

# Online Appendix

“Teenage Driving, Mortality, and Risky Behaviors”

Jason Huh and Julian Reif

Appendix **A**: Supplementary results

Appendix **B**: Data and additional background

# A Supplementary results

Table A.1 decomposes the female poisoning death estimates into those classified as suicides versus accidents. Tables A.2 and A.3 report estimates for motor vehicle fatalities and poisoning deaths, separately for sample observations where the MDA is 16 years and 0 months versus observations where it is not 16 years and 0 months.

## Plots of additional outcomes, by age in months:

- Figure A.1: vehicle miles driven (baseline and alternate specifications)
- Figure A.2: deaths from all causes, external causes, and internal causes
- Figure A.3: drowning deaths
- Figure A.4: deaths from other external causes
- Figure A.5: working for pay and school enrollment

## Heterogeneity by race and sex:

- Table A.4: driver's licensing rates
- Table A.5: vehicle miles driven
- Table A.6: motor vehicle fatalities
- Table A.7: poisoning deaths

## Heterogeneity by month of birth:

- Table A.8: motor vehicle fatalities (see also Figure A.6)
- Table A.9: female poisoning deaths (see also Figure A.7)

## Alternative specifications and robustness checks:

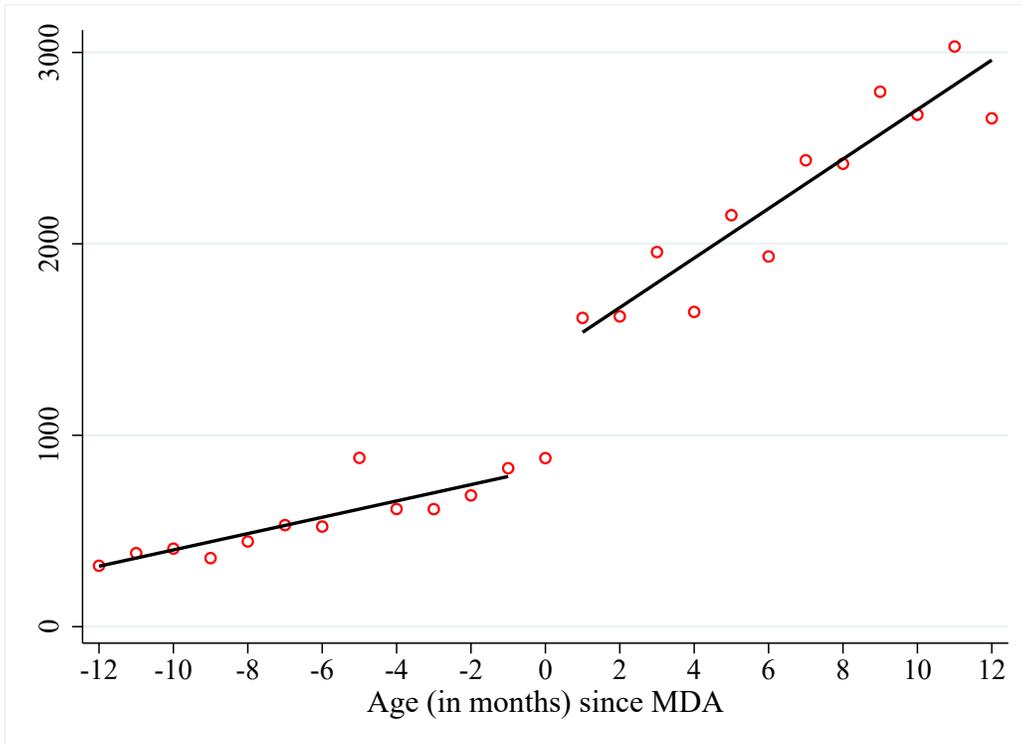
- Table A.10: different bandwidth selection procedures
- Table A.11: different polynomial approximations
- Table A.12: constant bandwidth of 24 months (OLS)
- Figure A.8: placebo tests

**Figure A.1:** Annual vehicle miles driven, 1995–1996

(a) Baseline specification

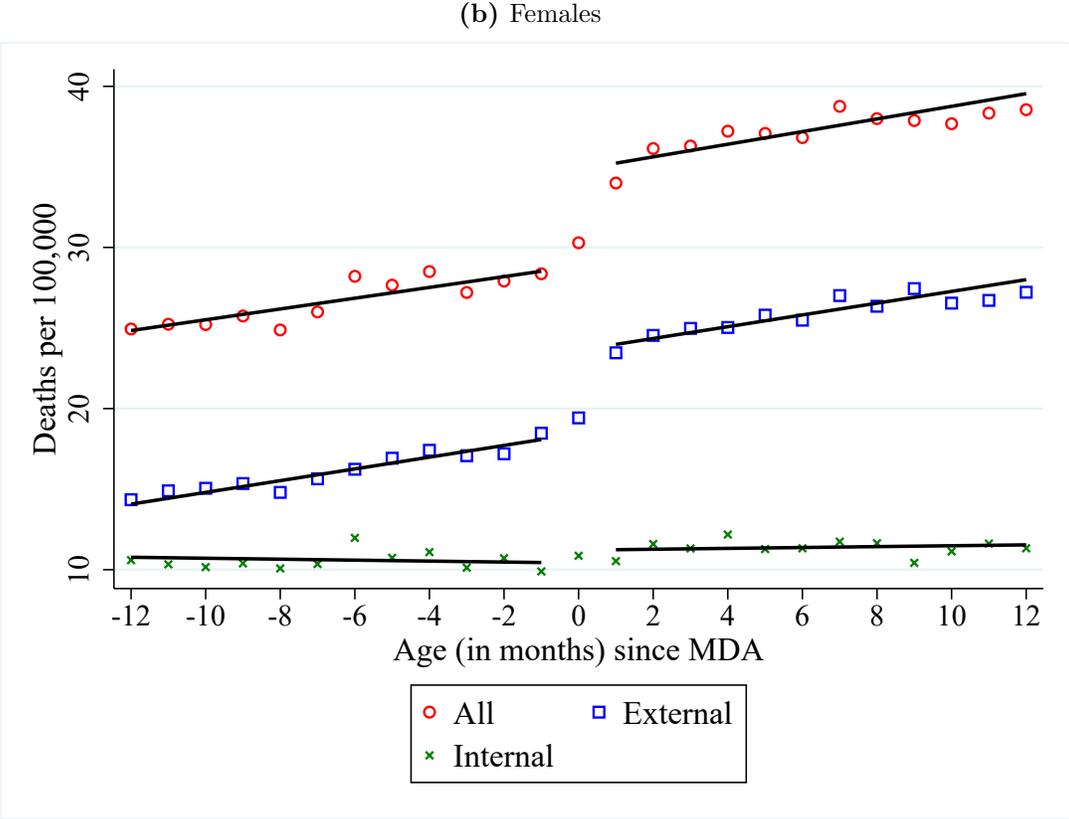


(b) Alternate specification



Notes: These figures show average annual vehicle miles driven by age, relative to the minimum driving age (MDA). Estimates are weighted using Add Health’s cross-sectional weights. The fitted lines are estimated using equation (1) with a bandwidth of 24 months. The baseline specification assigns a value of 150 to respondents who report driving “over 100” miles per week. The alternate specification assigns a value of 265.

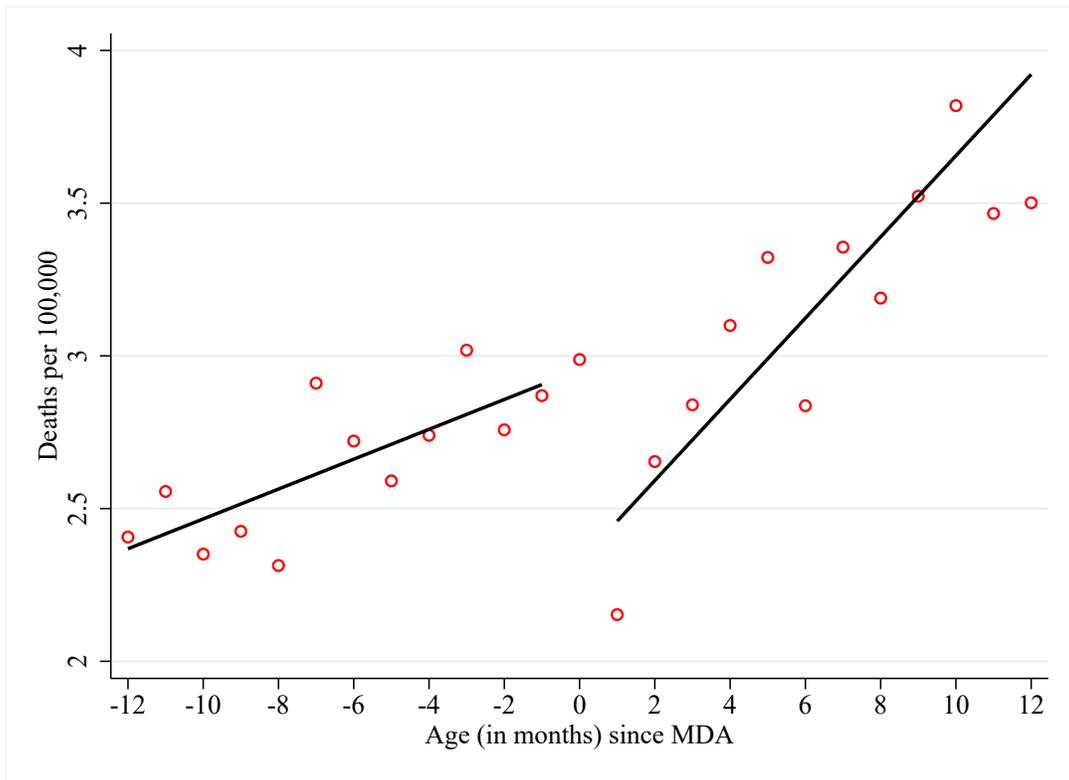
**Figure A.2:** Teenage deaths from all causes, external causes, and internal causes, 1983–2014



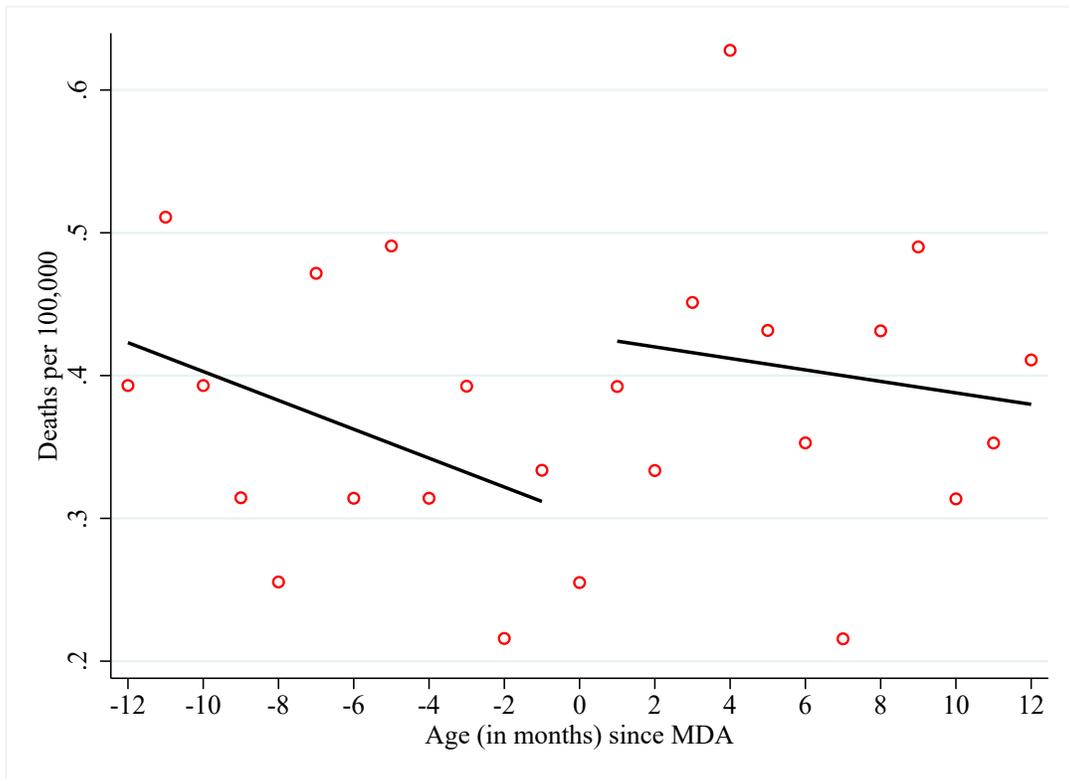
Notes: The figure shows US death rates by age, relative to the minimum driving age (MDA). The fitted lines are estimated using equation (1) with a bandwidth of 24 months.

