DISSERTATION

HOW ARE DRIVING LICENSURE STATUS, DELAY IN DRIVING LICENSURE, AND DRIVING EXPOSURE ASSOCIATED WITH ALCOHOL AND DRUG USE, PARENTAL MONITORING KNOWLEDGE, PEER ALCOHOL AND DRUG USE, AND HEALTH, EDUCATION, AND EMPLOYMENT OF EMERGING ADULTS?

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ABSTRACT

HOW ARE DRIVING LICENSURE STATUS, DELAY IN DRIVING LICENSURE, AND DRIVING EXPOSURE ASSOCIATED WITH ALCOHOL AND DRUG USE, PARENTAL MONITORING KNOWLEDGE, PEER ALCOHOL AND DRUG USE, AND HEALTH, EDUCATION, AND EMPLOYMENT OF EMERGING ADULTS?

Independence and mobility facilitated by driving privileges could have a major impact on alcohol and drug use, parental monitoring knowledge, peer alcohol and drug use, and health, education, and employment of emerging adults. Driving privileges may provide emerging adults with the ability to move more freely, and that mobility may affect their access to drugs and alcohol. It may also mean that emerging adults with driving privileges were more likely to be in environments where alcohol and drugs were available. Parents of emerging adults with driving privileges may be more involved in monitoring their child's driving activities, resulting in higher levels of parental monitoring knowledge. Emerging adults with driving privileges were more likely to report a higher level of peer alcohol and drug use because having access to a car allowed them to spend more time with their peers and engage in alcohol and drug use.

On the other hand, driving privileges may have positive impacts on the health, education, and employment of emerging adults. Having the ability to travel to places of employment and educational institutions may open more opportunities and allow for greater access to resources. This could lead to improved academic and professional outcomes.

Overall, driving privileges may have both positive and negative impacts on alcohol and drug use, parental monitoring knowledge, peer alcohol and drug use, and health, education, and employment of emerging adults. It was important to consider these trade-off impacts when considering how to best support emerging adults in their development.

My dissertation explored how were driving licensure status, delay in driving licensure, and driving exposure associated with alcohol and drug use, parental monitoring knowledge, peer alcohol and drug use, and health, education, and employment of emerging adults. Data was collected from a nationally representative sample of U.S. emerging adults starting at grade 10th for a seven-year longitudinal assessment. Having driving licensure in high school, no delay in driving licensure, and higher driving exposure were associated with higher levels of alcohol and drug use, higher levels of parental monitoring knowledge, higher levels of peer alcohol and drug use, better health, higher levels of education attainment, and more working hours in emerging adulthood. My dissertation could inform policymakers and practitioners on the importance of driving privileges in promoting the well-being of emerging adults.

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DEDICATION

Dedicated to my mom — Hui Jin

Your love is what got me through this – I love you.

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OVERVIEW

The initiation of emerging adult driving (roughly ages 18 - 25) has generally been focused on crash injury reduction. However, the most influential developmental phase for emerging adults may be when they transition into driving, as it may increase parental monitoring of risk behaviors such as alcohol and drug use, whilst simultaneously providing more opportunities (e.g., more thoroughly search alcohol and drug and access alcohol and drug outlets) through increased independence and mobility.

From a developmental perspective, driving licensure may have potential benefits for emerging adult outcomes, especially on their health, education, and employment, which would allow them to flourish in early adulthood. Driving may facilitate greater adolescent independence and mobility resulting in improved access to important health, education, and employment opportunities.

The current knowledge base focuses on crash injury among emerging adult drivers. Little attention has been shown to the effect of driving licensure status (having licensure vs. no licensure), delay in driving licensure (no delay in driving licensure vs. delay in driving licensure), and driving exposure after licensure (driving frequency and miles driven) on the nontraffic risks (alcohol and drug use), protective (positive parental monitoring) and risk (negative peer alcohol and drug use) factors of alcohol and drug use, and early adult health, education, and employment.

I used the NEXT Generation Health Study to answer my research questions. The Next Generation Health Study is a nationally representative youth cohort that was tracked for seven waves (W1 to W7), beginning in 2009 – 2010 when the cohort was in 10th grade, and ending four years after they had left high school. A multistage sampling strategy was employed, selecting primary sampling units (US school districts) from nine census divisions. Of the 145 selected schools, 81 agreed to participate, with African Americans being oversampled in order

to obtain an accurate sample size of 687. Surveys were administered annually in the spring semester. In total, 2,783 participants enrolled in the NEXT study, and 90%, 87%, 86%, 78%, 79%, 83%, and 83% of these participants completed the survey for each wave (W1 to W7) respectively. Informed parental consent was obtained for participants under 18 years of age, and those over 18 provided their own assent. The study protocol was reviewed and approved by the Institutional Review Board of the Eunice Kennedy Shriver National Institute of Child Health and Human Development.

In Chapter 1, I presented the overview/rationale, the study aims, and the hypotheses. The rationale for my dissertation was to understand how driving licensure, delay in driving licensure and driving exposure were associated with behaviors and outcomes that are of particular relevance to emerging adults. My dissertation aimed to examine the relationship between driving licensure, delay in driving licensure, and the non-crash risks and benefits associated with the transition period of emerging adults. Specifically, I planned to explore the extent to which emerging adult exposure to driving after licensure, such as driving frequency trajectory patterns, was associated with non-crash risks from intrapersonal (e.g., alcohol and drug use) to interpersonal (e.g., parental monitoring knowledge and peer substance use) levels, as well as the potential benefits (e.g., health, education, and employment) of emerging adults. The hypotheses of my dissertation were that having licensure, no delay in driving licensure, and more driving exposure were associated with higher alcohol and drug use, decreased parental monitoring knowledge, increased peer alcohol and drug use, and better health, higher education attainment, and more working hours of emerging adults.

In Chapter 2, I provided the literature review. Recent studies showed that driving licensure, delay in driving licensure, and driving exposure may be all associated with alcohol and drug use, parental monitoring knowledge, peer alcohol and drug use, and health, education, and employment of emerging adults. Emerging adults who obtained a driver's license earlier, those with no delay in driving licensure and more driving exposure showed greater alcohol and drug

use. Delay in driving licensure may be associated with lower alcohol and drug use, but this may be offset by increased peer alcohol and drug use. Parental monitoring knowledge may also associated with driving licensure and driving exposure, with greater knowledge being associated with lower alcohol and drug use. Finally, early adult health, education, and employment may be affected by driving licensure and driving exposure, with better outcomes being associated with earlier licensure and greater driving exposure.

In Chapter 3, I examined the associations of driving licensure status, delay in driving licensure, and driving exposure trajectory classes in emerging adulthood with emerging adult sociodemographic variables. The dependent variables were driving licensure status and driving frequency trajectory classes. Driving licensure status was defined as the process of obtaining independent licensure in high school, after high school, or no licensure in emerging adulthood. Driving frequency and miles driven trajectory classes were investigated using the latent class growth modeling (LCGM). The LCGM was conducted with SAS PROC Traj. The sociodemographic independent variables were sex, race/ethnicity, family structure, family affluence, parental education, urbanicity, social media use, and parental monitoring knowledge. Multinomial logistic regression was used to examine the associations of driving licensure and driving frequency trajectories with sociodemographic variables, taking complex survey sampling features into account. Of the 2779 participants eligible for obtaining a driver's license, 572 (20.57%) had yet to obtain one by emerging adulthood, 1344 (48.36%) obtained their license during high school, and 863 (31.05%) had obtained their license after high school. Three driving frequency trajectories were identified: low (N=358, 17.93%, weighted and hereafter), medium (N=864, 59.90%), and high (N=267, 22.17%) driving frequency classes. Emerging adults having a parent with high school or less as the highest education (AOR [Adjusted Odds Ratio]=0.21, 95%CI [Confidence Interval] 0.07, 0.66, p=0.027), living in urban areas (AOR=0.07, 95%CI 0.02 0.31, p<0.001), and having low family affluence (AOR=0.31, 95%CI 0.10 0.91, p<0.001) were less likely to have licenses in high school than no licensure in emerging adulthood. Emerging

adults with a single parent were less likely (AOR=0.48, 95%CI 0.24 0.96, p=0.035) to have licenses after high school than no licensure in emerging adulthood. Social media sedentary time was higher (β=1.18, 95%CI 1.08 2.25, p=0.032) in emerging adults with licenses in high school than no licensure in emerging adulthood. Mother's monitoring knowledge was higher in emerging adults with licensure in high school (β=2.14, 95%CI 1.04 4.42, p=0.040) and after high school (β=1.56, 95%CI 1.08 2.25, p=0.019) than no licensure in emerging adults, respectively. Compared with White emerging adults, Latinos were more likely (AOR=1.13, 95%CI 1.64 2.01, p=0.024) to be in the high driving frequency class than in the low driving frequency class. Compared with emerging adults living in rural areas, emerging adults living in urban areas were less likely to be in the high driving frequency class (AOR=0.22, 95%CI 0.06, 0.82, *p*=0.021) and the medium driving frequency class (AOR=0.44, 95%CI 0.19 0.52, *p*<0.001) than in the low driving frequency class, respectively. Compared with emerging adults living with both biological parents, emerging adults living with biological and step-parent were more likely (AOR=1.21, 95%CI 1.11 2.18, *p*=0.016) to be in the high driving frequency class than in the low driving frequency class. Social media sedentary time was higher in the high driving frequency class (β=1.37, 95%CI 1.24 1.51, p<0.001) and in the medium driving frequency class (β=1.14, 95%CI 1.04, 1.25, p<0.001) than in low driving frequency class, respectively. Race/ethnicity, socioeconomic status, urbanicity, family structure, social media use, and mother's monitoring knowledge contribute to emerging adult licensure and driving frequency. An upward trend of miles driven trajectory was identified in emerging adulthood.

In Chapter 4, I examined the associations of driving licensure status, delay in driving licensure, and driving frequency trajectory classes with alcohol drinking, binge drinking, and drug use trajectory classes in emerging adulthood. The independent variables were driving licensure status, delay in driving licensure, and driving frequency trajectory classes. Covariates were drinking age, race/ethnicity, sex, parental education, urbanicity, family structure, and family affluence. The dependent variables were alcohol drinking, binge drinking, and drug use

trajectory classes. Multinomial logistic regression analyses were used to examine the associations of driving licensure status, delay in driving licensure, and driving frequency trajectory classes among emerging adult drivers with their alcohol drinking, binge drinking, and drug use trajectory classes, respectively, taking complex survey sample features into account. Three alcohol drinking trajectory classes were identified (weighted %): abstainers to light (N=638, 47.59%), light (N=470, 42.80%), and escalators (N=86, 9.16%). Three binge drinking trajectory classes were identified (weighted %): abstainers to late escalators (N=670, 47.40%), escalators (N=446, 43.19%), and consistent high (N=78, 9.41%). Three drug use trajectory classes were identified (weighted %): abstainers (N=901, 60.68%), escalators (N=475, 29.50%), and experimenters (N=127, 9.83%). Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school were more likely (adjusted odds ratio [AOR]=4.07, 95% confidence interval [CI] 1.19 117.74, p=0.002) to be in the alcohol drinking escalators class than in the abstainers/light class. Compared with emerging adults with DDL, emerging adults without DDL were more likely (AOR=1.14, 95%CI 1.73 1.77, p=0.006) to be in the alcohol drinking escalators class than in the abstainers/light class. Compared with emerging adult with low driving frequency class, emerging adults in the medium driving frequency class were more likely (AOR=2.82, 95%CI 1.44 5.50, p=0.034) to be in the alcohol drinking light class than in the abstainers/light class. Compared with emerging adults in the low driving frequency class, emerging adults in the high driving frequency class were more likely (AOR=3.16, 95%CI 1.41 7.06, p=0.032) to be in the alcohol drinking light than in the alcohol drinking abstainers/light class. Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school (AOR=15.54, 95%CI 1.59 1.92, p=0.015) and after high school (AOR=9.15, 95%CI 1.05 7.97, p=0.016) were more likely to be in the high consistent binge drinking class than in the abstainers/late escalators class, respectively. Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses after high school were more likely (AOR=9.15, 95%CI 1.05 7.97,

p=0.016) to be in the high consistent binge drinking class than in the abstainers/late escalator class. Compared with emerging adults with DDL, emerging adults without DDL were more likely to be in the binge drinking escalators (AOR=1.09, 95%CI 1.69 1.71, p=0.007) class than in the abstainers/late escalators class. Compared with emerging adults in the low driving frequency class, emerging adults in the medium driving frequency class were more likely (AOR=1.65, 95%CI 1.91 2.17, p=0.033) to be in the binge drinking escalators than in the abstainers/late escalators class. Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school were more likely (AOR=1.30, 95%CI 1.08 2.18, p=0.022) to be in the drug use escalators class than in the abstainers class. Compared with emerging adults with DDL, emerging adults without DDL were more likely AOR=1.03, 95%CI 1.02 1.56, p=0.029) to be in the drug use escalators than in the abstainers class. Compared with emerging adults in the low driving frequency class, emerging adults in the medium driving frequency class were more likely (AOR=1.23, 95%CI 1.05 1.78, p=0.017) to be in the drug use escalator than in the abstainers class. Alcohol drinking, binge drinking, and drug use among emerging adulthood were greater among emerging adults with a driver's license in high school, no DDL, and a higher level of driving frequency.

In Chapter 5, I examined the associations of driving licensure status, delay in driving licensure, and driving frequency with mother's and father's monitoring knowledge separately across Wave 1 (2nd-year high school) to Wave 3 (last year in high school) and peer alcohol and drug use trajectory classes in emerging adulthood. Driving frequency was calculated as a numerical average (mean) in high school. Peer alcohol and drug use (W1-7) trajectory classes were investigated using Latent Class Growth Modeling. The independent variables were driving licensure status, DDL, a numerical average (mean) of driving frequency in high school (W1-3). The dependent variables were peer alcohol and drug use trajectory classes (W1-7) and mother's and father's monitoring knowledge separately across W1 (2nd-year high school) to W3 (last year in high school). The covariates were race/ethnicity, sex, parental education,

urbanicity, family structure, and family affluence. Multinomial logistic regression was used to examine the associations of driving licensure status, DDL, and driving frequency with peer alcohol and drug use, respectively in three separate models. Linear regression was used to examine the associations of driving licensure status, DDL, and driving frequency with a numerical average (mean) of a mother's and father's monitoring knowledge separately across W1 to W3. All analyses took complex survey sample features into account. Three peer alcohol and drug use trajectory classes were identified (weighted %): light (N=1131, 69.10%), escalating (269, 19.60%), and declining (103, 11.30%). Compared with emerging adults with no licensure in high school, emerging adults with licenses in high school were more likely to be in the declining (adjusted odds ratio [AOR]=1.74, 95% confidence interval [CI] 0.47 6.36, p=0.406) and escalating (AOR=1.48, 95%CI 0.85 2.56, p=0.163) peer alcohol and drug use classes than in the light peer alcohol and drug use class, respectively. Compared with emerging adults with DDL, emerging adults with no DDL were less likely (AOR=0.38, 95%CI 0.19 0.77, p=0.007) to be in the declining peer alcohol and drug use class than in the light peer alcohol and drug use class. One unite increased in driving frequency was associated with a higher likelihood of being in the declining peer alcohol and drug use class (AOR=1.03, 95%CI 0.96 1.09, p=0.450) and in the escalating peer alcohol and drug use class (AOR=1.01, 95%CI 0.98 1.04, p=0.573) than in the light peer alcohol and drug use class. Mother's monitoring knowledge was higher in high school emerging adults with 1) licenses (β[Beta]=0.08, 95%CI -0.02, 0.17, p=0.110) vs. no licensure, 2) no DDL (β=0.08, 95%CI 0.00, 0.16, p=0.050) vs. DDL, and 3) a higher driving frequency (β=0.003, 95%CI -0.00, 0.01, p=0.133). Father's monitoring knowledge was higher in high school emerging adults with 1) licenses (β=0.05, 95%CI -0.09 0.19, p=0.440) vs. no licensure, 2) no DDL (β=0.13, 95%CI 0.04 0.22, p=0.006) vs. DDL, and 3) a higher driving frequency (β=0.001, 95%CI 0.006, 0.004, p=0.648).High school emerging adults with licenses, no DDL, and a higher level of driving frequency were more likely to report increased peer alcohol and drug use and a higher level of mother's and father's monitoring knowledge.

In Chapter 6, I examined the associations of driving licensure status, delay in driving licensure, and driving frequency trajectory classes with their health, education, and employment four years after high school. In study 1, I investigated associations of delay in licensure with health, education, and employment four years after high school. The independent variable was delay in driving licensure (DDL [delaying ≥1 year] vs. No-DDL), defined as participants receiving driver licensure ≥1 year after initial legal eligibility time until W7. Outcome variables were health, education, and employment four years after high school. Covariates included sex, race/ethnicity, family affluence, parental education, and urbanicity. Multinomial logistic regression analyses were conducted considering complex survey features. No-DDL vs. DDL was associated with a higher likelihood of (1) excellent (adjusted odds ratio [AOR]=2.06, $p<.001$), good (AOR=1.74, $p<.001$), and fair (AOR=1.34, $p=.008$) health compared to poor health; (2) completing a 4-year college or graduate school [AOR=2.71, $p<.001$] and tech/community college [AOR=1.92, $p=.004$] compared to high school or less; and (3) working ≥30 hours/week (AOR=7.63, $p=.011$) and working <30 hours/week (AOR=1.54, $p=.016$) compared to not working. Among emerging adults, obtaining a driver's license without delay was associated with better health, higher educational attainment, and increased working hours four years after high school. Despite the potential increase in driving exposure and risk that comes with earlier licensure, avoiding any delays in receiving a driver's license appears to bring with it advantages in terms of health, education, and employment during early adulthood.

Additionally, in Study 2, I examined the associations of driving licensure status and driving frequency trajectory classes with health, education, and employment four years after high school. Independent variables were driving licensure status and frequency trajectories. The dependent variables were health, education, and employment four years after high school. Covariates were race/ethnicity, sex, parental education, urbanicity, family structure, and family affluence. Multinomial logistic regression analyses were conducted considering complex survey features. Having licenses in high school versus no licensure in emerging adulthood was

associated with a higher likelihood of reporting 1) excellent (AOR [adjusted odds ratio]=7.55, 95%CI [confidence interval]=1.81 7.76, p=0.048] than poor health; 2) bachelor's degree or graduate degree (AOR=4.11, 95%CI 1.76 9.62, p<0.001) and some college, technical school or associate degree (AOR=3.36, 95%CI 2.21 5.10, p<0.001) compared with less than or equal to high school diploma or GED; and 3) <30 hours (AOR=1.81, 95%CI 1.10 2.97, p=0.010) than no working hours. Emerging adults with a driver's license in high school are more likely to report better health, higher education, and more working hours four years after high school.

My dissertation shows that a more comprehensive study of the effects of driving licensure status, delay in driving licensure, and driving exposure after licensure on alcohol and drug use, as well as their associated protective (parental monitoring knowledge) and risk (peer alcohol and drug use) factors, may help better understand the risks beyond the direct consequences of vehicle crashes when emerging adults begin to drive. Specifically, decreased parental monitoring knowledge suggests that emerging adults may become less reliant on their parents for guidance and support. Additionally, increased peer alcohol and drug use may occur as a result of increased independence and access to substances. Furthermore, increased alcohol and drug use may become an issue, as the perceived risk of consequences may be lower due to the lack of parental supervision and knowledge. All non-crash risks are important to consider when discussing the implications of emerging adult driving privileges (e.g., having licensure in high school, no delay in driving licensure, more driving frequency, and higher miles driven). The findings can help inform decisions on how best to reduce the risk of alcohol and drug use among emerging adults when they begin to drive.

Additionally, my dissertation may provide important insights into how to best support and empower emerging adults when they begin to drive. Programs can be developed that focus on improving the health, education, and employment opportunities available to emerging adult drivers, helping them gain the knowledge, skills, and resources needed to succeed. Program could include providing access to career and educational resources and offering guidance and

mentorship. By taking these steps, we can help create a more secure and successful future for emerging adults when they begin to drive.

The results of my dissertation could inform future studies by demonstrating the importance of driving licensure status, delay in driving licensure, and driving exposure on the health, education, and employment of emerging adults, as well as their alcohol and drug use, parental monitoring knowledge, and peer alcohol and drug use. Further research is needed to explore the most effective ways to support emerging adults in obtaining driving licensure in a timely manner, avoiding delay in driving licensure, and increasing their driving exposure, while also enhancing parental monitoring knowledge and preventing peer alcohol and drug use influence. Contextual facets of licensure status, delay in licensure, and driving exposure should be evaluated to measure early adulthood success, taking into account changes in alcohol and drug use, peer alcohol and drug use, and parental monitoring knowledge. Qualitative studies could be used to gain a deeper understanding of how individual factors (e.g., beliefs, thoughts, and values) shape the associations of driving privileges with alcohol and drug use, parental monitoring knowledge, peer alcohol and drug use, and health, education, and employment of emerging adults.

CHAPTER 1 – INTRODUCTION, AIMS, AND HYPOTHESES

INTRODUCTION

Transportation is a vital structural facet of society, communities, and people's lives [1]. At the individual level, the word transportation is an image of someone driving a car or truck [1]. Cars are a crucial element of American's daily life [2]. There were 228.2 million licensed drivers in the United States in 2020 [3]. Emerging adult drivers, persons 15 to 20 years old operating a vehicle, accounted for 11.6 million (5.1%) of all licensed drivers in 2020 [3].

For many emerging adults, obtaining a driver's license is seen as a rite of passage into adulthood. Driving is an essential process of growing up and entering adulthood, and it has become an established aspect of emerging adults' maturation and socialization process [4]. Learning to drive is an important rite of passage, particularly in the United States, where limited public transportation in many areas can mean that the ability to drive is a key to independence [4]. Time to licensure varies among those who obtained a driver's license as an emerging adult. Many emerging adults get their driver's licenses when they reach state-legal driving age. However, some choose to delay in driving licensure (DDL). A nationally representative US emerging adult cohort study has shown that DDL was widespread among emerging adult drivers [5]. Nearly 70% of eligible adolescents who reach state-legal driving age delayed at least one year prior to obtaining their licenses during 2010-2017 [5]. Besides DDL, the extent of emerging adult exposure to driving after licensure (driving frequency and miles driven) may differ. Nevertheless, for emerging adult drivers, a certain level of driving exposure and experience to learn how to drive is necessary before they become safe drivers [6].

Previous research speculates that social media may allow youth to connect to friends digitally and decrease the need for in-person connection, thus reducing the need for a driver's license to travel for connection [7]. Some researchers also speculate that the built environment (e.g., living in a highly walkable environment to commute between home and school/work) [8],

graduated driving licensing policy (e.g., mandated supervised practice driving hours with adult supervision before getting an independent license) [9], and economic burdens (e.g., not being able to afford the cost and maintenance of a vehicle) [10, 11] as possible reasons for the increased numbers of emerging adults that DDL. Other possible explanations for DDL that have been explored include sociodemographic variables like race/ethnicity (e.g., African Americans vs. White) [10], family structure [e.g., living with a single parent vs. both biological parents] [12], and family affluence (e.g., low vs. high) [13-15]. While previous research has investigated sociodemographic variables, including minority race/ethnicity, socioeconomic status, urbanicity, and parental monitoring knowledge associated with DDL [5], the current knowledge base still has a limited understanding of sociodemographic variables associated with driving licensure (having licensure vs. no licensure) and driving exposure (driving frequency and miles driven). More comprehensive studies of sociodemographic variables are needed to assess their associations with driving licensure and driving exposure.

The advantages and disadvantages of emerging adults having a driver's license continue to be debated. Families can benefit from emerging adult drivers who can transport themselves to school and run errands. From a developmental perspective, driving licensure may have potential benefits for emerging adult outcomes, specifically on health, education, and employment, which would allow them to flourish in early adulthood. Previous studies indicate that driving facilitated greater adolescent independence and mobility, thus allowing them to access important health, education, and employment opportunities [16-20]. Evidence suggests that youth with consistent access to vehicle are more likely to access healthcare services than those with limited access to transportation [21, 22]. A cross-sectional study found that emerging adult drivers had higher average weekly salaries and demonstrated greater academic performance than non-drivers [23]. However, having a driver’s license can increase the likelihood of alcohol and drug use [24] and associated motor vehicle crash risks [25] among emerging adults. The potential advantages of early licensure (i.e., within state-specific legal eligibility) must be balanced against the relatively

earlier and greater driving exposure to risky behaviors (e.g., alcohol and drug use [24]) and related motor vehicle crash risk [25]. However, prospective associations of driving licensure (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure), and driving exposure (driving frequency and miles driven) with early adult health, education, and employment have not been fully assessed.

While obtaining a driver's license and driving are typically seen as important developmental milestones that can bring numerous advantages to the life course of emerging adults, it has been suggested that licensure and engaging in driving may increase risk of crashing and resulting in injury, which can have a negative impact on physical, mental, and social development [4]. For emerging adult drivers, the current literature base primarily focuses on transportation risks, including crash-related injury, disability, death, and harm to others [26-29]. There is limited study investigating association between driving licensure, DDL, and driving exposure with nontraffic health risks (e.g., alcohol and drug use). Potential nontraffic health risks may coexist during emerging adulthood. When emerging adults are licensed and exposed to driving, they have more opportunities for participating in nontraffic risk behaviors (e.g., alcohol and drug use) and interacting with peers who engage in such nontraffic risk behaviors (e.g., peer alcohol and drug use) [10]. Previous research found that obtaining a driver's license may increase the frequency of alcohol and drug use among long-term licensed emerging adult drivers [30]. However, the research on driving licensure, DDL, and what extent to which driving exposure to driving after licensure (driving frequency and miles driven) are associated with alcohol and drug use and peer alcohol and drug use is limited.

Further, parents have important roles to play concerning their novice emerging adult drivers who are licensed and introduced to driving. For example, parents may influence whether their emerging adults are ready to test for a learner's permit, how long and what type of supervised practice driving they will receive, whether they are prepared to test for an independent license, and whether they are allowed to access a vehicle, and what their driving privileges are after getting

an independent license [31, 32]. However, the actual role of driving licensure, delay in driving licensure, and driving exposure on parental monitoring knowledge has yet to be fully investigated. Although some studies have been conducted on the subject, the findings are inconsistent [33, 34]. One research shows that parental monitoring knowledge is lower when emerging adults obtain their licenses at an earlier age, suggesting that there is a link between driving licensure and parental monitoring knowledge [33]. On the other hand, other research shows that parental monitoring knowledge is higher when emerging adults obtain their licenses at an earlier age, providing contradictory evidence to the previous study [34]. This discrepancy indicates that further research is needed to determine the association between driving licensure, delay in driving licensure, and driving exposure on parental monitoring knowledge.

In summary, the current knowledge base shows limited investigation into driving licensure (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure) and driving exposure after licensure (driving frequency and miles driven) effects on alcohol and drug use, parent monitoring knowledge, peer alcohol and drug use, and early adult health, education, and employment. The primary purpose of this dissertation study is to assess the associations of driving licensure, DDL, and driving exposure after licensure with alcohol and drug use, parent monitoring knowledge, peer alcohol and drug use, and health, education, and employment in emerging adulthood. The study aims and hypotheses of the dissertation were to:

Study Aims, Hypotheses, and Statistical Approaches

Aim 1: Examined the associations of driving licensure status (having licensure vs. no licensure) and driving exposure (driving frequency and miles driven) trajectory classes in emerging adulthood with sociodemographic variables

Hypothesis 1: African Americans vs. Whites, a single parent vs. both biological parents, low family affluence vs. high family affluence, urban vs. rural, and parental high school or less education vs. parental bachelor or higher education associated with no licensure and a low level of driving frequency and miles driven.

Statistical approach 1: Driving exposure trajectory classes in emerging adulthood were investigated using the latent class growth modeling (LCGM). Example categories resulting from LCGM for each of driving frequency and miles driven were low, medium, and high levels.

The independent variables were emerging adult sociodemographic variables including race/ethnicity, sex, parental education, urbanicity, family structure, and family affluence. The dependent variables were driving licensure and driving exposure trajectories. Binomial logistic regression was used to examine the associations of driving licensure among emerging adult drivers with their sociodemographic variables, taking complex survey sampling features into account. Multinomial logistic regression was used to examine the associations of driving exposure trajectory classes among emerging adult drivers with their sociodemographic variables, taking complex survey sampling features into account.

Aim 2: Examined the associations of driving licensure status (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure), and driving exposure (driving frequency and miles driven) trajectory classes with alcohol drinking, binge drinking, and drug use trajectory classes in emerging adulthood

Hypothesis 2: Emerging adults with a driver's license, no delay in driving licensure, and driving more were more likely to report a high level of alcohol drinking, binge drinking, and drug use in emerging adulthood.

Statistical approach 2: Driving exposure trajectory classes among emerging adult drivers in emerging adulthood were investigated using Latent Class Growth Modeling (LCGM). The LCGM was used to investigate alcohol drinking, binge drinking, and drug use trajectory classes in emerging adulthood. The independent variables were driving licensure, DDL, driving exposure trajectory classes, and sociodemographic variables including race/ethnicity, sex, parental education, urbanicity, family structure, and family affluence. The dependent variables were alcohol drinking, binge drinking, and drug use trajectory classes. Multinomial logistic regression was used to examine the associations of driving licensure, DDL, and the driving exposure

trajectory classes among emerging adult drivers with their alcohol drinking, binge drinking, and drug use trajectory classes, respectively in three separate models, taking complex survey sample features into account.

Aim 3: Examined the associations of driving licensure status (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure), and driving exposure (driving frequency and miles driven) trajectory classes with father's and mother's monitoring knowledge separately across Wave 1 (2nd-year high school) to Wave 3 (last year in high school) and peer alcohol and drug use trajectory classes in emerging adulthood.

Hypothesis 3: Emerging adults with a driver's license, no delay in driving licensure, and driving more were more likely to report a high level of peer alcohol and drug use in emerging adulthood and a lower numerical average (mean) of father's and mother's monitoring knowledge separately across Wave 1 (2nd-year high school) to Wave 3 (last year in high school).

Statistical approach 3: Driving exposure trajectory classes in emerging adulthood were investigated using Latent Class Growth Modeling (LCGM). Example categories resulting from LCGM for each of driving frequency and miles driven were low, medium, and high levels. The LCGM was used to investigate peer alcohol and drug use trajectory classes in emerging adulthood. The independent variables were driving licensure, DDL, driving exposure trajectory classes, and sociodemographic variables including race/ethnicity, sex, parent education, urbanicity, family structure, and family affluence. The dependent variables were peer alcohol and drug use trajectory classes and father's and mother's monitoring knowledge separately across Wave 1 (2nd-year high school) to Wave 3 (last year in high school). Multinomial logistic regression was used to examine the associations of driving licensure, DDL, and driving exposure trajectory classes with peer alcohol and drug use trajectory classes, respectively in two separate models, taking complex survey features into account. Linear regression was used to examine the associations of driving licensure, DDL, and driving exposure trajectory classes with a numerical average (mean) of father's and mother's monitoring knowledge separately across Wave 1 (2nd-

year high school) to Wave 3 (last year in high school), respectively in two separate models at each Wave, taking complex survey features into account.

Aim 4: Examined the associations of driving licensure status (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure), and driving exposure (driving frequency and miles driven) trajectory classes with their health, education, and employment four years after high school

Hypothesis 4: Emerging adults with driving licensure, no delay in driving licensure, and driving more were more likely to report better health, higher education, and more working hours four years after high school.

Statistical approach 4: Driving exposure trajectory classes in emerging adulthood were investigated using Latent Class Growth Modeling (LCGM). Example categories resulting from LCGM for each of driving frequency and miles driven were low, medium, and high levels. Independent variables were driving licensure, DDL, driving exposure trajectory classes, and sociodemographic variables including race/ethnicity, sex, parent education, urbanicity, family structure, and family affluence. The dependent variables were health, education, and employment four years after high school. Multinomial logistic regression was used to examine the associations of driving licensure, DDL, and driving exposure trajectory classes with health, education, and employment four years after high school, respectively in three separate models, taking complex survey sampling features into account.

CHAPTER 2 – LITERATURE REVIEW

2.1 Licensure and driving as a pivotal point in emerging adulthood

2.1.1 Emerging adulthood

Emerging adulthood, spanning from late teens to the mid-twenties (approximately 18-25 years old) [35], is an essential transitional phase in which adolescents finish their primary and secondary education and begin to pursue full-time employment, enter marriage, and become parents [35, 36]. Unlike young adults in their thirties, most emerging adults have yet to make long-term commitments in both their relationships and career [35, 36]. During emerging adulthood, most emerging adults also start to learn to drive and get driver's licenses. For many emerging adults, driving is seen as a pivotal moment in the transition between childhood and adulthood. Obtaining a driver's license is an essential rite of passage, especially in the United States, where there is limited access to public transportation in many areas, making the ability to drive a fundamental part of achieving independence [4]. Emerging adults who must depend on others for rides can miss out on social and work opportunities. In addition, they can be placed at risk if they are catching rides with novice drivers without much driving experience. Allowing emerging adults to drive provides them with independence and the ability to have more control over where they go, with whom, and for how long.

2.1.2 Driving licensure process

During the 1990s, states enacted Graduated Driver Licensing (GDL) laws. The GDL laws are a state-level policy system intentionally developed to gradually introduce emerging adult novice drivers into the driving population in a safe and graduated fashion. The GDL program allows emerging adult drivers to gain driving experience before obtaining full driving privileges safely. The programs and restrictions vary from state to state [37, 38]. Most programs include three stages: 1) learner's permit, 2) intermediate license, and 3) full privilege (or unrestricted license). Specifically, within the learner stage, emerging adults can drive only under

the supervision of a licensed adult driver [9]. Emerging adult drivers with learners' permits must log a policy-defined number of supervised practice hours of driving [9] and are initially not allowed to drive during late night hours [9]. An intermediate stage of licensure limits unsupervised driving in high-risk situations [39]. Two common restrictions under an intermediate stage of licensure include limits on nighttime driving and driving with emerging adult passengers [39]. Emerging adult drivers with a full independent license can drive independently, and previous restrictions like nighttime driving and driving with emerging adult passengers are lifted. Across the U.S., the minimum age to obtain a driver's permit varies in different states and ranges from 14 to 17 years old. The minimum age to obtain a full independent license can range from 16.5 to 18 years old by state [40]. Further, the time taken to obtain a full independent driver's license in emerging adulthood varies significantly. While many young drivers receive their driver's license when they reach the legally accepted age for driving, some choose to delay the process, delay in driving licensure (DDL). A nationally representative study of young US cohorts conducted between 2010 and 2017 showed that DDL is widespread, with nearly 70% of eligible adolescents choosing to delay obtaining their licensure by at least a year [5]. It is widely acknowledged that driving at a younger age increases the risk of crashing [41], and while DDL may reduce the risk of crashes due to lack of exposure [42], both crash risk and crash rates still remain higher when emerging adults begin to drive without prior novice driver safety instructions and supervised driving experience [31, 43]. Additionally, the frequency and miles driven by emerging adults after licensure may differ significantly, although a certain level of driving exposure is necessary for emerging adults to become safe drivers [6].

2.1.3 Driving exposure

Primary access to vehicles among emerging adults is highly prevalent; 7 in 10 students in 9th, 10th, or 11th grade who drive on their own have reported having primary access to a vehicle [44]. Previous research demonstrated that parents support access to a car among their emerging adults; 3 of 4 emerging adults thought their parents would like them to have their

vehicles [45]. Emerging adult access to a car has been associated with parental desires to accelerate driving privileges, such as allowing driving after dark and driving with one emerging adult passenger in the first three months after licensure [45, 46]. Further, an increased demand on emerging adults, a greater responsibility for family duties (e.g., driving siblings to school and running errands), and greater accountability for commuting to and from work will be facilitated by emerging adults' increased access to a vehicle [47]. Additionally, with proper training and supervision of a licensed adult driver in GDL programs, driving provides a pathway that helps emerging adults become more autonomous emerging adults who rely less on parents with more opportunities to connect with peers outside home and school. Despite the fact that all emerging adults are expected to acquire a driving license, the extent to which they are exposed to driving after licensure, including the frequency and total miles driven, may vary. The existing literature is deficient in elucidating the effects of adolescent driving following licensure on their alcohol and substance use, their parents' supervision practices, the alcohol and substance use of their peers, and early adult health, education, and employment outcomes.

2.1.4 Risky driving

Motor-vehicle crashes are the leading course of unintentional injury and death among the young aged 5-23 [48], particularly for emerging adult drivers who drive at night [49-51]. In 2015, approximately 21% of fatally-injured drivers aged 15-20 years had a blood alcohol concentration (BAC) of 0.08g/dL or higher, despite the fact that the illegal limit for the underage group (<21 years) is between 0.00g/dL and 0.02g/dL according to zero tolerance laws, which vary by state [52]. About 21% of the youth aged 20 y/o reported riding with a driver impaired by alcohol in 2018 [53]. In 2008, about 52%-55% of the US and Canadian high school students reported “ever” riding with an impaired driver aged 21 y/o or more [54]. Further, 21%-33% of the US and Canadian high school students reported “ever” riding with an impaired peer in 2008 [54].

While inexperience accounts for crashes early in licensure, risky driving contributes to crashes throughout emerging adulthood [55, 56]. Risky driving can be defined as driving under

higher-risky driving conditions such as at night or in inclement weather; in a fast, aggressive, erratic, unsafe, or unlawful manner; engaging in distracting secondary tasks while driving; and impaired from alcohol or other drugs, a particular concern given that emerging adult drug use, which is both illegal and dangerous in many ways, increases during emerging adulthood [57], and the involvement of alcohol in a high proportion of fatal crashes among emerging adult drivers [56].

The development of these risky driving behaviors is not only shaped physically (e.g., binge drinking and illicit drug use) but also politically and culturally (e.g., minimum drinking-age laws and parent monitoring practice) [58]. These risky driving behaviors among young novice drivers all too frequently result in injury and fatal crashes that ultimately compromise emerging adult health. Despite national traffic safety policies (e.g., Graduated Driver Licensing programs [59]) and laws (e.g., minimum drinking-age laws [60]) having been implemented to prevent risky driving behaviors, emerging adult driver fatal crashes still remain unacceptably high [61-63].

Previous studies also have shown that risky driving behaviors among the young population are associated with individual and contextual factors [64, 65] and linked to later health care opportunities [66]. At an individual level, alcohol use and lack of restraint use (a vehicle safety device or feature activated by the force of a collision or sudden stop with the intention of preventing injury to the driver and passengers) contribute to risky driving [67, 68]. Further, sleep duration (i.e., sleep deprivation) [69], mental health status (i.e., mental disorder) [70], drug use [71], and alcohol drinking [71] contribute to risky driving. At a broader contextual level, lacking parental supervised practice [66, 72], drunk and marijuana-smoking peer [73], undesirable parenting practice [46], and parenting desire to have their youth drink alcohol (parents encouraging their youth to drink at home or in social settings, or even buying alcohol for their youth, driven by a belief that drinking alcohol is a normal part of growing up, or to make it easier for their youth to fit in socially) [73] can also contribute to risky driving. These individual and contextual factors may lead to higher levels of risky driving. High levels of risky driving can

lead to impaired independence and opportunities for enhanced short- and long-term well-being/health, education, and employment. Risky driving has been linked to increased risk of motor vehicle crashes, which can lead to physical and psychological injuries, disabilities, and even death [74]. These physical and psychological injuries can lead to impairments in independence, as well as impairments in educational and employment opportunities [74]. Additionally, risky driving can lead to increased likelihood of legal sanctions, such as fines, license suspensions, and possible imprisonment, which can further impede educational and employment opportunities [74].

Although considerable attention has been given to the risks associated with vehicle crashes that result from youthful inexperience and risk-taking behaviors including driving while impaired by alcohol, thrill-seeking, not wearing a seat belt, and using a mobile telephone while driving [28, 29, 75], there is a limited study investigating the effect of being licensed to drive, delay in driving licensure, and driving exposure on alcohol and drug use, peer alcohol and drug use, and parental monitoring knowledge in emerging adulthood and how being licensed to drive, delay in driving licensure, and driving exposure may associate with their later health, education, and employment.

2.1.5 Factors associated with driving licensure status, DDL, and driving exposure

Previous research has shown that social media may allow emerging adults to connect to friends digitally and decrease the need for in-person connection, thus leading to a reduction of the need for a driver's license to travel for connection [7]. Researchers have investigated the built environment (e.g., living in a highly walkable environment) [8], graduated driver licensing restrictions (e.g., mandated supervised practice driving hours with adult supervision) [9], and economic limitations (e.g., not being able to afford the cost and maintenance of a vehicle) [10, 11] as possible explanations for the increased numbers of emerging adults that delay in driving licensure. Specifically, they found that living in a highly walkable environment [8], more mandated practice driving hours with adult supervision [9], and not being able to afford the cost

and maintenance of a vehicle [10, 11] are associated with the increased numbers of emerging adults that DDL. Other potential reasons for emerging adults to delay in driving licensure include sociodemographic characteristics such as race (e.g., African Americans vs. Whites) [10], living with parent(s) [12], family affluence (e.g., low vs. high) [13-15], parental approval of licensure (e.g., parent's approval until emerging adults are "ready") [42], lack of care [15], parent unavailability [15], availability to get around without a car [15], and schedule unavailability in terms of other activities [15]. Specifically, African Americans vs. Whites [10], living with a single parent vs both biological parents [12], low vs. high family affluence [13-15], a longer waiting time for parent's approval until emerging adults are "read" [42], parent unavailability [15], and availability to get around without a car [15] associated with the increased numbers of emerging adults that DDL.

While previous research has explored sociodemographic variables for emerging adults that DDL [5], little is known about sociodemographic variables associated with driving licensure (having licensure vs. no licensure) and driving exposure to driving after licensure (driving frequency and miles driven). More comprehensive studies regarding sociodemographic variables are needed to examine their associations with driving licensure and driving exposure.

2.1.6 Potential roles of driving licensure status, DDL, and driving exposure associated with alcohol and drug use

Obtaining a driver's license is associated with increased alcohol, cigarette, and marijuana use over the longer-term with emerging adult drivers [30]. The immediate effect of licensing on novice drivers was associated with more negative attitudes toward driving while impaired by alcohol and reduced alcohol consumption [30]. Newly licensed drivers increased their awareness of the danger of driving while impaired by alcohol [30]. However, driving while impaired by alcohol increased among those with more extensive driving experience (more driving frequency and miles driven) [30]. The current knowledge base still lacks an understanding of how driving licensure (having licensure vs. no licensure), DDL (no delay in

driving licensure vs. delay in driving licensure), and driving exposure (driving frequency and miles driven) impact alcohol and drug use in emerging adult drivers.

