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Birth Order and Injury-Related Infant Mortality in the U.S

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Abstract

Introduction—The purpose of this study was to evaluate the risk of death during the first year of life due to injury, such as unintentional injury and homicide, by birth order in the U.S.

Methods—Using national birth cohort–linked birth–infant death data (births, 2000–2010; deaths, 2000–2011), risks of infant mortality due to injury in second-, third-, fourth-, and fifth or later–born singleton infants were compared with first-born singleton infants. Risk ratios were estimated using log-binomial models adjusted for maternal age, marital status, race/ethnicity, and education. The statistical analyses were conducted in 2016.

Results—Approximately 40%, 32%, 16%, 7%, and 4% of singleton live births were first, second, third, fourth, and fifth or later born, respectively. From 2000 to 2011, a total of 15,866 infants died as a result of injury (approximately 1,442 deaths per year). Compared with first-born infants (2.9 deaths per 10,000 live births), second or later–born infants were at increased risk of infant mortality due to injury (second, 3.6 deaths; third, 4.2 deaths; fourth, 4.8 deaths; fifth or later, 6.4 deaths). The corresponding adjusted risk ratios were as follows: second, 1.84 (95% CI=1.76, 1.91); third, 2.42 (95% CI=2.30, 2.54); fourth, 2.96 (95% CI=2.77, 3.16); and fifth or later, 4.26 (95% CI=3.96, 4.57).

Conclusions—Singleton infants born second or later were at increased risk of mortality due to injury during their first year of life in the U.S. This study's findings highlight the importance of investigating underlying mechanisms behind this increased risk.

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SUPPLEMENTAL MATERIAL
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INTRODUCTION

State-level studies suggest that young children with older siblings are at increased risk of hospitalization and death due to injury and that this risk is greatest when these children are infants.[1,2] However, recent national studies on birth order and infant mortality due to external causes, such as unintentional injury and homicide, are lacking.

Brenner et al.[3] previously described risk factors for infant injury death by type of external cause using U.S. data from infants born during 1983–1991 and reported that, in addition to factors like younger maternal age and lower maternal education, infants born to women with one or two plus previous live births were at increased risk of injury-related infant mortality compared with those born to primiparous women.[3] Yet, because these data are from infants born more than 25 years ago and the analysis did not estimate risks for infants born third or later separately, a new examination of the association between birth order and infant mortality due to external causes is warranted. Further, recent demographic shifts in characteristics associated with birth order and an apparent increase in the rate of unintentional injury infant deaths mean previous findings may not represent current data.[4,5]

The objective of this analysis is to evaluate the risk of infant mortality due to external causes in second-, third-, fourth-, and fifth or later–compared with first-born singleton infants in the U.S. using the most recent linked birth–infant death cohort data available (births, 2000–2010; deaths, 2000–2011).

METHODS

Study Population

Data were from the U.S. 2000–2010 birth cohort-linked birth–infant death vital statistics files released by the National Center for Health Statistics.[6] These files include all U.S. births occurring in a given year linked with death certificate data if the infant died before his or her first birthday and both birth and death occurred within the 50 states or the District of Columbia. On average, 99% of infant death certificates were linked to birth certificates each year. Statistical weights were provided in the linked files to account for unlinked infant deaths; these weights upweight the linked infant deaths slightly so the weighted sum matches the total number of deaths reported nationally.[6]

Measures

Maternal and infant characteristics were obtained from the birth certificate. During the study period, states were transitioning from the 1989 to 2003 version of the birth certificate. Most of the items included in this analysis were collected in a similar or identical fashion in both versions; the items that were not are described below.

Maternal characteristics included maternal age, race/ethnicity, marital status, education, and self-reported tobacco use during pregnancy.[7] Maternal educational attainment categories were collapsed from the 1989 birth certificate (<12 years, 12–15 years, and ≥16 highest grade completed) to approximately correspond with combined categories from the 2003 birth certificate data (less than high school, high school, bachelor’s degree or higher).

Tobacco use during pregnancy was assessed on the 1989 birth certificate as “tobacco use during pregnancy” (yes/no); on the 2003 certificate, it was assessed as the number of cigarettes smoked per day during each trimester and a recoded variable was created for any cigarette use during pregnancy (yes/no).

