Reassessing action on driver fatigue: Driver responsibility for fatigue risk management

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Fatigue: road safety issue

- Recognised as a contributor to crashes
  - Estimated 18% of fatal crashes
  - Fatigue-related crashes more serious
- ? classification of fatigue involvement in crashes
  - single vehicle off road, at night etc
  - (known poor validity of classification)
- (also a problem for other transport modes)

Current and traditional approaches to reduce driver fatigue....

- Primary approach:

  Telling drivers to stop and take a break (rest, power nap, etc) when they feel tired or note the symptoms of fatigue

  – Common in every state in Australia and many international jurisdictions

- But what if drivers can't tell when they should stop?

If drivers CAN'T predict

- Advising drivers to stop driving when tired will not be effective

➔ Need solutions that provide drivers better information about their current state, e.g., in-vehicle drowsiness detection devices, vehicle performance measures that provide information to drivers

If drivers CAN predict

- Drivers are aware of current state so **should** be able to make the decision to stop.

➔ Need solutions that increase motivation to do the right thing, e.g., penalties for driving while fatigued, including fines, loss of points, prosecutions.

What do we know already?

- People can detect :
  ↓ alertness, ↑ fatigue, ↑ sleepiness

Drivers asked to drive until too tired to keep going:

- Almost everyone gave up at same level of subjective fatigue, but differed in rate of becoming fatigued (range 40 to 180 mins). *(Nilsson et al, 1997)*

➲ Advice to stop after a certain time (e.g., 2 hrs) will not suit everyone, better to respond to fatigue symptoms

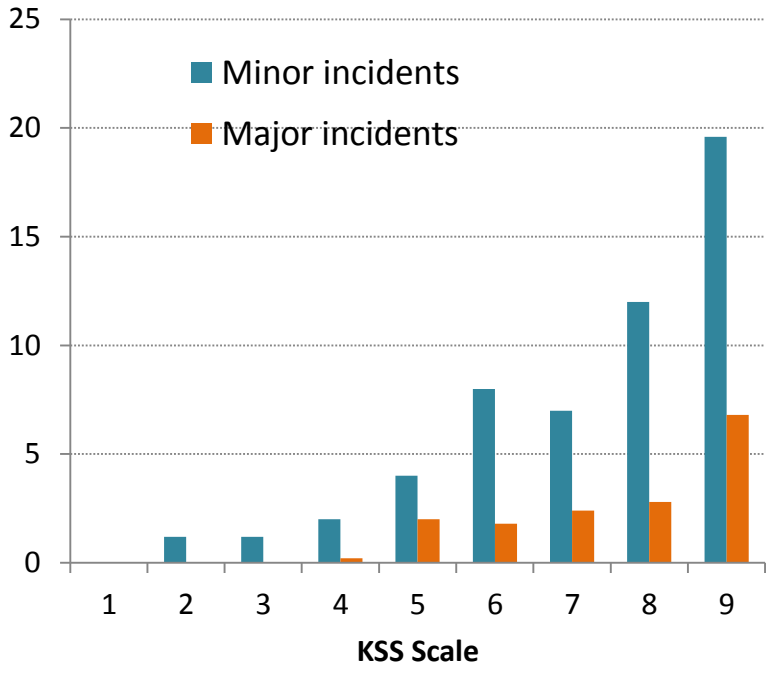
Evidence

- Mixed effects on prediction of ↓ performance

- Low to moderate and variable correlations between predicted/actual performance across performance tests in lab (Dorrian, et al, 2000; 2003)

- ↑Subjective sleepiness associated with ↑ incidents in driving simulator (Reyner and Horne, 1998)

- No relation between self-related fatigue and performance in on-road studies (Belz et al., 2004; Williamson, et al., 2000)



Evidence

- Poor prediction of sleep onset.

  - Likelihood of sleep higher before sleep than if sleep didnt occur, (78% Vs 42% likelihood) but association poorer for first sleep episode (55% Vs 42%) (Kaplan et al., 2007)
  - Overestimation of time to fall asleep and lack of awareness of being asleep (Baker et al. 1999)
  - People can maintain simple, skilled performance in early stages of sleep (eg., in lab, Ogilvie, et al., 1999; US truck drivers, Mitler et al., 1997)

Aim

- To examine the relationships between awareness of decreasing alertness, increasing fatigue and drowsiness and driving performance in a simulator.

How well can drivers predict the onset of sleepiness, falling asleep and crash risk before crashing?

Method

Design:

- Two hour simulator drive in monotonous terrain.
- Sleepiness increased by:
  Participants asked to have 5 hours sleep on night prior (actigraph validated) and testing between 14:30-16:30h

➢ **Purpose:**

To ensure that drivers will be tired

Study design

- 90 Drivers made judgements of current state over 2 hour drive.
- 3 conditions:
  1. Unprompted button press for likelihood of crashing
  2. Prompted ratings (~every 200secs) of sleepiness, likelihood of falling asleep and likelihood of crashing in the next few minutes
  3. Prompted ratings (~every 200secs) of sleepiness and likelihood of falling asleep, unprompted button press for likelihood of crashing