2.1.7 Potential roles of driving licensure status, DDL, and driving exposure associated with parental monitoring knowledge

Before emerging adults are allowed to independently drive or travel in a vehicle, parents may control travel decisions and activities that involve the use of a vehicle [4]. Once emerging adult drivers complete the Graduate Driver Licensing (GDL) program, they are able to drive in an extended environment that may be outside of direct parental monitoring. This offers a newfound sense of freedom and independence but also may result in activities or decisions that lack the protective parental monitoring, such as underage drinking or drug use. More comprehensive studies of driving licensure (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure), and driving exposure (driving frequency and miles driven) are needed to examine their associations with parental monitoring.

2.1.8 Potential roles of driving licensure status, DDL, and driving exposure associated with peer alcohol and drug use

Peer alcohol and drug use may play an important role from a risk or protective perspective, particularly when emerging adults face alcohol and drug use in a peer/friend group context. Perceived peer alcohol and drug use behavior is a well-known risk factor for increasing emerging adults' smoking [76]. Further, the availability of a vehicle, which parents or peers generally provide, allows the emerging adults to avoid parental supervision in the home environment and find another environment where they are potentially more likely to engage in alcohol use and drug use [4]. Specifically, emerging adults with a driving license and driving more often can meet with friends outside/away from their homes, and independence and responsibility over personal activities can substantially increase. However, the current knowledge base has not thoroughly investigated the effect of driving licensure (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure), and driving

exposure (driving frequency and miles driven) on the changes in peer alcohol and drug use among emerging adult drivers.

2.1.9 Potential roles of driving licensure status, DDL, and driving exposure associated with health, education, and employment

Driving licensure has potential benefits for emerging adult outcomes that allow them to flourish in early adulthood. Driving licensure and driving facilitated greater adolescent independence and allowed them to enhance health, education, and employment opportunities [16-20]. For example, evidence suggests that participants with consistent vehicle access were more likely to access healthcare services compared to those with barriers to access to transportation [21, 22]. One cross-sectional study found that emerging adult drivers had higher average weekly salaries and performed better academically than non-driving peers [23]. The prospective associations of driving licensure and exposure to driving with early adult health, education, and employment are missing in the current knowledge base. There is a need to further understand the measurable effects that driving licensure (having licensure vs. no licensure), delay in driving licensure (no delay in driving licensure vs. delay in driving licensure) and driving exposure (driving frequency and miles driven) might have on early adult self-reported overall physical health, education, and employment.

2.2 Emerging adulthood as a context for substance use

Lifetime prevalence of substance use, including alcohol and drug use, reaches the peak in emerging adulthood, about 49% among ages between 19 and 20, and about 72% among 27 y/o [77]. The findings from the Monitoring the Future study found that the prevalence of daily use, binge drinking, and daily drunkenness is the highest in the emerging adulthood [78]. Substance use has been linked to deaths, injuries, academic misconduct, fighting, and sexual harassment among emerging adults [79]. Using a nationally representative cross-sectional survey of college students from a sample of 119 public and private colleges, researchers found that college students with binge drinking were over 8 times more likely to get hurt or injured than

non-binge drinking counterparts, 17 more times more likely to have missed classes, 7 times more likely to engage in unplanned sexual activity, and 8 times more likely to be arrested at the campus or local police [80]. Besides injury, substance use is also associated with mortality among emerging adults. The percentage attributed to unintentional drug poisoning among emerging adults increased from 59% in 1999 to 76% in 2005 [81].

Emerging adulthood is not only an important developmental period characterized by peak prevalence of substance use, but it also influences later adult physical, mental, and social development [81-83]. Previous studies have identified emerging adulthood as a key developmental period characterized by rapid transitions in the social context, which improves greater freedom and less social control than adolescence [81, 84-86]. By the end of this period, emerging adults tend to complete the developmental tasks of emerging adulthood and begin adult roles and responsibilities, including the establishment of committed relationships, marriage and family responsibilities, completion of school, beginning of career employment, and financial responsibility. Successful transition into adult roles is associated with decreasing substance use [81]. However, for some emerging adults, failing to achieve the developmental tasks during the transition into adult roles is associated with drug use disorders, substance dependence, financial instability, failure to establish healthy relationships, and deteriorating mental health [81]. Successful transition into adult roles can have long-term positive implications for early adult health and well-being, which makes substance use an important factor in the development of substance use prevention among emerging adults [81].

Access to substance use may be greatly increased among emerging adults who have driving licenses with greater independence and mobility. The extent of exposure to driving after licensure (more driving frequencies and miles driven) may allow emerging adults to access substances in an extended environment (a space far from home or a private space provided by a vehicle). However, there is limited study investigating how driving licensure (having licensure vs. no licensure), DDL (delay in driving licensure vs. no delay in driving licensure), and the

extent of driving exposure to driving (driving frequency and miles driven) may associate with substance use in emerging adulthood.

2.2.1 Alcohol Use

The prevalence of alcohol consumption (any alcohol is defined as a drink of an alcoholic beverage [a can or bottle of beer, a glass of wine or a wine cooler, a shot of distilled spirits, or a mixed drink with distilled spirits in it], not counting a sip or two from a drink) increases during high school [87] and reaches its peak among 18- to 25-year-olds [88, 89]. In 2013, trends in 30-day drinking prevalence were projected to be 39.2% among high school seniors, 78% among 18- to 21-year-olds, and 86% among 22- to 26-year-olds [90]. The high prevalence of alcohol use among adolescents and young adults causes many negative consequences on health and behaviors among young people [91]. For instance, alcohol consumption is one of the most significant contributors to injuries in college students and accounts for more than half of traumatic brain injuries in adolescents [92]. Emerging adults with alcohol drinking are at an elevated risk of accidents and injuries leading to hospitalization [93]. Alcohol consumption is associated with 80% of deaths resulting from homicides, suicides, and unintentional injuries among adolescents [94]. Further, less alcohol use in adolescence contributes to better school attachment and higher grades, while early initiation and increased levels of alcohol consumption contribute to more absenteeism and lower grades [95]. Additionally, emerging adults with alcohol drinking are more likely to offend others, including verbal and physical offenses, and be violence victims [96]. Alcohol consumption may increase aggression because alcohol could detrimentally affect specific psychological and physiological processes that lead to the expression of aggressive behaviors like verbally and physically offending others [97].

Alcohol use in emerging adults has a developmental perspective [98]. Emerging adults seek greater autonomy from parents when they mature, which heightens their integration with their peers and increases the influence of their peers [98]. Previous studies have shown that increased alcohol use is reported by emerging adults spending more time on social events [99,

100]. Male university students are more likely than female university students to use alcohol for social reasons, such as to make new friends or to fit in with peers [101]. It is likely that this difference is due to societal expectations and norms around alcohol use, which may be more lenient for male students than female students [101]. Additionally, it could be due to the fact that male students may be more likely than female students to put themselves in social situations where alcohol is more readily available [101]. A review of studies on 16-20 y/o shows that there may be some constructive aspects of emerging adult alcohol use in terms of developmental tasks such as "identity exploration" and bonding with peers [102]. On the other hand, previous research reported strong associations between feelings of alienation, hopelessness, and powerlessness and favorable attitudes towards the irresponsible use of alcohol among high school students [103]. The latest study has shown that, for young adults from 15 to 39 years of age, there are no health benefits to consuming alcohol; 59.1% of young adults in this age group (15 to 39 years of age) reported unsafe amounts of alcohol (defined as more than one drink per day for women or more than two drinks per day for men) in 2020, with 76.7% of those young adults being male [104]. However, the risks of alcohol consumption differ by age and geographic location, especially for emerging male adults from 18 to 25 y/o [104].

According to the World Health Organization, “Alcohol consumption is highest among persons aged 15-29 years, and this age group experiences the greatest health harms related to alcohol consumption” [105]. Specifically, the highest risks for alcohol consumption for emerging male adults from 18 to 25 years of age can be found in Europe and South Africa [105]. The lowest risks for alcohol consumption are typically found in individuals outside of the 18 to 25 age range in African and Asia [105]. The alcohol consumption rates among emerging male aduts aged 18 to 25 years of age in the U.S. tend to fall between the highest risk European and South American countries and the lowest risk African and Asian countries, highlighting the need for special attention to alcohol consumption prevention strategies among emerging adults in the U.S. [106].

Previous research has shown that leaving home and going to college are significantly associated with increases in the frequency of alcohol use [107]. Although increases in the frequency of alcohol have been found for those emerging adults who go to college and move away from their parents [107], noncollege-attending counterparts who move out of their parent's homes also increase their frequency of alcohol use [108]. Getting an independent driver's license may increase personal freedom and enable emerging adults to access alcohol outside the home. As emerging adults move out of their parent's homes, they often begin to frequent bars and nightclubs. Parental control over social events (e.g., going to bars and nightclubs) is absent. Drinking is sensitive to environmental factors such as decreased parental supervision, high sensation seeking, and increased personal freedom facilitated by driving [109]. One could reasonably expect that the frequency of driving to acquire alcohol would increase beyond the levels seen when the alcohol is purchased for home use. However, the current literature review still lacks an understanding of how driving licensure (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure) and driving exposure (driving frequency and miles driven) contribute to alcohol use in emerging adults.

2.2.2 Binge drinking

According to the National Institute of Alcohol Abuse and Alcoholism (NIAAA) [110], binge drinking is defined as consuming 4 or more drinks for females, or 5 or more drinks for males, within 2 hours drinking session. Estimates of past-30-day binge drinking by high school students are 25% [111]. According to a study conducted by the National Institute on Alcohol Abuse and Alcoholism (NIAAA), approximately 65% of emerging adults (ages 18-25) reported binge drinking in the past month [112]. Further, binge drinking starts in late adolescence and may continue during early adulthood [113]. Binge drinking leads to an elevated risk for negative short-term consequences such as drunk driving, risky sexual behavior (i.e., unprotected sex), and illicit drug use [114], as well as long-term consequences such as comorbid psychiatric issues [115], academic failure [116], and neurocognitive impairments [117]. Initiating binge

drinking at an early age significantly increases the risk for subsequent adult alcohol use disorders [118].

Spikes in binge drinking among 18- to 24 y/o are possibly a function of developmental processes in this transitional period defined as emerging adulthood [82]. Multiple factors influence binge drinking in emerging adulthood including an individual's genetic susceptibility to alcohol, alcohol use during high school, college norms and perceptions related to drinking, expectations regarding the benefits and detrimental effects of drinking, penalties for underage drinking, parental attitudes about drinking [108], whether one is member of Greek organizations or involved in athletics, and conditions within the larger community that determines how accessible and affordable alcohol is [119]. Additionally, sensation seeking, the desire for novel and intense experiences, is another reason that can explain why emerging adults are at higher risk of binge drinking [120]. Specifically, with less likelihood of being monitored by their parents and constrained by adult roles, emerging adults may be more likely to pursue novel and intense experiences than adolescents, either voluntarily or involuntarily [120].

The transition from high school to post-high school is one of the major life changes, and emerging adults with independent driving licenses may move away from home, which may increase independence and mobility to access alcohol outlets and put them at risk of binge drinking. Although the previous research investigated trajectories of binge drinking across emerging adulthood [121], more research is needed to ascertain the impact of increased independence and mobility facilitated by independent driving licenses and exposure to driving after licensure on binge drinking initiated in emerging adulthood.

2.2.3 Drug use

In the late 20th century, U.S. emerging adults reached unexpectedly high levels of drug use [122]. According to a study conducted by the National Institute on Drug Abuse, approximately 14.4% of emerging adults between the ages of 18 and 25 reported having used illicit drugs in the past month [123]. The proportion of illicit drug use among 12th graders has

remained between 47% and 50% from 2011 to 2019 [122]. Emerging adults with persistent drug use are experiencing a wide range of problems, including compromised academic performance and delinquency [124]. Adolescent drug use contributes to lower grades, absenteeism from school and other academic activities, and an increased risk of dropping out of school [124, 125]. Further, emerging adults with continued drug use are more likely to engage in arrest, adjudication, and intervention executed by the juvenile justice system [124]. Drug use and delinquent behavior are strongly linked, and these two behaviors may lead to adverse consequences, including participation in negative peer drug use [126, 127].

Injuries due to car crashes, physical disabilities and disease, and the effects of possible overdoses are among the health-related consequences of emerging adult drug use [128]. Disproportionate numbers of emerging adults involved with alcohol and drugs face an increased risk of death through suicide, homicide, accident, and illness [128]. Additionally, many emerging adults with drug use engage in sexual behaviors that place them at high risk of HIV/AIDS or other sexually transmitted diseases [129]. These examples illustrate the detrimental health-related consequences of drug use in emerging adulthood. Besides personal and family distress, additional healthcare costs and loss of future productivity due to drug use may burden the community [130, 131].

Mental health disorders such as depression are linked to drug use among emerging adults [132]. Emerging adults with drug use are at higher risk than nonusers for mental disorders, depression, conduct problems, personality disorders, suicidal thoughts, attempted suicide, and suicide [133]. Marijuana use, prevalent among emerging adults, has been shown to interfere with short-term memory, learning, and psychomotor skills [134]. Motivation and psychosexual/emotional development also may be influenced by drug use [129]. Further, emerging adults with drug use disorders often are alienated from and stigmatized by their peers [129].

The home environment and parental influences are critical factors in the socialization of drug use among emerging adults. These influences shape the patterns of drug use behaviors observed in this population. Emerging adults socialized by parents who drink and use drugs are more likely to initiate drug use at younger ages [135-137]. Research linking parental monitoring and drug use in adolescents also exists in emerging adulthood. A lower level of parental monitoring contributes to drug use disorders in adolescence [138]. The environment may be of great importance in understanding drug use patterns when emerging adults move away from home. Emerging adults who move out from home with a low level of parental monitoring may have an increased opportunity to access drugs.

Further, getting an independent driving license may facilitate access to drugs with greater independence and mobility in an extended environment (e.g., a space far from home or a private space provided by a vehicle). However, the current knowledge base lacks an understanding of how driving licensure (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure), and the extent of exposure to driving (driving frequency and miles driven) after licensure may associate with drug use in emerging adulthood.

2.3 Emerging adulthood as a context for the changes in protective and risk factors for alcohol and drug use

2.3.1 Parental monitoring knowledge

Parental monitoring has been widely identified as an element of authoritative parenting practices, which has been linked to various types of adolescent behaviors, such as tobacco use [139-141], alcohol use [142], and marijuana use [143]. The current knowledge base has widely investigated the association between parental monitoring knowledge and alcohol use in adolescence. For example, positive parental monitoring knowledge could protect against adolescent alcohol use by limiting alcohol exposure or establishing expectations for not having their youth drink alcohol [125]. Several studies have extended this research to assess if parental monitoring knowledge remains important into emerging adulthood. One study found that

parental monitoring knowledge at 10 y/o was associated with a decreased risk of alcohol use disorders and dependence at 21 y/o (Odds Ratio [OR] 0.78, $p < 0.05$) [144]. This association remains significant when the parental monitoring knowledge is extended from 10 to 16 y/o (OR 0.77, $p < 0.05$) [144]. A birth cohort study also found that the significant association between ages 10-12 parental monitoring knowledge and decreased alcohol use. At ages 18-22 was only observed in males (OR 0.43, $p = 0.02$), but not in females (OR 0.51, $p = 0.25$) [145]. This suggests that for males, parental monitoring knowledge may have a long-term effect of reducing alcohol consumption, but for females, there is not a significant association between parental monitoring knowledge and alcohol consumption. This could be due to the fact that males tend to consume more alcohol than females, so the effects of parental monitoring knowledge are more pronounced in male cohorts. Further, the association between positive parental monitoring knowledge and decreased emerging adult alcohol use has also been found among college students [146]. Research has found that parental monitoring of their college-aged daughter's activities is associated with lower levels of risky behaviors [147]. Specifically, parental monitoring has been associated with lower rates of drug and alcohol use, sexual activity, and delinquency among college-aged women [148]. Furthermore, parental monitoring has been positively correlated with academic achievement [149]. Thus, parental monitoring can provide an important protective factor for college-aged female students. Parental monitoring knowledge has been identified as a protective factor against adolescent drug use [150, 151]. Parental monitoring knowledge during high school may reduce the risk of marijuana use among college students, even though this association was not found in not attending college counterparts [107].

The changing nature of the transition to adulthood may be extending the time when parents can still influence their emerging adults [152]. Emerging adults gradually gain their autonomy and grow in independence by fulfilling adult roles [152]. Emerging adults do not consider themselves adults [35] nor their parents [153]. Therefore, many parents feel they still

need to help their children navigate this period of experimentation and exploration while at the same time allowing them to gain the independence they want and need. Indeed, as emerging adults strive to gain more autonomy by fulfilling adult roles [152, 154, 155], different parent-child communication styles of interaction and mutuality may occur in emerging adulthood [152, 156]. For example, emerging adults increase their tendency to spend time outside their parents' home [157]. Accordingly, parents will decrease their reliance on direct supervision of their kids [158]. Further, emerging adults tend not to share their secrets with their parents compared to adolescents because of the awareness of increasing privacy [159]. As such, parental monitoring knowledge may look different in emerging adulthood than in childhood or adolescence, but it may still play an important role. Therefore, the tendencies of both parental monitoring efforts and emerging adults' willingness to share the information with their parents may decrease throughout emerging adulthood, leading to a decrease in parental monitoring knowledge. Collectively, research suggests that greater independence through driving licensure, no delay in driving licensure, and increased driving exposure may be associated with parental monitoring knowledge.

2.3.2 Peer influence

Throughout emerging adulthood, decision-making is regulated by both emotional and social factors, especially peer influence [160-162]. Emerging adults may spend a substantial amount of time with their peers, and they will identify themselves with each other's behavior [161, 163]. Emerging adults may practice risky behaviors to achieve and maintain a friendship, meet the expectations of their peers, be accepted by their peers, and feel attached to a group [164, 165]. Therefore, risky behavior facilitated by peer influence becomes more frequent and risky when emerging adults hang out with their peers [166]. Previous research has found that the presence of peers will improve sensitivity to participating in risky behaviors because of the potential rewards recognized by their peer [167].

Emerging adulthood is characterized by identity formation and exploration in terms of love, work, and world views [35]. Interaction with peers, whom they can identify themselves with, can play an essential role in identity formation and exploration. Peers can exert their influence via various mechanisms such as reinforcement, encouragement, pressure, and displaying behaviors that can be modeled or avoided. Furthermore, peers can provide or prevent contexts for pursuing behaviors or display antagonistic behaviors such as bullying, vandalism, and sexual harassment [168]. Peer influence in emerging adulthood increases their exposure to cultural norms and influences that may or may not be compatible with the norms and values of their family [169, 170]. If emerging adults move away from home to attend college, they will be around same-aged peers from various backgrounds and have much less contact with their parents. Many cultural myths and norms support the idea of engaging in risky behaviors like binge drinking. Adolescents with peers who had alcohol use may be more likely to become binge drinking when transitioning into emerging adulthood, which may in turn be associated with an increased risk of alcohol dependence [171]. Similarly, the other researchers found that emerging adults with peers who had tobacco use in the 12th grade were over 1.5 times more likely to become regular smoking by 23 y/o compared to emerging adults who did not have smoking peers in the 12th grade [172]. It is unclear if adolescent peer marijuana use predicts marijuana use in emerging adulthood. One study found that individuals who had peers with marijuana use between late adolescence and emerging adulthood were over 1.6 times more likely to initiate marijuana use by 26 y/o after controlling for other potential risk factors like parenting and personality [173]. Other research failed to find the association between adolescent peer marijuana use and later emerging adult marijuana use, but did find an association between adolescent peer marijuana use and other illicit drug use during emerging adulthood [174]. Two longitudinal studies assessed the association between peer alcohol use and emerging adult alcohol use among college students. A two-wave longitudinal study assessing precollege characteristics and college drinking found that precollege peer pro-

drinking norms were associated with binge drinking by the end of the first college semester [175]. Further, emerging adults whose close friends are binge drinking are more likely to report an increase in drinking within the year after graduation from high school, regardless of college attendance [176]. The level of pro-alcohol peer influence was higher among emerging adults who moved away from home to attend college than among either college students who lived with their parents or did not attend college [176].

However, how the increased independence in emerging adults due to driving licensure (having licensure vs. no licensure), delay in driving licensure (no delay in driving licensure vs. delay in driving licensure), and driving exposure (driving frequency and miles driven) may associate with peer alcohol and drug use is still limited.

2.4 Licensure and driving in emerging adulthood as a transitional life stage associated with health, education, and employment in early adulthood

Many emerging adults view driving as a transition between adolescence and adulthood, and it has become a fundamental part of the process of maturing and socializing. Particularly in the United States, where access to public transportation is often limited, getting a diver's license is a vital step to achieve independence [4]. The age at which emerging adults acquire a driver's license can vary. Many obtain it when they reach the legal driving age in their state, while others choose to delay driver licensure (DDL). A nationwide US cohort study has shown that DDL is common among emerging adult drivers, with nearly 70% of eligible adolescents waiting at least one year after reaching legal age before getting their license [5]. While the degree of driving exposure and experience after licensure may differ, it is essential for young drivers to have a certain level of exposure and practice in order to become safe drivers [6].

The debate around the advantages and disadvantages of emerging adults having a driver's license remains ongoing. Families may benefit from emerging adult drivers who are able to travel to school and complete errands independently. From a developmental standpoint, driving licensure may have positive efforts on non-injury-related health, education, and employment

outcomes for emerging adults, potentially allowing them to thrive in early adulthood. Previous research has indicated that driving helps to foster greater adolescent autonomy and mobility, thereby providing access to essential health, education, and employment opportunities [16-20]. Additionally, another cross-sectional study reported that emerging adult drivers had higher average weekly earnings and higher academic performance than non-drivers [23]. On the other hand, having a driver's license may also lead to increased risk of substance use and motor vehicle accidents [25]. Therefore, the potential benefits of early licensure (within legal eligibility) must be carefully weighed against the greater driving exposure to risky behaviors (e.g., drug and alcohol use [24]) and motor vehicle crash risk [25] that emerging adults experience. To date, there has been no thorough examination of the prospective associations between driving licensure (having licensure vs. no licensure), delayed driving licensure (no delay vs. delay), and driving exposure (driving frequency and miles driven) with early adult health, education, and employment.

2.4.1 Health

Healthy emerging adults are important for the nation's workforce, global competitiveness, public safety, and national security because they are starting off to adult roles like being parents and to the healthy development and well-being of the next generation. Recent studies suggest that emerging adult aged 18-25 are facing concerning health issues, particularly in relation to approaches to health care and risky behaviors [177]. Emerging adults are more likely to engage in risky behaviors such as smoking, drinking, and substance use than their adolescent counterparts [178]. In addition, emerging adults are less likely to have insurance or seek health care than any other age group [179]. As a result of these factors, emerging adults have an increased risk of ling-term health issues such as diabetes, heart disease, and mental health problems [180]. Collectively, these findings suggest that emerging adults are surprisingly unhealthy. There is an emerging recognition in the emerging adult health community that emerging adults from all backgrounds are less healthy than adolescents [181, 182]. Emerging adults also show a worse health profile than those in their late 20s and 30s [181, 182]. For

example, compared with adolescents and adults aged 26-34, emerging adults aged 18-25 are more likely to be injured or die in motor vehicle crashes and to have related hospitalizations and emergency room visits [181, 182]. As adolescents become emerging adults, they are less likely to eat breakfast, exercise, and get regular physical and dental checkups and more likely to eat fast food, sexually transmitted infections, smoke cigarettes, use marijuana and drugs, and binge drink [183]. Further, behavioral health among emerging adults is of particular concern. Emerging adulthood is the typical age of onset of the most serious psychotic disorders [184]. Compared with adults aged 25-34, emerging adults aged 18-25 are more likely to report serious psychological distress, and they are more likely to attempt suicide [185].

Socially, emerging adults tend to live more outside than adolescents, and they are less governed by their family's lifestyle and are less constrained by health habits under the parental monitoring [186]. At the same time, compared with older adults, they are less likely to participate in work and family roles that serve as solid social controls on preventing risk-taking behaviors. They often have less access to quality health care than younger adolescents or older adults. Consequently, some of the health advantages of emerging adulthood compared to adolescence or older adulthood may be undermined [183, 187]. Along with these health risk behaviors, emerging adults also engage in health-promoting behaviors. For example, emerging adults are more likely than any other group of adults to meet the recommended guidelines for physical activity (30 percent, compared with 24 percent of those aged 25-44 and 18 percent of those aged 45-54) [188].

Besides behavioral risk factors, previous research has shown that one of the most distinct factors that affect health care utilization is low population density, isolation, and large distances between residences and the medical services [16]. The ability to transverse these distances becomes important in access to the health care [16]. Without transportation, even a short distance to medical services may become a severe problem [16]. The opportunity for health care consumers to have a vehicle to transport them to a practitioner or facility is

especially important in areas where distances are relatively large, roads may be of poor quality, and public transportation is seldom available [189, 190]. Distance and transportation are often mentioned as problems in the discussion of the utilization of medical services [191-194]. Previous research found that providing medical transportation to those who lack access to transportation may have benefits, including decreases in health care costs and improved quality of life [195]. Transportation is one of the major concerns reported by residents far from medical services in discussing limitations to their access to health care or their participation in health programs [196, 197]. While the contribution of distance to medical services has been discussed, transportation should be discussed with acquiring a driver's license in terms of their early adult health.

Previous studies suggest that the increase in independence and opportunities provided by personal transportation may enhance short- and long-term well-being/health [16, 17]. More specifically, obtaining an independent driver's license might increase emerging adults' access to health care. For example, independent transportation could help those who live in geographic regions farther away from health care resources overcome large distances between residences and services and more freely travel to health care professionals and care centers when needed [16]. Further, if emerging adults delay their licensure and then later pursue licensure after the earliest time within state-specific legal eligibility, it is reasonable to speculate that emerging adults drivers are at high risk of vehicle crashes due to such little-to-no prior driving exposure, experience, and instruction, which in turn compromise health care opportunities [198, 199]. While the previous studies found that obtaining a driver's license was associated with increases in the frequency of accessing healthcare services [21, 22], whether obtaining a driver's license, delay in driving licensure, and how the extent of exposure to driving after licensure associated with emerging adult health are limited in the current knowledge base. Therefore, there is a need to further understand the measurable effects that driving licensure (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure), and the extent of

exposure to driving after licensure (driving frequency and miles driven) might have on emerging adult health.

2.4.2 Education

Emerging adulthood allows for longer and more widespread participation in the postsecondary education [36]. Emerging adulthood has an extended period that can be used for post-high school education that prepares emerging adults to contribute to the information and technology-based global economy [36]. Additionally, emerging adults have greater educational opportunities than those who are working class, and educational attainment makes an enormous difference in what takes place in emerging adulthood and future income and occupational opportunities [200].

The percentage of today's American emerging adults in postsecondary education is higher than at any time in American history [201]. In 1900, only 4% of 18- to 21-year-olds attended college, and by 1940 that proportion had risen only to 16% [202]. Of the 3.1 million high school graduates who graduated in the first 9 months of 2020, 2.0 million (63%) were enrolled in college in October 2020 [203]. Specifically, about 43% of high school graduates immediately enrolled in 4-year institutions, and 20% immediately enrolled in 2-year institutions [203]. Between 2009 Fall and 2020 Fall, total undergraduate enrollment decreased by 9% from 17.5 million to 15.9 million [203]. On the other hand, the number of associate's degrees conferred increased by 20% from 848,900 to 1.0 million in 2019-2020 than in 2019-2020 [203]. Further, the number of bachelor's degrees conferred increased by 24% from 1.6 million to 2.0 million in 2019-2020 than in 2019-2020 [203].

Emerging adults' academic achievement is closely associated with their families' socioeconomic characteristics. For example, studies have found that living in poverty, living in a household without a parent who has completed high school, and living in a single-parent household are associated with poor educational outcomes including low achievement scores, having to retake a class, and dropping out [204, 205]. Further, lacking a vehicle is associated

with exclusion from access to and achievement in school-level education [206-208]. Previous studies have shown the association between geography and education attainment [206-208]. Specifically, students who live in rural areas are more likely to reduce participation in extra-curricular activities [206-208]. An inquiry into having a reliable vehicle for students in further education found the consideration of transport throughout the student lifecycle to be an essential component of widening access to education opportunities amongst potential further education students [209]. Therefore, lacking a reliable vehicle to commute between home and school may be a barrier to participation in further education. However, there is no published study investigating the role of driving licensure in access to, or exclusion from, emerging adult education. Further, mobility enabled by driving licensure can improve educational opportunities like participation in extra-curricular activities [199]. Therefore, it may be a time of growth to access to educational opportunities but also of environmental vulnerability (home environment vs. an extended environment away from the home environment or provided by a private vehicle) [210-213]. Driving licensure allows emerging adults to change the environment by moving out of the home and facilitates greater emerging adult independence to access education opportunities [17]. However, the current knowledge base still lacks how driving licensure (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure), and driving exposure (driving frequency and miles driven) after licensure may associate with emerging adult education attainment.

2.4.3 Employment

The transition from school to work is one of many changes for emerging adults that take place during emerging adulthood [202]. Emerging adults experience a period of freedom to explore different jobs during and after post-secondary education. Several adolescents have their first work experience by the time they leave high school and work in part-time jobs in the tertiary education [202]. During this period, their purpose is often limited to earning money rather than laying a foundation for the future [202]. Their transition into a stable job is prolonged, and this

creates opportunities to restart when initial attempts to enter the labor market are unsatisfying [214]. Most emerging adults eventually find a satisfying job, although the chances of finding a job are higher in late emerging adulthood [202]. Further, the most central feature of emerging adults in transition to work is that it is a phase of the identity explorations [202]. Arnett stated that emerging adults learn to know themselves by exploring different possibilities in the work [202]. The process of identity formation already starts in adolescence but becomes more intense in emerging adulthood. Arnett also stated that for some students finding the perfect job that fits their personality is a real identity exploration [202]. By trying out different jobs, they discover their possibilities, and their career choices are guided by a search for the right match with their identity [202].

In 2021, about 88.06% of the 20- to 24-year-old adults in the labor force did find employment, and this rate is even higher for the 25- to 29-year-old adults in the labor force in the Organization for Economic Co-operation and Development (OECD) countries (91.64%) [215]. What happens during adolescence has profound and long-lasting implications for future employment and potential career paths. For example, previous research explored the impact of parenting style on the career choice of adolescents and found that parents play a key role in the career development of adolescents [216]. Specifically, attachment to the mother had a significant direct effect on career self-efficacy, an individual's beliefs that she or he has the ability to complete successfully the tasks related to decision making in relation to her or his career, and career self-efficacy again influences career aspiration [217]. Regarding the father's influence on adolescent career choice, spending time with adolescents provides the fathers with opportunities to show their affection towards their adolescent career choice [218]. Skills, competencies, and abilities are the most important factors, and the fathers are the most significant person influencing the career choice of their adolescents [219]. The occupational choice made by emerging adults also has its roots in earlier interactions and experiences during emerging adulthood [220, 221]. For example, adolescents begin to learn about possible future

jobs through seeing adults in their communities and parents' social networks [222]. During emerging adulthood, individuals often engage in and value the same activities as their friends to fulfill a need in the relatedness [223]. Such activity participation may lead them toward particular career paths. However, such influences imposed by parents and friends on career paths may be changed when emerging adults extend the environment by moving out of the home. Besides parents and peers, teachers may also exert an influence on emerging adult career choice. Teachers who pay early attention to students' skills and aptitudes, especially when teaching minority and under-representative students, are important to encourage them to pursue a career in the field of Science, Technology, Engineering, and Mathematics (STEM) [224]. For the majority of emerging adults, they may give priority to the career that their parents prefer, some may follow the career that their educational backgrounds fit, some may choose the career following their passion without considering the outcome, and some may prefer the career that may bring high-income [225]. The most important factor for students to enter the industry is salary, followed by lifestyle [226].

Reliable personal transportation provides people valuable independence and opportunity for the broader opportunity for employment. A private vehicle would enable people to conduct a geographically broader job search, accept employment offers far away from home, improve work attendance, and minimize the burden of commuting. Vehicle ownership may promote work performance if employment opportunities and job searches are enhanced with consistent access to reliable personal transportation. For example, vehicle ownership could expand job searches geographically, facilitate employment far from home (or in an area where public transportation is inaccessible), and facilitate employment requiring unusual or non-standard work hours that do not coincide with public transportation schedules which may be common for entry-level jobs, reduce employee absenteeism, and reduce commute times relative to that offered by public transportation [227-229]. In areas where public transportation is limited, having reliable personal transportation helps find a job. Many suburbs lack accessible public

transportation, which makes it difficult for those with lower incomes – or without cars – to be able to get around, inhibiting their access to jobs. Accessing these workplaces where public transportation is limited is time-consuming and makes it impossible for low-income residents of urban neighborhoods. Thus, reliable personal transportation is an important factor in improving employment status, especially for those who live in an urban neighborhood with low socioeconomic status. The current knowledge base is lacking on how emerging adult independence is facilitated by licensure (having licensure vs. no licensure), DDL (no delay in driving licensure vs. delay in driving licensure), and driving exposure after licensure (driving frequency and miles driven) that allows them to access employment opportunities far away from the home environment, which in turn may impact what extent they are employed like a number of hours per week/employed vs. not employed.

2.5 Summary of the literature

Licensure and driving may benefit emerging adults in health, education, and employment with greater independence and mobility. At the same time, driving licensure and driving would expose them to nontraffic risks from increased access to alcohol and drug use, along with negative peer alcohol and drug use and lacking high levels of positive parental monitoring. More research is needed to assess how driving licensure and driving are associated with behaviors and outcomes of adolescents transitioning to emerging adults.

To date, research on emerging adult driving has primarily focused on the crash injury [230]. While considerable attention has been given to the risks associated with highway crashes due to youthful inexperience and risk-taking (i.e., driving while impaired) [4], little attention has been shown to the effect of driving licensure (having licensure vs. no licensure), delay in driving licensure (no delay in driving licensure vs. delay in driving licensure), and driving exposure after licensure (driving frequency and miles driven) on the nontraffic risks (alcohol and drug use), protective (positive parental monitoring) and risk (negative peer alcohol and drug use) factors of alcohol and drug use, and emerging adult overall non-crash related health, education, and

employment. Therefore, the purposes of my dissertation study are to examine the associations of driving licensure, delay in driving licensure, and exposure to driving after licensure on alcohol drinking, binge drinking, drug use, parental monitoring knowledge and peer alcohol and drug use, and emerging adult health, education, and employment.

2.6 Hypothesized model

Previous research indicates that two environments affect emerging adults' behavior and development: the home environment and the extended environment [4]. Before being licensed and having access to a vehicle, the home environment influences are dominant in emerging adults' behavior and development. However, once emerging adults have a driver's license and have access to a vehicle, they can travel outside the home environment. Emerging adult drivers have access to locations where many local controls on risky behavior may be absent.

2.6.1. Home Environment

According to Bingham and Shope's figure entitled "Factors that Affect Emerging Adult Driving Behavior" [231], six domains—emerging adults, parents, peers, substance use, sociodemographic characteristics, and driving licensure and driving—have been identified under the home environment. The first domain, "Emerging Adults", looks at the maturity level of the driver and how they handle the responsibility of driving. This includes the driver's self-regulation and decision-making skills, as well as their attitude towards taking risks and obeying the law. The second domain, "Parents", looks at the role of the parents and the effect they have on the emerging adult drivers. This includes the extent to which they are involved in monitoring emerging adults' driving, setting rules, and enforcing consequences. The third domain, "Peers", looks at the effect of emerging adults' friends and peers on the driver's behavior. This includes the peer pressure to take risks, drive dangerously, and ignore traffic laws. The fourth domain, "Substance Use", looks at the use of alcohol and other substances by emerging adult drivers and the impact this has on their behavior. The fifth domain, "Sociodemographic Characteristics", looks at the cultural, economic, and racial background of emerging adult drivers and how this

affects their driving behavior. And finally, the sixth domain, "Emerging Adult Licensure and Driving", looks at how emerging adults' access to a driver's license and the opportunity to drive can affect their driving behavior. Overall, the figure provided by Bingham and Shope highlights the various factors that can influence the home environment of emerging adult drivers [231]. Each domain identified in the figure can have an effect on the driver's behavior and should be taken into consideration when attempting to understand the causes of driving accidents.

2.6.1.1 Emerging adults

Emerging adulthood (roughly ages 18-25) is a critical transitional period when youth finish primary and secondary education and start to find a full-time job, get married, and be a parent [35, 36]. In contrast with young adults in their thirties, most emerging adults have not yet made long-term commitments in relationships and work [35, 36]. During emerging adulthood, most emerging adults start to learn to drive and get driver's licenses. Many emerging adults view driving as a milestone in transitioning from adolescence to adulthood. Indeed, driving has become a fundamental part of maturation and socialization process [4], and is viewed as a crucial rite of passage, especially in the United States where the lack of public transportation in certain areas can necessitate the ability to drive for independence [4]. Emerging adults who lack access to a car may find themselves missing out on social and work opportunities, as well as potentially being exposed to increased risks due to relaying on inexperienced drivers for transportation. By allowing emerging adults to drive, they can gain greater independence, as well as the ability to better decide where to go, with whom, and for how long.

2.6.1.2 Parents

Most emerging adults who start to learn to drive are supervised by their parents in a car. Parents' driving styles strongly influence the driving styles of emerging adult drivers who have been shown to be similar to their parents' driving styles [45, 232, 233]. Parents can play an important role in their emerging adults' driving education and training [234], but parents are often unaware of the risks of emerging adult driving [235]. Parents' expectations of their

emerging adult drivers are important and can affect their driving. Emerging adult drivers are less likely to drive while impaired by alcohol [236], crashes, and offenses with parents who involve, monitor, and support their emerging adults' life with high expectations and optimistic attitudes [46, 237-239]. Parents in states where the Graduated Driving Licensing program has been established are more likely to enforce more appropriate emerging adult driving limits [240, 241]. Emerging adult drivers are less likely to report risky driving, offenses, and crashes with parents who set limits on their emerging adults' early driving when they get their driver's licenses at state-legal driving age [242]. More importantly, emerging adults' parents influence their alcohol and drug use in emerging adulthood [243]. Parents who live with their emerging adults are in the best position to monitor their activities and limit their alcohol and drug use [243, 244].

2.6.1.3 Peers

Beyond parents, peers can significantly influence emerging adults' driving [245]. Emerging adults who are susceptible to peer influence are more likely to report offenses and crashes [246]. Additionally, emerging adults who have friends involved with early alcohol use are more likely to report offenses and crashes [238, 247]. Emerging adult drivers exposed to their peers' risky driving practices are more likely to accept and engage in risky driving behaviors like driving while impaired by alcohol and drug [248]. Peer influence could be protective because the large peer groups formed around the community such as schools are likely to reflect community norms [249]. When a vehicle is available, however, small affinity groups of emerging adults can reach further locations where high-risk activities (i.e., substance use) are more possible and where parental monitoring is lacking [250]. In such extended environments, substance use is relatively unrestrained. Peers with deviant behaviors may influence individuals to join in group risk-taking activities (i.e., substance use) that they have not previously engaged in because of the limited opportunities in the home community due to limited mobility [251]. As Figure 2 suggests, health risks for emerging adults involving substance use can be influenced by parents and peers. Peer influence on substance use has been viewed

as a risk factor [252]. Interacting with affinity peers in smaller groups is more likely to have deviant attitudes, exert a negative influence and engage in risky behaviors compared to large groups at the community level [249].

2.6.1.4 Substance use

Emerging adults who have early access to and use alcohol, tobacco, or marijuana are more likely to report risky driving and more drinking and driving frequency [237-239, 247, 253, 254]. Parents and the home environment are very important in emerging adult substance use because of patterns of socialization around substance use. Emerging adults socialized by parents who drink and use drugs are more likely to initiate substance use at younger ages [135-137]. Research linking parental monitoring knowledge and drug use in adolescents also exists in emerging adulthood. A lower level of parental monitoring contributes to substance use disorders in adolescence [138]. The environment may be of great importance in understanding substance use patterns when emerging adults move away from home. Emerging adults who move out from home and move into the dormitory or apartment where parental monitoring is absent may have an increased opportunity to access substances.

Shope and Bingham's model suggests that alcohol and drug use can influence driving licensure and driving in the home environment by creating a context of risk [4]. Specifically, alcohol and drug use can influence emerging adults' attitudes towards risky behavior, which can lead to greater risk-taking when driving. Additionally, parents may be less likely to allow emerging adults to drive if they are under the influence of alcohol or drugs, limiting their access to driving privileges. Finally, alcohol and drug use can also increase the likelihood of engaging in dangerous driving behaviors, such as speeding, which can increase the risk of an accident.

2.6.1.5 Sociodemographic characteristics

Risky driving varies among different groups of emerging adults. Even though novice drivers have more crashes early on at any age, age at licensure is a contributor to crash risk [255-257]. Emerging adult drivers who get driver's licenses early have more crashes [255-257].

Male emerging adult drivers are more likely to be involved in fatal crashes [258], to engage in risky driving [259, 260], and to report driving while impaired by alcohol [236] compared to female emerging adult drivers. Emerging adult drivers who report that they live with both biological parents have less risky driving compared to those who live with only a single parent because two parents may have a greater ability to monitor and be involved in their emerging adults' behaviors than one parent [238, 239, 247].

Previous research also has shown that social media may allow youth to connect to friends digitally and decrease the need for in-person connection, thus leading to a reduction of the need for a driver's license to travel for connection [7]. Researchers have investigated the built environment (e.g., living in a highly walkable environment) [8], graduated driver licensing restrictions (e.g., mandated supervised practice driving hours with adult supervision) [9], and economic limitations (e.g., not being able to afford the cost and maintenance of a vehicle) [10, 11] as possible explanations for the increased numbers of youth that delay in driving licensure. Specifically, they found that living in a highly walkable environment [8], more strictly mandated supervised practice driving hours with adult supervision [9], and not being able to afford the cost and maintenance of a vehicle [10, 11] associated with the increased numbers of youth that delay in driving licensure.

Other potential reasons for emerging adults to delay in driving licensure include sociodemographic characteristics such as race (e.g., African Americans vs. Whites) [10], living with parent(s) [12], family affluence (e.g., low vs. high) [13-15], parental approval of licensure (e.g., parent's approval until emerging adults are "ready") [42], parent unavailability [15], and availability to get around without a car [15]. Specifically, African Americans vs. Whites [10], living with a single parent vs both biological parents [12], low vs. high family affluence [13-15], longer waiting time for parent's approval until emerging adults are "read" [42], parent unavailability [15], and availability to get around without a car [15] associated with the increased numbers of youth that delay in driving licensure.