Infant characteristics included live birth order, plurality, infant sex, birth weight, and gestational age at birth. Live birth order was the numeric count of all previous infants born alive to the mother, whether still living or dead, plus one for the index infant.[8–10] Low birth weight was defined as <2,500 g. Information on gestational age at birth was calculated using the date last normal menses began; the clinical (“obstetric”) estimate; or imputed based on procedures described elsewhere.[6,11] Preterm birth was defined as a gestational age <37 completed weeks.

Infant deaths due to external causes usually undergo a medicolegal investigation.[12] During 2003–2010, of the 94% of infant deaths due to external causes where autopsy status was known, approximately 93% included an autopsy as part of the investigation (autopsy status was not captured for 2000–2002 birth cohort mortality data because of budgetary constraints, but was presumed to be similarly comprehensive). Underlying and contributing causes of death were recorded on the death certificate by a medical examiner, coroner, or attending physician,[13] and these open text fields were coded by mortality medical coders according to ICD-10 using procedures outlined in National Center for Health Statistics instruction manuals[14] along with the assistance of automating software.[15] Age at time of death was calculated as the difference, in days, between birth and death dates.

External causes of death were defined using underlying cause of death ICD-10 codes and included accidents (unintentional injuries; V01–X59); assault (homicide; *U01, X85–Y09); complications of medical and surgical care (Y40–Y84); and other external causes (Y10–Y36). Because the classification of sudden unexpected infant death (SUID) includes an external cause code (accidental suffocation and strangulation in bed [W75]),[16, 17] and SUID has been categorized alongside external causes of death in previous analyses of “preventable-cause” or “potential maltreatment” mortality,[18, 19] three alternative classifications of infant mortality were also considered: external causes excluding W75 (accidental suffocation and strangulation in bed; *U01, V01–W74, W76–Y84); external causes plus SUID (which, in addition to W75, includes two pathologic causes of death: sudden infant death syndrome [R95] and other ill-defined and unspecified causes of mortality [R99][20]; *U01, V01–Y84, R95, R99); and SUID alone (W75, R95, R99). Risks of infant mortality due to unintentional injury and homicide were also examined, separately.

Statistical Analysis

The analysis was restricted to singleton infants because multiples are more likely to be both second or later born and at increased risk for infant death due to external causes[19, 21]; therefore, excluding these infants reduced potential confounding by plurality.

Given the prospective nature of the data and the study’s objective of estimating risk ratios, log-binomial models for infant death due to external causes were fit, comparing second-, third-, fourth-, and fifth or later–born with first-born infants. The following potential confounders were adjusted for based on associations observed in the literature and in the data: maternal age, race/ethnicity, education, and marital status (Appendix Tables 1 and 2, available online).[3,19,22] Birth weight, gestational age, tobacco use during pregnancy, and infant sex were not included as confounders because they did not precede live birth order and it was hypothesized they might lie along a causal pathway(s) between birth order and infant death due to external causes—adjusting for them might have introduced overadjustment bias[23, 24] (however, these variables were included in descriptive analyses). The denominator for analyses was total live-born infants because all live births were at risk of death due to external causes, even those who ultimately died as a result of pathologic causes. In regression models, applying the statistical weights for infant deaths resulted in nearly identical estimates and SEs compared with the unweighted analysis; thus, unweighted results were presented to preserve the correct number of births.

Curves were constructed showing hazard functions for death due to external causes in second-, third-, fourth-, and fifth or later–born versus first-born infants over the first year of life using the Kaplan–Meier survival function estimator. Infants who died from pathologic causes were censored at their age at death (in days) and surviving infants at day 366. Although deaths due to pathologic causes were a competing risk for deaths due to external causes, the risk of either outcome was so rare (<1%) that handling these deaths as censored observations provided nearly equivalent results to a competing risk analysis (data available upon request) while allowing for the presentation of the instantaneous hazards.[25]

A supplemental analysis was conducted to assess how the distribution of live birth order and the risk of infant death due to external causes may have changed during the study period.

The statistical analysis was conducted in 2016. SAS, version 9.3, was used for the majority of the analysis; Stata SE, version 13, was used for the Kaplan–Meier survival function estimation.

