Does the built environment affect when American teens become drivers? Evidence from the 2001 National Household Travel Survey

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ABSTRACT

Problem: Motor vehicle crashes are the most common cause of death for American adolescents. However, the impact of where teens live on when they begin driving has not been studied. *Method*: Data from the 2001 National Household Travel Survey were used to estimate the effect of residential density on the driver status of teens aged 16 to 19 years after matching on demographic characteristics. *Results*: Controlling for demographic characteristics, 16 and 17 year old teens in high density neighborhoods had driver rates 15 percentage points below teens living in less dense areas (p<0.001). The effect for 18 and 19 year olds was a 9 percentage point decrease (p<0.001). *Summary*: These results suggest teens living in less dense and more sprawling communities initiate driving at a younger age than comparable teens in compact areas, placing them at increased risk for crash related injuries. *Impact on Industry*: The role of environmental factors, such as neighborhood walkability and provision of transit, should be considered in young driver programs.

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1. Introduction

Despite on-going efforts to improve teen driver safety, motor-vehicle crashes remain the most common cause of death among adolescents in the United States (National Highway Traffic Safety Administration [NHTSA], 2005). More than 4,700 drivers aged 16 to 19 died in 2004 and more than 400,000 were injured in motor-vehicle crashes in 2005 (Centers for Disease Control and Prevention [CDC], 2007).

Numerous factors make teen driver safety a difficult issue to address. Risky driving behaviors such as speeding, close following, or seat belt non-use are highly prevalent among adolescents and resistant to change. Indeed, many previous attempts to improve driver education have been unsuccessful (Williams, 2006). This is due in large part to a confluence of developmental factors including normative risk-taking and individual personality traits (Shope, 2006). As a result, teens are involved in four to eight times the fatal crashes of mature drivers per mile driven (Gonzales, Dickinson, DiGuiseppi, & Lowenstein, 2005). Fortunately, there is growing evidence that limiting and delaying driving exposure through programs such as graduated driver licensing (GDL) significantly reduces teen motor-vehicle crash fatalities (Shope, Molnar, Elliott, & Waller, 2001; Shope & Molnar, 2003). Decreasing and modulating driving exposure appears to be particularly important among the youngest teens (16 to 17 year olds) given their substantially elevated risk of crash involvement (McCartt, Shabanova, & Leaf, 2003; Williams, 2003).

Previous efforts to extend the injury prevention benefits of limiting and delaying driving exposure among novice teen drivers have largely focused on further development and regulation of GDL. However, this approach largely ignores the potential impact of built environment features, such as land use and transportation options, that influence teen driving behavior and therefore support or resist interventions to limit and/or delay their driving exposure. A prominent example is sprawl, a development pattern typified by low-density construction and populations, poor street connectivity, and minimal land use mix (Frumkin, Frank, & Jackson, 2004) that has been previously associated with increased automobile dependency (Ewing & Cervero, 2001; Ewing, Schieber, & Zegeer, 2003).

Built environment features, such as sprawl, could modulate teen driving exposure through two mechanisms: (a) by affecting the distances driven by licensed teens and (b) by affecting the age at which teens become drivers. Previous research demonstrated an association between urban sprawl and increased daily miles driven by teens and therefore provides preliminary evidence of the first mechanism (Trowbridge & McDonald, 2008). However, the impact of the built environment on the transition to driving among adolescents in the United States is still not well understood. Research shows that teens delay driving because parents believe they are not ready or have not had sufficient practice driving (McCartt, Hellinga, & Haire, 2007), but the role of the neighborhood and regional context has not been explored.

We hypothesized that teens living in more compact, denser areas would learn to drive later than teens in more sprawling areas. Analysis of the 2001 National Household Travel Survey bore out this hypothesis, even after controlling for demographic characteristics. We believe the ease and availability of alternative transport options such as public transit, walking, and biking in denser areas makes it less necessary for teens to learn to drive as soon as they are legally able. Confirmation of this hypothesis could have considerable policy and research implications given the demonstrated importance of delaying and limiting driving exposure among adolescents to reduce fatality risk from motor-vehicle crashes.