**Figure A.3:** Teenage drowning deaths, 1983–2014

(a) Males



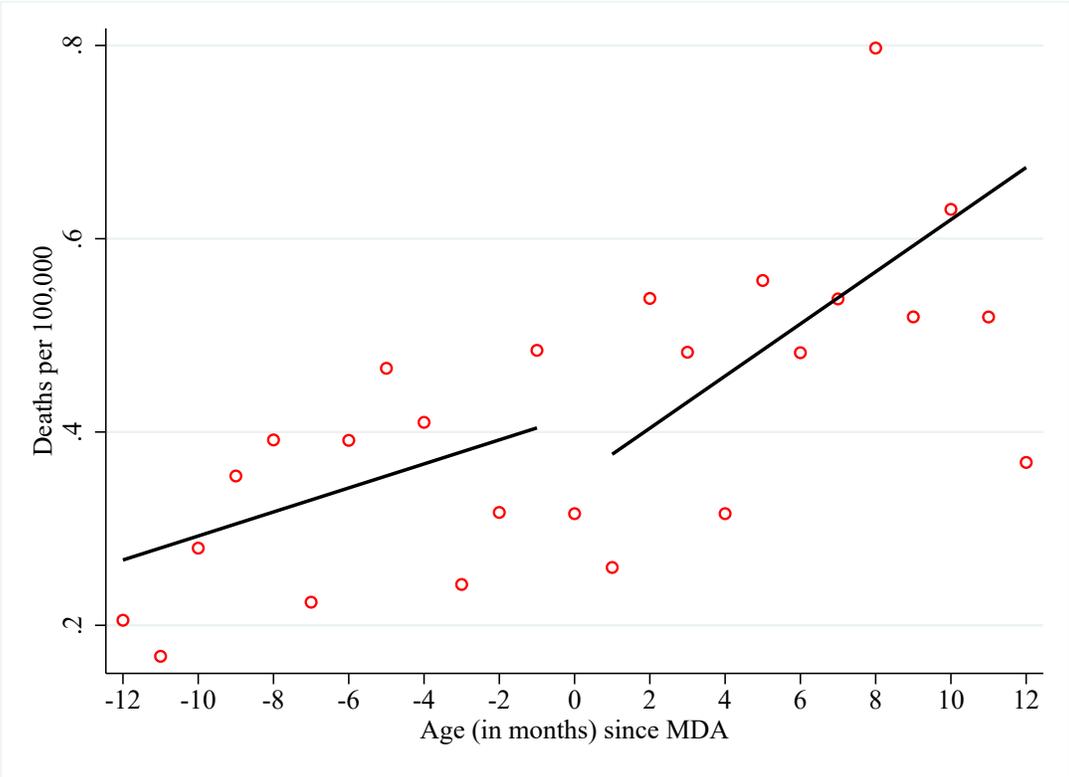
(b) Females



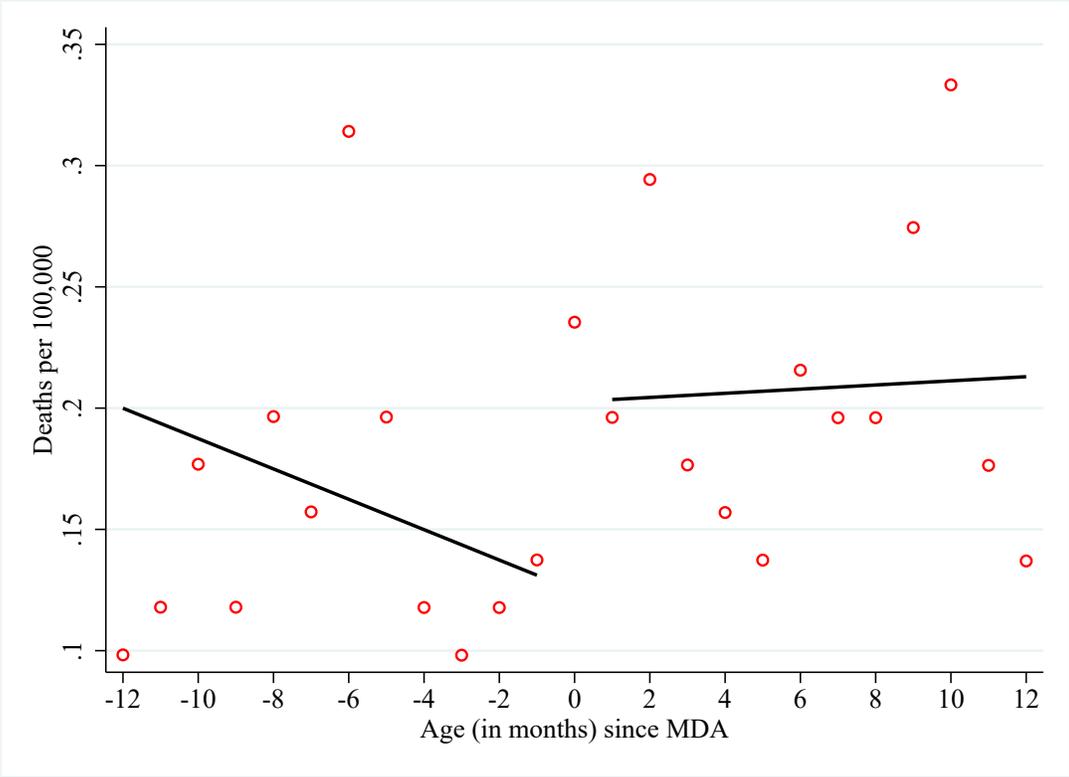
Notes: The figure shows US death rates by age, relative to the minimum driving age (MDA). The fitted lines are estimated using equation (1) with a bandwidth of 24 months.