➢ **Purpose:**

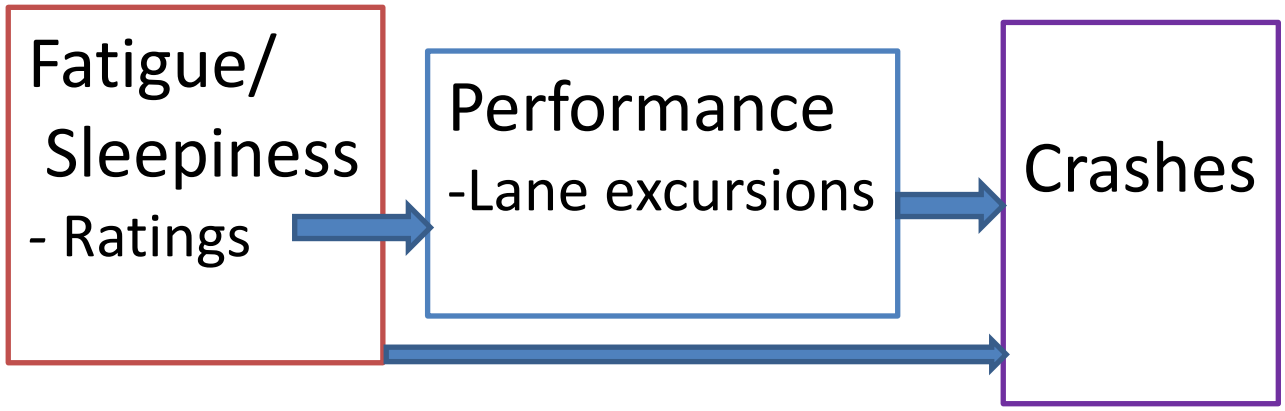
Counterbalancing of potential re-arousing effects of driver self-ratings during the drive (prompted or unprompted ratings)

Simulator and Procedure

- STIMSIM PC-based simulator
- Prompted conditions, ratings at beep every ≈ 200 secs
- **Sleepiness** measured by KSS (9 point scale)
- **Likelihood of falling asleep** or **likelihood of crashing** over the next few minutes by 5 point scale
- Unprompted button press (likely to crash) as required by participant
- Drowsiness measured by Optalert
- Driving performance: lane deviation, speed compliance
- Crashes and centreline crossings

Results

- Analysis format:



This presentation looks at:
Do feelings of fatigue/sleepiness, likelihood of falling asleep and likelihood of crashing precede crashes or centreline crossings?

Participants

- Mean age=45.8yrs (21-68yrs)
- Female=56.8%
- Most had drivers licence > 10yrs (83.5%)
- Most drove at least once per week (90.6%)
- Mean usual distance driven=140km (2 – 800km)
- BMI=Australian range of normal (28% overweight, 19% obese)
- Epworth Sleepiness scale within normal range, low frequency of sleep problems, Apnea risk low

➢ No difference between three groups for any of above

Behaviour before test session

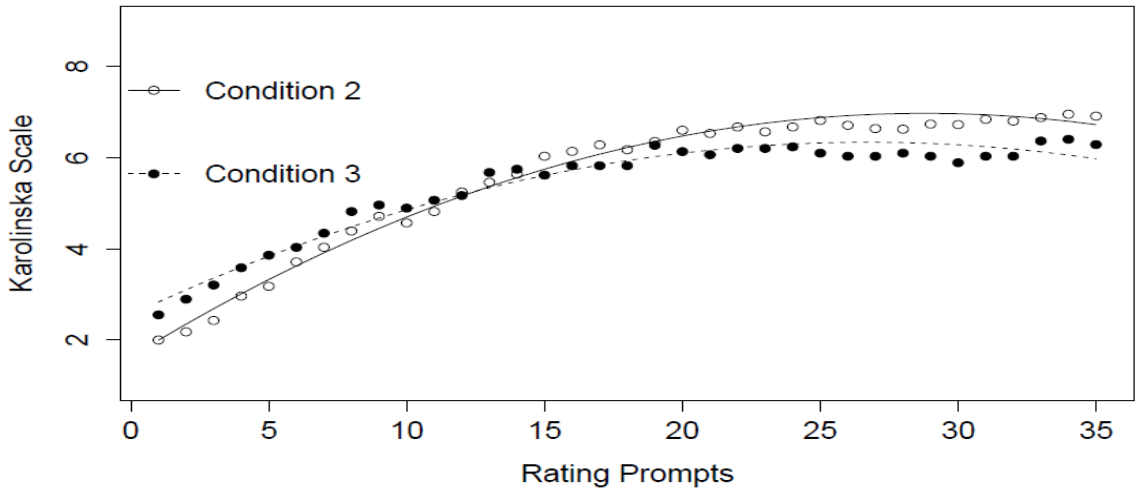
- Instructed to maintain normal daily practices (eg., caffeine, alcohol); no participants exhibited excessive behaviour.
- No statistically significant difference between three groups.

