Implications of the Bootstrap Analyses on SRS Co-Exposure Models

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Overview

- Background
- Questions for SRS WG Discussion
- Bootstrap Analysis
- Observations & Implications
- Conclusions

Background & Questions

SRS WG Assumption

Subcontractor construction trade workers (subCTWs) were hired for more hazardous work than DuPont CTWs, and therefore had greater potential for internal exposures.

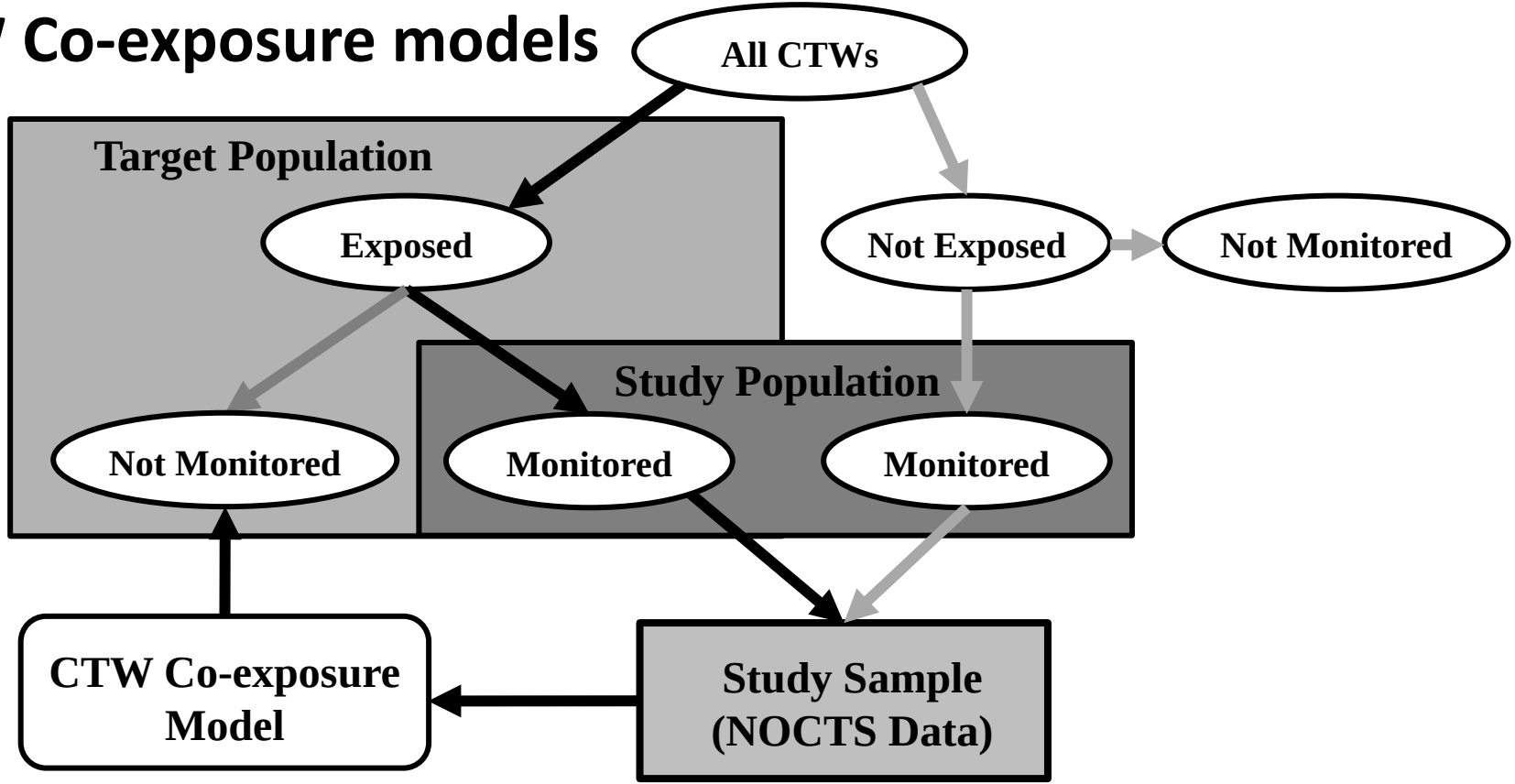
Generally discussed during the November SRS WG Meetings and the December 2020 ABRWH December 8th Meeting.

Questions for SRS WG Discussion?

- Do subcontractor construction trade workers (subCTWs) exhibit higher internal exposures than DuPont CTWs?
- Should subcontractor construction trade workers (subCTWs) have their own co-exposure model?
- Are the current co-exposure models (CTWs vs. non-CTWs) models acceptable for dose reconstruction purposes?

Bootstrap Analysis

CTW Co-exposure models



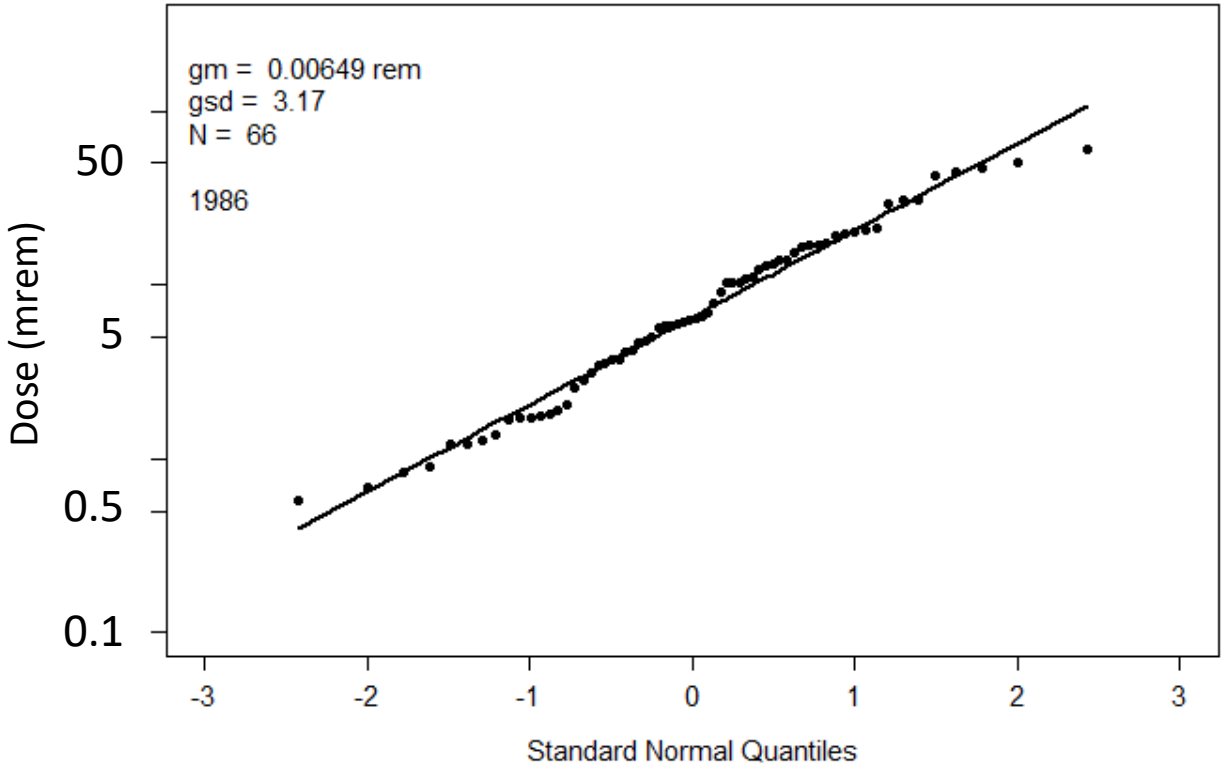
Study Sample (NOCTS Tritium Exposures)

