The Role of Poverty in California Teenagers' Fatal Traffic Crash Risk

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Abstract

Teenagers' high rates of motor vehicle crashes, accounting for 40% of external deaths among 16-19 year-olds, have been ascribed largely to inherent "adolescent risk-taking" and developmental hazards. However, the fact that compared to adults 25 and older, teenagers are twice as likely to live in poverty and low-income areas, risk factors for many types of violent death, has not been assessed. This paper uses Fatality Analysis Reporting System data on 65,173 fatal motor vehicle crashes by drivers in California's 35 most populous counties for 1994-2007 to analyze fatal crash involvements per 100 million miles driven by driver age, county, poverty status, and 15 other traffic safety-related variables. Fatal crash rates were substantially higher for every driver age group in poorer counties than in richer ones. Multivariate regression found socioeconomic factors, led by the low levels of licensing and high unemployment rates prevalent in low-income areas, were associated with nearly 60% of the variance in motor vehicle crash risks, compared to 3% associated with driver age. The strong association between fatal crash risk and poverty, especially for young drivers who are concentrated in high-poverty brackets and low-income areas, suggests that factors related to poorer environments constitute a major traffic safety risk requiring serious attention.

Keywords: adolescent risk, motor vehicle accident, poverty, socioeconomics

Introduction

Motor vehicle fatalities, comprising 41% of California teenagers' external deaths compared to 24% for adults, represent the widest gap between adolescents' and adults' non-natural mortality (EPICenter, 2008). Researchers typically ascribe teenagers' high rates of traffic casualty to factors allegedly innate to adolescence: developmental immaturity, peer influences, and biologically-impelled risk-taking (Steinberg, 2007; National Research Council, 2006; Hedlund, Shults, & Compton, 2003; Blum, Beuhring, & Rinehart, 2000; Ulmer, Williams, & Preusser, 1997; Chen et al, 2000; Simpson, 2003). At a 2006 conference of leading authorities on the "science of adolescence" sponsored by the National Academy of Sciences, experts cited "the tinderbox in the teenage brain" generating "difficulty in controlling their behavior" as the main cause of adolescents' "high rates of accidents… and reckless behaviors in general"

(Dahl, 2006, pp. 7, 15). Another review attributed "adolescents' inclination to engage in risky behavior" to "the temporal gap between puberty, which impels adolescents to thrill-seeking, and the slow maturation of the cognitive control system, which regulates these impulses" (Steinberg, 2007, p. 55).

"Teen drivers are different from other drivers," the National Highway Traffic Safety Administration's (2008) discussion. "Saving Teenage Lives," declares:

> On the basis of miles driven, teenagers are involved in three times as many fatal crashes as are all drivers. Why do young drivers have such poor driving performance? Three factors work together to make the teen years so deadly for young drivers:
> … Inexperience: All young drivers start out with very little knowledge or understanding of the complexities of driving a motor vehicle. Like any other skill,

learning to drive well takes a lot of time. Technical ability, good judgment and experience all are needed to properly make the many continuous decisions, small and large, that add up to safe driving…

Risk-taking behavior and immaturity: Adolescent impulsiveness is a natural behavior, but it results in poor driving judgment and participation in high-risk behaviors such as speeding, inattention, drinking and driving, and not using a seat belt. Peer pressure also often encourages risk taking.

Greater risk exposure: Teens often drive at night with other teens in the vehicle, factors that increase crash risk.

That NHTSA, like others, fails to assess, or even mention, low socioeconomic status as a risk to teenaged drivers is curious When evaluating the large differences in risks among various racial, ethnic, and regional groups—such as the high rates of homicide among African Americans or motor vehicle deaths among Southerners—researchers typically pursue social and economic explanations (i.e., Fox & Piquero, 2002). However, conclusions about adolescent risk-taking and its causes have been reached without first controlling for the differing socioeconomic conditions in which adolescents and adults live (Reyna & Rivers, 2008; Casey, 2008; for critique, see Males, 2009).

That such environmental conditions might be important variables in what is called "adolescent risk-taking" is indicated by the fact that for every race and locale, young people ages 15-19 and 20-24 are two to three times more likely to live in households with incomes below federal poverty thresholds than are adults ages 45-64 (US Census Bureau, 2008, 2008a, 2008b). Age-based income stratification is so pronounced that poverty rates averaging below 10% are found for teenagers in only five of California's 58 counties, versus 32 counties for ages 45-54. Meanwhile average poverty rates of 20% or higher afflict teenagers in 18 counties, versus none for Californians ages 45-54.