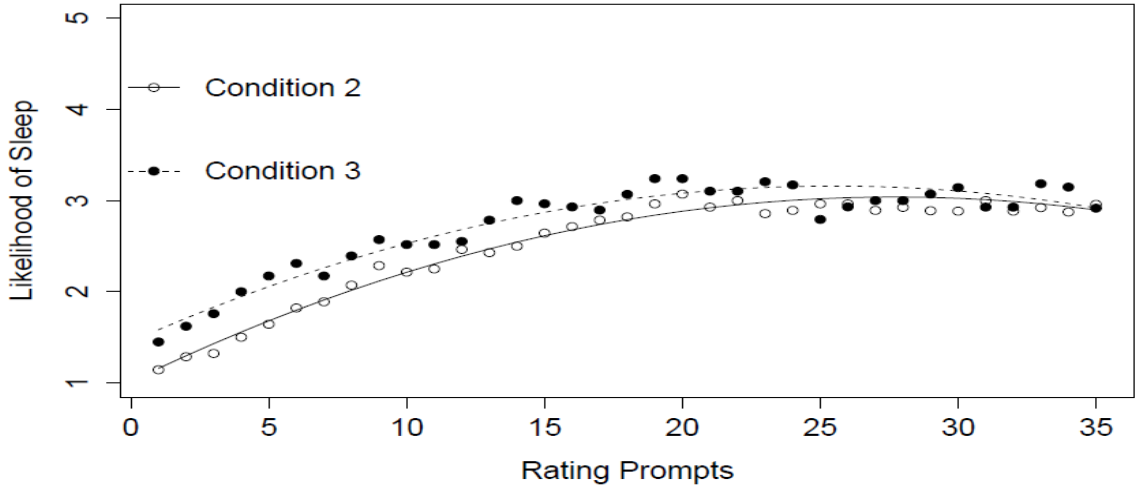
Sleep before test session

	Mean	Range
Average sleep time (diary/actiwatch validated)	4:24hrs	00:47-5:52
Rated Sleep quality (/100, high=best)	57.9	7-100
Rated Refreshed on waking (/100, high=best)	36.7	0-83
Time: waking to test	8:02hrs	4:37-11:31

➢No difference between three groups for any of above

Comparing Conditions

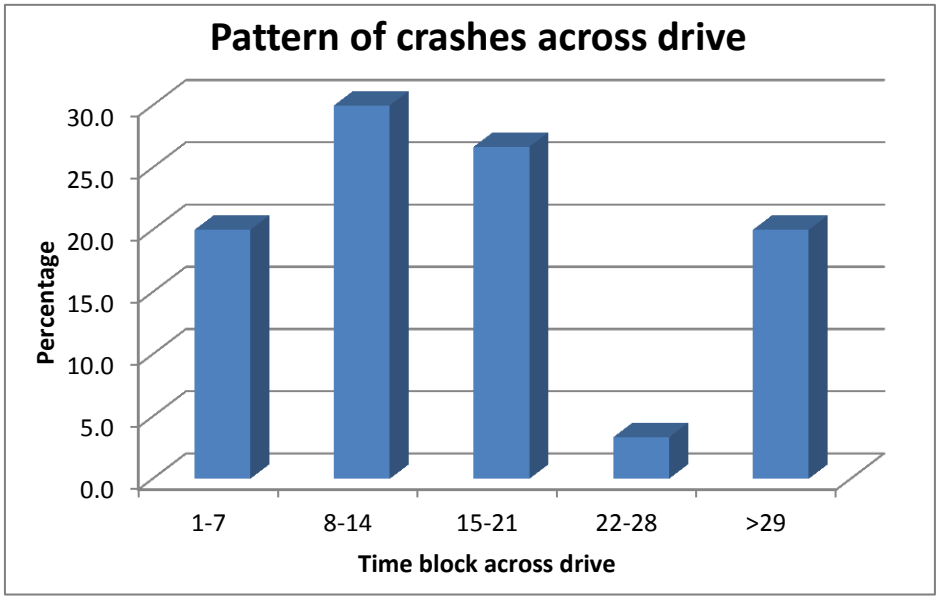




Shows similar increasing patterns for all rating measures across the drive
Few differences between groups so data combined

