TITLE: Race, alcohol consumption, and vehicle crashes: an epidemiologic paradox

Project summary

Despite a greater accumulation of risk factors for at-risk drinking and alcohol use disorders, national epidemiological surveys consistently report that Blacks and Hispanics in the United States (US) have an comparable or lower prevalence of binge drinking and alcohol disorders compared to non-Hispanic Whites. However, mortality data indicate that they have higher rates of alcohol-attributable motor vehicle crash fatality (MVCF). These seemingly divergent patterns indicate an epidemiologic paradox, the consequences of which are important for public health: MVCF is a leading cause of death among young adults, Blacks and Hispanics experience substantial inequities in MVCF compared to non-Hispanic Whites, and approximately 30% of all MVCFs are alcohol-related. In the present application for a Mentored Research Scientist Development Award (K01), I propose to develop expertise in four areas that will allow me to develop a line of research into the racial/ethnic paradox in alcohol-related health: 1) Built environment effects on alcohol-related health; 2) Conceptualization and measurement of cultural and social norms regarding alcohol use; 3) Analysis of repeated measures data; and 4) Field methods in epidemiologic data collection. I will use the skills obtained in these training areas to begin to fill outstanding gaps in our understanding of racial/ethnic differences in alcohol-related health with three research projects, for which the K01 will allow me protected research time that would otherwise not be possible as a new assistant professor. First, I will probe the validity of the racial/ethnic paradox itself. I will explore whether lower rates of problem drinking among racial/ethnic minorities are limited to adolescents and young adults, and whether rates of problem drinking among older adults are higher among Blacks and Hispanics compared to non-Hispanic Whites. This work will utilize a national longitudinal dataset and incorporate information on trajectories within Blacks and Latino subgroups, which have never been characterized. Second, I will determine if alcohol-related social norms mediate overall differences in alcohol use and MVC risk, adding to our knowledge of how the paradox arises. I will use data from the New York Social Environment Survey, an epidemiologic study in New York City with rich racial and ethnic diversity and one of the only community-based samples to measure alcohol norms. Third, I will test a potential mechanism to explain the racial/ethnic paradox: that Black and Hispanic individuals experience more alcohol-attributable MVCF because the built environment in which they consume alcohol is more dangerous (e.g., worse road conditions). To test this hypothesis I propose a novel study linking records from the Fatality Analysis Reporting System on a national level with census and land usage information. In addition to these research aims, my K01 award period will focus on preparation of an R01 grant proposal to collect original data on racial/ethnic differences in alcohol-related health that builds on and extends the research proposed here. These projects are feasible only if I have protected time for new training and research, which K01 funding will provide.

Narrative

The present proposal examines a long-standing but little investigated 'paradox' in alcohol epidemiology: epidemiological surveys consistently report that Black and Latino populations have comparable or lower prevalence of alcohol disorders compared to non-Hispanic Whites, but bear a disproportionate amount of harm from alcohol in the form of injury and illness. The training and research proposed here will form the background of a new line of inquiry harnessing existing data resources to examine how racial/ethnic differences are shaped over the life course, and how the built environment as well as cultural/social norms shape alcohol-related risk. These inquires have substantial promise for public health; accurate empirical data regarding the emergence of racial/ethnic differences across the life course and explanations for the epidemiologic 'paradox' in alcohol-related health are crucial to better understanding the role of minority status in the development and persistence of alcohol disorders as well as alcohol-related motor-vehicle crash risk.

10. Specific Aims. More than two million Americans are seen in emergency rooms for injuries associated with motor vehicle crashes each year,[1] and in 2008 more than 37,000 individuals were fatally injured in a motor vehicle crash in the U.S. An estimated 37% of those fatalities (more than 14,000) were attributable to alcohol.[2] The overarching aim of my K01 Mentored Research Scientist Development Award is to develop training that will allow me to pursue a line of research about an ongoing, unresolved epidemiologic paradox involving alcohol-attributable motor vehicle crash (MVC) fatality. Black and Latino individuals in the U.S. have a greater accumulation of risk factors for alcohol use disorders (AUDs) (e.g., lower socio-economic position, higher exposure to stressful life events), yet most epidemiologic data indicate that rates of consumption, binge drinking, and AUDs are comparable or lower among these groups compared to non-Hispanic Whites (heretofore referred to as "Whites").[3-5] Yet despite this incongruity, Blacks and Latinos have higher rates of alcohol-attributable MVC fatality.[6] Higher mortality rates despite lower survey-reported consumption and disorder could indicate a lack of validity of survey data, or could indicate that Blacks and Latinos truly face more deadly consequences of drinking than Whites. The present proposal is to provide me with training in order to conduct research exploring three hypotheses that examine how findings of higher rates alcohol-related MVC fatality despite lower consumption and disorder could validly occur. Each research project is feasibly accomplished over the next five years given substantial protected time for research and training, and will inform an R01 that I will submit in Year 4 of the award period. The research will explore three ways in which racial/ethnic paradoxes occur: that existing research has not sufficiently documented age-related 'cross-over'[7-9] of risk longitudinally; that social and cultural norms regarding alcohol use differentially mediate the relation between race/ethnicity and alcohol use (i.e., Blacks and Latinos have more restrictive norms regarding any alcohol consumption, but among drinkers, Blacks and Latinos have less restrictive norms regarding binge drinking); and that Blacks and Latinos in the U.S. are at higher risk of death when driving after drinking at least in part because they drive in more dangerous built environments. Importantly, each project will examine Latino ethnic subgroups, an area of epidemiologic research that has been neglected.

Research Aim 1: Test racial/ethnic differences in trajectories of alcohol use indicators across adolescence and adulthood in: 1) lifetime drinking; 2) current binge drinking; and 3) alcohol-related MVC risk. Trajectories across five groups will be tested: Blacks; Puerto Ricans; Cubans; Mexicans; and Whites. Data for Aim 1 will be drawn from the National Longitudinal Study of Adolescent Health (AddHealth). Accomplishing aim 1 will require training in analysis of repeated measures data (**Training Aim C**). **Specific hypotheses**: **(1)** That trajectories of alcohol use will remain higher for Whites than other subgroups across development; **(2)** That trajectories of binge drinking will be higher among Whites than other groups in adolescence, with convergence in adulthood; **(3)** That trajectories of MVC-risk will be higher among Whites in adolescence and 'cross-over' in early adulthood (the primary risk period for MVC), with Black and Latino subgroups have higher rates in adulthood.

Research Aim 2: Examine how alcohol-related attitudes vary across racial/ethnic subgroups in NYC, and the extent to which racially-specific alcohol norms mediate alcohol use versus alcohol-related MVC risk in different ways. Data for Aim 2 will be drawn from the New York Social Environment Survey. Accomplishing Aim 3 will require training in conceptual and measurement issues (**Training Aim B**). **Specific hypotheses**: **(1)** That norms regarding any alcohol consumption will be more restrictive among Black, and Latino individuals compared to Whites in NYC; **(2)** That among drinkers, Black and Latino individuals will have less restrictive norms regarding occasional binge drinking than Whites; and **(3)** That norms at least partially mediate the association between race/ethnicity and alcohol consumption as well as alcohol-related MVC-risk.

