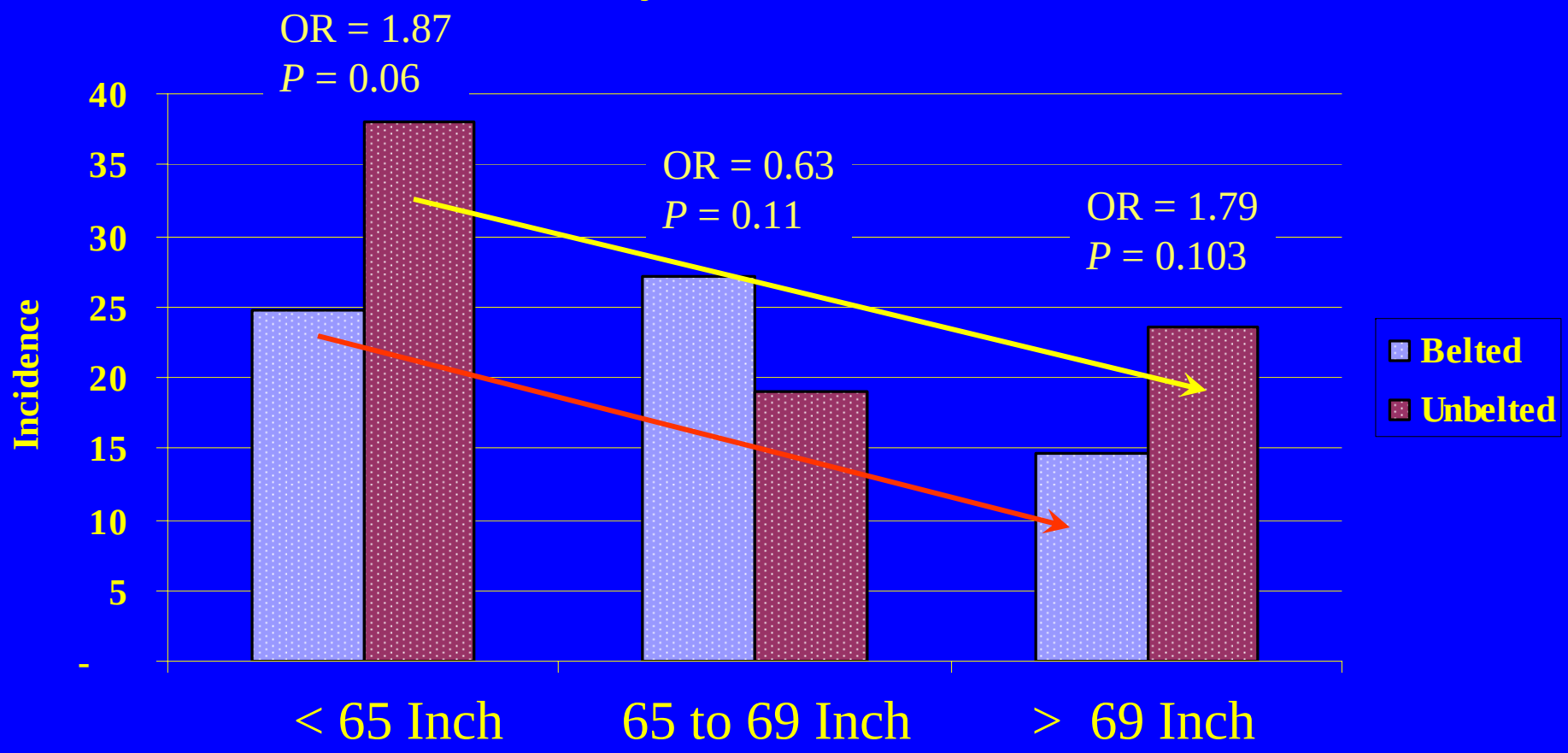


In passenger cars, after adding seatbelt as possible confounder, the negative relationship between driver height and risk of tibia/fibula fracture, did not change

In passenger cars, after adding seatbelt as possible confounder, taller drivers remained at a lower risk of tibia/fibula fracture compared to the other two groups.