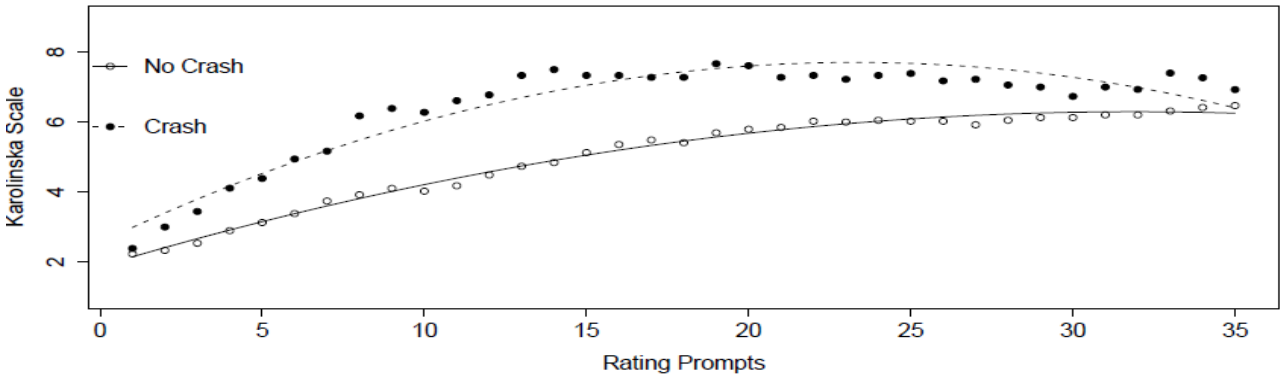
Patterns of safety-related outcomes

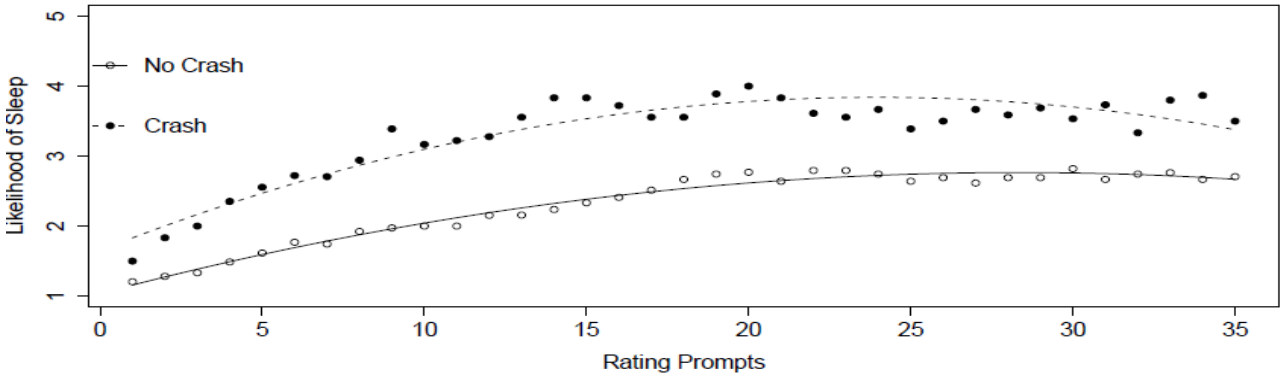
- 34.5% drivers had at least one crash, nearly half crossed centreline and almost all crossed road edge at least once.
- No differences in number of first crashes between groups

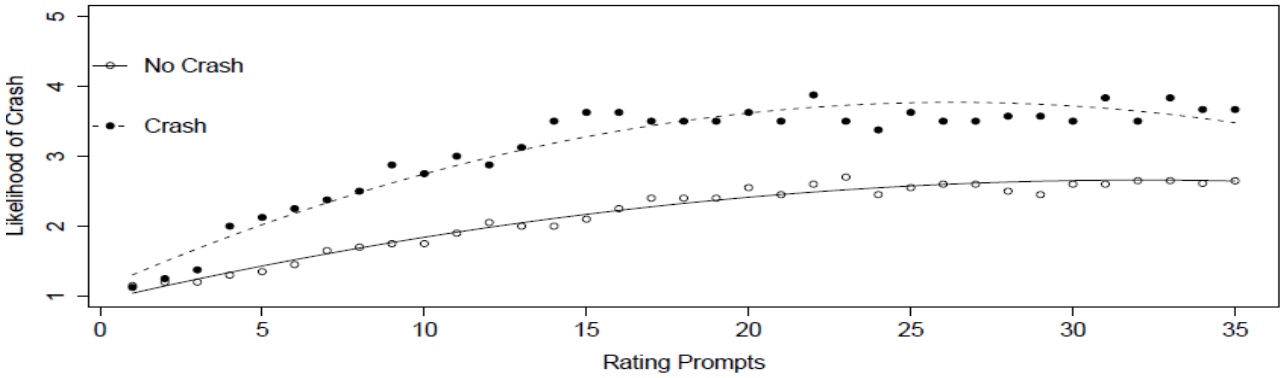


- Crashers/no crashers not different on any demographic, personal or recent behavioural characteristics.
- Button press to signify likelihood of crashing not related to actual crashes

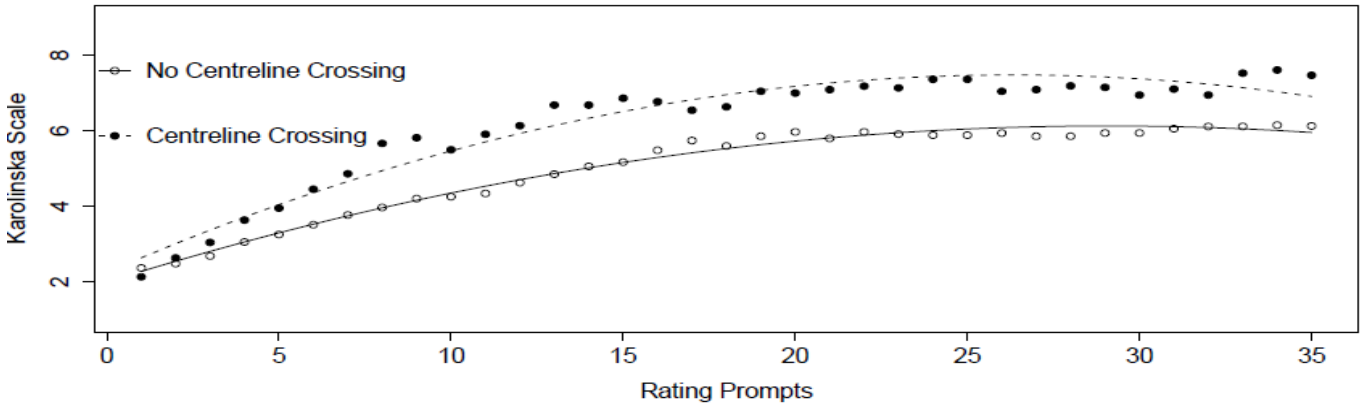
Changes in ratings over drive: **crashers and non-crashers**

