Beyond aging: the role of frailty in crash-related injuries

MARYLAND CIREN CENTER

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Overview

- Background
- Objectives/research question
- Data source/methods
- Results
- Discussion
- Conclusion

Background

- Older drivers are an area of particular interest in injury research
  - Aging population
  - Co-morbidities
  - Complications
  - Longer lengths of stay and higher medical charges

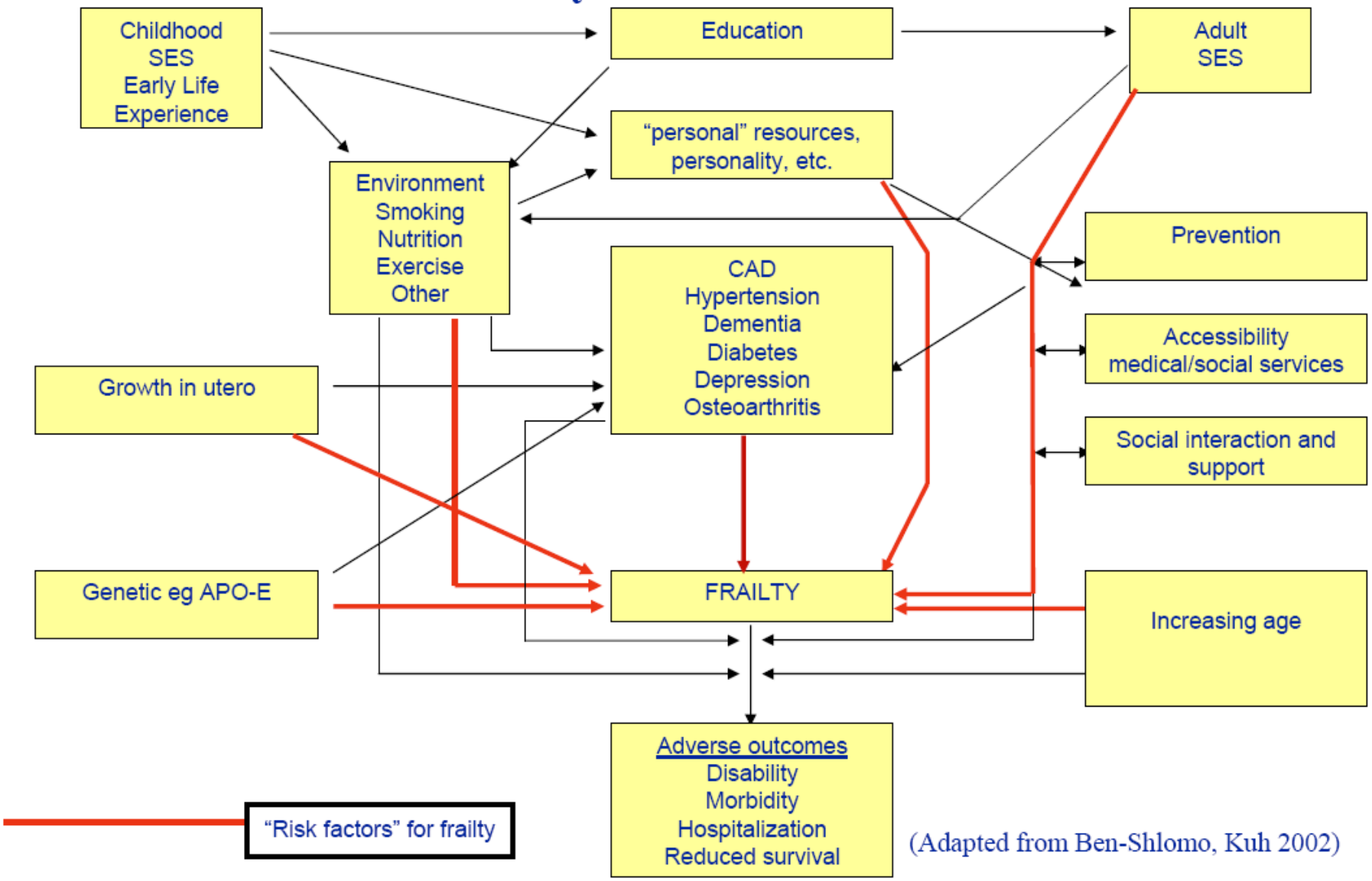
What is frailty?

