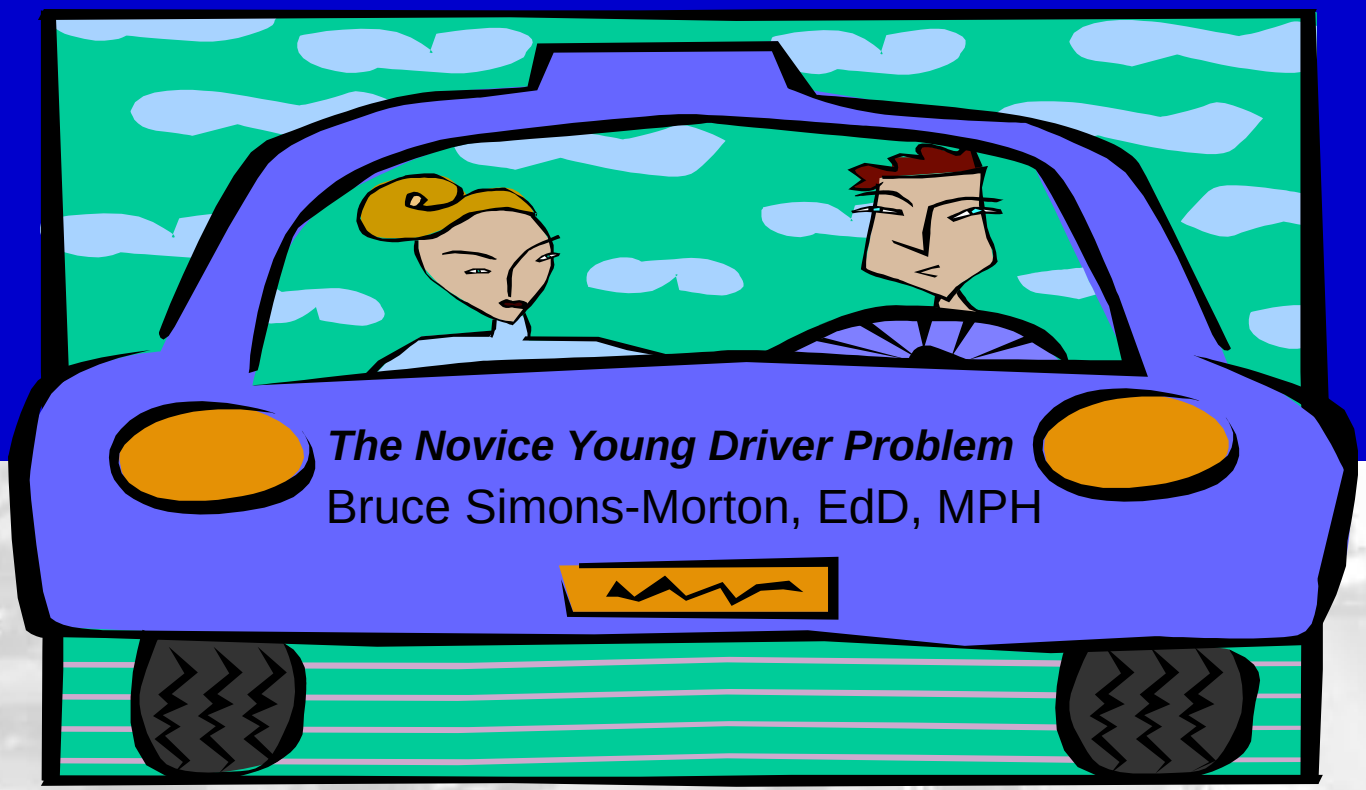


Elevated G-Force Event Rate Analyses Naturalistic Teenage Driver Study

1) Utility
2) Validity
3) Variability issues

Naturalistic Teenage Driving Study (NTDS)

A. Overview
   - 42 volunteer teens & parents recruited at permit
   - Instrumentation of primary vehicle
   - 18 month follow up
   - Examine teen driving performance over time

B. Crash and near crash (CNC) causes
   1) Road, traffic, trip conditions
   2) Driver behavior - risky driving
      - Distraction
      - Speeding
      - Elevated g-force events (risky driving)

Elevated G-Force Event Analyses

Advantages/utility

- Numerous events
- Objective measure of risky driving
  - Associated with Crash/Near Crash (CNC)
  - Higher in teenagers (novices) than adults (experienced drivers)
- Employed in safety programs for fleet operators, teenage drivers (e.g., Drive Cam; Green Road)

Limitations

- Variability

NTDS Crash and Near Crash Incidence (18-months)

	Crashes	Near Crashes	Total
Teenagers (n=42)	36	238	274
Adults (n=54)	2	31	33

NTDS
Kinematic Measures

Category	*g*-force	Frequency	% events
Rapid Starts	≥ .35	8747	39.6
Hard stops	≤ -.45	4228	19.1
Hard left turns	≤ -.05	4563	20.6
Hard right turns	≥ .05	3185	14.4
Yaw*	6°/ 3 sec	1367	6.2
Total (composite)	---	22090	100