2. Data

Travel and demographic data for 16 to 19 year olds were obtained from the 2001 National Household Transportation Survey (NHTS). The NHTS is a national random digit telephone survey conducted periodically by the Department of Transportation to provide a comprehensive measure of transportation patterns in the United States (U.S. Department of Transportation, 2004). The most recent NHTS, performed in 2001, collected data on 66,000 households between March 2001 and May 2002 and had a weighted person-level response rate of 34.1%. Data collection consisted of three phases. An initial interview documented all individuals and available vehicles in the household. The household was also assigned a 24-hour "travel day" and mailed a diary to record and describe all trips taken during this time period. Individual interviews were conducted with each member of the household to document specifics of their travel. The NHTS datasets include probability weights that incorporate several stages of non-response and non-coverage adjustment based on 2000 national census data to reduce sampling error and bias. Replicate weights allow calculation of standard errors that account for the survey's complex design. A full description of the NHTS sampling scheme and weighting procedure is available online at http://nhts.ornl.gov.

2.1. Sample selection

Teens were included in the analysis if they were between the ages of 16 and 19 and lived in census-defined urban areas. Urban households were defined as living in a block group that was an urbanized area, urban cluster, or adjacent to either of these categories. We excluded rural areas from the analysis because many states allow teens to drive early if they are engaged in farm work. Of these 4,905 eligible teens, we removed respondents with missing values for population density (n = 1), household income (n = 286), race/ethnicity (n = 15), whether the teen had a job (n = 5), and householder education level (n = 130). In addition, only one child per household was included in the sample. This was done to minimize correlation across observational units. The resulting sample size was 3,976 teens, which equates to a weighted population of 9.1 million.

2.2. Driver status

The NHTS asked the householder to report whether each member of the household was a driver. While this question does not address the type of license held (e.g., learner's permit or full license), it indicates that the parent believes the teen is able to drive. To ensure the results of our analysis of the national data were not confounded by state licensing requirements, we also replicated the analysis for individual states. The number of respondents varied by state; we used power analysis to estimate the minimum number of respondents needed to ensure reliable results. To have the probability of rejecting a false null hypothesis greater than 80% (i.e., the power), we estimated that a minimum of 200 respondents per state were necessary assuming a 10 to 20 percentage point differential between the two groups (Agresti & Finlay, 1997). The states of Maryland (n = 224), New York (n = 677), Texas (n = 329), and Wisconsin (n = 1100) met these sample size requirements.

The rules governing teen drivers differed between these states. Table 1 details the applicable regulations during the survey period using data obtained from Chen, Baker, and Li (2006). At the time of the survey, New York and Texas did not have a GDL program in place (i.e., there was no mandatory training period imposed on young drivers). However, teens in New York were only eligible to obtain their full licenses at 18 (17 with driver's education), while those in Texas could get them at 16.

At the time of the NHTS, Wisconsin and Maryland had GDL programs in place. However, they had only recently gone into effect (July 1999 for Maryland and July 2000 for Wisconsin). This means that many of the 18 and 19 year olds fell under the previous regulation. While the GDL requirements affected driving supervision, they had almost no effect on when driver's permits could be obtained and the minimum age for full licenses in those two states. The change in rules did not adversely affect our study because we only compared teens of the same age (i.e., those that were under identical licensing regulations).

