# NATURALISTIC STUDIES OF DRIVER DISTRACTION:

## EFFECTS OF ANALYSIS METHODS ON ODDS RATIOS AND POPULATION ATTRIBUTABLE RISK

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## ABSTRACT

**GOAL: Estimate valid odds ratios, prevalence, and population attributable risk percent for secondary tasks in naturalistic driving studies (NDS).**

**METHOD: Reanalyze data for conversation on a hand-held cell phone from the Virginia Tech Transportation Institute (VTTI) 100-Car NDS databases (VTTI 2010), using a Standard Method for epidemiological analysis, and compare the results to the Klauer et al. (2006) analysis method (VTTI Method).**

**RESULTS: The Standard Method lowered estimates for the odds ratio (OR), population exposure percent (*Pe%*) and population attributable risk percent (PAR%) vs. the VTTI Method. The OR overestimate with the VTTI Method was traced to an "assumption bias" that caused unmatched fault conditions for the exposed vs. unexposed crash/near-crash cases. The $P_e$% and PAR% overestimates were traced to an error in the VTTI Method for calculating *Pe%*.**

**DISCUSSION: The identified bias and error were systemic in the Klauer et al. (2006) analyses, overestimating OR, $P_e$%, and PAR% for all tasks examined.**

**CONCLUSION: Future research should seek to better understand the epidemiologic analysis methods that are most appropriate in the new and emerging field of naturalistic driving research.**

## INTRODUCTION

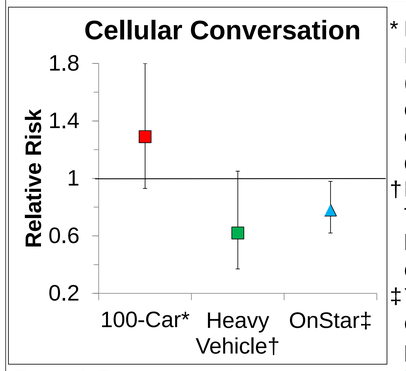


**Figure 1. Relative risk of cellular conversation while driving in 3 studies.**

* Klauer et al. (2006) in the 100-Car NDS estimated an OR of **1.29** (above 1) for crashes and near-crashes associated with hand-held cell phone conversation ("Talk"), discrepant with the 2 studies below.

† Hickman et al. (2010) estimated a Talk OR of **0.78** (below 1) in a heavy vehicle NDS in fleets with no cell phone policy.

‡ Young & Schreiner (2009) calculated an OnStar hands-free personal conversation rate ratio of **0.62** (below 1) for airbag-deployment crashes.

## METHOD

**Table 1. Epidemiological notation.**

**A. Standard Method**

| Event[i] | Exposure $X$[ii] | Not Exposure $X$[ii] | Total | $P_e$[iii] |
|---|---|---|---|---|
| Yes | *A* | *B* | *A+B* | |
| No | *C* | *D* | *C+D* | *C/(C+D)* |

OR = *AD/BC*

**B. VTTI Method**

| Event[a] | Exposure $X$[ii] | No Exposure[iv] | Total | $P_e$[iii] |
|---|---|---|---|---|
| Yes | *a* | *b* | *a+b* | |
| No | *c* | *d* | *c+d* | *c/(c+d)* |

OR = *ad/bc*

Notes: [i]Crash/Near-Crash [ii]$X$ = Supposed cause of event [iii]$P_e$ = Prevalence [iv]No exposure to any crash/near-crash cause

- This study conducted an analysis of recently-released 100-Car databases (VTTI 2010).
- It compared a Standard Method of epidemiological analysis (Table 1A) to the VTTI method (Table 1B).
- The Standard Method uses "Not Exposure" to the specific cause *X* being assessed.
- The VTTI Method uses "No Exposure" to any possible crash/near-crash cause.
- The ORs, prevalences ($P_e$%), population attributable risk (PAR%), and preventive population fraction (PPF%) were calculated using standard epidemiological formulae.

