Appendix 1: Pregnancy and the Risk of a Traffic Crash

TECHNICAL APPENDIX

Appendix to: Redelmeier DA, May SC, Thiruchelvam D, et al. Pregnancy and the risk of a traffic crash.
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OVERVIEW

The purpose of this appendix is to provide additional technical material for reviewers. The content reflects discussions with colleagues and presentations inside and outside our home institution. The organization appears as six main sections sequenced from general to specific: (§1) justification of selection criteria, (§2) definition of monthly time interval segments, (§3) overview of available databases, (§4) statistical modeling with McNemar's test, (§5) additional results, and (§6) supplementary references. Parts of this appendix may form the basis of a methodological article for a separate journal.

SECTION §1: SELECTION CRITERIA

Study Setting

Ontario is Canada's most populous province and has free health care access including prenatal and emergency visits [1]. Obstetrical and trauma services typically occur at different locations; however, an individual's experience could be tracked for years using universal health insurance linked identifiers validated in past research [2 3 4 5]. During 2008 (study midpoint) a total of 140,791 babies were born following 169,838 estimated pregnancies, equal to an average rate of 52.6 per 1,000 reproductive-age women annually [6 7]. During the same year, a total of 229,196 motor vehicle crashes occurred throughout the region that resulted in death, disability, or property damage [8]. A total of 17,929 of the crashes resulted in an emergency department visit by the driver, equal to a population average rate of 1.98 events per 1,000 licensed drivers annually.

Selection Criteria

The start date of the accrual interval (analogous to an enrollment interval for a clinical trial) was April 1, 2006. This date was selected to allow four years of observation prior to newborn delivery for each woman with no missing data (the available databases on motor vehicle crashes were not initiated prior to April 2002). The end date of the accrual interval was March 31, 2011. This date was selected to allow one year of observation following newborn delivery for each woman with no missing data (the available databases on motor vehicle crashes were not updated beyond March 31, 2012). The obstetrical codes were selected to encompass all physician-assisted births (normal vaginal, assisted vaginal, cesarean section). The purpose of these selection criteria was to identify a large cohort of women through health services databases.

We excluded women less than 18 years to ensure that each woman could potentially have a past driving history for at least two years (individuals below age 16 years are not legally allowed to drive in Ontario). We excluded persons living outside Ontario because records were not available for crashes occurring in outside regions. We excluded individuals who lacked a valid health-card identifier because individuals needed to be tracked through available health services databases. We excluded cases managed by a midwife because information on such cases was not available (midwife deliveries reflect fewer than 10% of total newborn deliveries in Ontario). These exclusions were conducted using pre-existing ICES computer algorithms and blind to outcome assessment. The purpose of these exclusion criteria was to ensure that each individual was observed in a consistent manner.

SECTION §2: MONTHLY TIME INTERVALS

Defining the Duration of a Month

The obstetrical literature often contains ambiguities due to colloquialisms such as "pregnancy lasts nine months", unstated referents (e.g. date of last menstrual period, date of conception, date of first missed period), unequal month durations (e.g. January compared to February), and other irregularities. These ambiguities are usually irrelevant. In our study, however, we explicitly defined "month" as 28 consecutive days to ensure identical time intervals in all comparisons. An added advantage was to guarantee the same number of weekend days in each month (weekends are associated with increased crashes compared to weekdays [9]). This definition implies that a one-year span equals about 13 segments of 28 days (13 x 28 = 364). As a consequence, annual estimates of crash risk are derived by multiplying monthly counts by a factor of 13, not a factor of 12.

Distinguishing the Enrollment Interval and Follow-Up Interval

Health services research commonly involves an extended interval for both identifying study participants and ascertaining study outcomes. The term “accrual interval” denotes the interval when individuals are identified. The term “follow-up interval” denotes the interval when outcomes are assessed. The term “look-back interval” denotes the interval prior to study accrual that might also contain study outcomes. In our study, the accrual interval was five years (April 1, 2006 to March 31, 2011). Our follow-up interval was one year, which implies a one-year span for the first woman accrued (April 1, 2006 to March 31, 2007) and a one-year span for the last woman accrued (March 31, 2011 to March 30, 2012). Our look-back interval was four years, which implies a four-year span for the first woman accrued (April 1, 2002 to March 31, 2006) and a four-year span for the last woman accrued (March 29, 2007 to March 30, 2011).

SECTION §3: OVERVIEW OF AVAILABLE DATABASES

Institute for Clinical Evaluative Sciences

The Institute for Clinical Evaluative Sciences contains a health services research databank dedicated to analyzing patterns of health and health care throughout Ontario. This study relied on four databases that have been extensively validated and applied in other research over the past 20 years. The physician billing database (OHIP) was the source for identifying clinical activity related to newborn care and delivery. The emergency department database (NACRS) was the source for identifying clinical activity related to emergency medical care because of a motor vehicle crash. The demographic database (RPDB) was the source for identifying baseline characteristics related to age, home location, and socio-economic status. The outpatient database (OHIP) and inpatient database (CIHI) were the sources for identifying prior medical care.