The contribution of socioeconomic status to motor vehicle crash mortality, the largest

category of external deaths among Americans ages 15 to 34, deserves comprehensive attention, yet only three studies can be located that even peripherally discuss the subject (Aguero-Valverde & Jovanis, 2006; Hasselberg & Laflamme, 2005, 2003) and one, this author's, that provides only a preliminary sketch (Males, 2007). The present study examines the associations between motor vehicle fatalities, socioeconomic status and related environmental variables among teenagers and adults in California for the purpose of testing the hypothesis that higher levels of poverty more efficiently explains the variance between teenage and adult motor vehicle fatality rates than does innate "adolescent risk-taking."

Methods

Data description
This analysis concentrates on characteristics of California resident drivers involved in motor vehicle crashes that caused at least one fatality on public roads, as compiled by the US Department of Transportation's Fatality Analysis Reporting System (FARS, 2008) for the full 1994-2007 period. Ten descriptive variables for drivers and vehicles involved in fatal crashes (single year of age, county of residence, driver's license status, seat belt/restraint use, alcohol or drug intoxication, age of vehicle driven, size of vehicle driven, number of vehicle occupants, and percent of accidents involving single vehicles or vehicle rollover) were entered into the database in conjunction with eight environmental variables by county (poverty rate by age, median per-capita personal income, per-capita motor-vehicle registrations, per-capita miles of roadway, percent of the labor force that is unemployed, percent of the population licensed to drive, population density per square mile, and percent of all commuter trips that are made by motor vehicle as opposed to public transportation and other modes) from the California Department of Finance's Demographic Research Unit (2008) and the Census (2008, 2008a, 2008b) (see Table 1). Driver speed is not included because values are missing for 47% of cases. The poverty rate is defined by the Census as the percentage of the population living on incomes below federal

poverty guidelines ($13,410 for a family of three in 1999). Where primary data is available only for age groups, values for individual ages were estimated by linear interpolation (Shyrock & Siegel, 1976).

The analysis excluded two sets of outliers. Drivers under age 16 and over age 74 were excluded to eliminate the effect on mortality of age-related physical limitations, and vehicles that were over 60 years old or which had 10 or more occupants also were excluded. To avoid

mathematical adjustments necessary to compensate for the effects of small cell size, only the 35 counties with populations of 100,000 or more in the 2000 census are included; these counties account for 96% of California's fatal traffic crashes. With these exclusions, 2,065 county-by-age cells with 65,531 drivers involved in fatal motor vehicle accidents over the 14-year study period remained; the elimination of a few cases with missing values for certain variables for the analyses reduced available cases to 65,173.

Table 1. Characteristics of fatal crash rates by driver age group

Driver age group →	All ages	16-19	20-24	25-34	35-44	45-54	55-64	65-74
Driver characteristics								
Fatal crashes/100m VMD	18.69	49.47	31.59	18.07	14.85	14.33	15.67	19.19
Fatal crashes/year	4,681	465	736	1,113	996	731	405	236
VMD/driver/year	10,568	4,826	9,745	12,045	12,543	11,850	9,430	6,608
Percent in poverty	12.0%	20.7%	23.0%	14.7%	11.5%	8.7%	9.0%	6.9%
Driver using restraint	71.5%	71.9%	67.3%	69.2%	70.7%	73.0%	73.5%	73.2%
Driver intoxicated	17.5%	15.4%	28.0%	25.6%	20.5%	16.7%	12.1%	7.8%
Percent unlicensed	14.7%	22.2%	27.4%	24.2%	16.1%	10.9%	7.4%	5.5%
Population (000)	23,698.2	1,946.8	2,390.3	5,112.3	5,345.4	4,302.8	2,740.4	1,860.2
Vehicle and crash characteristics								
Vehicle age (years)	8.57	9.56	8.48	8.52	8.60	8.29	8.32	8.78
Vehicle occupants	1.65	2.22	1.88	1.74	1.66	1.51	1.46	1.53
Vehicle size	1.95	1.67	1.70	1.89	2.07	2.06	2.01	1.95
Percent single vehicle	38.7%	51.4%	46.2%	39.9%	36.7%	36.3%	34.5%	36.9%
Percent vehicle rollover	20.4%	28.8%	26.0%	22.3%	19.7%	19.6%	18.0%	16.0%

One complication involves the potential effects of the state's graduated driver's licensing law, effective July 1, 1998, applied to new drivers under age 18. The rates of fatal involvements by drivers ages 16-19 increased relative to older drivers after the graduated licensing law took effect (Masten & Hagge, 2004; Males, 2007a). The effect of a law change that disproportionately raised teenage fatal crash involvements relative to older drivers' makes the study hypothesis more difficult to validate.