- Commonly used term, but difficult to define objectively
- Recent efforts have focused on identification of clinical syndrome causally related to, but distinct from, disability and comorbidity

What is frailty? (cont'd)

- Fried Model (2001), five components:
  - Weight loss
  - Exhaustion
  - Low physical activity
  - Weakness
  - Slowness
- Women's Health Initiative (1991-2006)
  - Vitality and physical functioning scores (SF-36) used to assess weakness, slowness, and exhaustion

Biological and psychosocial exposures across the life course in relation to frailty and its adverse outcomes



(Adapted from Ben-Shlomo, Kuh 2002)

Previous CIREN Analyses

Background

- Aging of the driving population
- Decreased MVC mortality → focus on non-fatal outcomes
- Literature suggests: older adults → poor outcome
- Unclear what factors affect recovery potential
- Need for standardized measures

Background

- MacKenzie (2002):
  - SF-36 physical and mental component summary scores
  - lower one year post-MVC compared to general population
  - Excluded cases ≥60 years
- Ameratunga et al. (2006):
  - compared drivers hospitalized following MVC to drivers not injured in a MVC
  - 10-fold increased chance of worse self-reported health (as indicated on the SF-36) at 18-months post-injury.

Objectives I

To examine the differences in self-reported health, as measured in domains of the Short-Form-36 (SF-36), between young (ages 18-64) and old (age $\geq$65) individuals prior to a MVC injury and at 6- and 12-months post-injury

Objectives II

To determine the independent effect of **advanced age,** comorbidity (the presence of 2 or more medical conditions), and the person's pre-injury self-reported functional status on the respective post-injury outcomes

Methods

- Two sites of the Crash Injury Research and Engineering Network (CIREN) study
  - Sites chosen based on the completeness of SF-36 data
- CIREN case occupants ≥18 years old
- Exclusions: missing baseline or follow up SF-36 values

Main Measures

- Main outcome variables:
  - SF-36 Scales: Physical Functioning, Vitality, and Mental Health (All on 0-100 scale)
  - Initial interview in hospital 6 and 12 month interview by phone
- Main predictor variable:
  - Age: 18-64 vs. 65+

