Effectiveness of Rear Seat Safety Belt Use

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Background

- About 250,000 rear seat passengers are injured every year in the U.S.

- Safety belt usage is lower among adult rear seat passengers than among front occupants.
  - Rear seat: 47%; front seat: 80% (nationwide in 2004)

- Estimates of rear seat belt effectiveness are sparse.
  - Three previous studies: 18-73%
  - Is the center rear seat safest position for adults ?
  - Estimate effectiveness separately for light trucks, vans and utility vehicles (LTV) and passenger cars.

Objective

- To estimate the effectiveness of safety belts for preventing fatalities among rear seat adult passengers.

- To examine if the effectiveness varies by vehicle body type, seating position, age, and vehicle rollover status.

Matched Cohort Design I

- Matched cohort design uses naturally matched pairs in the same vehicle. e.g. driver and passenger.
- The relative risk can be estimated without using information from vehicles in which all occupants survived.
- Information is not routinely collected from vehicles in which all occupants survived.
- Matching on crash and vehicle characteristics to control confounding
- Control selection bias

Matched Cohort Design II

Driver	Passenger		Total
	Died	Lived	
Died	(A) 80	(B) 720	800
Lived	(C) 920	(D) 8,280	9,200
Total	1,000	9,000	10,000

* Cell counts are for pairs, not individuals.

Relative risk = [(A+B)/(A+B+C+D)] /

[(A+C)/(A+B+C+D)]

= (A+B)/(A+C)

= 0.8

D cell is not needed.

Potential Selection Bias
in Ordinary Cohort Design

	Occupants in all crashes	Occupants in fatal crashes	Deaths
Belted	X	X'	A
Unbelted	Y	Y'	B

Risk ratio = (A/X) / (B/Y)

Risk ratio' = (A/X') / (B/Y')

Data Source and Study Population

- 2000-2004 Fatality Analysis Reporting System (FARS)
- Vehicles:
  - At least one rear seat passenger aged 16 years or older
  - The driver or at least one rear seat passenger died
  - Passenger cars and LTVs with a second row of seats with model years 1975 through 2005

Variables

- Exposure: seat belt use: (yes or no)
- Outcome: fatality
- Confounding variables
  - Seating position, age, gender, airbag presence
- Effect modifying variables
  - Vehicle body type, vehicle rollover status, vehicle model year, calendar year

Statistical Analysis I

- Cox proportional hazards model
  - Assign the same time to death or censoring for all occupants
  - Breslow method to handle tied survival times
  - Stratify estimates on vehicle
  - Produce the same results as conditional Poisson regression
  - Estimate adjusted relative risk (aRR)
- Likelihood ratio test to evaluate interaction terms

Statistical Analysis II

- Final model
  - Safety belt use, seating position, age, gender, airbag presence
  - Interactions between safety belt use and seating position, safety belt use and age
  - A three-way interaction of safety belt use, seating position, and age
- Safety belt effectiveness: 1 - aRR

Results

- 12,071 passenger cars and LTVs
- Missing:
  - safety belt use (10%)
  - airbag presence (1%)
- 10,736 (89%) vehicles and 26,349 drivers and rear seat occupants for analysis.

Comparing Occupants with Complete Data to Those with Missing Data

Characteristics	Occupants with complete data	Occupants with missing data
Age (mean)	32.5	32.0
Male (%)	63%	67%
Rear seat (%)	60%	56%
Fatalities (%)	49%	52%

Characteristics of Study Population

Characteristics	Rear seat, outboard n=13,585 (52%)	Rear seat, center n=2,337 (9%)	Driver n=10,427 (40%)
Passenger cars	66%	53%	66%
Safety belt use	29%	15%	57%
Male	59%	52%	71%
Age: 16-19	32%	37%	24%
20-34	37%	37%	42%
35-64	20%	20%	27%
65+	11%	6%	8%
Airbag present	0%	0%	62%
Rollover	42%	54%	41%
Fatalities	49%	44%	49%