Strata / Co-exposure Model	# tritium samples	# unique workers
Subcontractor CTWs	**12,484**	**237**
DuPont CTWs	**19,993**	**185**
Combined CTWs	**32,477**	**421***
nonCTWs	**110,602**	**728**
TOTALS	**143,079**	**1,079***

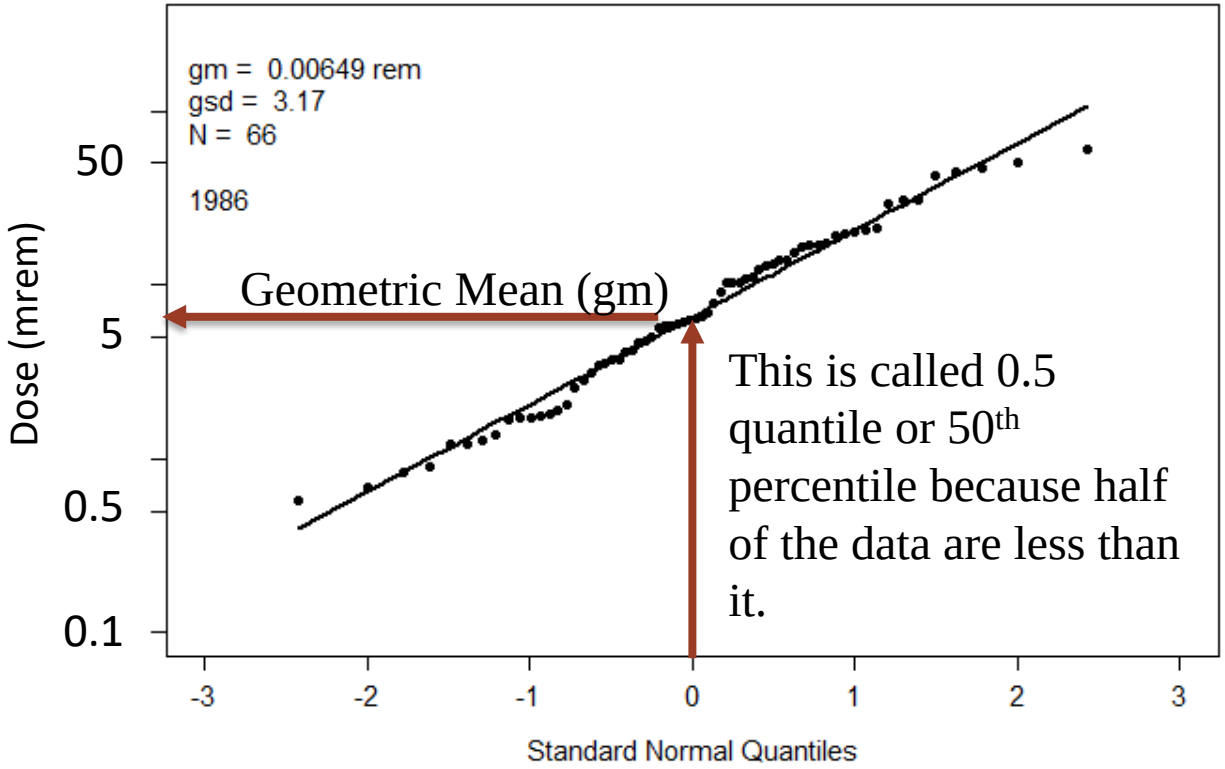
Co-exposure Models

* Some workers changed strata between 1972-1990. One worker is in both the subCTW and DuPont CTW counts, five workers in both the subCTW and nonCTW counts, and 65 workers in both the DuPont CTW and nonCTW counts.

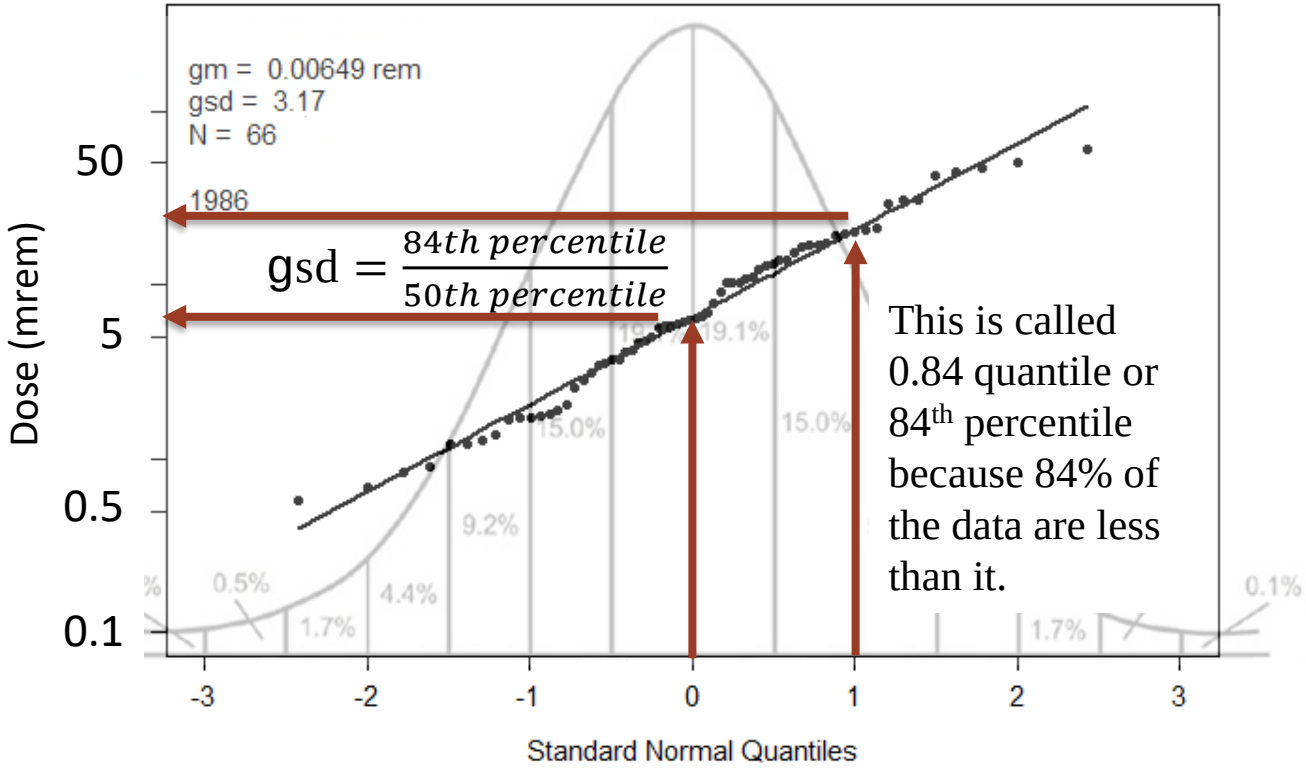
qq plots to graphically display the results



Geometric Mean



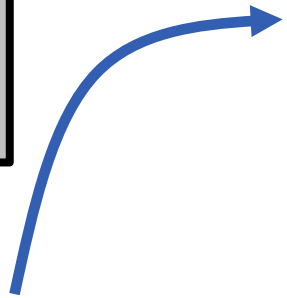
Geometric Standard Deviation



What is Bootstrapping? Sampling with Replacement

Study Sample (NOCTS Data)

<u>FOR EXAMPLE</u>
Tritium Exposures
Year = 1986
N = 66 CTWs
gm = 6.5 mrem
gsd = 3.17