2.6.1.6 Driving licensure and driving exposure

Driving licensure and driving exposure are bridging the extended environment where alcohol and drug use exists. Obtaining a driver's license was associated with increased alcohol, cigarette, and marijuana use over the longer-term [30]. The immediate effect of licensing on novice drivers was associated with more negative attitudes toward drinking and driving and reduced alcohol consumption [30]. Newly licensed drivers increased their awareness of the danger of driving after drinking [30]. However, driving while impaired by alcohol increased among emerging adults with more extensive driving exposure (more driving frequencies and miles driven) [30].

2.6.2 Extended environment

Before being licensed and having access to a vehicle, all these home environment influences are dominant throughout adolescence [261]. However, once emerging adults can travel more frequently between the neighborhood and reach outside the home environment on their own, they are more likely to have access to locations where home environmental controls like parental monitoring on alcohol and drug use may be absent. Access to a vehicle may also be considered an extended environment where emerging adults can participate in risky behaviors like alcohol and drug use away from adult supervision [261]. This is suggested in Figure 2.1, where, in the Extended Environment, the protective influence of parental monitoring knowledge is far away, even absent, and the influence of peer alcohol and drug use is increased.

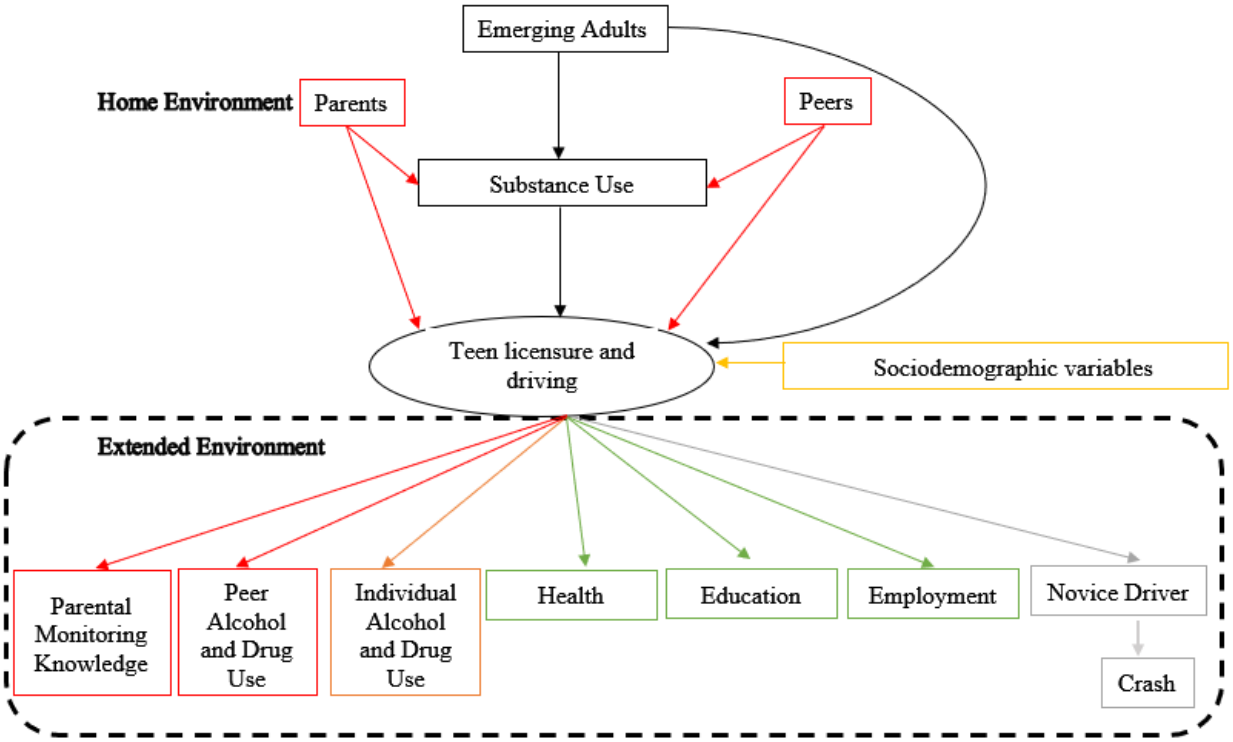

Figure 2.1 Hypothesized Model for Emerging Adult Alcohol and Drug Use and Health, Education, and Employment via Driving Licensure and Driving Derived from Bingham and Shope's (2008)

Yellow color indicates the research question – Are emerging adult sociodemographic variables associated with driving licensure and driving exposure in emerging adulthood?
Orange color indicates the research question – Are driving licensure status, delay in driving licensure, and driving exposure trajectory classes associated with the trajectory classes of individual alcohol and drug use?
Red color indicates the research question – Are driving licensure status, delay in driving licensure, and driving exposure trajectory classes associated with peer alcohol and drug use and parental monitoring knowledge?
Green color indicates the research question – Are driving licensure status, delay in driving licensure, and driving exposure trajectory classes associated with their health, education, and employment four years after high school?

The additional risk may be present in the extended environment where access to alcohol and drug outlets is increased. Driving licensure and driving exposure lead to the "non-crash risks" element, which includes the increased exposure to alcohol and drug outlets due to the opportunity to use alcohol and drug within the vehicle and the travel into high-risk environments. For alcohol and drug use, a vehicle can be a high-risk environment without leaving the home community due to the private micro-environment provided by the vehicle away from adult

supervision. The vehicle also offers an isolated environment where a small group of peers can use alcohol and drug, which heightens peer influence on alcohol and drug use.

Besides the "non-crash risks" element, driving licensure and driving exposure also lead to the risk of novice driving element, which includes crash injuries related to the limited skills of inexperienced drivers. However, the current literature base has primarily investigated transportation risks, including crash-related injury, disability, death, harm to others, and impaired driving [26-29, 262].

Driving licensure and driving exposure may have potential benefits for emerging adult outcomes that allow them to flourish in early adulthood. Driving facilitates greater adolescent independence and allows them to access important health, education, and employment opportunities [16-20]. For example, evidence suggests that youth with consistent vehicle access are more likely to access healthcare services compared to those with barriers to access to transportation [21, 22]. One cross-sectional study found that emerging adult drivers had higher average weekly salaries and performed better academically than non-driving peers [23]. However, prospective associations of driving licensure and exposure to driving with early adult self-report overall physical health, education, and employment have not been fully assessed.

2.7 Introduction to the dataset

All data used was derived from the NEXT Generation Health Study (NEXT), a longitudinal study that followed a nationally representative cohort of U.S. 10th grade students with an average age (16.3 y/o) transitioning into emerging adulthood. Specifically, this dataset consists of quantitative survey data collected by the NEXT Generation Health Study. The NEXT quantitative dataset has a large sample (N = 2,783), which includes 7 annual waves (W1-7) of survey assessment beginning at W1 in 10th grade (2009-2010) and ending four years after graduation from high school.

2.7.1 Major variables/scales used in my dissertation study

Transportation-related variables

- *Driving licensure status (having licensure vs. no licensure, W1-7).* Driving licensure status was generated from emerging adults reporting if they have licensure allowing independent, unsupervised driving.
- *Delay in driving licensure (no delay in driving licensure vs. delay in driving licensure, W1-7).* Time to licensure varies among those who obtained a driver's license as a youth. Many emerging adults get their driver's licenses when they reach state-legal driving age. However, some choose to delay driving licensure (DDL). Delay driving licensure (DDL) was derived using participants' age at the time of the survey, information on their legal requirements, and their self-reported driving licensure. Participants' date of birth was assessed at baseline, and their age at each wave was calculated. State requirements for initial legal eligibility for getting an independent driver's license was obtained for the NEXT survey years through the Department of Motor Vehicles websites for corresponding states. Driving licensure was ascertained by asking, "Do you have a driver's license?", with four possible responses: (1) no license of any sort, (2) permit to take the classroom component of driver education only, (3) permit allowing supervised practice driving with an instructor or licensed adult, and (4) license allowing independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.) from all seven waves. Therefore, participants who did not report licensure at any wave was set to missing in the analyses. Delay in driving licensure was defined as a dichotomous variable (no delay in driving licensure vs. delay in driving licensure), with participants in the delayed group had not obtained their independent license (i.e., response 4) at the first wave in which they are eligible. Specifically, delay in driving licensure was defined as participants receiving driver licensure ≥1 year after initial legal eligibility time until W7 (No-DDL vs. DDL [delaying ≥1 year]).
- *Exposure to driving after licensure.* Exposure to driving after licensure included two variables, including driving frequency and miles driven. Driving frequency is measured

with one question, “On how many of the last 30 days did you drive a vehicle?” with possible responses of the number of days from 0 to 30. Miles driven were measured with one question, “On average, about how many miles did you drive each day you drove?” with possible responses of the number of miles in whole numbers.

Substance use

- *Alcohol drinking.* Alcohol drinking was measured based on replies to 1 question derived from the Health Behavior in School-Aged Children questionnaire [263]: “On how many occasions (if any) have you drunk alcohol in the last 30 days?” Response options ranged from 1 (never) to 7 (40 times or more).
- *Binge drinking.* Binge drinking was measured using 1 question from the Monitoring the Future national survey [264]: “Over the last 30 days, how many times (if any) have you had four (for females)/five (for males) or more drinks in a row on an occasion?” Response options ranged from 1 (none) to 6 (10 or more times).
- *Drug use.* Drug use was measured by asking participants 10 questions derived from the Monitoring the Future survey on how often they had ever used drugs (i.e., marijuana, ecstasy, medication to get high) in the last 12 months, with 7 options (from 1 = never to 7 = 40 times or more). I generated a dichotomous variable (1 = used any of those drugs at least once vs. 0 = none) [265].

Protective and risk factors of alcohol and drug use

- *Parental monitoring knowledge*. Adolescents reported perceptions of their mother's and father's monitoring knowledge (separate items) from a 5-item scale [266], including who their friends were, how they spent their money, what they did with their free time, where they were after school, and where they went at night, with four response options (1 = don't have/see a father or mother/guardian, 2 = he/she doesn't know anything, 3 = he/she knows a little, and 4 = he/she knows a lot). Scores ranged from one to four

possible points. Because monitoring knowledge in W1-W3 was highly correlated, I calculated a numerical average (mean) of a father's and mother's monitoring knowledge separately across Wave 1 (2nd-year high school) to Wave 3 (last year in high school).

- *Peer alcohol and drug use.* The extent to which peers of the participants drank alcohol, got drunk, smoked/used marijuana, and took other drugs using separate questions derived from the National Longitudinal Study of Adolescent Health [267] in all waves (W1-7) by asking participants how often they thought their five closet friends drank alcohol, got drunk, smoked cigarettes, smoked/used marijuana, and took other drugs with five response options: 1 = never to 5 = almost always.

Health, education, and employment (four years after high school)

- *Health.* Self-reported overall physical health in emerging adulthood was measured with a single question derived from the National Youth Risk Behavior Surveillance consisting of all regular public and private schools with students in at least one of grades 9-12 in the 50 states and the District of Columbia, "Would you say your health is…?" with possible responses being, Excellent, Good, Fair, and Poor [268]. This question was derived from the National Youth Risk Behavior Surveillance [268].
- *Education*. Education attainment was measured with one question, "What is the highest grade of regular school have you completed (or anticipate completing by the end of the current academic term)?" with seven possible responses: <high school diploma; high school diploma; GED; some college or technical school; Associate degree; Bachelor's degree; and Graduate degree.
- *Employment.* Employment was measured with one question, "On average, what are the total hours per week you spent working in paid and/or unpaid jobs?" with possible responses: None; ≤5; 6-10; 11-15; 16-20; 21-25; 26-30; >30 hours/week.

Sociodemographic variables (in high school)

- *Sex*. The biological sex of participants was female or male.
- *Race/ethnicity*. The participants' race/ethnicity was Hispanic, African Americans, Whites, or Others, including Asian, American Indian or Alaska Native, and Native Hawaiian or Other Pacific Islanders.
- *Parental education level*. We defined the highest educational attainment of participants' parents as 1) Less than a high school diploma, a high school diploma or General Educational Diploma; 2) Some college, technical school, or associate degree; or 3) Bachelor's or graduate degree.
- *Family structure.* Information about participants' family structure was collected during the recruitment home visit by asking participants about the home where they lived all or most of the time. They were given the opportunity to respond about a second home, including how much time they lived there. The family structure was categorized as: both biological parents; one biological parent, one step-parent; single parent, mother only; single parent, father only; and other. This information was then collapsed into four groups for analysis: both biological parents, biological and step-parent, single parent, and other.
- *Family affluence.* We assessed family socioeconomic status using the Family Affluence Scale [269]. First, we asked participants how many cars they owned, the number of computers they owned, whether participants had their bedrooms, and the number of family vacations in the last 12 months. We then categorized participants' family socioeconomic status as low, moderate, or high affluence [270].
- *Urbanicity.* Urbanicity (suburban, rural, vs. urban) derived from participants' school location based on the seven National Center for Education Statistics categories, including large central city, mid-size city, the urban fringe of a large city, the urban fringe of the mid-size city, large town, small town, and rural [271].

2.8 Statistical approach

Latent Class Growth Modeling (LCGM) is a statistical technique used in the structural equation modeling (SEM) framework to estimate growth trajectories [272]. It is a longitudinal analysis technique to estimate growth over a period of time [272]. Latent Class Growth Modeling (LCGM) was useful to identify a set of discrete, mutually exclusive latent classes of participants based on their responses to driving exposure (driving frequency and miles driven), substance use (alcohol drinking, binge drinking, and drug use), and peer alcohol and drug use questionnaires (e.g., peer alcohol and drug use was measure by asking participants how often they thought their five closet friends drank alcohol, got drunk, smoked cigarettes, smoked/used marijuana, and took other drugs with five response options: 1 = never to 5 = almost always) [272]. The goodness-of-fit of LCGM is a measure of how well the model fits the data it is intended to explain [273]. It is an assessment of how well the estimated LCGM parameters capture the patterns of growth over time that are observed in the data. The most common measure for assessing the goodness-of-fit of the LCGM is the Bayesian Information Criterion (BIC), which compares the quality of fit of two or more models by penalizing overly complex models [274]. The lower the BIC score, the better the fit of the model [273, 274]. The fit of each nested model was compared using the estimate of the log Bayes factor [$2\log_e$ (B10) ≈ 2 (BIC)] [274]. Log Bayes Factor values greater than 10 were strong evidence of a model fit [274]. The estimate was approximately two times the difference in the BIC values for the two models being compared. To ensure parsimony, non-significant cubic and quadratic terms were removed from trajectories in a testing model, but linear parameters were retained irrespective of significance. Once non-significant terms were removed, each model was retested, yielding a new BIC value. The addition of trajectories continues until there was no significant improvement in model fit compared to the previously tested model. The average posterior probability of 0.70 or higher for the within-group membership was used to determine the internal reliability [274]. The model-fit criteria and average posterior probabilities was used to identify the number of driving exposure

(driving frequency and miles driven), substance use (alcohol drinking, binge drinking, and drug use), and peer alcohol and drug use trajectory classes. SAS® PROC Traj in SAS software version 9.4 (SAS Institute, Cary, NC) was used for capturing the patterns of change over time in multiple subgroups within the population [275]. Trajectory classes (e.g., driving frequency trajectory classes) were identified with the SAS® PROC Traj procedure using the censored normal mixture method as driving frequency was measured on a scale [274].

Missing data was deleted listwise. Descriptive statistics [e.g., mean, standard deviation (SD), and frequencies] were summarized to describe independent variables stratified by dependent variables. Those independent variables that were significantly different ($p < .05$) by dependent variables were compared using appropriate post-hoc tests (e.g., pairwise two-sample t-tests for a father's or/and mother's monitoring knowledge which was significantly different across driving exposure trajectories), and *p*-values was adjusted using Bonferroni's method to account for multiple comparisons and to control the Type I error rate [276]. Those independent variables that were significantly ($p < .05$) associated with dependent variables were included in multinomial regression. The significance level was set at $p = .05$ for the analyses and for guarding against Type II error. It is important to guard against Type II error because Type II error occurs when a false null hypothesis is accepted (e.g., the statistical result shows that there is no significant association of driving licensure, delay in driving licensure, and driving exposure with alcohol and drug use when this association actually exists) [277]. Type I and Type II error are related in the context of hypothesis testing. A Type I error occurs when a researcher erroneously rejects a true null hypothesis (e.g., the statistical result shows that there is significant association of driving licensure, delay in driving licensure, and driving exposure with alcohol and drug use when this association does not exist), while a Type II error occurs when a researcher erroneously fails to reject a false null hypothesis (e.g., the statistical result shows that there is no significant association of driving licensure, delay in driving licensure, and

driving exposure with alcohol and drug use when this association actually exists) [277]. In other words, a Type I error is a false positive, while a Type II error is a false negative. It is important to understand the relationship between the two types of errors to ensure that researchers are able to accurately interpret their results.

In Aim 1, multinomial logistic regression was used to examine the associations of driving licensure status (having licenses in high school vs. no licensure in emerging adulthood) and driving exposure (driving frequency and miles driven) trajectory classes among emerging adult drivers with their sociodemographic variables, taking complex survey sampling features into account. In Aim 2, multinomial logistic regression was used to examine the associations of driving licensure status, delay in driving licensure (no delay in driving licensure vs. delay in driving licensure), and driving exposure trajectory classes among emerging adult drivers with alcohol drinking, binge drinking, and drug use trajectory classes. In Aim 3, multinomial logistic regression was used to examine the associations of driving licensure status, delay in driving licensure, and driving exposure trajectory classes with peer alcohol and drug use trajectory classes. Additionally, linear regression was used to examine the associations of driving licensure status, delay in driving licensure, and driving exposure trajectory classes with a numerical average (mean) of a father's and mother's monitoring knowledge separately across Wave 1 (2nd-year high school) to Wave 3 (last year in high school), respectively, taking complex survey features into account. In Aim 4, multinomial logistic regression was used to examine the associations of driving licensure status, delay in driving licensure, and driving exposure trajectory classes with health, education, and employment four years after high school respectively, taking complex survey features into account. The study conceptual model has been presented in Figure 2.2.

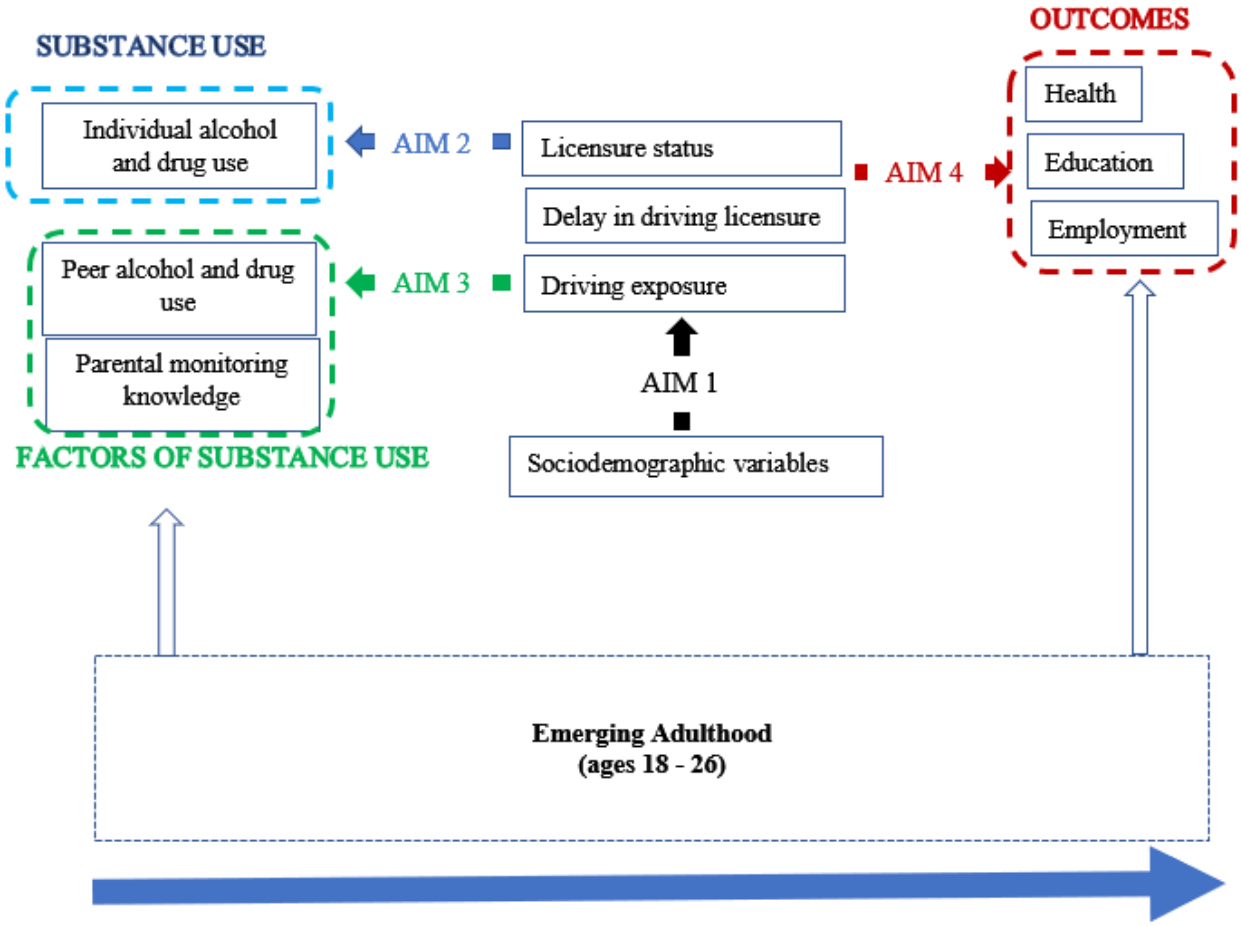

Figure 2.2 Study Conceptual Model The data was used from the NEXT Generation Health Study from high school through 4-years after leaving high school.

Aim 1: Examined driving licensure status, delay in driving licensure, and driving exposure trajectory classes in emerging adulthood and their associations with sociodemographic variables
Aim 2: Examined the associations of driving licensure status, delay in driving licensure, and self-report driving exposure with the trajectory classes of individual alcohol and drug use
Aim 3: Examined the associations of driving licensure status, delay in driving licensure, and driving exposure trajectory classes with the trajectory classes of peer alcohol and drug use and parental monitoring knowledge
Aim 4: Examine the associations of driving licensure status, delay in driving licensure, and driving exposure trajectory classes with their health, education, and employment four years after leaving high school

All analyses were performed in SAS software version 9.4 (SAS Institute, Cary, NC), taking complex survey sampling features into account [278].

Structural equation modeling (SEM) is an alternative tool for exploring the associations of driving licensure, delay in driving licensure, and driving exposure with alcohol and drug use,

parental monitoring knowledge, peer alcohol and drug use, and health, education, and employment of emerging adults. SEM allows researchers to test a theoretical model of these associations [279, 280]. SEM approach is useful for testing the strength of the associations between these variables, as well as for exploring potential mediators or moderators of these associations. The choice of which tool (LCGM vs. SEM) to use when investigating these associations depends on the research questions being asked and the data available. LCGM is better suited to examining change over time, while SEM is more useful for testing a theoretical model of the associations between the variables of interest. SEM is a form of multivariate statistical analysis that is designed to examine the associations between a set of variable, but it may be unable to account for the temporal dynamics that are present in the data [280]. In my dissertation, I aimed to identify subgroups of individuals who may have different trajectory classes of driving frequency, alcohol and drug use, peer alcohol and drug use over the course of emerging adulthood. Therefore, LCGM is the better choice. Future research should explore the impact of different contextual factors, such as culture, on the associations between driving licensure, delay in driving licensure, and driving exposure with alcohol and drug use, parental monitoring knowledge, peer alcohol and drug use, and health, education, and employment of emerging adults.

2.9 Power estimate

Regarding the Latent Class Growth Modeling (LCGM), simulation studies suggest that larger sample sizes are required when the number of trajectory classes and missing data increases and the distance between the classes and follow-ups decrease [281, 282]. Accordingly, in the best case, a minimum sample size of 200 is required when the true number of classes is 2 and a sample size of about 1000 when the true number of classes is close to 5 [281, 282]. The sample size of 2783 is large enough for LCGM to identify the true number of classes.

In multinomial logistic regression models, previous research recommended that predictive performance gradually improves as the number of multinomial events per predictor variable increases, at least until it reaches 50 events per predictor [283]. In AIM 1 – 4, there are a maximum of 7 independent variables in multinomial logistic regression. Therefore, a minimum sample size of 350 is adequate for fitting the multinomial logistic regression models. The sample size of 2783 is sufficient to provide statistical evidence in multinomial logistic regression.

With respect to binary logistic regression, a minimum sample size of 500 has been suggested as necessary to provide statistical evidence [284]. The other recommended rules of thumb are 50 observations per predictor plus 100 [284]. In AIM 3, there are a maximum of 7 independent variables in a binary logistic regression model. Therefore, a sample size of 450 is adequate for fitting the binary logistic regression model. The study sample size of 2783 is large enough to provide statistical evidence in a binary logistic regression model.

In terms of linear regression, power analysis is evaluated with G*Power [285]. In a linear regression model with 7 independent variables, power $(1-\beta) = .95$, $\alpha = .05$, two-tailed test, a total sample size n = 153 is sufficient to detect a medium effect size ($f^2 = .15$) which is widely used in the social, behavioral, and biomedical sciences [285]. The sample size of 2783 is large enough to provide statistical evidence in a linear regression model.

CHAPTER 3 – EMERGING ADULT DRIVING LICENSURE AND DRIVING EXPOSURE TRAJECTORIES: SOCIODEMOGRAPHIC CHARACTERISTICS OF A NATIONALLY REPRESENTATIVE SAMPLE

OVERVIEW

Objective: To examine the associations of driving licensure status and driving exposure with emerging adult sociodemographic variables

Methods: 2783 participants from the NEXT Generation Health Study, a nationally representative cohort of 10th graders, were recruited. The independent variables included sex, race/ethnicity, family structure, family affluence, parental education, urbanicity, social media sedentary time, and parental monitoring knowledge. The dependent variables were emerging adult licensure status and driving frequency trajectory classes. Multinomial logistic regression and latent class growth modeling were conducted.

Results: Emerging adults having a parent with high school or less as the highest education (AOR [Adjusted Odds Ratio]=0.21, 95%CI [Confidence Interval] 0.07, 0.66, p=0.027), living in urban areas (AOR=0.07, 95%CI 0.02 0.31, p<0.001), and having low family affluence (AOR=0.31, 95%CI 0.10 0.91, p<0.001) were less likely to have licenses in high school than no licensure in emerging adulthood. Emerging adults with a single parent were less likely (AOR=0.48, 95%CI 0.24 0.96, p=0.035) to have licenses after high school than no licensure in emerging adulthood. Social media sedentary time was higher (β=1.18, 95%CI 1.08 2.25, p=0.032) in emerging adults with licenses in high school than no licensure in emerging adulthood. Mother's monitoring knowledge was higher in emerging adults with licensure in high school (β=2.14, 95%CI 1.04 4.42, p=0.040) and after high school (β=1.56, 95%CI 1.08 2.25, p=0.019) than no licensure in emerging adults, respectively. Compared with White emerging adults, Latinos were more likely (AOR=1.13, 95%CI 1.64 2.01, p=0.024) to be in the high driving frequency class than in the low driving frequency class. Compared with emerging adults living in rural areas, emerging adults living in

urban areas were less likely to be in the high driving frequency class (AOR=0.22, 95%CI 0.06, 0.82, *p*=0.021) and the medium driving frequency class (AOR=0.44, 95%CI 0.19 0.52, *p*<0.001) than in the low driving frequency class, respectively. Compared with emerging adults living with both biological parents, emerging adults living with biological and step-parent were more likely (AOR=1.21, 95%CI 1.11 2.18, *p*=0.016) to be in the high driving frequency class than in the low driving frequency class. Social media sedentary time was higher in the high driving frequency class (β=1.37, 95%CI 1.24 1.51, p<0.001) and in the medium driving frequency class (β=1.14, 95%CI 1.04, 1.25, p<0.001) than in low driving frequency class, respectively.

Conclusions: Race/ethnicity, socioeconomic status, urbanicity, family structure, social media use, and mother's monitoring knowledge contribute to emerging adult licensure and driving frequency. An upward trend of miles driven trajectory was identified in emerging adulthood.

INTRODUCTION

When emerging adults drive, independent driving may put emerging adult drivers at high risk of risky driving leading to motor vehicle crashes [55, 56]. Risky driving can be defined as driving under higher-risky driving conditions such as at night or in inclement weather; in a fast, aggressive, erratic, unsafe, or unlawful manner; engaging in distracting secondary tasks while driving; and impaired from alcohol or other drugs, a particular concern given that emerging adult drug use, which is both illegal and dangerous in many ways, increases during emerging adulthood [57], and the involvement of alcohol in a high proportion of fatal crashes among emerging adult drivers [56]. Motor-vehicle crashes are the leading course of unintentional injury and death among the young aged 15-23 [48].

On the other hand, driving licensure has potential benefits for emerging adult outcomes that allow them to flourish in early adulthood. Emerging adult driving licensure and driving exposure (e.g., a higher level of driving frequency and miles driven) facilitated greater adolescent independence and allowed them to enhance health, education, and employment opportunities [16-20]. For example, evidence suggests that participants with consistent vehicle access were

more likely to access healthcare services compared to those with barriers to access to transportation [21, 22]. One cross-sectional study found that emerging adult drivers had higher average weekly salaries and performed better academically than non-driving peers [23]. More driving exposure like days and miles to drive may help emerging adults become more autonomous emerging adults who rely less on parents with more opportunities to connect with peers outside the community, such as home and school. However, the extent of emerging adult exposure to driving after licensure (driving frequency and miles driven) may differ.

In recent years, studies have shown that the number of emerging adults getting licensed has been on the decline. In 2010, only 28 percent of 16-year-olds had a driver's license, down from 31 percent in 2008 and 46 percent in 1983 [286, 287]. Licensed 17-year-olds were down to 46 percent in 2010 from 50 percent in 2008 and 69 percent in 1983 [286, 287]. Other researchers showed similar results that fewer young people were getting licensed and those licensed were driving fewer miles [10, 288, 289]. Graduated Driving Licensing (GDL) programs, a state-level policy system that typically applies to drivers licensed before age 18 y/o, intentionally develops to gradually introduce young novice drivers into the driving population in a safe and graduated fashion [13]. Emergiing adults who delay their licensure and obtain it later the age parameters of their stage GDL policy could be at an increased risk of getting into car crashes. This is because emerging adults who delay ethir licensure may miss out on the safety practices that GDL policies are designed to provide to emerging adult novice drivers [9]. GDL policies are created to help emerging adult drivers gain experience and develop their driving skills over time, while also reducing their risk of getting into a crash [9]. Therefore, delay in driving licensure could put emerging adults at an increased risk of getting into a crash. Emerging adult driving licensure data are annually provided by the Federal Highway Administration [290]. However, these data have limitations because of inconsistencies among states as to who qualifies as a licensed driver, and large, inexplicable year-to-year changes in counts in some sporadic states [290]. Some media reports have suggested that the rise of social media, smartphones, and the internet was the

primary reason for the decline [291]. They claimed that emerging adults are less interested in driving, instead turning to Facebook or Twitter to interact with friends. Researchers found that a higher proportion of internet users were associated with a lower licensure rate in a regression analysis on young drivers in 15 countries [7]. However, in a later survey, only 3 percent of 18-19 year-olds chose “Able to communicate and/or conduct business online instead” as their main reason for not currently having a driver’s license [292]. Researchers speculated that high internet usage may be a consequence, instead of a cause, of not having a driver’s license and being readily able to drive [292]. The top primary reason was “Too busy or not enough time to get a driver’s license,” with 38 percent of 18-19 year-olds choosing this response [292]. Second on the list was “Owning and maintaining a vehicle is too expansive,” chosen by 17 percent of respondents as the primary reason [292]. Other similar surveys found that emerging adults wait to get licensed primarily for practical or economic reasons [13, 15]. Further, researchers found that time to licensure in New Jersey varied highly based on sociodemographic variables, providing evidence that emerging adults may not have licensure and drive less for economic reasons [14]. Approximately 78 percent of residents living in New Jersey’s highest-income zip codes were licensed within 6 months of turning 17 [14]. Conversely, only 19 percent of residents in the lowest income areas were licensed by this time [14]. Thus, there is a need to better understand the characteristics of emerging adults who licensed versus not licensed in a nationally representative cohort.

Parents exert influence on novice emerging adult driver behaviors [42, 68]. Specifically, parental monitoring knowledge, particularly by fathers, can be a protective factor against alcohol-impaired/other drug-impaired driving, independent of the effect of substance use, among emerging adult drivers [68]. While previous research suggested that parent have important roles in determining when a emerging adult is ready to get a driver’s license [42], the current knowledge base is still lacking understanding how parental monitoring knowledge associates with driving licensure status (having licensure in high school, after high school, or no licensure in emerging

adulthood) and driving exposure (driving frequency and miles driven patterns in emerging adulthood).

The National Household Travel Survey provides extensive data on driving exposure [293, 294]. The number of miles driven per licensed driver continue to increase. On average, drivers in 2001 drive 3000 miles more per year than those in 1995 [294]. Although the number of miles driven per licensed driver seemed to decrease for all age groups between 2001 and 2009, the decrease in annual miles was significant for only the youngest two age groups (16 to 19 and 20 to 34 years old) [293]. Although the National Household Travel Survey provides extensive data on driving exposure, it was conducted sporadically two times in 2001 and 2009 [293, 294]. However, the trajectories of driving exposure like driving frequency and miles driven in emerging adult drivers are still lacking in the current knowledge base. Thus, there is a need to understand the characteristics of driving exposure trajectories in emerging adult drivers. To address these gaps, we used data from the NEXT Generation Health Study (NEXT), a nationally representative American youth cohort starting in 10th grade (Wave 1, 2009-2010) and ending four years after high school (Wave 7), with measures of self-reported driving licensure (having licensure in high school, having licensure after high school, and no licensure in emerging adulthood) and driving exposure (driving frequency and miles driven) at each of seven waves.

With a nationally representative longitudinal American youth cohort, we 1) examined prevalence of driving licensure among emerging adults; 2) characterized emerging adults with their licensure status; 3) examined trajectory classes of emerging adult driving exposure; and 4) characterized trajectory classes of emerging adult driving exposure.

METHODS

Sampling

This study used the data from the NEXT Generation Health Study (NEXT) with a nationally representative American youth cohort starting in 10th grade (Wave 1, 2009-2010) and ending four years after high school (Wave 7).

The NEXT used a multistage sampling strategy to select primary sampling units (PSU, U.S. school districts) from nine census divisions. Specifically, from each school district, schools were randomly selected and classrooms within the schools were randomly selected. Among the 145 selected schools, 81 schools agreed to participate. African American students were oversampled to obtain a large enough sample (N=687) for more accurate population estimates. Surveys were administered annually for each wave in the spring semester. In total, 2783 participants enrolled in the NEXT study. The data collected in W1 through W7 were used for this study. Among the 2,783 participants, 90% (N=2524), 87% (N=2439), 86% (N=2395), 78% (N=2177), 79% (N=2202), 83% (N=2306), and 83% (N=2323) of participants completed W1, W2, W3, W4, W5, W6 and W7, respectively. Parents provided informed consent for their child's participation. Participants younger than 18 years of age provided assent, and consent was obtained from participants once they reached age 18. The Institutional Review Board of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development reviewed and approved the study protocol.

Trajectory variables (dependent variables)

Driving licensure status (W1-7)

Driving licensure status was generated from emerging adults reporting if they had driving licensure following independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.). Participants were asked "Do you have a driver's license?" with four possible responses. Only participants who chose "License allowing independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.)" were counted as having licensure. Other responses including "No license of any sort", "Permit to take the classroom component of driver education only", and "Permit allowing supervised practice driving with an instructor or licensed adult" were counted as no licensure. W1-3 is 2nd year to 4th year high school. W4-7 was 1st year to 4th year after high school. W1-7 was emerging adulthood starting from 2nd year high school to four years after high school.

Participants were categorized into three groups: had an independent license in high school at any of first three waves (W1-3), had an independent license in high school any of last four waves (W4-7) but not at any of first three waves, and did not have an independent license. Participants were categorized as missing driver's license status if they didn't report their driver's license status at any wave.

Exposure to driving after licensure (W1-7)

Exposure to driving after licensure included two variables including driving frequency and miles driven. Driving frequency was measured with one question, "On how many of the last 30 days did you drive a vehicle?" with possible responses of the number of days from 0 to 30. Given that the possible responses for the number of the last 30 days was from 0 to 30, those participants who reported >30 were deleted. Miles driven were measured with one question, "On average, about how many miles did you drive each day you drove?" with possible responses of the number of miles in whole numbers. Preliminary analysis indicated that a small percentage of emerging adults (<1%) reported very high daily mileages including >100 miles at W1, >200 miles at W2, >200 miles at W3, >200 miles at W4, >200 miles at W5, >250 miles at W6, and >400 miles at W7. These small percentage of emerging adults (<1%) were excluded.

Independent variables

Sociodemographic variables

Participants' sex, race/ethnicity, parental education level, family affluence, family structure, and urbanicity were collected at the baseline visit (W1, 10th grade). The biological sex of participants was female or male. Participant race/ethnicity was categorized as Latinos, Non-Latino Blacks, Non-Latino Whites and Others (including Asian, American Indiana or Alaska Natives, and Native Hawaiians Other Pacific Islanders). The highest educational attainment of participant parents was categorized as: 1) Less than a high school diploma, a high school diploma or GED; 2) Some college, technical school or associate degree; or 3) Bachelor or graduate degree. The family socioeconomic status was obtained by the Family Affluence Scale, a widely used and

validated proxy for socioeconomic status [269]. Specifically, participants were asked how many cars their family owned, the number of computers owned, whether participants had their own bedroom, and the number of family vacations taken in the last 12 months. Then, participants' family affluence status was categorized as low, moderate, or high affluence [270]. Information about participants' family structure was collected during the recruitment home visit by asking participants about the home where they lived all or most of the time. They were given the opportunity to respond about a second home, including how much time they lived there. The family structure was categorized as: both biological parents; one biological parent, one step-parent; single parent, mother only; single parent, father only; and other. This information was then collapsed into four groups for the analysis: both biological parents, biological and step-parent, and other. Urbanicity (suburban, rural, vs. urban) was derived from participants' school location at W1 according to the National Center for Education Statistics [295].

Social media sedentary time

Participants were asked "How many hours a day do you usually use a computer, the Internet, or cell phone for chatting on-line, emailing, texting, tweeting or similar social networking (other than for a job or schoolwork) during your free time? (1=none at all; 2=about half an hour/day; …, to 9=about seven or more hours/day), separately for weekdays and weekends." Data were recorded to reflect minutes (e.g., 2=30 minutes, 3=60 minutes). Average daily social media use (minutes) was [(weekday minutes×5) +(weekend minutes×2)]/7 days.

Parental monitoring knowledge

Parental monitoring knowledge was assessed separately for mothers and fathers and was the mean of a 5-item scale in W1-3. The scale included how much mothers/fathers knew about who their friends were, how they spent their money, what they did with their free time, where they were after school, and where they went at night (1=do not have/see parent/guardian; 2=he/she does not know anything; 3=he/she knows a little; and 4=he/she knows a lot). Scores ranged from one to four possible points. Because monitoring knowledge in W1-3 is highly correlated,

we calculated a grand mean of father's and mother's monitoring knowledge separately across W1-3. The Cronbach's α values mother- and father-related questions were 0.83 and 0.95, 0.88 and 0.96, and 0.90 and 0.97, at W1, W2, and W3, respectively.

Statistical analyses

Descriptive statistics [e.g., means, standard deviation (SD), and frequencies] were summarized to describe participant sociodemographic variables stratified by driving licensure status and driving frequency trajectories. Latent Class Growth Modeling (LCGM) was conducted to identify a set of discrete, mutually exclusive latent classes of participants based on their responses to driving frequency and miles driven [296]. A censored normal mixture method was used for LCGM because driving frequency and miles driven were measured by a scale, with possible values ranging from 0 to 30 for driving frequency and with possible values ranging from 0 to 450 for miles driven [274]. We examined models that extracted different numbers and shapes (e.g., linear versus quadratic) of trajectories and selected the model that best fit the data [274] as evaluated using the Bayesian Information Criterion (BIC) [274]. The fit of each nested model was compared using the estimate of the log Bayes factor [2loge (B10) ≈ 2 (ΔBIC)] [274]. A log Bayes factor value greater than ten was interpreted as very strong evidence of a model fit [274]. Models were initially examined with all quadratic terms. If the quadratic term was non-significant, the cubic term was considered; otherwise, the linear term was included. We selected the best number of trajectories based on the BIC and estimated Bayes Factor. We decided on the best number of groups and then tested various models for the makeup of quadratic, cubic, and linear terms.

The average posterior probability and odds of correct classification were calculated to evaluate the model fit. Each subject in the sample was assigned a posterior probability—the probability of belonging to a trajectory class given their level of monthly driving frequency at each assessment—which was averaged for each trajectory class. The closer the average posterior probabilities are to one, the better the model fit. The equation for the odds of correct classification is outlined in [297], with an odds of correct classification equal to one indicating that the probability

of group membership is no better than random guessing. Generally, an odd of correct classification of 5 or higher is recommended and met or exceeded for all trajectory classes. An average posterior probability value of greater than 0.70 is interpreted as indicative of good internal reliability for within-group membership.