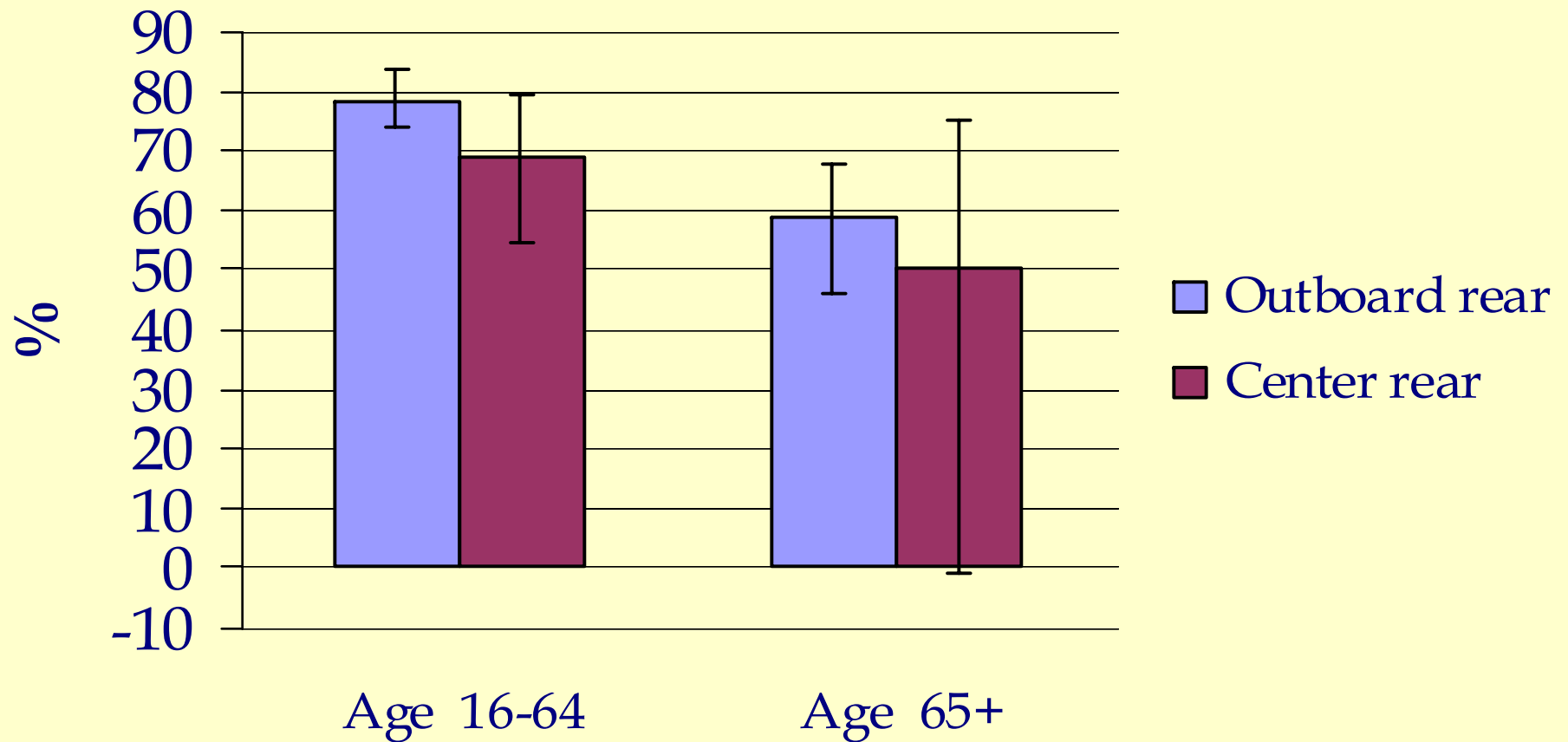# Estimates of Rear Seat Belt Effectiveness