Figure A.4: Teenage deaths categorized as “other external”, 1983–2014

(a) Males

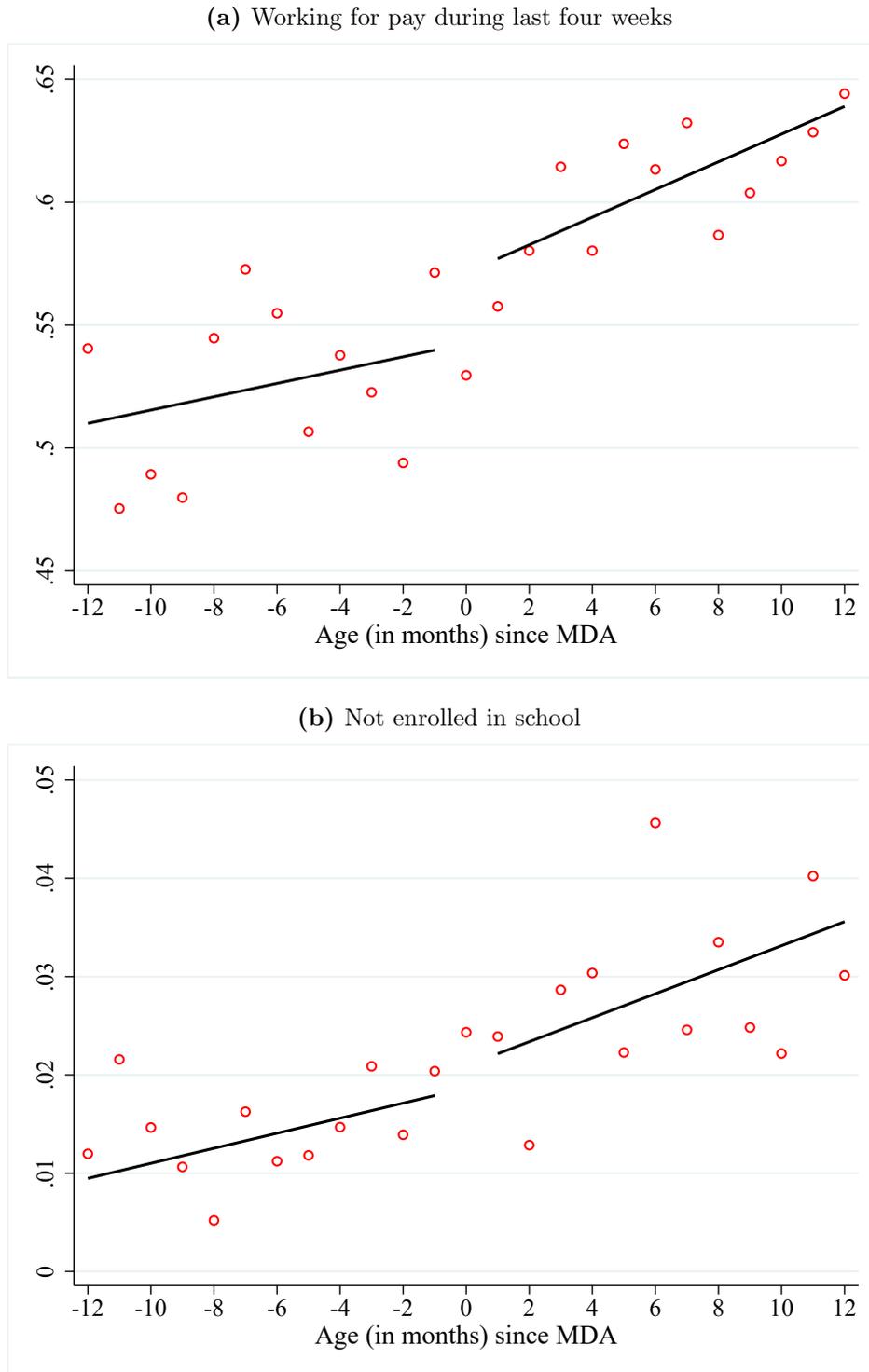


(b) Females



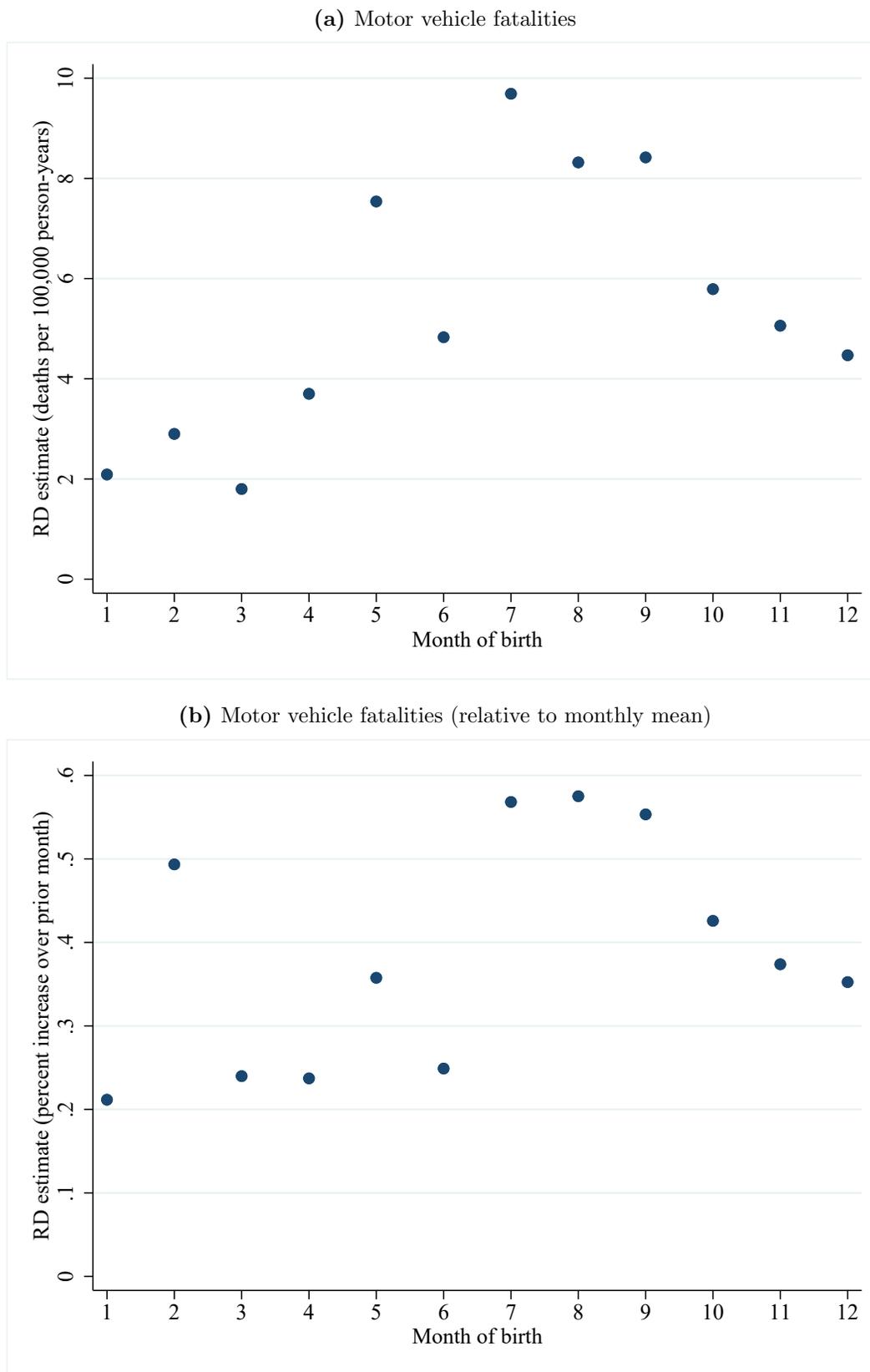
Notes: The figure shows US death rates by age, relative to the minimum driving age (MDA). The fitted lines are estimated using equation (1) with a bandwidth of 24 months.

**Figure A.5:** Proportion of teenagers working for pay and proportion not enrolled in school, 1995–1996



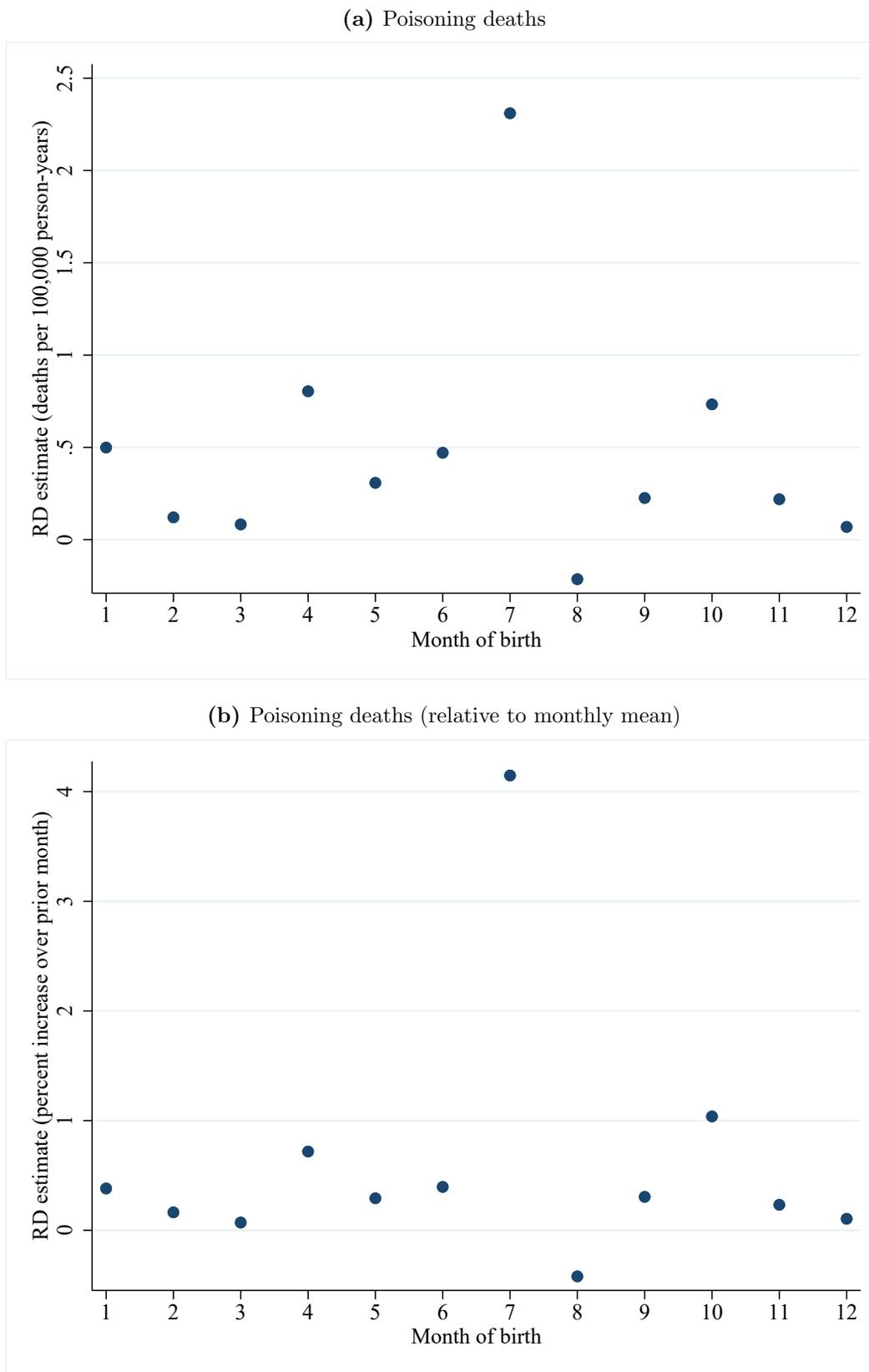
Notes: Panel (a) reports the proportion of teenagers who report ever working for pay during the last four weeks by age, relative to the minimum driving age (MDA). Working includes both formal jobs and informal jobs like babysitting or yard work. Panel (b) reports the proportion who report not being enrolled in school. The MSE-optimal RD estimate from equation (1) is an increase in working for pay of 2.9 percentage points ( $p = 0.411$ ), with a 95% robust bias-corrected confidence interval of  $[-0.0385, 0.0942]$ . The MSE-optimal estimate for not enrolled in school is  $-0.021$  percentage points ( $p = 0.829$ ), with a 95% robust bias-corrected confidence interval of  $[-0.0104, 0.0083]$ . These estimates are based on weighted responses to the 1995–1996 Add Health surveys.

**Figure A.6:** Effect of driving eligibility on motor vehicle fatalities, by month of birth



Notes: Panel (a) plots estimates from Table A.8. Panel (b) normalizes the point estimates by the mean reported in Column (1) of those tables. January is denoted as month 1.

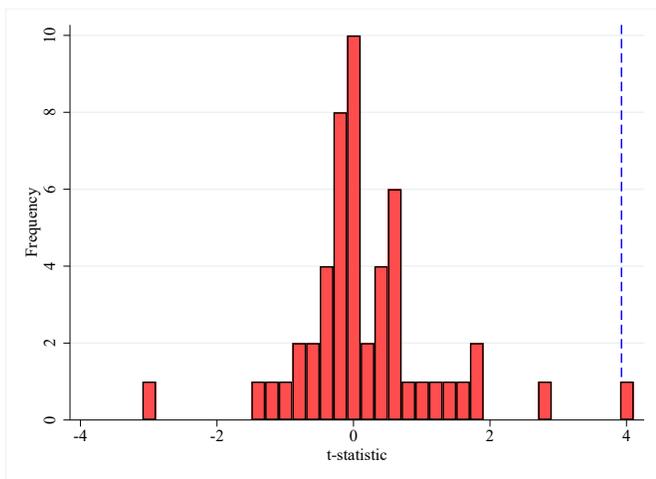
**Figure A.7:** Effect of driving eligibility on female poisoning deaths, by month of birth



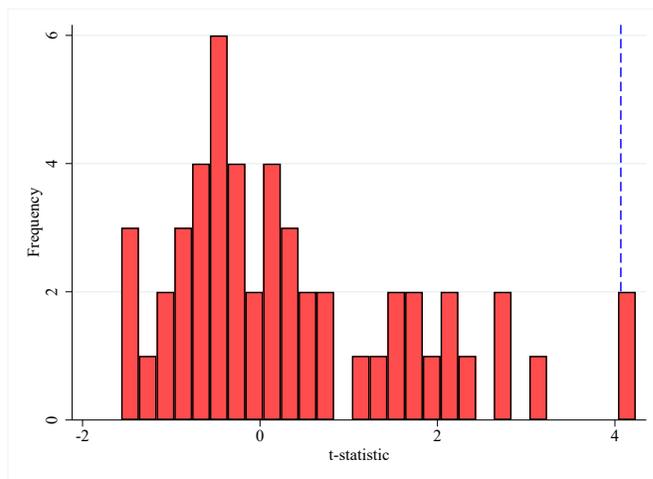
Notes: Panel (a) plots estimates from Table A.9. Panel (b) normalizes the point estimates by the mean reported in Column (1) of that table. January is denoted as month 1.

**Figure A.8:** Placebo estimates for motor vehicle fatalities and poisoning deaths

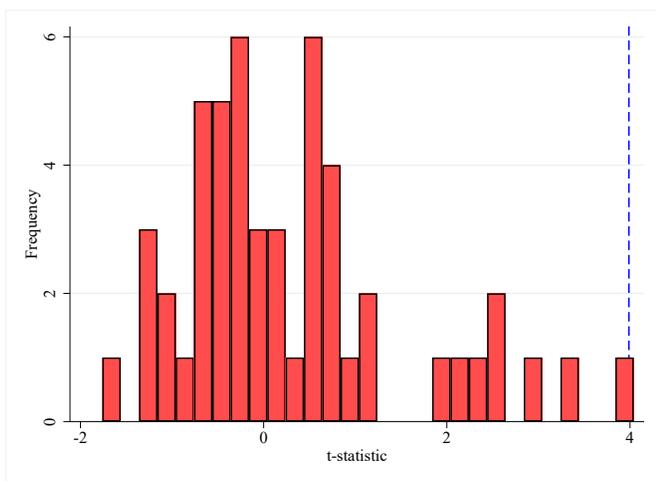
**(a)** Full sample: Motor vehicle fatalities