Chi-square statistical analyses were used to examine the association of driving licensure status and driving frequency trajectory classes with sociodemographic variables including sex, race/ethnicity, parent education, urbanicity, family structure, family affluence, social media use, and parental monitoring knowledge. Rao-Scott approach was conducted for categorical variables. Savage one-way approach was performed for continuous variables. Multinomial logistic regression was used to examine the associations of driving licensure status with their sociodemographic variables, social media sedentary time, and parental monitoring knowledge, taking complex survey sampling features into account. Multinomial logistic regression equation was $\text{logit}[\,p(Y_{\text{driving licensure status=had licensure in high school}})] = \log[\frac{p(Y_{\text{driving licensure status=had licensure in high school}})}{1-p(Y_{\text{driving licensure status=had licensure in high school})}}] = \beta 0 + \beta_{\text{race/ethnicity}}X_{\text{race/ethnicity}} + \beta_{\text{parental education}}X_{\text{parental education}} + \beta_{\text{urbanicity}}X_{\text{urbanicity}} + \beta_{\text{family structure}}X_{\text{family structure}} + \beta_{\text{family affluence}}X_{\text{family affluence}} + \beta_{\text{social media sedentary time}}X_{\text{social media use}} + \beta_{\text{mother's monitoring knowledge}}X_{\text{mother's monitoring kwnoledge}} + \beta_{\text{father's monitoring knowledge}}X_{\text{fathjer's monitoring knowledge}}$, where Y was driving licensure status in emerging adulthood as a dependent variable, $p(Y_{\text{driving licensure status=had licensure in high school}})$ was probability of having licensure in high school, $X_{\text{race/ethnicity}}$, $X_{\text{parental education}}$, $X_{\text{urbanicity}}$, $X_{\text{family structure}}$, $X_{\text{family affluence}}$, $X_{\text{social media use}}$, $X_{\text{mother's monitoring kwnoledge}}$, $X_{\text{fathjer's monitoring knowledge}}$, were independent variables, and βs were the coefficients (for example, $\beta_{\text{race/ethnicity}}$ was the coefficient for race/ethnicity). Additionally, multinomial logistic regression was used to examine the associations of driving frequency trajectory classes among

emerging adult drivers with their sociodemographic variables, social media sedentary time, and parental monitoring knowledge, taking complex survey sampling features into account. Multinomial logistic regression equation was $\text{logit}[\ p(Y_{\text{driving frequency trajectory classes=high driving frequency trajectory class}})] =$ $\log[\frac{p(Y_{\text{driving frequency trajectory classes=high driving frequency trajectory class}})}{1-\ p(Y_{\text{driving frequency trajectory classes=high driving frequency trajectory class}})}] = \beta 0 +$ $\beta_{\text{race/ethnicity}}X_{\text{race/ethnicity}} + \beta_{\text{parental education}}X_{\text{parental education}} + \beta_{\text{urbanicity}}X_{\text{urbanicity}} +$ $\beta_{\text{family structure}}X_{\text{family structure}} + \beta_{\text{family affluence}}X_{\text{family affluence}} +$ $\beta_{\text{social media use}}X_{\text{social media sedentary time}} +$ $\beta_{\text{mother's monitoring knowledge}}X_{\text{mother's monitoring kwnoledge}} +$ $\beta_{\text{father's monitoring knowledge}}X_{\text{fathjer's monitoring knowledge}}$ where Y was driving frequency trajectory class as a dependent variable, $p(Y_{\text{driving frequency trajectory classes=high driving frequency trajectory class}})$ was probability of high driving frequency trajectory class, $X_{\text{race/ethnicity}}$, $X_{\text{parental education}}$, $X_{\text{urbanicity}}$, $X_{\text{family structure}}$, $X_{\text{family affluence}}$, $X_{\text{social media use}}$, $X_{\text{mother's monitoring kwnoledge}}$, $X_{\text{fathjer's monitoring knowledge}}$, were independent variables, and βs were the coefficients (for example, $\beta_{\text{race/ethnicity}}$ was the coefficient for race/ethnicity). Results were reported as adjusted odds ratio (AOR). Adjusted odds ratio (AOR) was found using multinomial logistic regression equation. For example, the relative log odds of being in having licenses in high school vs. no licensure in emerging adulthood was $\log[\frac{P(driving\ licensture\ status=having\ licenses\ in\ high\ school)}{P(driving\ licensure\ status=no\ licensure\ in\ high\ school)}] =$ $b_0 + b_{race/ethnicity} + b_{parental\ education} + b_{urbanicity} + b_{family\ structure} + b_{family\ affluence} +$ $b_{social\ media\ sedentary\ time} + b_{mother's\ monitoring\ knowledge} + b_{father's\ monitoring\ knowledge}$. AOR was obtained by exponentiating the equation above, yielding regression coefficients that are AOR. The statistical significance level was set at $p = .05$ for all analyses. All analyses were performed in SAS software version 9.4 (SAS Institute, Cary, NC) taking complex survey sampling features into account [298].

RESULTS

Of 2779 participants eligible for licensure, 572 (20.57%) reported no licensure, 1344 (48.36%) had licensure in high school, and 863 (31.05%) had licensure after high school. Table 3.1 shows descriptive statistics by participant sociodemographic variables, social media sedentary time, parental monitoring knowledge and driving licensure status (no licensure, having licensure in high school, and having licensure after high school).

Table 3.2 shows the results of multinomial model examining the association between driving licensure status and independent variables. Compared with emerging adults having a parent with a bachelor or graduate degree, emerging adults had a parent with high school or less were associated with a lower likelihood (AOR=0.21, 95%CI [Confidence Interval] 0.07 0.66, p=0.027) of reporting independent licenses in high school than no licensure in emerging adulthood. Compared with emerging adults living in rural areas, emerging adults living in urban areas were associated with a lower likelihood (AOR=0.31, 95%CI 0.10 0.91, p<0.001) of reporting independent licenses in high school than no licensure in emerging adulthood. Compared with emerging adults having high family affluence, emerging adults having low family affluence were associated with a lower likelihood (AOR=0.31, 95%CI 0.10 0.91, p<0.001) of reporting independent licenses in high school than no licensure in emerging adulthood. Compared with emerging adults having both biological parents, emerging adults having a single parent were associated with a lower likelihood (AOR=0.48, 95%CI 0.24 0.96, p=0.035) of reporting independent licenses after high school than no licensure in emerging adulthood. A one-unit increase in the social media sedentary time was associated with a 1.18 increase (β=1.18, 95%CI 1.08 2.25, p=0.032) in the relative log odds of being in having independent licenses in high school compared with no licensure in emerging adulthood. A one-unit increase in the mother's monitoring knowledge was associated with a 2.14 increase (β=2.14, 95%CI 1.04 4.42, p=0.040) and a 1.56 increase (β=1.56, 95%CI 1.08 2.25, p=0.019) in the relative log odds of being in having

independent licenses in high school and after high school compared with no licensure in emerging adulthood, respectively.

One-, two-, three-, and four-class models were estimated from the latent class growth modeling for driving frequency. The BIC values for these models were -30327.02, -29480.05, -29337.13, and -29425.46, respectively. Non-significant cubic and quadratic terms were removed from trajectories in four-class model, resulting in two-class model. Therefore, the three-class model (Figure 3.1) was the best fit for the analyses with the smallest BIC. Among participants, 358 were categorized as stable low driving frequency class (17.93% [weighted and hereafter]), 868 (59.90%) as stable medium driving frequency class, and 267 (22.17%) as stable high driving frequency class. There was an overall average posterior probability of 84.27% and an average of odds of correct classification of 21.86 indicating a well fitting model (Table 3.3).

Table 3.4 shows descriptive statistics for participant sociodemographic variables stratified by driving frequency trajectory classes (low, medium, and high). Table 3.5 shows the results of the multinomial logistic model examining the association between driving frequency trajectory classes and independent variables. Compared with White emerging adults, Latinos were associated with a higher likelihood (AOR=1.13, 95%CI 1.64 2.01, p=0.024) of reporting high than low driving frequency. Compared with emerging adults who lived in rural areas, emerging adults who lived in urban areas were associated with a lower likelihood of reporting high (AOR=0.22, 95%CI 0.06, 0.82, *p*=0.021) and medium (AOR=0.44, 95%CI 0.19 0.52, *p*<0.001) than low driving frequency, respectively. Compared with emerging adults with high family affluence, emerging adults who lived in low family affluence were associated with a lower likelihood of reporting high (AOR=0.42, 95%CI 0.18 0.98, *p*=0.049) and medium (AOR=0.42, 95%CI 0.17 0.92, *p*=0.043) than low driving frequency, respectively. Compared with emerging adults who lived with both biological parents, emerging adults who lived with biological and step-parent were associated with a higher likelihood (AOR=1.21, 95%CI 1.11 2.18, *p*=0.016) of reporting high than low driving frequency. A one-unit increase in the social media sedentary time was associated with a 1.37

increase (β=1.37, 95%CI 1.24 1.51, p<0.001) and a 1.14 increase (β=1.14, 95%CI 1.04, 1.25, p<0.001) in the relative log odds of reporting high and medium compared with low driving frequency, respectively.

One- and two-class models were estimated from the latent class growth modeling for miles driven. The BIC values for these models were -45739.48 and -45823.80, respectively. Non-significant cubic and quadratic terms were removed from trajectories in two-class models, resulting in one-class model. Therefore, the one-class model, an upward trend of miles driven (Figure 3.2), was the best fit with the smallest BIC.

DISCUSSION

With a nationally representative sample, this study assessed associations of driving licensure status (no licensure, having licensure in high school, or having licensure after high school) and driving frequency trajectory classes in U.S. adolescents with their sociodemographic variables.

Our study found that only 20% of emerging adults did not have licensure in emerging adulthood. One study of licensure rate changes in several countries found that higher rates of accessing Internet were associated with lower licensure rates among emerging adults [299]. This could be accessing virtual contact may reduce the need for actual contact among emerging adults [299]. However, high social media use was found to be associated with having licensure in high school and high driving frequency pattern in emerging adulthood. This finding was consistent with previous research showing Internet use among young people to be associated with having driver's license [12]. Social media may allow youth to connect to friends digitally and decreases the need for in-person connection, thereby reducing the need for a driver's license to travel for connection [12]. Given these inconsistent findings, more research may be needed to fully understand the association between online activities and driving licensure and driving frequency patterns in emerging adulthood.

We found race/ethnicity differences on driving frequency patterns. Specifically, compared to Whites, Latinos were more likely to report medium than low driving frequency patters. This

finding was consistent with Transportation Federal Highway Administration showing that Latino drivers had higher person trips and vehicle trips than any other race/ethnicity drivers [300], even though the participants from Transportation Federal Highway Administration were all age groups. Our research was extending the findings that Latinos were at relatively high driving frequency patterns than other race/ethnicity from all age groups to emerging adults. Relatively high driving frequency pattern in emerging Latinos may position them to risky driving and vehicle crashes. Vehicle crash related preventions may be tailored on emerging Latinos.

Further, we found economic disparities on driving licensure status and driving frequency trajectory classes. Compared with emerging adults with a high family affluence, emerging adults with a low family affluence were less likely to have licensure in high school. This finding was consistent with the previous research showing that lower household income was independently associated with decreased probability of licensure [11]. Additionally, compared with emerging adult with a high family affluence, emerging adults with a low family affluence were less likely to be in the high driving frequency class and the medium driving frequency class than in the low driving frequency patterns. These phenomena could possibly be due to the financial demands of having vehicles for those emerging adults who live in a low family affluence [13].

We also found urbanicity differences in driving licensure status and driving frequency trajectory classes. Compared with emerging adults who lived in rural areas, emerging adults who lived in urban and suburban areas were less likely to have licenses in high school than no licensure in emerging adulthood and less likely to be in the higher driving frequency classes than in the low driving frequency class. Having early independent licenses may enable rural emerging adults to overcome geographical limitations to fulfill a greater responsibility for family duties (e.g., driving siblings to school and running errands) and a greater accountability for commuting to and from work [47]. Higher driving frequency patterns in rural areas indicated that emerging adult drivers who lived in rural areas expanded job searches geographically for employment far from home (especially in rural areas where public transportation is inaccessible) and employment

requiring unusual or non-standard work hours that do not coincide with public transportation schedules which may be common for entry-level jobs, reduce employee absenteeism, and reduce commute times relative to that offered by public transportation [227-229].

Family structure was found to be associated with driving licensure status and driving frequency trajectory classes. Compared with emerging adults who lived with both biological parents, emerging adults who lived with single parent were less likely to have licenses after high school than no licensure in emerging adulthood. The possible reason for this phenomenon can be the financial demands of vehicle ownership [13]. Living with both biological parents may have fewer economic burdens (e.g., not being able to afford the cost and maintenance of a vehicle) compared to those who live with a single parent, grandmother, grandfather, foster home or children's home, and someone or somewhere else [10, 11]. Further, compared with emerging adults who lived with biological parents, emerging adults who lived with biological- and stepparents were more likely to be in the high driving frequency class than in the low driving frequency class. I speculated that the tendencies of both biological parental involvement in novice emerging adult driving at risky driving conditions such as not allow their emerging adults to drive during late night hours were higher than emerging adults who lived with biological- and step-parents.

Parental education was found to be associated with driving licensure status, but not driving frequency trajectory classes. Compared with emerging adults with parents whose education were Bachelor or higher, emerging adults with parents whose education were high school or less were less likely to have licenses in high school than no licensure in emerging adulthood. Parents with higher education attainment like Bachelor or Graduate degree were more likely to have a better socioeconomic status and be able to afford the cost and maintenance of a vehicle compared with parents with higher school or less and some college [10, 11]. As a result, emerging adults with parents whose education were Bachelor or higher were more likely to get their parental approval of licensure (e.g., parent's approval until emerging adults are "ready" to have licensure) [42].

Mother's monitoring knowledge, not father's monitoring knowledge, in emerging adults with licenses in high school and after high school were higher than emerging adults without licensure in emerging adulthood. This finding was consistent with previous research showing that mother's approval until her emerging adults were "ready" to have licensure was associated with timing of licensure [42].

An upward trend of miles driven trajectory was identified among emerging adults. This result was significant because it suggested that emerging adults were driving more miles, which had implications for public health, transportation, and urban planning. For example, increased miles driven may lead to more traffic congestion, air pollution, and carbon emissions [301]. Additionally, as emerging adults drove more miles, they may be more likely to be involved in automobile accidents, leading to an increased risk of injury and death [302]. Therefore, this finding had potential implications for public safety, as well as for environmental health. In order to better understand the upward trend of miles driven trajectory among emerging adults, more research was needed to examine the reasons behind this phenomenon. Factors such as changes in employment, housing, and lifestyle preferences could be explored to better understand the motivations behind this trend [303]. Additionally, understanding the impacts of this trend on public health, transportation, and urban planning could help inform policies and interventions that can help address the associated risks (i.e., risky driving) and maximum the benefits (e.g., access to health, education, and employment opportunities) of increased miles driven.

Further, dan increase in driving frequency among emerging adults between three and four years after leaving high school was found as they might be pursuing higher education, seeking employment, or otherwise increasing their independence and need for transportation. As they become more independent, they may need to drive more often to carry out the activities of daily life such as commuting to work or school, running errands, and visiting friends and family. Additionally, as they become more confident in their driving ability, they may become more likely to drive more frequently. An intervention or preventive plan should begin as early as high school,

as this is the age when driving frequency typically starts to increase. The plan should include several components, including educational programs to educate young people on the dangers of driving while under the influence, distracted driving, and other dangerous practices. It should also include parent education programs to ensure that parents are aware of their children's driving habits and are able to intervene if their child is at risk for unsafe driving. Finally, the plan should include enforcement of laws, such as those related to seat belt use, speed limits, and other traffic laws. This can help ensure that those who choose to drive are doing so responsibly.

There are several limitations that existed in our study. First, all variables were measured with self-reported questions, and this inherently introduces the chance of social desirability and recall bias. Second, family affluence could not to be be accurately measured by household income, despite the fact that measuring household income has been a widely accepted and confirmed method of assessing affluence [270, 304]. This is because family affluence is more than just income and includes other factors such as access to resources and opportunities. For example, family affluence was associated with a range of factors, including access to educational opportunities, living in a safe and secure environment, and having access to healthcare [270, 304]. This demonstrates that family affluence is more than just income and should be assessed using a variety of measures. Third, some demographic variables were not measured in every single wave but were collected at baseline only (e.g., family structure and affluence). Therefore, the data may not show the dynamic changes over the period of emerging adulthood. Despite these limitations, our study had notable strengths. This study was the first of its kind to examine the impact of driving licensure status (obtained in high school, after high school, or not at all during emerging adulthood) on driving exposure, including driving frequency and miles driven, in relation to emerging adult sociodemographic characteristics. Further, this longitudinal study was based on a nationally representative sample that allowed the findings for nationally generalizability to the U.S. emerging adult populations.

The findings of our study provided important public health implications. Despite the potential for reduced overall driving exposure and, consequently, a decrease in crash-related injuries, the absence of licensure, lower driving frequency, and shorter distances driven may also lead to a reduced exposure to the safety benefits of graduated driving licensing programs, and thus, an increase in crash-related injuries. For emerging adult drivers, a certain level of driving exposure and experience to learn how to drive was necessary before they became safe drivers. Besides the crash due to lacking driving exposure and experience, driving facilitated greater emerging adult independence and mobility. From a developmental perspective over the course of lifespan, having licensure and more driving exposure and experience could have potential benefits for emerging adult outcomes, especially on accessing to health, education, and employment opportunities, which could allow emerging adults to flourish in emerging adulthood.

In conclusion, an increased daily miles driven pattern was found throughout emerging adulthood. Race/ethnicity, socioeconomic status, urbanicity, family structure, social media use, and mother's monitoring knowledge contribute to driving licensure status and driving frequency trajectory classes. Further study of these factors, including race/ethnicity, socioeconomic status, urbanicity, family structure, social media use, and mother's monitoring knowledge, and their individual and collective contributions to driving licensure status and driving exposure may be needed to balance crash-related injury and the health and prosperity of emerging adults.

Table 3.1 Descriptive statistics by participant sociodemographic variables, social media sedentary time, parental monitoring knowledge and driving licensure status (no licensure, having licensure in high school, and having licensure after high school)

		No licensure N (%[#])	Having licensure in high school N (%[#])	Having licensure after high school N (%[#])	χ^2	P
Overall[a]		572 (20.58)	1344 (48.36)	863 (31.05)		
Categorical variables						
Sample Sociodemographic variables						
Race/ethnicity[b]	Latino	253 (24.75)	171 (37.63)	372 (37.62)	82.003	<0.001
	African American	128 (20.10)	151 (46.96)	204 (32.94)		
	White	99 (10.34)	843 (76.84)	155 (12.82)		
	[c]Other	30 (26.08)	57 (54.66)	47 (19.26)		
Sex[b]	Male	219 (17.14)	582 (63.94)	329 (18.92)	1.870	0.393
	Female	292 (14.43)	641 (61.82)	451 (23.76)		
Parental education[b]	High school or less	280 (26.64)	281 (43.70)	372 (29.66)	99.851	<0.001
	Some college	130 (11.05)	498 (67.08)	236 (21.87)		
	Bachelor+	59 (8.91)	398 (82.35)	104 (8.74)		
Urbanicity[b]	Urban	298 (28.94)	192 (32.89)	405 (38.18)	29.886	<0.001
	Suburban	166 (16.56)	399 (57.80)	296 (25.64)		
	Rural	51 (9.24)	633 (81.65)	79 (9.11)		
Family affluence[b]	Low	272 (28.80)	208 (40.66)	323 (30.54)	236.015	<0.001
	Moderate	192 (13.21)	623 (64.72)	360 (22.07)		
	High	51 (8.66)	393 (78.70)	97 (12.64)		
Family Structure[b]	Both biological parents	218 (11.02)	718 (69.99)	383 (18.98)	41.110	<0.001
	Biological- and step-parents	90 (17.41)	197 (63.28)	131 (19.31)		
	Single parent	134 (21.71)	214 (52.74)	166 (25.56)		
	[d]Other	73 (25.72)	95 (42.32)	100 (31.96)		
Continuous variables		N (Mean ± SD)	N (Mean ± SD)	N (Mean ± SD)	χ^2	P[$]
Social media sedentary time		508 (5.54 ± 2.84)	1152 (5.73 ± 2.62)	744 (5.92 ± 2.70)	5.464	0.065
Mother's monitoring knowledge (W1-3 grand mean)		570 (3.39 ± 0.52)	1277 (3.52 ± 0.51)	833 (3.43 ± 0.49)	49.102	<0.001
Father's monitoring knowledge (W1-3 grand mean)		569 (2.59 ± 0.92)	1277 (2.94 ± 0.85)	833 (2.68 ± 0.89)	59.788	<0.001

Note: [#]Weighed %; [a]Weighed % using the weight based on W1-W7 weights. [b]Weighted % using W1 weight. [c]Including Asian American, Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders. [d]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else.

Table 3.2 Adjusted odds ratio, confidence interval, p value, resulting from multinomial logistic regression anlyses of driving licensure status (no licensure, having licensure in high school, and having licensure after high school) on participant sociodemographic variables, social media sedentary time, and parental monitoring knowledge

	Having licensure in high school versus no licensure			Having licensure after high school versus no licensure		
	AOR	95% CI	P	AOR	95% CI	P
Categorical variables						
Race/ethnicity						
Latino	0.29	0.13, 0.67	0.167	0.78	0.32, 1.90	0.327
African American	0.48	0.17, 1.40	0.576	0.72	0.21, 2.45	0.743
[b]Other	**0.19**	**0.07, 0.51**	**0.041**	0.27	0.10, 0.76	0.067
White			-	Ref	-	
Parental education						
High school or less	**0.21**	**0.07, 0.66**	**0.027**	0.88	0.26, 2.96	0.602
Some college	0.34	0.15, 0.76	0.272	1.19	0.07, 0.51	0.494
Bachelor+			-	Ref	-	
Urbanicity						
Urban	**0.07**	**0.02, 0.31**	**<0.001**	0.62	0.16, 2.46	0.451
Suburban	0.23	0.08, 0.67	0.747	0.83	0.25, 2.68	0.904
Rural			-	Ref	-	
Family affluence						
Low	**0.31**	**0.10, 0.91**	**<0.001**	0.94	0.25, 3.52	0.747
Moderate	0.69	0.26, 1.80	0.465	1.17	0.42, 3.27	0.457
High			-	Ref	-	
Family structure						
Biological and step-parent	0.99	0.41, 2.41	0.197	0.97	0.35, 2.67	0.265
Single parent	0.50	0.29, 0.84	0.178	**0.48**	**0.24, 0.96**	**0.035**
[c]Other	**0.43**	**0.21, 0.88**	**0.023**	0.64	0.18, 2.21	0.681
Both biological parents			-	-	-	
Continuous variables	β	95% CI	P	β	95% CI	P
Social media sedentary time	**1.18**	**1.08, 2.25**	**0.032**	1.09	0.99, 1.19	0.079
Mother's monitoring knowledge (W1-3 grand mean)	**2.14**	**1.04, 4.42**	**0.040**	**1.56**	**1.08, 2.25**	**0.019**
Father's monitoring knowledge (W1-3 grand mean)	1.18	0.78, 1.77	0.431	0.97	0.67, 1.41	0.876

Note: AOR=adjusted odds ratio; β: beta; CI=confidence interval; [a]Adjusted model: all variables in the table are included in the adjusted model and control for each other; [b]Including Asian, American Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders.; [c]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else.

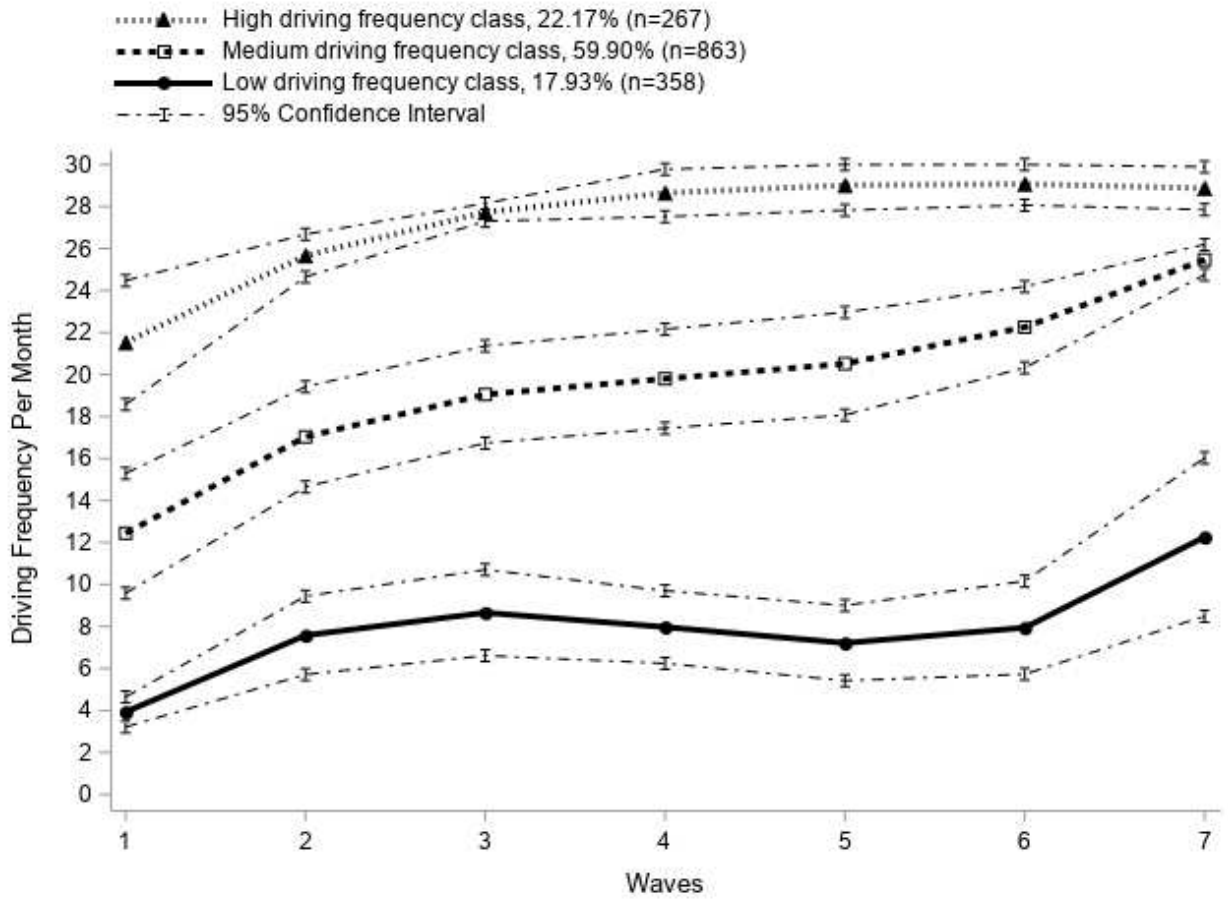

Figure 3.1 Trajectories of monthly driving frequency (low, medium, and high) among emerging adults over seven consecutive years beginning in the 10th grade.

Table 3.3 Proportions, average posterior probabilities, and odds of correction classifications of driving frequency trajectory classes among emerging adults

	N (Weighted %)	Average posterior probabilities (Range)	Odds of Correct Classification
Low driving frequency class	358 (17.93)	0.842 (0.500-1.000)	24.39
Medium driving frequency class	863 (59.90)	0.842 (0.501-0.996)	22.19
High driving frequency class	267 (22.17)	0.844 (0.504-0.995)	18.99

Note: Weighted % using the weight based on W1-W7 weights.

Table 3.4 Descriptive statistics by participant sociodemographic variables, social media sedentary time, parental monitoring knowledge and driving frequency trajectory classes (low, medium, and high)

		Low N (%#)	Medium N (%#)	High N (%#)	χ^2	P
Overall[a]		358 (17.93)	863 (59.90)	267 (22.17)		
Categorical variables						
Race/ethnicity[b]	Latino	214 (18.61)	471 (62.29)	107 (19.10)	27.980	<0.001
	African American	164 (25.66)	258 (58.67)	55 (15.68)		
	White	148 (12.87)	638 (59.71)	298 (27.42)		
	[c]Other	45 (25.34)	64 (45.24)	23 (6.96)		
Sex[b]	Male	243 (16.37)	642 (56.66)	231 (26.97)	4.443	0.110
	Female	332 (17.28)	789 (61.55)	252 (21.16)		
Parental education[b]	High school or less	240 (18.75)	537 (59.84)	148 (21.41)	5.847	0.210
	Some college	180 (15.43)	467 (56.48)	211 (28.08)		
	Bachelor+	111 (17.14)	340 (62.29)	102 (20.57)		
Urbanicity[b]	Urban	324 (33.74)	483 (55.22)	87 (11.04)	26.066	<0.001
	Suburban	165 (15.60)	516 (62.04)	168 (22.36)		
	Rural	86 (11.93)	437 (57.20)	228 (30.87)		
Family affluence[b]	Low	259 (25.30)	448 (57.29)	94 (17.41)	20.356	<0.001
	Moderate	247 (15.82)	670 (60.80)	244 (23.38)		
	High	69 (11.20)	318 (58.64)	145 (30.16)		
Family Structure[b]	Both biological parents	275 (15.16)	747 (57.28)	288 (27.56)	18.079	<0.001
	Biological and step-parent	85 (14.70)	238 (58.37)	88 (26.93)		
	Single parent	136 (19.77)	296 (64.87)	75 (15.36)		
	[d]Other	79 (24.65)	155 (61.83)	32 (13.52)		
Continuous variables		N (Mean ± SD)	N (Mean ± SD)	N (Mean ± SD)	χ^2	P[$]
Social media sedentary time		560 (5.39 ± 2.72)	1379 (5.68 ± 2.68)	493 (6.41 ± 2.59)	86.564	<0.001
Mother's monitoring knowledge (W1-3 grand mean)		686 (3.42 ± 0.50)	1512 (3.46 ± 0.53)	462 (3.54 ± 0.47)	18.633	<0.001
Father's monitoring knowledge (W1-3 grand mean)		686 (2.59 ± 0.91)	1511 (2.82 ± 0.89)	462 (2.94 ± 0.84)	44.431	<0.001

Note: [a]Weighted % using the weight based on W1-W7 weights. [b]Weighted % using W1 weight. [c]Including Asian, American, Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders. [d]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else.

Table 3.5 Adjusted odds ratio, confidence interval, and p value resulting from multinomial logistic regression analyses of driving frequency trajectory classes (low, medium, and high) on participant sociodemographic variables, social media sedentary time, and parental monitoring knowledge

	Driving Frequency Trajectories[a] High versus Low			Medium versus Low		
Categorical variables	AOR	95% CI	P	AOR	95% CI	P
Race/ethnicity						
Latinos	0.90	0.38, 2.15	0.462	**1.13**	**1.64, 2.01**	**0.024**
African Americans	0.57	0.26, 1.24	0.565	0.78	0.44, 1.40	0.969
Others	0.52	0.14, 1.94	0.531	**0.43**	**0.22, 0.86**	**<0.001**
Whites	Ref	-	-	-	-	-
Urbanicity						
Urban	**0.22**	**0.06, 0.82**	**0.021**	**0.44**	**0.19, 0.52**	**<0.001**
Suburban	0.82	0.34, 1.98	0.207	1.10	0.53, 2.27	0.071
Rural	Ref	-	-			
Family affluence						
Low	**0.42**	**0.18, 0.98**	**0.049**	**0.42**	**0.17, 0.92**	**0.043**
Moderate	0.69	0.35, 1.33	0.821	0.77	0.37, 1.61	0.564
High	Ref	-	-	-	-	-
Family structure						
Biological- and step- parents	**1.21**	**1.11, 2.18**	**0.016**	1.21	0.73, 2.00	0.679
Single parent	0.48	0.17, 1.30	0.202	1.11	0.67, 1.86	0.992
Others	0.46	0.21, 1.00	0.25	1.15	0.54, 2.47	0.922
Both biological parents	Ref	-	-	Ref	-	-
Continuous variables	β	95% CI	P	β	95% CI	P
Social media sedentary time	**1.37**	**1.24, 1.51**	**<0.001**	**1.14**	**1.04, 1.25**	**<0.001**
Mother's monitoring knowledge (W1-3 grand mean)	1.20	0.65, 2.22	0.555	0.81	0.54, 1.21	0.296
Father's monitoring knowledge (W1-3 grand mean)	0.98	0.65, 1.47	0.908	1.19	0.98, 1.45	0.079

Note: [a]AOR=adjusted odds ratio; β: beta; CI=confidence interval; [a]Adjusted model: all variables in the table are included in the adjusted model and control for each other

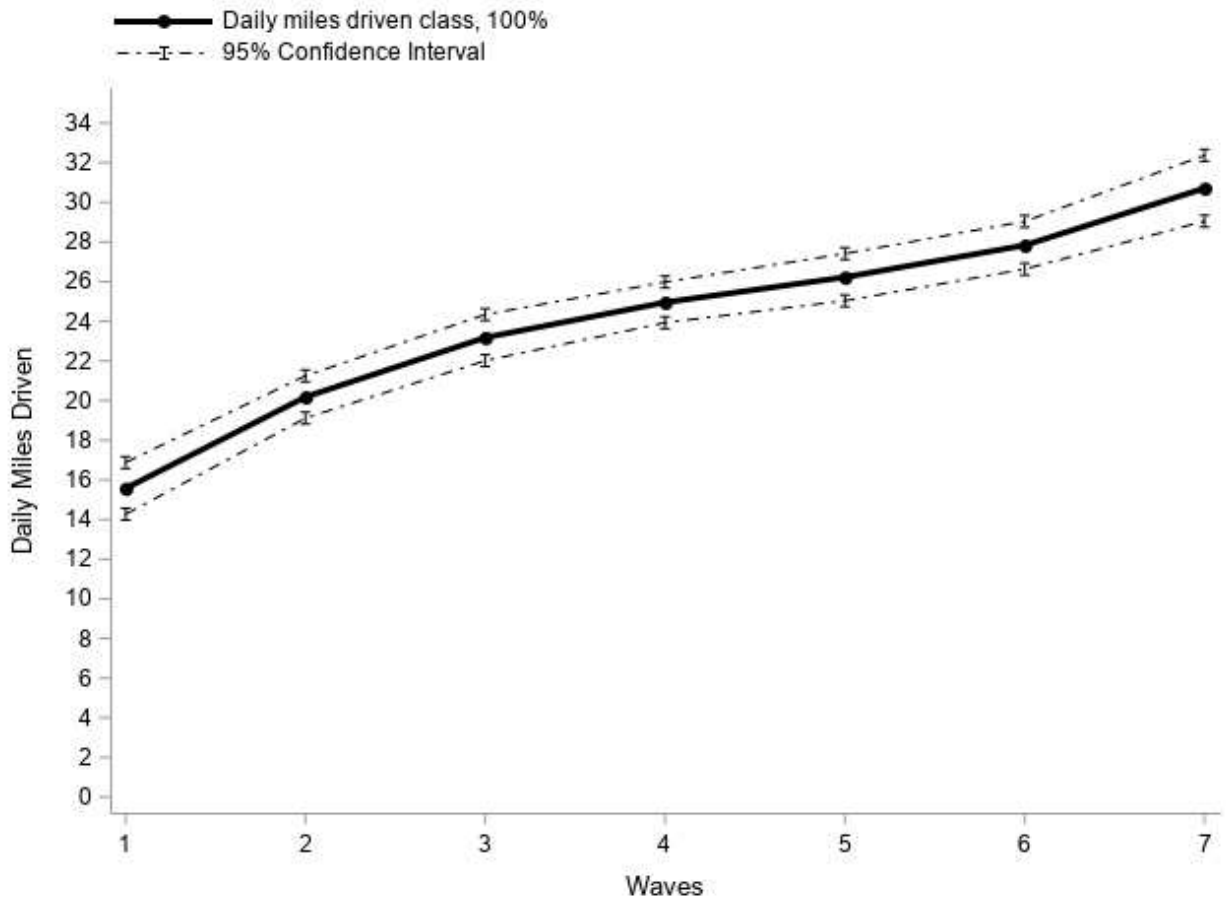

Figure 3.2 Trajectory of miles driven among those emerging adults over seven consecutive years beginning in the 10th grade.

CHAPTER 4 – ARE DRIVING LICENSURE STATUS, DELAY IN DRIVING LICENSURE, AND DRIVING FREQUENCY TRAJECTORY CLASSES ASSOCIATED WITH ALCOHOL DRINKING, BINGE DRINKING, AND DRUG USE TRAJECTORY CLASSES IN EMERGING ADULTHOOD?

OVERVIEW

Objective: To examine the associations of driving licensure status, delay in driving licensure, and driving frequency trajectory classes with alcohol drinking, binge drinking, and drug use trajectory classes in emerging adulthood

Methods: A total of 2783 participants were recruited from the NEXT Generation Health Study, a nationally representative cohort of 10th graders starting in 2009-2010. Data were analyzed from all seven annual assessments (W1-W7). Driving licensure status in emerging adulthood was categorized as 1) never; 2) during in high school; and 3) after high school. Delay in driving licensure (DDL) was defined as participants receiving driver licensure ≥ 1 year after the initial legal eligibility time until W7 (DDL [delaying ≥ 1 year] vs. No-DDL). Driving frequency trajectory classes among emerging adult drivers were investigated using Latent Class Growth Modeling (LCGM). The LCGM was also used to investigate alcohol drinking, binge drinking, and drug use trajectory classes in emerging adulthood. Multinomial logistic regression analyses were used to examine the associations of driving licensure status, DDL, and driving frequency trajectory classes (independent variables) among emerging adult drivers with their alcohol drinking, binge drinking, and drug use trajectory classes (dependent variables), respectively, taking complex survey sample features into account. Covariates, including drinking age, race/ethnicity, sex, parental education, urbanicity, family structure, and family affluence, were included in multinomial logistic regression analyses.

Results: Three alcohol drinking trajectory classes were identified (weighted %): alcohol drinking abstainers to light alcohol drinking (N=638, 47.59%), light alcohol drinking (N=470, 42.80%), and alcohol drinking escalators (N=86, 9.16%). Three binge drinking trajectory classes were

identified (weighted %): binge drinking abstainers to late escalators (N=670, 47.40%), binge drinking escalators (N=446, 43.19%), and consistent high binge drinking (N=78, 9.41%). Three drug use trajectory classes were identified (weighted %): abstainers (N=901, 60.68%), escalators (N=475, 29.50%), and experimenters (N=127, 9.83%).

Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school were more likely (adjusted odds ratio [AOR]=4.07, 95% confidence interval [CI] 1.19 117.74, p=0.002) to be in the alcohol drinking escalators class than in the abstainers/light class. Compared with emerging adults with DDL, emerging adults with no DDL were more likely (AOR=1.14, 95%CI 1.73 1.77, p=0.006) to be in the alcohol drinking escalators class than in the abstainers/light class. Compared with emerging adult with low driving frequency class, emerging adults in the medium driving frequency class were more likely (AOR=2.82, 95%CI 1.44 5.50, p=0.034) to be in the alcohol drinking light class than in the abstainers/light class. Compared with emerging adults in the low driving frequency class, emerging adults in the high driving frequency class were more likely (AOR=3.16, 95%CI 1.41 7.06, p=0.032) to be in the alcohol drinking light than in the alcohol drinking abstainers/light class.

Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school (AOR=15.54, 95%CI 1.59 1.92, p=0.015) and after high school (AOR=9.15, 95%CI 1.05 7.97, p=0.016) were more likely to be in the high consistent binge drinking class than in the abstainers/late escalators class, respectively. Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses after high school were more likely (AOR=9.15, 95%CI 1.05 7.97, p=0.016) to be in the high consistent binge drinking class than in the abstainers/late escalator class. Compared with emerging adults with DDL, emerging adults with no DDL were more likely to be in the binge drinking escalators (AOR=1.09, 95%CI 1.69 1.71, p=0.007) class than in the abstainers/late escalators class. Compared with emerging adults in the low driving frequency class, emerging

adults in the medium driving frequency class were more likely (AOR=1.65, 95%CI 1.91 2.17, p=0.033) to be in the binge drinking escalators than in the abstainers/late escalators class.

Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school were more likely (AOR=1.30, 95%CI 1.08 2.18, p=0.022) to be in the drug use escalators class than in the abstainers class. Compared with emerging adults with DDL, emerging adults with no DDL were more likely AOR=1.03, 95%CI 1.02 1.56, p=0.029) to be in the drug use escalators than in the abstainers class. Compared with emerging adults in the low driving frequency class, emerging adults in the medium driving frequency class were more likely (AOR=1.23, 95%CI 1.05 1.78, p=0.017) to be in the drug use escalator than in the abstainers class.

Conclusion: Alcohol drinking, binge drinking, and drug use among emerging adulthood were greater among emerging adults with a driver's license, no DDL, and a higher driving frequency.

INTRODUCTION

To many emerging adults, driving represents the transition between adolescence and adulthood and an essential element of their maturation and socialization [4]. Emerging adult driving may be particularly important in the United States (US), where limited public transportation in many areas can mean that the ability to drive is a key prerequisite to independence [4]. However, time to licensure varies among emerging adults who are eligible to obtain a driver's license. Some emerging adults get their driver's licenses as soon as they reach state-legal driving age, whereas many choose to delay driving licensure (DDL). A nationally representative US emerging adult cohort study has shown that DDL was widespread among eligible emerging adults. [5]. During the period of 2010-2017, nearly 70% of eligible emerging adults who reach state-legal driving age delayed obtaining their license at least one [5]. Besides DDL, the extent of emerging adult exposure to driving after licensure (e.g., driving frequency) may differ.

Early licensure increases exposure to crash risk and. However, it may offer, beneficial opportunities for life course development (e.g., access to important health, education, and

employment opportunities [16-20]), but possibly also adverse behavioral outcomes. The current literature on emerging adult driving licensure and driving experiences primarily focuses on transportation risks, including crash-related injury, disability, death, and harm to others [26-29]. There are limited studies investigating the effect of driving licensure status (whether or not a person has obtained a driver's license, allowing them to drive independently), DDL, and driving frequency on nontraffic health risks such as binge drinking among emerging adults.

Alcohol drinking is an important issue among emerging adults, as it is associated with a wide range of negative outcomes, including mental and physical health problems, social problems, and increased risk of motor vehicle accidents [305]. Although there are many factors associated with alcohol use among emerging adults, access to transportation may be an especially important factor. Having access to a car may allow emerging adults to obtain alcohol more easily, as well as increase their mobility and access to potential places where alcohol is available [306]. Previous research has focused on the influence of driving privileges on alcohol use in emerging adults. For example, one study found that emerging adults with access to cars and emerging adults who had obtained a driver's license were more likely to report alcohol use compared to emerging adults without driving privileges [306]. Similarly, another study found that emerging adults with access to cars and with driver's licenses were more likely to report alcohol use than emerging adults without access to cars and without driver's licenses [307]. The current study sought to build upon these findings by examining the associations between driving privileges (driving licensure status, DDL, and driving frequency) and alcohol use in high school-age emerging adults. Specifically, the study examined whether emerging adults having a driver's license, no delay in driving licensure, and a higher level of driving frequency, were more likely to report alcohol drinking compared to emerging adults without driving license, delay in driving licensure, and a lower level of driving frequency. The results of this study may have implications for prevention strategies targeting alcohol use, as well as for understanding the role of driving licensure and exposure in alcohol use among emerging adults.

According to the National Institute of Alcohol Abuse and Alcoholism (NIAAA) [110], binge drinking is defined as consuming 4 or more drinks for females, or 5 or more drinks for males, within a 2 hours drinking session. It was estimated that 25% of high school students reported binge drinking in past 30 days based on the data Youth Risk Behavior Surveys, United States, 1991-2015 [111]. Further, binge drinking starts in late adolescence and may continue during early adulthood [113]. Binge drinking leads to an elevated risk for negative short-term consequences such as drunk driving, risky sexual behavior (i.e., unprotected sex), and illicit drug use [114], as well as long-term consequences such as comorbid psychiatric issues [115], academic failure [116], and neurocognitive impairments [117]. Initiating binge drinking at an early age significantly increases the risk for subsequent adult alcohol use disorders [118]. Previous research found that obtaining a driver's license may increase the frequency of binge drinking among long-term licensed emerging adult drivers [30]. However, the research on association of binge drinking with driving licensure status, DDL, and driving frequency is limited.

