



LEVER

*Light Electric Vehicle Education + Research Center*

# E-bike Safety Research

**Chris Cherry**

Civil and Environmental Engineering

University of Tennessee, Knoxville

TRB Bicycle and Pedestrian Safety Analysis

January 14, 2015

# Outline

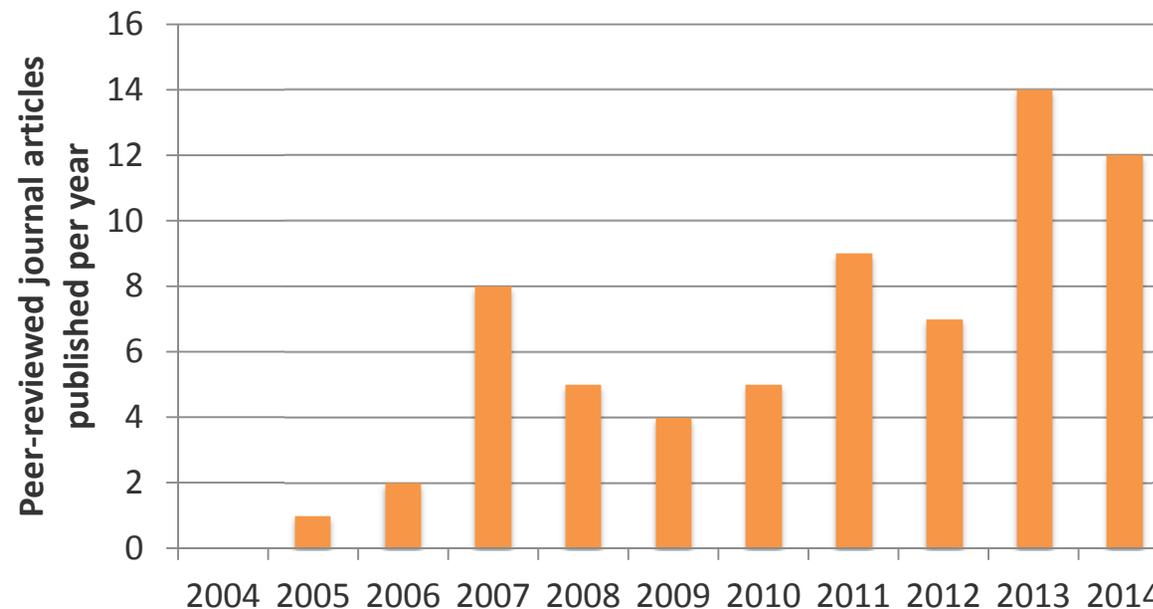
- E-bike research at TRB
- Quick review of e-bike safety research
  - China
  - Europe
- Our US-based safety behavior study

# Transportation Research Board (TRB) Activities

- Joint subcommittee revived in 2011 under TRB's Bicycling committee (chaired by J. Dill)
- Current co-chairs C. Cherry and G. Rose
- Active in developing calls for papers, research need statements, conference sessions etc.
- TRB is the single largest venue of publishing LEV research

# *E-bikes in the mainstream: Reviewing a decade of research*

- Elliot Fishman (Utrecht U. in Netherlands) and Chris Cherry (UT-Knoxville)
- In Review in “Transport Reviews” journal