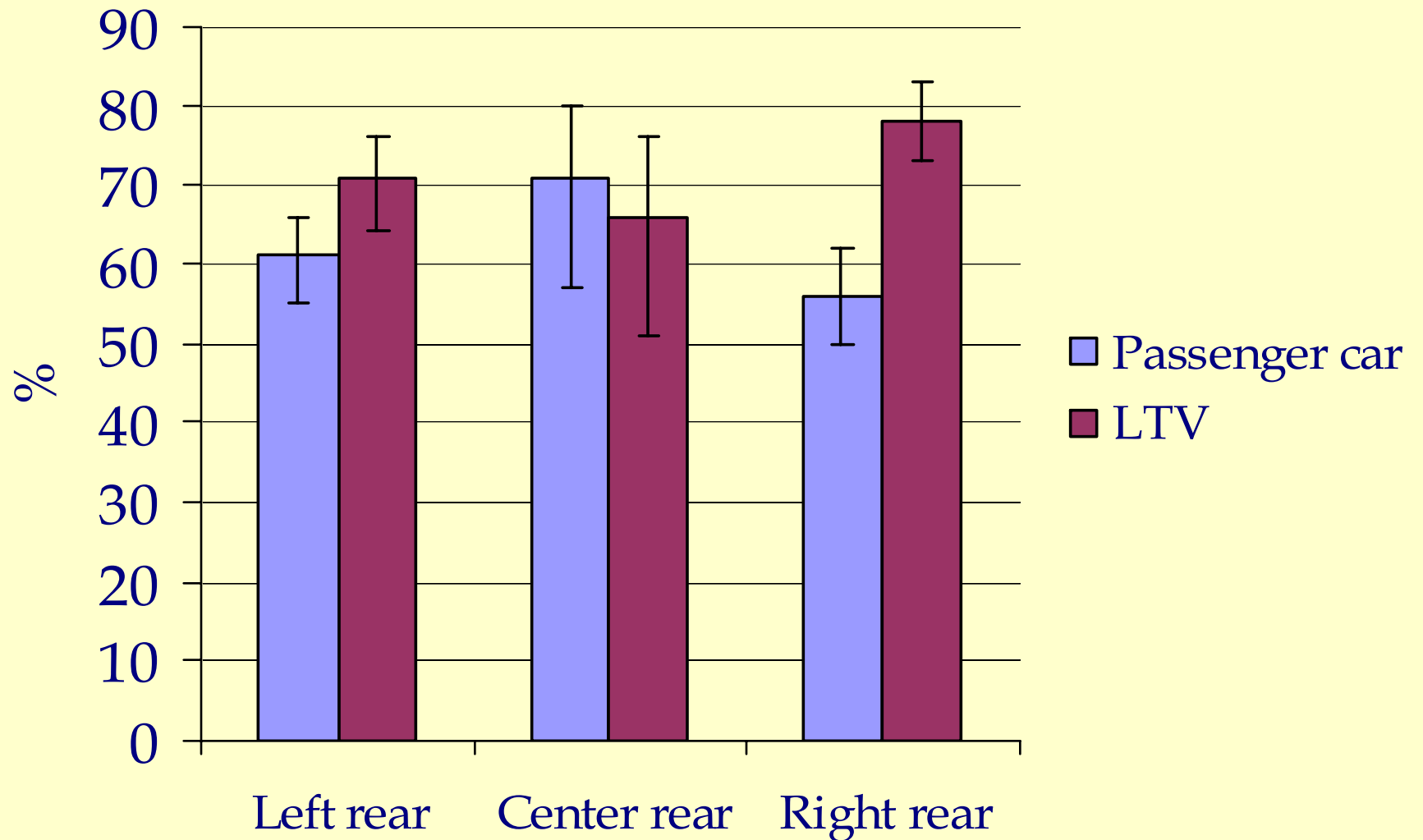
* The error bar indicates 95% confidence interval.