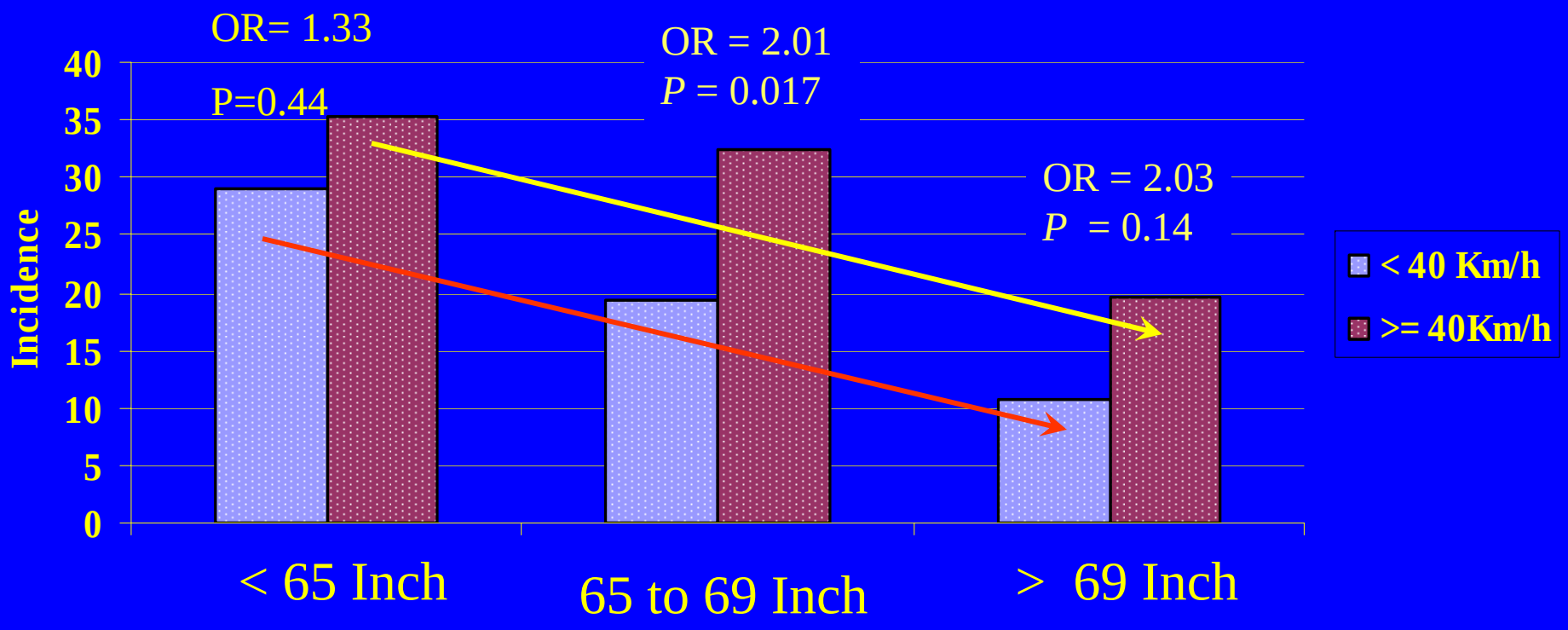


Tibia/Fibula Fractures in Passenger Cars by Seatbelt Use



Seatbelt use provided significant protection to short drivers

Tibia/Fibula Fractures in Passenger Cars by Delta-V

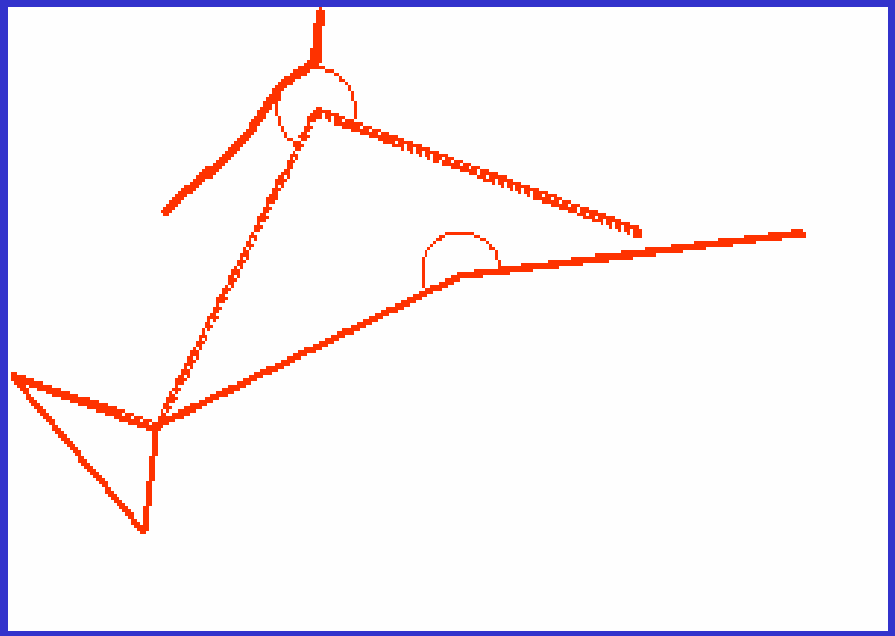


Delta-V increases the risk of tibia/fibula fractures among the three height groups

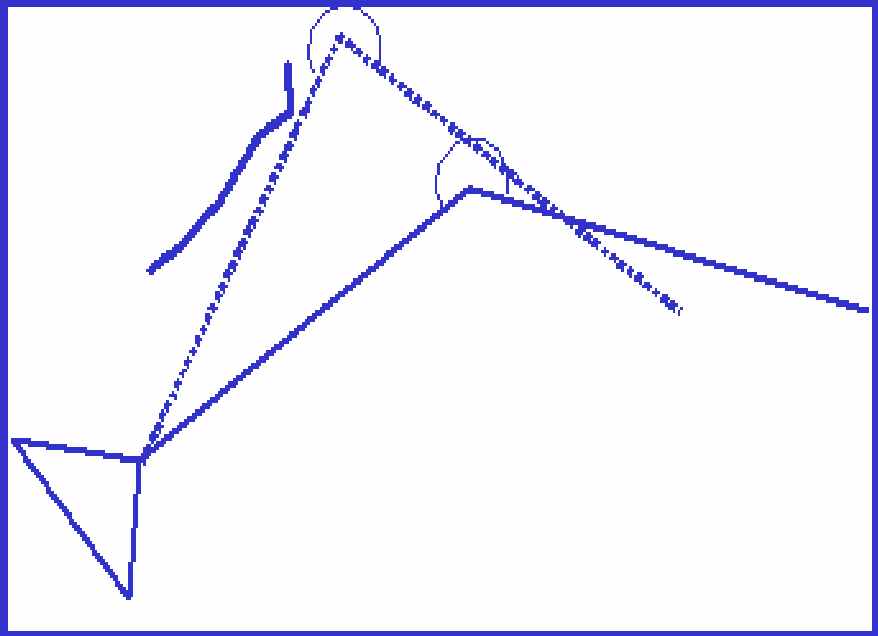
POSSIBLE REASONS FOR:

- Increased Risk of Below Knee Injuries for Shorter Drivers
- Increased Risk of Above Knee Injuries for Taller Drivers

5th Female



95th Male



Based on Crash Research Conducted by the University of Virginia (UVA)

CONCLUSIONS

- Driver height plays a significant role in the incidence of specific NALEF injury type:
  - Taller Drivers sustain more above knee NALEF injuries
  - Shorter Drivers sustain more below knee NALEF injuries

  "A trade-off pattern"
- Crash Delta-V increases the risk of NALEF injury - the pattern of injury remains significantly influenced by driver height

CONCLUSIONS

- Seatbelt protection is significant for above knee NALEF injuries - the pattern of injury remains significantly influenced by driver height.

- Seatbelt protection varies according to driver height and NALEF part:
  - Drivers of medium height are offered more above knee protection by seat belt use compared to the other two groups
  - Shorter drivers offered more below knee protection by seat belt use compared to the other two groups

CONCLUSIONS

- CIREN and NASS data showed a consistent relationship between driver height and risk of NALEF injury
- Compared to NASS, CIREN offers unique information:
  - more detailed medical information (e.g. acetabulum fracture) which can be obtained using ICD-9 codes
  - mechanism of injury obtained from case summaries
  - in the near future, mechanism of injury will be available in CIREN via the Bio-tab
  - outcome of injury measured via SF-36 at 6 and 12 months in CIREN vs. NASS where outcome obtained through working days lost in first 60 days post-discharge

Questions?