Composite Kinematic Measure

Total 18 Months Measures	Teen (N = 42) Standardized alpha = .78		
	Mean/ 100 mi	SD	Correlation w/ Composite
Rapid starts	2.73	3.81	0.86
Hard stops	1.71	1.63	0.59
Hard left turns	1.58	1.55	0.83
Hard right turns	1.17	1.26	0.63
Yaw	0.50	0.69	0.57
Composite/100 miles	7.68	6.73	

Kinematic Measures of Risky Driving
Analysis Issues

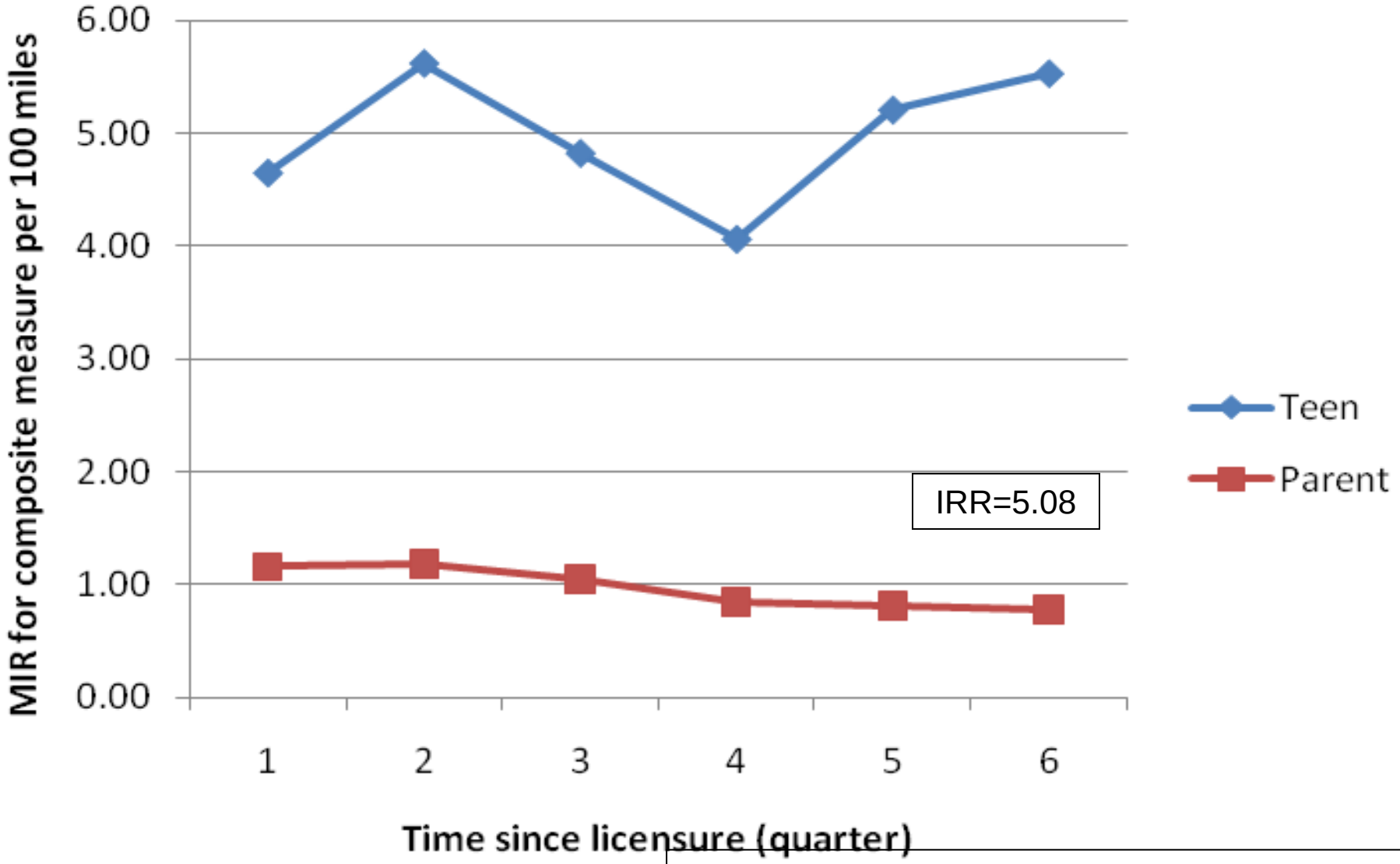
1. Rate calculation: mean or median incidence rates/miles
2. Aggregate over time (month or quarter)
3. Small sample; large number of trips
4. Variability within and between subjects
5. Enable assessment of covariates
6. Statistical approaches for modeling count data: Poisson; GEE with regression; marginal analysis of longitudinal count data; survival analysis; trajectory (latent) class
7. Model specifications
   - Logarithm of mileage offset
   - Subject-specific random effects to account for over-dispersion and serial correlation

NTDS Elevated G Force Rate Analyses
Inferential Questions

- Do rates change over time?
- Do teen and parent (adult) rates differ?
- What are the factors that influence g-force rates?