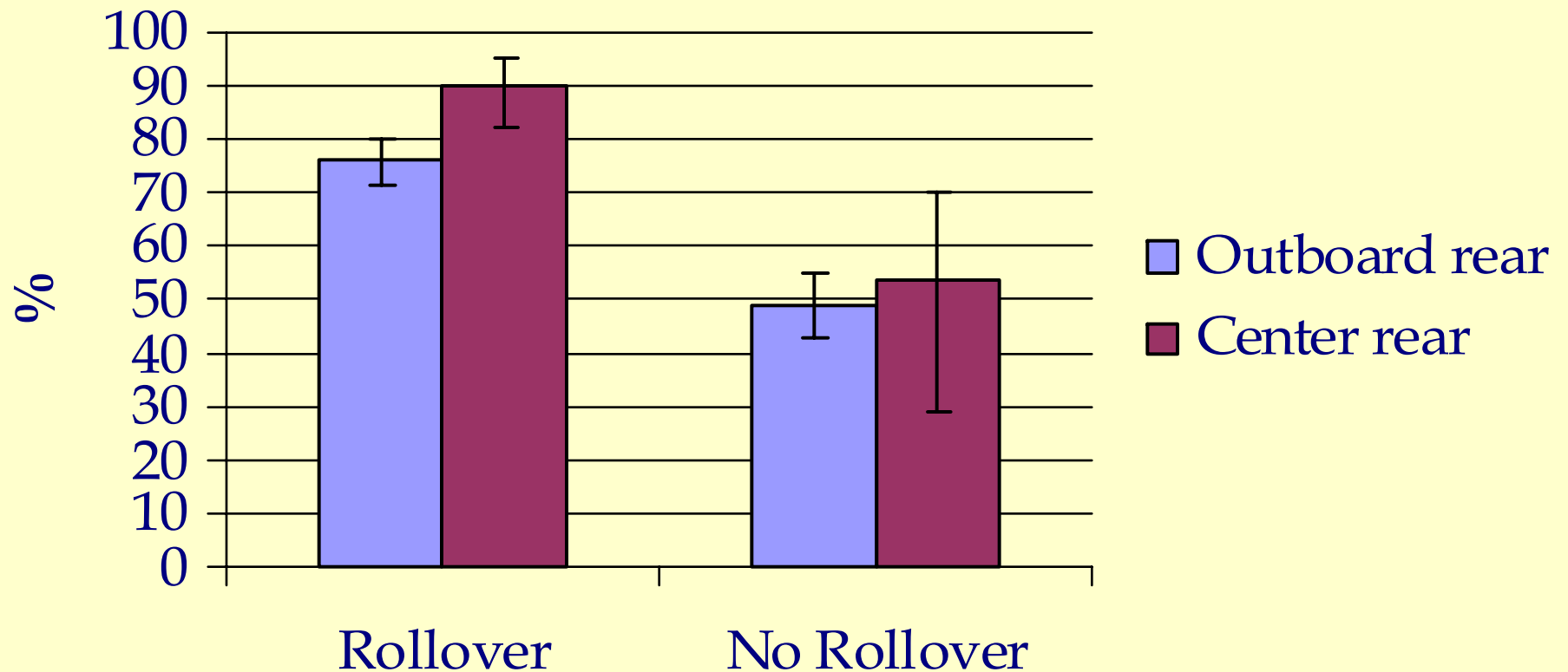# Estimates of Rear Seat Belt Effectiveness by Age for Passenger Cars
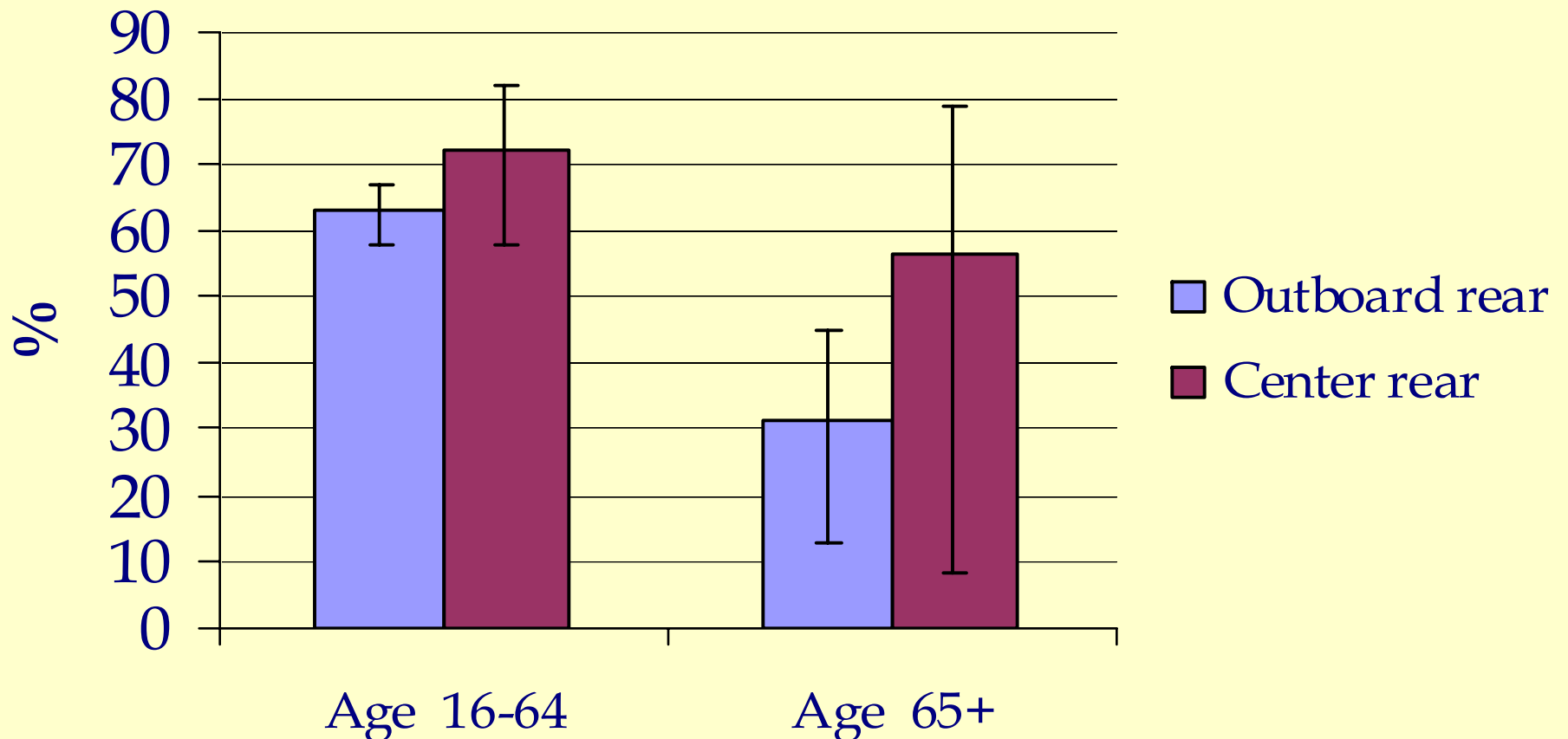