The transition from high school to post-high school is one of the major life changes, termed emerging adulthood. During this transitional period, an emerging adult may have an elevated chance to access alcohol outlets and experience binge drinking along with increased independence and mobility as newly licensed driver or a rider of their newly licensed driver friends. Nonetheless, among emerging adults, the effect of acquiring a driver’s privileges, including having independent driver’s license, no DDL, and more miles driven, and the transition to independent driving in determining binge drinking has received limited research attention. One study has been conducted on binge drinking either do not determine the licensure status of study participants or they altogether exclude emerging adults who are not currently licensed drivers [30]. Specifically, the researchers found that newly licensed drivers (obtained within three months of survey) were less likely to report binge drinking in the first 30 days, but binge drinking increased as emerging adult drivers gained more driving experience [30]. However, this association may be confounded by age, thus making it difficult to determine the independent

impact that possession of a driver's license had on binge drinking. In addition, although the previous research investigated trajectories of binge drinking across emerging adulthood [121], research is needed to examine potential association between of driving licensure status, DDL, and driving frequency with binge drinking among emerging adults.

In the late 20th century, U.S. emerging adults experienced unexpectedly high levels of drug use [122]. Since 2011, the proportion of illicit drug use among 12th graders has remained between 47% and 50% [122]. Emerging adults with persistent drug use are facing a range of problems, including reduced academic performance and delinquency [124]. Emerging adult drug use has been associated with lower graders, absenteeism from school and other academic activities, and an increased risk of dropping out of school [124, 125]. Additionally, emerging adults with continued drug use are more likely to encounter arrest, adjudication, and intervention by the juvenile justice system [124]. Research has shown that drug use and delinquent behavior are strongly related, and these two behaviors may result in a variety of adverse consequences, such as involvement in negative peer drug use [126, 127].

Further, getting an independent driving license may facilitate access to drugs with greater independence and mobility in an extended environment (e.g., a space far from home or a private space provided by a vehicle) [308]. However, the current knowledge base lacks an understanding of how driving licensure status (no licensure in emerging adulthood vs. having a driver's license in high school and after high school), DDL (no delay in driving licensure vs. delay in driving licensure), and the extent of emerging adult exposure to driving (driving frequency) after licensure may associate with drug use in emerging adulthood.

Latent Class Growth Modeling (LCGM) is a novel analytic technique that has been increasingly used in public health research to identify distinct trajectory classes of health behavior [309]. This approach allows researchers to estimate the likelihood of a person belonging to a specific trajectory class based on a set of observed variables over time. In this study, I use LCGM technique to identify distinct trajectory classes of being drinking and driving

frequency among emerging adults. This novel technique to identifying trajectory classes of binge drinking and driving frequency may allow me to gain a better understanding the dynamics of alcohol drinking, binge drinking, and driving frequency when transitioning from adolescence to adulthood.

To date, no known research has attempted to determine whether having a driver's license, no DDL, and a higher level of driving frequency as independent risk factors for alcohol drinking, binge drinking, and drug use among emerging adults. Collectively, I explored the associations of driving licensure status, DDL, and driving frequency trajectory classes with alcohol drinking, binge drinking, and drug use trajectory classes using data from a longitudinal cohort of U.S. adolescents.

METHODS

Sampling

This study used the data from the NEXT Generation Health Study (NEXT) with a nationally representative American youth cohort starting in 10th grade (Wave 1, 2009-2010) and ending four years after high school (Wave 7).

The NEXT used a multistage sampling strategy to select primary sampling units (PSU, U.S. school districts) from nine census divisions. Specifically, from each school district, schools were randomly selected and classrooms within the schools were randomly selected. Among the 145 selected schools, 81 schools agreed to participate. African American students were oversampled to obtain a large enough sample (N=687) for more accurate population estimates. Surveys were administered annually for each wave in the spring semester. In total, 2783 participants enrolled in the NEXT study. The data collected in W1 through W7 were used for this study. Among the 2,783 participants, 90% (N=2524), 87% (N=2439), 86% (N=2395), 78% (N=2177), 79% (N=2202), 83% (N=2306), and 83% (N=2323) of participants completed W1, W2, W3, W4, W5, W6 and W7, respectively. Parents provided informed consent for their child's participation. Participants younger than 18 years of age provided assent, and consent was

obtained from participants once they reached age 18. The Institutional Review Board of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development reviewed and approved the study protocol.

Covariates

Participants' sex, race/ethnicity, parental education level, family affluence, and urbanicity were collected at the baseline visit (W1, 10th grade). The biological sex of participants was female or male. Participant race/ethnicity was categorized as Latinos, Non-Latino Blacks, Non-Latino Whites and Others (including Asian, American Indiana or Alaska Natives, and Native Hawaiians Other Pacific Islanders). The highest educational attainment of participant parents was categorized as: 1) Less than a high school diploma, a high school diploma or GED; 2) Some college, technical school or associate degree; or 3) Bachelor or graduate degree. Urbanicity (suburban, rural, vs. urban) was derived from participants' school location at W1 according to the National Center for Education Statistics [295]. The family socioeconomic status was obtained by the Family Affluence Scale, a widely used and validated proxy for socioeconomic status [269]. Specifically, participants were asked how many cars their family owned, the number of computers owned, whether participants had their own bedroom, and the number of family vacations taken in the last 12 months. Then, participants' family affluence status was categorized as low, moderate, or high affluence [270]. Information about participants' family structure was collected during the recruitment home visit by asking participants about the home where they lived all or most of the time. They were given the opportunity to respond about a second home, including how much time they lived there. The family structure was categorized as: both biological parents; one biological parent, one step-parent; single parent, mother only; single parent, father only; and other. This information was then collapsed into four groups for the analysis: both biological parents, biological and step-parent, and other. For the first time having a drink of an alcoholic beverage, participants were asked how old they were the first time they had a drink of an alcoholic beverage.

Dependent variables

Alcohol drinking (W1-7). Alcohol drinking was measured based on replies to 1 question derived from the Health Behavior in School-Aged Children questionnaire [263]: “On how many occasions (if any) have you drunk alcohol in the last 30 days?” Response options ranged from 1 (never) to 7 (40 times or more). Specifically, the original response 1 indicated none alcohol drinking over the last 30 days (recorded to 0). The original response 2 indicated 1-2 times alcohol drinking over the last 30 days (recorded to 1.5). The original response 3 indicated 3-5 times alcohol drinking over the last 30 days (recorded to 4). The original response 4 indicated 6-9 times alcohol drinking over the last 30 days (recorded to 7.5). The original response 5 indicated 10-19 times alcohol drinking over the last 30 days (recorded to 14.5). The original response 6 indicated 20-39 times alcohol drinking over the last 30 days (recorded to 29.5). The original response 7 indicated 40 times or more alcohol drinking over the last 30 days (recorded to 40).

Binge drinking (W1-7). Binge drinking was measured using one question derived from the Monitoring the Future national survey [264]: “Over the last 30 days, how many times (if any) have you had four (for females)/five (for males) or more drinks in a row on an occasion?” Response options ranged from 1 (none) to 6 (10 or more times). Specifically, the original response 1 indicates no binge drinking over the last 30 days (recorded to 0). The original response 2 indicates 1 time binge drinking over the last 30 days (recorded to 1). The original response 3 indicates 2 times binge drinking over the last 30 days (recorded to 2). The original response 4 indicates 3 to 5 times binge drinking over the last 30 days (recorded to 4). The original response 5 indicates 6 to 9 times binge drinking over the last 30 days (recorded to 7.5). The original response 6 indicates 10 or more times binge drinking over the last 30 days (recorded to 10).

Drug use (W1-7). Drug use was measured by asking participants 10 questions derived from the Monitoring the Future survey on how often they had ever used drugs (i.e., marijuana, ecstasy,

medication to get high) in the last 12 months, with 7 options (from 1 = never to 7 = 40 times or more) [265]. Specifically, the original response 1 indicates no drug use over the last 12 months (recorded to 0). The original response 2 indicates 1-2 times drug use over the last 12 months (recorded to 1.5). The original response 3 indicates 3-5 times drug use over the last 12 months (recorded to 4). The original response 4 indicates 6-9 times drug use over the last 12 months (recorded to 7.5). The original response 5 indicates 10-19 times drug use over the last 12 months (recorded to 14.5). The original response 6 indicates 20-39 times drug use over the last 12 months (recorded to 29.5). The original response 7 indicates 40 times drug use over the last 12 months (recorded to 40).

Independent variables

Driving licensure status* (*W1-7). Driving licensure status was generated from emerging adults reporting if they had licensure following independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.). Participants were asked “Do you have a driver’s license?” with four possible responses. Only participants who chose “License allowing independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.)” were indicated as having licensure. Other responses including “No license of any sort”, “Permit to take the classroom component of driver education only”, and “Permit allowing supervised practice driving with an instructor or licensed adult” were indicated as no licensure. Participants were categorized into three groups: had an independent license in high school at any of first three waves [W1-W3]), had an independent license in high school any of last four waves [W4-W7] but not at any of first three waves, and did not have an independent license. Participants were categorized as missing driver’s license status if they didn’t report their driver’s license status at any wave.

Delay in driving licensure (DDL, W1-7). DDL was derived using participants’ age at the time of the survey, information in their state’s legal requirement, and their self-reported driving licensure status. Participant date of birth was assessed at baseline, and their age at each wave was

calculated. State requirements for initial legal eligibility for getting an independent driver's license were obtained for NEXT survey years through Department of Motor Vehicles websites for corresponding states. Driving licensure was ascertained by asking, "Do you have a driver's license?", with four possible responses: (1) no license of any sort, (2) permit to take the classroom component of driver education only, (3) permit allowing supervised practice driving with an instructor or licensed adult, and (4) license allowing independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.) from all seven waves. We defined DDL as a dichotomous variable, i.e., no-DDL versus DDL, with those in the delayed group having not obtained their independent license (i.e., response 1 to 3) at the first wave in which they were eligible.

Driving frequency (W1-7). Driving frequency was measured with one question, "On how many of the last 30 days did you drive a vehicle?" with possible responses of the number of days from 0 to 30. Given that the possible responses for the number of the last 30 days was from 0 to 30, those participants who reported >30 were deleted.

Statistical analyses

Descriptive statistics [e.g., means, standard deviation (SD), and frequencies] were summarized to describe participant sociodemographic variables (e.g., race/ethnicity, sex, parental education etc.) stratified by alcohol drinking, binge drinking, and drug use. Latent Class Growth Modeling (LCGM) was conducted to identify a set of discrete, mutually exclusive latent classes of participants based on their responses to alcohol drinking, binge drinking, drug use, and driving frequency, respectively [296]. The logistic (LOGIT) model of LCGM was designed to analyze the growth trajectories of binary outcome variables over time. The LOGIT model was designed to account for the fact that binary variables can be affected by both a temporally dynamic and a temporally stable latent factor (e.g., latent class). By incorporating both factors, the LOGIT model allowed researchers to better understand the underlying mechanisms of binary variables, as well as to more accurately identify the optimal growth trajectories of such binary variables [310]. The

LOGIT model of LCGM was used for alcohol drinking, binge drinking, and drug use as binary variables [296]. The censored (CORM) model of LCGM was designed to allow researchers to model longitudinal growth in data that were measured on a scale, such as a Likert scale [296]. The censored (CORM) model of LCGM was used for driving frequency measured by a scale [296]. We examined models that extracted different numbers and shapes (e.g., linear versus quadratic) of trajectories and selected the model that best fit the data [274] as evaluated using the Bayesian Information Criterion (BIC) [274]. The fit of each nested model was compared using the estimate of the log Bayes factor [2 log(B10) ≈ 2 (ΔBIC)] [274]. A log Bayes factor value greater than ten was interpreted as very strong evidence of a model fit [274]. Models were initially examined with all quadratic terms. If the quadratic term was non-significant, the cubic term was considered; otherwise, the linear term was included. We selected the best number of trajectories based on the BIC and estimated Bayes Factor. We decided on the best number of groups and then tested various models for the makeup of quadratic, cubic, and linear terms.

The average posterior probability and odds of correct classification were calculated to evaluate the model fit. Each subject in the sample was assigned a posterior probability—the probability of belonging to a trajectory class given their level of monthly driving frequency at each assessment—which was averaged for each trajectory class. The closer the average posterior probabilities are to one, the better the model fit. The equation for the odds of correct classification is outlined in [297], with an odds of correct classification equal to one indicating that the probability of group membership is no better than random guessing. Generally, an odd of correct classification of 5 or higher is recommended and met or exceeded for all trajectory classes. An average posterior probability value of greater than 0.70 is interpreted as indicative of good internal reliability for within-group membership.

Chi-square statistical analyses were used to examine the association between trajectory variables (alcohol drinking, binge drinking, and drug use) and sociodemographic variables (e.g., sex, race/ethnicity, parent education etc.). Rao-Scott approach was conducted for categorical

variables. Savage one-way approach was performed for continuous variables. Multinomial logistic regression was used to examine the associations of driving licensure status (no licensure in emerging adulthood vs. having licensure in high school and having licensure after high school), DDL (no delay in driving licensure vs. delay in driving licensure), and driving frequency trajectory classes with alcohol drinking, binge drinking, and drug use (independent variables), respectively, taking complex survey sample features into account. For example, multinomial logistic regression equation was $\text{logit}\,[\,\text{p}(\text{Y}_{\text{alcohol drinking trajectory class=escalator class}})] = \log[\frac{\text{p}(\text{Y}_{\text{alcohol drinking trajectory class=escalator class}})}{1-\,\text{p}(\text{Y}_{\text{alcohol drinking trajectory class=escalator class}})}] = \beta 0 + \beta_{driving\ licensure\ status} X_{driving\ licensure\ status} + \beta_{\text{race/ethnicity}}\text{X}_{\text{race/ethnicity}} + \beta_{\text{parental education}}\text{X}_{\text{parental education}} + \beta_{\text{urbanicity}}\text{X}_{\text{urbanicity}} + \beta_{\text{family structure}}\text{X}_{\text{family structure}} + \beta_{\text{family affluence}}\text{X}_{\text{family affluence}}$, where Y was alcohol drinking trajectory class as a dependent variable, $\text{p}(\text{Y}_{\text{alcohol drinking trajectory class=escalator class}})$ was probability of escalator class in alcohol drinking, $\text{X}_{\text{driving licensure status}}$ was driving licensure status as an independent variable, $\text{X}_{\text{race/ethnicity}}$, $\text{X}_{\text{parental education}}$, $\text{X}_{\text{urbanicity}}$, $\text{X}_{\text{family structure}}$, and $\text{X}_{\text{family affluence}}$ were covariates controlled in the multinominal logistic regression analyses, and βs were the coefficients (for example, $\beta_{\text{driving licensure status}}$ was the coefficient for driving licensure status). Adjusted odds ratio (AOR) was found using multinomial logistic regression equation. For example, the relative log odds of being in alcohol drinking escalators class vs. abstainers/light class was $\log[\frac{P(alcohol\ drinking\ trajectory\ class=escalator\ class)}{P(alcohol\ drinking\ trajectory\ class=abstainers/light\ class)}] = b_0 + b_{driving\ licensure\ status} + b_{race/ethnicity} + b_{parental\ education} + b_{urbanicity} + b_{family\ structure} + b_{family\ affluence}$. AOR can be obtained by exponentiating the equation above, yielding regression coefficients that are AOR. The statistical significance level was set at $p = .05$ for all analyses. All analyses were performed in SAS software version 9.4 (SAS Institute, Cary, NC) [298].

RESULTS

Among participants, 412 were categorized as abstainers to escalators (29.89% [weighted and hereafter]), 173 (42.57%) as experimenters, and 609 (51.15%) as escalators in alcohol drinking using LCGM. There was an overall average posterior probability of 0.87 and an average of odds of correct classification of 17.71 indicating a well fitting model (Table 4.1). Figure 4.1 shows trajectories (abstainers to escalators, escalators, and experimenters) of alcohol drinking in the last 30 days among emerging adults over seven consecutive years beginning in the 10th grade.

Among participants, 619 were categorized as binge drinking abstainers to late escalators (43.00% [weighted and hereafter]), 475 (43.64%) as binge drinking escalators, and 100 (13.37%) as consistent high binge drinking using LCGM. There was an overall average posterior probability of 0.88 and an average of odds of correct classification of 20.75 indicating a well fitting model (Table 4.2). Figure 4.2 shows trajectories (abstainers to late escalators, escalators, and consistent high) of binge drinking in the last 30 days among emerging adults over seven consecutive years beginning in the 10th grade.

Among participants, 901 were categorized as drug use abstainers (60.68% [weighted and hereafter]), 475 (29.50%) as escalators, and 127 (9.83%) as experimenters in drug use using LCGM. There was an overall average posterior probability of 0.918 and an average of odds of correct classification of 48.03 indicating a well fitting model (Table 4.3). Figure 4.3 shows trajectories (abstainers, escalators, and experimenters) of drug use at least once in the last 12 months among those emerging adults over seven consecutive years beginning in the 10th grade.

Among participants, 412 were categorized as alcohol drinking abstainers to escalators (29.89% [weighted and hereafter]), 173 (42.57%) as alcohol drinking experimenters, and 609 (51.15%) as alcohol drinking escalators. There was an overall average posterior probability of 0.87 and an average of odds of correct classification of 17.71 indicating a well fitting model (Table 4.1). Figure 4.1 shows trajectories (abstainers to escalators, escalators, and experimenters) of alcohol drinking in the last 30 days among emerging adults over seven consecutive years beginning in the 10th grade.

Table 4.4 shows participant sociodemographic variables (e.g., race/ethnicity, sex, parental education etc.) stratified by alcohol drinking trajectory classes (abstainers to light, light, and escalators). Alcohol drinking trajectory classes were significantly associated with urbanicity (Rao-Scott $\chi 2=11.515$, $p=0.021$).

Table 4.5 shows participant sociodemographic variables (e.g., race/ethnicity, sex, parental education etc.) stratified by binge drinking trajectory classes (abstainers to late escalators, escalators, and consistent high). Binge drinking trajectory classes were significantly associated with race/ethnicity (Rao-Scott $\chi 2=26.726$, $p<.001$) and urbanicity (Rao-Scott $\chi 2=14.866$, $p=0.005$), respectively.

Table 4.6 shows participant sociodemographic variables stratified by drug use trajectories (abstainers, escalators, and experimenters). Drug use was significantly associated with sex (Rao-Scott $\chi 2=11.033$, $p=0.004$).

There were statistically different odds of alcohol drinking trajectory classes on driving licensure status, delay in driving licensure, and driving frequency trajectory classes, respectively (Table 4.7). Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school were more likely (adjusted odds ratio [AOR]=4.07, 95% confidence interval [CI] 1.19 117.74, $p=0.002$) to be in the alcohol drinking escalators class than in the abstainers/light class. Compared with emerging adults with DDL, emerging adults with no DDL were more likely (AOR=1.14, 95%CI 1.73 1.77, $p=0.006$) to be in the alcohol drinking escalators class than in the abstainers/light class. Compared with emerging adult with low driving frequency class, emerging adults in the medium driving frequency class were more likely (AOR=2.82, 95%CI 1.44 5.50, $p=0.034$) to be in the alcohol drinking light class than in the abstainers/light class. Compared with emerging adults in the low driving frequency class, emerging adults in the high driving frequency class were more likely (AOR=3.16, 95%CI 1.41 7.06, $p=0.032$) to be in the alcohol drinking light than in the alcohol drinking abstainers/light class.

There were statistically different odds of binge drinking trajectory classes on driving licensure status, delay in driving licensure, and driving frequency trajectory classes (Table 4.8). Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school (AOR=15.54, 95%CI 1.59 1.92, p=0.015) and after high school (AOR=9.15, 95%CI 1.05 7.97, p=0.016) were more likely to be in the high consistent binge drinking class than in the abstainers/late escalators class, respectively. Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses after high school were more likely (AOR=9.15, 95%CI 1.05 7.97, p=0.016) to be in the high consistent binge drinking class than in the abstainers/late escalator class. Compared with emerging adults with DDL, emerging adults with no DDL were more likely to be in the binge drinking escalators (AOR=1.09, 95%CI 1.69 1.71, p=0.007) class than in the abstainers/late escalators class. Compared with emerging adults in the low driving frequency class, emerging adults in the medium driving frequency class were more likely (AOR=1.65, 95%CI 1.91 2.17, p=0.033) to be in the binge drinking escalators than in the abstainers/late escalators class.

There were statistically different odds of drug use trajectories on driving licensure status, delay in driving licensure, and driving frequency trajectory classes (Table 4.9). Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school were more likely (AOR=1.30, 95%CI 1.08 2.18, p=0.022) to be in the drug use escalators class than in the abstainers class. Compared with emerging adults with DDL, emerging adults with no DDL were more likely AOR=1.03, 95%CI 1.02 1.56, p=0.029) to be in the drug use escalators than in the abstainers class. Compared with emerging adults in the low driving frequency class, emerging adults in the medium driving frequency class were more likely (AOR=1.23, 95%CI 1.05 1.78, p=0.017) to be in the drug use escalator than in the abstainers class.

DISCUSSION

To the best of our knowledge, this is one of the first studies to assess the associations of driving licensure, delay in driving licensure (DDL), and driving frequency with alcohol drinking, binge drinking, and drug use when transitioning to early adulthood. The results indicated that obtaining a driver's license in high school, no delay in driving licensure, and more driving frequency were associated with a higher likelihood of experiencing alcohol drinking, binge drinking, and drug use to a greater extent in emerging adulthood.

We found that the majority of emerging adult participants (51.15%) were categorized as alcohol drinking escalators. This is consistent with previous research on alcohol drinking in youth and emerging adults, which has suggested that adolescents and young adults are more likely to increase their alcohol consumption in emerging adulthood [311]. This result highlights the importance of preventive strategies to reduce alcohol use in emerging adults. Preventive strategies to reduce alcohol use in emerging adults can include providing education on the potential health risks of alcohol use, increasing access to mental health and substance abuse services, implementing alcohol-free social activities, limiting access to alcohol in public places, and enforcing strict laws and regulations on alcohol sales and consumption. Additionally, providing support networks for emerging adults and involving family members in conversations about alcohol use and its potential risks can go a long way in helping reduce alcohol use among this group. Finally, offering educational resources and support services to those already struggling with alcohol abuse can help promote healthier lifestyles.

In terms of binge drinking, we found the trajectory classes of binge drinking among emerging adults over seven consecutive years beginning in the 10th grade. Among the participants, 619 (43.00% weighted) were identified as binge drinking abstainers to late escalators, 475 (43.64%) as binge drinking escalators, and 100 (13.37%) as high consistent binge drinking. These findings are significant because the trajectories of binge drinking among emerging adults can help inform intervention strategies and prevention methods. For example, interventions tailored to the specific needs of being drinking escalators may be more effective than a

generalized intervention for all emerging adults. Additionally, prevention programs can be implemented to target the consistent high binge drinkers in order to help reduce the prevalence of binge drinking in emerging adults. Previous research has also highlighted the importance of understanding the trajectories of binge drinking among emerging adults [312]. The majority of emerging adults who drank alcohol reported weekly heavy driving, indicating that binge drinking was a common occurrence among emerging adulthood [312]. Furthermore, binge drinking can increase the risk of developing alcohol-related harms in the future. Therefore, it is essential to continue studying the trajectories of binge drinking in order to develop effective interventions and prevention programs for emerging adults.

Regarding drug use, we found that drug use increased over time for the escalator and experimenter categories, while the abstainer category remained steady. This result is supported by previous research, which indicates that substance use is a complex behavior that is impacted by numerous environmental and personal factors [313]. Further, the research has shown that abstaining from drug use is one of the most effective ways to prevent drug use in adolescents and young adults [314]. Therefore, these results indicate that refraining from drug use may be targeted for emerging adults.

Driving privileges, including getting an independent driving license, no delay in driving licensure, and a higher level of driving frequency, are associated with independence and mobility among emerging adults. Driving is an important part of the transition to adulthood, as emerging adults gain the ability to travel and explore in ways they were not able to when they were younger [315]. Driving can provide a sense of freedom and control, allowing emerging adults to make their own choices about where to go and when [316]. Furthermore, the act of getting a driver's license is a milestone for many emerging adults and is often seen as a symbol of adulthood [317]. Having an independent driver's license can increase mobility and freedom among emerging adults. For example, emerging adults with a driver's license often have increased access to activities, employment, and social engagement [316]. In one study, emerging adults without a driver's

license were more restricted in their ability to move around, which can lead to feelings of frustration and isolation [315]. Additionally, a driver's license can make it easier to access safe, reliable transportation options, which can provide a sense of security and independence [317]. Obtaining a driver's licenses can also affect emerging adults' mobility and freedom. Obtaining a driver's license soon after turning 16 y/o can increased access to activities, employment, and social engagement [316]. Conversely, if emerging adults delay getting their driver's license, they are more likely to experience decreased mobility and freedom [315]. Further, the number of miles emerging adults drive can also effect their mobility and freedom to explore and experience new places and activities [317]. Collectively, getting an independent driving license, no delay in driving licensure, and more miles driven can serve as agents and indicators of facilitating independence and mobility among emerging adults. By providing increased access to activities, employment, and social engagement, these driving privileges can help emerging adults gain a sense of freedom. However, early licensure could also be associated with negative outcomes such as binge drinking.

The found associations of obtaining a driver's license in high school, no DDL, and more driving frequency with alcohol use, binge drinking, and drug use indicated an increase in substance use, including alcohol use, binge drinking, and drug use, when emerging adults begin to drive. According to a study conducted by the Centers for Disease Control and Prevention (CDC), the likelihood of substance use among adolescents is significantly higher in those who have obtained their driver's license in high school [318]. Further, the study found that adolescents who obtained their license at the legal age of 16 were more likely to engage in substance use than those who waited until they were older than 16 years old [318]. This suggests that the earlier adolescents obtain their license, the higher their likelihood of engaging in substance use. Additionally, the results of our study show that adolescents who drove more frequently were more likely to engage in substance use. This is supported by a study conducted by the National Institute on Alcohol Abuse and Alcoholism (NIAAA), which found that adolescents who were licensed

drivers had higher rates of substance use than those who were not licensed drivers [319]. Furthermore, the study found that among adolescents who were licensed drivers, those who drove more frequently had higher rates of substance use than those who drove less frequently [319].

Our research has found that emerging adult drivers with driver's licenses are more likely to report binge drinking than those without a license. This finding is consistent with previous research, which has suggested that emerging adults with greater access to transportation were more likely to engage in underage drinking [320]. Binge drinking among emerging adults can be attributed to a number of factors, such as the increased freedom and access to alcohol that comes with having a driver's license [321]. The increased mobility associated with having a license might also make it easier for emerging adults to access alcohol, as well as provide them with more opportunities to engage in binge drinking [320]. In order to reduce binge drinking among emerging adults, it is important to address the underlying factors that contribute to binge drinking. Policies such as increasing the legal drinking age and increasing enforcement of existing laws against alcohol drinking among emerging adults may help reduce access and availability of alcohol to underage drinkers [321]. Additionally, interventions that focus on educating emerging adults about the risks associated with binge drinking can help reduce their binge drinking [320]. Ultimately, reducing binge drinking among emerging adults will require a comprehensive approach that involves both policy and education interventions.

Several limitations exist in our study. First, drug use measures were self-reported and assessed annually. We generated a dichotomous variable of drug use if participants used any kinds of drugs (i.e., marijuana, ecstasy, medication to get high). More frequent assessments of drug use would be informative. Second, all variables were self-reported, and thereby introduce the potential for reporting bias. Third, it would be ideal to know the exact date (i.e., month/date/year) when participants received their driving license so that an exact DDL measure could have been used in our analysis. Given that the exact licensure dates were not available in

the NEXT study, we calculated and approximated the DDL variable as any delay in licensure past the earliest assessment when a participant was eligible for licensure with consideration of their state's legal requirements. Fourth, statistical significance (e.g., AOR=1.03, 95%CI 1.02 1.56, p=0.029) does not necessarily imply that the association between DDL and drug use is practically significant. A small difference between DDL and drug use may be statistically significant, but the difference may be too small to be meaningful. Thus, it is important to consider both statistical and practical significance when interpreting the effects of DDL on drug use. Despite these limitations, our study has notable strengths. The strengths of the research include a relatively large, nationally representative sample of adolescents surveyed longitudinally over 7 years, with data on driving licensure, DDL, driving frequency, alcohol drinking, binge drinking, and drug use the first year after high school. Further, this longitudinal study was based on a nationally representative sample that allows the findings for nationally generalizability to the U.S. emerging adult populations.

In conclusion, the study findings highlight the increased risk for alcohol drinking, binge drinking, and drug use among emerging adults with driving privileges including having licensure in high school, no DDL, and more driving frequency. Policymakers should consider the adoption of preventive measures to deter emerging adult drivers with binge drinking from obtaining driving privileges in the first place. Parents and other responsible adults should be made aware of the tradeoffs between increase independence and risk associated with early licensure and greater early driving exposure.

Table 4.1 Proportions, average posterior probabilities, and odds of correct classifications of alcohol drinking trajectory classes among emerging adults

	N (Weighted %)	Average posterior probabilities (Range)	Odds of Correct Classification
Alcohol Drinking Abstainers to Light Alcohol Drinking	638 (47.59)	0.880 (0.504-0.999)	8.08
Light Alcohol Drinking	470 (42.80)	0.863 (0.502-1.000)	8.42
Alcohol Drinking Escalators	86 (9.61)	0.916 (0.504-1.000)	112.38

Note: Weighted % using the weight based on W1-W7 weights

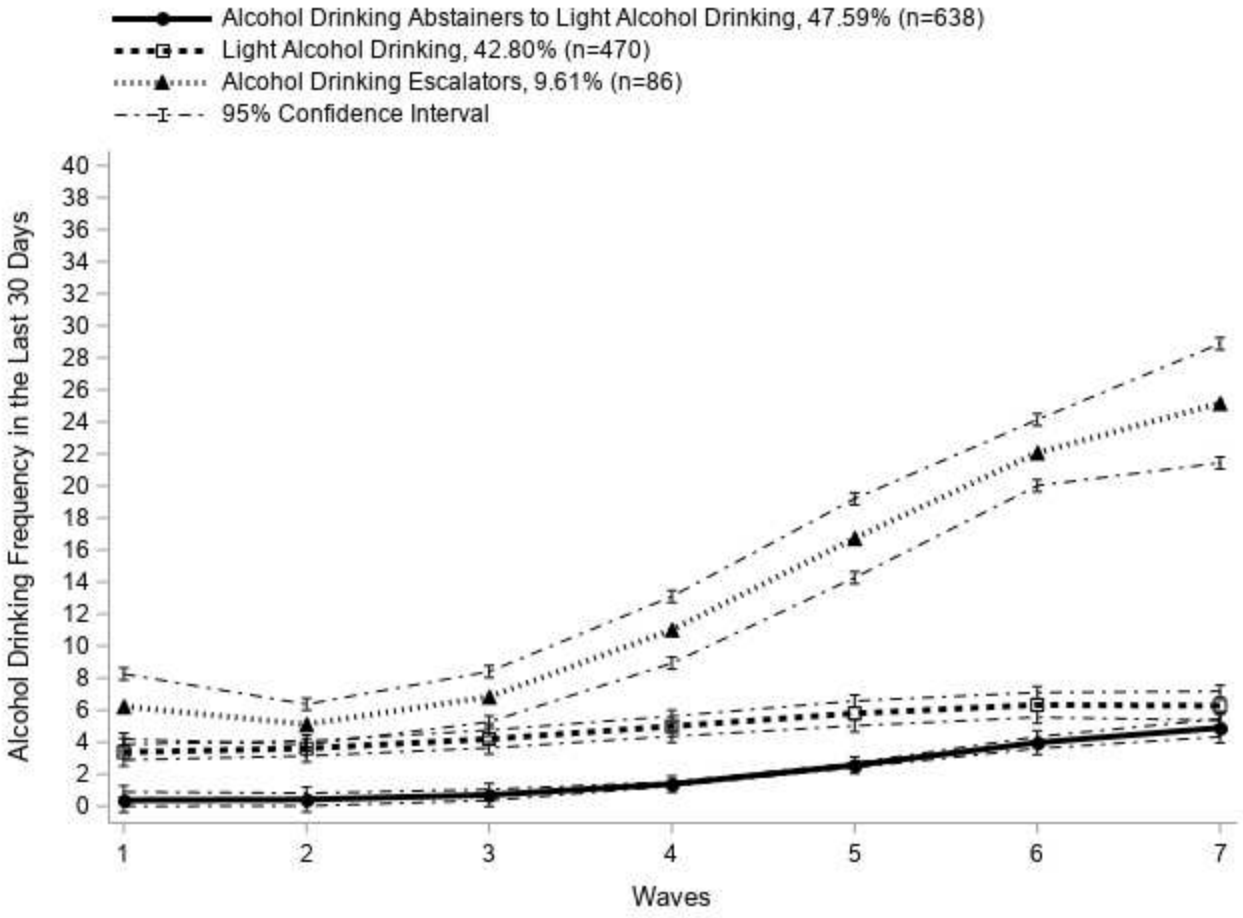

Figure 4.1 Trajectories (Abstainers to Escalators, Escalators, and Experimenters) of alcohol drinking in the last 30 days among emerging adults over seven consecutive years beginning in the 10th grade

Table 4.2 Proportions, average posterior probabilities, and odds of correct classifications of binge drinking trajectory classes among emerging adults

	N (Weighted %)	Average posterior probabilities (Range)	Odds of Correct Classification
Binge Drinking Abstainers to Late Escalators	670 (47.40)	0.902 (0.500-0.999)	10.214
Binge Drinking Escalators	446 (43.19)	0.873 (0.507-0.997)	9.042
Consistent High Binge Drinking	78 (9.41)	0.882 (0.513-1.000)	71.960

Note: Weighted % using the weight based on W1-W7 weights

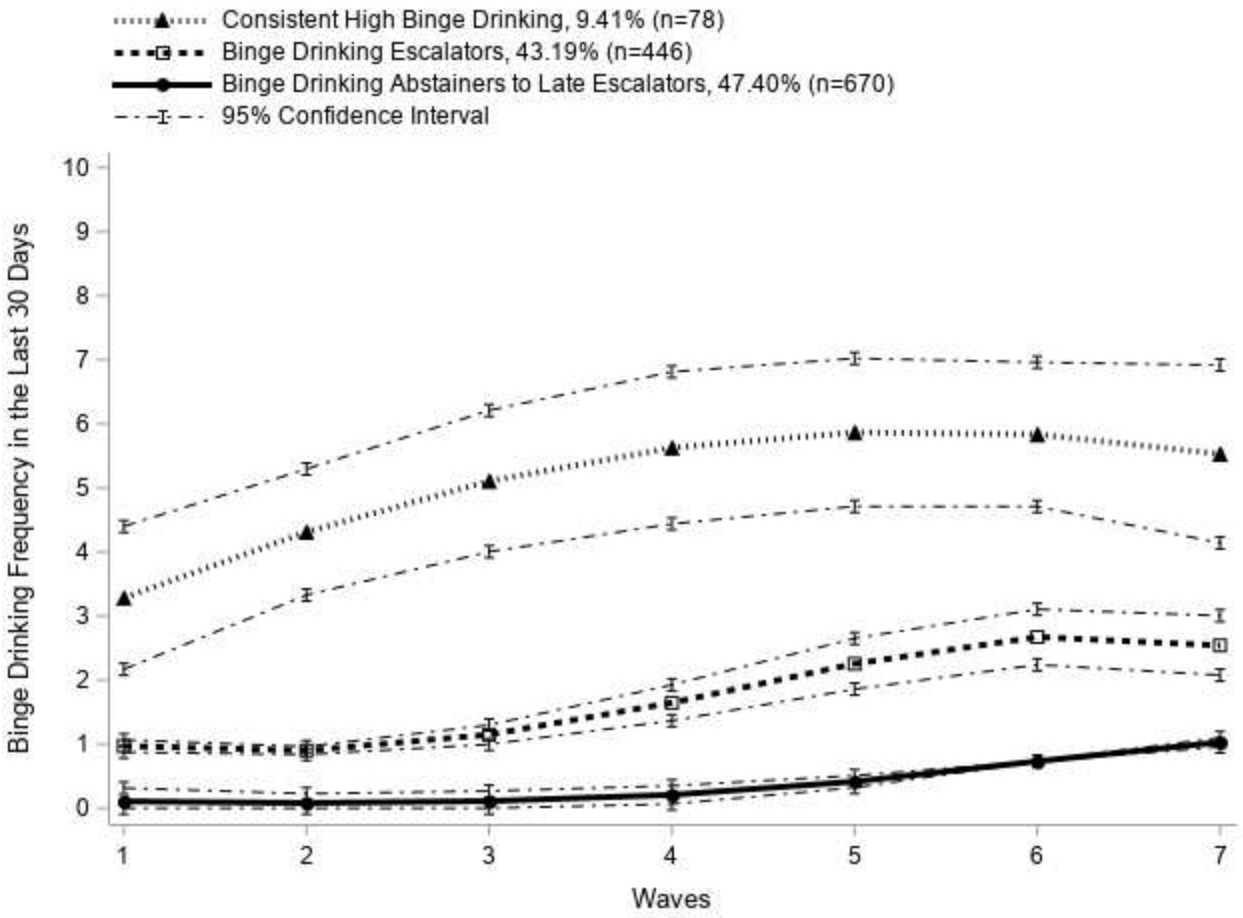

Figure 4.2 Trajectories (Abstainers to Late Escalators, Escalators, and Consistent High) of binge drinking in the last 30 days among emerging adults over seven consecutive years beginning in the 10th grade.

Table 4.3 Proportions, average posterior probabilities, and odds of correct classifications drug use trajectory classes among emerging adults

	N (Weighted %)	Average posterior probabilities (Range)	Odds of Correct Classification
Abstainers	901 (60.68)	0.944 (0.506-0.987)	10.92
Escalators	475 (29.50)	0.885 (0.503-1.000)	18.39
Experimenters	127 (9.83)	0.926 (0.511-1.000)	114.79

Note: Weighted % using the weight based on W1-W7 weights

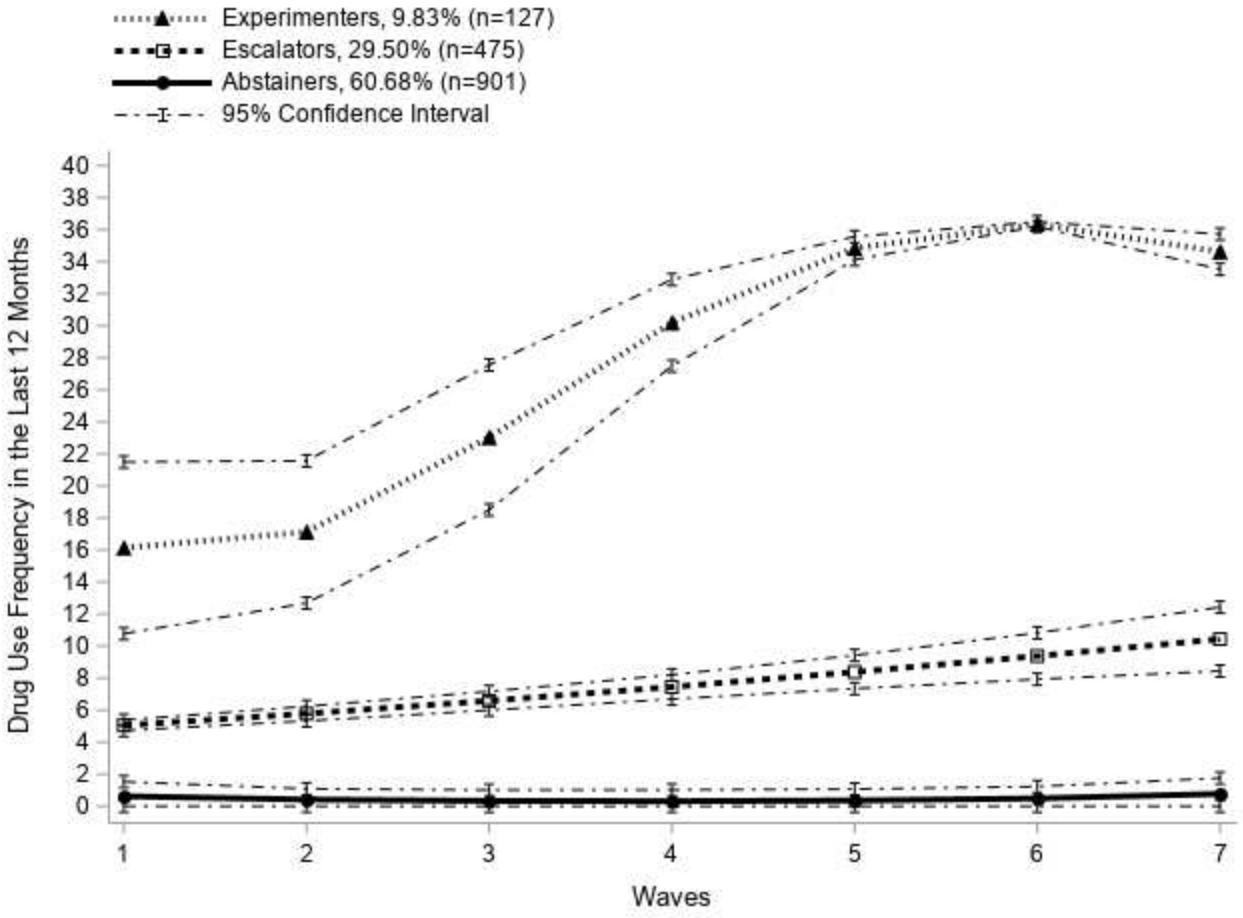

Figure 4.3 Trajectories (Abstainers, Escalators, and Experimenters) of drug use in the last 12 months among emerging adults over seven consecutive years beginning in the 10th grade.