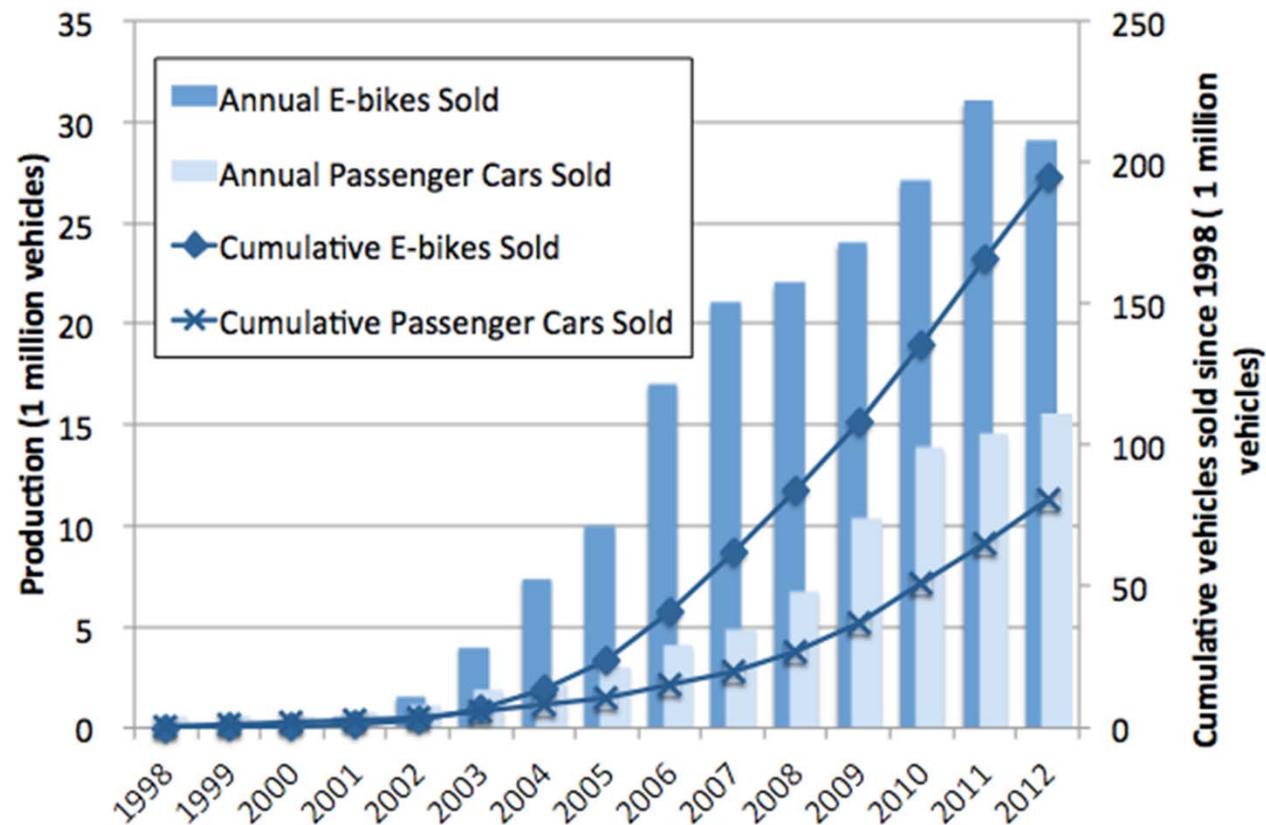


# Safety Research

- Not much out there: little data, qualitative
- China: Hospital and crash data, video conflicts
- North America: Some GPS studies, qualitative
- Europe: Two recent studies using hospital/crash data.

# Behavioral Research: Asia

- China



# Safety Research

- Perceptions and Behavior
  - Some riders perceive e-bikes are safer, esp. at intersections (North America and China)
  - In China, e-bike riders with at-fault crash history generally have lower safety attitudes and lower risk perception.
  - Better e-bike performance makes users state they behave better (Popovich) contrary to Langford observations.

1. Popovich, N. et al. Travel Behaviour and Society. *Travel Behaviour and Society* 1, 37–44 (2014).
2. MacArthur, J., Dill, J. & Person, M. E-Bikes in the North America: Results from an online survey. (2014).
3. Langford, B. C. A comparative health and safety analysis of electric-assist and regular bicycles in an on-campus bicycle sharing system. (2013).
4. Lin, S., He, M., Tan, Y. & He, M. Comparison Study on Operating Speeds of Electric Bicycles and Bicycles: Experience from Field Investigation in Kunming, China. *Transportation Research Record: Journal of the Transportation Research Board* 2048, 52–59 (2008).
5. Weinert, J. X., Ma, C., Yang, X. & Cherry, C. R. Electric Two-Wheelers in China: Effect on Travel Behavior, Mode Shift, and User Safety Perceptions in a Medium-Sized City. *Transportation Research Record* 2038, 62–68 (2007).