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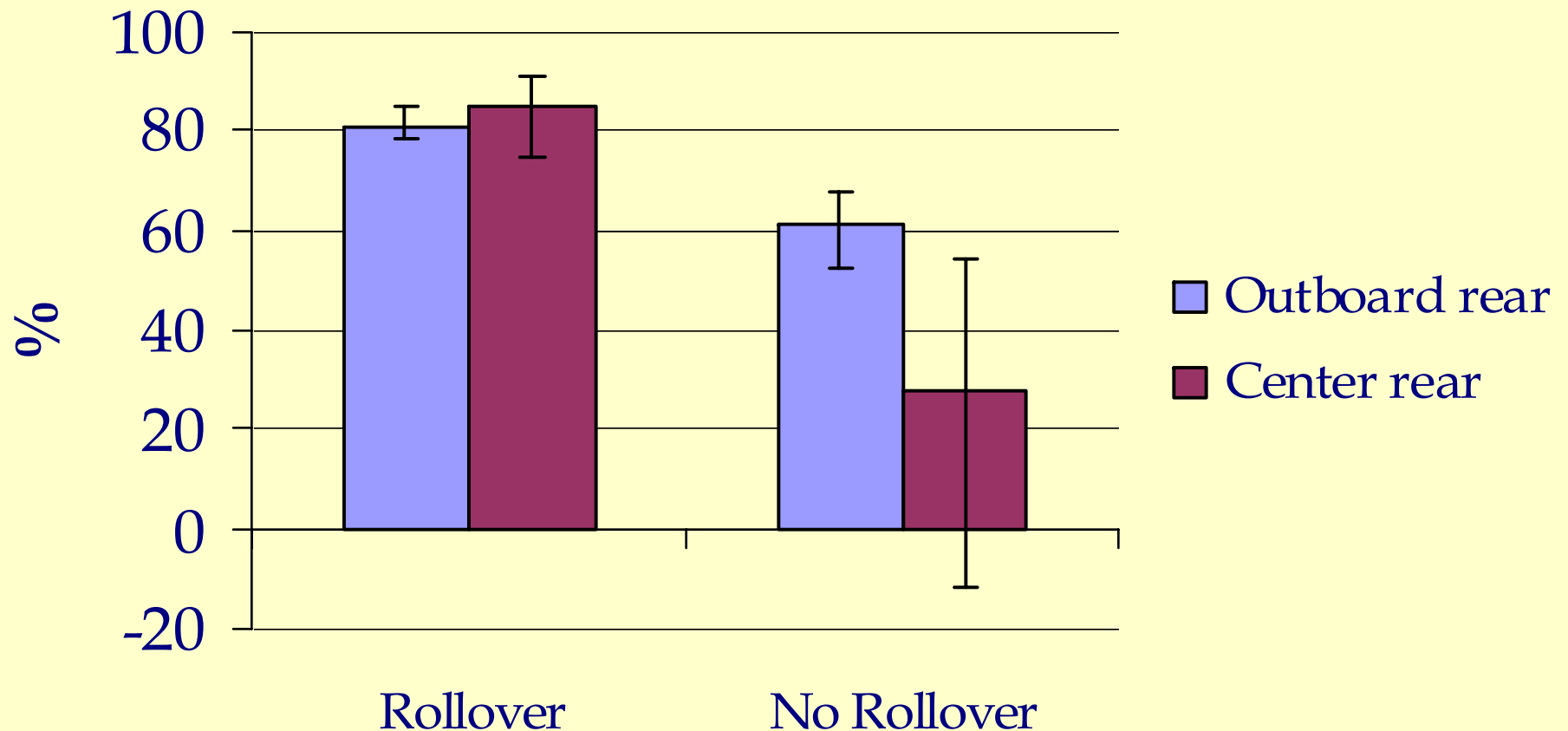# Estimates of Rear Seat Belt Effectiveness by Age for LTVs