2.3. Built environment measures

Handy (2005) defined the built environment as "consisting of three general components: land use patterns, the transportation system, and design." Studies have operationalized these factors in different ways. We have chosen gross residential population density, measured as persons per square mile, because previous research has shown that it is significantly correlated with travel behavior (Cervero & Kockelman, 1997; Ewing & Cervero, 2001) and is easily available at multiple geographic scales for the entire country. The tradeoff is that it does not readily identify which aspects of the built environment have an influence on behavior and is therefore difficult to link to policy (Crane, 2000; Handy, 1996). The majority of analyses in our study measure density at the Census block group level. While the area of block groups varies throughout the country, they generally contain between 600 and 3,000 people with a preferred size of 1,500 people (U.S. Census Bureau, 2005). Therefore this measure reflects the very local environment – a few blocks in cities and a somewhat larger area in suburban areas. The median value for gross residential density in this study was 2,749 persons per square mile, the 25th percentile was 995 and the 75th percentile was 5,482. For comparison, the density of Manhattan is 66,940; New Haven, Connecticut is 6,558; and Ames, Iowa is 2,352. These densities only reflect where people live and not where they work.

To test the robustness of our findings, we measured density at different scales (e.g., Census tract and county level), and used Ewing,

Table 1
State Licensing Regulations in 2001.

	Maryland	New York	Texas	Wisconsin
Age at Permit	15, 9mo.	16	15	15, 6 months
Mandatory Holding Period	4 mo (15 days before 7/1/99)	None	None	6 months (None before 7/1/00)
Supervised Driving Hours Required	40 (0 before 7/1/99)	None	None	30 hours, 10 at night (None before 7/1/00)
Minimum Age for Intermediate License	16, 1mo (None prior to 7/1/99)	16	None	16 (None before 7/1/00)
Minimum Age for Full License	17, 7 mo.	18 (17 if driver's education)	16	16, 9 months (16 before 7/1/00)
Nighttime Restriction	Yes (Midnight-5 am)	Yes (9 pm-5 am)	None	Yes (Midnight-5 am) (None before 7/1/00)

Source: Chen et al. (2006).

Pendall, and Chen's (2002) county-level sprawl index. This measure incorporates 22 measures related to 4 factors: residential density, segregation of land use, strength of metropolitan centers, and accessibility of the street network. For example, density is measured by seven variables including: simple population density, percentage of the population living at block group densities less than 1,500 persons per square mile, and estimated density at the center of the area. The continuous index is calculated so that a score of 100 is average. Areas with values above 100 are more compact; those with an index below 100 are more sprawling. The index is only available at the county and metropolitan levels. For counties, the metric ranges from 55 (Jackson County; Topeka KS) to 352 (Manhattan-New York County, NY).

3. Methods

The goal of our analysis was to measure the difference in the proportion of teens that are drivers between high and low density areas. Simple comparisons of proportions are not appropriate when other factors such as household income also correlate with density and driver status. Analysts have traditionally used multivariate modeling techniques such as regression to overcome this problem. However, when there is substantial correlation among explanatory variables, regression methods are often inadequate because there are no controls against off-support inference (i.e., the problem of using statistical methods to infer behavior where there are no such respondents). This is particularly problematic in examinations of the built environment where demographic characteristics such as race, ethnicity, and income are often correlated with space. Oakes and Johnson (2006) refer to this as "structural confounding."

Therefore we have opted to employ Rubin's (1974) model. Under this framework, the goal is to compare the driver status of a teen in a less urban environment with what their driver status *would have been* if they lived in a more urban environment (and vice versa) by stratifying on key confounding factors. This counterfactual, which is by definition unobservable, is estimated by identifying similar observations. For example, 16 year olds from wealthy households living in a low density area would only be compared to wealthy 16 year olds living in a high density area. The difference in the proportion that are drivers between the two groups is the average treatment effect.

Multiple methods exist for finding comparable respondents. Two of the most commonly used are propensity scoring (Lunceford & Davidian, 2004) and direct matching (Imbens, 2004). We used both methods to estimate the effect of the environment on teen driver status. In practice, both estimators returned similar results and therefore only the results of the non-parametric matching estimator are presented.[1] This method does not rely on appropriate parameterization of the propensity score and is therefore more robust than propensity score methods (Abadie & Imbens, 2007).