Table 4.4 Participant sociodemographic variables stratified by alcohol drinking trajectories (Abstainers to Light, Light, and Escalators)

		Abstainers to Light N (%[#])	Light N (%[#])	Escalators N (%[#])	χ^2	P
Overall[a]		637 (48.23)	464 (42.40)	84 (9.37)		
Sample Sociodemographic variables						
Race/ethnicity[b]	Latinos	299 (50.90)	196 (39.36)	27 (9.74)	10.137	0.119
	African Americans	185 (59.59)	83 (30.53)	14 (9.88)		
	Whites	323 (41.99)	352 (46.66)	81 (11.35)		
	[c]Others	39 (40.37)	30 (57.74)	3 (1.89)		
Sex[b]	Male	346 (45.76)	267 (43.12)	68 (11.12)	0.240	0.887
	Female	500 (46.85)	394 (43.14)	58 (10.01)		
Parental education[b]	High school or less	320 (47.67)	232 (45.14)	31 (7.19)	2.633	0.621
	Some college	288 (45.71)	236 (42.00)	50 (12.29)		
	Bachelor+	179 (44.20)	167 (43.38)	39 (12.42)		
Urbanicity[b]	Urban	328 (56.51)	207 (36.39)	34 (7.10)	11.515	**0.021**
	Suburban	296 (46.77)	220 (43.95)	35 (9.29)		
	Rural	222 (41.93)	234 (44.57)	57 (13.50)		
Family affluence[b]	Low	279 (50.65)	185 (41.97)	21 (7.38)	5.879	0.208
	Moderate	404 (48.09)	302 (42.21)	62 (9.70)		
	High	163 (40.56)	174 (45.46)	43 (13.98)		
Family Structure[b]	Both biological parents	458 (45.98)	349 (44.54)	65 (9.48)	3.124	0.793
	Biological and step-parent	127 (45.42)	108 (42.01)	20 (12.57)		
	Single parent	178 (51.10)	128 (38.24)	27 (10.66)		
	[d]Others	83 (40.04)	76 (48.16)	14 (11.80)		
Driving Licensure Status	No license	87 (63.18)	49 (32.82)	5 (4.00)	14.681	**0.005**
	Have license in high school	297 (43.56)	283 (44.51)	64 (11.94)		
	Have license after high school	253 (58.36)	132 (38.80)	15 (2.83)		
Delay in Driving Licensure Status	No Delay in Driving Licensure	132 (46.85)	146 (42.08)	34 (11.08)	1.168	0.558
	Delay in Driving Licensure	499 (48.22)	316 (43.06)	50 (8.72)		
Driving frequency	Low	172 (69.72)	77 (23.99)	12 (6.29)	17.084	**0.002**
	Medium	371 (45.42)	280 (45.66)	45 (8.92)		
	High	94 (40.78)	107 (46.64)	27 (12.57)		

Note: [#]Weighed %; [a]Weighted % using the weight based on W1-W7 weights. [b]Weighted % using W1 weight. [c]Including Asian, American, Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders. [d]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else.

Table 4.5 Participant sociodemographic variables stratified by binge drinking trajectories (Abstainers to Late Escalators, Escalators, and Consistent High)

		Abstainers to Late Escalators N (%[#])	Escalators N (%[#])	Consistent High N (%[#])	χ^2	P
Overall[a]		668 (47.79)	441 (43.04)	76 (9.17)		
Sample Sociodemographic variables						
Race/ethnicity[b]	Latinos	305 (50.39)	202 (42.62)	15 (6.98)	26.726	**<.001**
	African Americans	229 (74.16)	49 (19.80)	4 (6.04)		
	Whites	318 (38.90)	350 (47.68)	88 (13.42)		
	[c]Others	40 (48.59)	30 (49.59)	2 (1.82)		
Sex[b]	Male	346 (41.50)	280 (46.02)	55 (12.47)	4.152	0.125
	Female	546 (50.85)	352 (39.90)	54 (9.25)		
Parental education[b]	High school or less	335 (51.14)	223 (43.00)	25 (5.86)	4.318	0.365
	Some college	307 (47.53)	226 (40.38)	41 (12.09)		
	Bachelor+	192 (42.04)	154 (43.91)	39 (14.05)		
Urbanicity[b]	Urban	360 (64.33)	194 (32.36)	15 (3.31)	14.866	**0.005**
	Suburban	308 (44.88)	211 (44.38)	32 (10.74)		
	Rural	224 (43.26)	227 (43.55)	62 (13.19)		
Family affluence[b]	Low	309 (59.44)	162 (34.31)	14 (6.25)	10.446	**0.034**
	Moderate	416 (45.86)	298 (42.55)	54 (11.60)		
	High	167 (39.78)	172 (48.15)	41 (12.07)		
Family Structure[b]	Both biological parents	460 (45.28)	342 (43.77)	70 (10.95)	1.643	0.949
	Biological and step-parent	145 (51.57)	98 (37.94)	12 (10.49)		
	Single parent	189 (45.89)	126 (43.25)	18 (10.86)		
	[d]Others	98 (50.36)	66 (41.91)	9 (7.73)		
Driving Licensure Status	No license	97 (66.93)	42 (32.62)	2 (0.45)	19.532	**0.001**
	Have license in high school	302 (42.27)	277 (46.55)	65 (11.18)		
	Have license after high school	269 (59.28)	122 (35.13)	9 (5.58)		
Delay in Driving Licensure Status	No Delay in Driving Licensure	132 (43.06)	140 (46.24)	40 (10.70)	12.432	**0.029**
	Delay in Driving Licensure	532 (51.57)	297 (39.83)	36 (8.60)		
Driving frequency	Low	165 (60.33)	92 (37.76)	4 (1.91)	9.695	**0.046**
	Medium	395 (44.16)	252 (45.90)	49 (9.94)		
	High	108 (48.42)	97 (39.44)	23 (12.14)		

Note: [#]Weighed %; [a]Weighted % using the weight based on W1-W7 weights. [b]Weighted % using W1 weight. [c]Including Asian, American, Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders. [d]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else.

Table 4.6 Participant sociodemographic variables stratified by drug use trajectories (Abstainers, Escalators, and Experiments)

		Abstainers N (%#)	Escalators N (%#)	Experimenters N (%#)	χ^2	P
Overall[a]		894 (61.20)	471 (29.19)	123 (9.613)		
Sample Sociodemographic variables						
Race/ethnicity[b]	Latinos	461 (61.95)	271 (30.79)	60 (7.26)	4.225	0.646
	African Americans	294 (61.06)	149 (27.14)	34 (11.80)		
	Whites	666 (58.98)	304 (28.23)	114 (12.79)		
	[c]Others	87 (56.11)	37 (33.03)	8 (10.86)		
Sex[b]	Male	641 (56.37)	338 (28.70)	137 (14.93)	11.033	**0.004**
	Female	870 (62.67)	424 (28.82)	79 (8.51)		
Parental education[b]	High school or less	547 (59.36)	301 (29.90)	77 (10.74)	0.244	0.993
	Some college	532 (60.36)	255 (27.88)	71 (11.77)		
	Bachelor+	338 (59.67)	160 (28.84)	55 (11.49)		
Urbanicity[b]	Urban	504 (58.49)	310 (32.73)	80 (8.785)	7.152	0.128
	Suburban	527 (58.39)	245 (27.68)	77 (13.93)		
	Rural	482 (62.43)	209 (28.68)	60 (8.89)		
Family affluence[b]	Low	497 (62.50)	242 (27.62)	62 (9.88)	1.401	0.844
	Moderate	712 (59.76)	353 (28.47)	96 (11.77)		
	High	304 (57.58)	169 (30.22)	59 (12.20)		
Family Structure[b]	Both biological parents	824 (63.77)	387 (27.43)	99 (8.80)	10.618	0.101
	Biological and step-parent	253 (55.99)	117 (29.63)	41 (14.39)		
	Single parent	298 (55.56)	161 (30.40)	48 (14.04)		
	[d]Others	138 (54.25)	99 (30.88)	29 (14.87)		
Driving Licensure Status	No license	137 (65.08)	54 (26.31)	19 (8.60)	2.109	0.716
	Have license in high school	448 (58.90)	237 (30.96)	71 (10.13)		
	Have license after high school	309 (66.04)	180 (25.40)	33 (8.57)		
Delay in Driving Licensure Status	No Delay in Driving Licensure	215 (61.60)	110 (29.25)	33 (9.15)	0.130	0.937
	Delay in Driving Licensure	673 (61.51)	356 (28.42)	90 (10.07)		
Driving frequency	Low	222 (65.92)	108 (25.68)	28 (8.40)	2.061	0.725
	Medium	520 (60.91)	270 (29.05)	73 (10.04)		
	High	152 (58.14)	93 (32.41)	22 (9.45)		

Note: #Weighed %; [a]Weighted % using the weight based on W1-W7 weights. [b]Weighted % using W1 weight. [c]Including Asian, American, Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders. [d]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else.

Table 4.7 Multinominal logistic regression of alcohol drinking trajectory classes on driving licensure status, delay in driving licensure, and driving frequency trajectory classes, respectively

	Escalators vs. Abstainers to Light			Light vs. Abstainers to Light		
	AOR	95%CI	P	AOR	95%CI	P
No independent license in emerging adulthood	Ref.	-	-	Ref.	-	-
Have independent license in high school	**4.07**	**1.94, 17.74**	**0.002**	1.83	0.65, 5.16	0.110
Have independent license after high school	0.76	0.14, 4.11	0.118	1.23	0.46, 3.32	0.741
Delay in driving licensure	Ref.	-	-	Ref.	-	-
No delay in driving licensure	**1.14**	**1.73, 1.77**	**0.006**	0.95	0.67, 1.34	0.767
Low driving frequency class	Ref.	-	-	Ref.	-	-
Medium driving frequency class	2.06	0.94, 4.52	0.576	**2.82**	**1.44, 5.50**	**0.034**
High driving frequency class	3.08	0.83, 11.48	0.164	**3.16**	**1.41, 7.06**	**0.032**

Note: No independent license in emerging adulthood, delay in driving licensure, and low driving frequency class were the reference groups; Logit models used alcohol drinking late escalators as the reference category; AOR: adjusted odds ratio; CI: confidence interval

Table 4.8 Multinominal logistic regression of binge drinking trajectory classes on driving licensure status, delay in driving licensure, and driving frequency trajectory classes, respectively

	High Consistent vs. Abstainers/Late Escalators			Escalators vs. Abstainers/Late Escalators		
	AOR	95%CI	P	AOR	95%CI	P
No licensure in emerging adulthood	Ref.	-	-	Ref.	-	-
Have independent license in high school	**15.54**	**1.59, 1.92**	**0.015**	**1.72**	**1.92, 3.23**	**0.025**
Have independent license after high school	**9.15**	**1.05, 7.97**	**0.016**	1.07	0.49, 2.33	0.496
Delay in driving licensure	Ref.	-	-	Ref.	-	-
No delay in driving licensure	1.88	0.43, 1.79	0.724	**1.09**	**1.69, 1.71**	**0.007**
Low driving frequency	Ref.	-	-			
Medium driving frequency	5.70	0.92, 35.09	0.108	**1.65**	**1.91, 2.17**	**0.033**
High driving frequency	5.35	0.87, 32.85	0.147	1.98	0.52, 1.85	0.469

Note: No independent license in emerging adulthood, delay in driving licensure, and low driving frequency class were the reference groups; Logit models used alcohol drinking late escalators as the reference category; AOR: adjusted odds ratio; CI: confidence interval

Table 4.9 Multinominal logistic regression of drug use trajectory classes on driving licensure status, delay in driving licensure, and driving frequency trajectory classes, respectively

	Experimenters vs. Abstainers			Escalators vs. Abstainers		
	AOR	95%CI	P	AOR	95%CI	P
No independent license in emerging adulthood	Ref.	-	-	Ref.	-	-
Have independent license in high school	1.31	0.34, 5.02	0.585	**1.30**	**1.08, 2.18**	**0.022**
Have independent license after high school	0.99	0.36, 2.76	0.651	0.95	0.50, 1.82	0.535
Delay in driving licensure	Ref.	-	-	Ref.	-	-
No delay in driving licensure	0.91	0.52, 1.58	0.735	**1.03**	**1.02, 1.56**	**0.029**
Low driving frequency	Ref.	-	-	Ref.	-	-
Medium driving frequency	1.32	0.67, 2.59	0.508	**1.23**	**1.05, 1.78**	**0.017**
High driving frequency	1.24	0.44, 3.48	0.848	1.43	0.79, 2.56	0.284

Note: No independent license in emerging adulthood, delay in driving licensure, and low driving frequency class were the reference groups; Logit models used alcohol drinking late escalators as the reference category; AOR: adjusted odds ratio; CI: confidence interval

CHAPTER 5 – ASSOCIATIONS OF DRIVING LICENSURE STATUS, DELAY IN DRIVING LICENSURE, AND DRIVING FREQUENCY IN HIGH SCHOOL WITH PEER ALCOHOL AND DRUG USE TRAJECTORY CLASSES AND PARENTAL MONITORING KNOWLEDGE

OVERVIEW

Objective: To examine the associations of driving licensure status, delay in driving licensure, and driving frequency with mother's and father's monitoring knowledge separately across Wave 1 (2nd-year high school) to Wave 3 (last year in high school) and peer alcohol and drug use trajectory classes in emerging adulthood.

Methods: A total of 2783 participants were recruited in the NEXT Generation Health Study, a nationally representative cohort of 10th graders starting in 2009-2010. Driving licensure status in high school (W1-3) was categorized as 1) no licensure and 2) have licenses. Delay in driving licensure (DDL) in high school was defined as participants receiving driver licensure ≥ 1 year after the initial legal eligibility time until W3 (DDL [delaying ≥ 1 year] vs. No-DDL). Driving frequency was calculated as a numerical average (mean) in high school. Peer alcohol and drug use (W1-7) trajectory classes were investigated using Latent Class Growth Modeling. The independent variables were driving licensure status, DDL, a numerical average (mean) of driving frequency in high school (W1-3). The dependent variables were peer alcohol and drug use trajectory classes (W1-7) and mother's and father's monitoring knowledge separately across W1 (2nd-year high school) to W3 (last year in high school). The covariates were race/ethnicity, sex, parental education, urbanicity, family structure, and family affluence. Multinomial logistic regression was used to examine the associations of driving licensure status, DDL, and driving frequency with peer alcohol and drug use, respectively in three separate models. Linear regression was used to examine the associations of driving licensure status, DDL, and driving frequency with a numerical average (mean) of a mother's and father's

monitoring knowledge separately across W1 to W3. All analyses took complex survey sample features into account.

Results: Three peer alcohol and drug use trajectory classes were identified (weighted %): light (N=1131, 69.10%), escalating (269, 19.60%), and declining (103, 11.30%). Compared with emerging adults with no licensure in high school, emerging adults with licenses in high school were more likely to be in the declining (adjusted odds ratio [AOR]=1.74, 95% confidence interval [CI] 0.47 6.36, p=0.406) and escalating (AOR=1.48, 95%CI 0.85 2.56, p=0.163) peer alcohol and drug use classes than in the light peer alcohol and drug use class, respectively. Compared with emerging adults with DDL, emerging adults with no DDL were less likely (AOR=0.38, 95%CI 0.19 0.77, p=0.007) to be in the declining peer alcohol and drug use class than in the light peer alcohol and drug use class. One unite increased in driving frequency was associated with a higher likelihood of being in the declining peer alcohol and drug use class (AOR=1.03, 95%CI 0.96 1.09, p=0.450) and in the escalating peer alcohol and drug use class (AOR=1.01, 95%CI 0.98 1.04, p=0.573) than in the light peer alcohol and drug use class. Mother's monitoring knowledge was higher in high school emerging adults with 1) licenses (β[Beta]=0.08, 95%CI -0.02, 0.17, p=0.110) vs. no licensure, 2) no DDL (β=0.08, 95%CI 0.00, 0.16, p=0.050) vs. DDL, and 3) a higher driving frequency (β=0.003, 95%CI -0.00, 0.01, p=0.133). Father's monitoring knowledge was higher in high school emerging adults with 1) licenses (β=0.05, 95%CI -0.09 0.19, p=0.440) vs. no licensure, 2) no DDL (β=0.13, 95%CI 0.04 0.22, p=0.006) vs. DDL, and 3) a higher driving frequency (β=0.001, 95%CI 0.006, 0.004, p=0.648).

Conclusion: Emerging adults with licenses, no DDL, and a higher driving frequency in high school were more likely to report increased peer alcohol and drug use and a higher level of mother's and father's monitoring knowledge.

INTRODUCTION

Driving licensure status may be one of the main factors that influence peer alcohol and drug use. Emerging adults with a driver's license may be more likely to have a greater number of

peers who drink, smoke, and use illicit substances than emerging adults in high school without a license [322, 323]. The mechanism through which the increased exposure to substance use may occur is hypothesized to be due to the fact that driving licensure provides emerging adults with increased access to substances, as emerging adults in high school are no longer dependent on public transportation or rides from parents or friends [323]. Peers may use licensure status as a marker of adulthood and maturity, causing emerging adults to conform and emulate alcohol and drug use among their peers with driver's license [324]. Despite the potential of licensure status to affect peer alcohol and drug, current knowledge of the association between driving licensure status in high school and peer alcohol and drug use is limited. Further, parents may play an important role in monitoring their emerging adult's behaviors, and driving licensure is an important factor that affects parental monitoring. There are inconsistent findings about parental monitoring knowledge and driving licensure existed in the current knowledge base. One study has shown that parents are more likely to provide monitoring when their emerging adults have a valid driver's license [325]. Parents assume that their emerging adults will be driving, and thus require increased parental monitoring [325]. However, other research has found that driving licensure has been linked to increased freedom for emerging adults, which may lead to a decrease in parental monitoring [326]. Additionally, parental monitoring tends to decrease over time after the emerging adults receive a driver's license [326]. Therefore, additional research is needed to identify the relationship between driving licensure and parental monitoring knowledge. Such studies could provide guidance on the best practices for parents of emerging adults.

Emerging adults are facing unprecedented levels of peer influence when it comes to alcohol and drug use, and research suggests that the delay in driving licensure (DDL) due to cost and process barriers is a major factor. According to a 2016 report from the Insurance Institute for Highway Safety, the process of obtaining a full license in the United States has become increasingly more expensive and complex, with the average cost of a driver's license

topping $200 [327]. As a result, emerging adults are waiting longer to obtain their license, and spending more time in a "transitional period" where they have either a learner's permit or a restricted license [328]. DDL has been linked to an increased risk of peer influence, as emerging adults are spending more time in unsupervised situations with their peers [328]. Furthermore, research suggests that DDL can lead to an increase in risky behaviors, such as substance abuse, due to the lack of direct parental supervision [328]. Therefore, there is a need for more comprehensive research that looks at how DDL affects emerging adult's peer influence on alcohol and drug use to develop prevention and intervention efforts. Additionally, the current body of research surrounding the effects of DDL on parental monitoring is conflicting. While research has shown that families with emerging adults who delay getting their license are more likely to monitor their emerging adults' activities more closely compared to families with emerging adults who obtain their license earlier [329], other research has found that parents of emerging adults that delay licensure are no more likely to be involved with their emerging adults' activities than parents of emerging adults who obtain licenses earlier [330]. The discrepancy in the results of these studies suggests that further research is necessary to understand the relationship between delay in licensure and parental monitoring knowledge.

Recent research has investigated how driving frequency affects peer alcohol and drug use among emerging adults. Studies have shown that driving frequency can be associated with greater drinking behaviors among emerging adults [331]. Research has revealed that those who drive more frequently are more likely to be exposed to larger social networks that include friends who are more likely to drink [332]. This suggests that driving frequency may play a role in influencing peer drinking. However, there is still a gap in the current knowledge base in terms of how driving frequency affects peer alcohol and drug use. For example, more research is needed to examine potential links between driving frequency and peer drug use. Additionally, research is needed to explore the potential mechanisms that may be driving the relationship between driving frequency and peer alcohol and drug use. New research exploring how driving frequency

affects the social interactions of emerging adults, as well as how peer influences may be related to driving frequency, is crucial for identifying potential interventions to reduce alcohol and drug use among emerging adults. Additionally, the current knowledge base investigating how driving frequency affects parental monitoring knowledge is limited. While previous research has demonstrated that parental monitoring of emerging adults is linked to the quality of parent-teen relationships, less is known about the effect of driving frequency on parental monitoring knowledge [333]. For example, it is unclear whether driving infrequently can lead to less knowledgeable parents or whether frequent driving produces the same outcome. Similarly, there is a dearth of research on how driving frequency affects the level of parental knowledge about the activities their children engage in when away from home. Therefore, it appears that more research is needed to determine the optimal driving frequency for parental monitoring knowledge [334]. Additionally, studies focused on the quality of the parent-teen relationship and family dynamics are needed to clarify the driving frequency-parental monitoring knowledge relationship.

To fill these gaps, I explored the associations of driving licensure status, DDL, and driving frequency with parental monitoring knowledge and peer alcohol and drug use using data from a longitudinal cohort of U.S. adolescent.

METHODS

Sampling

This study used the data from the NEXT Generation Health Study (NEXT) with a nationally representative American youth cohort starting in 10th grade (Wave 1, 2009-2010) and ending four years after high school (Wave 7).

The NEXT used a multistage sampling strategy to select primary sampling units (PSU, U.S. school districts) from nine census divisions. Specifically, from each school district, schools were randomly selected and classrooms within the schools were randomly selected. Among the 145 selected schools, 81 schools agreed to participate. African American students were

oversampled to obtain a large enough sample (N=687) for more accurate population estimates. Surveys were administered annually for each wave in the spring semester. In total, 2783 participants enrolled in the NEXT study. The data collected in W1 through W7 were used for this study. Among the 2,783 participants, 90% (N=2524), 87% (N=2439), 86% (N=2395), 78% (N=2177), 79% (N=2202), 83% (N=2306), and 83% (N=2323) of participants completed W1, W2, W3, W4, W5, W6 and W7, respectively. Parents provided informed consent for their child's participation. Participants younger than 18 years of age provided assent, and consent was obtained from participants once they reached age 18. The Institutional Review Board of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development reviewed and approved the study protocol.

Independent variables

Sociodemographic variables. Participants' sex, race/ethnicity, parental education level, family affluence, and urbanicity were collected at the baseline visit (W1, 10th grade). The biological sex of participants was female or male. Participant race/ethnicity was categorized as Latinos, Non-Latino Blacks, Non-Latino Whites and Others (including Asian, American Indiana or Alaska Natives, and Native Hawaiians Other Pacific Islanders). The highest educational attainment of participant parents was categorized as: 1) Less than a high school diploma, a high school diploma or GED; 2) Some college, technical school or associate degree; or 3) Bachelor or graduate degree. Urbanicity (suburban, rural, vs. urban) was derived from participants' school location at W1 according to the National Center for Education Statistics [295]. The family socioeconomic status was obtained by the Family Affluence Scale, a widely used and validated proxy for socioeconomic status [269]. Specifically, participants were asked how many cars their family owned, the number of computers owned, whether participants had their own bedroom, and the number of family vacations taken in the last 12 months to the categorized affluence status into as low, moderate, or high affluence groups [270]. Information about participants' family structure was collected during the recruitment home visit by asking participants about the

home where they lived all or most of the time. They were given the opportunity to respond about a second home, including how much time they lived there. The family structure was categorized as: both biological parents; one biological parent, one step-parent; single parent, mother only; single parent, father only; and other. This information was then collapsed into four groups for the analysis: both biological parents, biological and step-parent, and other.

Driving licensure status* (*W1-3). Driving licensure status was generated from emerging adults reporting if they have licensure following independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.). Driving licensure was ascertained by asking, “Do you have a driver’s license?”, with four possible responses: (1) no license of any sort, (2) permit to take the classroom component of driver education only, (3) permit allowing supervised practice driving with an instructor or licensed adult, and (4) license allowing independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.) from all seven waves. Only participants who chose “License allowing independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.)” were counted as having licensure. Other responses including “No license of any sort”, “Permit to take the classroom component of driver education only”, and “Permit allowing supervised practice driving with an instructor or licensed adult” were counted as no licensure. Participants were categorized into two groups: had an independent license in high school at either of first three waves and did not have an independent license at any of first three waves. Participants were categorized as missing driver’s license status if they didn’t report their driver’s license status at any wave.

Delay in driving licensure (DDL, W1-3). DDL was derived using participants’ age at the time of the survey, information in their state’s legal requirement, and their self-reported driving licensure status. Participant date of birth was assessed at baseline, and their age at each wave was calculated. State requirements for initial legal eligibility for getting an independent driver’s license were obtained for NEXT survey years through Department of Motor Vehicles websites

for corresponding states. Driving licensure status was ascertained by asking the questions above. I defined DDL as a dichotomous variable, i.e., no-DDL versus DDL, with those in the delayed group having not obtained their independent license (i.e., response 1 to 3) at the first wave in which they were eligible.

Driving frequency (W1-3). Driving frequency was measured with one question, "On how many of the last 30 days did you drive a vehicle?" with possible responses of the number of days from 0 to 30. Given that the possible responses for the number of the last 30 days was from 0 to 30, those participants who reported >30 were deleted. I calculated a grand mean of driving frequency across W1-3. A Cronbach's α value at least 0.70 is generally considered to be a good indication of internal consistency and reliability [335]. The Cronbach's α values for driving frequency were 0.75 at W1, 0.79 at W2, and 0.71 at W3, respectively, indicating a good internal consistency and reliability of driving frequency measurement in high school.

Dependent variables

Parental monitoring knowledge (W1-3). Parental monitoring knowledge was assessed separately for mothers and fathers and was the mean of a 5-item scale in W1-3. The scale included how much mothers/fathers knew about who their friends were, how they spent their money, what they did with their free time, where they were after school, and where they went at night (1=do not have/see parent/guardian; 2=he/she does not know anything; 3=he/she knows a little; and 4=he/she knows a lot). Scores ranged from one to four possible points. Because monitoring knowledge in W1-3 was highly correlated, we calculated a grand mean of mother's and father's monitoring knowledge separately across W1-3. A Cronbach's α value at least 0.70 is generally considered to be a good indication of internal consistency and reliability [335]. The Cronbach's α values for mother's and father's monitoring knowledge questions were 0.83 and 0.95 at W1, 0.88 and 0.96 at W2, and 0.90 and 0.97 at W3, respectively, indicating a good internal consistency and reliability of mother's and father's monitoring knowledge measurement in high school.

Peer alcohol and drug use (W1-7). At each wave, emerging adults were asked to think of their five closest friends and report the frequency that their five closest friends drink alcohol, get drunk, smoke cigarettes, smoke/use marijuana, and take other drugs. On a 5-point scale, response opinions ranged from *never* to *almost* always. Responses to the five items were averaged to create a measure of peer alcohol and drug use. A Cronbach's α value at least 0.70 is generally considered to be a good indication of internal consistency and reliability [335]. The Cronback's α values for peer alcohol and drug use were 0.85 at W1, 0.85 at W2, 0.87 at W3, 0.84 at W4, 0.83 at W5, 0.80 at W6, and 0.78 at W7, respectively, indicating a good internal consistency and reliability of peer alcohol and drug use measurement in emerging adulthood.

Statistical analyses

Descriptive statistics [e.g., means, standard deviation (SD), and frequencies] were summarized into describe participant sociodemographic variables (e.g., race/ethnicity, sex, parental education etc.) stratified by peer alcohol and drug use. Latent Class Growth Modeling (LCGM) was conducted to identify a set of discrete, mutually exclusive latent classes of participants based on their responses to peer alcohol and drug use [296]. The censored (CORM) model of LCGM was designed to allow researchers to model longitudinal growth in data that were measured on a scale, such as a Likert scale [296]. The censored (CORM) model of LCGM was used for peer alcohol and drug use measured by a scale, with possible values ranging from 1 (never) to 5 (almost always) [296]. We examined models that extracted different numbers and shapes (e.g., linear versus quadratic) of trajectories and selected the model that best fit the data [274] as evaluated using the Bayesian Information Criterion (BIC) [274]. The fit of each nested model was compared using the estimate of the log Bayes factor [2loge (B10) ≈ 2 (ΔBIC)] [274]. A log Bayes factor value greater than ten was interpreted as very strong evidence of a model fit [274]. Models were initially examined with all quadratic terms. If the quadratic term was non-significant, the cubic term was considered; otherwise, the linear term was included. We selected the best number of trajectories

based on the BIC and estimated Bayes Factor. We decided on the best number of groups and then tested various models for the makeup of quadratic, cubic, and linear terms.

The average posterior probability and odds of correct classification were calculated to evaluate the model fit. Each subject in the sample was assigned a posterior probability—the probability of belonging to a trajectory class given their level of monthly driving frequency at each assessment—which was averaged for each trajectory class. The closer the average posterior probabilities are to one, the better the model fit. The equation for the odds of correct classification is outlined in [297], with an odds of correct classification equal to one indicating that the probability of group membership is no better than random guessing. Generally, an odd of correct classification of 5 or higher is recommended and met or exceeded for all trajectory classes. An average posterior probability value of greater than 0.70 is interpreted as indicative of good internal reliability for within-group membership.

Chi-square statistical analyses were used to examine the association of peer alcohol and drug use trajectory classes and parental monitoring knowledge with sociodemographic variables including sex, race/ethnicity, parent education, urbanicity, family structure, and family affluence. Rao-Scott approach was conducted for categorical variables. Savage one-way approach was performed for continuous variables. Multinomial logistic regression was used to examine the associations of driving licensure status (no licensure in high school vs. having licenses in high school), DDL (no delay in driving licensure vs. delay in driving licensure), and driving frequency (a grand mean across W1-3) with peer alcohol and drug use trajectory classes, respectively in three separate models, taking complex survey features into account. For example, multinomial logistic regression equation was

$$\text{logit}\left[\text{p}\left(\text{Y}_{\text{peer alcohol and drug use trajectory classes=escalating peer alcohol and drug use trajectory class}}\right)\right] =$$

$$\log\left[\frac{\text{p}\left(\text{Y}_{\text{peer alcohol and drug use trajectory classes=escalating peer alcohol and drug use trajectory class}}\right)}{1-\text{p}\left(\text{Y}_{\text{peer alcohol and drug use trajectory classes=escalating peer alcohol and drug use trajectory class}}\right)}\right] = \beta 0 +$$

$$\beta_{driving\ licensure\ status} X_{driving\ licensure\ status} + \beta_{\text{race/ethnicity}} \text{X}_{\text{race/ethnicity}} +$$

$\beta_{\text{parental education}}X_{\text{parental education}} + \beta_{\text{urbanicity}}X_{\text{urbanicity}} + \beta_{\text{family structure}}X_{\text{family structure}} + \beta_{\text{family affluence}}X_{\text{family affluence}}$, where Y was peer alcohol and drug use trajectory classes as a dependent variable, $P(Y_{\text{peer alcohol and drug use trajectory classes=escalating peer alcohol and drug use trajectory class}})$ was probability of escalating peer alcohol and drug use trajectory class, $X_{driving\ licensure\ status}$ was an independent variable, $X_{\text{race/ethnicity}}$, $X_{\text{parental education}}$, $X_{\text{urbanicity}}$, $X_{\text{family structure}}$, and $X_{\text{family affluence}}$ were covariates controlled in the multinominal logistic regression analyses, and βs were coefficients (for example, $\beta_{\text{driving licensure status}}$ was coefficient for driving licensure status). Adjusted odds ratio (AOR) was found using multinomial logistic regression equation. The relative log odds of being in peer alcohol and drug use declining class vs. light class was $\log\left[\frac{P(peer\ alcohol\ and\ drug\ use\ trajectory\ class=declining\ class)}{P(peer\ alcohol\ and\ drug\ use\ trajectory\ class=light\ class)}\right] = b_0 + b_{driving\ licensure\ status} + b_{race/ethnicity} + b_{parental\ education} + b_{urbanicity} + b_{family\ structure} + b_{family\ affluence}$. AOR can be obtained by exponentiating the equation above, yielding regression coefficients that were AOR. Additionally, linear regression was used to examine the associations of driving licensure status, DDL, and driving frequency with a numerical average (mean) of a mother's and father's monitoring knowledge separately across W1 to W3, taking complex survey features into account. The beta coefficient in linear regression model for driving licensure status was found $\beta_{driving\ licensure\ status} = (y_{mother's\ monitoring\ knowledge} - \beta_{\text{race/ethnicity}}X_{\text{race/ethnicity}} + \beta_{\text{parental education}}X_{\text{parental education}} + \beta_{\text{urbanicity}}X_{\text{urbanicity}} + \beta_{\text{family structure}}X_{\text{family structure}})/X_{driving\ licensure\ status}$. The statistical significance level was set at p=0.05 for all analyses. All analyses were performed in SAS software version 9.4 (SAS Institute, Cary, NC) [298].

RESULTS

One-, two-, three-, and four-class models were estimated from the latent class growth modeling (LCGM) for peer alcohol and drug use. The BIC values for these models were -18866.11, -

17364.54, -16027.12, and -16733.63. Non-significant cubic and quadratic terms were removed from trajectories in four-class mode, resulting in three-class model. Therefore, the three-class model of peer alcohol and drug use (Figure 5.1) was the best fit with the smallest BIC. Among participants, 1131 were categorized as light (69.10% [weighted and hereafter]), 269 (19.60%) as escalating, and 103 (11.30%) as declining in peer alcohol and drug use using LCGM. There was an overall average posterior probability 0.919 and an average of odds of correct classification of 48.79 indicating a well fit model (Table 5.1). Figure 5.1 shows trajectories (light, escalating, and declining) of peer alcohol and drug use among emerging adults over seven consecutive years beginning in the 10^{th} grade.

Out of the 1,067 participants surveyed over the first three waves, 547 (41.44%) reported no delay in obtaining their driver's license, while 773 (58.56%) experienced a delay in driving licensure. Of the participants, 1,424 (51.90%) did not have a driver's license while in high school, while 1,320 (48.10%) held a driver's license. The mean driving frequency among participants over the first three waves was 14.87 times over the last 30 days, with a standard deviation of 10.87 times over the last 30 days.

Table 5.2 shows participant sociodemographic variables (e.g., race/ethnicity, sex, parental education etc.) stratified by peer alcohol and drug use trajectory classes (light, escalating, and declining). Peer alcohol and drug use trajectory classes were significantly associated with race/ethnicity (Rao-Scott $\chi2=28.280$, $p<0.001$) and family affluence (Rao-Scott $\chi2=10.302$, $p=0.113$), respectively.

Table 5.3 shows participant sociodemographic variables (e.g., race/ethnicity, sex, parental education etc.) stratified by mother's and father's monitoring knowledge and their bivariate linear regression. Compared to female, male was in 0.152 lower in mother's monitoring knowledge ($\beta=-0.152$, $p=0.001$). Compared to parental bachelor or higher degree, parental high school or less was in 0.089 lower in mother's monitoring knowledge ($\beta=-0.089$, $p<0.001$). Compared to emerging adults who lived in rural area, those emerging adults who lived in urban

area were in 0.092 lower in mother's monitoring knowledge (β=-0.092, p=0.004). Compared to emerging adults from high family affluence, those emerging adults from low family affluence were in 0.186 lower in mother's monitoring knowledge (β=-0.186, p=0.001). Compared to emerging adults with both biological parents, those emerging adults with single parent were lower in 0.187 in mother's monitoring knowledge (β=-0.187, p=0.002). Compared to Whites, Latinos (β=-0.302, p<0.001) and African Americans (β=-0.641, p<0.001) were in 0.302 and 0.641 lower in father's monitoring knowledge, respectively. Compared to female, male was higher in 0.210 in father's monitoring knowledge (β=0.210, p=0.002). Compared to parental bachelor or higher degree, parental high school or less (β=-0.278, p=0.014) and parental some college (β=-0.205, p=0.017) were in 0.278 and 0.205 lower in father's monitoring knowledge, respectively. Compared to emerging adults who lived in rural area, those emerging adults who lived in urban (β=-0.285, p=0.005) and suburban (β=-0.211, p=0.008) were in 0.285 and 0.211 lower in father's monitoring knowledge, respectively. Compared to emerging adults from high family affluence, those emerging adults from low family affluence were in 0.435 lower in father's monitoring knowledge (β=-0.435, p<0.001). Compared to emerging adults with both biological parents, those emerging adults with biological and step-parent (β=-0.394, p<0.001) and single parent (β=-1.188, p<0.001) were in 0.394 and 1.188 lower in father's monitoring knowledge, respectively.

There were different odds of peer alcohol and drug use trajectory classes on driving licensure status, delay in driving licensure, and driving frequency, respectively (Table 5.4). Compared with emerging adults with no licensure in high school, emerging adults with licenses in high school were more likely to be in the declining (adjusted odds ratio [AOR]=1.74, 95% confidence interval [CI] 0.47 6.36, p=0.406) and escalating (AOR=1.48, 95%CI 0.85 2.56, p=0.163) peer alcohol and drug use classes than in the light peer alcohol and drug use class, respectively. Compared with emerging adults with DDL, emerging adults with no DDL were less likely (AOR=0.38, 95%CI 0.19 0.77, p=0.007) to be in the declining peer alcohol and drug use

class than in the light peer alcohol and drug use class. One unite increased in driving frequency was associated with a higher likelihood of being in the declining peer alcohol and drug use class (AOR=1.03, 95%CI 0.96 1.09, p=0.450) and in the escalating peer alcohol and drug use class (AOR=1.01, 95%CI 0.98 1.04, p=0.573) than in the light peer alcohol and drug use class.

There were different coefficients of mother's and father's monitoring knowledge on driving licensure status, delay in driving licensure, and driving frequency, respectively (Table 4). Even the results were not statistically significant, mother's monitoring knowledge was higher in high school emerging adults with 1) licenses (β[Beta coefficient from linear regression]=0.08, 95%CI -0.02, 0.17, p=0.110) vs. no licensure, 2) no DDL (β=0.08, 95%CI 0.00, 0.16, p=0.050) vs. DDL, and 3) a higher driving frequency (β=0.003, 95%CI -0.00, 0.01, p=0.133), respectively. Even some results were not statistically significant, father's monitoring knowledge was higher in high school emerging adults with 1) licenses (β=0.05, 95%CI -0.09, 0.19, p=0.440) vs. no licensure, 2) no DDL (β=0.13, 95%CI 0.04, 0.22, p=0.006) vs. DDL, and 3) a higher driving frequency (β=0.001, 95%CI 0.006, 0.004, p=0.648), respectively.

DISCUSSION

To the best of our knowledge, this study was one of the first studies to assess the associations of driving licensure status, delay in driving licensure (DDL), and driving frequency with peer alcohol and drug use trajectory classes and parental monitoring knowledge when transitioning to early adulthood.

A large majority of emerging adult participants, approximate 90%, were in classes characterized by light to escalating peer alcohol and drug use, either starting in high school or escalating later. This finding is concerning as the period of emerging adulthood is a critical time for individuals to develop healthy behaviors, values, and attitudes [336]. Exposure to peer alcohol and drug use has been linked to an increased risk of developing substance use problems later in life [337]. Therefore, understanding the prevalence of peer alcohol and drug use among emerging adults is important to develop effective prevention and intervention

strategies that can reduce the risk of developing substance use problems in emerging adulthood. To further explore the prevalence of peer alcohol and drug use among emerging adults, it is important to consider the contexts in which these behaviors occur. For example, previous research has shown that peer alcohol and drug use is more likely to occur in settings where there is less parental supervision [338]. It is also important to consider the types of substances being used, as different substances have different levels of risk associated with them. For example, alcohol use is typically seen as less risky than the use of illicit drugs. Understanding the contexts and substances associated with peer alcohol and drug use may help develop more targeted prevention and intervention strategies. In addition, it is important to consider the potential causes of peer alcohol and drug use among emerging adults. Previous research has shown that there are several potential risk factors that may lead to increased peer alcohol and drug use, such as the availability of substances, social norms, stress, and mental health problems [338]. Understanding these factors may help identify potential strategies for preventing and reducing peer alcohol and drug use in emerging adulthood.

The results showed that obtaining a driver's license in high school and more driving frequency were more likely to report increased peer alcohol and drug use in high school emerging adults. For high school emerging adults, the transition from being transported by parents to driving has the potential for modifying peer influence and alcohol and drug availability. High school emerging adults with an independent driver's license may transport them to an environment where peer alcohol and drug use is strengthened with an increased alcohol and drug availability. During the transition from adolescence to adulthood, acquiring a driver's license in high school is common. High school emerging adults initiate their transition to independent living. Previous research assessed independent living in New Zealand youths that occurred around 17.7 years old in high school emerging adults [339]. Researchers followed the alcohol and drug use patterns of these high school emerging adults in New Zealand for up to 6 years and compared alcohol and drug use before and after transitioning to early adulthood

[339]. They reported that regular drinkers who consumed 2.3 drinkers per week in the period prior to transitioning to early adulthood increased to 10.1 drinks per week following transitioning to early adulthood ($p<0.001$) [339]. Both the exposure to an environment where alcohol and drug were more available and peer alcohol and drug use were found to be significant factors in the increase in post-transition alcohol and drug use [339]. Although transitioning to independent living is a more difficult and significant step than transitioning to driving, more research should be done to investigate the peer alcohol and drug use that often accompanies getting a driver's license in high school. This could include looking into the effects of peer pressure on emerging adults when it comes to substance use and how it could be prevented or reduced. Additionally, more driving frequency may indicate the increase in traveling with peers, especially traveling with small affinity groups of emerging adults that can move to locations where high-risk activities are more possible with less supervision. In such environments, the behavior of the small reference group is relatively unrestrained, and individuals may be influenced by their intimate peers with deviant behavioral norms to join in group activities (i.e., alcohol and drug use) that they have not previously engaged in due to limited opportunities in the home community.

Further, a higher level of father's and mother's monitoring knowledge was found in more driving frequency in high school emerging adults. Parental monitoring has been shown to be an important factor in the development of healthy behaviors and decision-making skills in children and adolescents [340]. As children reach emerging adulthood, parental monitoring is increasingly important for supporting the development of independent decision-making and safe driving habits. Previous studies have shown that parental monitoring may be associated with driving frequency in emerging adults [340, 341]. Specifically, a higher level of parental monitoring are found to be associated with decreased driving frequency in emerging adults, likely due to the fact that parents are able to set limits on driving activities and provide guidance to their children about safe driving habits [341]. The current study adds to the existing literature by demonstrating that a higher level of father's and mother's monitoring knowledge is

associated with more driving frequency in high school emerging adults. This finding is significant in that it suggests that parents can positively influence the driving behavior of their children. Furthermore, this finding suggests that parents should be encouraged to actively monitor their children's driving and provide guidance about safe driving habits. The results of this study have implications for parents, educators, and policy makers. For parents, the findings suggest that they should be actively involved in monitoring the driving behavior of their children and providing guidance about safe driving habits. Educators and policy makers can use these findings to develop strategies to promote safe driving habits among high school emerging adults. For example, they could provide educational programs that emphasize the importance of parental monitoring and provide parents with the tools and resources they need to actively monitor their children's driving.