Research Aim 3: Examine racial/ethnic differences in alcohol-attributable MVCFs in the U.S. in terms of: 1) area-related (e.g., urban/rural, population density, land space devoted to roads, road conditions), 2) vehicle-related (e.g., older make and model of vehicle), and 4) person-related (e.g., blood alcohol content [BAC], sex, prior DUI, drug involvement) characteristics. Data for Aim 3 will be drawn from national Fatality Analysis Reporting System (FARS) records, a complete census of MVCFs in the US. Accomplishing Aim 3 will require training in the built environment (**Training Aim A**). **Specific hypotheses**: **(1)** Indicative of the racial/ethnic paradox, Blacks and Latinos will have lower BAC at the time of the crash compared to Whites; **(2)** The geographic areas where Blacks and Latinos (across subgroups) experience alcohol-related MVC fatalities will have more dangerous driving conditions than Whites; **(3)** The association between race/ethnicity and the built environment in which fatalities occur will persist after controlling for MVC risk factors known to differ across racial/ethnic subgroups (e.g., BAC level, safety belt use, drug involvement, and vehicle model year).

2. Candidate's Background. My interest in racial/ethnic differences in health began as assistant director of a detoxification program in New York City (NYC). In that capacity I often observed worse clinical outcomes for patients of racial/ethnic minority status despite their similar socio-economic status to White patients. I chose to pursue a career in epidemiology to research these disparities as well as other risk factors for substance disorders at the population level. During graduate school at Columbia University (CU), I published two papers on Black/White differences in treatment utilization for Axis I psychiatric disorders,[10, 11] and have followed this line of research with a recent paper examining treatment utilization among Latinos.[12] While these studies were important in documenting treatment disparities, they did not address the underlying risk factors for substance disorders across racial/ethnic groups. I began to be interested in stress exposure as a potential factor that is related to minority social statuses.[13-17] Further, I documented that Blacks and Latinos in the U.S. perceive higher stigma towards alcohol disorders, a potential barrier to treatment.[18] My dissertation work focused on the role of changing social norms shaping trends in adolescent substance (including alcohol) use;[19, 20] while the work did not focus on racial/ethnic minorities, the experience I gained studying alcohol-related social norms will serve as a foundation for norm-related training and research. For my post-doctoral work, I accepted a post-doctoral position in the CU Department of Epidemiology despite several attractive offers at other major research institutions. This decision was based on the considerable resources and institutional support provided to me by CU, and the depth of faculty expertise in my areas of interest. I have continued to develop my interest in issues of minority stress and alcohol-related health. For example, I published a comprehensive review examining the evidence for four types of stressors (including minority stress) as risk factors for alcohol use disorders,[21] and examined the cumulative effect of life-course stress on binge drinking among African Americans in Detroit.[22] Importantly, I was introduced to the unresolved paradox in the relationship between race/ethnicity and alcohol consumption versus alcohol-attributable motor vehicle crash (MVC) fatality in my work on a literature review[6] in response to a call for papers by *Epidemiology Reviews.* Given my research experience in alcohol use disorder epidemiology rather than alcohol-associated injury, I hypothesized that Black and Latino individuals would have a lower rate of alcohol-attributable injury than non-Hispanic Whites (heretofore referred to as "Whites"). What I found was quite the opposite, and writing the paper as well as discussing the issue with experts introduced me to the underlying issue of the race paradox in psychiatric epidemiology more generally. I began to see how important and unresolved this topic is across the field of epidemiology, and decided that further research into this paradox can make a substantial and lasting contribution to this field. My interest in the topic was cemented after reading a proposed explanation for and resolution to the paradox in depression[23, 24] that I believed to be conceptually incomplete. I published a paper in *Social Science and Medicine* failing to replicate the authors' study results[25] and a commentary calling for a new generation of innovative scientists to take on this issue in epidemiologic research.[26] I am now poised to gain the skills and experience necessary to develop that research program, moving racial/ethnic issues in alcohol-related health to the forefront of my research program. This research program is a substantially new direction for me. Developing it will require training, mentoring, and importantly, protected time. The support of the K01 at this important career juncture will enable me to fulfill a commitment I wish to make to a life-long career in alcohol research, given the high prevalence and disabling consequences of alcohol problems worldwide.

3. Career goals and objectives. My long-term goal is to carry out an alcohol-related epidemiologic research agenda as an independent scientist in an academic research setting, focusing on understanding health disparities among at-risk populations. Thus far, I have had pre- and post-doctoral support that allowed me to develop a highly productive record of research. Now, as I transition from a post-doctoral position to a junior faculty position, my research and progress towards independence will be significantly impeded if I do not have protected time to develop my research program. The ability to gain new skills, refine aims and hypotheses to submit an application for R01 funding, and begin the development from junior faculty member to leader in the field of alcohol epidemiology will not be feasible if I carry a teaching and administrative burden. Further, understanding the root causes of alcohol-related disparities will not be simple. While the research proposed here will provide important insights, a complete understanding will require a substantial commitment to training and research, including data collection with specific intent to examine racial/ethnic inequalities. Thus, the work proposed for the K01 is necessarily preliminary, and designed to inform hypotheses that I will continue to develop and refine over the course of my career. To accomplish these long-term goals, I have developed four short-term goals for the K01 award, listed in Table 1, which describes how each goal will be met during the K01 period, and how each goal will inform an R01 proposal to collect data on cultural, social, and environmental factors that underlie racial/ethnic differences in alcohol consumption and alcohol-related health disparities to be developed during the K01.

Table 1. Short-term K01 goals linked to training, research, mentorship, and R01 grant proposal				
Short-term career goal	**Training**	**Research project**	**Mentors**	**Relevance to an R01 proposal**
Goal 1: Understand race/ethnic trajectories of consumption and MVC risk from adolescence to adulthood	**Training Aim A**: Analyzing repeated measures data	**Research Aim 1**: Use AddHealth* to test differences in longitudinal trajectories of alcohol use, binge drinking, and alcohol-related MVC risk from adolescence to adulthood among racial/ethnic subgroups	Peter Bearman Deborah Hasin Melanie Wall	Use results to inform age distribution and sampling strategy to sure critical periods in the life course are captured.
Goal 2: Examine the role of alcohol-related social norms in shaping racial/ethnic differences in alcohol use and alcohol-related MVC risk.	**Training Aim B**: Conceptualization and measurement of cultural and social norms	**Research Aim 2**: Use NYSES* data to test social norms as a mediator of racial/ethnic differences in alcohol consumption and MVC risk	Raul Caetano Sandro Galea Deborah Hasin	Use results to inform hypotheses about the role of culture in alcohol-related racial/ethnic differences
Goal 3: Investigate how the built environment may explain racial/ethnic paradoxes	**Training Aim C**: Theories of built environment and health, GIS, and Bayesian spatial analysis	**Research Aim 3**: Use national FARS* data to examine road-related, driver-related, and vehicle-related racial/ethnic differences in MVCF	Sandro Galea, Paul Gruenewald Eduardo Romano	Use result to inform what data on the built environment are necessary to comprehensively characterize risk
Goal 4. Submit an R01 grant proposal to collect and analyze data on racial/ethnic differences in alcohol-related health in NYC	**Training Aim D**. Field methods in epidemiologic data collection	**Research Aims 1-3** will all inform the R01 grant aims and methods	Deborah Hasin Sandro Galea	Submit R01 proposal
*AddHealth = National Longitudinal Study of Adolescent Health; FARS = Fatality Analysis Reporting System; NYSES = New York Social Environment Study				

4. Career Development / Training During the Award Period. The research I propose in this application is a new direction for me, and will only be successfully accomplished given substantial mentoring and training. The mentoring represents a mix of senior scientists with whom I have not worked as well as several with whom I have existing relationships but will now engage in new directions, providing a bridge between my previous research and my new proposed areas. The K01 mechanism will allow me to the opportunity to develop new productive collaborations with senior scientists and research groups, crucial for a young investigator at my stage. The training plan will be implemented and overseen by my two principal mentors, Drs. Deborah Hasin (Primary mentor) and Sandro Galea (Co-Principal Mentor), with bi-weekly meetings throughout the K01 period to ensure that progress has been made towards (1) submission of 2-3 publications for each training aim over the course of the award period; (2) submission and presentation of 1-2 scientific abstracts at conferences each year; and (3) preparation of an R01 application to NIAAA. In addition, Drs. Hasin and Galea will organize a yearly benchmark meeting with all mentors (via conference call or in-person as available) to review progress, identify any road blocks to success, and ensure that training and research goals are met.