3.1. Treatment definition

Our measures of the built environment are continuous (e.g., population density and the sprawl index), yet the matching methods are usually implemented with binary treatments. While we are generally reluctant to eliminate information, we have chosen to dichotomize our measures of the environment because simple averages suggest that the effect of the built environment on driver status is not linear.

Because the choice of break-point between high- and low-density is arbitrary, we have tested several possibilities including the 67th, 75th, and 80th percentiles of population density and the sprawl index. In general, the pattern of significance is the same regardless of the

Table 2
Comparison of demographics between teens living at block groups densities above the 67th percentile (high density) and below (low density).

Variable	High Density Areas	Low Density Areas	Difference	p-value
Female	48.6%	47.7%	0.9%	0.611
Age	17.2	17.1	0.1	<0.001
Teen has job	43.5%	49.5%	-6.0%	<0.001
Non-White	36.5%	14.0%	22.5%	<0.001
Income (1,000 $)	51.3	62.1	-10.8	<0.001
Household Size	4.0	3.9	0.1	0.017
Education of Householder	3.8	4.2	-0.4	<0.001

breakpoint. Effect sizes are somewhat larger in absolute terms as the percentile increases as we would expect. We present results that define more urban as being in the top tertile of residential density. This equates to a cutoff of 4,358 persons per square mile. Less urban (control) is defined as living in the bottom 2 tertiles of density. This means that teens receiving treatment would live in environments that are mostly higher-density suburbs. For example, many areas of Nassau and Suffolk Counties on Long Island, New York are in the treatment group. Our treatment definition is broad enough that we are not simply analyzing whether adolescents in major American cities are less likely to be drivers than their peers.

To determine the covariates used in the matching process, we estimated a logit model with driver status as the outcome variable. All significant dummy variables (i.e., minority status and teen has job), as well as the teen's age[2] were required to match exactly.[3] The other variables used to match were significant at the 95% confidence level in the logit model and included: household income, householder education, and household size. We did not include an indicator of household automobile ownership because research shows the number of vehicles in a household is influenced by household location (Bhat & Pulugurta, 1998; Train, 1986) and it would therefore be improper to include in the matching variables (Imbens, 2004; Oakes & Johnson, 2006). For example, households of similar economic circumstances tend to own more vehicles in suburban rather than urban areas. As Table 2 shows, teens living in high density block groups are different demographically from those in less dense places. For example, teens living in block groups with densities above the 67th percentile were more likely to be in single-parent households, less likely to have a job, more likely to be a racial or ethnic minority, and have lower average household incomes than teens living at lower densities. By matching on these factors, we ensure the reported effects of density on driver status are the results of differences in neighborhood density and not demographics.

To check the robustness of the national findings, several additional analyses were done. First, we conducted state-level analyses for Maryland, New York, Texas, and Wisconsin to eliminate the potential confounding effects of state driver licensing rules in the national sample. For example, if states with higher average densities granted licenses at later ages, this would confound the results. In addition, we tested how the results changed when the scale of measurement of the built environment changed. Specifically, we tested measures of density at the block group, tract, and county levels. Finally, we used another measure of the built environment – the sprawl index developed by Ewing et al. (2002) – to see whether the particular choice of built environment metric affected the results.

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[1] The non-parametric results presented here were estimated using the bias corrected matching estimator developed by Abadie, Drukker, Herr, and Imbens (2004); Abadie and Imbens (2007) and implemented in the *nnmatch* function in Stata (Version 9.2, College Station, Texas).

[2] We required an exact match for 16 and 17 year olds, i.e. 16 year olds were only compared with 16 year olds. However, we allowed 18 and 19 year olds to be compared with each other. This compromise was necessary since the sample of older teens was smaller.

[3] We also tested models where the teen's state of residence was an exact match variable. The results of these models were comparable to those without matching on state. However, matching on state limited the sample size because some states were largely low density.