RESULTS

During 2000–2010, there were approximately 43.9 million singleton infants born to residents of the U.S.; 40% (average *n* per year=1,614,478) were first; 32% (*n*=1,267,828) were second; 16% (*n*=658,241) were third; 7% (*n*=261,309) were fourth; and 4% (*n*=169,011) were fifth or later born (≅0.5% per year [*n*=19,010] had missing information on birth order and were excluded from further analysis). Characteristics more prevalent among second and later–born compared with first-born infants included maternal age >25 years, Hispanic ethnicity, non-Hispanic black race, married marital status, less than high school educational attainment, and tobacco use during pregnancy (Table 1). Risks of preterm and low birth weight births were lowest among second-born infants.

Overall, 258,407 (≅23,492 per year) singleton infants died in their first year of life during 2000–2011, which corresponds to 58.9 deaths per 10,000 live births (Table 2). On average, 2.9 deaths per 10,000 first-born infants were due to external causes during their first year of life; for later-born infants, the corresponding average risks increased monotonically from 3.6 deaths (second born) to 6.4 deaths (fifth or later) per 10,000 births. The following characteristics were associated with higher risk of infant death due to external causes within each birth order group: maternal age <25 years, non-Hispanic black race, unmarried marital status, less than high school educational attainment, and tobacco use during pregnancy; and preterm birth, low birth weight, and male infant sex (Appendix Tables 1 and 2, available online).

The majority of infant mortality due to external causes occurred during the post-neonatal period (age 28–365 days) for each birth order group (ranged from 88% in first born to 91% in second born) (Appendix Table 3, available online). Overall, the most common manners of these deaths were unintentional injuries (ranged from 68% in first born to 78% in fifth or later born) and homicide (ranged from 25% in first born to 15% in fifth or later born). The risks per 10,000 births for deaths due to individual external cause ICD-10 groupings tended to increase with birth order (Appendix Table 4, available online).

Figure 1 shows the cumulative and smoothed instantaneous hazard functions for infant mortality due to external causes by birth order. The greatest risk of death due to external causes and the greatest relative difference in risk between first-born and second-, third-, fourth-, and fifth or later–born infants occurred at ≅2 months of life.

The unadjusted risk ratios for infant mortality due to external causes in later born compared to first-born infants increased from 1.24 (in second) to 2.22 (in fifth or later) (Table 3; test for linear trend, $p<0.0001$). After adjustment for maternal factors, these estimates were magnified, ranging from 1.84 (in second) to 4.26 (in fifth or later) (Table 3; test for linear trend, $p<0.0001$). Higher risk ratios by birth order were also observed for each alternative classification of external causes of death, similarly increased upon adjustment, and all tests for linear trend across birth order categories were statistically significant ($p<0.05$). Compared with external causes of death alone, inclusion of SUID causes of death and examination of unintentional injury deaths, separately, resulted in higher risk ratio estimates, whereas examination of homicide deaths resulted in lower risk ratio estimates.

The supplemental analysis showed little change in the distribution of birth order across the study years (Appendix Figure 1, available online), whereas risk of infant death due to external causes increased across the study period from 3.2 to 3.9 deaths per 10,000 live births (linear trend, $p<0.0001$) (Appendix Figure 2, available online). The risk ratios for birth order and infant mortality due to external causes varied over the study years, but increased risk of infant mortality with increasing birth order was found for all years (Appendix Table 5, available online).

DISCUSSION

For births occurring to U.S. residents during 2000–2010, second and later–born singleton infants had 24% (3.6 deaths per 10,000 births for second) to 122% (6.4 deaths per 10,000 births for fifth or later) higher risk of death due to external causes within the first year of life compared with first-born infants (2.9 deaths per 10,000 births). Accounting for sociodemographic differences increased these risks to approximately two to four–fold compared with first-born infants. The greatest differences in risk occurred at ≅2 months of life. Inclusion of components of SUID and examining only deaths due to unintentional injury resulted in higher risk ratio estimates, whereas examining only deaths due to homicide slightly lowered risk ratio estimates, suggesting that mechanisms underlying risk for unintentional injury by birth order may be different from those for homicide risk by birth order. However, all adjusted analyses found an increased risk of infant mortality with increasing birth order. These findings highlight the importance of future investigation into the underlying mechanisms behind this increased risk.