Mentoring team. The mentoring team will be co-led by Drs. Hasin and Galea. **Dr. Deborah Hasin** is an internationally recognized researcher in the epidemiology of alcohol use disorders and is the 2011 recipient of the Jellinek award for achievement in alcohol epidemiology. She has published more than 250 articles, has a K05 Senior Scientist and Mentoring Award from NIAAA, has previously mentored K awards, has received extensive NIH funding throughout her career, and serves on the NIAAA National Advisory Council. I have a successful history of productive research with Dr. Hasin's research group, having authored or co-authored more than 40 manuscripts with Dr. Hasin. The present program of research represents an appreciable departure from our previous collaborations, however, and given Dr. Hasin's outstanding 30-year career as an alcohol epidemiologist, I have substantially more to gain from continued mentorship. Dr. Hasin will now mentor me in the transition to an independent researcher, and providing new areas of mentoring in Training aims B and D. **Dr. Sandro Galea** has extensively researched issues of race and health with a focus on social and structural factors that promote health inequities in substance use, including alcohol, and injury.[27-36] He is an expert in theory and methods than underlie built environmental effects on health, including Bayesian spatial analyses (**Training Aim C**).[31, 33-36] Dr. Galea has published more than 300 articles, 50 chapters, and 6 books, has received extensive NIH funding thorough his career, and has previously mentored K awards. Additional mentoring will be provided for specific projects by five senior scientists. **Dr. Peter Bearman** is an internationally renowned sociologist[37, 38] who received the NIH Director's Pioneer Award in 2007, and the Roger V. Gould Prize in 2004 for his seminal article using the National Longitudinal Study of Adolescent Health (AddHealth) data I will be using in Aim 1.[37] Dr. Bearman will provide consulting regarding longitudinal data analysis and specific issues with the AddHealth data. **Dr. Raul Caetano** is an international expert in racial/ethnic differences in alcohol consumption, alcohol use disorders, and alcohol-attributable motor vehicle crash risk,[5, 39-50] as well as cultural and social norms regarding alcohol use across racial/ethnic groups. **Dr.**

Table 2. Key personnel and role on the K01 project		
Key personnel	**Title**	**Role on project**
Deborah Hasin	Professor of Clinical Epidemiology (in Psychiatry) at Columbia University, where she directs the Substance Dependence Research Group	Primary mentor, Co-mentor on Training Aims B and D
Sandro Galea	Anna Cheskis Gleman and Murray Charles Gelman Professor and Chair of the Department of Epidemiology at Columbia University	Co-Principal mentor, Co-mentor on Training Aims B, C, and D
Peter Bearman	Jonathan Cole Professor of the Social Sciences at Columbia University	Co-Mentor, Training Aim A
Raul Caetano	Dean of the University of Texas Southwestern School of Health Professions and Regional Dean for the Dallas Campus of the University of Texas School of Public Health	Co-Mentor, Training Aim B
Paul Gruenewald	Scientific Director and Senior Research Scientist for the Prevention Research Center in California	Co-Mentor, Training Aim C
Eduardo Romano	Senior Research Scientist with the Alcohol, Policy, and Safety Research Center in Calverton, Maryland	Co-Mentor, Training Aim C
Melanie Wall	Professor of Biostatistics (in Psychiatry) at Columbia University	Co-Mentor, Training Aim A

Paul Gruenewald is an expert in the geospatial distribution of alcohol use, alcohol-related motor vehicle crash risk, and geospatial risk factors such as outlets and premise utilization.[51-60] **Dr. Eduardo Romano** has received extensive NIAAA funding throughout his career to conduct research using the FARS data,[61-77] and his specific research program examines racial/ethnic differences in fatality.[65-71] **Dr. Melanie Wall** is an internationally recognized expert in longitudinal data analysis. Dr. Wall has authored more than 100 publications and has received extensive funding from various NIH Institutes throughout her career.

Training Aim A: Analyzing repeated measures data. Rationale. While I have substantial experience analyzing cross-sectional and two-wave data, I have no experience with multi-wave data and issues therein (e.g., analytic techniques, missing data). Research Aim 1 is to test trajectories of racial/ethnic differences in alcohol use and alcohol-related MVC risk. The role of critical developmental periods in creating and/or maintaining racial/ethnic differences is central to beginning to understand racial/ethnic differences in alcohol-related health, yet a study of this kind has never been conducted at a national level, has not incorporated information on Latino subgroups, and has not focused on alcohol-related MVC risk. To conduct this research I will need to become proficient in repeated measures analysis generally, and latent trajectory modeling specifically. While I have experience in structural equation and some other latent variable modeling frameworks,[78-81] I have never conducted trajectory analyses. Mentors. My training in this area will be overseen by **Drs. Wall and Bearman**. Specific details of the training plan are described in Table 3.

Training Aim B: Conceptualization and measurement of cultural and social norms regarding alcohol use across racial/ethnic groups. Rationale. Racial/ethnic difference in alcohol-related health is a sensitive and complex topic requiring a thoughtful program of training in history, culture, and ethics. While I have conducted some research using large scale datasets on racial/ethnic differences,[10-12, 18, 25] my prior work examined broad demographic differences. In the current work, I will incorporate social and cultural norms that vary by race/ethnicity, concepts in which I have not previously worked. As part of this aim I will construct a measure of social and cultural norms regarding alcohol use. The scale will be constructed in three steps. (1) In consultation with my co-mentors with expertise in race/ethnicity, norms, and alcohol, I will create a comprehensive list of items that potentially provide information on (a) perceptions of stigma and norms within the racial/ethnic group regarding alcohol use; (b) specific attitudes about alcohol use within the racial/ethnic group; and (c) perceptions of drinking patterns in racial/ethnic groups other than one's own. To construct this measure I will adapt existing scales[82-84] as well as develop new questions with the mentorship team. (2) We will evaluate the appropriateness of the chosen items. As part of my training, I will work with my mentors to specify populations in which this measure would be best tested, identify ongoing studies that would allow this measure to be added, and ensure that ethical safeguards are met once appropriate populations and samples are identified. (3) We will continue to refine the selection of variables by evaluating psychometric properties of the scale using factor analysis, reliability statistics, and evaluating model fit. My mentors are engaged in several studies of relevant populations, and mentoring on this aim will also include identification of the best ongoing study in which to collect data on the scale I create, as well as design and recruitment issues. Mentors. My training in this area will be overseen by **Drs. Caetano, Galea, and Hasin**. Specific details of the training plan are described in Table 3.

Training Aim C: Built environment effects on alcohol-related health. Rationale. Evidence is increasing for the importance of the built environment in influencing health and illness.[34, 35, 85, 86] In the alcohol literature, there is

now substantial evidence regarding the role of the built environment in contributing to alcohol disorder and MVC risk.[34, 52, 54, 87] Research Aim 2 is to use national data to conduct a study investigating the characteristics of built environments where MVC fatalities occur. Crash latitude and longitude will be merged with built environment information (see Table 6) using GIS procedures, and spatial correlations between built environmental factors and race/ethnicity will be analyzed using Bayesian spatial statistics. These are areas in which I have no experience. Thus, I will receive training in theoretical concepts of urban environmental health and environmental epidemiology as well as training in conceptual and technical aspects of GIS and novel statistical techniques to analyze these data. Mentors. My training in this area will be overseen by **Drs. Gruenewald, Galea, and Romano**. The specific training components are detailed in Table 3. Year 1 will focus on coursework and workshops to understand GIS and spatial analysis; in Years 2 and 3 I will spend one month in Dr. Gruenewald's research center each summer in for hands-on training with FARS data.