4. Results

Driver status was closely tied to age. Nationwide, 54% of 16 year olds were reported to be drivers, compared with 82% of 19 year olds (Fig. 1). There were differences in driver rates by state. New York and Maryland had lower driver rates, even after removing teens living in New York City from the analysis. Texas and Wisconsin had higher driver rates at each age and by 19, nearly all teens in those states were drivers. The 'driving' teens also had relatively high levels of vehicle access. Nearly 42% of 16 year-old drivers had primary access to a household vehicle (Fig. 2). Nearly three in four 19 year-old drivers had their own car.

4.1. Unadjusted effect of residential density on teen driver status

The proportion of teens that can drive was lowest in the densest places. Fig. 3 shows the proportions of teens that were drivers by population density quintiles. As density increased, the teen driver rate decreased. For example the rate was 45% in the top quintile and 80% in the bottom quintile. Simple t-tests of the difference in the driver rate between the top and lower quantiles also showed driver rates were lower in the denser areas regardless of which quantile was used (Table 3). However, these averages do not adjust for differences in demographic characteristics between high and low density areas.

4.2. Adjusted effects of residential density on teen driver status

After matching on demographic characteristics to ensure only similar teens are compared, we found that the built environment still had a statistically significant effect on whether teens were drivers. The average adjusted effect of living in block groups with densities greater than the 67th percentile (treatment) was a 13 percentage point decrease (p<0.001) in the teen driver rate compared with those living at block group densities of less than the 67th percentile (control) (Fig. 4). For reference, the unadjusted difference for that same comparison was 25 points.

The effect of living in a higher density neighborhood on teen driver status was strongest for 16 and 17 year olds (Fig. 4). For example, 16 and 17 year olds living in the top tertile by residential density had driver rates 15 points lower (p<0.001) than their peers even after adjusting for covariates. In comparison, the effect was smaller (9 points, p<0.001), but still statistically significant, for 18 and 19 year olds.

4.3. Robustness – state licensing regulations

As suggestive as the national findings were, they are not conclusive because the national analysis may be confounded by variation in state
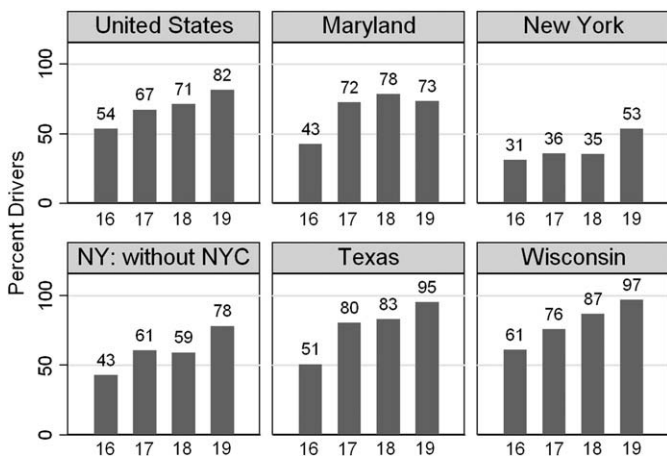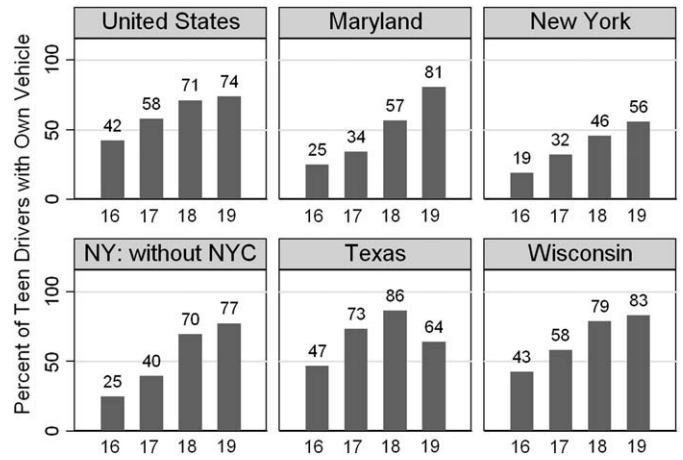