Randomly sampled 66 values from original 1986 NOCTS Data with replacement

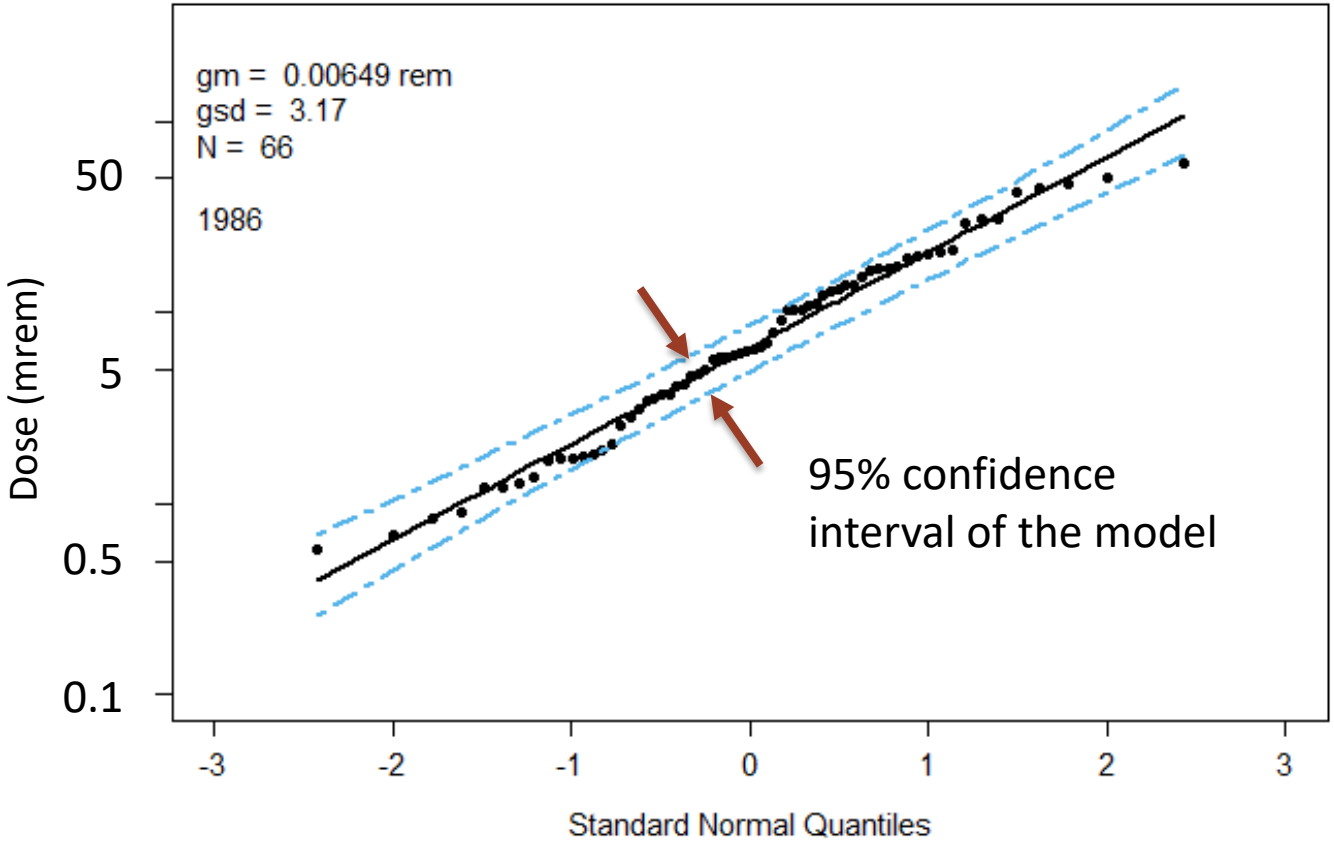
1. gm = 7.8 mrem; gsd = 2.72
2. gm = 6.0 mrem; gsd = 3.15
3. gm = 6.4 mrem; gsd = 2.08
4. .
5. .

10,000. gm = 5.2 mrem; gsd = 3.19

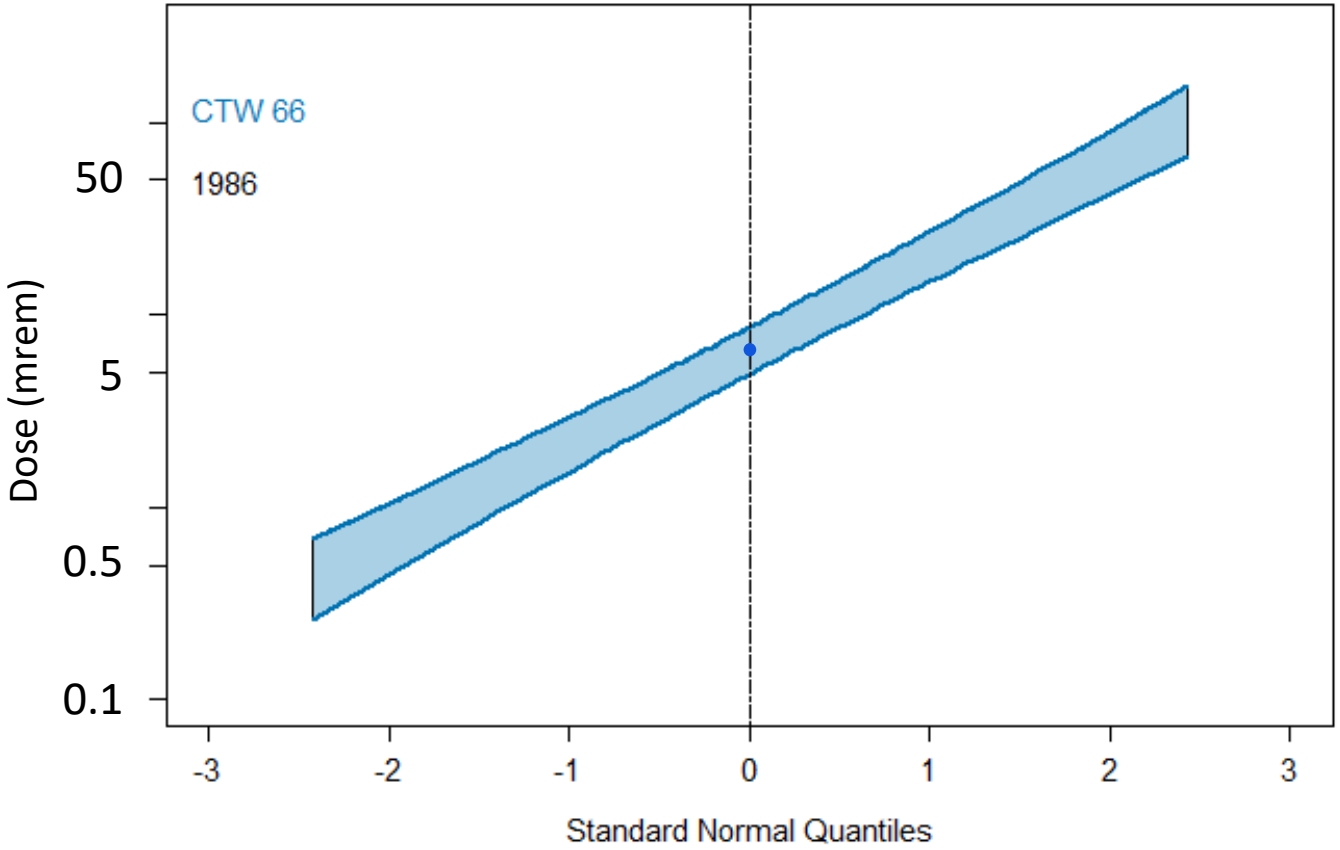
<u>BENEFIT:</u> Estimate statistical parameters for things that have unknown properties.