Inference

G-Force Event Rates – Teens and Parents



Simons-Morton et al., American Journal of Public Health, 2011

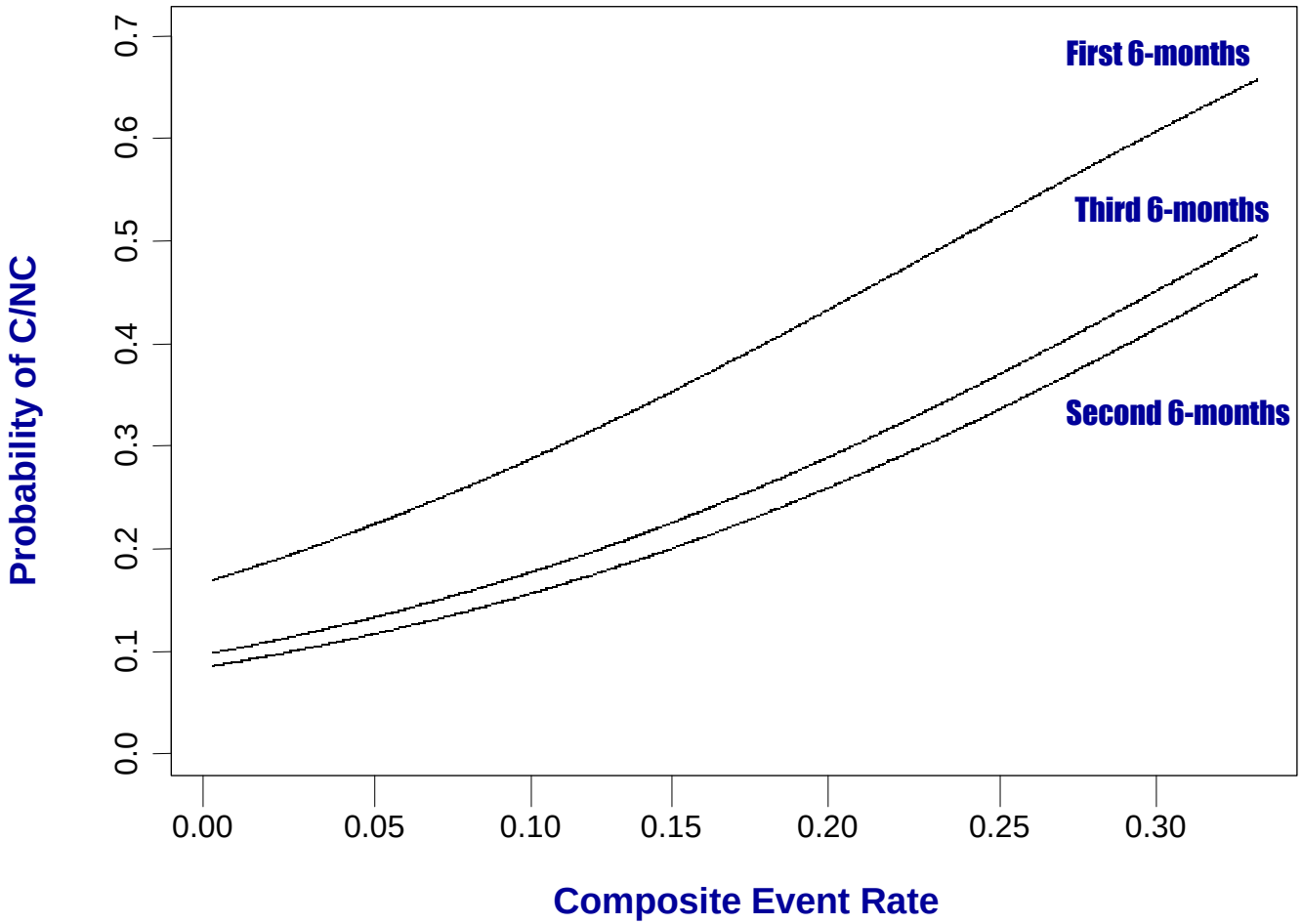
Elevated G-Force Event Rate Analyses
Association and Prediction of CNC

1. Correlation of Risky Driving & CNC -- 18 months
2. Generalized Equation Estimation regression model
3. Time to crash – Cox Survival Model
4. ROC curve – Zeger-Qagish Model
5. Trajectory classes

Elevated G-Force Events & CNC Correlations

Kinematic Measure	Pearson Correlations	Spearman Rank Order Correlations
Hard Stops	0.71	0.76
Rapid Starts	0.25	0.75
Left Turns	0.35	0.53
Right Turns	0.57	0.62
Yaw	0.31	0.46
Composite	**0.52**	**0.60**