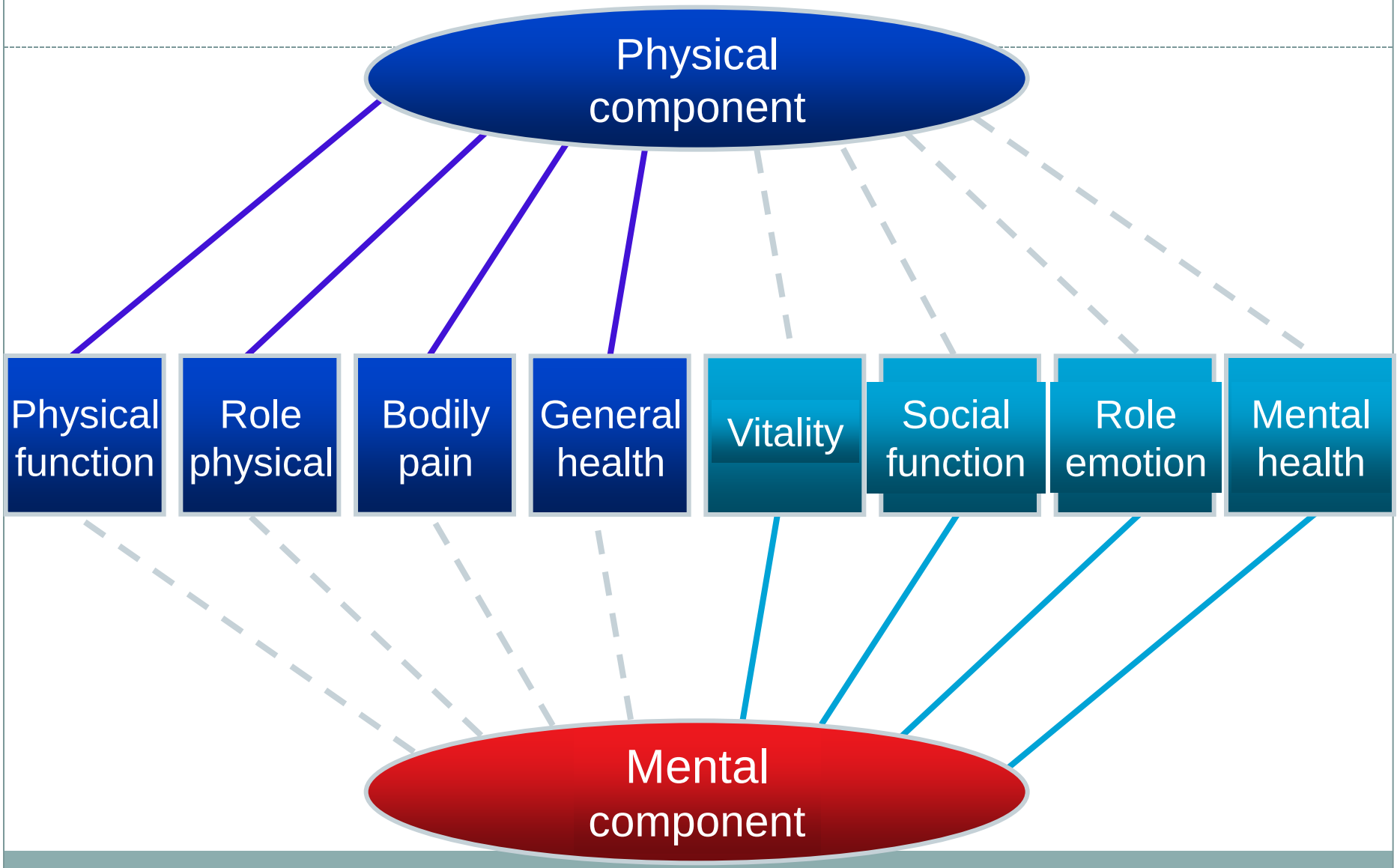
Measures (covariates)

- Comorbidity:
  - evidence of ≥2 categorized disease classes present at the injury hospital admission
- Injury Severity Score (ISS):
  - Minor (1-8)
  - Mild (9-15)
  - Moderate (16-24)
  - Severe (25+)

SF-36: Short Form 36 Health Survey

- Validated, widely used generic measure of health related quality of life
  - 8 Domains
    - Scored 0-100; age; gender adjusted norms
  - 2 Summary Scores
    - Physical Component
      - Measures how decrements in physical function affect day to day activities
      - Impact of physical impairment/disability
    - Mental Component
      - Impact of mental affect, symptoms of pain
  - Facilitates comparison with other disease states

SF-36


Physical component
Physical function
Role physical
Bodily pain
General health
Vitality
Social function
Role emotion
Mental health
Mental component

Physical Functioning

- The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

  Yes, Limited A Lot

  Yes, Limited A Little

  No, Not Limited At All

Activities

- Vigorous activities such as running, lifting heavy objects, participating in strenuous sports
- Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling or playing golf
- Lifting or carrying groceries
- Climbing several/one flight of stairs
- Bending, kneeling, or stooping
- Walking more than a mile/several blocks/one block
- Bathing or dressing yourself

Vitality

During the past 4 weeks….