Estimates of the best measure of risk exposure, the average number of vehicle-miles driven (VMD) per driver, are not available for

California. Thus, VMD by driver age and resident county was calculated using a standard, three-step process (McCarthy, 2002). First, estimates of gross vehicle-miles traveled (VMT) and the proportion of gasoline sales to total fuel sales by county available from the California Department of Transportation's Transportation System Information Program (2008) were used to estimate gross personal vehicle-miles traveled by county. Second, the estimate of gross personal VMT per county was prorated according to the proportion of licensed drivers by age tabulated by the California Department of Motor Vehicles (2007) for each county to produce an estimate of gross VMD by age. Since

teenaged drivers do not drive as much per person as adults, a third adjustment used estimates of VMD per person by age group from the most recent U.S. Department of Transportation's National Household Travel Survey (Bureau of Transportation Statistics, 2001) to estimate VMD by age group for each California county. The results this estimation technique yielded for VMD by age of California driver are very similar to those of the NHTS, indicating the technique is not biased with regard to estimating the relative proportions of driving by age. Estimates are shown in Table 1.

Table 2. Characteristics of fatal crash rates by county income bracket

County income bracket →	Richest fifth	Second fifth	Middle fifth	Fourth fifth	Poorest fifth
County characteristics					
Income per capita	$33,370	$25,370	$21,130	$17,470	$14,760
Poverty rate	7.6%	8.9%	11.7%	14.4%	17.4%
Unemployment rate	4.2%	5.3%	6.9%	9.2%	12.7%
Teens, pct. of population	6.6%	7.9%	8.3%	9.6%	10.0%
Population/square mile	3,368	759	736	173	84
Percent licensed to drive	87.8%	89.9%	83.8%	85.6%	75.8%
Percent of trips by MV	79.8%	87.9%	87.3%	90.1%	91.2%
Percent of trips by transit	10.4%	2.2%	3.2%	1.2%	1.3%
Road miles per capita	3.84	7.52	7.87	9.81	13.03
Driver, vehicle, and crash characteristics					
Fatal crashes/100m VMD	12.04	14.94	16.34	28.86	40.46
Fatal crashes/100k pop	13.56	18.44	19.30	30.36	38.40
Driver using restraint	72.5%	74.9%	70.9%	69.8%	69.4%
Driver intoxicated	16.8%	17.5%	16.9%	18.4%	17.9%
Vehicle age (years)	8.13	8.49	8.13	9.01	9.10
Vehicle occupants	1.65	1.60	1.65	1.63	1.73
Vehicle size	1.90	1.86	1.93	1.99	2.06
Percent single vehicle	43.4%	38.7%	38.8%	38.9%	33.3%
Percent vehicle rollover	17.2%	18.9%	20.3%	21.6%	24.0%
Percent unlicensed	13.4%	14.0%	13.8%	15.7%	16.8%
Average annual counts					
Drivers in fatal crashes	578	581	1,818	1,020	684
Total population (000)	4,473.4	3,594.0	10,543.6	3,383.7	1,703.6

Counties by income level:
Richest fifth: Marin, San Mateo, San Francisco, Santa Clara, Contra Costa, Placer, Alameda;
Second fifth: Santa Cruz, Napa, Orange, Sonoma, El Dorado, Ventura, Santa Barbara;
Middle fifth: San Diego, San Luis Obispo, Solano, Sacramento, Los Angeles, Monterey, Yolo;
Fourth fifth: Riverside, Shasta, Butte, San Joaquin, Humboldt, Stanislaus, San Bernardino;
Poorest fifth: Kings, Kern, Fresno, Madera, Merced, Tulare, Imperial.

Analysis

The principal outcome measure of interest, fatal crash involvements per 100 million VMD by age of driver and county, was calculated. The summary results are shown in the Appendix. Appendix Table A shows that counties vary substantially in fatal crash risk, as well as in poverty levels, miles driven per resident, personal income, and related variables. Drivers in Central Valley, northern California, and

Sierra foothill counties display much higher risks, as well as generally higher poverty and lower personal income levels, than southern coastal and mid-coastal counties.