This study's results are similar to an older analysis of infant injury deaths using U.S. linked infant birth-death files from 1983 to 1991.[3] The study by Brenner and colleagues[3] found that risks of infant death were higher for infants born to women with one or two plus previous live births compared with those born to primiparous women for injury deaths overall and certain types of unintentional injuries, but not for homicide. This study, however, found that second or later–born infants were also at increased risk for homicide, albeit to a lesser degree than for all external causes of death. In addition, this study was able to document that injury-related risk of infant death increased monotonically by birth order up to fifth or later–born infants.

Another study, from Tennessee, linked state-level birth–infant death files from 1985 to 1994.[2] They found infants born second, third, and fourth or later were 2.02, 2.42, and 3.29 times more likely, respectively, to die because of injury compared with first-born infants after adjustment for maternal, pregnancy, and infant characteristics. Despite a slightly different set of adjustment factors and this study's more recent national data, the Tennessee study's estimates agree quite closely with this study's estimates (second, 1.84; third, 2.42; fourth, 2.96; and fifth or later, 4.26 times more likely to die because of injury).

This study's findings are also in line with a study using a Washington state 1989–1996 birth–death file linkage, which found the number of older siblings was positively associated with risk of hospitalization or death due to injury among children aged ≤6 years, with the greatest risk by age observed for children aged ≤2 years.[1]

Previous research has proposed that one reason for increased injury risk in children born second or later might be divided parental attention.[26–29] As the number of children in a household increases, parental stress can increase[30,31] and parental attention can be divided,[26] potentially resulting in more oversight by older siblings.[3,29] This is supported by studies that have found increased risks of childhood injury for children with larger family sizes, a hazard that appears to be restricted to later-born siblings.[32] Mothers to second or later–born infants are less likely to initiate prenatal care early, take prenatal vitamins, and breastfeed compared with their first-born infant, a pattern suggestive of lower parental investment in and social support for the health and well-being of later-born children.[33]

Limitations

This study has several limitations. First, even though live birth order was assumed to serve as a proxy for how many other children are being cared for in the home, some children may have died or left the household by the time of the birth of the index child, and there may be children not birthed by the mother living in the home. Second, no information was available on timing of previous live births, which could be an important effect measure modifier of the relationship between birth order and infant mortality due to injury. Third, more complete information about the conditions surrounding the injury would have been helpful in identifying specific situations where infant mortality due to external causes is higher in later-born children. Fourth, this study's primary analysis used 2000–2010 data in aggregate because injury-related deaths in fourth- and fifth or later–born infants occurred in fewer than 130 infants per year, respectively; the supplemental analysis found small variations in risk ratios over time could have been obscured by this pooling over years. Finally, there may be residual confounding by unmeasured parental and family factors or environmental factors and hazards, which may be related to both birth order and risk of mortality due to external causes; these factors are not captured in the birth or death certificate data.

Strengths of this study include the use of the most recent national linked cohort data on infant births and deaths, improving upon prior analyses that have been limited to one state or that have used national data from decades ago. This large data set allowed for precise estimation of the risks for each birth order group individually, up to the fifth or later–born infant category, and operationalization of external causes of death in several alternative ways. In addition, use of the linked birth–infant death cohort files permitted multivariable regression analysis and construction of hazard curves for full birth year cohorts, analyses that would not have been possible with the national period linked birth–infant death files. Further, as birth order is not a characteristic collected in either national health-related survey data or mortality files, linked birth–infant death records provide one of the few nationally representative data sets available to examine the association between birth order and injury, in general.

CONCLUSIONS

These data suggest that infants born second or later are at higher risk of potentially preventable injury deaths compared with first-born infants during their first year of life. Importantly, because only 2%–3% of injuries requiring medical care among infants and children are estimated to result in fatality,[34,35] capturing live birth order information in other large studies on childhood injury could help evaluate whether second or later–born children are at increased risk for non-fatal injuries across infancy and childhood. Further examination of the higher risk of injury by birth order across childhood could help inform the development and targeting of injury prevention interventions and policies at the state and federal level. The prevention of fatal injuries among infants and children has been recognized as an important public health priority, and wider implementation of effective injury prevention strategies could reduce infant and child mortality and morbidity.[36,37]

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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All authors have contributed to the analysis or interpretation of the data, drafting or review of the manuscript, and have given approval for the final version of the manuscript. KAA, MET, LMR, MW, and AES designed the study, interpreted the results, and revised the manuscript. KAA and LMR ran the analyses and KAA wrote the first draft of the manuscript. KAA had full access to all aspects of the research and writing process and takes final responsibility for the paper.