<u>95% Confidence Intervals</u>

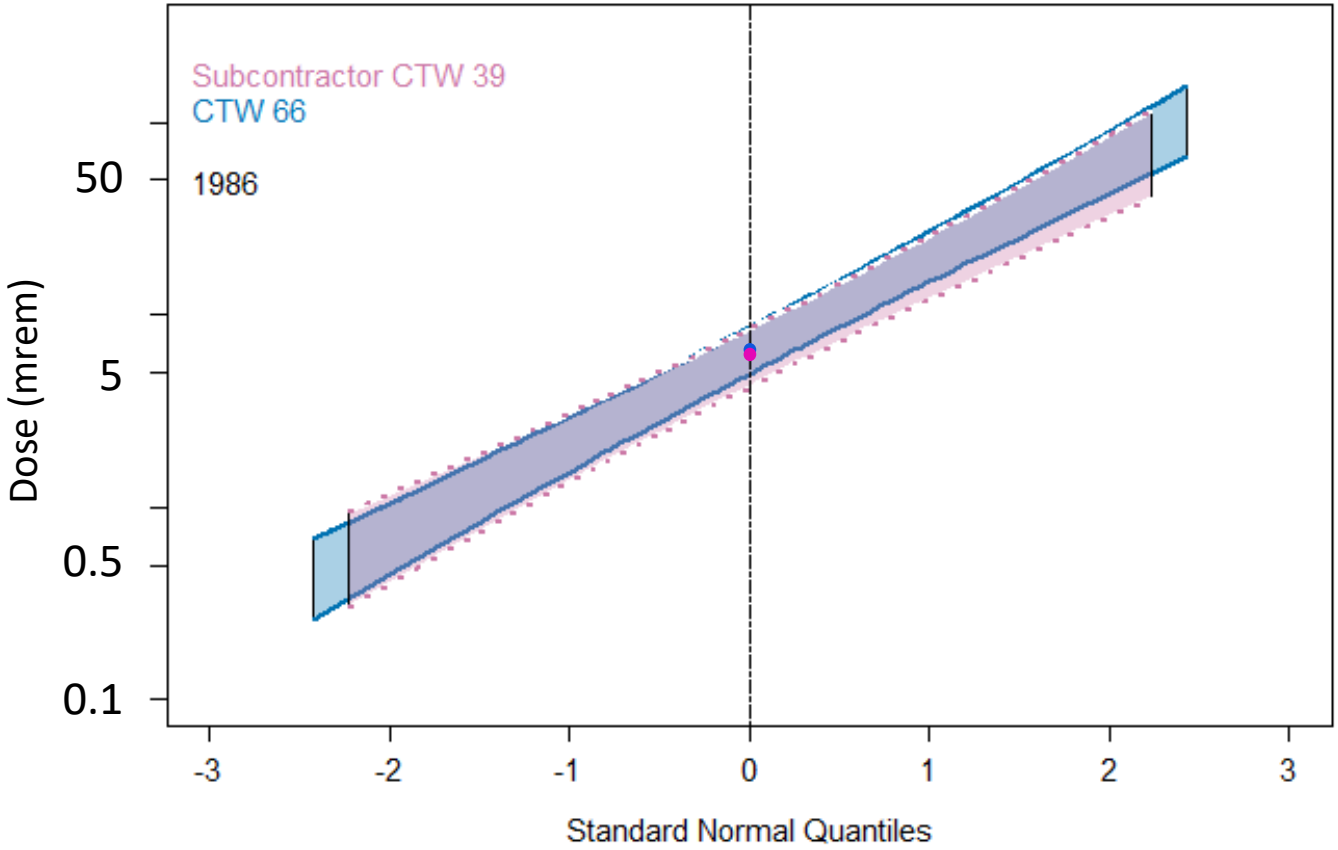
1986 CTW co-exposure model with confidence intervals



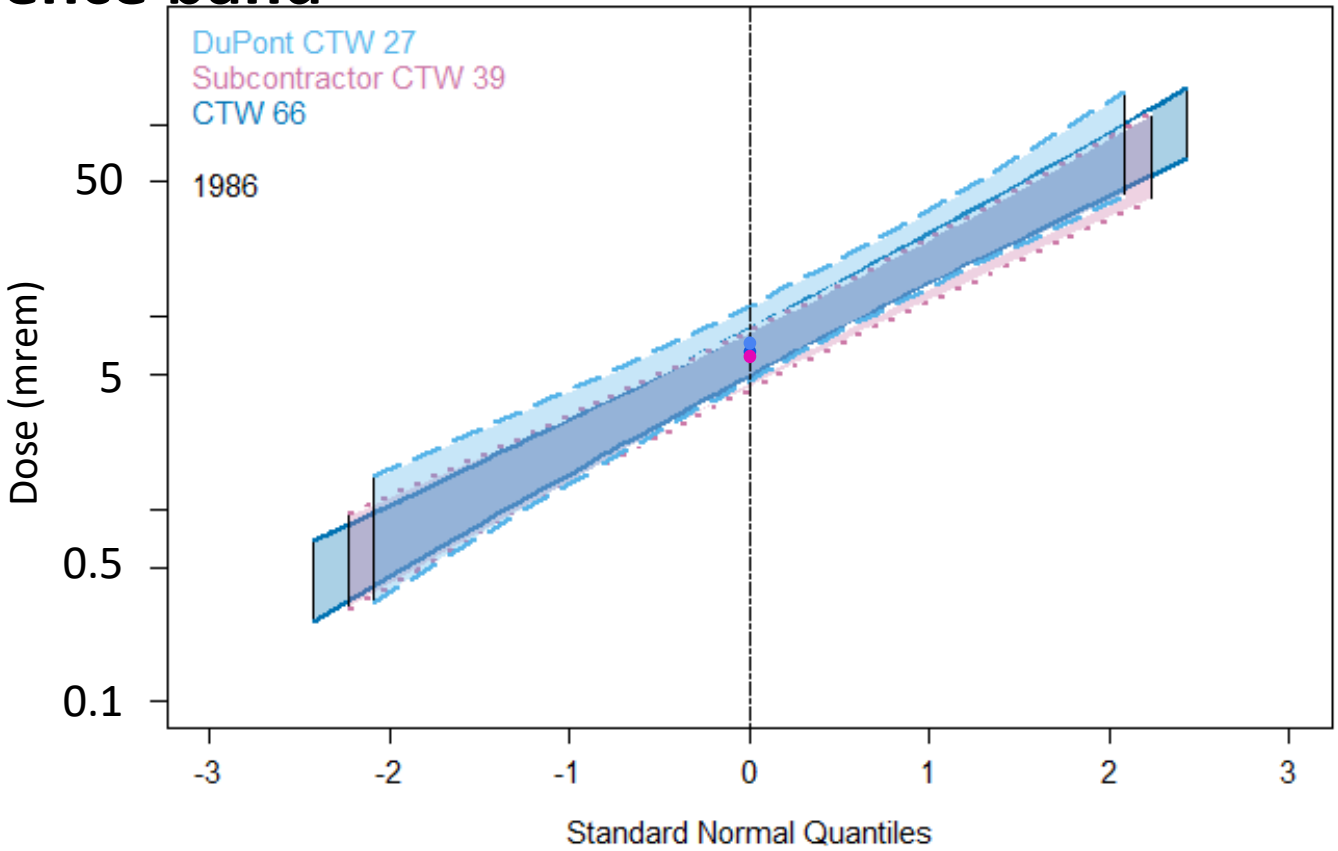
1986 CTW co-exposure model confidence band