GEE With Logistic Regression Prediction of C/NC by Period



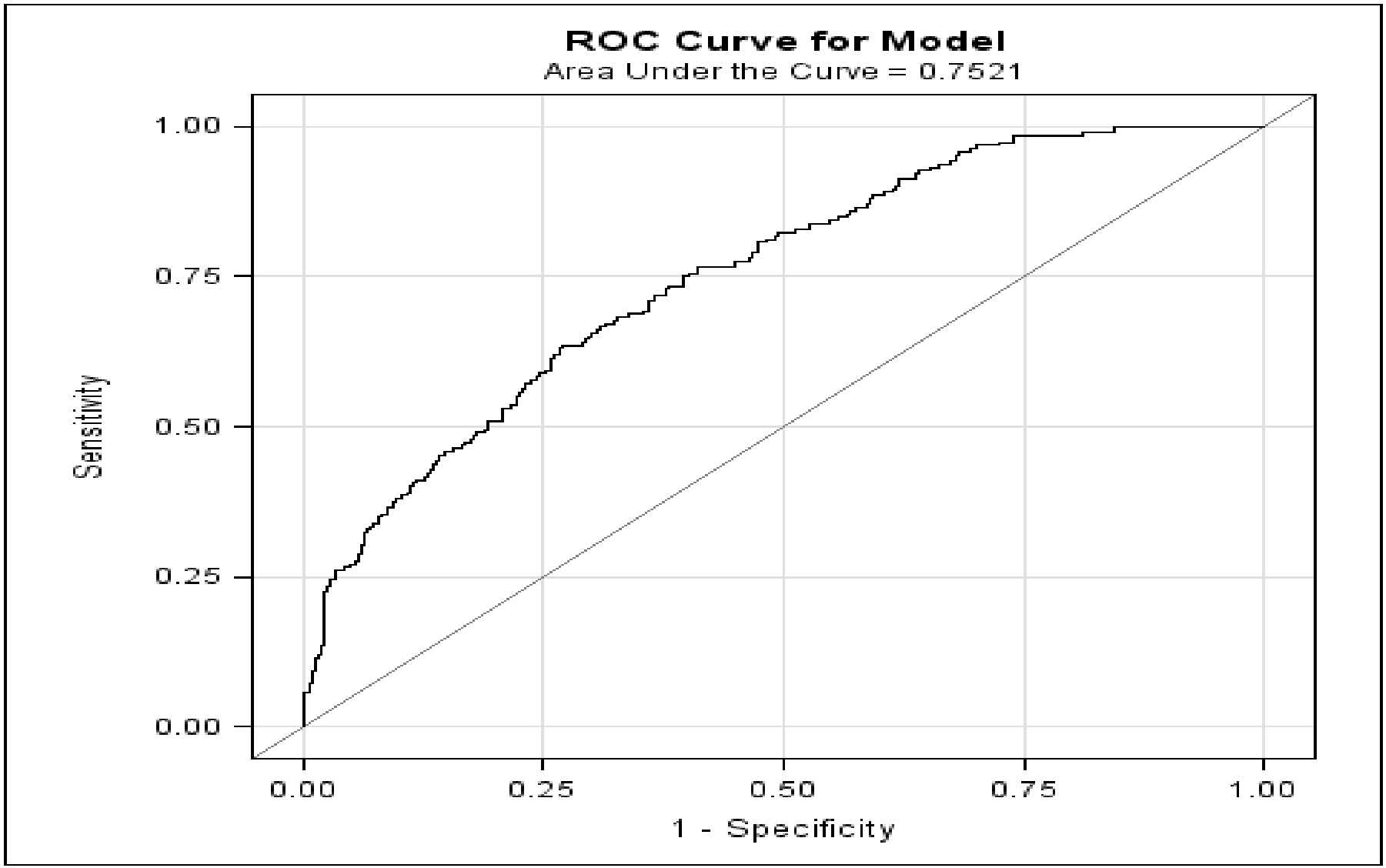
Simons-Morton et al., American Journal of Epidemiology, 2012