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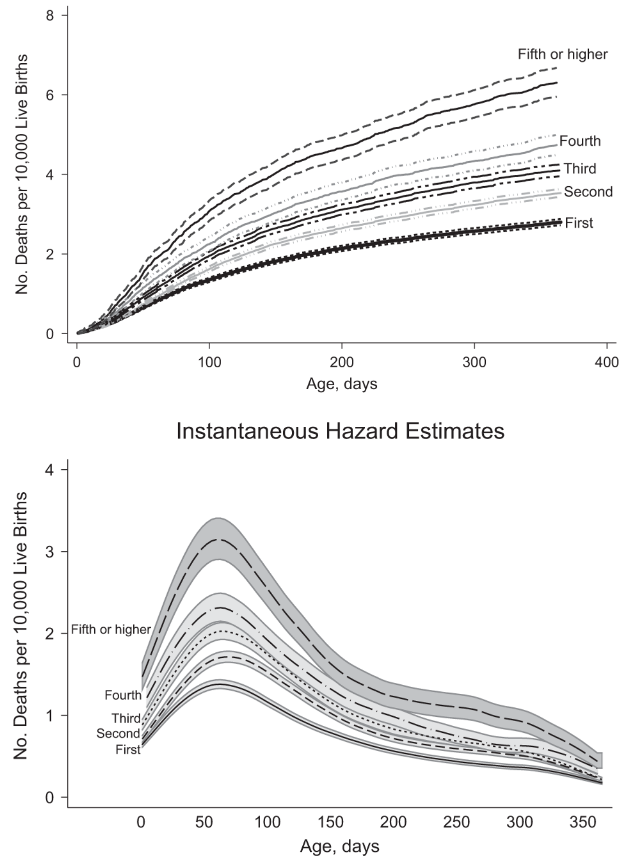

Figure 1.

Cumulative and smoothed instantaneous hazard functions for infant mortality due to external causes by live birth order, singleton births in the U.S., 2000–2010.

Note: (A) Solid lines represent estimated cumulative hazard functions and 95% confidence limits are represented by dashed lines, with different dashed line patterns by birth order. (B) Black lines represent smoothed instantaneous hazard functions and 95% confidence bands are represented by gray shading, with different black line patterns and gray shading by birth order.

Table 1

Selected Maternal and Infant Characteristics by Live Birth Order, Singleton Births in the U.S., 2000–2010

Maternal and infant characteristics	Total births (n=3,989,841[a,b])	First (n=1,614,478[a])	Second (n=1,267,828[a])	Third (n=658,241[a])	Fourth (n=261,309[a])	Fifth or later (n=169,011[a])
Maternal age at time of birth (years), mean	27.4	25.1	27.9	29.4	30.5	32.5
Maternal age at time of birth (years), %						
<20	10.6	21.1	5.4	1.6	0.5	0.1
20–24	25.1	29.8	26.5	20.0	14.2	6.7
25–29	27.3	24.6	28.7	30.7	30.3	24.3
30–34	22.9	16.4	25.3	28.4	30.7	32.3
35–39	11.3	6.4	11.6	15.8	19.3	26.0
40–54	2.8	1.6	2.5	3.5	5.1	10.6
Maternal race/ethnicity, %						
Hispanic	23.3	20.9	22.2	27.2	30.6	29.3
Non-Hispanic white	55.1	57.4	57.4	52.2	46.5	42.1
Non-Hispanic black	14.4	13.9	13.0	14.9	17.6	22.4
Other[c]	7.1	7.8	7.4	5.6	5.3	6.2
Maternal marital status at time of birth, %						
Not married	37.5	44.8	31.2	32.0	35.4	39.0
Married	62.5	55.2	68.8	68.0	64.6	61.0
Maternal years of education at time of birth (1989 birth certificate), %						
<12	20.4	19.2	16.9	22.4	29.1	37.7
12–15	51.6	49.8	52.4	54.2	53.4	49.4
≥16	26.7	29.8	29.6	22.2	16.1	10.8
Not stated or unknown	1.3	1.3	1.1	1.2	1.5	2.0
Maternal educational attainment at time of birth (2003 birth certificate), %						
No high school diploma or GED	21.8	19.5	17.9	24.8	32.5	41.7
High school diploma or GED	52.4	51.5	53.0	54.4	52.9	47.9
Bachelor’s degree or higher	24.6	27.8	28.0	19.6	13.3	8.7