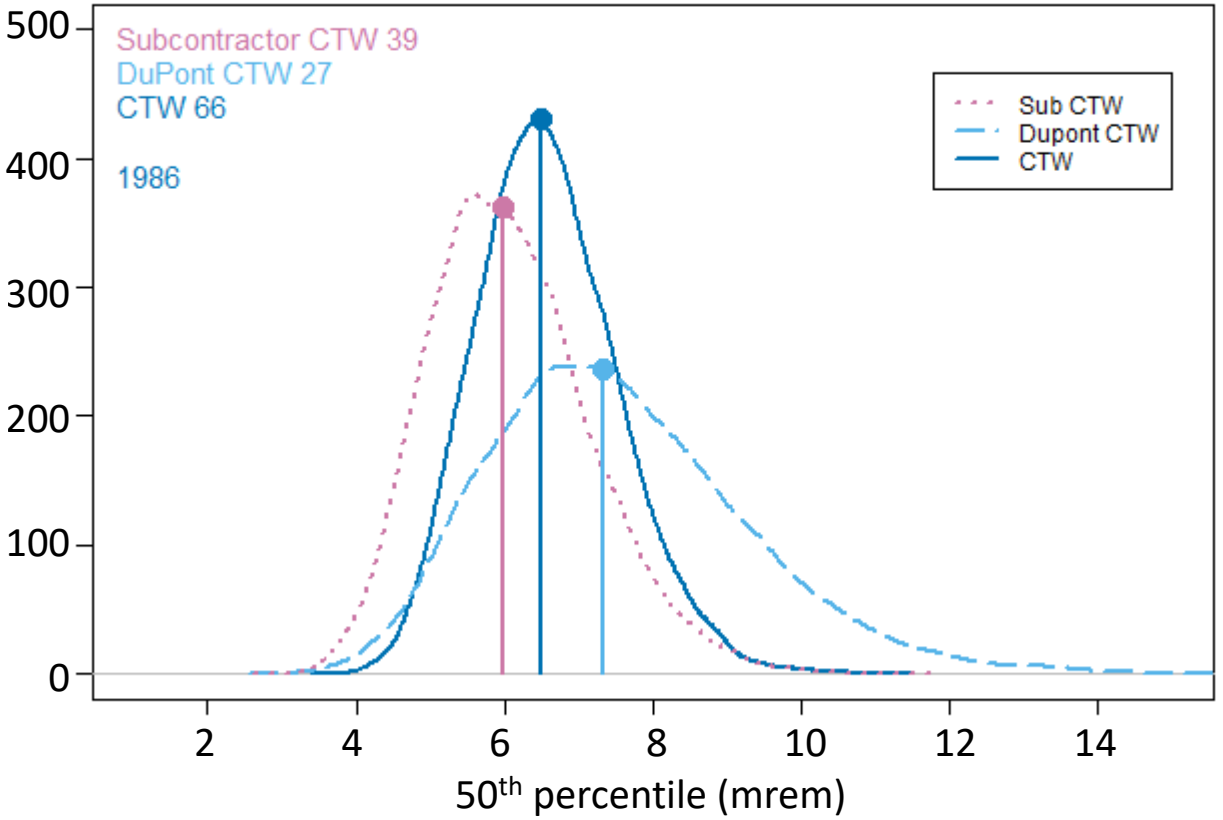
1986 CTW & sub-CTW co-exposure model confidence band



1986 CTW, sub-CTW, & DuPont CTW co-exposure model confidence band



1986 density plots with bootstrap uncertainties

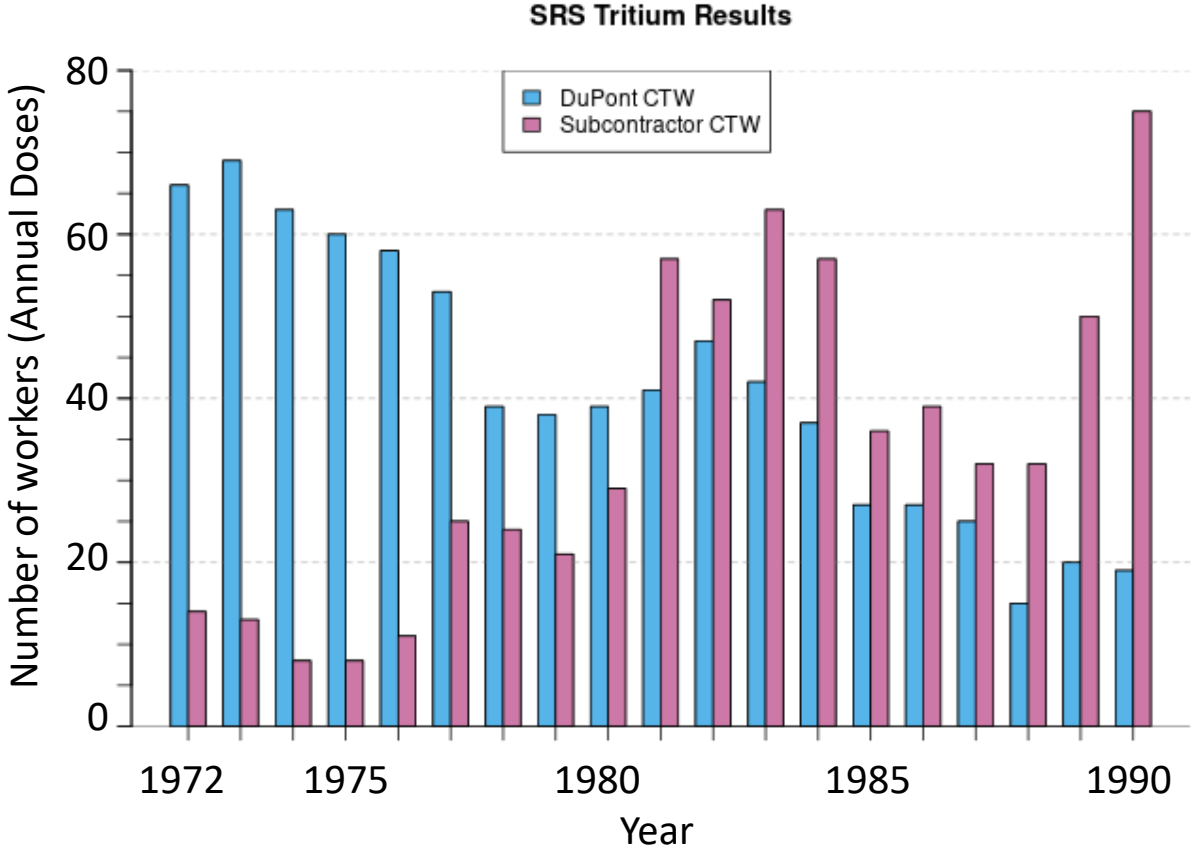


Observations & Implications

Implication 1: Representativeness

Smaller # subCTWs than DuPont CTWs in the 1970s

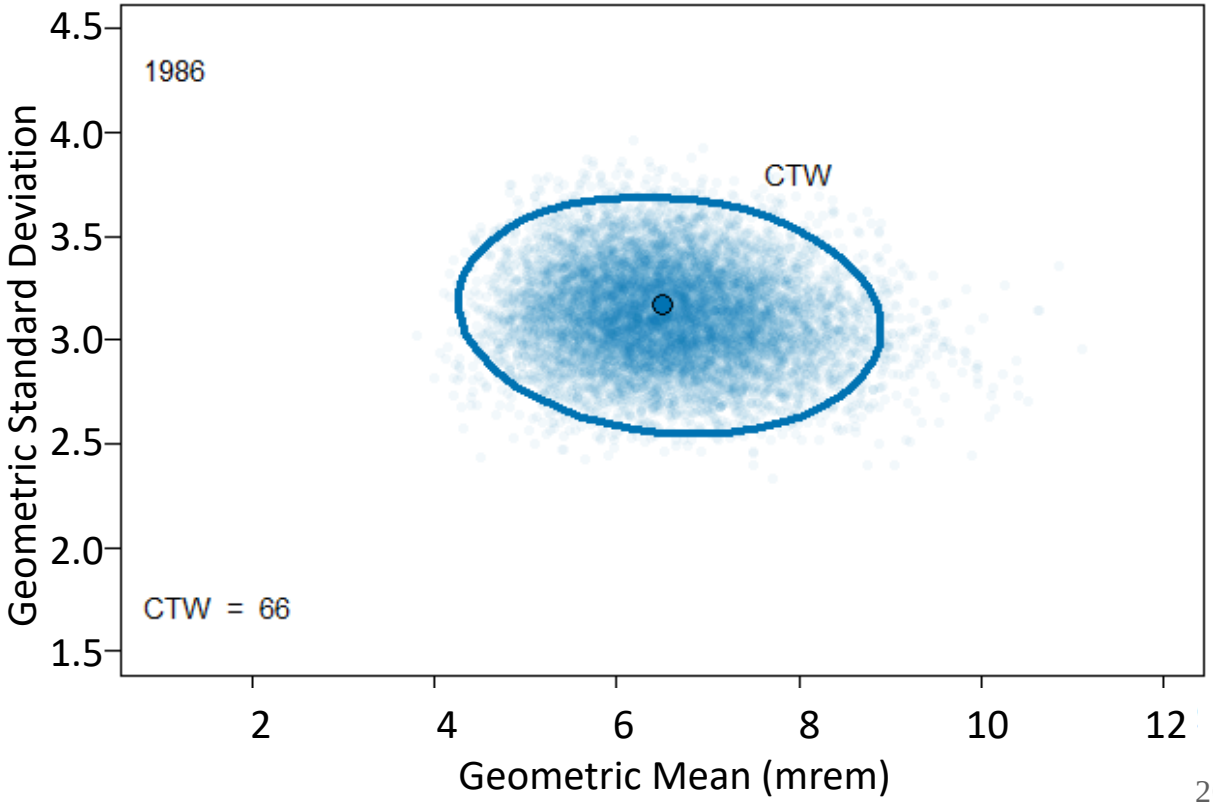
Larger # subCTWs than DuPont CTWs in the 1980s



