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# Comments on External Review Draft of PM Integrated Science Assessment

## Prepared on behalf of Utility Air Regulatory Group
## For presentation to CASAC
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# Why Does C-R Shape Matter?

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- Evidence of an *association* between pollutant and health risk helps inform the question of whether a C-R relationship exists at all

- *Shape* of the C-R relationship addresses whether the slope of a C-R relationship varies at different exposure levels
  - Information on C-R shape thus better informs the question of whether/where/how much public health might be improved by reducing $PM_{2.5}$ exposures
  - This is the key question for a sound judgment on the $PM_{2.5}$ NAAQS

Estimates of C-R shape are subject to both statistical uncertainty and model uncertainty

# No Clear Pattern Appears in the Recent C-R Shape Estimates, Even Without Showing Their Statistical Uncertainties

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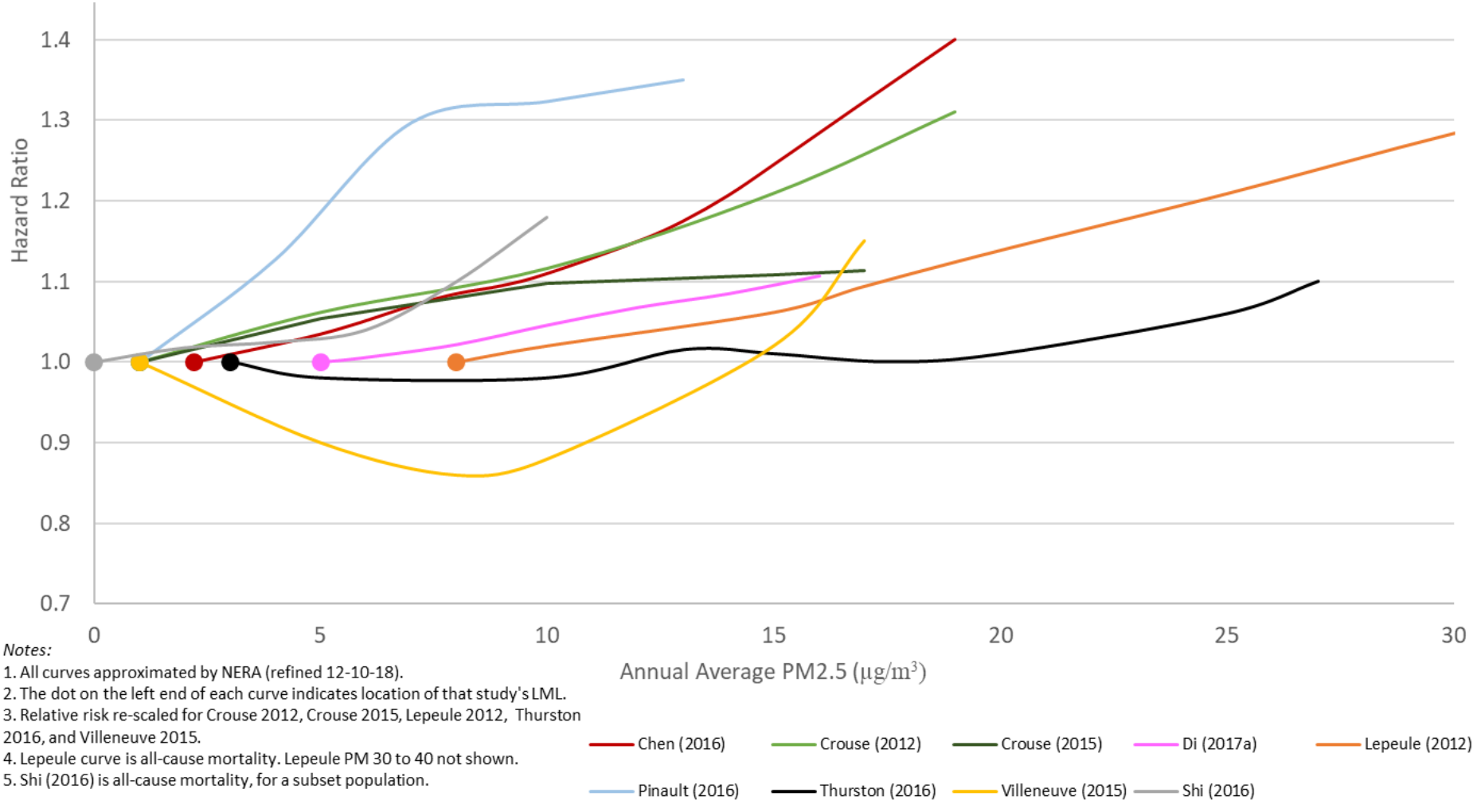
Example: Chronic Nonaccidental Mortality Risk "Best Estimate" Shapes (for all U.S. & Canadian papers cited in ISA, graphed with consistent scales and reference points)




*Notes:*

1. All curves approximated by NERA (refined 12-10-18).
2. The dot on the left end of each curve indicates location of that study's LML.
3. Relative risk re-scaled for Crouse 2012, Crouse 2015, Lepeule 2012, Thurston 2016, and Villeneuve 2015.
4. Lepeule curve is all-cause mortality. Lepeule PM 30 to 40 not shown.
5. Shi (2016) is all-cause mortality, for a subset population.