# Safety Research: China

- **Crash and Hospitalization Data**
  - Crash burden increasing
  - Going up nearly as fast as e-bike numbers rising
  - E-bike rider injuries more severe than bicyclist injuries
  - Motor vehicle collisions are most serious
  - Head injuries highest proportion of injuries requiring hospitalization—recommend helmets

1. Du, W. et al. Epidemiological profile of hospitalised injuries among electric bicycle riders admitted to a rural hospital in Suzhou: a cross-sectional study. *Injury Prevention* (2013). doi:10.1136/injuryprev-2012-040618
2. Feng, Z. et al. Electric-bicycle-related injury: a rising traffic injury burden in China. *Injury Prevention* 16, 417–419 (2010).
3. Hu, F., Lv, D., Zhu, J. & Fang, J. Related Risk Factors for Injury Severity of E-bike and Bicycle Crashes in Hefei. *Traffic Injury Prevention* 15, 319–323 (2014).

# Safety Research: China

- **Safety Behavior at Intersections**
  - Recent trend in video intersection safety behavior
  - E-bike riders tend to run red lights more than bikes
  - E-bike riders tend to wait less time at red lights
  - E-bike riders generally behave badly at high rates (along with bicyclists).
  - **The only worse offender in intersection conflicts are cars.**

1. Bai, L., Liu, P., Chen, Y., Zhang, X. & Wang, W. Transportation Research Part D. Transportation Research Part D 20, 48–54 (2013).
2. Du, W. et al. Accident Analysis and Prevention. Accident Analysis and Prevention 59, 319–326 (2013).
3. Wu, C., Yao, L. & Zhang, K. The red-light running behavior of electric bike riders and cyclists at urban intersections in China: An observational study. Accident Analysis and Prevention 1–7 (2011). doi:10.1016/j.aap.2011.06.001
4. Yang, J., Hu, Y., Du, W., Powis, B. & Ozanne-Smith, J. Unsafe riding practice among electric bikers in Suzhou, China: an observational study. BMJ ... (2014). doi:10.1136/bmjopen-2013-003902
5. Zhang, Y. & Wu, C. Accident Analysis and Prevention. Accident Analysis and Prevention 52, 210–218 (2013).