Implication 2: Stratification leads to increased uncertainty

(1986 CTW model with gm & gsd uncertainties)

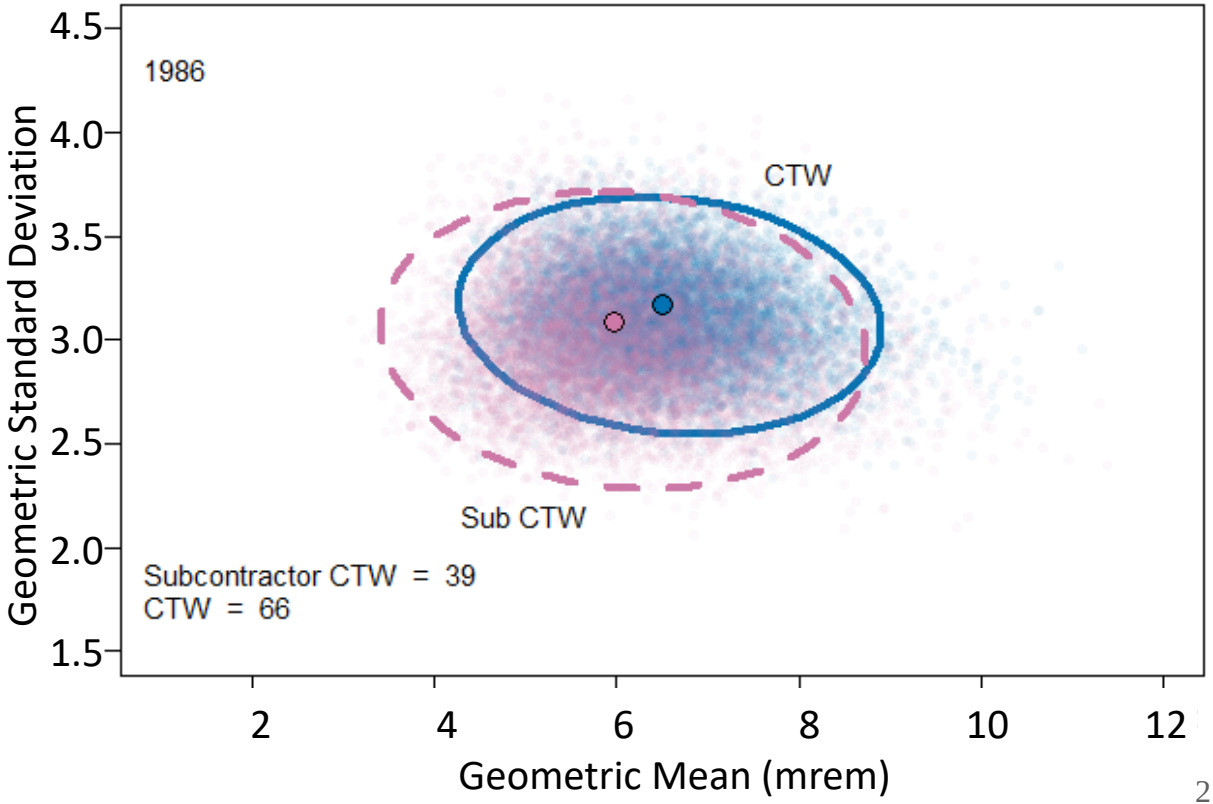
Uncertainty in parameter estimates increases when CTW model is further stratified into subCTW and DuPont CTWs, due to smaller sample sizes



Implication 2: Stratification leads to increased uncertainty

(1986 CTW & sub-CTW models with gm & gsd uncertainties)

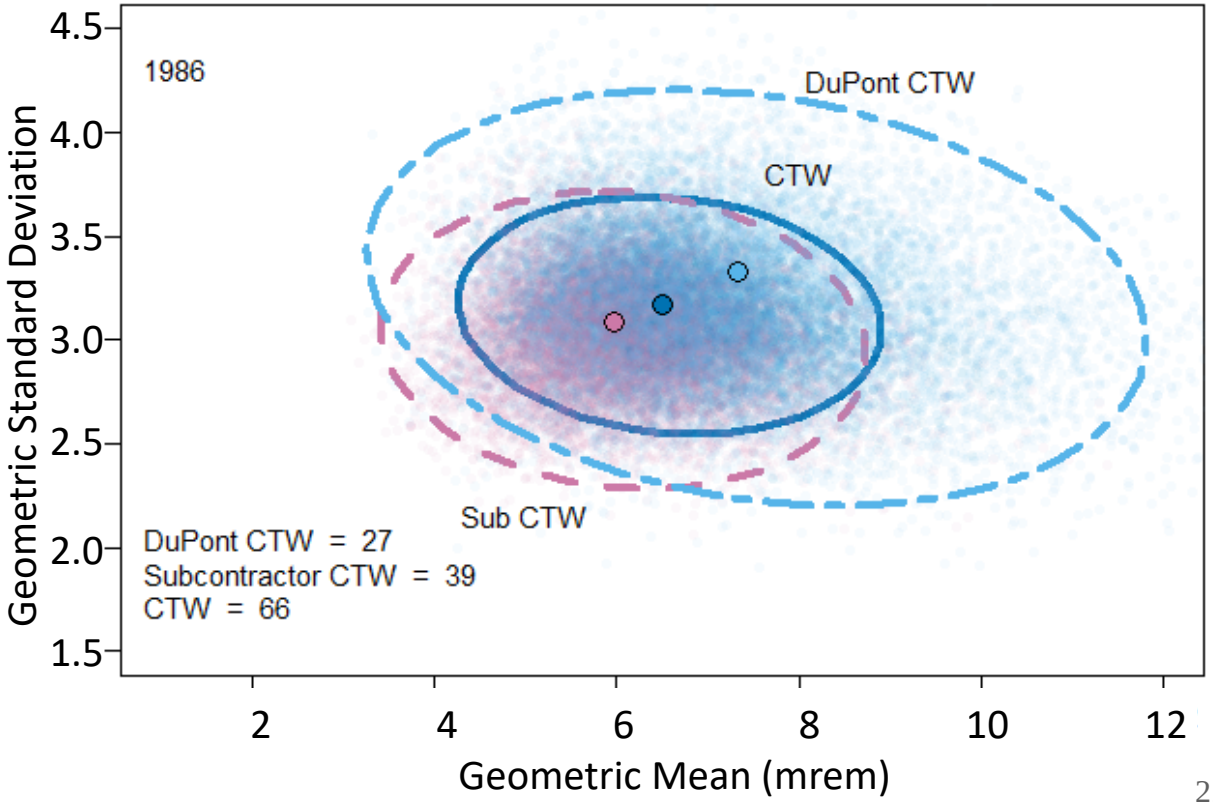
Uncertainty in parameter estimates increased when CTW model separated into subCTW and DuPont CTWs, due to smaller sample sizes