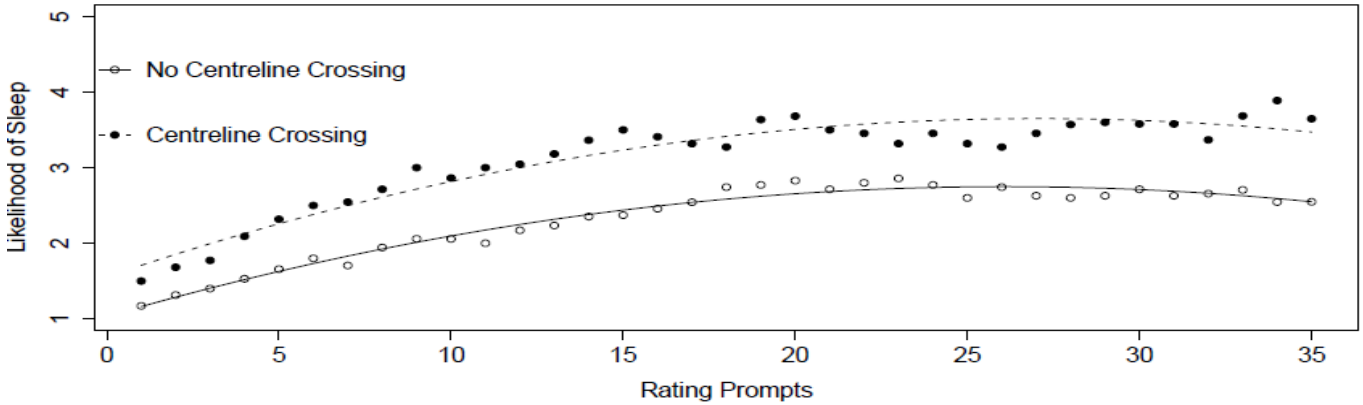


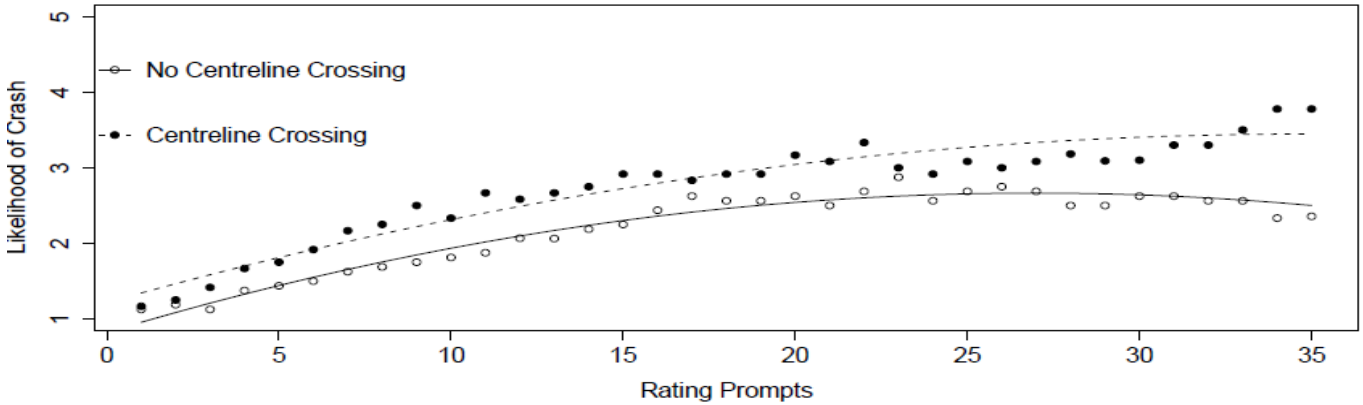




Ratings for drivers with