Driver, vehicle, and fatal crash characteristics are shown by driver age group (Table 1) and by county income bracket for all drivers (Table 2). Fatal crash involvement rates by driver age group and poverty bracket for all drivers are shown in Table 3. Tables 4a and 4b provide cross sections of the characteristics of fatal crash

involvements for the drivers with the highest rates, those age 16-17, and those with the lowest rates, age 46-47. Table 5 shows the simple bivariate association between each predictor and fatal crash involvement rates. The driver and county variables were then subjected to hierarchical multiple regression (Table 6) to estimate the most important predictors when all variables were controlled. Multicollinearity diagnostics were conducted to assess covariance, especially with regard to the three major demographic variables (driver age, poverty rate,

Table 3. California driver' fatal crash involvement rates by age and poverty level Poverty quintile, 35 largest California counties, 2000

Driver age:	Richest fifth	2nd fifth	Middle fifth	4th fifth	Poorest fifth
Fatal crashes per 100 million VMD by driver age					
16-19	34.35	37.98	46.56	65.73	82.76
20-24	22.05	25.99	28.08	43.92	58.15
25-34	11.61	14.10	15.71	29.40	42.43
35-44	9.36	11.72	12.69	23.85	34.29
45-54	9.17	11.81	12.37	22.39	31.56
55-64	10.41	13.05	13.69	24.08	31.73
<u>65-74</u>	<u>13.18</u>	<u>15.14</u>	<u>17.50</u>	<u>26.00</u>	<u>37.22</u>
Ages 16-74	12.04	14.94	16.34	28.86	40.46
Percent in poverty, by age group					
16-19	13.5%	16.7%	21.8%	24.3%	27.1%
20-24	15.2%	19.6%	26.2%	27.2%	26.9%
25-34	8.1%	10.9%	13.5%	18.6%	22.7%
35-44	6.6%	7.9%	10.7%	14.0%	18.2%
45-54	5.7%	5.9%	7.9%	10.9%	13.3%
55-64	5.9%	6.3%	8.3%	10.8%	13.8%
<u>65-74</u>	<u>5.5%</u>	<u>4.9%</u>	<u>6.6%</u>	<u>7.2%</u>	<u>10.1%</u>
Ages 16-74	7.8%	9.6%	12.7%	15.9%	19.2%

Note: Each poverty quintile consist of seven counties in the 35 county-ranking by per-capita income bracket. See Table 2 and Appendix A.

and county per-capita income) and variables that potentially may more efficiently predict the specific criterion of fatal crash involvement risk. Variables were entered into a stepwise multivariate regression in the order of greatest probability of F as selected by the stepwise program, and the number and order of variables significant at the 0.05 limit shown in Table 6

represents the number of steps and the order of variable entry.

Results

The results of the analysis of the 18 predictors of fatal crash involvement risk are shown in Tables 1-6. As expected, teen drivers ages 16-19 were

2.7 times more at risk of fatal crash involvement than the average for all drivers (Table 1). Interestingly, teens involved in fatal crashes were somewhat more likely than older drivers to have been using seat belts or other restraints and less likely to have been intoxicated. Teens also were nearly twice as likely to occupy high-poverty brackets; were driving vehicles that averaged one year older, were substantially smaller, and contained more occupants (Table 1); and were considerably more likely to live in low-income counties (Table 2). In turn, drivers at every age level who resided in low-income counties were two to three times more likely to suffer fatal crashes, both per capita and per mile driven, than drivers in the wealthiest counties. These risks, which accelerated at poverty rates of 12% and higher and county per-capita incomes of $20,000 and lower, were in part functions of lower use of restraints, generally older vehicles, and higher proportions of unlicensed drivers, vehicle rollovers, and single-vehicle accidents. Low-income counties also

were characterized by high levels of poverty and unemployment, lower population density, and less extensive public transit (Tables 2, 3). The average poverty level for teenagers and young adults in the wealthiest quintile was similar to that of middle-aged drivers in the poorest quintiles, and fatal crash risks for older drivers averaged only slightly lower than those of younger ones subjected to similar poverty levels.

Tables 4a and 4b's cross-section, or "snapshot," showed, as expected, that drivers ages 16-17 suffer overall fatal crash rates four times higher per mile than drivers age 46-47. However, crash rates are more than twice as high per mile driven for age 16-17, and three times higher among age 46-47, in the poorest county income quintile compared to the richest quintile. Comparison of population distributions in the bottom line of each table showed teenagers are considerably more concentrated in poorer counties and age 46-47 is more represented in the richer ones, reflected in teenaged poverty rates

Table 4a. Cross section of fatal crash involvements among California drivers age 16-17 by county income bracket, 1994-2007