* The error bar indicates 95% confidence interval.

Legend:
- Outboard rear
- Center rear

X-axis: Age 16-64, Age 65+

Y-axis: % (-10 to 90)

Estimates of Rear Seat Belt Effectiveness for Passenger Cars in Rollover vs. No Rollover

* The error bar indicates 95% confidence interval.

Estimates of Rear Seat Belt Effectiveness for LTVs in Rollover vs. No Rollover

Legend:
- Outboard rear
- Center rear

X-axis: Rollover, No Rollover

Y-axis: % (-20 to 100)

* The error bar indicates 95% confidence interval.

Comparison with Other Studies I

- Our estimate of rear reat belt effectiveness:
  - 60% for passenger cars
  - 70% for LTVs
- Evan's study of FARS 1975-1985:
  - Effectiveness estimate: 18%
  - Lap belt only
  - Rear seat belt use: 3%

Comparison with Other Studies II

- Morgan's study of 1988-1997 FARS
  - Effectiveness estimates
    - 44% (95% CI: 36-51%) for passenger cars
    - 73% (95% CI: 63-80%) for LTVs
    - Confounding by individual-level variables
- Smith and Cumming's study of 1990-2001 FARS
  - Effectiveness estimates
    - 58%, 58%, 41% for ages 13-29, 30-59, and 60+.

Limitations

- Inaccuracy of safety belt information
  - Surviving occupants falsely report using safety belt.
  - Sensitivity: 91%, specificity: 88%
  - Other researchers reported that police reported belt use and investigator reported belt use produced similar belt effectiveness estimates.
- Lack of complete data about belt use
  - 10% missing
  - Individuals with complete data were not very different from those with missing data.

Implications

- 7,682 adult rear occupants not wearing a safety belt died from 2000-2004 in the U.S.

- Rear seat belt use by all passengers would save 1,000 lives per year in the U.S.

- Only 10 states and D.C. have primary rear seat belt law.

- Health education and awareness campaigns would increase safety belt use among rear seat passengers.

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