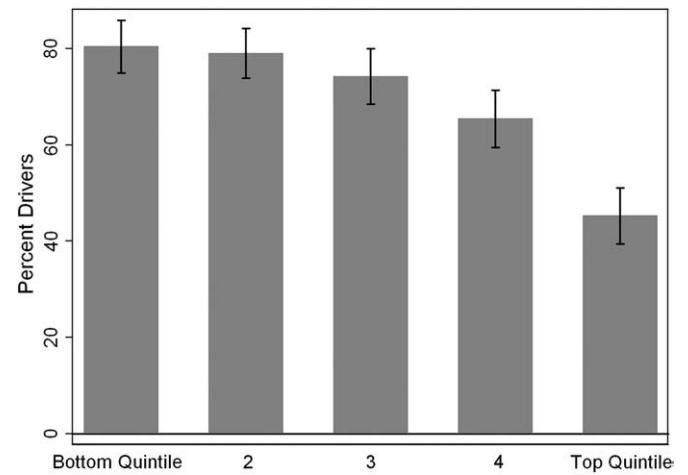Fig. 2. Percent of Teen Drivers with Primary Access to a Household Vehicle.

Fig. 3. Driver Status by Population Density Quintile: United States, 16-19 years old.

licensing requirements. For example, if less dense states allowed teens to obtain licenses earlier, we could see an effect of the built environment on teen driver status. However, this would be an artifact of state regulations – not teen behavior. To ensure the robustness of our findings, we conducted state-level analyses for Maryland, New York, Texas, and Wisconsin. These analyses confirmed the pattern observed with the national data (Fig. 5). In each state, teens living in dense areas were less likely to be drivers than comparable peers living in less dense areas. For example, the adjusted average treatment effect of living at high density in Maryland was a 20 point decrease in driver rates (p=0.005). In New York, the effect was a 15 point decrease (p<0.001) for the entire sample or a 9 point decrease (p=0.034) for

Fig. 1. Driver Rate by Area and Age.

Table 3

Unadjusted Proportions of Teens that are Drivers by Population Density Quantiles: United States.

Quantile Definition	High Density (Top Quantile)	Low Density (Lower Quantiles)	Difference	p-value
Tertile (67th percentile)	51.5%	76.6%	−25.1	<0.001
Quartile (75th percentile)	49.5	74.9	−25.4	<0.001
Quintile (80th percentile)	45.2	74.4	−29.2	<0.001
Decile (90th percentile)	37.0	72.0	−35.0	<0.001

teens living outside New York City. In Texas, the decline was 12.4 points (p = 0.049) and 10.0 points (p = 0.001) in Wisconsin.

4.4. Robustness – scale and type of environmental measure

From the modifiable areal unit problem (MAUP), we know that correlations among variables may depend on the level of spatial aggregation and that there are no simple ways to predict how spatial scale will affect correlations (Fotheringham & Wong, 1991). For example, Flowerdew, Manley, and Sabel (2008) found that the spatial scale of the neighborhood significantly affected whether there was an association between place and long-term illness in England. In contrast, Haynes, Jones, Reading, Daras, and Emond (2008) found that the "shape and size of neighborhoods had very little effect on the measured variations between areas" in a study of accident occurrence in pre-school British children. Because of this issue, we investigated the effect of spatial scale in our data.

Population density, unlike most other measures of the environment, is readily available at the census block, tract, and county levels. To test the effect of spatial aggregation, we have replicated our analysis at the tract and county levels. For each scale, we re-calculated the 67th percentile (at the national level) and used that to define the treatment groups. The cut points were 3,664 persons per square mile for census tracts and 693 persons per square mile for counties.