# Statistical Uncertainty on Each Estimate Can Limit Conclusions About C-R Slope in Specific $PM_{2.5}$ Exposure Ranges

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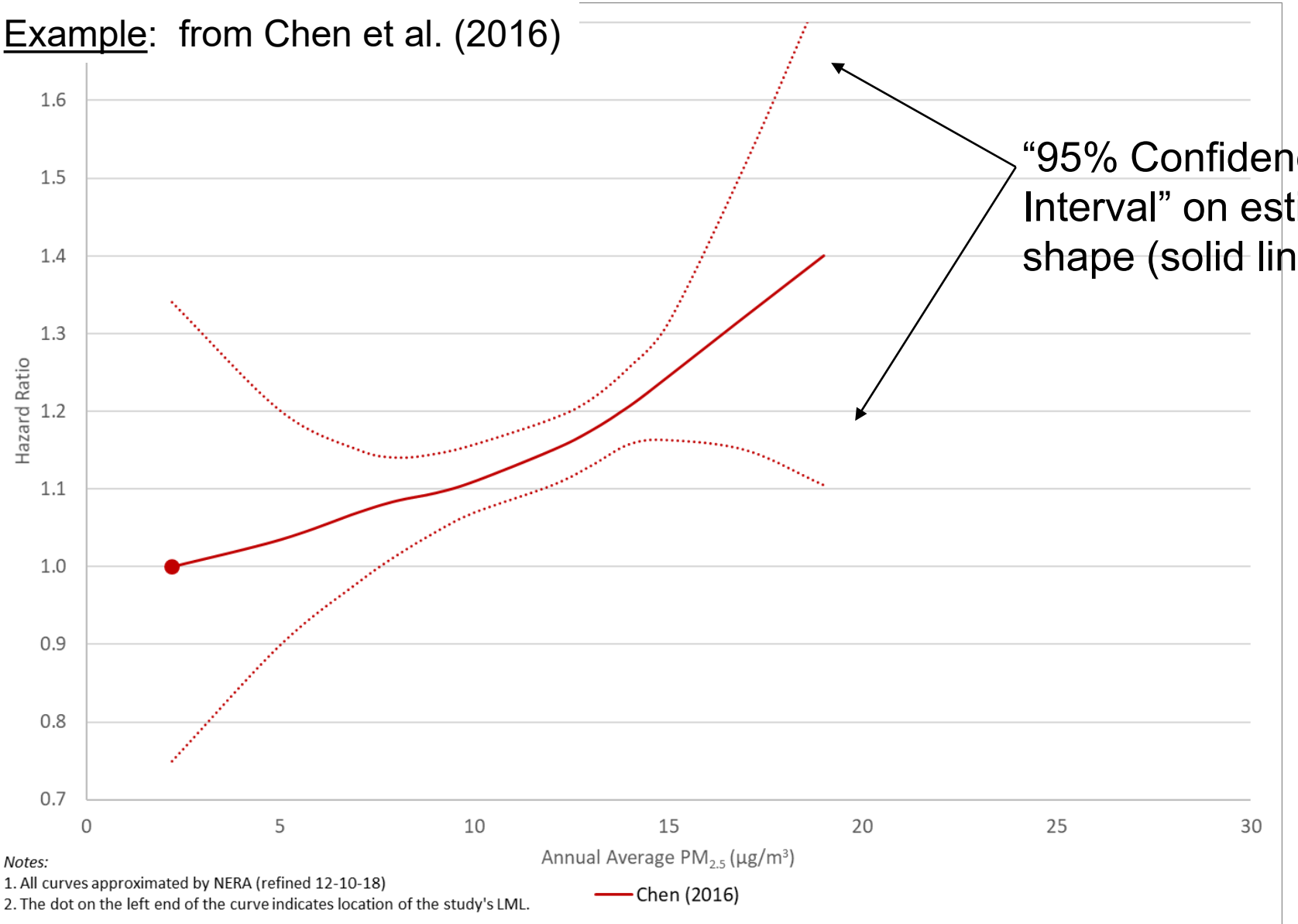
Example: from Chen et al. (2016)




"95% Confidence Interval" on estimated shape (solid line)

*Notes:*
1. All curves approximated by NERA (refined 12-10-18)
2. The dot on the left end of the curve indicates location of the study's LML.