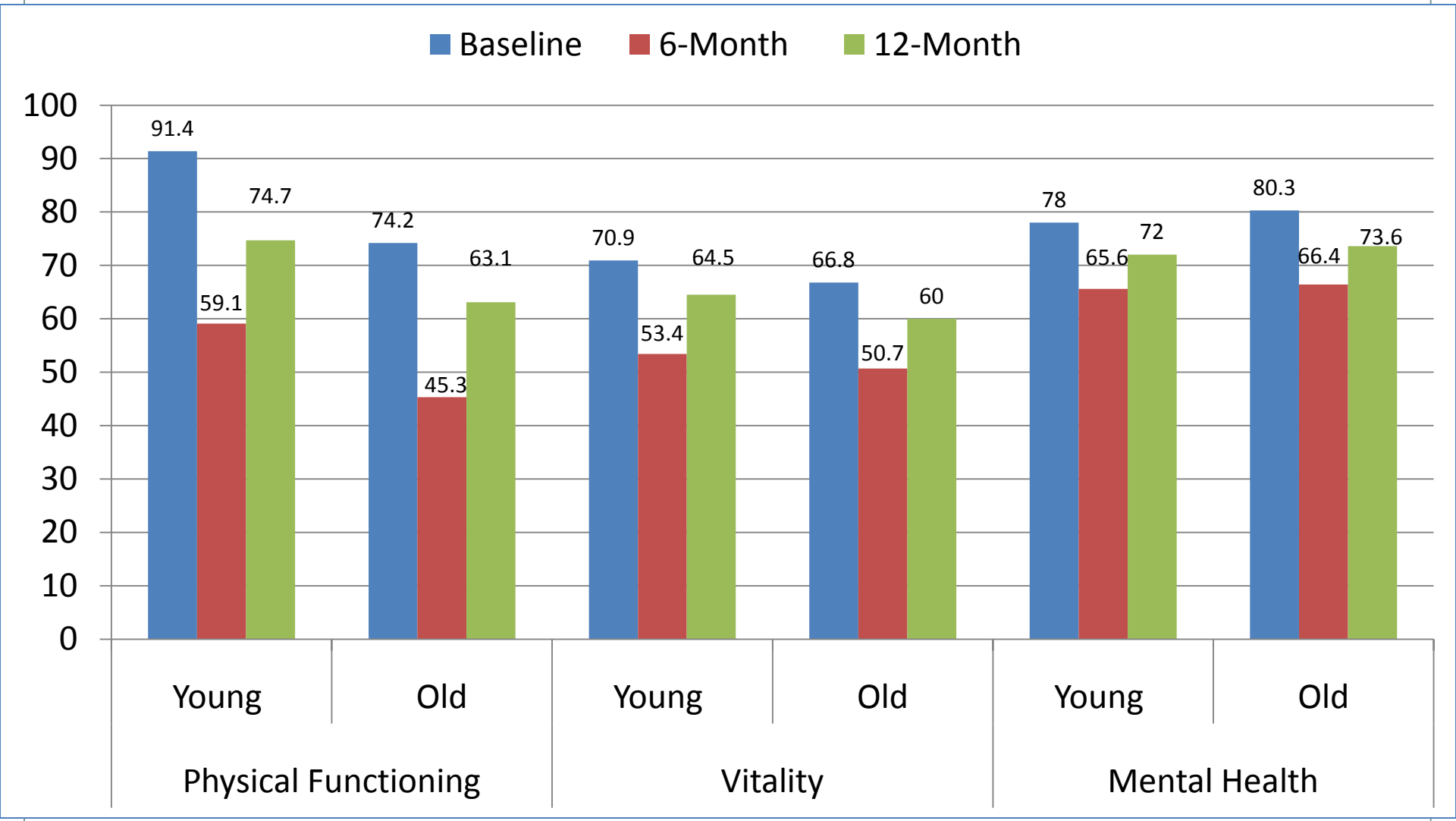
- Did you feel full of pep?
- Did you have a lot of energy?
- Did you feel worn out?
- Did you feel tired?
  - All of the time
  - Most of the time
  - A Good Bit of the time
  - Some of the time
  - A little of the time
  - None of the time

Statistical Analyses

- Demographic and health characteristics comparison by age group (< 65 and ≥ 65) using Pearson's chi-square statistics
- Unadjusted effect of age group on outcome measures at 6 months and 12 months for each of 3 domains of the SF-36 → Student's t-tests
- Multiple linear regression → association between age group and outcome while adjusting for covariates

Results

Unadjusted Age Differences in SF-36 Scores



Physical Functioning

	6 month		12 month	
Variable	**Estimate**	**P-**	**Estimate**	**P-**
Age 18-64 (ref)				
65+	0.81	0.84	0.92	0.79
Comorbid No (ref)				
Yes	**-12.6**	**<.001**	**-10.67**	**<.001**
Baseline SF-36 PF*	**0.56**	**<.001**	**0.65**	**<.001**
ISS<8 (ref)				
9-15	-6.34	0.16	-1.635	0.66
16-24	-1.11	0.82	3.315	0.41
25+	**-9.60**	**0.05**	-3.558	0.38