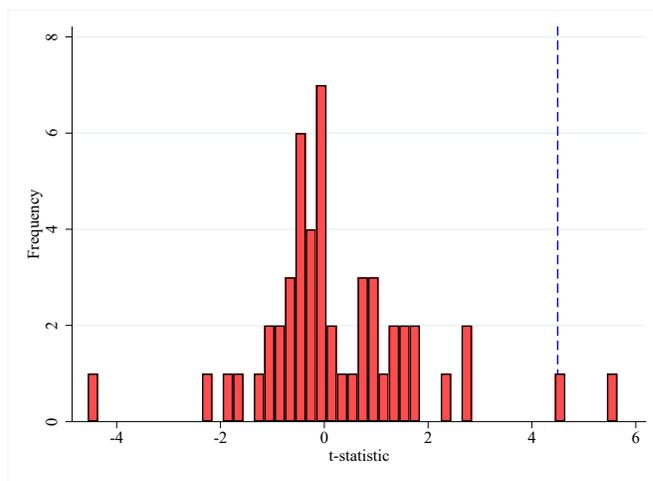
**(b)** Full sample: Poisoning deaths



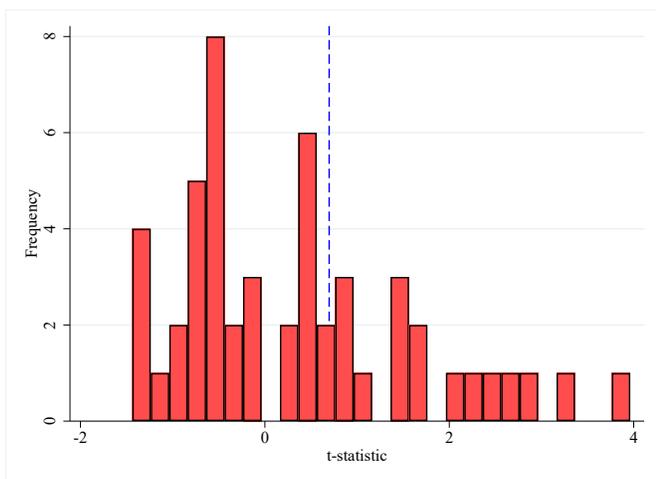
**(c)** Male: Motor vehicle fatalities



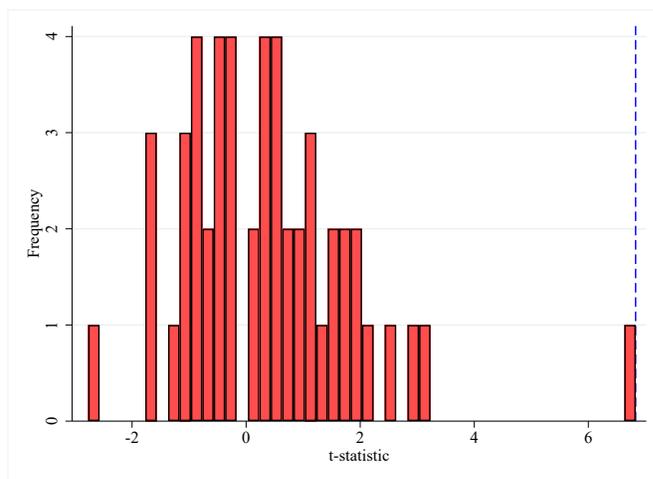
**(d)** Female: Motor vehicle fatalities



**(e)** Male: Poisoning deaths



**(f)** Female: Poisoning deaths



Notes: The figure shows the distribution of  $t$ -statistics for estimates of  $\beta$  from equation (1) using 50 placebo cutoffs (25 on each side of the true cutoff). The figure also reports the  $t$ -statistic obtained when using the true cutoff and tags that value with a vertical dashed line.

**Table A.1:** Effect of driving eligibility on female suicides and accidents

	(1)	(2)	(3)	(4)	(5)	(6)
	Female suicides		Female accidents		Female suicides and accidents	
Cause of death	Mean	RD	Mean	RD	Mean	RD
Total suicides/accidents	3.05	0.0449 [-0.341, 0.545]	2.02	0.280* [0.0421, 0.589]	5.07	0.337 [-0.0259, 0.849]
Firearm	1.15	-0.322* [-0.678, -0.0497]	0.144	-0.0254 [-0.142, 0.0753]	1.29	-0.333* [-0.715, -0.0560]
Poisoning	0.537	0.233** [0.0957, 0.443]	0.447	0.339** [0.229, 0.547]	0.984	0.747** [0.591, 1.07]
Drug overdose	0.488	0.180* [0.0281, 0.426]	0.342	0.341** [0.287, 0.503]	0.830	0.646** [0.476, 0.999]
Carbon monoxide and other gases	0.0491	0.105** [0.0371, 0.174]	0.105	0.0219 [-0.0426, 0.107]	0.154	0.127** [0.0333, 0.243]
Drowning	0.0295	0.00725 [-0.0160, 0.0421]	0.337	0.117* [0.00739, 0.258]	0.367	0.126 [-0.00258, 0.270]
Other	1.33	0.0440 [-0.361, 0.489]	1.09	-0.0462 [-0.373, 0.186]	2.43	0.0749 [-0.519, 0.639]

Notes: This table reports MSE-optimal estimates of  $\beta$  from equation (1). The dependent variable is deaths per 100,000 person-years. Columns (1), (3), and (5) report means of the dependent variable one year before reaching the minimum driving age (MDA). Columns (5)–(6) reproduce the numbers reported in Columns (5)–(6) of Table 1. The estimates in Columns (2) and (4) do not necessarily add up to the estimate in Column (6) because bandwidths are not constant across different regressions. Robust, bias-corrected 95% confidence intervals are reported in brackets. A \*/\*\* indicates significance at the 5%/1% level using conventional inference. Familywise  $p$ -values are not reported in this exploratory analysis.

**Table A.2:** Effect of driving eligibility on motor vehicle fatalities by state minimum driving age

	(1)	(2)	(3)
		RD estimate	
Subgroup	Mean	OLS	MSE optimal
Male			
Full sample	13.560	6.25** (0.636)	5.67** [2.76, 8.10]
MDA is 16	13.786	6.72** (0.816)	5.92** [2.90, 8.37]
MDA is not 16	12.789	4.67** (0.974)	4.66** [1.58, 6.98]
Female			
Full sample	8.748	4.83** (0.564)	4.46** [2.41, 6.14]
MDA is 16	9.116	5.52** (0.570)	5.26** [3.46, 6.87]
MDA is not 16	7.496	2.49 (1.32)	2.67 [-0.597, 4.90]

Notes: This table reports estimates of  $\beta$  from equation (1) for different subgroups. The dependent variable is deaths per 100,000 person-years. Column (1) reports means of the dependent variable one year before reaching the minimum driving age (MDA). Column (2) reports OLS estimates from a model employing a bandwidth of 24 months and reports robust standard errors in parentheses. Column (3) reports MSE-optimal estimates and reports robust, bias-corrected 95% confidence intervals in brackets. A \*/\*\* indicates significance at the 5%/1% level using conventional inference.

**Table A.3:** Effect of driving eligibility on poisoning deaths by state minimum driving age

	(1)	(2)	(3)
		RD estimate	
Subgroup	Mean	OLS	MSE optimal
Male			
Full sample	1.167	0.121 (0.133)	0.133 [-0.218, 0.458]
MDA is 16	1.168	0.172 (0.159)	0.161 [-0.315, 0.570]
MDA is not 16	1.164	-0.0518 (0.404)	-0.0554 [-0.943, 0.792]
Female			
Full sample	0.984	0.473** (0.104)	0.747** [0.591, 1.07]
MDA is 16	1.023	0.477** (0.115)	0.739** [0.516, 1.16]
MDA is not 16	0.851	0.462* (0.220)	0.509** [0.200, 0.972]

Notes: This table reports estimates of  $\beta$  from equation (1) for different subgroups. The dependent variable is deaths per 100,000 person-years. Column (1) reports means of the dependent variable one year before reaching the minimum driving age (MDA). Column (2) reports OLS estimates from a model employing a bandwidth of 24 months and reports robust standard errors in parentheses. Column (3) reports MSE-optimal estimates and reports robust, bias-corrected 95% confidence intervals in brackets. A \*/\*\* indicates significance at the 5%/1% level using conventional inference.

**Table A.4:** Effect of driving eligibility on proportion of teenagers with a license for different subgroups

	(1)	(2)	(3)
		RD estimate	
Subgroup	Mean	OLS	MSE optimal
Full sample	0.013	0.186** (0.0138)	0.186** [0.124, 0.231]
Race			
White	0.013	0.230** (0.0185)	0.229** [0.149, 0.286]
Nonwhite	0.013	0.0501 (0.0263)	0.0623** [0.0232, 0.101]
Sex			
Male	0.016	0.193** (0.0103)	0.193** [0.139, 0.231]
Female	0.010	0.178** (0.0229)	0.179** [0.103, 0.232]
Race and sex			
White male	0.015	0.246** (0.0124)	0.246** [0.178, 0.293]
White female	0.011	0.215** (0.0338)	0.217** [0.113, 0.289]
Nonwhite male	0.021	0.0390 (0.0345)	0.0586 [-0.00354, 0.125]
Nonwhite female	0.007	0.0585 (0.0316)	0.0561* [0.00752, 0.0987]

Notes: This table reports estimates of  $\beta$  from equation (1) for different subgroups. The dependent variable is the proportion of teenagers with a driver's license. Column (1) reports means of the dependent variable one year before reaching the minimum driving age (MDA). Column (2) reports OLS estimates from a model employing a bandwidth of 24 months and reports robust standard errors in parentheses. Column (3) reports MSE-optimal estimates and reports robust, bias-corrected 95% confidence intervals in brackets. A \*/\*\* indicates significance at the 5%/1% level using conventional inference.

**Table A.5:** Effect of driving eligibility on vehicle miles driven (baseline) for different subgroups

	(1)	(2)	(3)
		RD estimate	
Subgroup	Mean	OLS	MSE optimal
Full sample	514	371** (53.3)	375** [159, 530]
Race			
White	536	499** (66.3)	497** [242, 682]
Nonwhite	450	-5.23 (82.1)	-40.8 [-340, 179]
Sex			
Male	569	484** (116)	486** [195, 734]
Female	458	235 (116)	234 [-105, 479]
Race and sex			
White male	575	720** (146)	709** [366, 1,045]
White female	496	272 (165)	272 [-138, 566]
Nonwhite male	552	-113 (128)	-78.7 [-435, 216]
Nonwhite female	350	101 (72)	94.3 [-118, 235]

Notes: This table reports estimates of  $\beta$  from equation (1) for different subgroups. The dependent variable is average annual vehicle miles driven (baseline specification). Column (1) reports means of the dependent variable one year before reaching the minimum driving age (MDA). Column (2) reports OLS estimates from a model employing a bandwidth of 24 months and reports robust standard errors in parentheses. Column (3) reports MSE-optimal estimates and reports robust, bias-corrected 95% confidence intervals in brackets. A \*/\*\* indicates significance at the 5%/1% level using conventional inference.

**Table A.6:** Effect of driving eligibility on motor vehicle fatalities for different subgroups

	(1)	(2)	(3)
		RD estimate	
Subgroup	Mean	OLS	MSE optimal
Full sample	11.217	5.57** (0.492)	4.92** [2.36, 7.07]
Race			
White	12.204	7.20** (0.637)	6.39** [3.71, 8.57]
Nonwhite	7.634	-0.448 (0.541)	-0.507 [-2.81, 1.37]
Sex			
Male	13.560	6.25** (0.636)	5.67** [2.76, 8.10]
Female	8.748	4.83** (0.564)	4.46** [2.41, 6.14]
Race and sex			
White male	14.469	7.95** (0.918)	7.50** [4.68, 9.77]
White female	9.807	6.40** (0.740)	6.04** [3.74, 8.02]
Nonwhite male	10.228	-0.0517 (0.936)	-0.107 [-3.70, 2.91]
Nonwhite female	4.949	-0.872 (0.539)	-0.903 [-2.41, 0.0198]

Notes: This table reports estimates of  $\beta$  from equation (1) for different subgroups. The dependent variable is deaths per 100,000 person-years. Column (1) reports means of the dependent variable one year before reaching the minimum driving age (MDA). Column (2) reports OLS estimates from a model employing a bandwidth of 24 months and reports robust standard errors in parentheses. Column (3) reports MSE-optimal estimates and reports robust, bias-corrected 95% confidence intervals in brackets. A \*/\*\* indicates significance at the 5%/1% level using conventional inference.

**Table A.7:** Effect of driving eligibility on poisoning deaths for different subgroups

	(1)	(2)	(3)
		RD estimate	
Subgroup	Mean	OLS	MSE optimal
Full sample	1.078	0.293** (0.0848)	0.314** [0.183, 0.522]
Race			
White	1.196	0.268* (0.121)	0.258* [0.0216, 0.558]
Nonwhite	0.649	0.379 (0.185)	0.412** [0.157, 0.839]
Sex			
Male	1.167	0.121 (0.133)	0.133 [-0.218, 0.458]
Female	0.984	0.473** (0.104)	0.747** [0.591, 1.07]
Race and sex			
White male	1.325	0.0788 (0.178)	0.105 [-0.345, 0.506]
White female	1.059	0.467** (0.110)	0.653** [0.581, 0.898]
Nonwhite male	0.588	0.271 (0.159)	0.280 [-0.0669, 0.694]
Nonwhite female	0.714	0.492 (0.310)	0.565* [0.121, 1.32]

Notes: This table reports estimates of  $\beta$  from equation (1) for different subgroups. The dependent variable is deaths per 100,000 person-years. Column (1) reports means of the dependent variable one year before reaching the minimum driving age (MDA). Column (2) reports OLS estimates from a model employing a bandwidth of 24 months and reports robust standard errors in parentheses. Column (3) reports MSE-optimal estimates and reports robust, bias-corrected 95% confidence intervals in brackets. A \*/\*\* indicates significance at the 5%/1% level using conventional inference.