Emerging adults with no DDL were more likely to report increased peer alcohol and drug use in high school and a higher level of mother's and father's monitoring knowledge. The results of this study are significant to the field of high school emerging adult development as DDL may be a risk factor for peer alcohol and drug use in high school. Furthermore, the results indicated that high school emerging adults with no DDL may have increased parental knowledge of their activities, which may lead to a decrease in peer alcohol and drug use in high school. This is likely since DDL may lead to increased autonomy for the adolescent, which can lead to decreased parental monitoring and an increase in risk taking behaviors. Previous research has found that DDL is associated with increased autonomy, which has been associated with increased risk-taking behaviors [342]. Additionally, parental monitoring is associated with lower levels of adolescent risk taking [342]. Therefore, it is possible that the increase in parental monitoring knowledge associated with no DDL may lead to decreased risk-taking behaviors among high school emerging adults. Given the implications of this research, it is important to consider the implications of delayed driving licensure for emerging adults. For example, it may

be beneficial to consider interventions aimed at increasing parental knowledge of their adolescent's activities to help increase parental monitoring and decreased risk-taking behaviors.

We recognized that several limitations existed in our study. First, some demographic information was not obtained at each wave but only was collected at baseline (e.g., family affluence and structure) and parental monitoring knowledge was only collected in W1-3. Second, it would have been ideal to know the exact date on which participants obtained their driver's license so that DDL could be more accurately estimated. However, these data are not explicitly available in the NEXT survey data. As a result, we were limited to calculating and approximating the DDL variable. Third, our study used participant self-reports instead of direct parent reports in assessment of parental monitoring knowledge. This inherently introduces potential for reporting bias. Despite these limitations, there are notable strengths including a relatively large, nationally representative sample of adolescents surveyed longitudinally over seven years and a focus on peer alcohol and drug use. Using these rich data, this study was able to assess trajectories of peer alcohol and drug use over time and relate driving licensure, DDL, and driving frequency to trajectory class membership.

In conclusion, having a driver's license, no DDL, and a higher driving frequency during high school is associated with greater exposure to peer alcohol and drug use, as well as higher levels of parental monitoring knowledge. High school emerging adults should be monitored more closely as they gain access to driving privileges (having independent license, no DDL, and more driving frequency), as driving privileges may have an influence on their peer behavior and involvement in alcohol and drug use. Driving privileges provide could be beneficial to emerging adult development as it could help them become more aware of the need for parental monitoring knowledge.

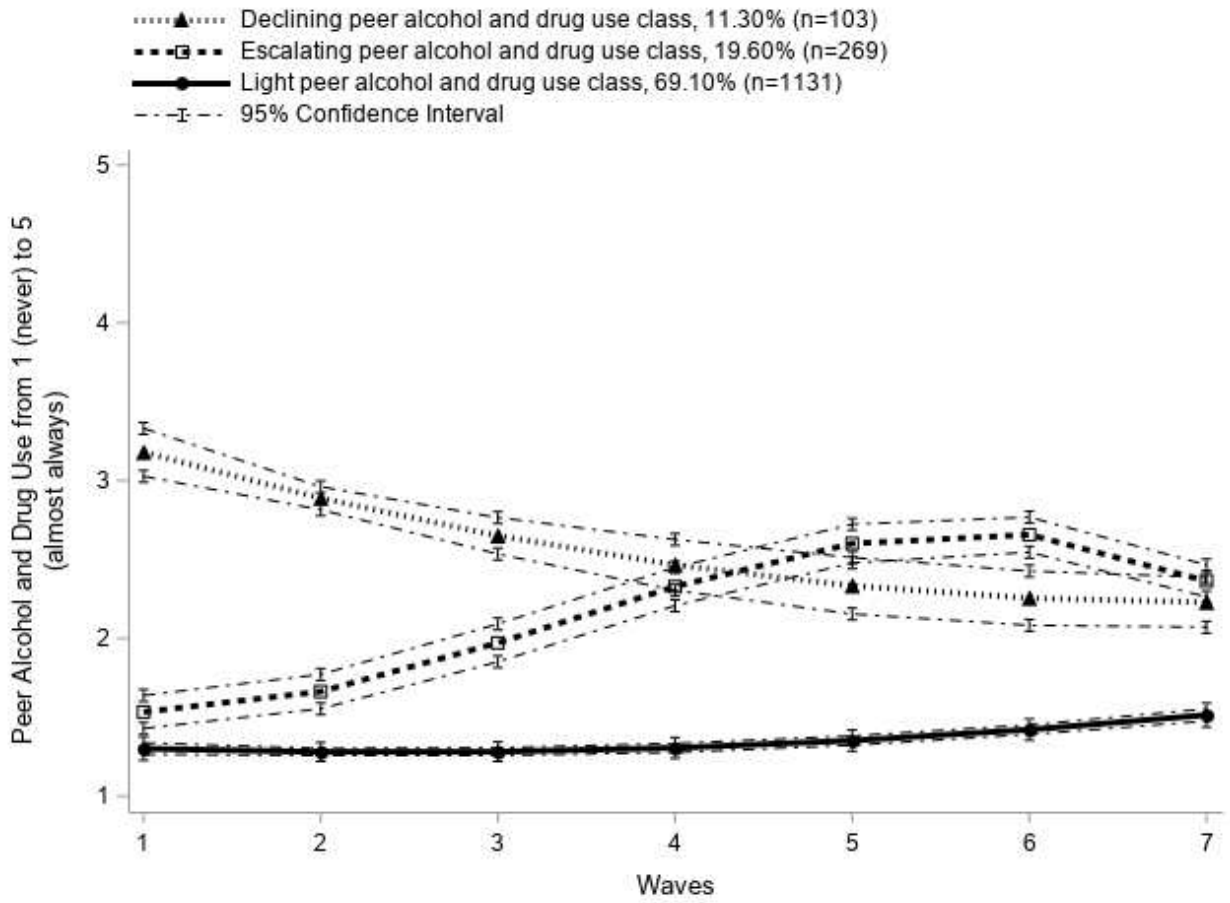

Figure 5.1 Trajectories of peer alcohol and drug use (declining, escalating, and light) among emerging adults over seven consecutive years beginning in the 10th grade

Table 5.1 Proportions, average posterior probabilities, and odds of correct classifications of peer alcohol and drug use trajectory classes among emerging adults

	N (Weighted %)	Average posterior probabilities (Range)	Odds of Correct Classification
Light peer alcohol and drug use	1131 (69.10)	0.963 (0.504-1.000)	11.64
Escalating peer alcohol and drug use	269 (19.60)	0.861 (0.504-1.000)	25.41
Declining peer alcohol and drug use	103 (11.30)	0.933 (0.507-1.000)	109.31

Note: Weighted % using the weight based on W1-W7 weights

Table 5.2 Participant sociodemographic variables stratified by peer alcohol and drug use trajectory classes (light, escalating, and declining)

		Light N (%#)	Escalating N (%#)	Declining N (%#)	χ^2	P
Overall[a]		1124 (69.75)	267 (19.43)	97 (10.82)		
Sample Sociodemographic variables						
Race/ethnicity[b]	Latinos	654 (80.12)	83 (8.81)	55 (11.08)	28.280	**<0.001**
	African Americans	390 (78.97)	67 (17.98)	20 (3.04)		
	Whites	717 (62.22)	229 (22.17)	138 (15.61)		
	[c]Others	102 (68.63)	20 (12.49)	10 (18.88)		
Sex[b]	Male	834 (68.46)	177 (17.49)	105 (14.06)	2.078	0.354
	Female	1032 (69.40)	223 (19.12)	118 (11.49)		
Parental education[b]	High school or less	715 (71.74)	129 (15.15)	81 (13.12)	7.181	0.127
	Some college	652 (71.35)	135 (15.97)	71 (12.68)		
	Bachelor+	370 (61.41)	123 (26.45)	60 (12.15)		
Urbanicity[b]	Urban	708 (78.50)	120 (16.08)	66 (5.43)	8.104	0.088
	Suburban	644 (67.93)	130 (18.36)	75 (13.71)		
	Rural	518 (66.77)	150 (19.23)	83 (14.00)		
Family affluence[b]	Low	643 (75.17)	99 (13.55)	59 (11.28)	13.380	**<0.001**
	Moderate	871 (70.39)	185 (16.48)	105 (13.13)		
	High	356 (61.02)	116 (25.97)	60 (13.01)		
Family Structure[b]	Both biological parents	978 (70.63)	234 (20.06)	98 (9.31)	10.302	0.113
	Biological and step-parent	300 (64.59)	62 (19.56)	49 (15.84)		
	Single parent	395 (69.27)	67 (16.22)	45 (14.51)		
	[d]Others	197 (68.24)	37 (10.56)	32 (21.20)		

Note: #Weighed %; χ^2: Rao-Scott χ^2; [a]Weighted % using the weight based on W1-W7 weights. [b]Weighted % using W1 weight. [c]Including Asian, American, Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders. [d]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else

Table 5.3 Participant sociodemographic variables stratified by mother's and father's monitoring knowledge (W1-3 grand mean) and their bivariate linear regression

		Mother's monitoring knowledge				Father's monitoring knowledge			
		N	Mean	β	P	N	Mean	β	P
Overall		2750	3.46	-	-	2749	2.78	-	-
Race/ethnicity	Latinos	829	3.53	-0.064	0.105	829	2.72	-0.302	<0.001
	African Americans	678	3.40	-0.096	0.055	675	2.45	-0.641	<0.001
	Whites	1092	3.56	Ref.	-	1092	3.04	Ref.	-
	[a]Others	140	3.31	-0.329	0.106	140	2.78	-0.105	0.331
Sex	Male	1237	3.39	-0.152	0.001	1236	2.88	0.210	0.002
	Female	1508	3.52	Ref.	-	1508	2.70	Ref.	-
Parental education	High school or less	966	3.41	-0.089	<0.001	968	2.70	-0.278	0.014
	Some college	917	3.51	-0.041	0.347	917	2.84	-0.205	0.017
	Bachelor+	616	3.52	Ref.	-	617	2.97	Ref.	-
Urbanicity	Urban	899	3.43	-0.092	0.004	898	2.71	-0.285	0.005
	Suburban	851	3.46	-0.062	0.136	852	2.76	-0.211	0.008
	Rural	752	3.55	Ref.	-	752	3.02	Ref.	-
Family affluence	Low	911	3.38	-0.186	0.001	910	2.53	-0.435	<0.001
	Moderate	1269	3.47	-0.046	0.183	1269	2.85	-0.112	0.058
	High	569	3.57	Ref.	-	569	3.04	Ref.	-
Family structure	Both biological parents	1309	3.55	Ref.	-	1308	3.22	Ref.	-
	Biological and step-parent	411	3.46	-0.036	0.273	411	2.73	-0.394	<0.001
	Single parent	507	3.39	-0.173	0.001	507	2.16	-1.188	<0.001
	[b]Others	266	3.30	-0.187	0.002	266	2.23	-1.189	<0.001

Note: [a]Including Asian, American, Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders. [b]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else. β: regression coefficient.

Table 5.4 Multinominal logistic regression of peer alcohol and drug use trajectory classes on driving licensure status (W1-3), delay in driving licensure (W1-3), and driving frequency (W1-3 grand mean), respectively

	Declining vs. Light			Escalating vs. Light		
	AOR	95%CI	P	AOR	95%CI	P
No licensure in high school	Ref.	-	-	Ref.	-	-
Have independent license in high school	1.74	0.47, 6.36	0.406	1.48	0.85, 2.56	0.163
Delay in driving licensure	Ref.	-	-	Ref.	-	-
No delay in driving licensure	**0.38**	**0.19, 0.77**	**0.007**	1.11	0.60, 2.03	0.744
Driving frequency	1.03	0.96, 1.09	0.450	1.01	0.98, 1.04	0.573

Note: No licensure in high school and delay in driving licensure were the reference group; Logit models used light peer alcohol and drug use trajectory class as the reference category; AOR: adjusted odds ratio; CI: confidence interval

Table 5.5 Linear regression of mother's and father's monitoring knowledge on driving licensure status, delay in driving licensure, and driving frequency trajectory classes, respectively

	Mother's monitoring knowledge			Father's monitoring knowledge		
	β	95%CI	P	β	95%CI	P
No licensure in high school	Ref.	-	-	Ref.	-	-
Have licenses in high school	0.08	-0.02, 0.17	0.110	0.05	-0.09, 0.19	0.440
Delay in driving licensure	Ref.	-	-	Ref.	-	-
No delay in driving licensure	**0.08**	**0.00, 0.16**	**0.050**	**0.13**	**0.04, 0.22**	**0.006**
Driving frequency	0.003	-0.00, 0.01	0.133	0.001	0.006, 0.004	0.648

Note: No independent license in emerging adulthood is the reference group. CI: confidence interval; β=beta

CHAPTER 6 – ASSOCIATIONS OF DRIVING LICENSURE STATUS, DELAY IN DRIVING LICENSURE, AND DRIVING FREQUENCY TRAJECTORY CLASSES WITH HEALTH, EDUCATION, AND EMPLOYMENT IN EMERGING ADULTHOOD

STUDY 1. IS DELAYED DRIVING LICENSURE ASSOCIATED WITH EMERGING ADULT HEALTH, EDUCATION, AND EMPLOYMENT?

OVERVIEW

Background: Driving licensure remains a major developmental milestone for adolescents as they become more independent to access important health, education, and employment opportunities. Today, more emerging adults are delaying driving licensure than before. We investigated associations of delayed licensure with health, education, and employment 4 years after high school.

Methods: We analyzed data from all seven annual assessments (W1-W7) of the NEXT Generation Health Study, a nationally representative cohort survey starting at 10th grade (W1, 2009-2010). The independent variable was delaying driving licensure (DDL [delaying ≥1 year] vs. No-DDL), defined as participants receiving driver licensure ≥1 year after initial legal eligibility time until W7. Outcome variables were self-reported health, education, and employment at W7. Covariates included sex, race/ethnicity, family affluence, parental education, and urbanicity. Multinomial logistic regression analyses were conducted considering complex survey features.

Results: No-DDL vs DDL was associated with a higher likelihood of (1) excellent (adjusted odds ratio [AOR]=2.06, p<.001), good (AOR=1.74, p<.001), and fair (AOR=1.34, p=.008) health compared to poor health; (2) completing a 4-year college or graduate school [AOR=2.71, p<.001] and tech/community college [AOR=1.92, p=.004] compared to high school or less; and (3) working ≥30 hours/week (AOR=7.63, p=.011) and working <30 hours/week (AOR=1.54, p=.016) compared to not working.

Conclusions: Among emerging adults, no delay in driving licensure was associated with better self-reported health, higher education, and more working hours four years after leaving high school. While earlier driving licensure increases driving exposure and risk, avoiding DDL appears to provide advantages for health, education, and employment during early adulthood.
Keywords: delayed driving licensure, health, education, employment, emerging adults

Implications and Contributions statement:

Although driving licensure is viewed as a major developmental milestone, nearly 70% of eligible adolescents delayed licensure at least 1-year. Those without licensure delay reported better health, education, and employment in emerging adulthood. Future study should assess DDL contextual facets and provide detail of measured early adulthood success.

INTRODUCTION

Transportation is a vital structural facet of the day-to-day workings in society, communities, and the lives of people [343]. At the individual level, the word transportation typically calls up an image of someone using public transportation, and even more commonly, someone driving a car or truck [343]. Reliable personal transportation provides people valuable independence. Specifically, for emerging adults, greater independence likely results from driving to an array of opportunities such as attending healthcare-related visits, participating in supplemental education opportunities (e.g., volunteer positions to gain educational experience), and/or taking an off-campus part-time or full-time employment [16, 17].

While driving licensure is viewed as a major developmental and transitional milestone, studies consistently show that learning to drive and becoming licensed are accompanied by measurable risk of harm and injury due to crashes. Adolescents in the U.S. are at high risk of nonfatal injury, physical disability, and death caused by motor vehicle crashes [344]. In 2018, 1,719 young drivers were killed in motor vehicle crashes and 199,000 were injured [26]. Motor vehicle crashes remain the leading cause of death for emerging adults through age 24 years [27].

To prevent and reduce fatal and nonfatal injuries among novice emerging adult drivers, Graduated Driver Licensing (GDL) programs were developed to introduce new young drivers to safely gain driving experience before obtaining full independent driving privileges [345]. GDL programs reduce emerging adult crashes and deaths. Comprehensive GDL programs have contributed to the reduction fatal crashes among emerging adult drivers in the U.S. by as much as 20% to 40%. [40] In the U.S., all states have a GDL program that include three stages: leaner's permit; intermediate license; and unrestricted license, although the content (i.e., types of restrictions) of these stages vary across states [346].

The advantages GDL may lead to improved safety on roads and having independent transportation may considerably enhance short- and long-term well-being/health, education, and employment for emerging adult drivers [16-19]. Despite the potential benefits of obtaining licensure as an emerging adult novice driver, there has been a downward trend of obtaining licensures among emerging adults. One epidemiological study has shown that the rate of obtaining unsupervised driving licenses among U.S. high school students has dropped from 81% to 72% during 2006 to 2015 [347]. More recently, a nationally representative U.S. young cohort study has shown that delaying driver licensure was widespread and nearly 70% of eligible adolescents delayed at least one year to obtain their licensure during 2010 to 2017 [5].

Accordingly, if emerging adults delay their licensure and then later pursue licensure outside the age parameters of their state GDL policy, it is conceivable that they may miss out on graduated driving safety practices that are intentionally tailored to bolster emerging adult driver safety and lower crash risk among young novice drivers [5, 9]. While delaying driving licensure (DDL) may contribute to lower emerging adults' crash risk due to no exposure to driving [42], both crash risk and crash rates remains high later when emerging adults begin to drive without much, if any, prior novice driver safety instructions and/or supervised driving experience [31, 43]. Thus, it is reasonable to suggest that many emerging adult drivers who have delayed licensure may initially have a heightened risk for crash. Such little-to-no prior driving exposure,

experience, and instructions among emerging adults that pursue licensure beyond GDL policy age limits could conceivably compromise some of their own subsequent beneficial opportunities related to health, education, and employment [198, 199]. In addition to potentially experiencing increased crash-related injuries and disabilities, DDL may contribute to other important consequences (e.g., getting traffic tickets, license suspension) resulting from increased risky driving behaviors (e.g., speeding, distracted driving, tailgating) among emerging adults due to the unique developmental considerations (e.g., sensation seeking, lower inhibitory control, less efficient working memory, or poorer attention) [348]. These consequences may impact emerging adults' future health, education, and employment opportunities to different extents [35].

Taken together, there is a need to further understand measurable effects that DDL might have on health, education, and employment among emerging adults. The purpose of this study was to evaluate the associations of DDL among adolescents with their health, education, and employment 4 years after high school.

METHODS

Sampling

We used the data from all seven waves (W1-7) of the NEXT Generation Health Study that encompassed a nationally representative youth cohort starting at W1 in 10th grade (2009-2010) and ending four years after leaving high school. The NEXT study used a multistage sampling strategy to select primary sampling units (PSU, U.S. school districts in the NEXT study) from nine census divisions. Specifically, from each school district, schools and classrooms within the schools were randomly selected. Among the 145 selected schools, 81 schools agreed to participate. African Americans were oversampled to obtain a large enough sample (N=687) for more accurate population estimates. Surveys were administered annually for each wave in the spring semester. In total, there were 2,783 participants who enrolled in the NEXT study. From W1 to W7, 90% (N=2,524), 87% (N=2,439), 86% (N=2,395), 78% (N=2,177), 79% (N=2,202), 83% (N=2,306), and 83% (N=2,323) of the 2,783 participants completed the survey each year,

respectively. Parents provided informed consent for their child's participation. Participants younger than 18 years of age provided assent, and consent was obtained from participants once they reached 18 years of age. The Institutional Review Board of the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development reviewed and approved the study protocol.

Independent variable

Delaying driving licensure (DDL, W1-7)

Delaying driving licensure (DDL) was derived using participants' age at the time of the survey, information on their state's legal requirement, and their self-reported driving licensure status. Participant date of birth was assessed at baseline and their age at each wave was calculated. State requirements for initial legal eligibility for getting an independent driver's license were obtained for NEXT survey years through Department of Motor Vehicles websites for corresponding states. Driving licensure was ascertained by asking, "Do you have a driver's license?", with four possible responses: 1) no license of any sort; 2) permit to take the classroom component of driver education only; 3) permit allowing supervised practice driving with an instructor or licensed adult; and 4) license allowing independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.) from all seven waves. Therefore, those participants who did not report licensure status at any wave were defined as missing in the analyses. We defined DDL as a dichotomous variable, i.e., No-DDL vs. DDL, with those in the delayed group having not obtained their independent license (i.e., response 4) at the first wave in which they were eligible.

Outcome variables

Overall physical health in emerging adulthood (W7)

Perceived overall physical health was measured with a single question, "Would you say your health is...?" with four possible responses, Excellent, Good, Fair, and Poor at W7 [268].

Education attainment (W7)

Education attainment was measured with one question, “What is the highest grade of regular school you have completed (or anticipate completing by the end of the current academic term)?” with seven possible responses: less than high school diploma; high school diploma; General Educational Diploma (GED); some college or technical school; associate’s degree; bachelor’s degree; and graduate degree. The seven categories were collapsed into three categories: less than or equal to high school diploma or GED; some college, technical school, or associate’s degree; and bachelor’s degree or graduate degree.

Employment in emerging adulthood (W7)

Employment and volunteer work were measured with one question, “On average, what are the total hours per week you spend working in paid and/or unpaid jobs?” with possible responses: None; ≤5; 6-10; 11-15; 16-20; 21-25; 26-30; >30 hours/week. The eight categories were collapsed to three categories: None; <30; and ≥30 hours/week.

Demographics and Covariates

Participants’ sex, race/ethnicity, parental education level, family affluence, overall physical health, and urbanicity were collected at the baseline visit (W1, 10th grade high school). The biological sex of participants was female or male. Participant race/ethnicity was categorized as Latinos, Non-Latino Blacks, Non-Latino Whites and Other (including Asians, American Indians or Alaska Natives, and Native Hawaiians Other Pacific Islanders). The highest education attainment of participants’ parents was defined as: 1) Less than a high school diploma, a high school diploma or GED; 2) Some college, technical school or associate degree; or 3) Bachelor or graduate degree. The family socioeconomic status was obtained by the Family Affluence Scale, a widely used and validated proxy for socioeconomic status [269]. Specifically, participants were asked how many cars their family owned, the number of computers owned, whether participants had their own bedroom, and the number of family vacations taken in the last 12 months. Then, participants’ family affluence status was categorized as low, moderate, or high affluence [270]. Adolescent perceived overall physical health was measured with a single

question, “Would you say your health is...?” with four possible responses, Excellent, Good, Fair, and Poor at W1 [268]. Urbanicity (suburban, rural, vs. urban) was derived from participants’ school location at W1 according to the National Center for Education Statistics [295].

Statistical analyses

Multinominal logistic regression analyses were conducted to assess associations of DDL among adolescents with their health, education, and employment 4 years after high school. Unadjusted and adjusted model analyses were conducted. For example, multinomial logistic regression equation for the association between DDL and health four year after high school controlling for covariates was $\text{logit}[\ \text{p}(\text{Y}_{\text{Health at W7=Excellent}})] = \log\left[\frac{\text{p}(\text{Y}_{\text{Health at W7=Excellent}})}{1-\text{P}(\text{Y}_{\text{Health at W7=Excellent}})}\right] = \beta 0 + \beta_{\text{DDL}}\text{X}_{\text{DDL}} + \beta_{\text{sex}}\text{X}_{\text{sex}} + \beta_{\text{race/ethnicity}}\text{X}_{\text{race/ethnicity}} + \beta_{\text{family affluence}}\text{X}_{\text{family affluence}} + \beta_{\text{urbanicity}}\text{X}_{\text{urbanicity}} + \beta_{\text{parental education attainment}}\text{X}_{\text{parental education attainment}} + \beta_{\text{W1 general health}}\text{X}_{\text{W1 general health}}$, where Y was health status four year after high school as a dependent variable, $\text{P}(\text{Y}_{\text{Health at W7=Excellent}})$ was probability of excellent health four years after high school, X_{DDL} was DDL as an independent variable, X_{sex}, $\text{X}_{\text{race/ethnicity}}$, $\text{X}_{\text{family affluence}}$, $\text{X}_{\text{urbanicity}}$, $\text{X}_{\text{parental education}}$, and $\text{X}_{\text{W1 general health}}$ were covariates controlled in the multinominal logistic regression analyses, and βs were the coefficients (for example, β_{DDL} was the coefficient for DDL). For example, the relative log odds of being in excellent health vs. poor health was $\log\left[\frac{P(Health\ at\ W7=Excellent\ health)}{P(Health\ at\ W7=Poor\ health)}\right] = b_0 + b_{DDL} + b_{sex} + b_{race/ethnicity} + b_{family\ affluence} + b_{urbanicity} + b_{parental\ education} + b_{W1\ health}$, where bs were the regression coefficients (for example, b_{DDL} was the regression coefficient for DDL). AOR can be obtained by exponentiating the equation above, yielding regression coefficients that were AOR. All statistical analyses were performed using SAS software version 9.4 (SAS Institute, Cary, NC) taking complex survey sampling features [i.e., strata (i.e., the nine census divisions), clustering (i.e., PSU), and sampling weights] into account [349]. Odds ratio (OR), Adjusted odds ratio (AOR), and 95%

confidence interval (95% CI) were reported. The statistical significance level was set at $p = .05$ for the analyses.

RESULTS

Out of 2,783 participants, 258 were excluded from the analyses because they did not report licensure status at any wave. Table 6.1 shows demographic characteristics of included and excluded participants. The weighted mean ages of participants at W1, W2, W3, W4, W5, W6, and W7 were 16.27 years (SE = 0.03), 17.19 years (SE = 0.03), 18.17 years (SE = 0.03), 19.16 years (SE = 0.02), 20.28 years (SE = 0.02), 21.28 years (SE = 0.02), and 22.64 years (SE = 0.03), respectively. Table 6.2 shows participant characteristics and outcome measures stratified by delaying licensure status. Out of 2,525 participants who were legally eligible for licensure through W7, 1965 (69.29%, weighted and hereafter) reported DDL. The results of Rao-Scott χ^2 test show that DDL is significantly associated with race/ethnicity (χ^2=41.65, p<.001), parent education (χ^2=27.11, p<.001), and family affluence (χ^2=58.38, p<.001). Additionally, the results of Rao-Scott χ^2 test show that DDL is significantly associated with W1 overall physical health (χ^2=37.82, p<.001), W7 overall physical health (χ^2=15.41, p=.002), education attainment (χ^2=45.57, p<.001), and employment indicated by working hours per week (χ^2=5.97, p=0.050).

Table 6.3 shows multinomial logistic regression of overall physical health, education attainment, and working hours at W7 on delay in driving licensure. Compared to DDL, No-DDL was associated with higher likelihood of excellent (AOR=1.67, 95% CI 2.19, 7.12), good (AOR=1.45, 95% CI 1.81, 5.61), and fair (AOR=1.21, 95% CI 1.29, 4.98) health compared to poor health. Compared to DDL, No-DDL was associated with higher likelihood of completing a bachelor's degree or graduate degree (AOR=2.55, 95% CI 1.52, 4.28) and some college/technical school or an associate's degree (AOR=1.89, 95% CI 1.21, 2.97) compared to a high school diploma or less than a high school diploma or a GED. Compared to DDL, No-DDL was associated with higher likelihood of working ≥30 hours/week (AOR=7.53, 95% CI 1.40, 40.48) and working <30 hours/week (AOR=1.47, 95% CI 1.04, 2.09) compared to not working.

DISCUSSION

To the best of our knowledge, this study is one of the first to assess the association of emerging adult DDL with their later health, education, and employment when transitioning to early adulthood. Our study shows that adolescents who obtained their driver's license within a year of legal eligibility were more likely to report better health status, higher education attainment, and more employment compared to those who delayed driving licensure.

Our findings are consistent with previous studies indicating that the increase in independence and opportunities provided by personal transportation may enhance short- and long-term well-being/health, education, and employment [16, 17]. More specifically, obtaining independent driving licensure might increase emerging adults' access to health care. For example, independent transportation could help those who live in geographic regions further away from health care resources overcome large distances between residences and services and more freely travel to health care professional and care centers when needed [16]. Apart from having access to health care resources, the greater independence due to licensure may offer a variety of important opportunities like supplemental education, extracurricular activities, and employment seeking if those opportunities are at a distance from their homes [17]. Thus, the potential benefits of such opportunities facilitated by independent transportation could boost emerging adults' future health, education, and employment when they transition to the broader developmental, social, and environmental context of emerging adulthood [18, 19].

The potential advantages of earlier licensure (within state-specific legal eligibility) must be balanced against the relatively earlier and greater driving exposure and related-risk [25]. It is well understood that with greater exposure to driving, particularly at younger ages, there is heightened risk for crash [27]. Despite the added risk due to exposure, for many emerging adults and their families, the licensure can increase independence and opportunities for enhanced short- and longer-term well-being/health, education, and employment are enough to outweigh the associated risks of driving licensure and risky driving [16-19]. Our findings highlight

short-, intermediate-, and potentially long-term benefits of independent driving licensure (licensure typically gained through participating in a state GDL program) at important transitional periods for the development of youth.

The rate of new driver licensure among high school seniors has continued to decrease [347]. Previous studies suggest that this reduction trend in driving licensure may be linked to GDL policy restrictions (e.g., permit holding periods, initial legal eligibility time of licensure, nighttime driving, number of passengers in vehicle) [5, 9] and economics of driving [13]. The upward trend of DDL among adolescents is of note because young drivers who delay licensure may miss out on GDL driving safety instructions and restrictions that have been shown to enhance novice driver safety. Currently, most state GDL policies only apply to young drivers aged ≤ 18 y/o [350]. Thus, those who miss out on GDL due to DDL beyond age 18 y/o may potentially heighten their risk of crash when and if they pursue licensure at a later age [13]. In line with previous evidence, young drivers that DDL may compromise later beneficial opportunities related to health, education, and employment [198, 199].

The findings from our study imply that the opportunities for young drivers to flourish in emerging adulthood might be enhanced if emerging adults pursued licensure soon after they reach the age of state legal eligibility. Of course, one needs to take into consideration the individual variability that exists among emerging adults when it comes to being developmentally ready to drive at the earliest state legal age. Nevertheless, not delaying licensure could assure emerging adult exposure to the many driver safety benefits of GDL, although, admittedly, it would also increase driving exposure and related risk, but this would unlikely be beyond what is already present when adhering to state-level licensure policies for emerging adult drivers.

There are limitations to our study. First, it would have been optimal to know the exact date (i.e., month/date/year) when participants received their driving license so that an exact DDL measure could have been used in our analysis. Given that the exact licensure dates were not available in the NEXT study, we calculated and approximated the DDL variable as any delay

in licensure past the earliest assessment when a participant was eligible for licensure with consideration of their state's legal requirements. Second, measures of health, education, and employment were based on annual self-reported questions, and this inherently introduces potential for social desirability and recall bias. In addition, employment was measured with self-reported paid and/or unpaid jobs and this does not differentiate employment from volunteer activities. This could overestimate the time in paid employment. However, many volunteer activities represent valuable educational opportunities. Third, the NEXT survey was not designed to explore crash risk among adolescents and emerging adult participants. As such, we are not able to empirically test any speculated association between DDL-related heightened crash risk and its relationship to later health, education, and employment. There remains a need to empirically explore and examine this link.

Despite these limitations, our research has notable strengths. Our study was based on a longitudinal design that allows us to examine the long-term association of emerging adult DDL with their later health, education, and employment 4 years after high school. Additionally, we used a nationally representative sample that allows for sound national generalizability to the U.S. emerging adult populations.

In conclusion, adolescents with no delay in driving licensure had a higher likelihood of self-reported better health status, higher education attainment, and more employment as emerging adults. This suggests that timely, legally eligible emerging adult driving licensure could provide advantages for health, education, and employment during early adulthood. The findings of this study can provide families and injury prevention programs with important additional facets of information when considering the timing and pursuit of licensure for adolescents and emerging adult driver safety education.

Table 6.1 Excluded versus included participants' characteristics and outcome measures

	Exclusion		Inclusion		Total			
	N	Weighted %	N	Weighted %	N	Weighted %	Rao-Scott χ^2	P
Overall[#]	258	8.70	2525	91.30	2783	100	548.885	<.001
Sample characteristics[#]								
Race								
Latinos	109	11.37	726	88.63	835	100	7.628	0.054
Non-Latino Blacks	63	7.21	624	92.79	687	100		
Non-Latino Whites	60	7.32	1046	92.68	1106	100		
Others	19	17.08	123	82.92	142	100		
Sex								
Male	135	10.95	1119	89.05	1254	100	3.412	0.065
Female	118	6.57	1406	93.43	1524	100		
Parent Education								
High school or less	124	13.98	853	86.02	977	100	16.899	<.001
Some college	62	5.77	862	94.23	924	100		
Bachelor or more	37	5.87	589	94.13	626	100		
Urbanicity								
Urban	114	10.03	790	89.97	904	100	0.323	0.851
Suburban	88	8.82	777	91.18	865	100		
Rural	40	8.20	724	91.80	764	100		
Family Affluence								
Low	128	15.40	792	84.60	920	100	14.303	<.001
Moderate	99	7.55	1186	92.45	1285	100		
High	31	4.41	547	95.59	578	100		

Note: [#]weighted % using the overall weight based on W1-W7 weights. Others: including Asian, American, Indiana or Alaska Native, and Native Hawaiian or Other Pacific Islanders.

Table 6.1 Excluded versus included participants' characteristics and outcome measures (Continue)

	Exclusion		Inclusion		Total			
	N	Weighted %	N	Weighted %	N	Weighted %	Rao-Scott χ^2	P
Overall[#]	258	8.70	2525	91.30	2783	100	548.885	<.001
Sample characteristics[#]								
W1 Health								
Excellent	39	7.83	390	92.17	429	100	1.965	0.580
Good	114	7.63	1154	92.37	1268	100		
Fair	65	9.65	619	90.35	684	100		
W7 Health								
Excellent	1	0.57	350	99.43	351	100	1.188	0.756
Good	13	1.44	1199	98.56	1212	100		
Fair	9	2.29	608	97.71	617	100		
Poor	2	1.00	118	99.00	120	100		
W7 Education								
High school or less	10	2.81	697	97.19	707	100	4.468	0.107
Tech/Community College	9	1.05	1024	98.95	1033	100		
4-Year College+	5	0.78	546	99.22	551	100		
W7 Work status (working hrs./week)								
None	28	2.83	1334	97.17	1362	100	30.849	<.001
<30 hrs.	3	0.15	887	99.85	890	100		
≥30 hrs.	1	1.89	31	98.11	32	100		

Note: [#]weighted % using the overall weight based on W1-W7 weights. Others: including Asian, American, Indiana or Alaska Native, and Native Hawaiian or Other Pacific Islanders.

Table 6.2 Participant characteristics and outcome measures stratified by delaying driving licensure status

	No-DDL		DDL (≥ 1 year)		Total			
	N	%	N	%	N	%	Rao-Scott χ^2	P
Overall[#]	560	30.71	1965	69.29	2525	100	16.208	<.001
Sample characteristics								
Race[^]								
Latinos	38	10.03	659	89.97	697	100	35.988	<.001
Non-Latino Blacks	43	18.04	392	81.96	435	100		
Non-Latino Whites	438	42.33	601	57.67	1039	100		
Others	23	38.71	92	62.29	115	100		
Sex[^]								
Male	248	32.50	761	67.50	1009	100	0.213	.645
Female	294	31.08	986	68.92	1280	100		
Parent Education[^]								
High school or less	105	19.51	716	80.49	821	100	29.226	<.001
Some college	224	34.01	584	65.99	808	100		
Bachelor or more	194	42.69	333	57.31	527	100		
Urbanicity[^]								
Urban	61	17.04	729	82.96	790	100	4.080	.130
Suburban	164	27.70	612	72.30	776	100		
Rural	317	43.12	406	56.88	723	100		
Family Affluence[^]								
Low	57	13.66	633	86.34	690	100	46.797	<.001
Moderate	274	31.90	813	68.10	1087	100		
High	211	45.51	301	54.49	512	100		

Note: [#]weighted % using the overall weight based on W1-W7 weights. ^weighted % using W1 weight. [$]weighted % using W7 weight. Others: including Asian, American, Indiana or Alaska Native, and Native Hawaiian or Other Pacific Islanders. DDL: Delaying Driving Licensure

Table 6.2 Participant characteristics and outcome measures stratified by delaying driving licensure status (Continue)

	No-DDL		DDL (≥ 1 year)		Total			
	N	%	N	%	N	%	Rao-Scott χ^2	P
Overall[#]	560	30.71	1965	69.29	2525	100	16.208	<.001
Sample characteristics								
W1 Health[^]								
Excellent	121	40.36	269	59.64	390	100	37.819	<.001
Good	299	33.88	855	66.12	1154	100		
Fair	104	23.04	515	76.96	619	100		
Poor	16	18.39	100	81.61	116	100		
W7 Health[$]								
Excellent	96	39.21	254	60.79	350	100	15.412	.002
Good	286	33.09	913	66.91	1199	100		
Fair	104	24.07	504	75.93	608	100		
Poor	5	11.48	113	88.52	118	100		
W7 Education[$]								
High school or less	81	18.13	616	81.87	697	100	45.571	<.001
Tech/Community College	211	31.64	813	68.36	1024	100		
4-Year College+	195	45.23	351	54.77	546	100		
W7 Work status (working hrs./week) [$]								
None	279	27.59	1055	72.41	1334	100	5.970	.051
<30 hrs.	199	35.74	688	64.26	897	100		
≥30 hrs.	9	55.67	22	44.33	31	100		

Note: [#]weighted % using the overall weight based on W1-W7 weights. ^weighted % using W1 weight. [$]weighted % using W7 weight. Others: including Asian, American, Indiana or Alaska Native, and Native Hawaiian or Other Pacific Islanders. DDL: Delaying Driving Licensure

Table 6.3 Multinomial logistic regression analyses of overall physical health, education attainment, and working hours at W7 on delaying driving licensure

			^No-DDL
	AOR	95%CI	P
$Health			
Excellent vs. poor	1.67	2.19, 7.12	<0.001
Good vs. poor	1.45	1.81, 5.61	<0.001
Fair vs. poor	1.21	1.29, 4.98	0.012
$Education attainment			
Bachelor's degree or graduate degree vs. less than or equal to high school diploma or GED	2.55	1.52, 4.28	<0.001
Some college, technical school or associate degree vs. less than or equal to high school diploma or GED	1.89	1.21, 2.97	0.005
$Working hours			
≥30 hours vs. no working hours	7.53	1.40, 40.48	0.019
<30 hours vs. no working hours	1.47	1.04, 2.09	0.031

Note: DDL (>1 yr) was the reference group; Logits models used poor health, high school or less, and no working hours per week as the reference category; AOR: adjusted odds ratio; CI: confidence interval; $Dependent variables and ^Independent variable; Covariates included in the adjusted models were race, parent education, and family affluence.

STUDY 2. ARE DRIVING LICENSURE STATUS AND DRIVING FREQUENCY TRAJECTORY CLASSES ASSOCIATED WITH EARLY ADULT HEALTH, EDUCATION, AND EMPLOYMENT?

OVERVIEW

Objective: To examine the associations of driving licensure status and driving frequency trajectory classes with early adult health, education, and employment

Methods: A total of 2783 participants were recruited in the NEXT Generation Health Study, a nationally representative cohort of 10th graders starting in 2009-2010. I analyzed data from all seven annual assessments (W1-7). Driving licensure status was defined as having independent licensure in high school, after high school, or no licensure in emerging adulthood. Driving frequency trajectory classes were investigated using Latent Class Growth Modeling (LCGM). Independent variables were driving licensure status and frequency trajectories. The dependent variables were health, education, and employment four years after high school. Covariates were race/ethnicity, sex, parental education, urbanicity, family structure, and family affluence. Multinomial logistic regression analyses were conducted considering complex survey features.

Results: Having licenses in high school versus no licensure in emerging adulthood was associated with a higher likelihood of reporting 1) excellent (AOR [adjusted odds ratio]=7.55, 95%CI [confidence interval]=1.81 7.76, p=0.048] than poor health; 2) bachelor's degree or graduate degree (AOR=4.11, 95%CI 1.76 9.62, p<0.001) and some college, technical school or associate degree (AOR=3.36, 95%CI 2.21 5.10, p<0.001) than less than or equal to high school diploma or GED; and 3) <30 hours (AOR=1.81, 95%CI 1.10 2.97, p=0.010) than no working hours.

Conclusion: Emerging adults with a driver's license in high school are more likely to report better health, higher education, and more working hours four years after high school.

INTRODUCTION

Previous studies suggest that the increase in independence and opportunities provided by personal transportation may enhance short- and long-term well-being/health [16, 17]. More specifically, obtaining an independent driver's license might increase emerging adults' access to health care. For example, independent transportation could help those who live in geographic regions farther away from health care resources overcome large distances between residences and services and more freely travel to health care professionals and care centers when needed [16]. While the previous studies found that obtaining a driver's license was associated with increases in the frequency of accessing healthcare services [21, 22], when obtaining a driver's license and how the extent of exposure to driving after licensure associated with emerging adult health are limited in the current knowledge base. Therefore, there is a need to further understand the measurable effects that driving licensure status (having licenses in high school, after high school vs. no licensure in emerging adulthood) and the extent of exposure to driving after licensure (driving frequency) might have on emerging adult health.

Lacking a vehicle is associated with exclusion from access to and achievement in school-level education [206-208]. Previous studies have shown the association between geography and education attainment [206-208]. Specifically, students who live in rural areas are more likely to reduce participation in extra-curricular activities [206-208]. An inquiry into having a reliable vehicle for students in further education found the consideration of transport throughout the student lifecycle to be an essential component of widening access to education opportunities amongst potential further education students [209]. Therefore, lacking a reliable vehicle to commute between home and school may be a barrier to participation in further education. However, there is no published study investigating the role of driving licensure status in access to, or exclusion from, emerging adult education. Further, mobility enabled by driving licensure can improve educational opportunities like participation in extra-curricular activities [199]. Therefore, it may be a time of growth to access to educational opportunities but also of environmental vulnerability (home environment vs. an extended environment away from the

home environment or provided by a private vehicle) [210-213]. Having a driver's license may allow emerging adults to change the environment by moving out of the home and facilitates greater emerging adult independence to access education opportunities [17]. However, the current knowledge base still lacks how driving licensure (having licensure in high school, after high school vs. no licensure in emerging adulthood) and driving frequency after licensure may associate with emerging adult education attainment.