and without **centreline crossings**



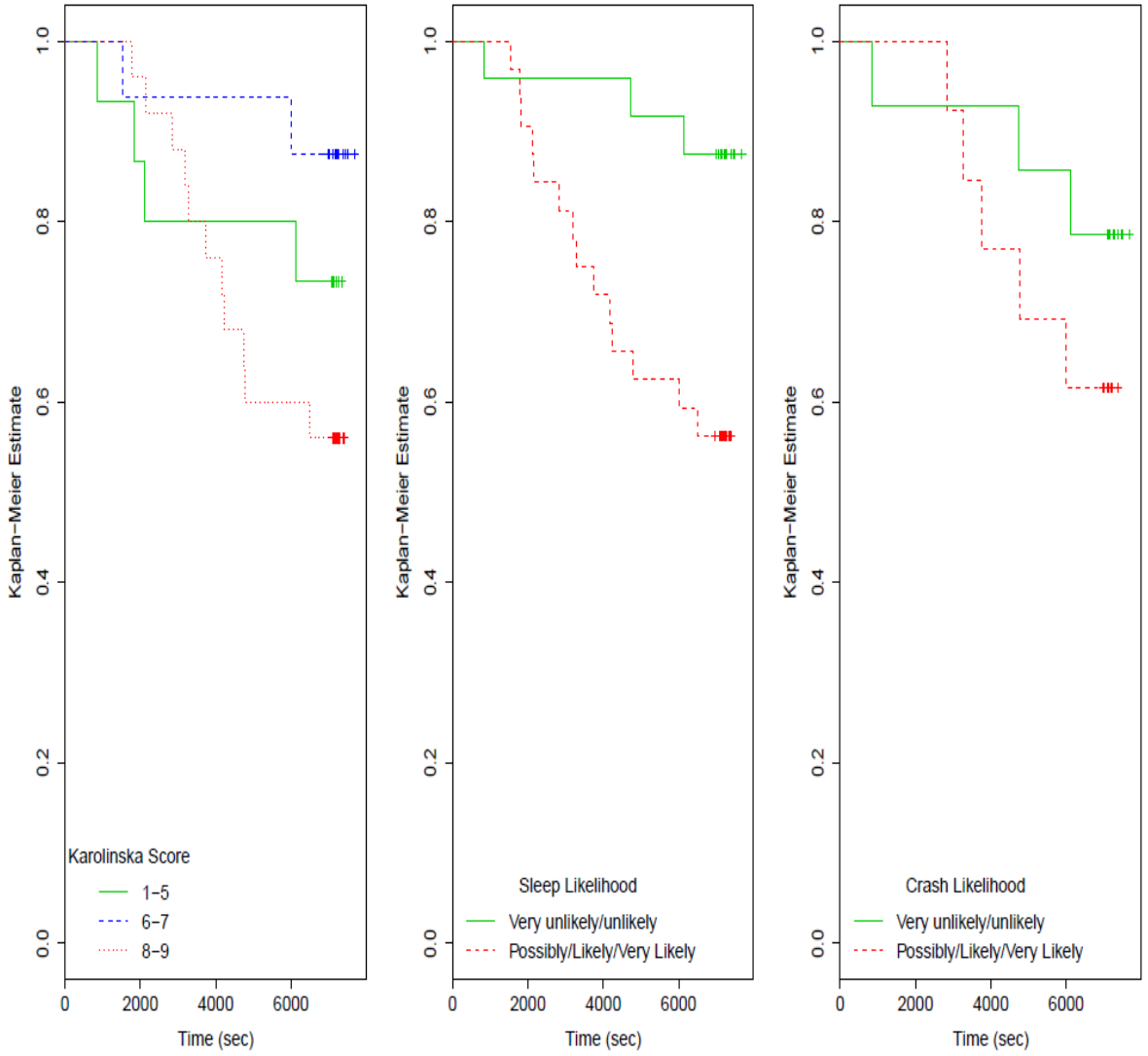




Do ratings predict crashes?