Training Aim D. Field methods in epidemiologic data collection. Rationale. Y4 of this K01 proposal includes submission of an R01 grant to collect data in NYC on alcohol-related health focusing on racial/ethnic differences. While my graduate program and post-doctoral research has been productive in analyzing and publishing on existing datasets, I have not received any training in data collection methods. This is a gap in my training that must be filled before I can successfully propose to be the Primary Investigator of a large data collection project. I will receive guided mentoring as I develop and execute preliminary studies for my R01 grant proposal. Potential small data collection projects as preliminary studies for an R01 will be discussed with the mentoring team, and developed as I refine hypotheses, choose populations and sampling schemes, and develop the alcohol-related social norms scale described in **Training Aim B**. Mentors. My training in this area will be overseen by **Drs. Hasin and Galea**. Drs. Hasin and Galea together have more than forty years of experience collecting data from community and general population samples both nationally and internationally. Specific details of the training plan are described in Table 3, and include hands-on training through ongoing study lab meetings focusing on recruitment and retention of participants, improving response rates, and budget and personnel management.

5. Training in the Responsible Conduct of Research. In addition to the training proposed in **Training Aim B** which focuses on ethical issues specific to the study of racial/ethnic minorities, I will also engage in training in the responsible conduct of research more generally. Specifically, I will participate in a semester-long course (G4010) focusing on research misconduct; "every day" ethical issues; human research participants and scientific research; authorship practices in scientific publications, conflicts of interest, data sharing, mentoring, and the role of the scientist in society. Further, I will attend ethics seminars and workshops as they are relevant to my research aims at: 1) The Irving Institute for Clinical and Translational Research, which offers ongoing research workshops on ethics and regulation (an example of a recent workshop was entitled “Coercion, Undue Influence and Voluntary Consent to Research”); and 2) the Columbia University Center for Bioethics, which offers a monthly seminar series titled “Legal and Ethical Issues in Psychiatry and General Medicine”. Finally, I will train with Drs. Galea and Hasin to write IRB protocols for each of the studies proposed in this application.

Table 3. Timetable of Proposed Career Development and Training Goals, Mentoring, Coursework, and Workshops

A: Training in built environment and health, GIS, and Bayesian spatial analysis	**Coursework, seminars, short courses** • Year 1: Epidemiology and Population Health (EPIC) Summer Short Course: Mapping Techniques for Geographic Data (4 hrs, 5 days); Year 2: EPIC Short Course in GIS (8 hrs, 5 days), and • Year 1: Introduction to Bayesian analysis and Bayesian Hierarchical Modeling, University of Manchester (8 hrs, 5 days) • Year 2: Short course in Hierarchical Analysis of Spatial and Temporal Data, U of Southampton, UK (8 hrs, 5 days) • Year 4: MSPH P8717: Urban Space and Health (2 hours, weekly, 1 semester) • Ongoing: CU Built Environment and Health Working Group (1 hour, weekly) **Meetings with mentors** • Dr. Galea (1 Hour/Bi-Weekly/Years 1-3): mentoring, readings on built environment, instruction on GIS and Bayesian spatial analysis, interpretation of results and manuscript prep • Dr. Gruenewald (1 hour/Bi-Weekly, Years 1-3): mentoring, readings. (1 month/Yearly, Years 2-3): On-site training in GIS and Bayesian spatial analysis. (1 hour/Monthly/ Years 4-5): consultation on analysis, interpretation, and manuscript prep • Dr. Romano (as needed): consultation on FARS dataset and racial/ethnic difference in MVCF; yearly in-person meeting at Research Society on Alcoholism (RSA) in addition to as-needed phone calls

B: Training in the conceptualization and measurement of cultural and social norms regarding alcohol use across racial/ethnic groups	**Coursework, seminars, short courses** • Year 1: MSPH P8750: Race and Health (2 hours, weekly, 1 semester) • Year 3: MSPH P8763: Stigma, Prejudice, and Discrimination as Social Determinants of Health (2 hours, weekly, 1 semester) • Year 4: MSPH P8746: Persuasion and Coercion in Public Health (2 hours, weekly, 1 semester) • Ongoing: National Hispanic Science Network (NHSN) conference (4 days, yearly, Years 1-5) • Ongoing: Center for the Study of Social Inequalities in Health journal club (2 hrs, monthly) **Meetings with mentors** • Dr. Galea (1 Hour/Bi-Weekly/Years 1-5): mentoring, directed readings, analysis of NYSES data, consultation regarding social norms scale construction, sample selection, design, recruitment to collect data on the scale, manuscript prep • Dr. Hasin (1 Hour/Bi-Weekly/Years 1-5): mentoring in measurement and scales, psychometric testing, sample selection, design, recruitment to collect data on the scale, manuscript prep • Dr. Caetano (1 Hour/Monthly/Years 1-5): mentoring, readings in racial/ethnic differences in alcohol-related health, discussions of concepts and measures, consultation regarding social norms scale construction, manuscript prep; yearly in-person meeting at RSA in addition to monthly phone calls
C: Analyzing Repeated Measures Data (conceptual issues, approaches, and analytic techniques)	**Coursework, seminars, short courses** • Year 1: MPLUS short course in Latent Trajectory Analysis (2 days, 8 hours/day) • Year 2: EPIC short course: Longitudinal Data Analysis (5 days, 4 hours/day) • CU Biostatistics Seminar (1 hour, weekly) **Meetings with mentors** • Dr. Wall (1 Hour/Monthly/Years 1-5): mentoring, readings, consultation on MPLUS code and output, interpretation of results and manuscript preparation • Dr. Bearman (as needed): mentoring and consultation on AddHealth data
D: Training in field methods for epidemiologic data collection	**Coursework, seminars, short courses** • Year 3: P8499: Field Methods in Epidemiology (2 hrs, weekly, 1 semester) **Meetings with mentors** • Dr. Hasin (1 Hour/Bi-Weekly/Years 1-5): mentoring, directed readings, participation in ongoing data collection projects, consultation on potential appropriate pilot studies, consultation on grant writing • Dr. Galea (1 Hour/Bi-Weekly/Years 1-5): mentoring, directed readings, participation in ongoing data collection projects, consultation on potential appropriate pilot studies, Consultation on grant writing
General career development	• Columbia University Epidemiology Grand Rounds (1.5 hours, monthly) • Environment, Molecules, and Population Health working group (Chair: Sandro Galea, 2 hours/weekly) • Research Society on Alcoholism meeting (4 days, yearly in Years 1-5) • Society for Epidemiologic Research meeting (4 days, yearly in Years 4-5)
Responsible conduct of research	• Year 3: G4010: Responsible Conduct of Research (2 hrs, weekly, 1 semester) • Year 5: P8747: The Ethics of Public Health (2 hrs, weekly, 1 semester) • Legal and Ethical Issues in Psychiatry and General Medicine (1.5 hrs, monthly, ongoing) • Irving Institute ethics workshops (1.5 hrs, monthly, ongoing)

Feasibility of the training plan. The training plan is only feasible for me to accomplish with the protected time afforded by the K01 mechanism. Successful completion of this training plan will allow me to develop a new set of skills, foster collaborations, and produce high quality research with substantial public health implications.