Reliable personal transportation provides people valuable independence and opportunity for the broader opportunity for employment. A private vehicle would enable people to conduct a geographically broader job search, accept employment offers far away from home, improve work attendance, and minimize the burden of commuting. Vehicle ownership may promote work performance if employment opportunities and job searches are enhanced with consistent access to reliable personal transportation. For example, vehicle ownership could expand job searches geographically, facilitate employment far from home (or in an area where public transportation is inaccessible), and facilitate employment requiring unusual or non-standard work hours that do not coincide with public transportation schedules which may be common for entry-level jobs, reduce employee absenteeism, and reduce commute times relative to that offered by public transportation [227-229]. In areas where public transportation is limited, having reliable personal transportation helps find a job. Many suburbs lack accessible public transportation, which makes it difficult for those with lower incomes – or without cars – to be able to get around, inhibiting their access to jobs. Accessing these workplaces where public transportation is limited is time-consuming and makes it impossible for low-income residents of urban neighborhoods. Thus, reliable personal transportation is an important factor in improving employment status, especially for those who live in an urban neighborhood with low socioeconomic status. The current knowledge base is lacking on how emerging adult independence is facilitated by driving licensure (having licensure in high school, after high school vs. no licensure in emerging adulthood) and driving frequency that allows them to access

employment opportunities far away from the home environment, which in turn may impact what extent they are employed.

With a nationally representative longitudinal American youth cohort, I aimed to examine the associations of driving licensure status and driving frequency trajectory classes with early adult health, education, and employment.

METHODS

Sampling

I used the data from all seven waves (W1-7) of the NEXT Generation Health Study that encompassed a nationally representative youth cohort starting at W1 in 10th grade (2009-2010) and ending four years after leaving high school. The investigators from the NEXT study used a multistage sampling strategy to select primary sampling units (US school districts in the NEXT study) from nine census divisions. Specifically, from each school district, schools and classrooms within the schools were randomly selected. Among the 145 selected schools, 81 schools agreed to participate. African Americans were oversampled to obtain a large enough sample (N=687) for more accurate population estimates. Surveys were administered annually for each wave in the spring semester. In total, there were 2783 participants who enrolled in the NEXT study. From W1 to W7, 90% (N=2524), 87% (N=2306), 86% (N=2395), 78% (N=2177), 79% (N=2202), 83% (N=2306), and 83% (N=2323) of the 2783 participants completed the survey each year, respectively. Parents provided informed consent for their child's participation. Participants younger than 18 years of age provided assent, and consent was obtained from participants once they reached 18 years of age. The Institutional Review Board of the Eunice Kennedy Shriver National Institute of Child Health and Human Development reviewed and approved the study protocol.

Independent variables

Driving licensure status (*W1-7)*

Driving licensure status was generated from emerging adults reporting if they had licensure following independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.). Participants were asked “Do you have a driver’s license?” with four possible responses. Only participants who chose “License allowing independent, unsupervised driving (with or without temporary restrictions on late night driving, passengers, etc.)” were indicated as having licensure. Other responses including “No license of any sort”, “Permit to take the classroom component of driver education only”, and “Permit allowing supervised practice driving with an instructor or licensed adult” were indicated as no licensure. Participants were categorized into three groups: had an independent license in high school at any of first three waves [W1-W3]), had an independent license in high school any of last four waves [W4-W7] but not at any of first three waves, and did not have an independent license. Participants were categorized as missing driver’s license status if they did notreport their driver’s license status at any wave.

Driving frequency (W1-7)

Driving frequency was measured with one question, “On how many of the last 30 days did you drive a vehicle?” with possible responses of the number of days from 0 to 30. Given that the possible responses for the number of the last 30 days was from 0 to 30, those participants who reported >30 were deleted.

Dependent variables

Health (W7)

Perceived overall physical health was measured with a single question, “Would you say your health is…?” with four possible responses, excellent, good, fair, and poor at W7 [351].

Education (W7)

Education attainment was measured with one question, “What is the highest grad of regular school you have completed (or anticipate completing by the end of the current academic term)?”

with seven possible responses: less than high school diploma, high school diploma, General Education Diploma (GED), some college or technical school, associate's degree, bachelor's degree, and graduate degree. The seven categories were collapsed into three categories: less than or equal to high school diploma or GED; some college, technical school, or associate's degree; and bachelor's degree or graduate degree.

Employment (W7)

Employment and volunteer work were measured with one question, "On average, what are the total hours per week you spend working in paid and/or unpaid jobs?" with possible responses: none, ≤5, 6-10, 11-15, 16-20, 21-25, 26-30, and >30 hours/week. The eight categories were collapsed into three categories: none, <30, and ≥ 30 hours/week.

Demographics and covariates

Participants' sex, race/ethnicity, parental education level, family affluence, overall physical health, urbanicity were collected at the baseline visit (W1, 10th grade high school). The biological sex of participants was female or male. Participant race/ethnicity was categorized as Latinos, non-Latino Blacks, non-Latino Whites, and other (including Asians, American Indians or Alaska Natives, and Native Hawaiians or other Pacific Islanders). The highest education attainment of participants' parents was defined as the following (1) less than a high school diploma, a high school diploma, or GED; (2) some college, technical school, or associate degree; or (3) bachelor or graduate degree. The family socioeconomic status was obtained by the Family Affluence Scale, a widely used and validated proxy for socioeconomic status [352]. Specifically, participants were asked how many cars their family owned, the number of computers owned, whether participants had their own bedroom, and the number of family vacations taken in the last 12 months. Then, participants' family affluence status was categorized as low, moderate, or high affluence [270]. Adolescent-perceived overall physical

health was measured with a single question, “Would you say your health is…?” with four possible responses, excellent, good, fair, and poor at W1 [351]. Urbanicity (suburban, rural, vs. urban) was derived from participants’ school location at W1 according to the National Center for Education Statistics [353].

Statistical analyses

Descriptive statistics [e.g., means, standard deviation [SD], and frequencies] were summarized to describe participant sociodemographic variables stratified by health, education attainment, and employment indicated by working hours four years after high school, respectively. Latent Class Growth Modeling (LCGM) was conducted to identify a set of discrete, mutually exclusive latent classes of participants based on their responses to driving frequency [296]. A censored (CORM) model of LCGM was used for driving frequency because driving frequency was measured by a scale, with possible values ranging from 0 to 30 [296]. We examined models that extracted different numbers and shapes (e.g., linear versus quadratic) of trajectories and selected the model that best fit the data [274] as evaluated using the Bayesian Information Criterion (BIC) [274]. The fit of each nested model was compared using the estimate of the log Bayes factor [2log (B10) ≈ 2 (ΔBIC)] [274]. A log Bayes factor value greater than ten was interpreted as very strong evidence of a model fit [274]. Models were initially run with all quadratic terms. If the quadratic term was non-significant, the cubic term was run; otherwise, the linear term was run. We selected the best number of trajectories based on the BIC and estimated Bayes Factor. We decided on the best number of groups and then tested various models for the makeup of quadratic, cubic, and linear terms.

The average posterior probability and odds of correct classification were calculated to evaluate the model fit. Each subject in the sample was assigned a posterior probability—the probability of belonging to a trajectory class given their level of monthly driving frequency at each assessment—which was averaged for each trajectory class. The closer the average posterior

probabilities are to one, the better the model fit. The equation for the odds of correct classification is outlined in [297], with an odds of correct classification equal to one indicating that the probability of group membership is no better than random guessing. Generally, an odd of correct classification of 5 or higher is recommended and met or exceeded for all trajectory classes. An average posterior probability value of greater than 0.70 is interpreted as indicative of good internal reliability for within-group membership.

Chi-square statistical analyses were used to examine the association of health, education, and employment with sociodemographic variables including sex, race/ethnicity, parent education, urbanicity, family structure, and family affluence. Rao-Scott approach was conducted for categorical variables. Savage one-way approach was performed for continuous variables. Multinominal logistic regression analyses were conducted to assess associations of driving licensure status and driving frequency trajectory classes among emerging adults with their health, education, and employment four years after high school, taking complex survey sampling features into account. For example, multinomial logistic regression equation for the association between driving licensure status and health four year after high school controlling for covariates was $\text{logit}[\ p(Y_{\text{Health at W7=Excellent}})] = \log[\frac{p(Y_{\text{Health at W7=Excellent}})}{1-P(Y_{\text{Health at W7=Excellent}})}] = \beta 0 +$

$\beta_{\text{driving licensure status}} X_{\text{driving licensure status}} + \beta_{\text{race/ethnicity}} X_{\text{race/ethnicity}} +$

$\beta_{\text{parental education}} X_{\text{parental education}} + \beta_{\text{urbanicity}} X_{\text{urbanicity}} + \beta_{\text{family structure}} X_{\text{family structure}} +$

$\beta_{\text{family affluence}} X_{\text{family affluence}}$, where Y was health status four year after high school as a dependent variable, $P(Y_{\text{Health at W7=Excellent}})$ was probability of excellent health four years after high school, $X_{\text{driving licensure status}}$ was driving licensure status as an independent variable, $X_{\text{race/ethnicity}}$, $X_{\text{parental education}}$, $X_{\text{urbanicity}}$, $X_{\text{family structure}}$, and $X_{\text{family affluence}}$ were covariates controlled in the multinominal logistic regression analyses, and βs were the coefficients (for example, $\beta_{\text{driving licensure status}}$ was the coefficient for driving licensure status). For example, the relative log odds of being in excellent health vs. poor health was

$\log\left[\frac{P(Health\ at\ W7=Excellent\ health)}{P(Health\ at\ W7=Poor\ health)}\right] = b_0 + b_{driving\ licensure\ status} + b_{race/ethnicity} + b_{parental\ education} + b_{urbanicity} + b_{family\ affluence} + b_{W1\ health}$, where bs were the regression coefficients (for example, $b_{driving\ licensure\ status}$ was the regression coefficient for driving licensure status). AOR can be obtained by exponentiating the equation above, yielding regression coefficients that were AOR. All statistical analyses were performed using SAS software, version 9.4, (SAS Institute, Cary, NC) taking complex survey sampling features (i.e., strata [i.e., the nine census divisions], clustering [i.e., primary sampling unit], and sampling weights) into account [278]. Odds ratio (OR), adjusted odds ratio (AOR), and 95% confidence interval (95% CI) were reported. The statistical significance level was set at p=.05 for all analyses.

Results

Of 2779 participants eligible for licensure, 572 (20.57%) reported no licensure, 1344 (48.36%) had licensure in high school, and 863 (31.05%) had licensure after high school.

Table 6.4 shows participant sociodemographic variables stratified by health (excellent, good, fair, and poor) at W7. Health at W7 was significantly associated with race/ethnicity (Rao-Scott $\chi2=55.891$, $p<0.001$), sex (Rao-Scott $\chi2=12.315$, $p=0.006$), parental education (Rao-Scott $\chi2=45.077$, $p<0.001$), urbanicity (Rao-Scott $\chi2=19.728$, $p=0.003$), family affluence (Rao-Scott $\chi2=13.842$, $p=0.141$), and health at W1 (Rao-Scott $\chi2=102.585$, $p<0.001$), respectively.

Table 6.5 shows participant sociodemographic variables stratified by education attainment (less than or equal to high school diploma or GED, some college, technical school or associate degree, and Bachelor's degree or graduate degree) at W7. Education attainment was significantly associated with race/ethnicity (Rao-Scott $\chi2=14.192$, $p=0.028$), sex (Rao-Scott $\chi2=10.013$, $p=0.007$), parental education (Rao-Scott $\chi2=171.457$, $p<0.001$), family affluence (Rao-Scott $\chi2=35.800$, $p<0.001$), and family structure (Rao-Scott $\chi2=38.190$, $p<0.001$), respectively.

Table 6.6 shows participant sociodemographic variables stratified by employment indicated by working hours (no working hours per week, <30 working hours per week, ≥ 30 working hours per week). Employment indicated by working hours was significantly associated with race/ethnicity (Rao-Scott $\chi2=30.740$, $p<0.001$), parental education (Rao-Scott $\chi2=14.168$, $p=0.007$), urbanicity (Rao-Scott $\chi2=29.458$, $p<0.001$), family structure (Rao-Scott $\chi2=22.524$, $p=0.001$), respectively.

Table 6.7 shows multinomial logistic regression of health, education attainment, and working hours at W7 on driving licensure status. Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school were more likely (AOR=7.55, 95%CI 1.81 7.76, p=0.048) to report excellent health than poor health. Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school were more likely (AOR=1.75, 95%CI 1.25 1.93, P=0.007) to report good health than poor health four years after high school. Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school were more likely to have Bachelor's degree or graduate degree (AOR=4.11, 95%CI 1.76 9.62, p<0.001) and some college, technical school or associate degree (AOR=3.36, 95%CI 2.21 5.10, p<0.001) than less than or equal to high school diploma or GED four years after high school, respectively. Compared with emerging adults with no licensure in emerging adulthood, emerging adults with licenses in high school were more likely (AOR=1.81, 95%CI 1.10 2.97, p=0.010) to report <30 hours than no working hours four years after high school. Compared with emerging adults with no licensure in emerging adults, emerging adults with licenses after high school were more likely (AOR=1.20, 95%CI 1.11 1.91, p=0.041) to report ≥30 hours than no working hours four years. Further, there was no significant association found between driving frequency trajectory classes and health, education, and working hours four years after high school (Table 6.8).

One-, two-, three-, and four-class models were estimated from the latent class growth modeling for driving frequency. The BIC values for these models were -30327.02, -29480.05, -

29337.13, and -29425.46, respectively. Non-significant cubic and quadratic terms were removed from trajectories in four-class model, resulting in two-class model. Therefore, the three-class model (Figure 3.1) was the best fit for the analyses with the smallest BIC. Among participants, 358 were categorized as stable low driving frequency class (17.93% [weighted and hereafter]), 868 (59.90%) as stable medium driving frequency class, and 267 (22.17%) as stable high driving frequency class. There was an overall average posterior probability of 84.27% and an average of odds of correct classification of 21.86 indicating a well-fitting model (Table 3.3).

DISCUSSION

To the best of knowledge, this study is one of the first studies to assess the association of emerging adult driving licensure and driving frequency trajectories with their later health, education, and employment when transitioning to early adulthood. The study shows that emerging adults having a driver's license in high school are more likely to report better self-report overall physical health, higher education, and more working hours four years after high school than those without a driver's license in emerging adulthood. No statistically significant correlation was identified between driving frequency and later health, educational, and employment outcomes when transitioning to early adulthood.

This study has shown that possessing a driver's license in high school has a positive impact on overall health, higher education, and more working hours four years after high school. This suggest that there are many benefits to obtaining a driver's license during emerging adulthood. Physical health is an important indicator of overall well-being, and this study has shown that having a driver's license in high school is associated with better self-reported physical health four years after high school. This could be due to the increased freedom and mobility that a driver's license provides, which can lead to higher levels of physical activity and better overall health. Studies have shown that having access to a car can lead to increased physical activity, reduced risk of chronic diseases, improved mental health, and better overall health outcomes [354]. The study also shows that those with a driver's license in high school

are more likely to pursue higher education four years after high school. This could be due to the increased mobility that a driver's license provides, allowing students to access educational opportunities that may not be available to those without a driver's license. Studies have shown that having access to a car can facilitate access to higher education, as well as other important social and economic opportunities [355]. Further, the study found that those with a driver's license in high school had higher levels of working hours four year after high school. This could be due to the increased freedom and flexibility that a driver's license provides, allowing those with a license to access employment opportunities that are not available to those without a license. Studies have shown that having access to a car can increase the likelihood of finding employment, as well as increase wages and overall job satisfaction [356].

In line with the previous studies indicating that the increase in independence and opportunities provided by personal transportation may enhance short- and long-term well-being/health, education, and employment [16, 17], the findings highlight that obtaining independent driving license in high school might increase emerging adults' access to health care. Specifically, independent driving license may help those high school students who live in geographic regions further away from health care resources overcome large distance between residences and services and more freely travel to health care professional and care centers when needed. Apart from having access to health care resources, the greater independence due to obtaining independent driving license in high school may offer a variety of important opportunities such as supplemental education, extracurricular activities, and employment seeking if those opportunities are at a distance from their homes.

The findings from the study imply that the opportunities for emerging adults to flourish in emerging adulthood might be improved if emerging adults pursued licensure in high school. Of course, one needs to take into consideration the individual variability that exists among emerging adults when it comes to being developmentally ready to drive in high school. Nevertheless, getting licensure in high school could assure emerging adult exposure to the

many driver safety benefits of graduated driver licensing (GDL) programs, which introduce new young drivers to safely gain driving experience before obtaining full independent driving privileges [345]. GDL programs reduce emerging adult crashes and deaths. Comprehensive GDL programs have contributed to the reduction fatal crashes among emerging adult drivers in the United States by as much as 20% - 40% [40]. In the United States, all states have a GDL program that includes three stages: learner's permit, intermediate license, and unrestricted license, although the content (i.e., types of restrictions) of these stages varies across states [357]. Overall, becoming a licensed driver in high school through the safety benefits offered as a result of GDL and having reliable independent transportation may considerably enhanced short- and longer-term well-being/health, education, and employment for young drivers [16-19].

Driving a car in emerging adulthood is related to do daily activities such as accessing health care, seeking supplemental education, and job searching. It is reasonable to expect that high driving frequency emerging adult drivers will show a better physical health, higher education attainment, and more working hours. However, there was no significant association found between driving frequency trajectories and overall physical health, education attainment, and working hours 4 years after high school. It is well understood that with greater exposure to driving like higher driving frequency, particularly at younger ages, there is heightened risk for crashes [41]. Hence, the beneficial effects of high driving frequency on health, education, and employment may be balanced by the relatively earlier and greater driving exposure and related risk [41]. Furthermore, the study was limited to a 7-year period, and it is possible that driving frequency may have had a greater influence on health, education, and employment outcomes if the study had followed participants for a longer period of time.

There are limitations to this study. First, measures of health, education, and employment were based on annual self-reported questions, and this inherently introduces potential for social desirability and recall bias. In addition, employment was measured with self-reported paid and/or unpaid jobs, and this does not differentiate employment from volunteer activities. This

could overestimate the time in paid employment. However, many volunteer activities represent valuable educational opportunities. Second, the NEXT survey was not designed to explore crash risk among adolescents and emerging adult participants. As such, we are not able to empirically test any speculated association between driving frequency-related heightened crash risk and its relationship to later health, education, and employment. There remains a need to empirically explore and examine this link.

Despite these limitations, this research has notable strengths. This study was based on a longitudinal design that allows to examine the long-term association of driving licensure and driving frequency trajectory classes with their later health, education, and employment 4 years after high school. In addition, I used a nationally representative sample that allows for sound national generalizability to the US emerging adult populations.

In conclusion, emerging adults with a driver's license in high school are more likely to report better health, higher education, and more working hours four years after high school. This suggests that high school driving licensure could provide advantages for health, education, and employment during early adulthood.

Table 6.4 Participant sociodemographic variables stratified by health (W7)

		Excellent N (%[#])	Good N (%[#])	Fair N (%[#])	Poor N (%[#])	χ^2	P
Overall[a]		345 (14.46)	1202 (53.08)	612 (28.60)	118 (3.87)		
Race/ethnicity[b]	Latinos	83 (7.50)	314 (48.60)	202 (34.49)	56 (9.42)	55.891	<0.001
	African Americans	63 (15.99)	200 (43.07)	119 (37.35)	22 (3.60)		
	Whites	150 (16.16)	528 (59.54)	195 (22.63)	14 (1.67)		
	[c]Others	15 (16.44)	49 (28.94)	32 (49.52)	7 (5.10)		
Sex[b]	Male	169 (18.76)	464 (53.13)	195 (25.51)	26 (2.60)	12.315	0.006
	Female	142 (11.44)	629 (53.05)	353 (31.07)	73 (4.44)		
Parental education[b]	High school or less	83 (9.96)	393 (53.35)	226 (31.49)	51 (5.20)	45.077	<0.001
	Some college	118 (16.44)	371 (48.04)	192 (31.01)	38 (4.51)		
	Bachelor+	88 (18.00)	271 (58.43)	91 (22.34)	9 (1.24)		
Urbanicity[b]	Urban	103 (13.29)	368 (53.56)	223 (27.27)	49 (5.88)	19.728	0.003
	Suburban	109 (13.93)	360 (49.24)	197 (32.60)	41 (4.23)		
	Rural	99 (15.72)	365 (58.77)	128 (23.62)	9 (1.90)		
Family affluence[b]	Low	83 (11.46)	316 (47.32)	192 (35.56)	48 (5.66)	13.842	0.032
	Moderate	150 (14.99)	522 (53.81)	254 (27.62)	40 (3.58)		
	High	78 (15.95)	255 (56.63)	102 (25.20)	11 (2.22)		
Family Structure[b]	Both biological parents	176 (15.58)	591 (54.54)	290 (27.72)	45 (2.17)	13.495	0.141
	Biological- and step- parents	41 (12.68)	166 (51.57)	92 (29.42)	16 (6.34)		
	Single parent	68 (12.73)	215 (51.48)	114 (32.67)	18 (3.11)		
	[d]Others	26 (14.93)	121 (51.03)	52 (25.47)	20 (8.57)		
W1 health[b]	Excellent	111 (27.91)	191 (57.14)	34 (13.11)	4 (1.84)	102.585	<0.001
	Good	148 (13.77)	637 (59.64)	220 (24.68)	24 (1.90)		
	Fair	44 (7.79)	227 (37.74)	245 (47.42)	48 (7.05)		
	Poor	6 (6.96)	34 (44.99)	45 (34.03)	23 (15.03)		

Note: [#]Weighed % using W7 weight. [b]Weighted % using W1 weight. [c]Including Asian American, Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders. [d]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else

Table 6.5 Participant sociodemographic variables stratified by education attainment (W7)

		Less than or equal to high school diploma or GED N (%[#])	Some college, technical school or associate degree N (%[#])	Bachelor's degree or graduate degree N (%[#])	χ^2	P
Overall[a]		755 (34.62)	967 (42.68)	546 (22.69)		
Race/ethnicity[b]	Latinos	266 (40.22)	282 (44.91)	104 (14.87)	14.192	0.028
	African Americans	162 (36.39)	186 (49.59)	57 (14.02)		
	Whites	237 (31.09)	359 (40.64)	285 (28.27)		
	[c]Others	32 (38.26)	31 (37.56)	39 (24.18)		
Sex[b]	Male	323 (36.04)	357 (46.07)	171 (17.89)	10.013	0.007
	Female	374 (32.86)	502 (40.94)	315 (26.20)		
Parental education[b]	High school or less	332 (47.58)	317 (41.61)	98 (10.81)	171.457	<0.001
	Some college	225 (33.08)	322 (48.34)	170 (18.58)		
	Bachelor+	84 (16.70)	170 (37.75)	204 (45.55)		
Urbanicity[b]	Urban	280 (30.29)	317 (47.16)	146 (22.55)	5.168	0.271
	Suburban	256 (36.13)	307 (44.77)	141 (19.10)		
	Rural	161 (32.82)	235 (38.55)	199 (28.62)		
Family affluence[b]	Low	273 (44.30)	275 (44.63)	91 (11.08)	35.800	<0.001
	Moderate	328 (35.03)	387 (40.65)	244 (24.32)		
	High	96 (24.08)	197 (45.94)	151 (29.98)		
Family Structure[b]	Both biological parents	333 (29.20)	428 (40.76)	337 (30.04)	38.190	<0.001
	Biological- and step- parents	124 (41.02)	142 (45.02)	48 (13.96)		
	Single parent	151 (35.23)	193 (48.59)	69 (16.17)		
	[d]Others	89 (47.30)	96 (40.41)	32 (12.29)		

Note: [#]Weighed % using W7 weight. [b]Weighted % using W1 weight. [c]Including Asian American, Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders. [d]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else

Table 6.6 Participant sociodemographic variables stratified by employment indicated by working hours (W7)

		No working hours per week	<30 working hours per week	≥ 30 working hours per week	χ^2	P
		N (%[#])	N (%[#])	N (%[#])		
Overall[a]		1346 (65.19)	883 (33.74)	32 (1.07)		
Race/ethnicity[b]	Latinos	383 (69.22)	256 (29.43)	11 (1.35)	30.740	<0.001
	African Americans	219 (58.54)	175 (41.27)	2 (0.18)		
	Whites	579 (67.98)	295 (30.88)	14 (1.14)		
	[c]Others	45 (35.18)	55 (64.30)	2 (0.52)		
Sex[b]	Male	546 (68.47)	294 (30.17)	12 (1.36)	3.926	0.141
	Female	681 (62.83)	488 (36.45)	17 (0.72)		
Parental education[b]	High school or less	481 (73.95)	255 (25.43)	11 (0.61)	14.168	0.007
	Some college	427 (63.09)	277 (35.79)	7 (1.12)		
	Bachelor+	244 (56.43)	209 (42.53)	8 (1.04)		
Urbanicity[b]	Urban	409 (54.88)	317 (43.76)	13 (1.37)	29.458	<0.001
	Suburban	410 (64.26)	282 (35.06)	6 (0.68)		
	Rural	408 (70.90)	183 (27.83)	10 (1.27)		
Family affluence[b]	Low	398 (69.13)	232 (30.03)	6 (0.84)	7.381	0.117
	Moderate	577 (66.97)	367 (31.80)	17 (1.23)		
	High	252 (58.56)	183 (40.78)	6 (0.66)		
Family Structure[b]	Both biological parents	623 (60.87)	468 (38.12)	15 (1.00)	22.524	0.001
	Biological- and step- parents	211 (73.81)	96 (26.13)	1 (0.06)		
	Single parent	253 (65.75)	148 (33.07)	9 (1.18)		
	[d]Others	140 (72.22)	70 (25.58)	4 (2.20)		

Note: [#]Weighed % using W7 weight. [b]Weighted % using W1 weight. [c]Including Asian American, Indiana or Alaska Native, and Native Hawaiian or other Pacific Islanders. [d]Including grandmother, grandfather, foster home or children's home, and someone or somewhere else

Table 6.7 Multinomial logistic regression of health, education attainment, and working hours at W7 on driving licensure status

	^Driving licensure status					
	High school			After high school		
	AOR	95%CI	P	AOR	95%CI	P
$Health						
Excellent vs. poor	**7.55**	**1.81, 7.76**	**0.048**	1.94	0.44, 8.58	0.418
Good vs. poor	2.75	0.51, 4.91	0.076	**1.75**	**1.25, 1.93**	**0.007**
Fair vs. poor	2.73	0.50, 4.88	0.089	1.18	0.79, 2.84	0.228
$Education attainment						
Bachelor's degree or graduate degree vs. less than or equal to high school diploma or GED	**4.11**	**1.76, 9.62**	**<0.001**	1.49	0.57, 3.85	0.364
Some college, technical school or associate degree vs. less than or equal to high school diploma or GED	**3.36**	**2.21, 5.10**	**<0.001**	**2.71**	**1.51, 4.86**	**0.016**
$Working hours						
≥30 hours vs. no working hours	0.57	0.13, 2.47	0.680	**1.20**	**1.11, 1.91**	**0.041**
<30 hours vs. no working hours	**1.81**	**1.10, 2.97**	**0.010**	1.85	1.08, 3.15	0.101

Note: No licensure was the reference group; Logit models used poor health, less than or equal to high school diploma or GED, and no working hours as the reference category; AOR: adjusted odds ratio; CI: confidence interval; $Dependent variables and ^Independent variable; Covariates included in the adjusted model for health were race/ethnicity, sex, parental education, urbanicity, family affluence, and W1 health; Covariates included in the adjusted model for education attainment were race/ethnicity, sex, parental education, family affluence, and family structure; Covariates included in the adjusted model for working hours were race/ethnicity, parental education, urbanicity, and family structure.

Table 6.8 Multinomial logistic regression of health, education attainment, and working hours at W7 on driving frequency trajectory classes

	^Driving frequency trajectory classes					
		Medium			High	
	AOR	95%CI	P	AOR	95%CI	P
$Health						
Excellent vs. poor	1.35	0.35, 5.29	0.630	1.09	0.22, 5.44	0.923
Good vs. poor	0.88	0.26, 2.99	0.859	0.67	0.17, 2.60	0.499
Fair vs. poor	0.88	0.25, 3.11	0.919	0.72	0.17, 3.04	0.605
$Education attainment						
Bachelor's degree or graduate degree vs. less than or equal to high school diploma or GED	0.74	0.44, 1.25	0.677	1.21	0.75, 1.93	0.472
Some college, technical school or associate degree vs. less than or equal to high school diploma or GED	0.66	0.32, 1.36	0.389	1.93	0.11, 3.37	0.180
$Working hours						
≥30 hours vs. no working hours	0.55	0.16, 1.90	0.135	1.07	0.67, 1.71	0.691
<30 hours vs. no working hours	1.77	0.37, 8.58	0.235	1.31	0.78, 2.22	0.235

Note: Low driving frequency trajectory was the reference group; Logit models used poor health, less than or equal to high school diploma or GED, and no working hours as the reference category; AOR: adjusted odds ratio; CI: confidence interval; $Dependent variables and ^Independent variable; Covariates included in the adjusted mode for health were race/ethnicity, sex, parental education, urbanicity, family affluence, and W1 health; Covariates included in the adjusted model for education attainment were race/ethnicity, sex, parental education, family affluence, and family structure; Covariates included in the adjusted model for working hours were race/ethnicity, parental education, urbanicity, and family structure.

CHAPTER 7 – SUMMARY

7.1 Conclusions

My dissertation assessed the associations of driving licensure status, delay in driving licensure, and driving exposure with alcohol and drug use, parental monitoring knowledge, peer alcohol and drug use, and health, education, and employment in emerging adulthood.

Increased independence and mobility after having a driver's license in high school, no delay in driving licensure, and more driving frequency may facilitate substance use. Increased independence and mobility may enable emerging adults to easily access substances that may be present in their living areas. The increased access may put emerging adults at greater risk of substance use, as it can make it easier for them to purchase, transport, and possess substances. Additionally, the increased access to places outside of emerging adult living areas may provide them the opportunities to purchase or obtain substances that may have otherwise been unavailable to them. If there is no delay in driving licensure, emerging adults are more likely to be exposed to substances at an earlier age than they would have been otherwise. Further, driving more frequently may enable emerging adults to use substance by providing them with greater access to places where substances are more readily available. This could include bars, clubs, or other areas where alcohol and drugs may be more likely to be found.

Having a driver's license in high school, no delay in driving licensure, and more driving frequency may lead to more opportunities to hang out with peers who use alcohol and drug and increased parental monitoring knowledge. Having a driver's license may provide emerging adults with more opportunities to meet peers who use substances, as they will have more freedom to go to places where they may find peers who use substances. If emerging adults are driving more frequently, they may be more exposed to peers who use substances as they travel to different places and locations. Additionally, having a driver's license in high school and more driving frequency could lead to increased monitoring knowledge as parents may be more aware

of their emerging adults' whereabouts and the potential risks involved in driving. Parents may also be more likely to set rules and expectations for safe driving and to enforce those roles.

Increased independence and mobility after having a driver's license in high school may help facilitate health, education, and employment in a variety of ways. For example, having access to a vehicle allows emerging adults to take control of their own health care by scheduling and attending medical appointments, accessing medical care in a timely manner, and receiving follow-up care when needed. Access to a car also allows emerging adults to attend college and job training programs in distant locations, and to have access to a variety of employment options that are not easily accessible without the use of a vehicle. Furthermore, with no delay in driving licensure, emerging adults may start seeking employment and access more job opportunities sooner, enabling them to take advantages of the current job market conditions. This ultimately enables them to gain experience, build up their resumes, and increase their earning potential as they transition into adults. Additionally, increased driving frequency allows emerging adults to travel to and from work more quickly, which can lead to increased productivity and improved employment outcomes.

In Chapter 3, "Emerging adult driving licensure and driving exposure trajectories: sociodemographic characteristics of a nationally representative sample," I demonstrated that increased daily miles driven pattern was found throughout emerging adulthood. Emerging adults are increasingly driving more miles each day. The trend of increased daily miles is continuing into adulthood. The finding suggests that emerging adults may be more likely to be involved in accidents due to lacking driving experience, which could potentially be mitigated by increased monitoring of their driving. Further, race/ethnicity, sociodemographic status, family structure, social media use, and mother's monitoring knowledge contribute to driving licensure and driving frequency. This finding could be used to inform future research and public policy decisions to reduce the risk of accidents by emerging adult drivers. For instance, future research should aim to identify ways to reduce the influence of these factors (e.g., race/ethnicity, sociodemographic

status, family structure, social media use, and mother's monitoring knowledge) on driving frequency, such as by providing more opportunities for emerging adults to obtain driver's licenses or increasing public awareness of the risks of driving. Public policy may be developed to address the various factors (e.g., race/ethnicity, sociodemographic status, family structure, social media use, and mother's monitoring knowledge) that contribute to emerging adult driving frequency, such as providing instructions for parents to monitor their emerging adult's driving activities, or providing resources to enable emerging adults from underprivileged backgrounds, such as those with low family affluence, to gain greater awareness of the risks associated with driving.

In Chapter 4, "Are driving licensure status, delay in driving licensure, and driving frequency trajectory classes associated with alcohol drinking, binge drinking, and drug use trajectory classes in emerging adulthood?" I demonstrated the increased risk for alcohol drinking, binge drinking, and drug use among emerging adults with driving licensure in high school, no DDL, and more driving frequency. This finding has several important implications for public health. First, it suggests that public health initiatives may recommend emerging adults with alternative forms of transportation, such as public transportation or ride-sharing services, to reduce the need for emerging adults to drive to social activities. Second, public health initiatives may aim to reduce the ease of obtaining a driving license for emerging adults and increase the requirements for licensure. This could include raising the minimum age for licensure and implementing stricter rules for obtaining a license. Third, public health initiatives may provide emerging adults with evidence-based education on the risks of alcohol and drug use, as well as the dangers of driving while under the influence of alcohol or drugs. These public health initiatives may also provide emerging adults with alternative forms of recreation, such as sports and other activities, to reduce the need for emerging adults to drink or use drugs to have a good time. The findings also provide an important foundation for further research on the relationship between driving licensure and substance use in emerging adults. For example, further research

could explore the role of parental and peer influences in the relationship between driving licensure and substance use. Additionally, further research could explore other factors, such as access to vehicles (who has reliable access, what types of vehicles [e.g., car, truck, SUV, etc.], or if they're limited to public transportation), that may influence emerging adults' willingness to engage in risky behaviors. By understanding the factors that influence emerging adults' substance use, public health initiatives can be tailored to target specific risk factors and reduce the risk of substance use in emerging adults.

High school emerging adults are defined as students attending a high school, typically in their junior or senior year, who have moved from childhood into what is referred to as the transitional period between adolescence and emerging adulthood. During this time, they are beginning to explore their independence, identity, career paths, and social/interpersonal relationships in preparation for adulthood. In Chapter 5, "Associations of driving licensure status, delay in driving licensure, and driving frequency in high school with peer alcohol and drug use trajectory classes and parental monitoring knowledge," I demonstrated that high school emerging adults with driver's licenses, no DDL, and a higher driving frequency were more likely to report increased peer alcohol and drug use because emerging adults may be more mobile and have more access to drug and alcohol use. Having a driver's license and no delay in driving licensure give emerging adults the freedom and opportunity to access alcohol and drug more easily. The result suggests that educators should be aware of the potential risks, such as increased peer alcohol and drug use, that may arise from allowing emerging adult drivers to have more chances to stay with peers who use substances. There may also be a need to provide additional education and resources to help emerging adults make safe and responsible decisions when it comes to driving. Further research could be conducted to determine the most effective strategies for decreasing peer alcohol and drug use among high school emerging adults with driving privileges, such as withhold or reduce driving privileges if these teens are identified as engaging in drug or alcohol use or implementing deterrents such as a zero-

tolerance policy for drugs and alcohol for all those holding a valid driver's license, and creating opportunities for education and support among peers. Through interventions like these, we may be able to help decrease the overall rate of peer alcohol and drug use among high school emerging adults with driving privileges. In addition, a higher level of parental monitoring knowledge was found in high school emerging adults with driver's license, no DDL, and a higher driving frequency. The implication of this finding is that driving privileges in high school emerging adults could be beneficial to their development, as driving privileges may help high school emerging adults become more aware of the need for parental monitoring. Having driving privileges in high school emerging adults may provide their parents with the opportunity to educate their emerging adults on the importance of safe driving and the risks associated with driving. Further research may investigate the effects of driving privileges on high school emerging adults and the implications for parental monitoring. Research into the potential risks associated with driving privileges in high school emerging adults could be conducted to better inform the decision-making process. Strategies for developing effective communication between parents and their high school emerging adults regarding driving privileges could be explored.

In Chapter 6, "Associations of driving licensure status, delay in driving licensure, and driving frequency trajectory classes with health, education, and employment in emerging adulthood," Study 1 demonstrated that although driving licensure is viewed as a major developmental milestone, nearly 70% of eligible adolescents delayed licensure at least 1-year. Emerging adults without licensure delay reported better health, education, and employment in emerging adulthood. Future study should assess DDL contextual facets and provide detail of measured early adulthood success. Study 2 demonstrated that emerging adults having a driver's license in high school were more likely to report better health, higher education, and more working hours four years after high school. This suggests that high school driving licensure could provide advantages for health, education, and employment during early adulthood.

By conducting a thorough study of the impact that driving licensure status, DDL, and driving exposure have on alcohol and drug use, as well as on alcohol and drug use protective factors (such as parental monitoring knowledge and risk factors (like peer alcohol and drug use), what I can add to the current knowledge base is a better understanding of the non-crash risks associated with increased independence and mobility when emerging adults begin to drive, beyond the risks resulting from vehicle crashes. The findings of my dissertation could provide families and injury prevention programs with valuable insight when making decisions about whether granting driving licenses, delaying driving licensure, and increasing driving exposure for emerging adults to reduce alcohol and drug use.

The findings of my dissertation suggest that driving privileges (e.g., having a driver's license in high school, no DDL, and more driving frequency) among emerging adults are positively associated with early adult outcomes such as health, education, and employment. The findings indicate that driving may be beneficial to the overall development of emerging adult drivers. Based on the findings, it is possible to develop programs that are tailored to support emerging adult drivers to maximize their potential and enhance their opportunities for health, education, and employment. Programs developed from the findings could focus on providing emerging adult drivers with resources, guidance, and support to help them succeed in their health, education, and employment goals. These programs could also provide access to career counseling and other opportunities to help emerging adult drivers reach their full potential. Additionally, programs may seek to build a sense of community and camaraderie among emerging adult drivers to ensure that they are better able to flourish in their emerging adulthood.

The findings on the potential conflict between the risks and benefits of having a driver's license in high school are mixed. While having a driver's license in high school may provide enhanced opportunities for health, education, and employment, it can also lead to increased alcohol and drug use and peer alcohol and drug use and decreased parental monitoring knowledge. To balance these risks, delaying driving licensure until a later age and limiting the

amount of driving exposure may help reduce the risks. On the other hand, providing emerging drivers with more driving exposure may help them develop better driving skills and increase their knowledge about safe driving practices, which can help reduce crash risk. Ultimately, it is important for parents to weigh the potential risks and benefits of having a driver's license in high school and make an informed decision that works best for their family. It has been observed that obtaining driving privileges may carry both risks and benefits. Non-crash risks include increased alcohol and drug use, peer alcohol and drug use, and decreased parental monitoring knowledge. Conversely, benefits include enhanced opportunities for health, education, and employment. Bearing that, driving licensure, DDL, and driving exposure contextual facets should be assessed to provide details of measured early adulthood success with the consideration of their alcohol and drug use, peer alcohol and drug use, and parental monitoring knowledge changes.

7.2 Other considerations

The research I conducted did not necessarily include an exploration of graduating driving licensure (GDL), although the further investigation into this topic may be worthwhile. GDL policies are implemented on a state-by-state basis and vary in the specific rules they require. For example, as of 2021, California requires drivers under the age of 18 to hold a learner's permit for a minimum of six months before they can obtain a license, while Texas requires drivers under 18 to hold a learner's permit for a minimum of six months and complete 32 hours of driver education before they can obtain a license [347]. Recent studies have found that GDL policies can have significant benefits for emerging adult drivers. According to a study conducted by the Insurance Institute for Highway Safety (IIHS), GDL policies reduce the crash rate for 16-year-old drivers by as much as 40% [348]. Additionally, the study found that restrictions on nighttime driving, passenger restrictions, and minimum age requirements for a full license can further reduce crash rates for emerging adults [348]. GDL policies have been effective in reducing the crash rates of emerging adult drivers and may also produce beneficial outcomes

for the education, health, and employment of emerging adults [349]. It appears that my dissertation may provide additional evidence that GDL policies could have a positive impact on emerging adults, beyond just reducing crash rates. This information could be utilized to inform current and future GDL policies to maximize their potential for positive outcomes for emerging adults. For example, states might consider expanding GDL policies to include additional restrictions on emerging drivers or increasing the number of supervised driving hours required before obtaining a license. Such changes could potentially result in further reductions in crash rates and improved outcomes in health, education, and employment for emerging adults.

Additionally, the NEXT study was conducted prior to the pandemic, and thus my research did not consider the impacts of the post-pandemic on driving licensure. I hypothesize that the post-pandemic may impact on driving privileges, such as having a driver's license in high school, no delay in driving licensure, and a higher driving frequency, among emerging adulthood, thus leading to less substance use and a higher level of parental monitoring knowledge, better health, higher education attainment, and more working hours in early adulthood. The post-pandemic period has the potential to bring about lasting changes in how emerging adults obtain driving privileges, and these changes may ultimately have a positive impact on their health and development in early adulthood. Specifically, high school students may gain their driver's license more quickly, there may be no delay in obtaining driving licensure, and they may be able to drive more frequently. Many states have relaxed their restrictions for obtaining a learner's permit or driver's license. Some states have changed their minimum age requirements and/or allowed for applications to take driver's classes online. With the lifting of restrictions due to the post -pandemic, states may be allowing more frequent driving and/or permit renewals. Many states have started to allow both adults and youth to driver in both daytime and nighttime hours. Parental monitoring knowledge may be improved due to increased responsibility and maturity that comes with potential driving privileges among emerging adults will help foster trust in emerging adults and provide the parents with more

insight and understanding of their emerging adults' activities. As a result, emerging adults may be more likely to abstain from substance use due to better parental monitoring knowledge and more time spent behind the wheel rather than engaging in risky behaviors. Additionally, higher levels of driving exposure may result in improve health, higher education attainment, and more working hours in early adulthood. All these results hinge on the ability of emerging adults to drive, and the effects of the post-pandemic on driving privileges. It is therefore important to consider the ways in which the post-pandemic has impacted emerging adults' access to driver's licenses, the availability of driving lessons and tests, and how driving has been crippled due to the strict travel restrictions. To account for these post-pandemic changes, it is essential to evaluate the availability of resources to emerging adult drivers, develop protocols for safely engaging in the learning process, and create strategies for giving emerging adult drivers greater access to driving opportunities. Additionally, it is important to consider how parents could support their emerging adults in obtaining their driver's license and receive adequation education about proper driving practices. By addressing these issues in a comprehensive manner, the post-pandemic period may indeed lead to more positive outcomes in terms of driving privileges, substance use, parental monitoring, and long-term development among emerging adults. However, it is essential to develop thoughtful and targeted strategies to capitalize on the potential benefits of driving for emerging adults, while ensuring that they remain safe while behind the wheel.

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