Ref=referent; ISS = Injury Severity Scale; Estimate refers to the parameter estimate in multivariate linear regression models
*Refers to the baseline value for the respective outcome measure in each analysis

Limitations

- CIREN selection criteria and methodology:
  - Not a random sample
- Non-inclusion of other CIREN sites
- Lack of SES adjustment
- Secondary data analyses
  - Limited by available data
  - Unable to compare age groups among “older adults”

Conclusion

- SF-36 trajectories similar for the two age groups
- Advanced age was associated with worse self-reported health in physical functioning and vitality
- Age association not a significant indicator of outcomes when comorbidities, pre-injury health status, and injury severity were considered

Conclusion

- Pre-injury self-reported physical functioning, vitality score, mental health and comorbidities influenced the self-reported functional status at 6 and 12 months post-injury
- Injury severity influenced the physical functional status at 6 months only

Discussion

- Age itself is not a significant predictor of the potential for recovery when other age-associated conditions are considered!!!!
- Age differences in outcomes mediated by comorbidities and pre-injury functional status:
  - Need to be accounted for in functional outcome research following vehicular injuries
- Older patients require rehabilitation efforts focused more on physical domains of functioning

ROLE OF FRAILTY IN INJURY CAUSATION??

Study objectives

- The purpose of this analysis was to examine the role of frailty in injury causation.

Research Question

- Case / Control (frail/non-frail)
  - Are the crash, occupant, vehicle and injury characteristics among those who are frail different than among those who are not frail?
  - Is frailty associated with physical characteristics (age, BMI) or specific injuries (fractures, TBI)?

Data Source

- CIREN dataset
- Baseline SF-36 scores
  - Within 2 weeks of admission date
  - Physical functioning (PF) score < 75

Data Limitations

- All subjects are injured in at least one body region
- Incomplete data capture
  - Varies by enrolling center
  - Baseline evaluation ranges from date of admission to 4 months post-admission
  - Could not include all centers in analysis
  - Unable to identify baseline values for all cases

Study definition of frailty

- CIREN is unable to account for weight loss or low physical activity
- SF-36 metrics previously used
  - Vitality
  - Physical functioning
- This study evaluated physical functioning alone as a frailty marker

Definition of frailty marker

- Higher correlation found between lower physical functioning scores and crash circumstances
  - Comparing low PF only, low VS only, low PF and low VS, all normal

CIREN Population

- Total CIREN cases = 4,380

- PFS<75 only = 116 (2.7%)
- VS<55 only = 174 (4.0%)
- PVS<75 and VS<55 = 121 (2.8%)
- Both above = 1,325 (30.2%)
- Missing baseline score = 2,644 (60.4%)

- Total with baseline PFS = 1,747

Frailty Categories
(N=1,736)

	PFS<75 only (%)	VS<55 only (%)	Both less (%)	Both over (%)
Age				
<50	32.8	76.4	34.7	68.2
Gender				
Male	34.5	43.7	34.7	48.6
BMI				
Underweight/Normal	32.0	39.7	34.7	44.2
Comorbidities				
3+	56.9	34.5	62.8	20.5
Injury Type				
Femur fracture	12.1	16.1	17.4	15.6
Multiple rib fractures	37.9	23.0	42.2	25.2

Final definition

- Use PFS < 75 to identify cases with frailty markers
- Compare those ‘frail’ case occupants with all others
  - Crash characteristics
  - Injuries sustained

Results

- Crash/vehicle circumstances
  - Delta V
  - Crash type
  - Restraint use

Descriptive Statistics: Crash
(N=1,747)

	PFS<75 (%)	P-value
Delta V		
<45	17.4	
45+	9.0	<0.01
Crash Type		
Frontal	15.9	
Near side	11.6	
Far side	14.6	
Rollover	6.9	0.02
Belt Use		
Yes	13.5	
No	14.0	NS