## RESULTS

**Table 2. Analysis of Talk task with the two Methods.**

| **A. Standard** | | Talk | Not Talk | Total | $P_e$%[iii] |
|---|---|---|---|---|---|
| Crash/Near Crash | Yes | 44[ii] | 769[ii] | 813 | |
| | No | 1,339 | 18,276 | 19,615 | 6.8% |
| OR (95% CI) | | 0.78 (0.56 to 1.06) | | | |
| PPF% (95% CI) | | 1.5% (-0.2% to 3.2%) | | | |

| **B. VTTI[i]** | | Talk | No Distraction[iv] | Total | $P_e$%[iii] |
|---|---|---|---|---|---|
| Crash/Near Crash | Yes | 44[v] | 237[vi] | 281 | |
| | No | 1,299 | 9,059 | 10,358 | 12.5% |
| OR (95% CI) | | 1.29 (0.93,1.80) | | | |
| PAR% (95% CI) | | 3.6% (3.1% to 4.1%) | | | |

[i]Hankey (2007, Table 6) [iii]$P_e$% = Prevalence% [ii]Regardless of subject driver fault [iv]No secondary task observed [v]At-fault or where Talk "played a role in the crash" [vi]At-fault only

| | OR | $P_e$% | Pop.% |
|---|---|---|---|
| **Standard** | 0.78 | 6.8% | 1.5% |
| **VTTI** | 1.29 | 12.5% | 3.6% |

- The VTTI Method overestimated prevalence and PAR% because its "No Exposure" method underestimated *d* and hence the total baseline video clips *c+d*.
- VTTI effectively counted all "Talk" cases regardless of fault in the *a* cell by assuming that Talk was a distraction that "played a role in the crash" even if the subject driver was judged as not at-fault.
- This is an *assumption bias* that "begs the question," a logical fallacy.
- The "No Distraction" *b* cell counted only driver at-fault cases, so the fault conditions were effectively not matched for "Talk" vs. "No Distraction," and the fewer cases in cell *b* biased the OR upward.
- The Standard Method (Table 2A) avoids this OR bias by matching fault between "Talk" and "Not Talk"
- It also avoids the $P_e$% and PAR% errors by using all 19,615 baseline clips to estimate them.

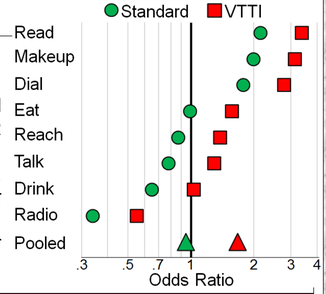


**Figure 2. Major secondary task ORs.**
**Red: VTTI Method. Green: Standard Method.**

- The bias and error identified in the VTTI Method were systemic, affecting all secondary task OR estimates (Fig. 2, red).
- The Standard ORs are all lower (Fig. 2, green), and even reverse from causal to preventive for Reach, Talk, and Drink.
- The pooled Standard OR (green triangle) is near that of baseline driving (solid line, OR = 1).

## DISCUSSION & CONCLUSION

- The Klauer et al. (2006) analysis method ("VTTI Method") estimated OR, $P_e$%, and PAR% values that were consistently higher than those from the Standard Method for hand-held cell phone talking/listening ("Talk") task, and all other tasks examined.
- The OR overestimates in the VTTI Method were traced to an "assumption bias" that created unmatched fault conditions between exposed and unexposed cases.
- The prevalence and PAR% overestimates were traced to an error in the "No Distraction" baseline calculation in the VTTI Method.
- The Standard Method was free of this bias and error, and its lower OR and prevalence estimates for "Talk" were consistent with those in independent studies.
- Future research should seek to better understand the epidemiologic analysis methods that are most appropriate in the new and emerging field of naturalistic driving research.

## ACKNOWLEDGMENTS

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