The results of this analysis showed no statistically significant differences in the effect sizes estimated with block group, tract, or county-based treatment definitions. In the analysis above, we found that teens living in the top tertile of block group density had driver rates 13 points (95% CI: -16, -10) below that of comparable peers living at lower densities. When treatment was defined at the census tract level, the average treatment effect was a 12 point (95% CI: -15, -9) decline. The respondents lived in 717 counties, but the distribution was uneven with 62% of respondents living in about 10% of all counties in the sample. With a county-level treatment definition, the effect was a 15 point (95% CI: -18, -11) decline. We concluded that our results were not heavily impacted by the level of spatial aggregation.

As discussed above, we used population density as a built environment metric because it is readily available and is correlated with many environmental features such as transit availability, gridded street network, proximate destinations, and mixed land uses. However, we wanted to see if the effect of the environment would still be significant if we measured its effects with another measure. Ewing et al. (2002) have developed an index of urban sprawl that incorporates density as well as segregation of land use, strength of metropolitan
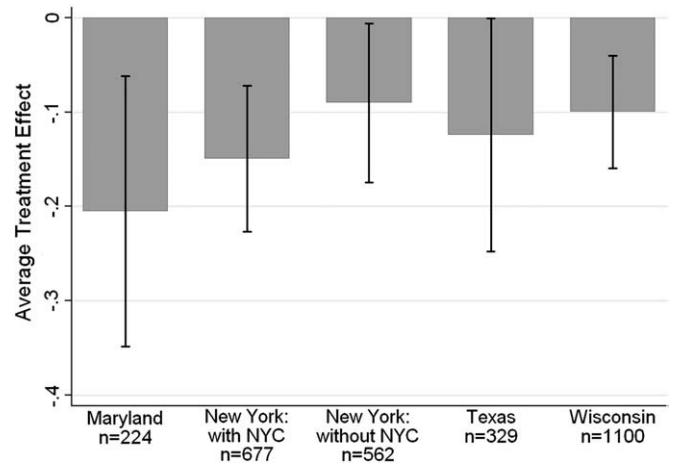
Fig. 5. Adjusted Average Treatment Effect and 95% CI of Living in High vs. Low Density by State: 16-19 year olds.

centers, and accessibility of the street network. Analyses at the county level using the sprawl index found that the average treatment effect of living in the top tertile of the sprawl index (i.e., the least sprawling counties) was a 6 point (95% CI: -9, -3) decrease in teen driver rates. This effect size is approximately one-third of that measured with county-level residential density. This suggests that the particular measure of the built environment influences the effect size and that further research should be done to identify which aspects of the environment have the strongest correlation with teen behavior.

5. Discussion

This study provides the first evidence that the place where teens live can affect when they become drivers. The national and state-level analyses suggest that 16 and 17 year olds living in denser neighborhoods had driver rates 15 percentage points below those of comparable teens living in less dense areas. The effect is weaker for 18 and 19 year olds, but still statistically significant. Together these data suggest that the characteristics of denser, more compact places are associated with a delay in teens becoming drivers. This is important because 16 and 17 year olds have the highest crash rates and any factors that reduce their driving exposure deserve attention. Also previous research on the factors affecting when teens become drivers has not considered the effects of the built environment (McCartt et al., 2007).

In order to translate these findings into an intervention, further questions must be answered: Why is there a difference in behavior between compact and sprawling locations? What is it about denser places that make teens less likely to get their drivers licenses? While further research using qualitative methods and a prospective methodology will be needed to fully address these questions, existing research provides some possible explanations. Dense, urban places tend to have some features in common. Common destinations such as schools, shopping, and recreation are often close to residences. Transit service is usually much better in denser places. Both of these factors make it easier for teens to get where they want to go without driving.