Results

- Person/injury circumstances
  - Age
  - Gender
  - BMI
  - Comorbidities (number)
  - ISS
  - MAIS

Descriptive Statistics: Occupant
(N=1,747)

	PFS<75 (%)	P-value
Age		
<55	8.5	
55+	27.1	<0.01
Gender		
Male	16.8	
Female	10.3	<0.01
Comorbidities		
0-1	11.6	
2+	46.7	<0.01

Descriptive Statistics: Occupant
(N=1,747)

	PFS<75 (%)	P-value
BMI		
Underweight	17.1	
Normal	10.6	
Overweight	11.6	
Obese	19.3	
Extremely obese	24.4	<0.01
BMI		
Normal/Overweight	11.0	
Underweight/Obese/Extremely Obese	20.1	<0.01

Descriptive Statistics: Injury
(N=1,747)

	PFS<75 (%)	P-value
ISS		
<16	14.6	
16+	12.9	NS
MAIS 3+		
Head	10.1	0.04
Face	9.3	NS
Neck	0.0	0.03
Thorax	15.0	NS
Abdomen	10.7	NS
Spine	9.3	0.04
Upper Extremity	13.4	NS
Lower Extremity	14.6	NS

Recap

- Frailty → Injury
- CIREN does not have a control group (uninjured people)

- Analytical approach
  1. Frailty → delta v for specific injuries (adjusting for crash and occupant characteristics):
     - Head
     - Rib fractures
     - Femur fracture

Frailty association with log delta v: Head

Head (AIS 3+)	Coefficient	P-value
Age	-0.175	0.145
Gender	-0.097	0.368
Comorbidity count	0.048	0.814
BMI	-0.116	0.451
Frailty	-0.245	0.259

Belted occupants, frontal crash only
Comorbidity count 0-2 vs 3+
Frailty (PF<75 vs 75+)
Agegrp (<55 vs 55+)
Gender (men vs women)
BMI (normal/overweight vs other

Frailty association with log delta v: Multiple ribs

Multiple rib fractures	Coefficient	P-value
Age	-0.00174	0.21
Gender	-0.01839	0.79
Comorbidity count	-0.00174	0.99
BMI	0.00098	0.99
Frailty	-0.18775	0.04*

Belted occupants, frontal crash only
Comorbidity count 0-2 vs 3+
Frailty (PF<75 vs 75+)
Agegrp (<55 vs 55+)
Gender (men vs women)
BMI (normal/overweight vs other

Frailty association with log delta v: Multiple ribs

- For person with multiple rib fractures:
  - PFS≥75 (n=102) mean dV = 47.1
  - PFS< 75 (n=26) mean dV = 39.1
    p=.03

Frontal crashes, belted occupants

Similar trend for Head AIS3+ injuries but n is much smaller for selection group

Frailty association with log delta v: Femur

Femur fracture	Coefficient	P-value
Age	-0.032	0.71
Gender	-0.047	0.51
Comorbidity count	0.119	0.47
BMI	-0.020	0.79
Frailty	-0.099	0.35

Belted occupants, frontal crash only
Comorbidity count 0-2 vs 3+
Frailty (PF<75 vs 75+)
Agegrp (<55 vs 55+)
Gender (men vs women)
BMI (normal/overweight vs other

Discussion

- Although unable to identify frail occupants
  - Use low PF scores as a marker
    - Higher correlation than VS
    - Need better identifiers for frailty and more complete data

Conclusions

- Frailty metrics are crucial and difficult to apply
- Systems with detailed injury and kinematics data should capture frailty indices for evaluation
- Physical functioning scores, while correlated with frailty characteristics, are not significantly associated with injury outcomes

Implications

- Focus on mitigating crash and injury characteristics that more likely will occur among the growing number of frail vehicular occupants.