	Poverty quintile, 35 largest California counties, 2000					
	All counties	Richest fifth	Second fifth	Middle fifth	Fourth fifth	Poorest fifth
Average levels, age 16-17						
Fatal crashes/100m VMD	55.62	41.15	47.91	48.82	76.64	89.25
Fatal crashes/100k pop	15.03	12.51	14.74	12.00	21.12	23.50
Poverty rate	17.0%	11.0%	12.8%	15.9%	19.7%	25.8%
Miles/driver per year	2,702	3,039	3,075	2,458	2,756	2,633
Percent licensed to drive	29.1%	32.1%	32.9%	27.2%	29.4%	24.0%
Vehicle age (years)	9.78	9.59	10.94	8.60	9.70	10.03
Vehicle size	1.70	1.74	1.74	1.65	1.72	1.65
Percent single vehicle	53.0%	54.3%	52.6%	54.6%	53.3%	50.2%
Percent vehicle rollover	29.5%	22.3%	26.7%	29.1%	33.3%	35.5%
Driver using restraint	74.1%	71.7%	78.4%	78.0%	72.2%	69.8%
Driver intoxicated	11.6%	10.2%	10.0%	8.9%	13.5%	15.4%
Number of occupants	2.39	2.49	2.34	2.41	2.42	2.30
Percent unlicensed	23.9%	18.6%	22.5%	25.0%	27.3%	25.6%
Average annual counts, age 16-17						
Drivers in fatal crashes	147	19	21	53	35	20
Population	980,200	149,100	142,000	437,500	164,700	86,900

Table 4b. Cross section of fatal crash involvements among California drivers age 46-47 by county income bracket, 1994-2007

	Poverty quintile, 35 largest California counties, 2000					
	All counties	Richest fifth	Second fifth	Middle fifth	Fourth fifth	Poorest fifth
Average levels, age 46-47						
Fatal crashes/100m VMD	14.24	8.67	11.84	12.30	22.39	31.59
Fatal crashes/100k pop	17.44	10.52	14.59	15.05	27.82	37.88
Poverty rate	9.3%	6.0%	6.3%	8.4%	11.5%	14.1%
Miles/driver per year	12,242	12,138	12,328	12,236	12,427	11,993
Percent licensed to drive	95.2%	98.0%	99.3%	95.5%	96.1%	86.0%
Vehicle age (years)	8.47	8.17	7.99	8.66	8.82	8.72
Vehicle size	2.09	1.94	1.98	2.01	2.25	2.27
Percent single vehicle	35.4%	39.8%	31.4%	41.5%	34.9%	29.3%
Percent vehicle rollover	19.0%	12.5%	19.7%	23.6%	16.2%	23.1%
Driver using restraint	71.4%	76.3%	73.8%	66.5%	70.9%	69.8%
Driver intoxicated	17.5%	18.3%	12.7%	22.4%	16.6%	17.2%
Number of occupants	1.55	1.56	1.55	1.55	1.41	1.65
Percent unlicensed	10.9%	13.1%	6.1%	13.5%	11.7%	9.9%
Average annual counts, age 46-47						
Drivers in fatal crashes	167	20	22	64	38	25
Population	958,500	187,400	149,300	421,900	135,000	64,900

approximately 1.8 times higher overall and in every quintile than among middle-agers. The 3.9-fold gap between 16-17 year-olds' and 46-47-year-olds' fatal crash rates per mile driven shrinks to 1.5 to 1.8 times higher under reasonably equal poverty levels (e.g., the richest and second richest teen quintiles and versus the fourth richest and poorest quintiles for age 46-47).

Tables 4a and 4b also reveal some unexpected patterns. Teens age 16-17 in poorer counties had higher rates of accidents involving vehicle rollover and generally lower rates of driver licensing and miles driven per driver. However, while crash-involved teens in the poorest income quintile did show considerably higher rates of driving while intoxicated and failure to use restraint, these factors did not vary consistently with county income level. Nor were crash-involved teens in poorer counties driving smaller or older vehicles or carrying more passengers than teens in more affluent counties. For drivers age 46-47, the sharp increase in fatal crash rates from richer to poorer county income quintiles varied chiefly with a rising percentage of crashes involving vehicle rollover, older vehicle age, and greater vehicle size; other variables were more inconsistent. Teens in fatal crashes were somewhat less likely to have been intoxicated and more likely to have used restraints than their middle-aged counterparts.