**Table A.8:** Effect of driving eligibility on motor vehicle fatalities by month of birth

	(1)	(2)	(3)
		RD estimate	
Month of birth	Mean (monthly)	OLS	MSE optimal
January	9.877	2.40* (1)	2.09* [0.0258, 3.58]
February	5.877	3.11** (0.870)	2.90** [1.13, 4.99]
March	7.504	2.07 (1.06)	1.80 [-1.45, 4.33]
April	15.600	3.65* (1.53)	3.70 [-1.14, 7.60]
May	21.084	7.86** (1.62)	7.54** [2.58, 13.5]
June	19.400	6.02** (1.21)	4.83* [0.353, 7.84]
July	17.053	9.81** (1.40)	9.69** [7.12, 12.3]
August	14.467	9.29** (1.14)	8.32** [6.03, 10.1]
September	15.216	8.42** (0.370)	8.42** [7.46, 9.04]
October	13.596	6.12** (1.04)	5.79** [1.83, 8.70]
November	13.535	6.09** (0.777)	5.06** [2.30, 6.82]
December	12.681	4.61** (1.23)	4.47** [1.75, 6.76]

Notes: This table reports estimates of  $\beta$  from equation (1) for different subgroups. The dependent variable is deaths per 100,000 person-years. Column (1) reports means of the dependent variable one year before reaching the minimum driving age (MDA). Column (2) reports OLS estimates from a model employing a bandwidth of 24 months and reports robust standard errors in parentheses. Column (3) reports MSE-optimal estimates and reports robust, bias-corrected 95% confidence intervals in brackets. A \*/\*\* indicates significance at the 5%/1% level using conventional inference.

**Table A.9:** Effect of driving eligibility on female poisoning deaths by month of birth

	(1)	(2)	(3)
		RD estimate	
Month of birth	Mean (monthly)	OLS	MSE optimal
January	1.308	0.394 (0.359)	0.499 [-0.226, 1.34]
February	0.739	0.347 (0.492)	0.121 [-0.720, 1.02]
March	1.166	0.0752 (0.378)	0.0826 [-0.664, 0.833]
April	1.120	0.978 (0.476)	0.804** [0.252, 1.65]
May	1.054	0.110 (0.503)	0.308 [-0.566, 1.51]
June	1.190	0.303 (0.506)	0.471 [-0.597, 2.05]
July	0.557	2.20** (0.388)	2.31** [1.83, 3.22]
August	0.509	0.0430 (0.249)	-0.214 [-0.681, 0.369]
September	0.740	0.227 (0.543)	0.226 [-0.486, 1.10]
October	0.706	0.747** (0.235)	0.733** [0.450, 1.24]
November	0.942	0.243 (0.371)	0.219 [-0.420, 0.921]
December	0.657	0.154 (0.383)	0.0690 [-0.671, 0.929]

Notes: This table reports estimates of  $\beta$  from equation (1) for different subgroups. The dependent variable is deaths per 100,000 person-years. Column (1) reports means of the dependent variable one year before reaching the minimum driving age (MDA). Column (2) reports OLS estimates from a model employing a bandwidth of 24 months and reports robust standard errors in parentheses. Column (3) reports MSE-optimal estimates and reports robust, bias-corrected 95% confidence intervals in brackets. A \*/\*\* indicates significance at the 5%/1% level using conventional inference.

**Table A.10:** Effect of driving eligibility on mortality using different bandwidth selection procedures

Subgroup	(1)	(2)	(3)	(4)	(5)
	Mean	RD estimate			
		MSE optimal (1)	MSE optimal (2)	CER optimal (1)	CER optimal (2)
<b>A. All deaths</b>					
Full sample	38.9	5.84** [1.99, 9.36] ±11	5.81** [1.98, 8.92] -12/+11	5.66** [1.43, 9.67] ±8	5.55** [1.39, 9.22] -10/+8
Male	50.6	5.72 [-0.809, 11.3] ±10	5.93 [-0.0738, 10.6] -13/+11	5.58 [-1.44, 12.0] ±8	5.62 [-0.759, 11.1] -11/+8
Female	26.7	5.76** [4.35, 7.53] ±11	5.99** [4.42, 7.69] -9/+11	5.70** [3.99, 7.63] ±9	5.99** [4.17, 7.89] -7/+8
<b>B. Motor vehicle fatalities</b>					
Full sample	11.2	4.92** [2.36, 7.07] ±9	4.98** [2.70, 6.54] -15/+9	4.66** [1.75, 7.31] ±7	4.74** [2.21, 6.80] -12/+7
Male	13.6	5.67** [2.76, 8.10] ±9	5.55** [2.58, 7.60] -13/+9	5.29** [2.00, 8.28] ±7	5.22** [1.89, 7.96] -10/+7
Female	8.75	4.46** [2.41, 6.14] ±10	4.43** [2.76, 5.68] -17/+10	4.20** [1.93, 6.23] ±8	4.28** [2.48, 5.82] -14/+8
<b>C. Poisoning deaths</b>					
Full sample	1.08	0.314** [0.183, 0.522] ±11	0.294** [0.154, 0.519] -10/+12	0.386** [0.273, 0.553] ±9	0.361** [0.235, 0.546] -8/+10
Male	1.17	0.133 [-0.218, 0.458] ±14	0.130 [-0.220, 0.458] -14/+13	0.111 [-0.242, 0.444] ±11	0.127 [-0.219, 0.457] -11/+11
Female	0.984	0.747** [0.591, 1.07] ±7	0.644** [0.460, 0.978] -6/+12	0.838** [0.589, 1.20] ±6	0.713** [0.496, 1.04] -5/+10

Notes: The dependent variable is deaths per 100,000 person-years. Column (1) reports means of the dependent variable one year before reaching the minimum driving age (MDA). Columns (2)–(5) report estimates of  $\beta$  from equation (1) using different bandwidths. The MSE-optimal method selects a bandwidth that minimizes the mean squared error (MSE) of the point estimator. The coverage error rate (CER) optimal method selects a bandwidth that minimizes the asymptotic CER of the robust bias-corrected confidence interval. Column (2) reports estimates from our preferred specification, MSE optimal (1), which selects one common bandwidth on each side of the cutoff. Columns (3)–(5) report estimates using different bandwidth selection procedures: MSE optimal with different bandwidths on each side of the cutoff, CER optimal with one common bandwidth, and CER optimal with different bandwidths on each side of the cutoff. Robust, bias-corrected 95% confidence intervals are reported in brackets. The selected bandwidths (rounded to the nearest month) are reported below the confidence interval. A \*/\*\* indicates significance at the 5%/1% level using conventional inference.

**Table A.11:** Effect of driving eligibility on mortality using different polynomial approximations

	(1)	(2)	(3)	(4)
		RD estimate		
Subgroup	Mean	Linear	Quadratic	Cubic
<b>A. All deaths</b>				
Full sample	38.9	5.84** [1.99, 9.36]	5.58* [1.14, 10.1]	5.23* [0.338, 10.4]
Male	50.6	5.72 [-0.809, 11.3]	5.22 [-1.96, 11.9]	4.66 [-3.80, 13.3]
Female	26.7	5.76** [4.35, 7.53]	5.50** [3.30, 8.06]	5.79** [3.60, 8.33]
<b>B. Motor vehicle fatalities</b>				
Full sample	11.2	4.92** [2.36, 7.07]	4.68** [1.72, 7.37]	4.50** [1.53, 7.37]
Male	13.6	5.67** [2.76, 8.10]	5.31** [1.95, 8.51]	5.02** [1.63, 8.55]
Female	8.75	4.46** [2.41, 6.14]	3.95** [1.11, 6.40]	3.91** [1.03, 6.47]
<b>C. Poisoning deaths</b>				
Full sample	1.08	0.314** [0.183, 0.522]	0.423** [0.282, 0.601]	0.587** [0.319, 0.872]
Male	1.17	0.133 [-0.218, 0.458]	0.115 [-0.335, 0.493]	0.151 [-0.250, 0.554]
Female	0.984	0.747** [0.591, 1.07]	0.881** [0.605, 1.26]	0.970** [0.617, 1.40]

Notes: The dependent variable is deaths per 100,000 person-years. Column (1) reports means of the dependent variable one year before reaching the minimum driving age (MDA). Columns (2)–(4) report estimates of  $\beta$  from equation (1) using different polynomial approximations: linear (our preferred specification), quadratic, and cubic. Robust, bias-corrected 95% confidence intervals are reported in brackets. A \*/\*\* indicates significance at the 5%/1% level using conventional inference.

**Table A.12:** OLS estimates of effect of driving eligibility on teenage driving and mortality

Outcome variable	(1)	(2)	(3)	(4)	(5)	(6)
	Full sample		Male		Female	
	Mean	RD	Mean	RD	Mean	RD
<b>A. Driving</b>						
Has driver's license	0.0130	0.186** (0.0138)	0.0163	0.193** (0.0103)	0.0101	0.178** (0.0229)
Miles driven (miles/yr) (baseline)	514	371** (53.3)	569	484** (116)	458	235 (116)
Miles driven (miles/yr) (alternate)	549	581** (96.4)	613	798** (198)	484	327 (181)
<b>B. Mortality</b>						
All causes	38.9	6.16** (0.934) {<0.0001}	50.6	6.29** (1.23) {<0.01}	26.7	5.98** (0.758) {<0.0001}
Internal causes	12.2	0.390 (0.375) {0.844}	13.8	-0.00387 (0.455) {1.00}	10.5	0.799 (0.545) {0.850}
External causes	26.7	5.77** (0.608) {<0.0001}	36.8	6.29** (0.948) {<0.0001}	16.1	5.18** (0.439) {<0.0001}
Motor vehicle accident	11.2	5.57** (0.492) {<0.0001}	13.6	6.25** (0.636) {<0.0001}	8.75	4.83** (0.564) {<0.0001}
Suicide and accident	10.5	0.221 (0.159) {0.696}	15.6	0.0940 (0.210) {0.999}	5.07	0.334 (0.185) {0.716}
Firearm	3.64	0.102 (0.121) {0.877}	5.87	0.514** (0.136) {0.0217}	1.29	-0.342 (0.183) {0.697}
Poisoning	1.08	0.293** (0.0848) {0.0248}	1.17	0.121 (0.133) {0.985}	0.984	0.473** (0.104) {<0.01}
Drug overdose	0.864	0.187 (0.0944) {0.401}	0.897	0.0345 (0.114) {0.999}	0.830	0.347* (0.142) {0.335}
Carbon monoxide and other gases	0.214	0.106 (0.0598) {0.486}	0.270	0.0865 (0.0785) {0.964}	0.154	0.127 (0.0618) {0.587}
Drowning	1.53	-0.260* (0.118) {0.305}	2.64	-0.629** (0.191) {0.0622}	0.367	0.126 (0.0741) {0.730}
Other	4.23	0.0856 (0.202) {0.966}	5.93	0.0879 (0.202) {0.999}	2.43	0.0764 (0.298) {0.999}
Homicide	4.80	-0.0204 (0.210) {0.994}	7.33	0.0114 (0.411) {1.00}	2.14	-0.0653 (0.132) {0.999}
Other external	0.243	0.00378 (0.0714) {0.994}	0.328	-0.0667 (0.109) {0.998}	0.154	0.0778 (0.0437) {0.716}

Notes: This table replicates Table 1 but uses an OLS estimator with a bandwidth of 24 months instead of an MSE-optimal estimator. Columns (1), (3), and (5) report means of the dependent variable one year before reaching the minimum driving age (MDA). Columns (2), (4), and (6) report OLS estimates of  $\beta$  from equation (1). Robust standard errors are reported in parentheses. A \*/\*\* indicates significance at the 5%/1% level using conventional inference. Family-wise  $p$ -values, reported in braces, adjust for the number of outcome variables in each family and for the number of subgroups.