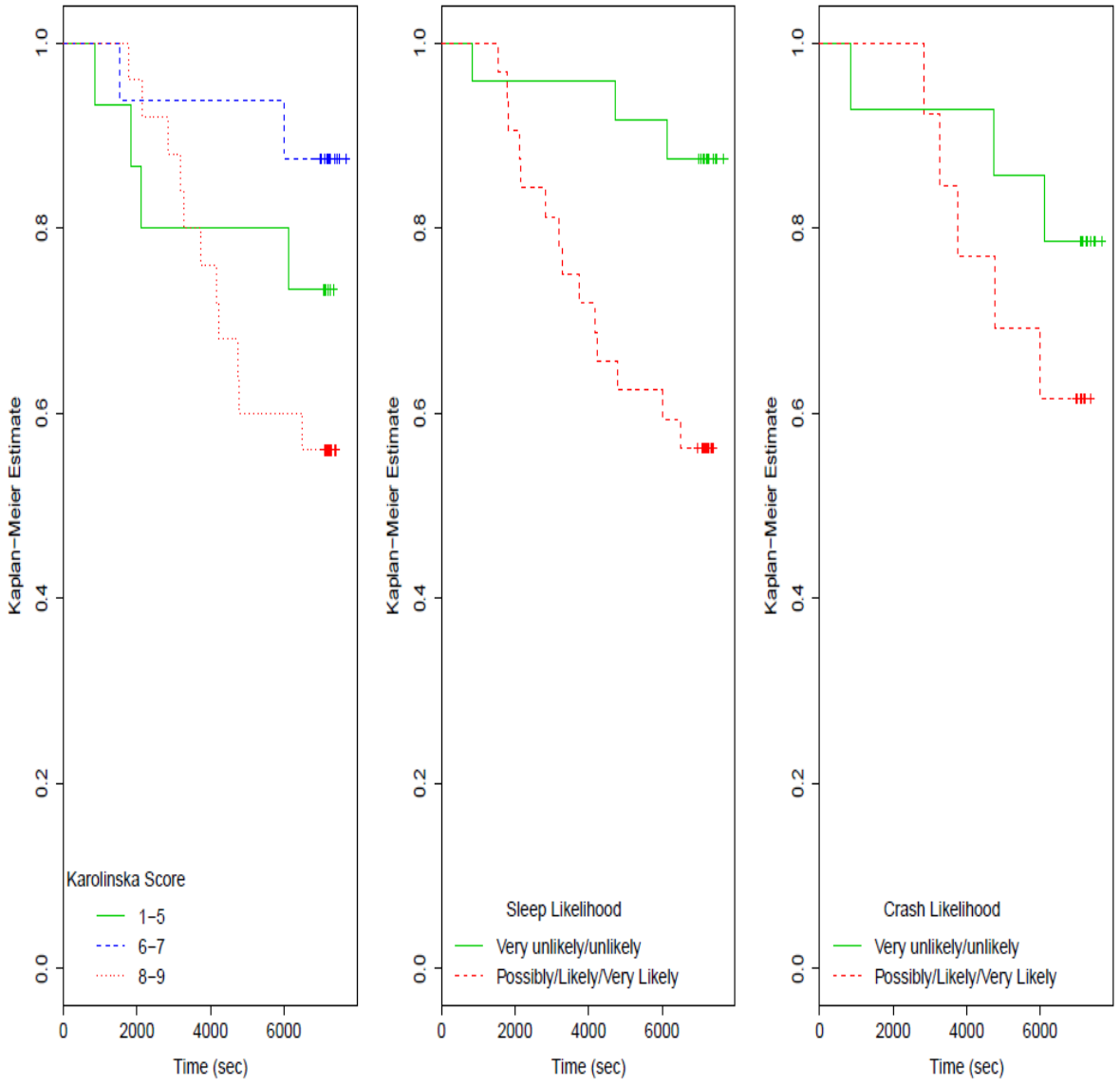
Survival analysis using Cox regression

- Ratings of falling asleep predicted first off-road crashes ($X^2_{(1)}=6.24, p<0.01$)
- Drivers rating falling asleep as possible/likely/very likely in the next few minutes increased hazard of first off-road crash by 4.3 times compared to those rating crashing as very/unlikely.
- Neither Sleepiness or Likelihood of crashing predicted crashes



Do ratings predict centreline crossings?

- Ratings of sleepiness and falling asleep predicted first centreline crossings ($X^2_{(1)}$=6.24,p<0.01)
- Rating high sleepiness in the next few minutes = 10.4 times higher hazards of crossings.
- Rating high likelihood of falling in the next few minutes= 9.4 times higher hazards of crossings.



Conclusions – Study design

1. Simulated drive produced increasing sleepiness (KSS), ratings of likelihood of falling asleep and of crashing.
   - ➲ Study manipulation was effective
2. Prompting ratings did not affect numbers of crashes or rating levels
   - ➲ No unintended effects of prompts

Can we detect when we are too tired to drive?

YES

- Drivers are clearly aware of increasing sleepiness and likelihood of falling asleep and of crashing
- Drivers who felt that they possibly could fall asleep in the next few minutes, were at least four times more likely to crash and showed 9 times the hazard of centreline crossings.
- Drivers who rated sleepiness as likely subsequently crossed centrelines 10 times more often than those who were alert
- Drivers' prediction of crash likelihood (prompted or not) was not as good.

What does this mean?

- Drivers ARE aware of increasing sleepiness, and increased likelihood of falling asleep BEFORE safety-related outcomes occur.
- Effect does not extend to crash likelihood.
- Higher ratings associated with safety-related outcomes.
- Drivers **can** make an 'informed decision' about the safety of their driving when fatigued.

What do we tell drivers about fatigue management?

Message to drivers:

- Drivers DO know that they are getting increasingly more tired so can choose to do something about it or not.
- Driving when tired is a road safety decision the same as the decision to drink and drive or to drive above the speed limit.

How do we influence drivers?

- We need solutions that increase motivation to manage fatigue (stop and rest or change to different activity), e.g.:

  Punitive approaches: penalties for driving while fatigued, including fines, loss of points, prosecutions.

  Facilitatory approaches: providing rest areas especially those that encourage people to use them, education on the need for responsible fatigue management as a driver.