# Confidence Intervals on C-R Shapes Are Being Calculated Inconsistently

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Example: 2 papers both using natural splines, both with reference at LML:

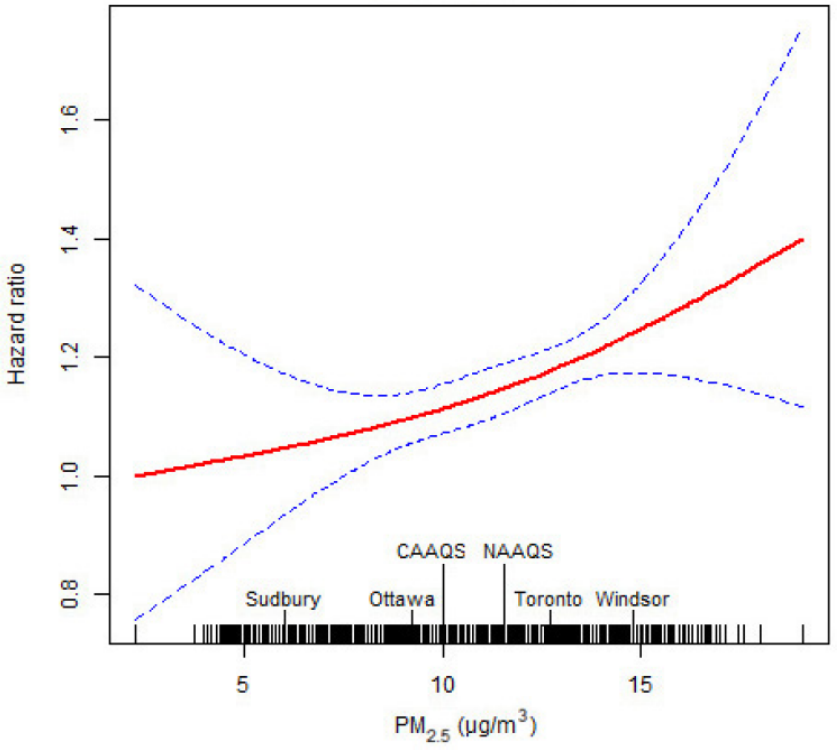


Fig.2, Chen et al. (2016)

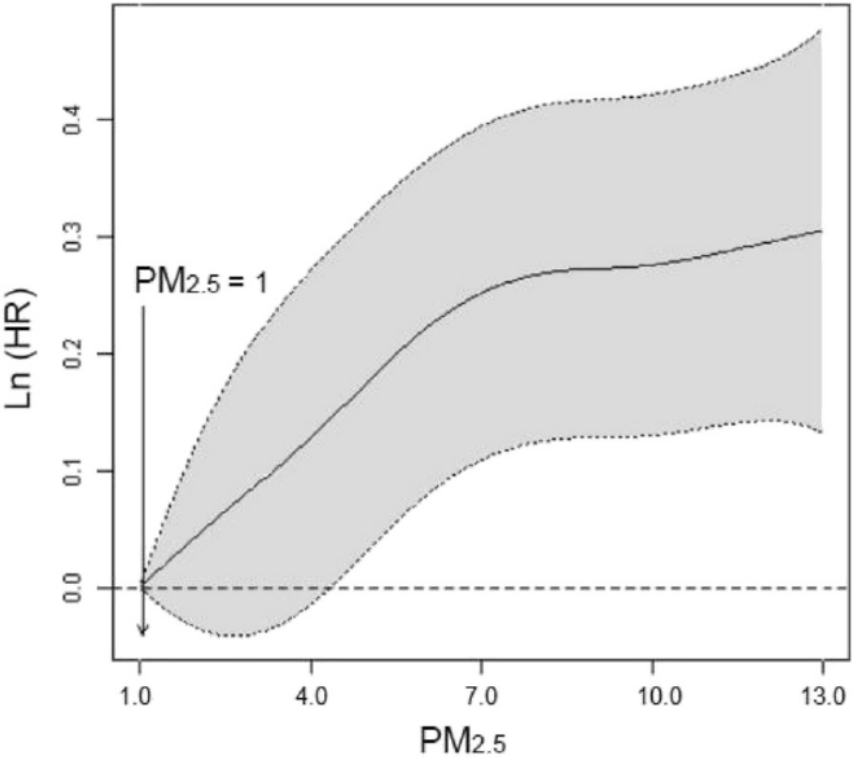


Fig.2, Pinault et al. (2016)

With such inconsistency, the fundamental interpretation of the confidence intervals may differ with each paper

# Conclusions and Recommendations

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- More shape estimates now than in prior $PM_{2.5}$ NAAQS reviews
  - Highly varied, ranging from sublinear to supralinear
  - Their confidence intervals (CIs) further erode any ability to discern what shape applies at any $PM_{2.5}$ level
- Smoothing methods need closer evaluation and development
  - Precise interpretation of the meaning of shape CIs
  - Evaluation of inconsistencies in how CIs are computed
- Methods needed for synthesizing model uncertainty and statistical uncertainty on slope at varying $PM_{2.5}$ exposure levels

Both needed before C-R shape evidence can be considered robust and reliable as a *primary* basis for policy judgments.