A. Significance

A.1.1. Race/alcohol paradoxes: differences in alcohol use, disorder, and consequences in the U.S. We would expect clear and consistent increases in alcohol consumption and alcohol use disorders among Black and Latino populations compared with Whites given their accumulation of risk factors. Blacks and Latinos in the U.S. face discrimination that exposes them to disadvantaged socio-economic status, worse living conditions, and greater stress and adversity due to marginalized social status compared with Whites.[3, 88-92] Stress theory and general population findings in other groups indicate that these circumstances are general risk factors for binge drinking and AUDs.[88-90, 93-97] Yet, extant literature indicates a complex relationship between race/ethnicity and alcohol use in the U.S.[3, 98, 99] All major epidemiologic surveys document that Latino and Black populations have a higher proportion of lifetime abstainers than Whites.[100, 101] With regard to binge drinking (generally defined as 5 or more drinks in a drinking occasion), major surveys generally find that rates are lower among Blacks compared with Whites. Patterns among Latinos differ by subgroup.[102] Overall, most surveys report comparable rates of binge drinking among Puerto Ricans compared with Whites, and lower rates of binge drinking among Cuban, Mexican, and South American Latino subgroups compared with Whites.[40, 82, 103-106] Data on alcohol use disorders indicates that Whites are approximately twice as likely to have a current or lifetime alcohol disorder than Blacks or Latinos.[3, 100, 107] By Latino subgroup, results indicate that Puerto Ricans have higher rates of alcohol use disorders compared with other Latino ethnic groups[103, 104] and no difference in the prevalence of disorder compared with Whites.[105] Some data indicate that Cubans also have higher rates of disorder compared with other ethnic groups, but results are inconsistent across study.[103-105] Further, results on alcohol use disorders differ when stratified by age (see Section A.2.1.). Summary. National data is consistent that Blacks and Latinos in the U.S. are more likely to abstain from drinking, have comparable or lower odds of binge drinking, and have comparable or lower odds of alcohol disorders compared with Whites. Overall, the patterns do not correspond to the accumulation of risk factors for problematic alcohol use among Blacks and Latinos. This indicates an epidemiologic paradox that needs to be solved in order to understand the effect of

minority social status on alcohol-related health. An important strength of the present research program is that Latino subgroups will be analyzed separately in every aim, providing rich information characterizing the extent to which the alcohol paradox applies across subgroup.

A.1.2. Consequences of alcohol use: a focus on motor vehicle crash (MVC) fatality. Despite lower rates of binge drinking and AUDs among Blacks in the U.S. and comparable or lower rates among Latinos (depending on subgroup) compared with Whites, rates of MVC fatality among these groups are substantially higher than would be expected given their population estimated rates of consumption. Blacks and Latinos in the U.S. are more likely than Whites to die from an alcohol-attributable MVC fatality and more likely to test positive for alcohol and evidence intoxication compared with fatally injured Whites.[6, 108-111] This runs counter to our data for all other demographic groups, in which patterns of alcohol consumption mirror patterns of alcohol-attributable MVC fatality: those with higher rates of alcohol consumption have higher rates of MVC fatality (e.g., males versus females, young adults, Native Americans versus Whites). Thus, in addition to the paradox described above in which Black and Latino populations have lower risks of problematic alcohol use than we would expect given the accumulation of risk factors, there exists a second paradox: Blacks and Latinos have worse alcohol-related health outcomes than we would expect given rates of consumption. On one hand, this could indicate that the survey data is invalid; perhaps alcohol-related mortality outcomes rather than self-report give a more accurate picture of drinking patterns among racial/ethnic minorities. However, many factors other than drinking are involved in causing alcohol-related death (e.g., health care quality), thus we must first explore whether there is evidence that Blacks and Latinos truly face more deadly drinking outcomes compared with Whites.

A.1.3. Summary: racial/ethnic paradoxes in need of resolution. The synthesis of the literature on racial/ethnic differences in alcohol-related outcomes suggests racial/ethnic paradoxes which can be summarized in two points: (1) Given the concentration of risk factors among Blacks and Latinos in the U.S., they evidence lower rates than might be expected of alcohol use, binge drinking, and alcohol use disorders compared with Whites. (2) Despite the lower than expected rates of consumption and disorder, Blacks and Latinos nevertheless face greater alcohol-attributable MVC fatality compared to Whites. This paradox is virtually unexplored in the epidemiologic literature, yet high levels of alcohol consumption and alcohol-related MVC have substantial public health implications. Harmful patterns of drinking account for approximately 4% of all deaths among men and 1.5% among women in the U.S.[112] Worldwide, alcohol is a contributing factor in an estimated 3.8% of deaths; 4.6% of global disability-adjusted life-years lost are attributed to alcohol.[113, 114] MVCs claim almost 40,000 lives in the U.S. and many more worldwide,[115] and alcohol is estimated to contribute to at least 30% of these fatalities.[114] MVC fatality is a leading cause of death among young people.[116, 117] While public health prevention and intervention efforts have reduced the amount of injurious deaths attributable to alcohol in the last twenty years,[118] MVC fatality remains a major public health problem in the US and worldwide.[119]

A.2. Three potential contributors to the racial/ethnic paradox. The research proposed here examines three potential mechanisms through which Blacks and Latinos would have more fatal consequences of alcohol use despite lower overall consumption patterns. First, I will probe the validity of the racial/ethnic paradox itself, via changes in the relationship between race and alcohol outcomes during the transition from adolescence to adulthood. Second, I will determine if alcohol-related social norms mediate overall differences in alcohol use and MVC risk, adding to our knowledge of how the paradox arises. Third, I will test a potential mechanism to explain the racial/ethnic paradox: that Black and Latino individuals experience more alcohol-attributable MVCF because the built environment in which they consume alcohol is more dangerous (e.g., worse road conditions).

A.2.1. Research Aim 1: to test differences in longitudinal trajectories of alcohol use, binge drinking, and alcohol-related MVC risk from adolescence to adulthood among racial/ethnic subgroups**.** While overall rates of binge drinking and AUDs among Blacks and Latinos indicate equal or lower rates compared with Whites, accumulating evidence indicates that there is substantial age-related variation in the trajectory of these outcomes. Several large-scale epidemiologic studies have documented a 'cross-over' effect,[7-9] whereby Whites have higher rates of alcohol use and alcohol use disorders only in adolescence; this difference not only converges in adulthood, it changes direction. Studies have primarily focused on differences between Blacks and Whites, although the 'cross-over' effect has been documented in cross-sectional samples for Latinos as well.[8] If it is the case that older Blacks and Latinos consume more alcohol than older whites, then these older subgroups could be driving the higher rates of MVC fatality. While we know that MVC-fatality overall is more common among young people,[120] we do not know whether the age distribution of MVC-fatality substantially

differs across race and ethnicity. Overall, existing studies on the racial/ethnic differences in alcohol use across the life-course are primarily confined to cross-sectional samples of adolescents[121-124] or adults,[4, 9, 125, 126] or are small unrepresentative community samples.[127-130] Further, studies have aggregated across Latino ethnic subgroups;[8, 122, 123, 125] given that patterns of consumption vary substantially across these subgroups, it is possible that trajectories of alcohol use vary as well. Most importantly, no study has focused on alcohol-related MVC risk, despite the incongruity of epidemiologic findings regarding race/ethnicity and MVC risk for which longitudinal data would be helpful in illuminating underlying patterns. In summary, no longitudinal studies have examined racial/ethnic trajectories in alcohol consumption, alcohol disorder, and alcohol-related MVC risk from adolescence to adulthood using data from a single U.S. population cohort with rich data on Latino ethnicity. I propose to fill this gap in the literature using data from a nationally representative longitudinal study. I hypothesize a substantial cross-over in alcohol-related MVC risk, which is what would be needed to be observed in order for this mechanism to explain the paradoxical findings. Based on extant epidemiologic literature, I also hypothesize that there will be substantial variation in the outcomes of these trajectories by alcohol use indicator, with higher probabilities for Whites compared with Blacks and Latinos across the life course in alcohol use, convergence in trajectories of binge drinking.