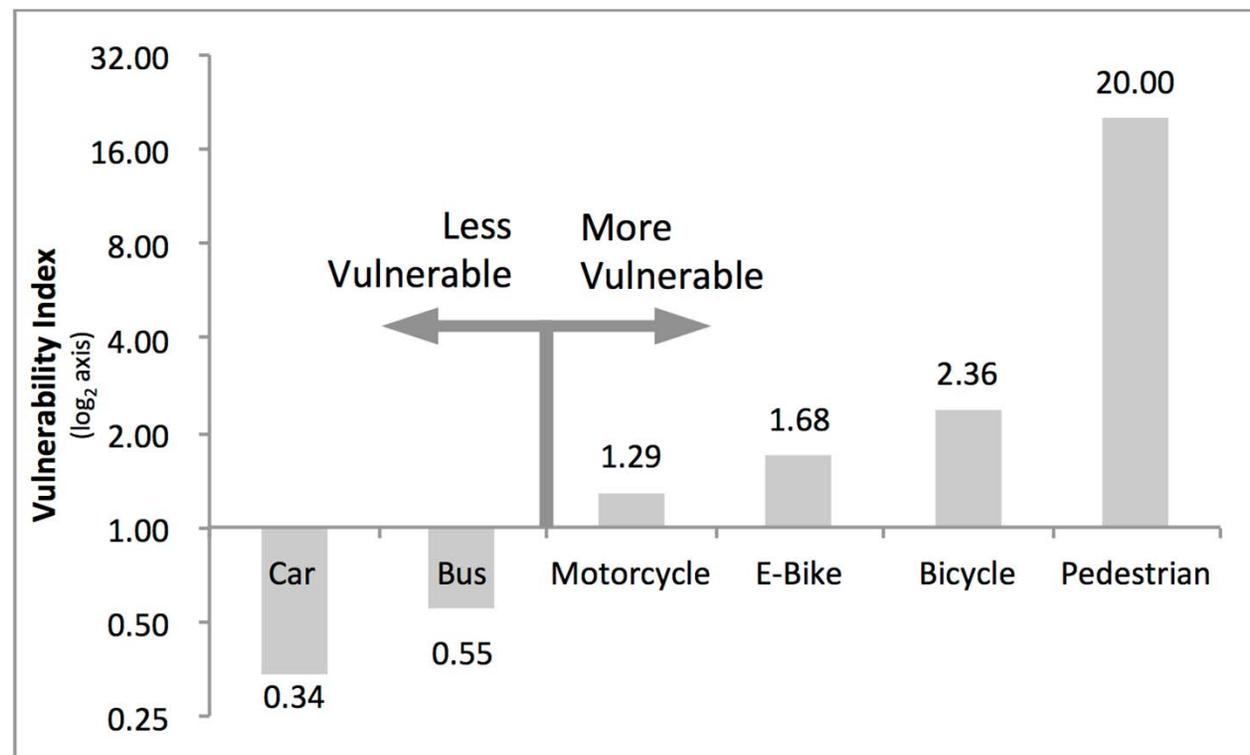
# Safety Research: China

- E-bike Speed
  - Three studies investigated cruising speed of e-bike riders
  - All three found  $\sim +40\%$  speed differential with bicycles
  - Main holes in literature is related to fault, vulnerability, and conflict modes

1. Cherry, C. & He, M. Alternative Methods of Measuring Operating Speed of Electric and Traditional Bikes in China-Implications for Travel Demand Models. *Journal of the Eastern Asia Society for Transportation Studies* **8**, 1424–1436 (2010).
2. Lin, S., He, M., Tan, Y. & He, M. Comparison Study on Operating Speeds of Electric Bicycles and Bicycles: Experience from Field Investigation in Kunming, China. *Transportation Research Record: Journal of the Transportation Research Board* **2048**, 52–59 (2008).
3. Yang, J., Hu, Y., Du, W., Powis, B. & Ozanne-Smith, J. Unsafe riding practice among electric bikers in Suzhou, China: an observational study. *BMJ* ... (2014). doi:10.1136/bmjopen-2013-003902

# E-bikes unsafe or vulnerable?

- Recent studies on e-bikes find:
  - e-bike riders behave poorly
  - e-bike fatalities up a little less than e-bike growth



# Safety Research: Europe

- Two new studies investigate hospitalization data
  - 23 hospitalizations in Switzerland. Head and upper extremity.
    - Not as severe as China (helmet use and single-vehicle crashes)
  - 294 e-bike crashes in Netherlands
    - Very little difference between bikes
    - E-bikes that displace cars would have positive safety benefits

1. Papoutsis, S., Martinolli, L., Braun, C. T. & Exadaktylos, A. K. E-Bike Injuries: Experience from an Urban Emergency Department—A Retrospective Study from Switzerland. *Emergency Medicine International* **2014**, 1–5 (2014).  
2. Schepers, J. P., Fishman, E., Hertog, den, P., Wolt, K. K. & Schwab, A. L. Accident Analysis and Prevention. *Accident Analysis and Prevention* **73**, 174–180 (2014).

# cycleUshare



# Safety Research

- North America
  - E-bike riders act almost exactly like bicyclists
  - Violate traffic control devices or wrong-way ride at about same rate
  - Travel speeds are not detrimental to e-bikes