## B Data and additional background

### B.1 Background information on teenage driver’s licenses

Figure B.1 presents trends in the proportion of teenagers with a restricted or full driver’s license during our 1983–2014 sample period.<sup>1</sup> Figure B.2 presents corresponding trends in vehicle miles traveled for licensed teenagers.

States with a Graduated Driver Licensing (GDL) program have three distinct licensing stages: learner’s permit, intermediate licensure, and full licensure. States without a GDL program generally have just two stages: learner’s permit and full licensure. Below, we provide details about the licensing process for teenage drivers.

#### B.1.1 Learner’s permit

Teenagers begin the licensing process by first obtaining a learner’s permit, allowing them to drive under the supervision of an adult. The minimum age for a learner’s permit ranges from 14 to 16. Since 1991, 7 states have decreased this minimum age, 3 states have increased it, and 2 states did both. In 38 states, a driver’s education program is required either before applying for a learner’s permit or a restricted driver’s license. There is no driver’s education program requirement in the remaining 12 states plus DC. Instead, those states have alternative requirements. For instance, learner’s permit holders in Arizona who did not complete driver’s education must have a minimum of 30 hours of supervised driving (10 of which must be during nighttime) before they can apply for a restricted license.<sup>2</sup>

In all states, a teenager with a learner’s permit must be supervised by a licensed driver when driving a motor vehicle. A majority of the states (36 states plus DC) require the supervisor to be at least 21 years of age. The lowest/highest age requirement for the supervisor is 18/25. In addition, states usually impose driving experience, ranging from 1 to 5 years, on a supervisor.

#### B.1.2 Intermediate licensure

Beginning in 1996, states began adopting GDL programs. These programs introduced new restrictions that prohibit unsupervised driving by licensed teenagers under the age of 18 during certain nighttime hours and limit the number and age of passengers in their cars. The minimum age for a restricted driver’s license (also known as a “probationary,” “provisional,” “junior,” or “intermediate” license) ranges from 14 to 17. Upon reaching the MDA for a restricted license, the teenager becomes eligible to take a driving test and to apply for a restricted driver’s license after satisfying the following requirements:

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<sup>1</sup>The figure is based on license counts from the Federal Highway Administration (FHWA). Those data are publicly available at: [www.fhwa.dot.gov/policyinformation/quickfinddata/qfdrivers.cfm](http://www.fhwa.dot.gov/policyinformation/quickfinddata/qfdrivers.cfm).

<sup>2</sup>See <https://www.dmv.org/drivers-ed.php> for specific driver’s education requirements by state.

1. Learner’s permit holding period. This holding period ranges from 10 days to 12 months and was required in all states by the end of our sample period. Some states also require that the teenager has no traffic violations or accidents within a certain number of months, such as 3 or 6 months, before applying for a restricted driver’s license.
2. Behind-the-wheel training. This required training was introduced in all but four states during our sample period. The hours required for the training vary between 12 and 70, and some states waive or reduce this requirement with completion of an optional driver’s education course.

Two types of driving restrictions were adopted or modified during our sample period: nighttime restrictions (42 states plus DC) and passenger restrictions (44 states plus DC). By the end of our sample period, 42 states plus DC had both nighttime and passenger restrictions. The night driving restrictions prohibit unsupervised driving during certain times, for example, between 8pm and 6am. The passenger driving restrictions limit the number and age of passengers, and sometimes the relationship of passengers to the driver. For instance, restricted driver’s licenses typically do not allow more than one to three non-adult passengers in the teenager’s vehicle, and under stricter GDL laws, no passengers are allowed other than family members or driving instructors.

### **B.1.3 Full licensure**

After both nighttime and passenger restrictions (if in force) are lifted at ages 16 to 18, restricted driver’s license holders become eligible to apply for a full driver’s license. Teenagers with traffic violations or accidents within a certain number of months before the application may have their eligibility for a full driver’s license delayed in some states.

## **B.2 Minimum driving age laws**

Table [B.1](#) provides the data we collected on MDAs. Indiana, Kansas, and South Dakota have lower MDAs for teenagers who complete a driver’s education program.<sup>3</sup> For these three states, we use the MDAs that apply to teenagers who have completed a driver’s education program.

The data for the time period 1995–2014 were obtained from the Insurance Institute for Highway Safety and the data for the 1983–1994 period were obtained from HeinOnline.<sup>4</sup> We made two corrections to the Insurance Institute for Highway Safety data. The original data reported that Hawaii increased the MDA from 15 years and 3 months to 16 on 1/9/2006, and Nevada had an MDA of 15 years and 9 months before 1995. However, the corresponding dates indicated in the session laws are 1/1/2001 for Hawaii and 7/1/2001 for Nevada, so we use these corrected dates in our analysis.

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<sup>3</sup>In Indiana, starting in July 2010, the MDA is 16 years and 9 months for teenagers who did not complete a driver’s education program, but it is 16 years and 6 months for those who did complete the program. In Kansas, the MDA is 16 years without completion and 15 years with completion. In South Dakota, starting in January 1999, the MDA is 14 years and 6 months without completion and 14 years and 3 months with completion.

<sup>4</sup>The HeinOnline database is available at <https://home.heinonline.org/content/session-laws-library>.

Most states have hardship exemptions that allow teenagers below the MDA to obtain a limited license for certain occupational, medical, and educational purposes.<sup>5</sup> However, hardship exemptions are very rare. For example, less than 1% of teenagers within one year of the MDA obtained a hardship license in Ohio in 2017 (authors’ calculations using Ohio administrative licensing data). In addition, some states issue farmer’s permits that have a lower MDA than the MDA we employ (e.g., Kansas, Minnesota, and New Jersey), but these permits are uncommon and are intended only for farming purposes.

### B.3 Mortality

Table B.2 provides the list of ICD-9 and ICD-10 codes used to classify the cause of death in the Vital Statistics data. (The ICD-9 classification was replaced by ICD-10 in 1999.) We follow Carpenter and Dobkin (2009) and classify alcohol- or drug-related internal causes of death as “other external” (e.g., ICD-9 codes 291 and 292). A small number of deaths are classified as “undetermined intent,” i.e., neither accidents nor suicides. These deaths are more likely to be suicides than accidents: prior work has argued that medical examiners and coroners may classify a death as “undetermined” when there is pressure to avoid a classification of suicide (Gray et al., 2014; Stone et al., 2017). We therefore classify deaths of undetermined intent as suicides.

Table B.3 reports annual death rates by sex for different five-year age groups during our sample period. Figure B.3 reports annual teenage death rates for the years 1983–2014, separately for males and females. Figure B.4 shows how trends in suicides and accidents vary across different categories for both males and females.

### B.4 Add Health

We obtained a restricted-use version of the 1995 and 1996 Add Health survey data that includes pseudo-state identifiers and age in months. Table B.4 documents the codings for the Add Health variables employed in our analysis. Minimum driving ages for each combination of pseudo-state and survey year (1995 or 1996) were inferred by plotting the proportion of respondents with a license as a function of age in months and visually locating the discontinuity. We validated this procedure by checking that the aggregate number of pseudo-states with a particular MDA was consistent with the data presented in Table B.1.

We dropped person-year observations that were missing values for the pseudo-state identifier, sample weight, birth month, or birth year. We also dropped observations from eight pseudo-states for which we were unable to reliably infer an MDA. In total, we excluded 3,177 observations. Our final sample included 32,307 person-year observations.

We confirmed that respondents’ answers to questions about driving behavior are consistent with national data on license counts published by the Federal Highway Administration (FHWA). In 1995, the MDA was 16 in most states (Table B.1). According to Figure B.1, data published by the FHWA

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<sup>5</sup>See <https://automobiles.uslegal.com/drivers-hardship-license-law> for details.

indicate that just over 40% of all 16-year-olds and just over 60% of all 17-year-olds were licensed drivers in 1995. Similarly, Figure 1a shows that our Add Health data estimate that just under 40% of teenagers in Add Health had a driver’s license 6 months after eligibility (i.e., at 16y6m for a state where the MDA was 16). Extending the x-axis of Figure 1a further out (not reported) reveals that about 65% of teenagers in Add Health had a driver’s license 18 months after eligibility (i.e., at 17y6m for a state where the MDA was 16).

## B.5 Minimum legal school leaving age

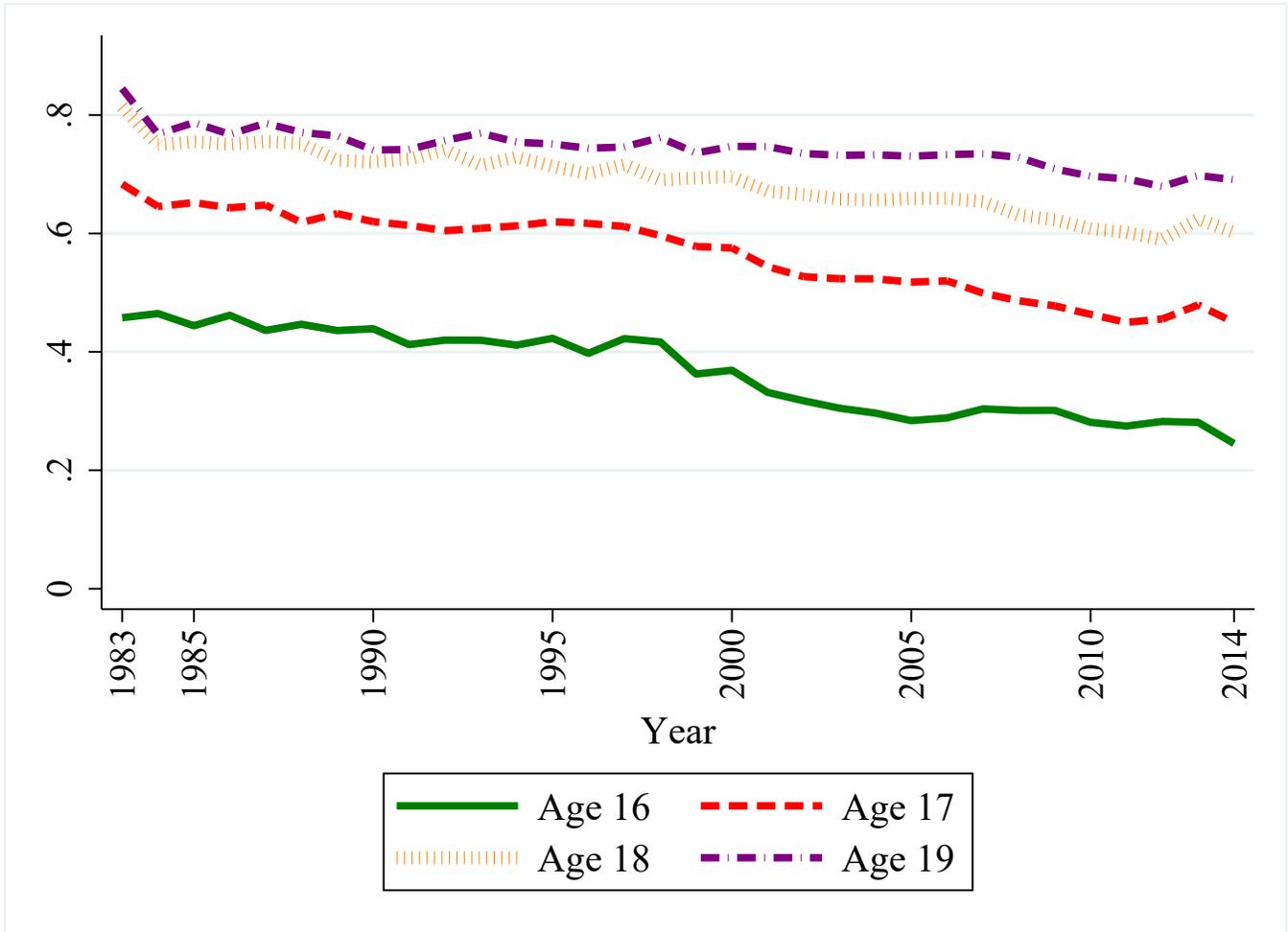
We collected state-level information on the minimum legal school leaving age from the National Center for Education Statistics.<sup>6</sup> Data are available for the following 13 years: 1994, 1996, 1997, 2000, 2002, 2004, 2006–2010, 2013, and 2014.