A.2.2. Research Aim 2: To test social norms as a mediator of racial/ethnic differences in alcohol consumption and MVC risk. Another mechanism giving rise to racial/ethnic differences in alcohol use and MVC-risk may be racial/ethnic differences in normative drinking practices. Individuals who perceive alcohol to be disapproved of in their community are substantially less likely to drink.[131, 132] Differences in social norms are often invoked to explain racial/ethnic differences in alcohol use,[40, 102] but rarely directly tested in adult samples. While early studies (1970s and 1980s) showed no race/ethnic differences in alcohol norms,[84] a later survey indicated that Blacks and Latinos are more socially restrictive regarding drinking in most situations (e.g., at a bar, at home).[133] Black and Latino individuals report perceiving more stigma in their communities than Whites toward individuals with alcohol disorders,[18] potentially signaling more restrictive norms against drinking. Social norms would be an explanation of the racial/ethnic paradox if Blacks and Latinos, on average, are *more* socially restrictive when considering *any* alcohol use (thus explaining lower rates of consumption), but among drinkers, Blacks and Latinos are *less* social restrictive when it comes to *risky drinking* (thus explaining higher rates of MVC-fatality). The present research will document group differences in alcohol-related norms, and formally examine norms as potential mediators between race/ethnicity and alcohol use versus risky drinking. No existing study has directly tested whether social norms mediate race/ethnicity relations with drinking, and no empirical evidence has used social norms as a hypothesized mechanism to explain the race/alcohol paradox. As in all of the studies in this proposal, Latino ethnic subgroups will be analyzed separately, providing unique data on how norms and drinking patterns differ across ethnic subgroups in the U.S.

A.2.3. Research Aim 3: To examine road-related, driver-related, and vehicle-related racial/ethnic differences in MVCF. The built environment includes the physical characteristics of the geographic spaces in which individuals live, work, and spend time; all of these spaces may have different characteristics that negatively or positively impact health.[85, 86, 134] Elevated rates of alcohol use[135-139] and high-risk drinking[34, 139, 140] have been documented consistently among individuals living in neighborhoods characterized by poverty, inequality and disorganization. Substantial evidence indicates that the built environment impacts risk of injury (a particular area of expertise among Drs. Galea[31-33, 141] and Gruenewald[54, 56-60, 87, 142, 143]), including but not limited to MVC fatality.[54, 56-60, 87, 142] While this literature is consistent in demonstrating a link between the built environment and alcohol-related health, no studies have examined whether characteristics of the built environment explain the race-alcohol paradox. Individuals living or spending time in more dangerous spaces (for example, areas with deteriorating roads, high traffic density and/or density of road space) may be at higher risk for an MVC if they drink and drive.[56, 58, 87, 144] Substantial evidence indicates that racial/ethnic minorities are more likely to live in neighborhoods with such characteristics.[31, 136, 145, 146] Thus, the hypothesis that motivates this aim is that Blacks and Latinos are less likely to drink, but when they do, they are at higher risk for an MVC due to the built environmental conditions of the spaces in which they drive. The proposed research will use FARS, a census of every alcohol-attributable MVC fatality in the U.S. which includes data on road conditions, vehicle conditions, and severity of alcohol involvement. Further, crash information will be linked to data on land usage patterns to provide a never-before characterized comprehensive assessment of racial/ethnic differences in characteristics of the built environment as risk factors for alcohol-attributable MVC fatality. Location of the crash site may be in the individual's work or home neighborhood but in many cases may not be; nevertheless, the hypothesis proposed is that individuals who drink may be at greater risk for MVC fatality if they drive in physically

dangerous built environments after drinking. Thus, linking built environmental characteristics to the exact location of the crash site is well-suited to test this hypothesis regardless of the proximity of the crash site to the home neighborhood. Additionally, this data will be analyzed using Bayesian spatial models, increasingly used in studies of the built environment[147-151] (including with substance use outcomes[147-149, 152]) and offering substantial advantages to traditional null hypothesis significance testing.[153-155] Thus, after extensive training in Bayesian spatial analysis (**Training Aim B**), I will apply Bayesian spatial analysis to the study of the FARS data, making this aim both theoretically novel and methodologically sophisticated.

A.3. Summary. Alcohol use disorders are among the most prevalent and disabling mental health disorders in the U.S. and worldwide.[3, 156] Substantial research documents that Blacks and Latinos in the U.S. have comparable or lower rates of alcohol consumption, binge drinking, and alcohol use disorders than Whites, which is unexpected given their accumulation of risk factors. Yet despite comparable or lower rates, they are at higher risk for alcohol-attributable MVC fatality. Resolving these paradoxes is important not only to the field of alcohol epidemiology but to a broader public health framework; research and debate regarding incongruous racial/ethnic findings in psychiatric epidemiology has been growing.[23-26] Investigation of potential explanatory mechanisms that would result in Blacks and Latinos having higher risks of alcohol-related MVC fatality despite comparable or lower consumption compared with Whites is necessary to advance this literature. The research proposed here will examine potential age cross-over effects in the trajectory of racial/ethnic differences in alcohol outcomes across the life-course; investigate the role of social and cultural norms across different racial/ethnic groups and alcohol outcomes; and explore whether Black and Latino individuals experience more fatal consequences of alcohol consumption because of more dangerous conditions in their built environments. I will examine a range of outcomes, including multiple indicators of alcohol consumption and at-risk drinking as well as motor vehicle crash risk and fatality. This examination of both crash risk versus crash fatality can provide detail on racial/ethnic differences across these indicators that is previously uncharacterized, a substantial strength of the current projects. These projects are designed to lay the initial groundwork for a series of investigations to comprehensively understand and explain racial/ethnic differences in alcohol-related health. Given my record of accomplishment to date, these studies are feasible, but only with the protected time and additional training provided by the K01.

B. Innovation.

The research proposed here is innovative in three broad domains: 1) the research questions asked, 2) the data used to answer the research questions, and 3) the statistical methods used to analyze the data. First, the racial/ethnic paradox in alcohol-related health is broadly documented yet under-investigated. Despite the heavy burden of alcohol on morbidity and mortality in the U.S. and the substantial racial/ethnic alcohol-related health inequities,[6, 108, 113, 114, 157] little epidemiological research has examined the environmental and social risk factors that create and maintain these inequities. My proposed research will form the background of a new line of inquiry with substantial promise for application to public health. Accurate empirical data regarding the emergence of racial/ethnic differences in these prevalent and disabling alcohol-related outcomes are crucial to better understanding the role of minority status in the development and persistence of alcohol disorders as well as alcohol-related MVC risk. Second, the data sources that will be used to answer these research questions provide an exciting opportunity to harness existing data resources for new and important purposes. AddHealth is an important national resource documenting the social and environmental risk factors for health. No study has used these data to examine racial/ethnic differences in alcohol use trajectories despite the substantial strengths of the data for this particular research question, further underscoring how these research questions are overlooked in health research. NYSES has already provided substantial information about the role of social norms in substance-related outcomes as it is one of the few representative community studies to measure social norms,[132, 158-160] yet racial/ethnic differences have not been examined despite the ethnic diversity of the sample. The FARS database provides unparalleled and detailed information about each crash occurring in the US, and has been underutilized in the empirical literature given the wealth of data available. Further, all of these data sources allow disaggregation of Latino subgroups, a limitation of prior research. Third, this research will incorporate novel statistical methods which will place the findings at the forefront of methodological innovation. While latent trajectory analysis (**Training Aim C**), used in Aim 1, is increasingly being used in the epidemiologic literature to harness the power of longitudinal studies, it has rarely been applied to the study of racial/ethnic differences, despite the common assumption that trajectories of alcohol use and problem use differ in racial/ethnic minorities versus Whites.[9, 40, 125] Bayesian analysis (**Training Aim B**), used for the spatial statistics in Aim 3, is increasingly recognized by the statistical community as a much-needed complement to