Implication 2: Stratification leads to increased uncertainty

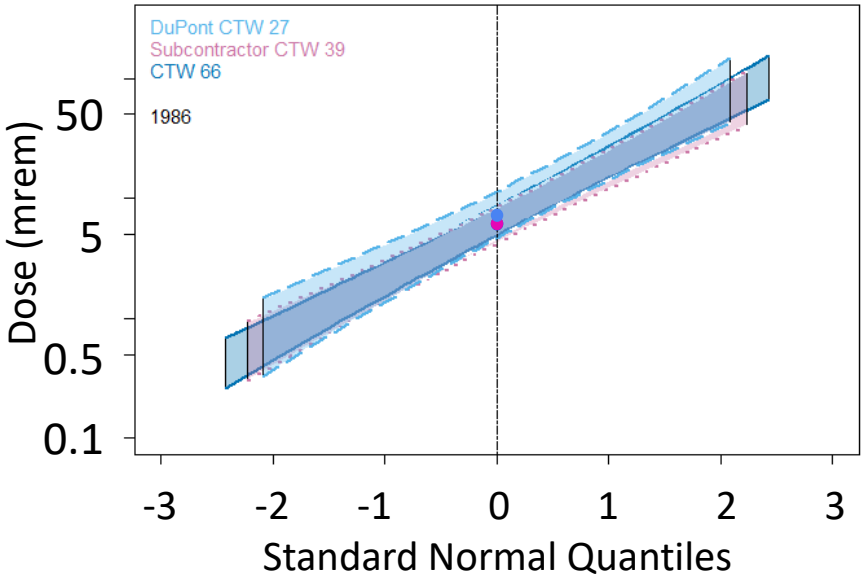
(1986 CTW, sub-CTW, & DuPont CTW models with gm & gsd uncertainties)

Uncertainty in parameter estimates increased when CTW model separated into subCTW and DuPont CTWs, due to smaller sample sizes

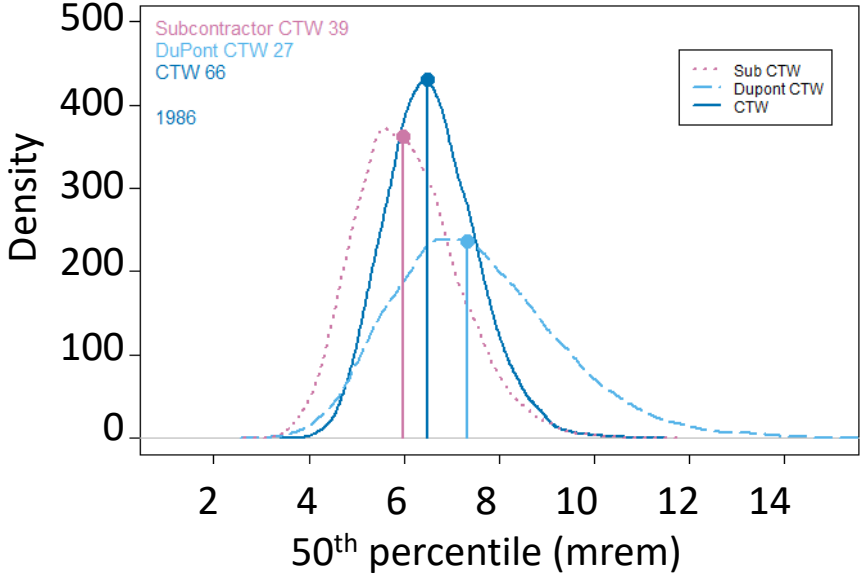


Implication 2: (1986 confidence band and density plots)

Confidence Bands for all CTWs,



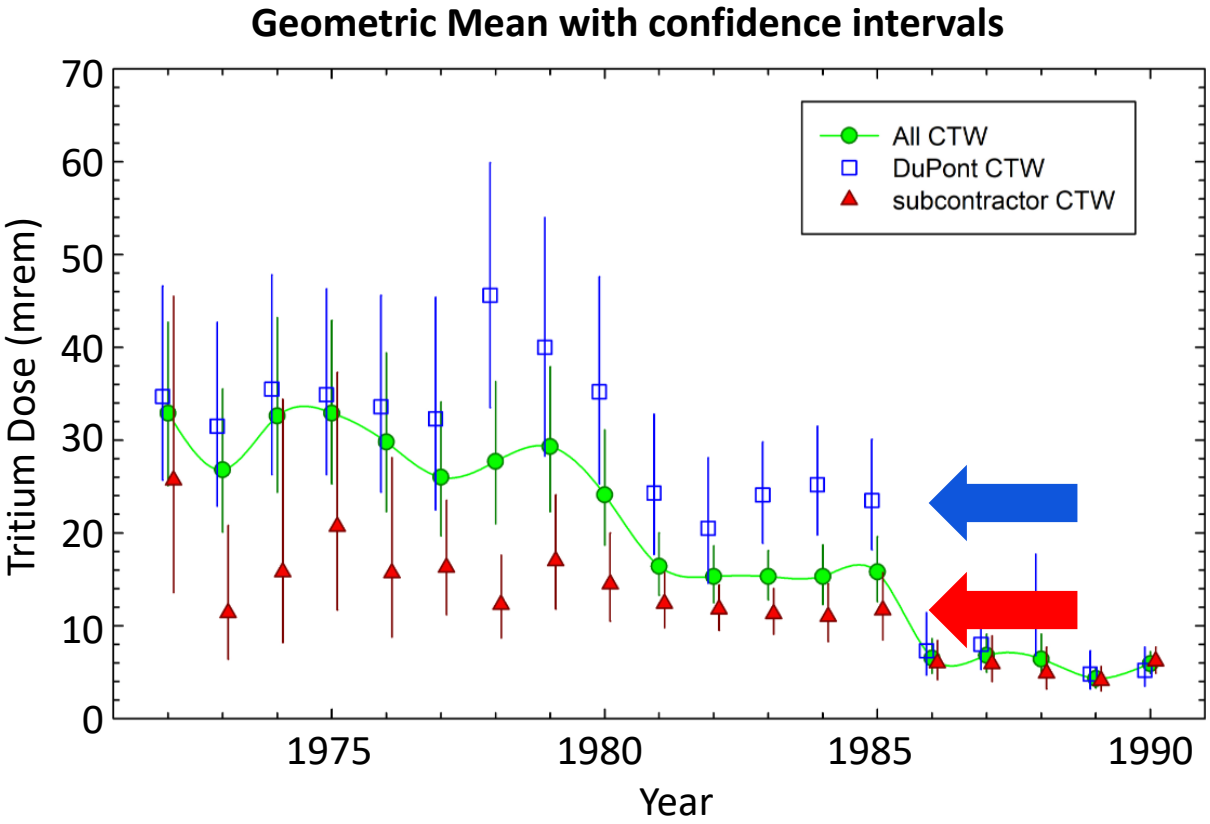
Density Plots of the 50th percentile



Implication 3: Sub-CTWs generally lower than DuPont CTWs

Subcontractor CTWs exposures were generally lower than DuPont CTWs between 1972 and 1990.