Maternal and infant characteristics	Total births (n=3,989,841[a,b])	First (n=1,614,478[a])	Second (n=1,267,828[a])	Third (n=658,241[a])	Fourth (n=261,309[a])	Fifth or later (n=169,011[a])
Not stated or unknown	1.2	1.2	1.1	1.2	1.4	1.8
Maternal tobacco use during pregnancy (1989 birth certificate), %						
No	79.2	81.0	79.9	77.3	74.8	72.6
Yes	8.6	7.3	8.2	10.1	11.7	13.2
Not stated or unknown	12.2	11.7	11.9	12.6	13.6	14.1
Maternal tobacco use during pregnancy (2003 birth certificate), %						
No	71.9	72.5	72.4	71.4	70.4	69.5
Yes	8.6	7.8	8.2	9.5	10.5	11.4
Not stated or unknown	19.6	19.6	19.4	19.1	19.1	19.0
Gestational week at birth, %						
<37 (preterm birth)	10.6	10.6	9.7	10.8	12.4	14.5
37–39	53.2	47.7	57.5	57.5	56.0	52.3
40	20.1	22.9	18.7	17.7	17.3	17.6
41	9.3	11.5	7.9	7.5	7.5	8.2
≥42	6.2	6.8	5.7	5.8	6.0	6.4
Unknown or not stated	0.6	0.5	0.6	0.7	0.8	1.1
Birthweight (g), %						
Low birthweight	6.3	7.4	5.1	5.5	6.4	7.9
1,500	1.1	1.4	0.9	0.9	1.1	1.4
1,500–2,499	5.2	6.0	4.2	4.6	5.3	6.4
≥2,500	93.7	92.6	94.9	94.5	93.6	92.1
Unknown or not stated	0.0	0.0	0.0	0.0	0.0	0.0
Sex, %						
Female	48.8	48.7	48.8	48.9	49.0	49.1
Male	51.2	51.3	51.2	51.1	51.0	50.9

[a]Unweighted counts of average live births per year.

[b]Includes births with live birth order unknown or not stated (n=209,116 for 2000–2010); this group is not presented separately in the table.

[c]Includes Asian or Pacific Islander, American Indian or Alaska Native, other, and Hispanic origin unknown or not stated.

GED, General Educational Development test.

Table 2

Infant Death Risks by ICD-10 Groupings and Live Birth Order, Singleton Births in the U.S., 2000–2010

	Total deaths		First		Second		Third		Fourth		Fifth or later	
ICD-10 grouping	**n[a,b]**	**Per 10,000 births**	**n[a]**	**Per 10,000 births**	**n[a]**	**Per 10,000 births**	**n[a]**	**Per 10,000 births**	**n[a]**	**Per 10,000 births**	**n[a]**	**Per 10,000 births**
All causes	258,407	58.9	107,883	60.7	69,682	50.0	40,880	56.5	19,786	68.8	16,588	89.2
External causes (U01, V01-Y84)	15,865	3.6	5,110	2.9	4,990	3.6	3,008	4.2	1,380	4.8	1,186	6.4
External causes, excluding W75 (accidental suffocation and strangulation in bed) (U01, V01-W74, W76-Y84)	10,021	2.3	3,427	1.9	3,233	2.3	1,847	2.6	836	2.9	706	3.8
External causes and SUID (U01, V01-Y84, R95, R99)	50,508	11.5	15,673	8.8	15,998	11.5	9,860	13.6	4,825	16.8	3,718	20.0
SUID only (R95, R99, W75)	40,307	9.2	12,246	6.9	12,765	9.2	8,013	11.1	3,989	13.9	3,012	16.2

[a]Weighted infant death counts; unweighted counts of live births used for number of live births.