The simple bivariate correlation shown in Table 5 found 15 of the 19 predictor variables were significantly associated with the fatal crash involvement criterion at the 0.001 level, and one at the 0.01 level. The percentage of the population licensed to drive (negative), poverty rate (positive), county unemployment rate (positive), county per-capita income (negative), driver age (negative), and motor vehicle occupants (positive) showed the strongest associations with fatal crash rates. When subjected to standard diagnostics, these variables showed strong multicollinearity, suggesting most represent various expressions of economic conditions and/or driver age. However, trivariate regressions (not shown) of fatal crash rates with the most direct measures—poverty and driver age (multiple R^2=0.279), and county income level and driver age (multiple R^2=0.308)—

Table 5. Bivariate associations of 18 predictors with fatal crash involvement rates for drivers age 16-74 per billion vehicle-miles driven

Percent of population licensed to drive by age and county	-.680**
Percent of population living on incomes below poverty guidelines by age and county	.527**
Percent of labor force unemployed by county	.490**
Personal income per capita by county	-.433**
Ages of drivers involved in fatal crashes by county	-.348**
Number of occupants in motor vehicle	.329**
Percent of fatal crashes that involve unlicensed drivers by age and county	.229**
Percent of total trips by public transit by county	-.204**
Percent of total trips by motor vehicle by county	.203**
Percent of fatal crashes involving vehicle rollover	.198**
Miles of public roadways per capita by county	.191**
Vehicle miles driven (VMD) per person by age and county	-.187**
Ages of vehicles involved in fatal crashes by driver age and county	.180**
Population per square mile by county	-.123**
Sizes of vehicles involved in fatal crashes by driver age and county	-.094**
Percent of fatal crashes involving single vehicles	.071*
Percent of fatal crashes involving driving under the influence of alcohol (DWI)	.046
Percent of drivers using restraint system properly	-.052
Motor vehicle registrations per capita by county	.033

$**p < 0.001, *p < 0.01$. N=2,065 age-by-county combinations.

proved inefficient in explaining variance. Driver age, in particular, explained virtually none of the variance in crash rates once poverty level was controlled and just 12% of the variance once county income was controlled, and the predictor pairs together accounted for less than one-third of total variance in both cases. This suggests that other variables that covary with economic status and age may prove better operational representations of fatal crash risk, a question testable by multivariate regression.

Of the 18 variables entered in the hierarchical multiple regression shown in Table 6, eight remained significant predictors accounting for three-fifths of the total variance in fatal crash risk for all drivers (R=0.786 adjusted R^2=0.616, p=0.000). Poverty and county incomes dropped out as significant predictors and driver age became a minor predictor of fatal crash risk. These were replaced by two major correlates (percent of the population licensed to drive by age and county, and county unemployment rate) and several minor ones (miles driven per year by driver age and county, percent of total trips in

the county that involved public transportation, vehicle age by driver age and county, and population per square mile by county). These variables appeared to more efficiently operationalize the general economic measures as driving-related factors. Driver age remained a significant predictor even after these variables were controlled, though it accounted for just 3% of total variance and 5% of explained variance.

Discussion

California drivers of all ages living in poorer areas suffer substantially higher fatal crash rates than those in richer areas. The relationship between poverty and income status and fatal crash risk is strong and consistent both between and within driver age groups. Teenagers are more likely than older adults to live in low-income counties (16-19 year-olds comprise 10.6% of poorer Tulare County's population age 16-74, compared to 5.4% of affluent Marin County's), and, within every county, younger ages suffer poverty levels approximately twice those of older adults.

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Table 6. Hierarchical multiple regression of predictors of fatal crash risk, drivers age 16-74

Variable	Regression coefficients			Multiple R	R^2	Adjusted R^2	Standard error	Change in R^2
	Beta	T	p					
Percent licensed to drive	-0.527	-33.504	0.000	0.680	0.463	0.463	20.158	0.463
Unemployment rate	0.239	14.520	0.000	0.740	0.548	0.547	18.503	0.085
Driver age	-0.200	-13.538	0.000	0.760	0.578	0.578	17.875	0.030
Miles driven per year	-0.134	-9.493	0.000	0.774	0.599	0.598	17.441	0.020
Percent trips by transit	-0.260	-7.134	0.000	0.781	0.610	0.609	17.187	0.012
Vehicle age	0.066	4.755	0.000	0.784	0.614	0.613	17.102	0.004
Population/square mile	0.144	4.111	0.000	0.786	0.618	0.616	17.036	0.003
(Constant)	115.555	35.567	0.000					

Note: n=2,065 county-by-age combinations including 65,173 fatal crash involvements by California residents ages 16-74 in 1994-2007 in the 35 counties with a 2000 population of 100,000 or more, comprising 95.6% of the fatal crashes statewide.