For those 13 years, 52% of our state-year observations have a minimum school leaving age equal to 16 years. The MDA in 31% of states is the same as the minimum school leaving age during those 13 years. However, the minimum school leaving age is not equal to the MDA in any state where the MDA is not 16 years.

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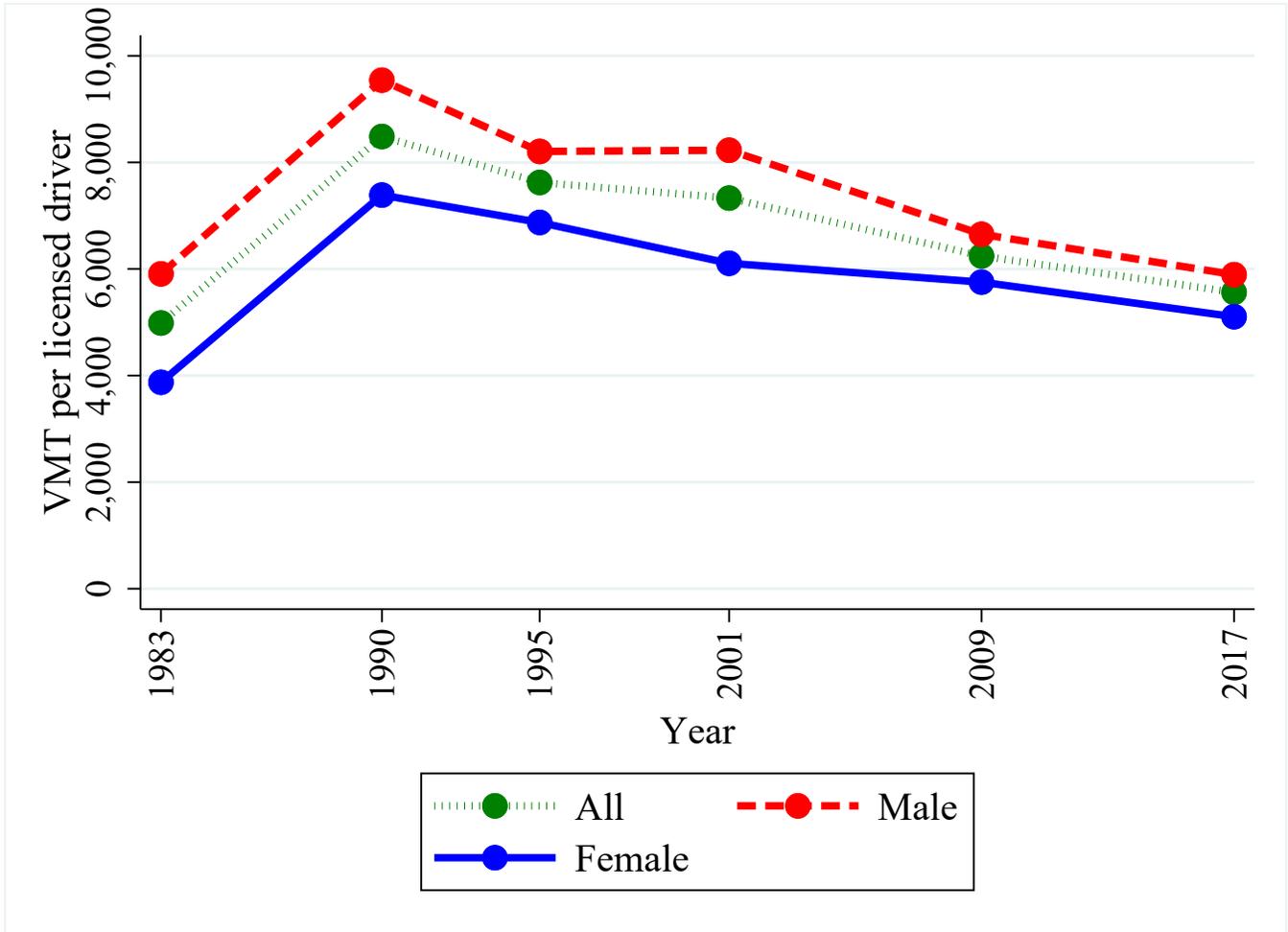
<sup>6</sup>See <https://nces.ed.gov/programs/digest/> for details.

**Figure B.1:** Proportion of US teenagers with a driver's license, by age and year



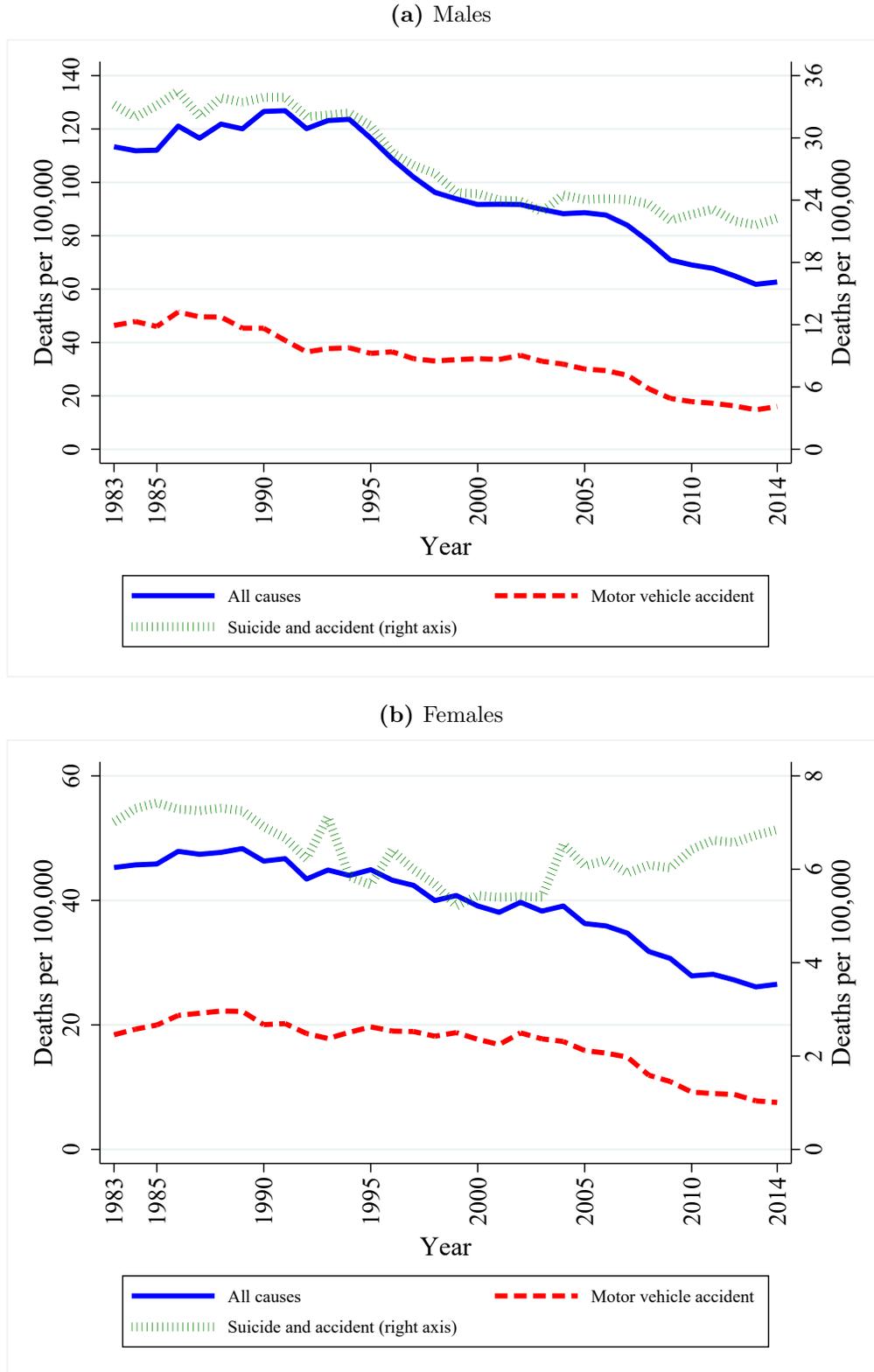
Notes: The figure reports the proportion of US teenagers with a restricted or full driver's license. Annual counts of licensed drivers are obtained from the Federal Highway Administration (FHWA). Annual population estimates come from the Surveillance, Epidemiology, and End Results (SEER) Program.

**Figure B.2:** Average annual vehicle miles traveled, ages 16–19



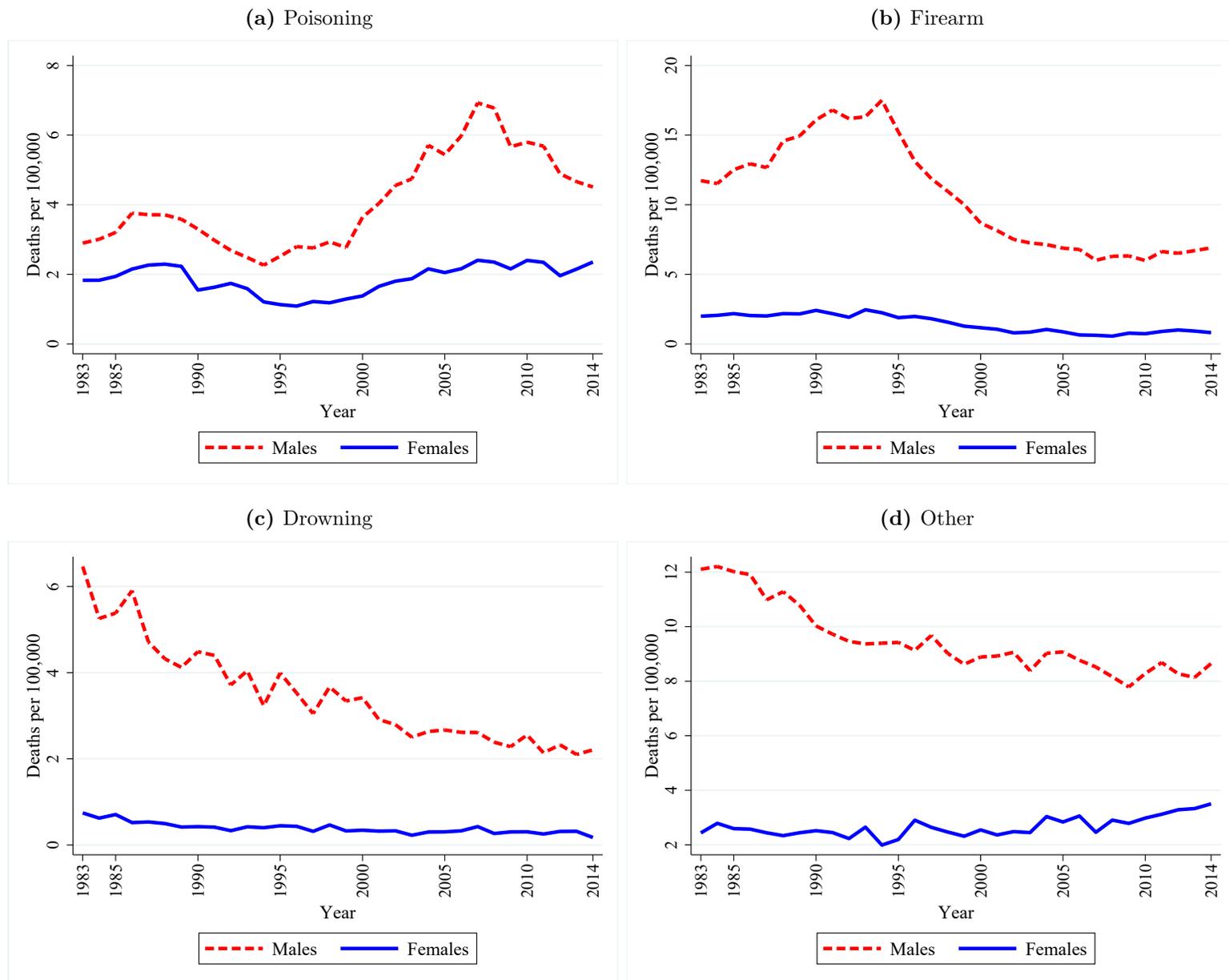
Notes: The figure plots self-reported average annual vehicle miles traveled for licensed teenagers ages 16–19. The data are obtained from Table 23 of [McGuckin and Fucci \(2018\)](#) and are available only for select years between 1983 and 2017.