[b]Total infant deaths includes infants whose live birth order was unknown or not stated (n=3,592); this group is not presented separately in the table. SUID, sudden unexpected infant death.

Table 3

Risk Ratios for Live Birth Order and Infant Death by ICD-10 Grouping, Singleton Births in the U.S., 2000–2010

ICD-10 grouping/Live birth order	Deaths, n[a]	Unadjusted, RR (95% CI)	Adjusted,[b] RR (95% CI)
External causes (U01, V01-Y84)[c,d]	15,538		
First	5,066	1.0	1.0
Second	4,947	1.24 (1.20, 1.29)	1.84 (1.76, 1.91)
Third	2,981	1.44 (1.38, 1.51)	2.42 (2.30, 2.54)
Fourth	1,368	1.67 (1.57, 1.77)	2.96 (2.77, 3.16)
Fifth or higher	1,176	2.22 (2.08, 2.36)	4.26 (3.96, 4.57)
External causes, excluding W75 (accidental suffocation and strangulation in bed) (U01, V01-W74, W76-Y84)[c,d]	9,958		
First	3,396	1.0	1.0
Second	3,204	1.20 (1.14, 1.26)	1.74 (1.66, 1.83)
Third	1,830	1.32 (1.25, 1.40)	2.17 (2.04, 2.31)
Fourth	828	1.51 (1.40, 1.63)	2.61 (2.41, 2.84)
Fifth or higher	700	1.97 (1.82, 2.14)	3.69 (3.37, 4.04)
External causes and SUID (U01, V01-Y84, R95, R99)[c,d]	49,627		
First	15,531	1.0	1.0
Second	15,858	1.30 (1.27, 1.33)	1.91 (1.86, 1.95)
Third	9,771	1.54 (1.50, 1.58)	2.57 (2.50, 2.64)
Fourth	4,782	1.90 (1.84, 1.97)	3.36 (3.24, 3.48)
Fifth or higher	3,685	2.27 (2.19, 2.35)	4.35 (4.17, 4.53)
SUID only (R95, R99, W75)[c,d]	39,669		
First	12,135	1.0	1.0
Second	12,654	1.33 (1.30, 1.36)	1.95 (1.90, 2.00)
Third	7,941	1.61 (1.56, 1.65)	2.68 (2.60, 2.77)
Fourth	3,954	2.01 (1.94, 2.09)	3.57 (3.43, 3.72)
Fifth or higher	2,985	2.35 (2.26, 2.45)	4.53 (4.33, 4.75)
Accidents (unintentional injuries)[c,d]	11,234		
First	3,463	1.0	1.0
Second	3,564	1.31 (1.25, 1.37)	1.91 (1.82, 2.01)
Third	2,242	1.59 (1.51, 1.67)	2.62 (2.47, 2.78)
Fourth	1,050	1.87 (1.75, 2.01)	3.28 (3.04, 3.54)
Fifth or higher	915	2.52 (2.35, 2.71)	4.80 (4.41, 5.21)
Assault (homicide)[d,e]	3,155		
First	1,245	1.0	1.0
Second	1,012	1.04 (0.95, 1.12)	1.60 (1.46, 1.74)
Third	512	1.01 (0.91, 1.12)	1.79 (1.60, 2.01)

ICD-10 grouping/Live birth order	Deaths, n[a]	Unadjusted, RR (95% CI)	Adjusted,[b] RR (95% CI)
Fourth	212	1.05 (0.91, 1.22)	1.99 (1.70, 2.33)
Fifth or higher	174	1.34 (1.14, 1.56)	2.78 (2.33, 3.31)

[a]Unweighted counts of infant deaths. Excludes deaths and births among infants with unknown or not stated birth order.

[b]Adjusted: covariates included maternal age (<20, 20–24, 25–29, 30–34, 35–39, 40–54 years); race (Hispanic, non-Hispanic white, non-Hispanic black, other); education (no high school diploma or GED, high school diploma or GED, bachelor's degree or higher, not stated or unknown); and marital status (married, unmarried).

[c]p-value <0.0001 for test for linear trend in unadjusted model.

[d]p-value <0.0001 for test for linear trend in adjusted model.

[e]p-value <0.05 for test for linear trend in unadjusted model.

GED, General Educational Development test; RR, risk ratio; SUID, sudden unexpected infant death.