Zeger-Qagish Logistic Regression Model

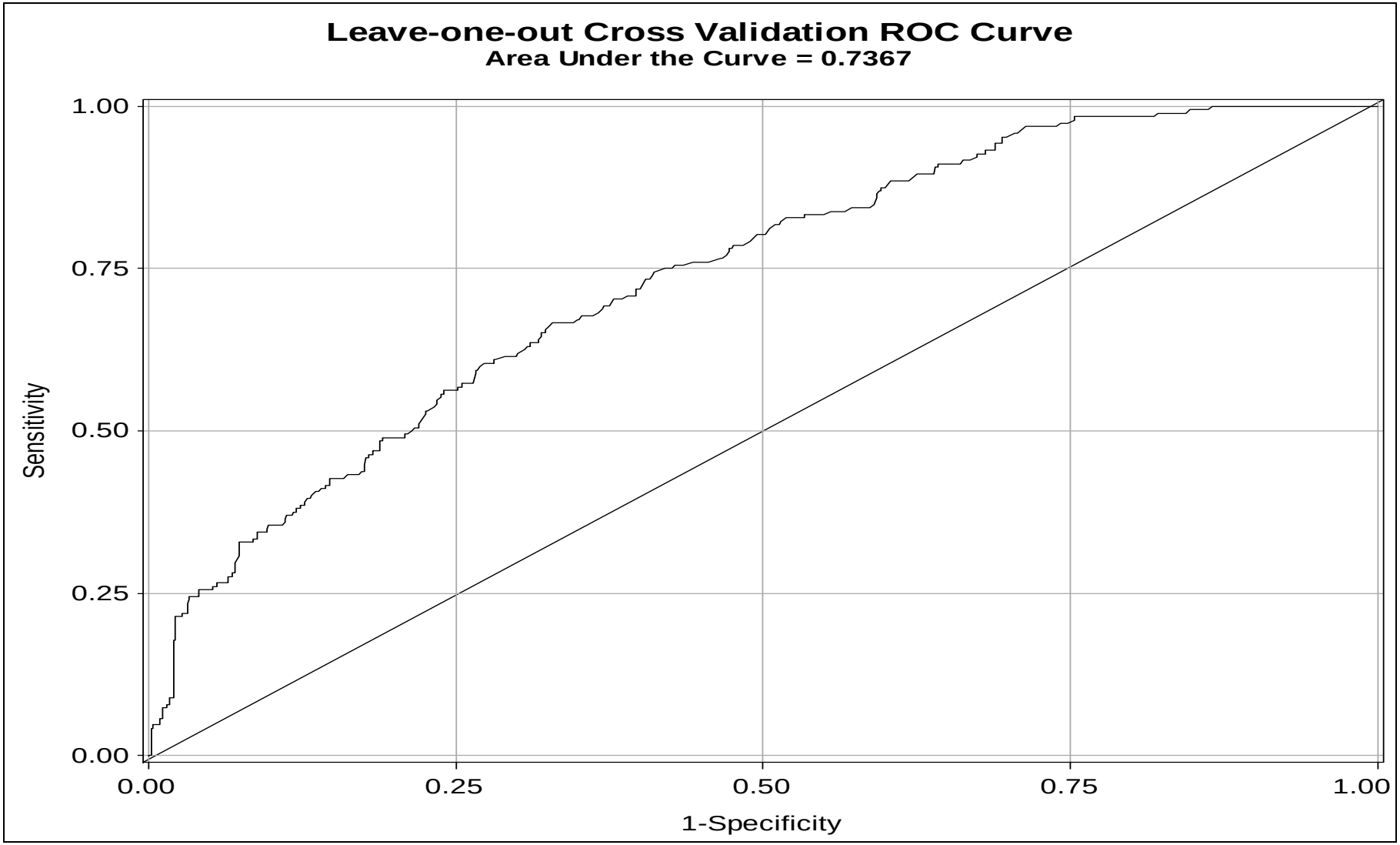
Does risky driving in past month predict CNC?

1. Repeat for each CNC event, each study participant
2. Kinematic event rates past month as IV
3. Account for CNC in past 2 months
4. Mileage offset
5. Area under the curve/ROC
    - Sensitivity
    - specificity