**Figure B.3:** Aggregate trends in mortality rates for teenagers ages 15–19, by sex



Notes: Figures show US death rates from all causes, suicides and accidents, and motor vehicle accidents for ages 15–19. Death counts are from the 1983–2014 National Vital Statistics, and population data are from the Surveillance, Epidemiology, and End Results (SEER) Program.

**Figure B.4:** Aggregate trends in deaths from suicides and accidents for teenagers ages 15–19, by category



Notes: Death counts are from the 1983–2014 National Vital Statistics, and population data are from the Surveillance, Epidemiology, and End Results (SEER) Program. Aggregate trends in deaths from all suicides and accidents are reported in Figure B.3.

**Table B.1:** US minimum driving age laws, 1983–2014

State	MDA 1	MDA 2 (date)	MDA 3 (date)	MDA 4 (date)
Alabama	16yr 0mo			
Alaska	16yr 0mo			
Arizona	16yr 0mo			
Arkansas	18yr 0mo	16yr 0mo (3/10/1993)		
California	16yr 0mo			
Colorado	16yr 0mo			
Connecticut	16yr 0mo	16yr 4mo (1/1/1997)		
Delaware	16yr 0mo	16yr 4mo (7/1/1999)	16yr 6mo (8/31/2006)	
District of Columbia	16yr 0mo	16yr 6mo (1/1/2001)		
Florida	16yr 0mo			
Georgia	16yr 0mo			
Hawaii	15yr 0mo	15yr 3mo (7/1/1997)	16yr 0mo (1/1/2001)	
Idaho	14yr 0mo	15yr 0mo (4/1/1990)		
Illinois	16yr 0mo			
Indiana	16yr 1mo	16yr 6mo (7/1/2010)		
Iowa	15yr 0mo	16yr 0mo (5/7/1991)		
Kansas	15yr 0mo			
Kentucky	16yr 0mo	16yr 6mo (10/1/1996)		
Louisiana	15yr 0mo	16yr 0mo (1/1/1998)		
Maine	16yr 0mo			
Maryland	16yr 0mo	16yr 1mo (7/1/1999)	16yr 3mo (10/1/2005)	16yr 6mo (10/1/2009)
Massachusetts	16yr 6mo			
Michigan	16yr 0mo			
Minnesota	16yr 0mo			
Mississippi	15yr 0mo	16yr 0mo (9/1/1995)	15yr 6mo (7/1/2000)	16yr 0mo (7/1/2009)
Missouri	16yr 0mo			
Montana	15yr 0mo			
Nebraska	16yr 0mo			
Nevada	16yr 0mo	15yr 9mo (7/1/2001)	16yr 0mo (10/1/2005)	
New Hampshire	16yr 0mo			
New Jersey	17yr 0mo			
New Mexico	15yr 0mo	15yr 6mo (1/1/2000)		
New York	16yr 0mo	16yr 6mo (9/1/2003)		
North Carolina	16yr 0mo			
North Dakota	14yr 0mo	14yr 6mo (4/4/1985)		
Ohio	16yr 0mo			
Oklahoma	16yr 0mo			
Oregon	16yr 0mo			
Pennsylvania	16yr 0mo	16yr 6mo (12/22/1999)		
Rhode Island	16yr 0mo	16yr 6mo (1/1/1999)		
South Carolina	15yr 0mo	15yr 3mo (7/1/1998)	15yr 6mo (3/5/2002)	
South Dakota	14yr 0mo	14yr 3mo (1/1/1999)		
Tennessee	16yr 0mo			
Texas	16yr 0mo			
Utah	16yr 0mo			
Vermont	16yr 0mo			
Virginia	16yr 0mo	16yr 3mo (7/1/2001)		
Washington	16yr 0mo			
West Virginia	16yr 0mo			
Wisconsin	16yr 0mo			
Wyoming	16yr 0mo			

Notes: The column labeled “MDA 1” lists the minimum driving age that was in effect on January 1, 1983 for each state. The next three columns provide information on when (month/day/year) the law changed and what the new minimum driving age became, up through December 31, 2014. Source: Insurance Institute for Highway Safety

(<http://www.iihs.org/iihs/topics/laws/graduatedlicenseintro?topicName=teenagers>) for 1995–2014 and HeinOnline

(<https://home.heinonline.org/content/session-laws-library>) for 1983–1994.

**Table B.2:** ICD-9 and ICD-10 codes for cause of death

Cause of death	ICD-9 (1983–1998)	ICD-10 (1999–2014)
Internal causes	001-799 (excl alcohol- and drug-related)	A00-R99 (excl alcohol- and drug-related)
External causes	E800-E996	V01-Y98
Motor vehicle accident	E810-E825	V01-V04, V06-V14, V16-V79, V80.0-V80.5, V80.7-V81.1, V82-V89
Suicide	E950-E959, E980-E989	X60-X84, Y10-Y34, Y87.0
Firearm	E955, E985	X72-X75, Y22-Y24
Poisoning	E950-E952, E980-E982	X60-X69, Y10-Y19
Drug overdose	E950, E980	X60-X65, X68-X69, Y10-15, Y18-Y19
Carbon monoxide and other gases	E951-E952, E981-E982	X66-X67, Y16-Y17
Drowning	E954, E984	X71, Y21
Other	E953, E956-E959, E983, E986-E989	X70, X76-X84, Y20, Y25-Y34, Y87.0
Accident	E800-E807, E826-E869, E880-E929	V05, V15, V80.6, V81.2-V81.9, V90-V99, W00-X59
Firearm	E922	W32-W34
Poisoning	E850-E869	X40-X49
Drug overdose	E850-E866	X40-X45, X48-X49
Carbon monoxide and other gases	E867-E869	X46-X47
Drowning	E910	W65-W70, W73-W74
Other	E800-E807, E826-E849, E880-E909, E911-E921, E923-E929	V05, V15, V80.6, V81.2-V81.9, V90-V99, W00-W31, W35-W64, W75-X39, X50-X59
Homicide	E960-E969	X85-X99, Y00-Y09
Other external	E808-E809, E870-E879, E930-E949, E970-E979, E990-E996, 291-292, 303-304, 305.0-305.9, 332.1, 357.5, 357.6, 425.5, 535.3, 571.0-571.3, 790.3	Y35-Y86, Y87.1-Y87.2, Y88-Y98, E24.4, F10-F19, F55, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K85.2, K86.0, R78.0, T40-T43, T51

Notes: This table provides ICD-9 and ICD-10 codes used to categorize the cause of death. ICD-10 replaced ICD-9 starting in 1999. The following ICD-9 codes are for alcohol-related internal causes: 291, 303, 305.0, 357.5, 425.5, 535.3, 571.0-571.3, and 790.3. The following ICD-9 codes are for drug-related internal causes: 292, 304, 305.1-305.9, 332.1, and 357.6. The following ICD-10 codes are for alcohol-related internal causes: E24.4, F10, G31.2, G62.1, G72.1, I42.6, K29.2, K70, K85.2, K86.0, R78.0, and T51. The following ICD-10 codes are for drug-related internal causes: F11-F19, F55, and T40-T43.

**Table B.3:** Annual US deaths per 100,000 population, 1983–2014

	(1)	(2)	(3)	(4)
Cause of death	Ages 10–14	Ages 15–19	Ages 20–24	Ages 25–29
<b>A. All</b>				
All causes	20.57	68.63	98.49	106.12
Internal causes	9.52	14.94	23.30	37.52
External causes	11.06	53.69	75.18	68.60
Motor vehicle accident	4.84	25.10	28.82	20.98
Suicide and accident	4.80	17.11	28.11	30.79
Firearm	1.09	5.97	8.75	8.09
Poisoning	0.26	3.05	8.07	11.21
Drug overdose	0.18	2.45	7.17	10.14
Carbon monoxide and other gases	0.08	0.60	0.90	1.07
Drowning	0.95	1.95	1.96	1.67
Other	2.50	6.14	9.33	9.81
Homicide	1.30	10.99	16.97	14.40
Other external	0.12	0.49	1.27	2.43
<b>B. Males</b>				
All causes	24.97	96.70	146.46	153.01
Internal causes	10.27	17.27	27.04	45.07
External causes	14.70	79.44	119.41	107.94
Motor vehicle accident	5.96	33.28	43.32	31.68
Suicide and accident	6.94	27.30	45.94	49.37
Firearm	1.78	10.28	15.33	13.95
Poisoning	0.27	4.17	11.80	16.24
Drug overdose	0.18	3.29	10.35	14.50
Carbon monoxide and other gases	0.09	0.87	1.45	1.74
Drowning	1.43	3.43	3.44	2.88
Other	3.46	9.43	15.37	16.30
Homicide	1.66	18.11	28.19	23.33
Other external	0.14	0.75	1.95	3.56
<b>C. Females</b>				
All causes	15.96	39.05	48.68	58.60
Internal causes	8.73	12.49	19.42	29.87
External causes	7.23	26.55	29.26	28.74
Motor vehicle accident	3.66	16.48	13.77	10.14
Suicide and accident	2.54	6.37	9.60	11.96
Firearm	0.36	1.43	1.92	2.16
Poisoning	0.25	1.87	4.20	6.12
Drug overdose	0.19	1.57	3.87	5.73
Carbon monoxide and other gases	0.07	0.30	0.33	0.40
Drowning	0.44	0.39	0.43	0.44
Other	1.49	2.68	3.05	3.24
Homicide	0.93	3.48	5.33	5.35
Other external	0.09	0.23	0.56	1.29

Notes: Death counts come from the National Vital Statistics. Population estimates come from the Surveillance, Epidemiology, and End Results (SEER) Program.

**Table B.4:** Add Health variable definitions and codings

Description	Variable	Survey Question	Formula
Interview month	imonth	N/A	N/A
Interview year	iyear	N/A	N/A
Birth month	bmonth	N/A	N/A
Birth year	byear	N/A	N/A
Sex	bio_sex	N/A	N/A
Pseudo state identifier	w1state; w2state	N/A	“State” = w1state if iyear = 95; “State” = w2state if iyear = 96
Sample weight	gswgt1; gswgt2	N/A	“Weight” = gswgt1 if iyear = 95; “Weight” = gswgt2 if iyear = 96
Race	h1gi6a	What is your race?	White (= 1)
Driver’s license	h1ee10; h2ee10	Do you have a valid driver’s license (not a driver’s permit)?	Yes (= 1)
Vehicle miles driven (baseline)	h1ee11; h2ee11	About how many miles do you drive each week?	0 (= 1); 25 miles (= 2); 75 miles (= 3); 150 miles (= 4)
Vehicle miles driven (alternate)	h1ee11; h2ee11	About how many miles do you drive each week?	0 (= 1); 25 miles (= 2); 75 miles (= 3); 265 miles (= 4)
Work for pay	h1ee3; h2ee3	In the last 4 weeks, did you work—for pay—for anyone outside your home? This includes both regular jobs and things like baby-sitting or yard work.	Yes (= 1)
Not enrolled nor graduated	h1gi21; h2gi10	Why aren’t/weren’t you going to school?	For any reason other than graduation (= 1, 2, 3, 5 or 6 if iyear = 95; = 1, 2, 3, 4, 5, 7 or 8 if iyear = 96)

Notes: This table lists the codings and definitions from Wave I (1995) and Wave II (1996) of Add Health that were used in the analysis. Responses were coded as missing if the respondent answered “don’t know” or “refused” to a question. Detailed survey documents are available at: <https://www.cpc.unc.edu/projects/addhealth/documentation/restricteduse/datasets>.