Teenaged drivers differ from older adults in significant ways other than age. First, not only are teenagers as a population poorer and more concentrated in lower income counties, those involved in fatal crashes were driving vehicles that averaged more than one year older and were substantially smaller compared to older adults'. What we call "teenage risk," at least in terms of traffic fatality, appears less a function of age-based hazards than it is of a larger "poverty risk" that boosts traffic fatality rates among adult drivers as well. That young age is reduced to a marginal predictor of fatal crash risk when socioeconomic factors are controlled (especially given that this analysis excludes more accident-prone drivers 75 and older to prevent the older-age "U-shaped" crash-rate curve that dilutes young-age effects) suggests that environments are pivotal contributors to young-driver risks.

Second, unexpectedly, teenaged drivers involved in fatal crashes were not taking greater risks than their adult counterparts. Teen drivers were slightly more likely to have used seat belts and other restraints and were less likely to have been intoxicated than were adults 20 and older; teens appeared similar to middle-aged drivers in these respects. One possibility is that teenagers, being less experienced drivers, get into fatal crashes under a wider variety of circumstances. A potentially useful factor not measured by FARS is years of driving experience, which would help sort out whether driver age or driving experience is more closely related to fatal crash risk.

Third, another unexpected finding was that even though younger teen drivers ages 16-17 in poorer counties suffered strongly elevated rates of fatal crashes, particularly those involving vehicle rollover and unlicensed drivers, other variables (smaller and older vehicles, single vehicles, driver intoxication and failure to use restraints, and more vehicle occupants) did not vary consistently with poverty rate and county income level except for teens in the poorest quintile. A similar pattern is evident among drivers age 46-47, in which vehicle rollover propensity was the only consistent driver- and vehicle-level correlate of the higher crash rates associated with lower income and higher poverty levels. There are many potential explanations. One is that even in richer counties, impoverished drivers may disproportionately be involved in crashes. Further, there may be an intangible "vehicle risk" that is not completely measured by vehicle age and size but may be better reflected in vulnerability to rollover. Rollover propensity, in turn, appears to be complex, involving larger vehicles with high centers of gravity such as vans and SUVs; smaller vehicles that are poorly maintained, lack modern stabilizing features and restraints, and/or are struck by larger ones; driver steering skills; and road hazards found more commonly in rural

areas (NHTSA, 2008a). The complex interactions between vehicle rollover propensity by type of accident (single-vehicle versus collision), vehicle age, size, and type; driver age and poverty; and county rurality and other characteristics appear a productive area for future analysis.

How does an environment of poverty translate into greater traffic hazard? It should be emphasized that this study finds that poorer environments, not necessarily individual poverty, are connected to higher risk. One risk is self-evident: the manifestly higher fatal crash rates, both per-capita and per mile driven, in poorer counties exposes all resident drivers to disproportionately higher risks of fatal involvement with each other, as the higher proportion of collision accidents in poorer counties indicates. Further, low-income drivers tend to drive older, less-maintained vehicles (Bureau of Transportation Statistics, 2001). Other connections are more speculative. Poorer counties have lower tax bases, possibly leading to less maintained local roads, lower quality emergency response and health care, and deficient public transportation. Counties with high proportions of teenagers, and of poverty and unemployment, also tend to have much lower population densities than more affluent, older-populated counties, which may be tied to a variety of more hazardous conditions including scarcer public transportation and slower emergency response.

Particularly at young ages, poverty is associated with considerably lower rates of driver's licensing and less driving overall, leading to slower acquisition of driving experience that reduces crash risk (see Dee & Evans, 2001). For example, drivers ages 16-19 in affluent counties such as Marin and San Mateo, despite driving 2,000 to 3,000 more miles each every year, have just one-third the per-person risk and one-fifth the per-mile risk of fatal crash involvement than do teenaged drivers in impoverished counties such as Humboldt and Tulare. Evidence that teenagers who are least at risk tend to be those who are licensed to drive and who drive the most, factors that covary with higher socioeconomic status, challenges the assumption that more teenagers driving more miles necessarily elevates fatality hazards. To assess directly the effect of driver inexperience, a data set that includes not just drivers' ages but years of driving experience (a variable not provided by FARS), would be necessary. It is clear that what aspects of poverty, income, unemployment, rates of driver licensing, population age structure, population density, and public transportation prevalence interact in what ways to contribute to unlicensed driving, driving while intoxicated, driving without restraints, and vehicle rollover incidence that in turn contribute to fatal crash risk are complexities that remain to be explored.