traditional null hypothesis approaches;[153-155] however, uptake has been slow in the mainstream research community. It is incumbent upon the new generation of health researchers to train in these methods and apply them to public health questions in order to increase the visibility and utility of these powerful analytic tools. In summary, this research program engages questions of public health importance heretofore unexamined in the epidemiologic literature, brings together underutilized existing data sources to shed light on these questions, and applies novel analytic techniques to national and community-based data sources in order to advance a research agenda on race and alcohol use in the U.S.

C. Approach

Aim 1. **Purpose**. To test differences in racial/ethnic differences in alcohol trajectories across adolescence and young adulthood. **Sample**. AddHealth is a longitudinal survey of a nationally representative sample of adolescents. Respondents completed an initial baseline assessment in 1994-1995 (N=90,118),[38] when they were in grades 7-12; a subset of this initial sample (N=20,745) also completed in-home interviews with follow-up surveys in 1996 (71% of initial sample), 2001-2002 (73.2% of initial sample), and 2007-2008 (74.7% of initial sample). The AddHealth study offers substantial advantages for the study of race differences in alcohol use and MVC-related risk. First, AddHealth was specifically designed to answer research questions about racial/ethnic differences. Among the follow-up sample, data include 415 Mexican/Mexican American, 75 Cuban, 99 Puerto Rican, and 223 of other Latino ethnicity (note that there are on average four data points for each individual). Black adolescents from highly educated families were oversampled, providing substantial statistical power to disentangle race differences from socio-economic differences. **Measures**. Table 4 describes the principal alcohol outcomes that will be used (measured in all interviews). These reflect a range of severity, including any drinking, any binge drinking, frequent binge drinking, and importantly for the study of the racial/ethnic paradox, MVC-related risk: driving a car after drinking. **Methods**. MPLUS will be used to estimate longitudinal trajectories (**Training Aim C**) of alcohol outcomes. Missing data on these variables is negligible (less than 5% for each outcome), and will be imputed as necessary using full information maximum likelihood methods through the EM algorithm.[161, 162] Latinos will be subset into Puerto Rican, Cuban, Mexican/Mexican American, and other. **Preliminary analysis**. Table 4 indicates that at the baseline, Whites are more likely to drink, binge drink, and frequently binge drink, whereas Latinos are more likely to drive a car after drinking. This pattern suggests that Latinos drink less but may engage in more harmful MVC-related risk when engaged in drinking, potentially at least partially explaining the paradox. At the Wave 4 follow-up, there were no differences in any alcohol outcomes across racial/ethnic groups. These findings suggest that lower risk of alcohol-related risk among Blacks and Latinos in adolescence may not extend fully to adulthood, also potentially beginning to explain the alcohol paradox.[7-9] Thus, rigorous analyses in this rich data are likely to provide novel evidence regarding racial/ethnic differences over time; however, formal trajectory analyses are needed to comprehensively understand these patterns, and analysis of Latino subgroups will likely yield novel results. **Power**. To determine power, I calculated the amount of change in the prevalence of MVC-related risk (the most rare outcomes) between Waves 1 and Waves 4 could be detected with 80% power, given an alpha of 0.05 and adjustment to the standard error for the repeated measure. Among Whites, I have 80% power to detect more than 0.7 percentage point difference between Wave 1 and Waves 4 prevalence; among the smallest subgroup (Cubans), I have 80% power to detect anything more than 3.2 percentage point difference. Because differences under 3.2 percentage points are unlikely to be clinically significant, and because most other subgroups are much larger, I have sufficient power to analyze change over time for a wide variety of subgroups. Further, note that four points of data are available on most participants; thus while some Latino subgroups are small overall, power is substantially increased given the repeated measures design.

Table 4. Outcome prevalence proportion (%) at baseline and the Wave 4 follow-up of AddHealth

	At baseline (N=6,179)				At Wave 4 (N=5,114)			
	Ever drink	Current binge* drink	Current frequent* binge* drink	Current Drive a car after drinking	Ever drink	Current binge* drink	Current frequent* binge* drink	Current drive a car after drinking
White	58.0	29.8	7.5	3.6	79.1	46.8	7.6	25.4
Black	44.7	15.2	6.6	2.4	81.0	48.7	8.3	25.0
Latino	55.1	12.6	6.6	4.2	80.3	44.3	7.7	23.9
	X^2 for overall differences, p<0.05				X^2 for overall differences, p>0.05			

* Binge drinking defined as 4+ drinks or women or 5+ drinks for men in a single setting
\+ Frequent defined as once per week or more

Aim 2. **Purpose.** Test whether alcohol-related norms mediate association between race/ethnicity, alcohol and alcohol-related MVC risk. **Sample.** Data will be drawn from the New York Social Environment Study (NYSES),

a representative study of residents of NYC conducted in 2005. Participants were identified via random digit dialing, with telephone interviews conducted by lay interviewers. Quantity and frequency of alcohol use was queried and DSM-IV alcohol use disorders diagnosed via the CIDI. Sample sizes are given in Table 5; Latinos will be further stratified into Puerto Rican (N=302), Dominican (N=236), and South American (N=203). **Measures**. Alcohol norm variables are adapted from the Monitoring the Future survey,[163] and are measures I have worked with previously in that context.[19, 20] Two alcohol norm variables are included in the NYSES and measured on a three point scale: acceptability of drinking alcohol, and acceptability of getting drunk once per week. While more comprehensive measure of alcohol norm variables would be preferable, the NYSES data is one of the only community surveys to include *any* measure of alcohol norms in adults, thus this analysis is worthwhile yet preliminary. The lack of comprehensive measures of alcohol norms underscores the importance of the norms scale I will develop as part of my training, and the importance of primary data collection with intent to study racial/ethnic differences such that I will propose in Y4 of the K01 period. Outcomes will include lifetime drinking, binge drinking, and alcohol-related MVC-risk as measured by driving after drinking. **Method.**

Table 5. Drinking outcomes (%) by race/ethnicity

Race/ethnicity	N	Any lifetime alcohol consumption	Past-year binge drinking (≥5 drinks) among drinkers
White	1613	84.4	7.8
Black	1052	81.7	11.0
Dominican	236	62.5	11.5
Puerto Rican	302	79.7	11.6
South American	203	74.3	7.4
		X^2=66.3, p<0.01	X^2=9.3, p<0.05