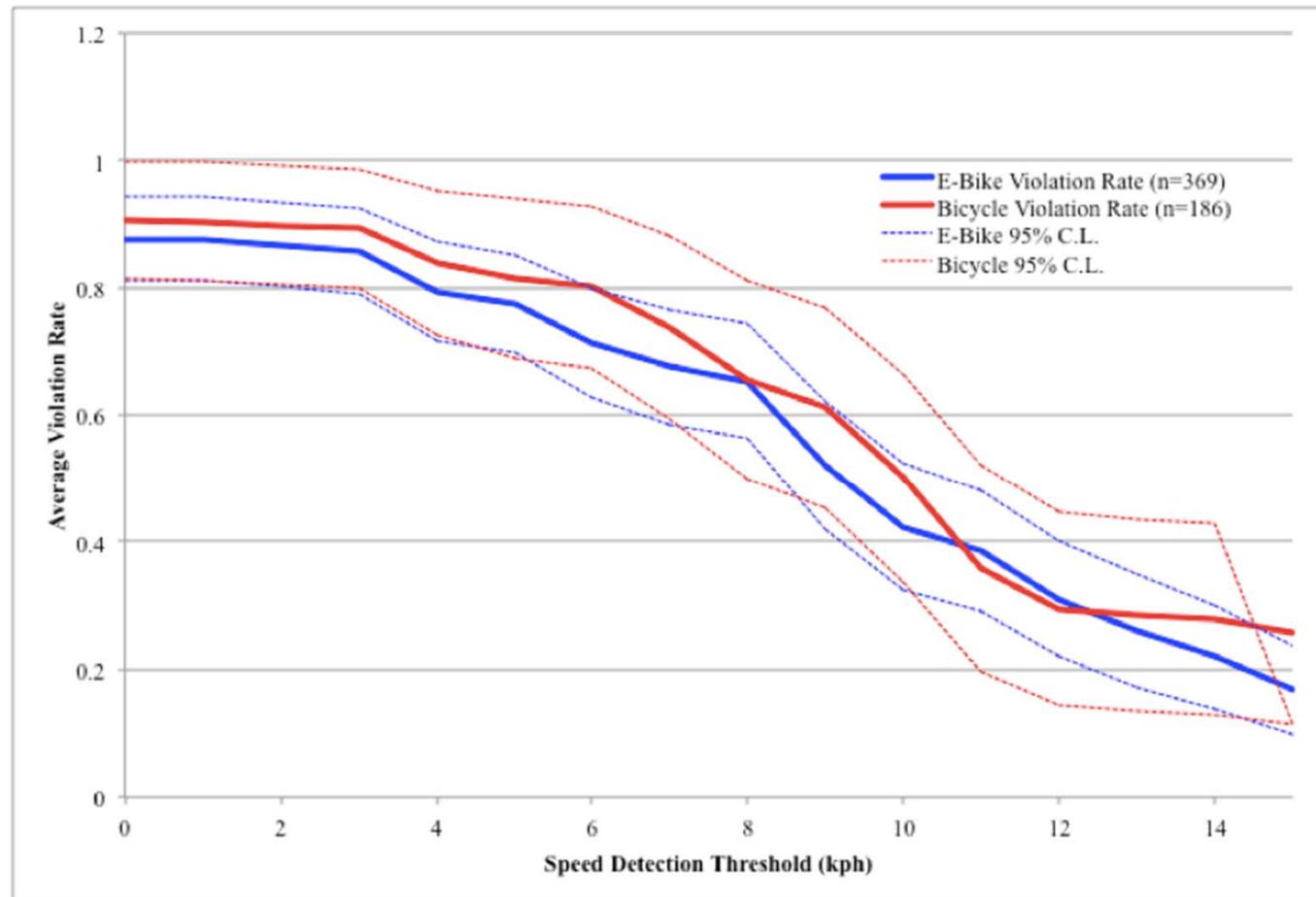
**Study of e-bike user behaviors at UTK**

## Travel Speeds

		Mode	Average	Top Speed (99th Percentile)
On Road	Bicycle		10.5	29.0
	E-Bike		13.3	32.0
Shared Use	Bicycle		12.6	26.0
	E-Bike		11.0	25.4

1. Langford, B. C. A comparative health and safety analysis of electric-assist and regular bicycles in an on-campus bicycle sharing system. (2013).