These findings dispute popular theories now dominating "adolescent risk" discussion in the US. Theories attributing differences between teenage and adult behaviors to adolescents' innate immaturities and risk-taking (Reyna & Rivers, 2008; Steinberg, 2007; Dahl, 2006; Hedlund, Shults, & Compton, 2003; Ulmer, Williams, & Preusser, 1997; Chen et al, 2000) have emerged and proliferated without considering societally-imposed disadvantages such as poverty and low-income environments. The claim that risk-taking is innate to teenagers has led to advocacy for policies curtailing teenage driving and perhaps even banning it altogether, strategies more likely to add to teenage risks by preventing youths from gaining necessary driving experience. In fact, the most effective measures to combat high rates of motor vehicle fatality may emerge from careful analyses necessary to understand how California's excessive rates of poverty, particularly among young people, and deficient driving conditions in poorer areas interact to substantially elevate fatality risks.

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Appendix A

Characteristics of 35 counties with 100,000+ total population, ranked by per-capita income, Ages 16-74

County	Fatal crashes per		Average annual:		Percentage:		Crashes	Percapita
	100m VMD	100k pop	Population	Crashes	income	licensed	unlicensed	income
Marin	7.11	9.57	185,114	18	6.6%	95.2%	20.6%	$44,962
San Mateo	8.16	10.53	517,595	55	5.7%	91.8%	16.9%	$36,045
El Dorado	21.46	26.19	116,720	31	7.1%	96.4%	22.9%	$34,556
San Francisco	16.44	9.44	618,992	58	10.9%	80.1%	20.2%	$32,795
Napa	18.82	20.59	88,817	18	7.7%	89.1%	24.2%	$30,615
Monterey	21.79	23.30	276,259	64	12.3%	79.9%	23.6%	$27,963
Santa Clara	10.88	12.17	1,229,324	150	7.2%	92.4%	19.9%	$26,680
Santa Barbara	15.61	16.70	285,654	48	14.1%	86.6%	26.2%	$26,396
San Diego	15.00	17.14	2,031,613	348	11.4%	87.5%	21.4%	$26,395
Contra Costa	15.73	15.95	686,254	109	6.9%	90.2%	24.5%	$25,826
Los Angeles	15.80	16.12	6,764,270	1,091	15.8%	78.3%	24.6%	$25,724
Yolo	19.71	22.63	125,639	28	19.7%	79.0%	25.4%	$25,560
Orange	12.56	14.01	2,047,946	287	9.4%	88.7%	19.4%	$24,600
Santa Cruz	18.25	17.87	187,433	34	12.1%	88.2%	24.1%	$23,059
Placer	19.84	25.99	185,515	48	5.7%	94.2%	19.6%	$22,926
Ventura	16.54	17.34	539,267	94	8.4%	90.0%	20.6%	$21,864
Sonoma	22.63	21.59	328,147	71	7.9%	92.0%	20.9%	$21,731
Sacramento	21.32	21.59	881,282	190	12.3%	84.7%	24.3%	$21,142
Alameda	11.53	13.36	1,050,605	140	10.4%	86.6%	25.7%	$20,683
Solano	16.25	20.36	282,113	57	7.4%	85.3%	23.0%	$20,165
San Luis Obispo	17.73	21.18	182,411	39	13.7%	86.8%	22.7%	$19,365
Shasta	28.06	33.48	119,489	40	14.1%	92.8%	24.1%	$18,689
Butte	33.20	39.88	146,513	58	19.6%	87.3%	23.1%	$17,738
Madera	41.32	44.14	87,875	39	18.6%	70.9%	29.7%	$17,517
San Joaquin	31.12	31.87	393,161	125	15.7%	79.6%	28.6%	$17,365
Stanislaus	34.77	30.19	309,679	94	14.4%	84.1%	22.8%	$17,203
San Bernardino	26.16	28.80	1,207,759	348	13.9%	79.7%	24.2%	$16,913
Riverside	29.11	29.14	1,112,770	324	12.8%	78.0%	25.9%	$16,856
Tulare	52.36	47.11	251,702	119	20.5%	75.6%	28.9%	$15,848
Kings	42.14	36.48	93,214	34	17.3%	61.3%	27.1%	$15,760
Fresno	39.56	38.51	554,441	214	19.6%	76.4%	29.7%	$15,495
Kern	37.11	37.28	468,513	175	18.2%	76.5%	26.6%	$14,682
Merced	44.67	47.97	145,190	70	19.1%	76.8%	24.8%	$14,257
Imperial	28.14	33.47	102,652	34	20.3%	78.1%	20.8%	$14,006
Humboldt	30.55	32.42	94,287	31	19.6%	90.7%	22.9%	$13,239
Total	*18.69*	*19.75*	*23,698,213*	*4,681*	*12.8%*	*83.3%*	*24.1%*	*$22,418*