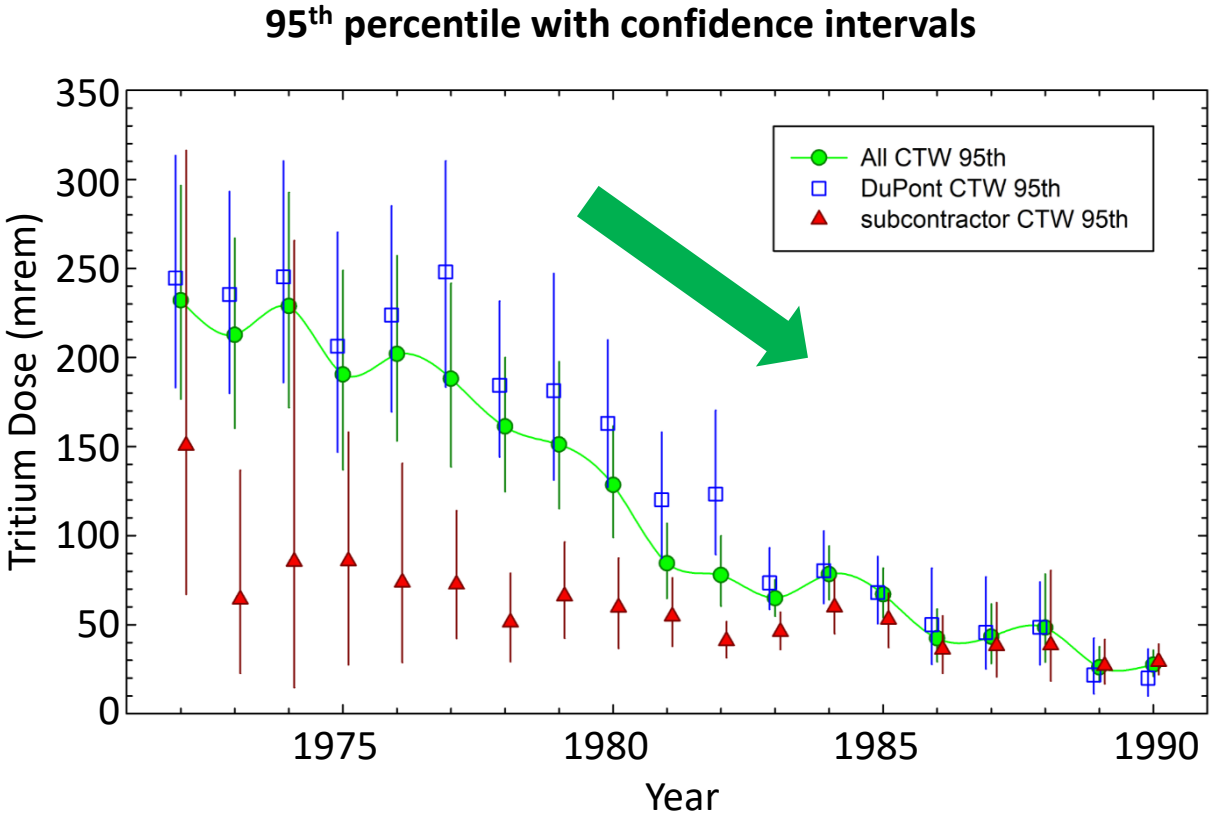
There is no practical difference between these groups and the current combined-CTW model.



Implication 4: Downward trend in tritium dose

Downward trend in tritium doses between 1972 and 1990.

Typical of improved radiological controls and decreased exposure potential over time.

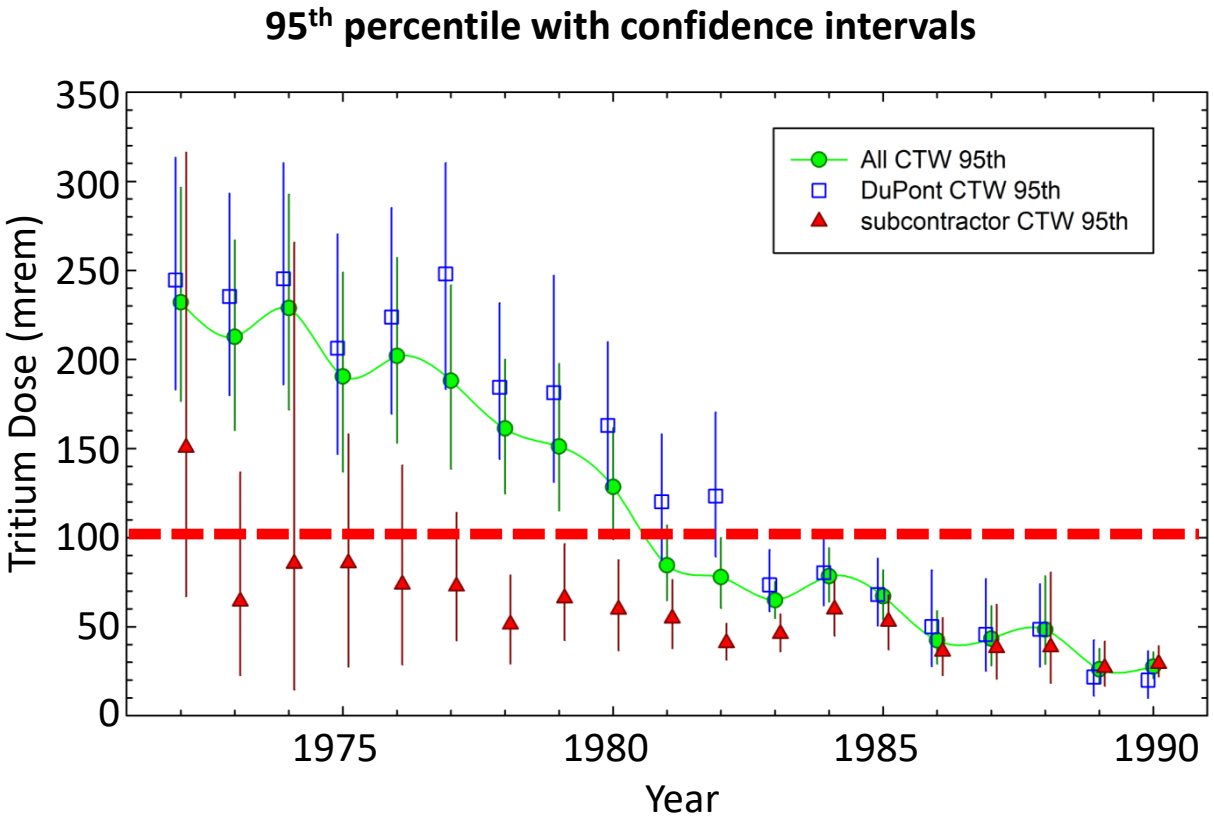


Implication 5: 1980's doses less than 100 mrem

100 mrem is the current monitoring threshold for committed effected dose.

Modern-day workers would not require internal personal monitoring below this level.

Combined CTW model can be used to bound dose estimates for subCTWs.



Implication 6: Generalized results

The results and observations from this analysis can reasonably be generalized to other radionuclide exposures at SRS and is further supported by the trend observed for type-S plutonium exposures between 1973 and 1987.

Year	DuPont-CTW 50th % (dpm/d)	sub-CTW 50th % (dpm/d)	DuPont-CTW 95th % (dpm/d)	sub-CTW 95th % (dpm/d)
1973-1978	**15.71**	6.97	**268.7**	169.4
1979-1987	**26.38**	22.65	279.2	**326.1**

[SRDB Ref ID: 176875]

Conclusions

Conclusions (1 of 2)

- Data used to generate these models meet the completeness definition as described in the implementation guide.

- The assumption that subCTWs were hired for more hazardous work than DuPont CTWs, and therefore had greater potential for tritium internal exposure, is not supported based on this analysis.

- SubCTWs, in general, experienced lower tritium doses than DuPont CTWs at 50th and 95th percentiles. (Slides 24 & 25)

Conclusions (2 of 2)

- Significant overlap in the uncertainties implies there is no practical difference between subCTWs and DuPont CTWs.

- Current co-exposure models (CTWs vs. non-CTWs) will produce bounding or representative dose estimates.

- Conducting this type of analysis for plutonium or other internal radionuclides would be very time consuming and difficult due to the complexity of the procedure to estimate intake or dose (e.g., multiple imputation for censored data, Time-Weighted One Person One Statistic, and Integrated Module for Bioassay Analysis intake modeling).

Questions for SRS WG Discussion?

- Do subcontractor construction trade workers (subCTWs) exhibit higher internal exposures than DuPont CTWs? *The bootstrap uncertainty analysis of tritium and the intake analysis of plutonium do not support this hypotheses.*

- Should subcontractor construction trade workers (subCTWs) have their own co-exposure model? *WG Discussion*

- Are the current co-exposure models (CTWs. vs. non-CTWs) acceptable for dose reconstruction purposes? *WG Discussion*

Questions?

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.