Canadian Community Health Survey and Newborn Database

Conventional health services research databases have limited information about patient symptoms, subjective measures of well-being, and family connections. As a consequence, we supplemented our study by linking individuals to the largest community-based ongoing survey in Ontario. Special permission was required and obtained from both

ICES and the Ontario Ministry of Health and Longterm Care. The Canadian Community Health Survey (CCHS) database was the source for identifying information related to lifestyle such as alcohol, smoking, and gambling. We also supplemented our analysis by linking the mother to their newborn through the MOMBABY database.

SECTION §4: STATISTICAL MODELING

Simplified Analysis with McNemar's Test

Our study sample size was a total of 507,262 women. These individuals accounted for 555 crashes during the middle three months of the baseline interval. These individuals account for 757 crashes during the three months of the second trimester. No individual had a crash during both three-month intervals. Hence, a 2x2 table for McNemar's test would yield 0 individuals in the North-West corner, 757 individuals in the North-East corner, 555 individuals in the South-West corner, and 505,950 individuals in the South-East corner. A conventional McNemar's test would assess the ratio of 757 to 555 against the null hypothesis ratio of 1:1. This yields a relative risk of 1.36 (95% confidence interval 1.22 to 1.55). Notice that this analysis provides a simple McNemar's test because identical time durations appear in the baseline interval and comparison interval.

Expanded Analysis with Modified McNemar's Test

Our study actually had an extensive baseline interval that provided more rigor. A baseline interval that was twice as long (middle 6 months rather than middle 3 months of baseline), for example, would assess departures against the null hypothesis of a ratio of 1:2. In our cohort, the actual counts were 757 (same middle months of pregnancy) and 1095 (longer baseline interval before pregnancy) and yield a relative risk of 1.38 (95% confidence interval 1.26 to 1.52). Similarly, a baseline interval that was four times as long (12 months not 3 months) would assess departures against the null hypothesis of a ratio of 1:4. In our cohort, the actual counts were 757 and 2215 and the results yield a relative risk of 1.37 (95% confidence interval 1.26 to 1.49).

Our entire baseline amounted to 39 months (because a 3 year interval divided into months of exactly 28 days duration results in a total of 13 consecutive intervals in each of 3 years). Hence, the null hypothesis assessed departures from the ratio 1:13. The marginal counts are shown in the abstract section as 757 and 6922 and yield a relative risk of 1.42 (95% confidence interval 1.32 to 1.53). Interestingly, the full analysis contains 3 individuals in the North-West corner due to repeat crashes that lead to a slightly shifted estimate to become a relative risk of 1.42 (95% confidence interval 1.31 to 1.53). This adaptation to McNemar's test allows for different time durations for the baseline interval and the comparison interval. The main finding is that the standard McNemar's test and the modified McNemar's test yield similar results.

Expanded Analysis with GEE Model

Our data can also be subjected to analysis through a Poisson Generalized Estimating Equation (GEE). The basic approach uses a first-order autoregressive correlational structure and models time in consecutive 28-day segments. The main advantage of this approach is to accommodate the slight declining trend visible on Figure 1 related to increasing age (all women are five years older at the end compared to the beginning). This GEE model yielded a relative risk of 1.56 (95% confidence interval 1.42 to 1.72). Notice that this GEE estimate is slightly more extreme than the McNemar estimate of 1.42 (95% confidence interval 1.32 to 1.53) and that the two confidence intervals overlap each other. In our study we provide McNemar's estimate since it is more conservative and can be verified by readers.

STATISTICAL APPROACH	Estimate	95% Confidence Interval
Standard McNemar's (3 months)	1.36	1.22 – 1.55
Modified McNemar's (12 months)	1.37	1.26 – 1.49
Modified McNemar's (3 years)	1.42	1.32 – 1.53
GEE Model	1.56	1.42 – 1.72

SECTION §5: ADDITIONAL RESULTS

Individual Women Having Multiple Crashes

No woman had multiple separate crashes as drivers within the same month. Few women (n = 456, <0.1%) had multiple separate crashes as drivers during their five-year study interval. Counting duplicates once or twice made no material difference to the relative risk estimate of 1.42 (95% confidence interval 1.32 to 1.53). The overall baseline rate of a crash was 4.55 per 1,000 individuals annually. Hence, the risk of a crash over an extrapolated five-year interval would be about 22.75 per 1,000 individuals (4.55 x 5) and the risk of two crashes over an extrapolated five-year interval would be about 0.52 per 1,000 individuals ($22.75^2 / 1000^2$). As a consequence, a population of 507,262 total individuals would be anticipated to have about 262 double crashes during a five-year interval (0.52 x 507.262). The observed recidivism (n = 456) exceeds the expected recidivism (n = 262) yet accounts for few of the total crashes observed (n = 10,451). Positive serial correlation is natural and does not bias a self-matched analysis using McNemar’s test.

SECTION§6: REFERENCES

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