Recent research in physical activity has underscored the association between proximate destinations and walking (Lee & Moudon, 2006; McCormack, Giles-Corti, & Bulsara, 2008). If the presence of proximate destinations and a safe infrastructure for walking also delay teens becoming drivers, there are intervention synergies. Perhaps efforts at using urban design to make neighborhoods more walkable will make it more attractive for teens to delay driving. If true, this would substantially increase the public health case for environmental interventions.
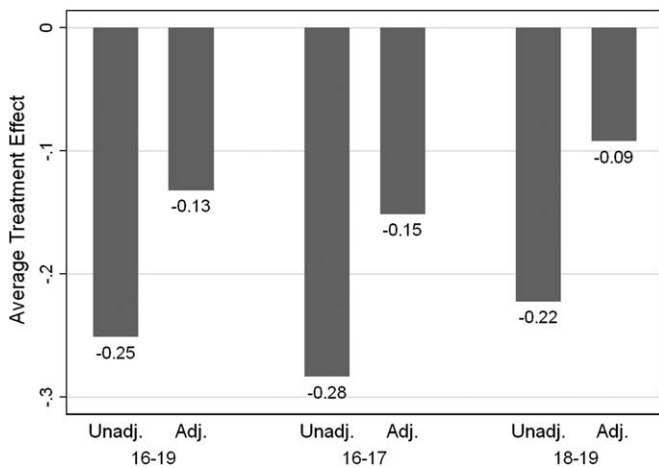
Fig. 4. Adjusted and Unadjusted Average Treatment Effect of Living in a High-Density Block Group on the Proportion of Teen Drivers, United States.

Similarly, if access to public transit is associated with delaying driving, that creates a public health case for subsidizing transit passes for teens. Because many urban areas rely on public transport to get teenagers to school, some cities have programs in place to provide transit passes to teens. However, there is substantial variation in the level of subsidy. For example, MUNI, the San Francisco transit provider, charges $10 per month. The New York City school system provides students with 3 free transit trips per day. In Atlanta, MARTA charges $10.50 for a 10 trip pass. This equates to $42 per month if a student rode transit back and forth to school every day. Some providers, such as AC Transit in the San Francisco Bay Area, have tried providing free passes but found it too costly to continue (McDonald, Librera, & Deakin, 2004). The existence of pass programs in many cities and the links to the schools provide a mechanism to offer students high levels of mobility at a reasonable price. Additional subsidies from health agencies might be able to lower the cost of transit passes in areas where they are high.

While the evidence of a link between where teens live and their driver status is exciting, this study has several limitations that deserve mention. First, there is a possibility that unobserved factors, which are correlated with density, are the true reason that teens in denser areas delay driving. For example, if Department of Motor Vehicle (DMV) offices located in denser areas had substantially longer wait times and delays in scheduling driver exams and this led teens to postpone becoming a driver, than the effect we observe could be a spurious correlation. While we cannot rule this out, the effect of living at higher density was observable whether we used the 67th, 75th, or 80th percentiles as the cutoff for high density. Our choice of the 67th percentile meant that we were not simply looking at teens living in cities where we might expect DMVs to be especially congested. Another limitation of the study is that it does not address how the introduction of GDL regulation might affect these findings. These data were collected in 2001 at a time when many states were just implementing their programs. Because GDL requirements limit driving exposure of 16 and 17 year olds, that might lessen the effects observed here. However, the analysis in Wisconsin and Maryland – where the younger teens were subject to GDL regulations – still found that higher density areas had significantly lower driver rates for 16 and 17 year olds. Due to sample size limitations, we were only able to conduct state-level analyses for Maryland, Wisconsin, Texas, and New York. To ensure the robustness of findings, it would be preferable to analyze multiple states. Finally, the effect of political boundaries was not addressed due to our research design.

6. Conclusion

The results of this study demonstrate a clear association between population density and whether teens are drivers. Consistent with expectations, teens living in less dense areas are more likely to be drivers than their counterparts living in more compact areas. More research is needed to identify the precise mechanism of the built environment's impact on age of driving initiation by teens. However, given the demonstrated ability of delaying licensure and limiting driving exposure by 16 and 17 year olds to decrease fatalities from motor-vehicle crashes among adolescents, it is clear that built environment factors such as density should be considered when designing future teen driver safety programs.

Acknowledgements

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