ROC Curve for Model

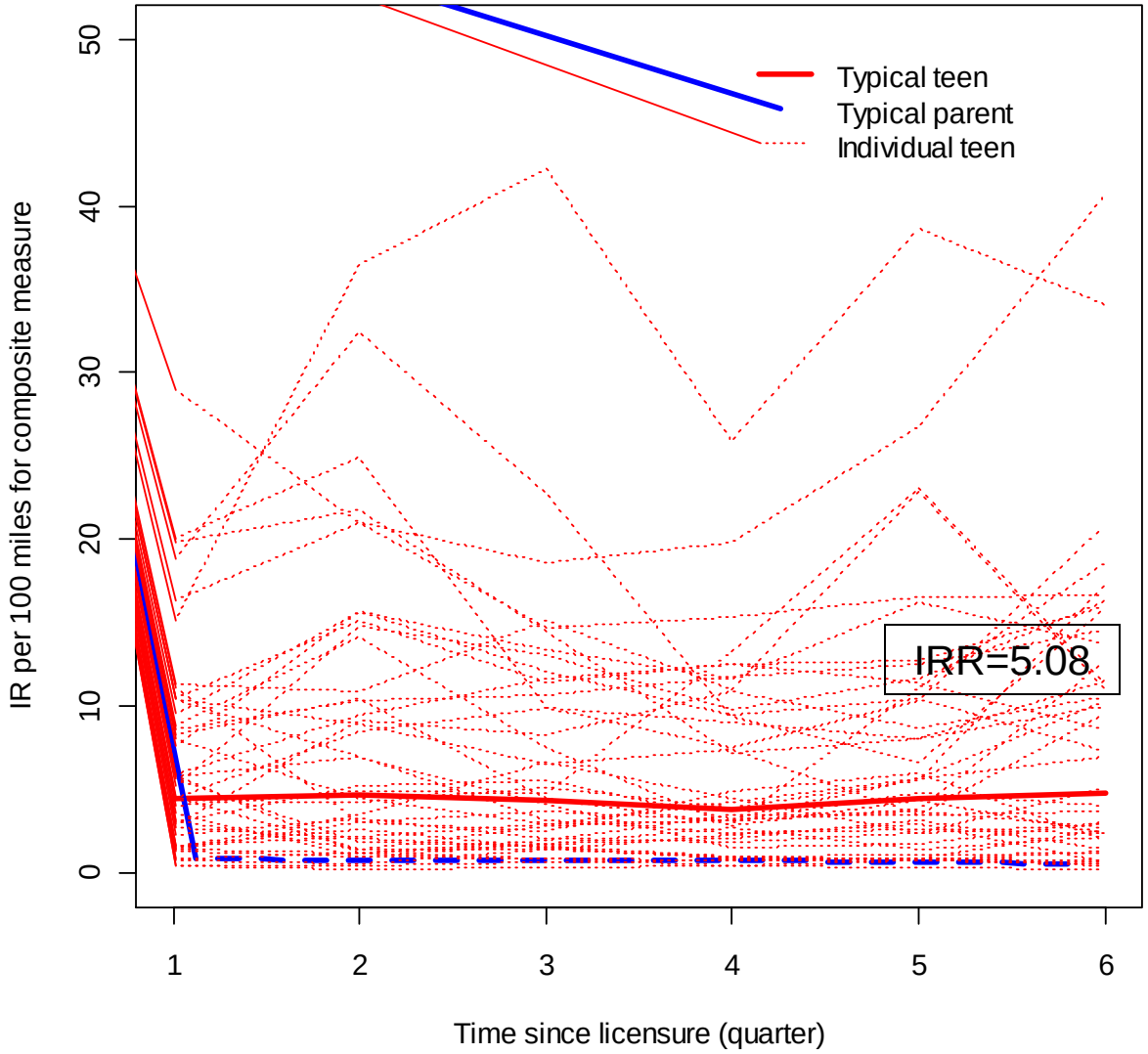


ROC Curve for Model
Bias-adjusted Estimate

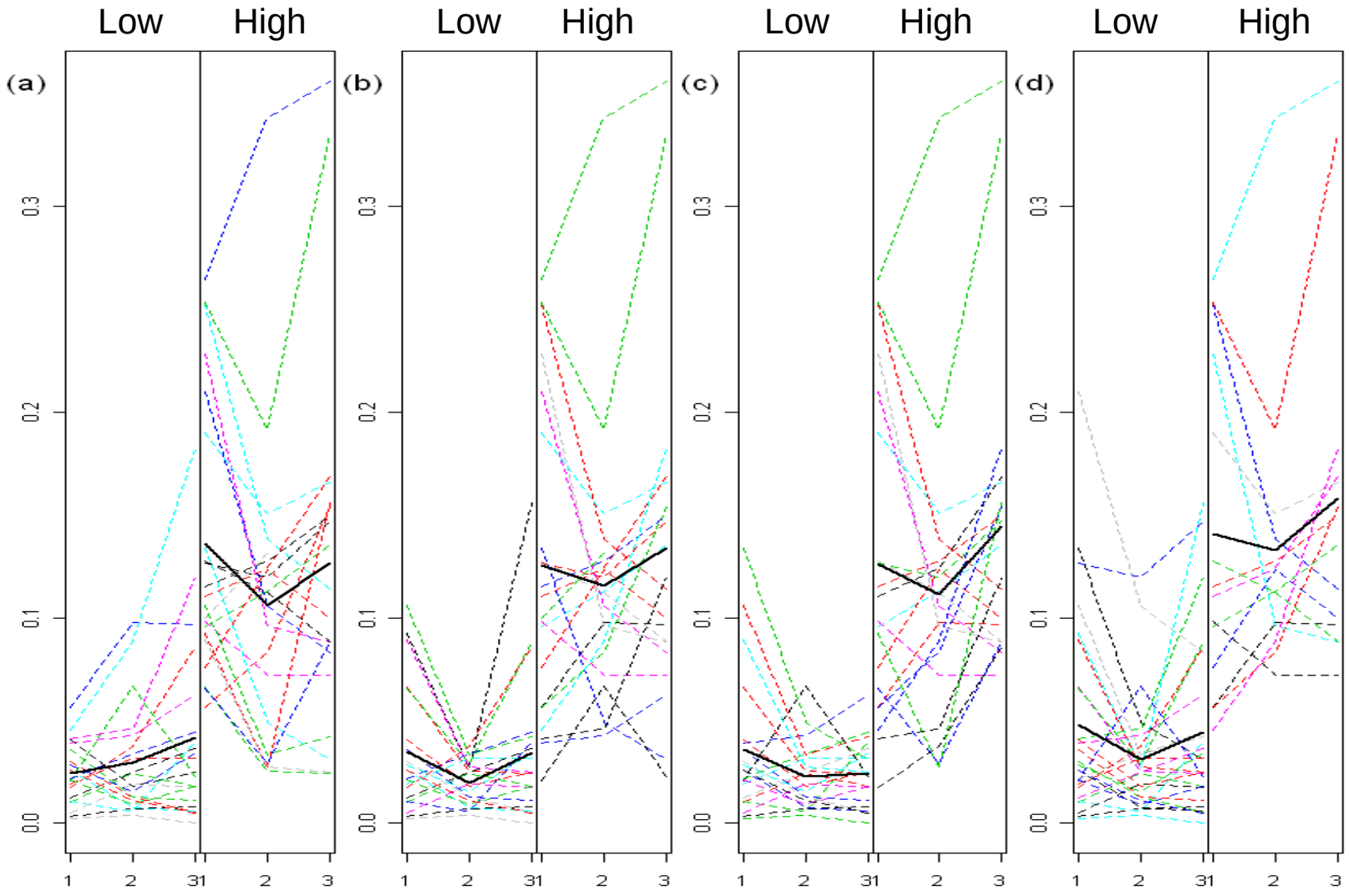


Simons-Morton et al., American Journal of Epidemiology, 2012

Variability in Elevated G-Force Event Rates



Longitudinal Trajectory Classes
Latent Class Models



1st 6-months | 2nd 6-months | 3rd 6-months | 18 months

Summary & Conclusions

1. G-force event rates driving correlated w CNC over 18 mo.
2. Survival analyses
    - Previous month = hazard ratio of 10 x
    - 18 month = hazard ratio of ~45 x
3. ROC/AUC indicates that risky driving is ~73% predictive
    - Need to test model with another data set
4. Trajectory classes = 2