- Need to develop more objective anatomic/physiologic correlates of frailty that could better account for putative association

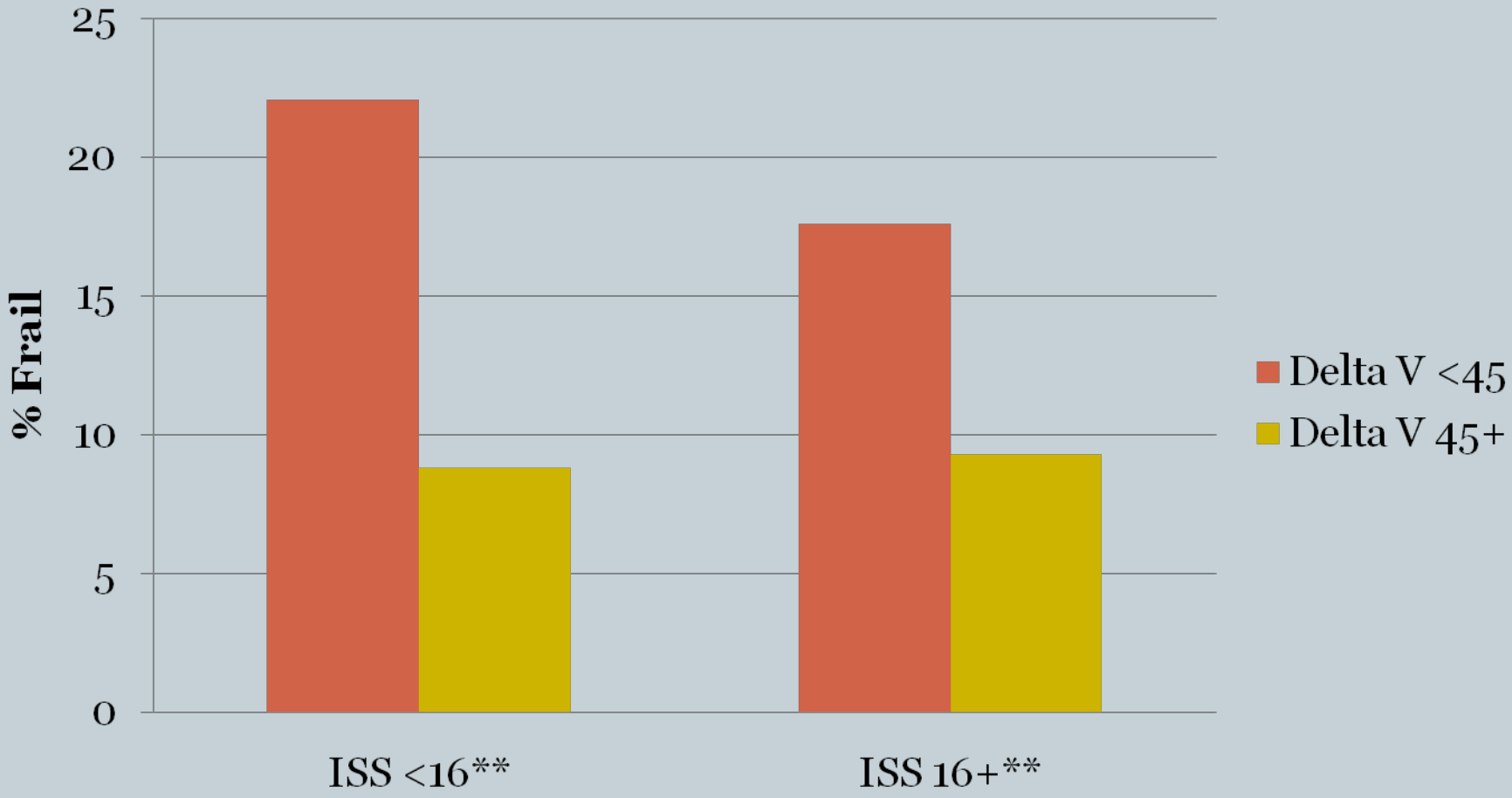
Future Directions

- Larger sample / Improve SF-36 completion rates
- Collaboration with other facilities for follow-up
- More robust measures, including biochemical markers for prospective analyses
- Predictive models of poor long-term outcomes in older MVC victims

Questions??

THANK YOU

Frailty association with delta v within ISS groups



**p<0.01

Breslow-Day = NS

Frailty association with delta v within ISS groups

- Delta v is significantly associated with frailty
  - A higher proportion of people injured at the lower delta v were frail
- This association exists at all levels of ISS