Acknowledgements

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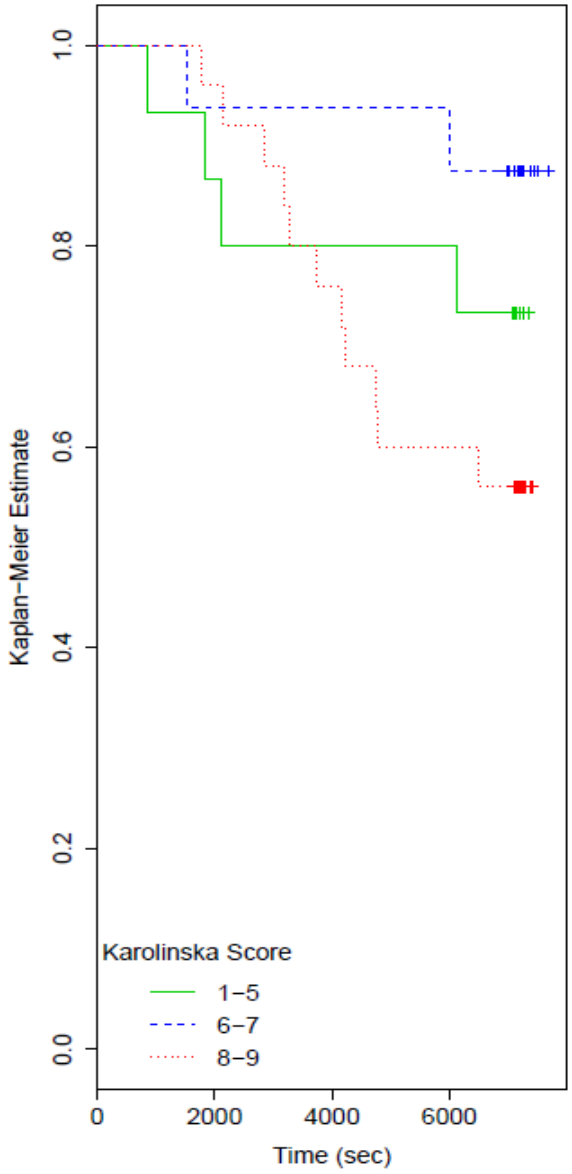
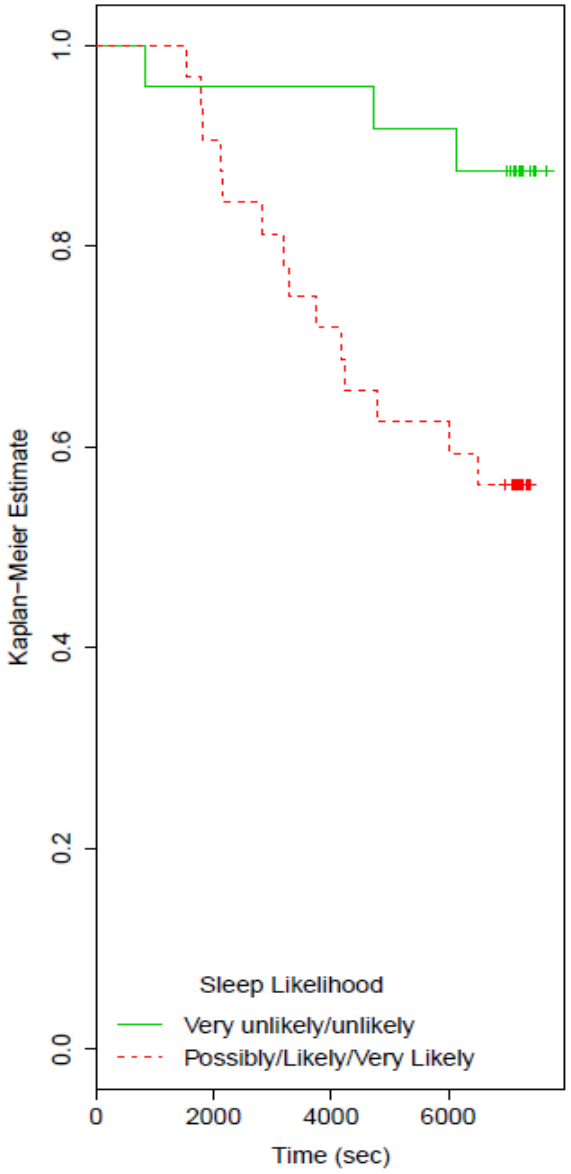
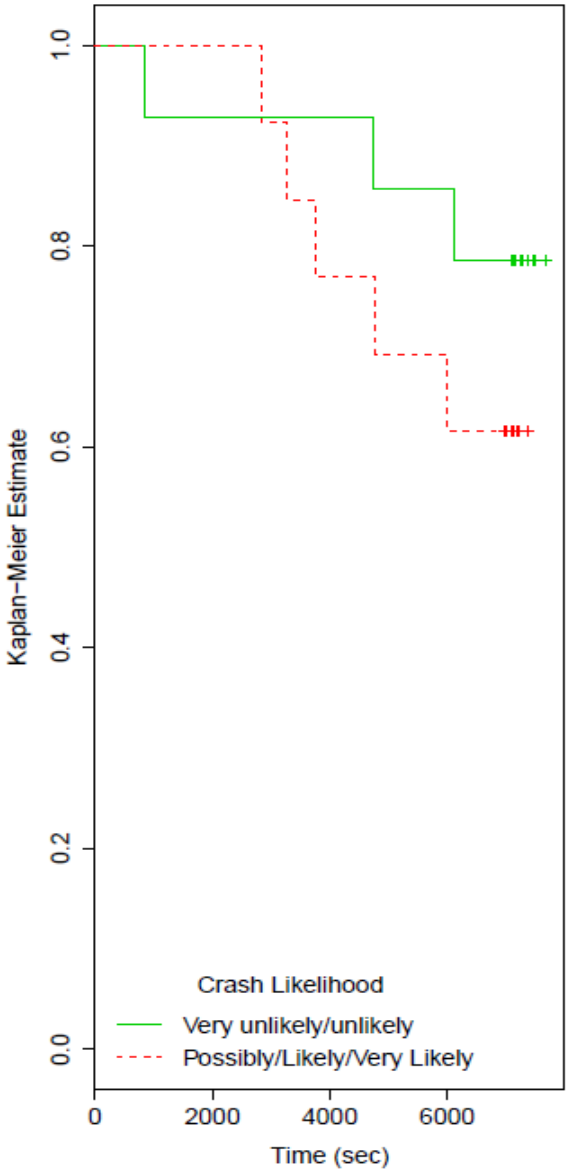
Survival plots for ratings preceding CRASHES







Survival plots for ratings preceding Centreline Crossings