Conclusion: Kinematic measures valid measure of risky driving

Limitations: High variability and small sample size

- Marginal analyses of count data

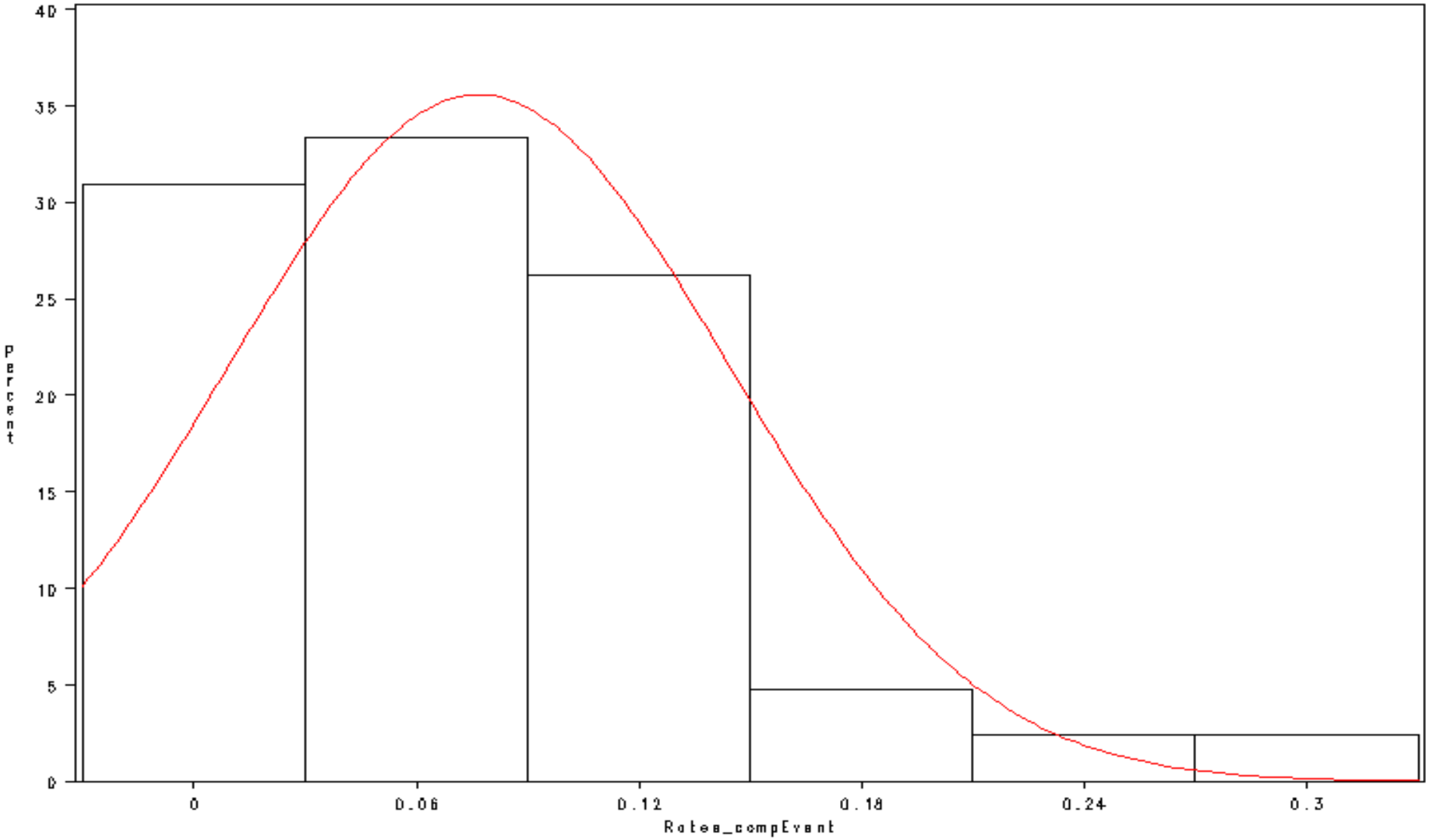
Collaborators

NICHD: Marie Claude Ouimet, Paul Albert, Zhiwei Zhang, Jing Wang, Anuj Pradhan

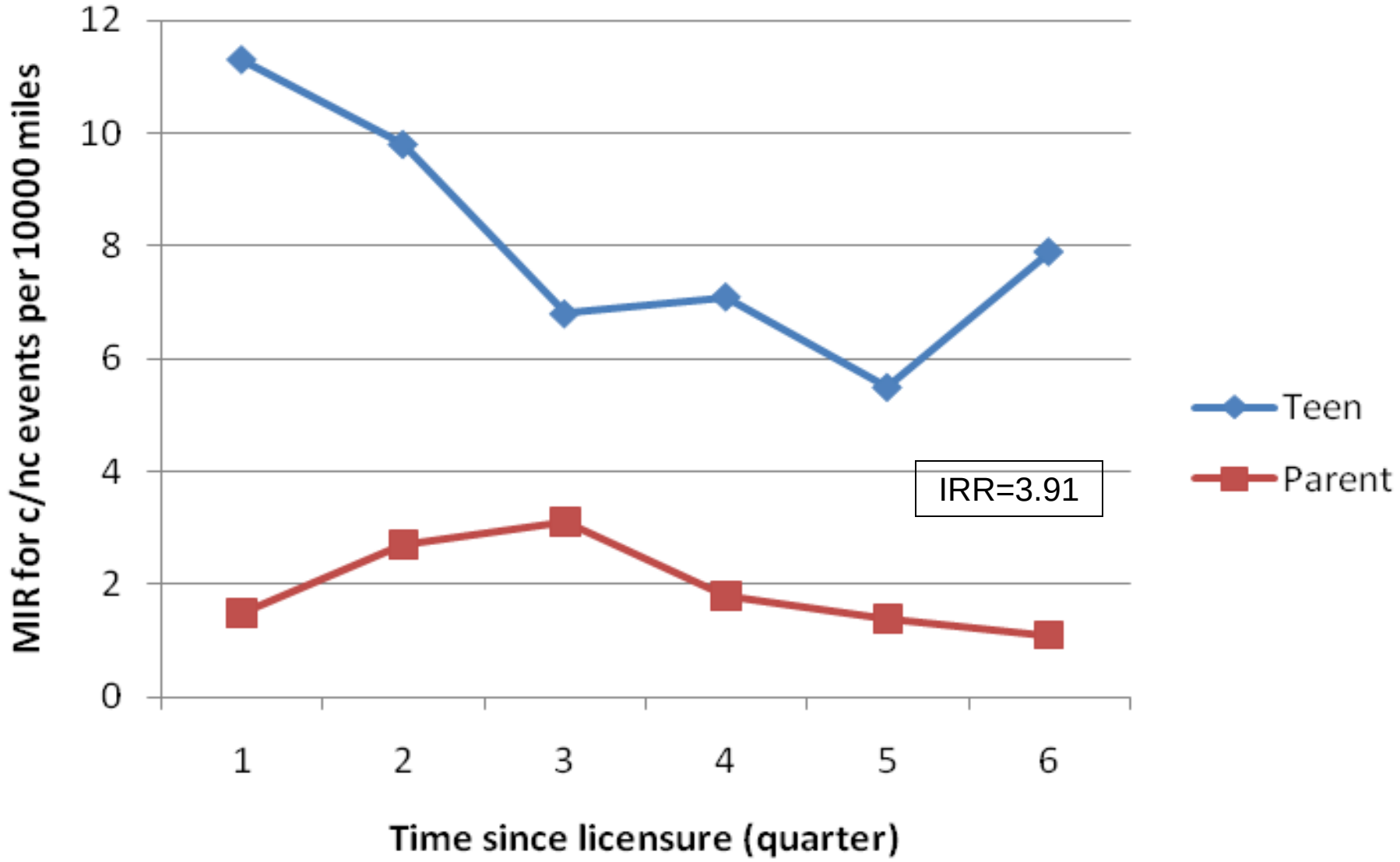
VTTI: Tom Dingus; Charlie Klauer; Suzie Lee, Feng Guo

Thank you

Histogram of Teen Risky Driving (Composite Measure; Rates/100 Miles)



Crash/Near Crash – Teens and Parents



Does Risky Driving Change After a Crash/Near Crash?

Time/miles before & after C/NC	Wilcoxon Signed Rank
2 Days	$p = 0.13$
1 week	$p = 0.72$
1 month	$p = 0.85$

Risky Driving 2 days Before & After each CNC