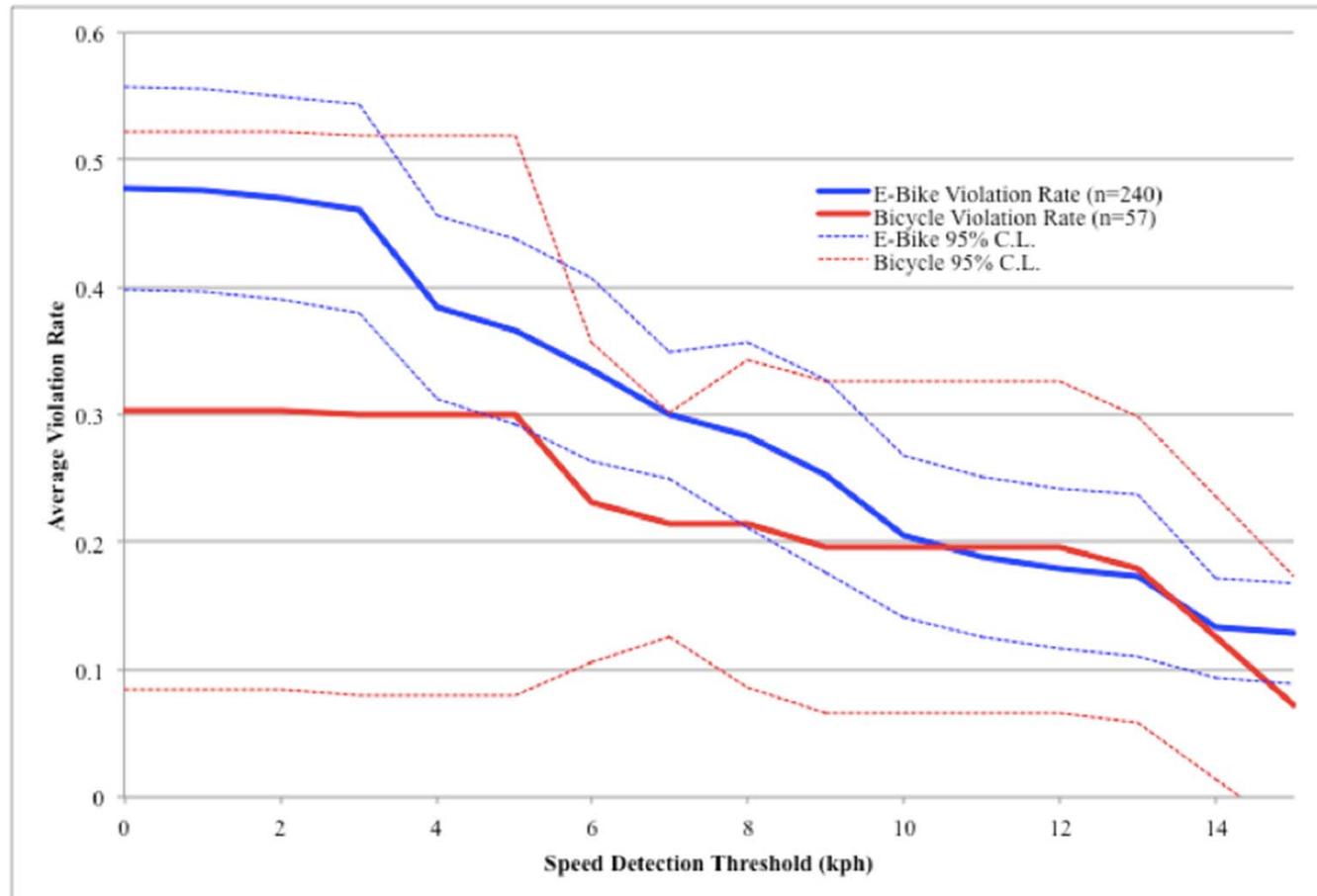
# Safety Research



**Figure 9: Average Violation Rates at Stop-Control Intersection Approaches.**

1. Langford, B. C. A comparative health and safety analysis of electric-assist and regular bicycles in an on-campus bicycle sharing system. (2013).

# Safety Research



**Figure 10: Average Violation Rates at Signalized Intersection Approaches.**

1. Langford, B. C. A comparative health and safety analysis of electric-assist and regular bicycles in an on-campus bicycle sharing system. (2013).

# Conclude

- E-bikes in NA and Europe about the same as bicycles (so far as we can tell)
- Pure safety research usually needs more and detailed data
  - possible but not available in China and not necessarily transferable elsewhere
  - Safety behavior is best proxy we have
  - Big gaps in cause/fault analysis
- Big data and telematics can help
- Behavioral data is key to all questions about impacts on the transportation/health system. How do people use e-bikes and what modes do they displace