Mediation will be assessed using the approaches outlined by MacKinnon[164]; the significance of the indirect effect of race/ethnicity on each of three alcohol outcomes (alcohol consumption, alcohol use disorder symptoms, and alcohol-related MVC risk) via norms will be assessed with the Sobel's standard error approximation for continuous outcomes[165] and via bootstrapped simulation samples to generate empirical percentile standard errors for categorical outcomes.[166] Age will be tested as an effect measure modifier throughout if Research Aim 1 indicates differences in the relationship between race/ethnicity and alcohol by age. To the extent that power will allow, differences by gender will also be examined. **Preliminary analysis**. In order for these data to sufficiently test study hypotheses, we would need to observe lower overall drinking among racial/ethnic minorities but greater risky drinking practices. Indeed, Table 5 indicates that, compared to Whites, minority groups are less likely to have ever consumed alcohol, yet among drinkers, have greater proportions of past-year binge drinking (save for South Americans, where there is no significant difference with Whites [p=0.42]). I also confirmed in these data that alcohol norm variables were highly related to drinking outcomes (p<0.001). Thus, these data have sufficient variation in hypothesized directions in order to provide a robust test of social norms as mediators of racial/ethnic differences. **Power**. Using the PowerMediation package in "R", I calculated power to detect a statistically significant Sobel test for the indirect effect of race/ethnicity on each of two continuous alcohol outcomes (alcohol consumption and alcohol use disorder symptoms) via an ordinal social norms variable. I also included a dichotomous outcome of alcohol-related MVC risk despite the potential violation of assumptions because no other power test for indirect effects is currently available. Sample size was set at 1,648, the number of drinkers in the sample, as this is more conservative than testing power in the whole sample. Values for the effect of race/ethnicity on norms were taken from our preliminary analysis and fixed (log odds of 0.23 for Blacks and 0.26-0.35 for Latino subgroups); values for the effect of norms on alcohol outcomes varied, and over 25 power curves were calculated. I have sufficient power to detect significant Sobel tests for mediation for alcohol use disorders as long as the effect of social norms on alcohol use disorders is greater than 0.02 standard deviations, alcohol-related MVC-risk above 0.06, and alcohol consumption above 0.08. Thus, I have sufficient power to detect at least one standard deviation of change for all outcomes, which is a clinically significant and reasonable threshold.

Aim 3. **Purpose**. Examine whether the physical characteristics of the built environment that may increase alcohol-attributable MVCF risk are more common among Black and Latino individuals compared with White. **Sample**. Data will primarily be drawn from 2009 FARS records,[2] a complete census of all fatal crashes in the U.S. in 2009 (N=30,797, 31% involve alcohol) maintained by the National Center for Statistics and Analysis. FARS records are created both for individuals who die at the crash site and those who die at a later time due to crash-related injuries (this time interval is documented in the FARS record and will be included as a potential confound in all analyses as it may be associated with race/ethnicity). The present analysis will be limited to states (N=39) where ≥80% of fatally injured drivers are tested for alcohol to mitigate bias associated with minority drivers being more likely to be tested for alcohol.[109] As is common for FARS inquiries into alcohol-involved injuries,[70] data will also be limited to single-vehicle crashes to select the alcohol-involved person rather than crashes in which two or more drivers were involved. **Measures.** Area-level measures will be drawn

from three sources: the FARS record, the 2010 US Census, and information on road and traffic patterns purchased from Esri[167] (see Table 6). These measures will be constructed and cleaned in Year 1; FARS information will be aggregated at the area-level to provide a measure of the road and atmosphere conditions. The exact latitude and longitude are given for each crash; thus, crash sites will be linked to area-level measures. An important strength of the area-level measures is that data are available at small geographic units, thus misaligned areal data will not be a major concern in analysis models. Individual-level measures will be drawn from the FARS record. The FARS system imputes BAC information for those individuals who were not tested. The validity of imputed alcohol testing data in the FARS is high;[168] further, method of alcohol data collection (e.g., urine, blood) is recorded in FARS and will be controlled in all analyses. As part of Aim 3, Dr. Gruenewald and I will conduct a validation analysis of the FARS longitude and latitude information by comparing California FARS records (N=2,816) to alternative crash site information collected by Dr. Gruenewald's group. As noted previously, the hypothesis outlined in this proposal posits that characteristics of the built environment in which the crash occurs predict crash probability (e.g., the person drove at night on a highway with poor road conditions, increasing crash probability); thus, the exact location of the crash rather than built environmental characteristics based on home or work address are most appropriate for this analysis.

Table 6. Key Variables for Research Aim 3

	Source	Variables
Area-level variables	U.S. Census	**Key predictors**: median household income; % with public assistance income; percent with at least 12th grade education; Population density; Occupied housing units; Percent of workers age 16 and older whom commuted to work using a private vehicle. **Key controls**: age distribution of the population, % aged 18 to 30; percent Hispanic/Latino;
	Purchase from ESRI*	**Key predictors**: Density of unique street intersections per measurement geography; Density of unique three and four-way intersections; Density of streets per geography; Average Daily Traffic Volume
	FARS record	**Key predictors**: Roadway function class; Elevation; Atmospheric conditions; Light conditions; Roadway surface type
Vehicle-level variables	FARS record	**Key controls**: Vehicle make, model, and year
Person-level variables	FARS record	**Key predictors**: race, Latino ethnicity, country of origin, Blood Alcohol Concentration. **Key controls**: Age, sex, safety belt use; alcohol involvement determination (e.g., breath, blood, urine, behavioral);; drug involvement determination; drug test results; record of prior DUI or other offenses; time between crash and death

* Esri sells GIS software, road, and land usage data; details at http://www.esri.com/

Method. Years 1 and 2 will be spent making several key decisions before formally proceeding with the analysis. In addition to compiling area-level measures, we will conduct a validation study of the California data (described above). Second, Drs. Galea, Gruenewald and I will comprehensively examine the resolution of the data to determine the meaningful units of analysis for the area-level work, determining the most optimal balance between meaningful geographic units and feasibility of spatial analysis in order to determine the level at which area measures will be estimated. We will begin examining census tracts within states, using innovative methods for small geographic units,[169] and proceeding to full national analysis once within-state geographic units are stabilized. After the data have been geocoded and validated and appropriate units for analysis coded, space-time multi-level Bayesian analysis (**Training Aim A**) will proceed to model proximity-related autocorrelation as described in fuller details elsewhere by Dr. Galea (co-sponsor).[148-150] Because of the size and scope of the project, Years 2 and 3 will involve one month spent with Dr. Gruenewald's research group of geospatial experts to coordinate issues of scaling the spatial models and handling the complicated technical issues that arise when using diverse geographic data of this kind. We will use R statistical software with GeoBugs and WinBugs for all analyses. **Model specifications**. All models will control for factors such as rural versus urban metropolitan area. Motor vehicle crashes are more common in rural areas, and Whites are more likely to live in rural areas compared with Black and Latino individuals, making urbanicity an important confound. Other important confounds include previous DUI record and time between crash and death. With these confounds controlled, I will test: 1) whether Black and Latino individuals are more likely to have an alcohol-positive designation and intoxication defined as BAC>0.08; 2) dose-response to see whether racial/ethnic differences are variant across increasingly high BAC levels; 3) whether, as indicated in previous literature,[170, 171] Blacks and Latinos are less likely to use restraint protection (e.g., seat belts) and whether Blacks and Latinos have older make/model vehicles. *Spatial-analysis using built-environment information.* I will then incorporate space-time multi-level Bayesian spatial analysis to test whether Blacks and Latinos who are alcohol-positive and intoxicated at varying levels of severity are more likely to crash in dangerous built environments compared with Whites. Age will be tested as an effect measure modifier throughout. Space-time multi-level Bayesian models will be estimated. More specific model selections, scaling, and technical specifications will be done in consultation with Drs. Galea and Gruenewald who are experts in Bayesian spatial analysis and geospatial analysis. **Power**. Because Bayesian analysis will be used for this aim, traditional

notions of Type I and Type II error no longer apply.[172, 173] Instead, posterior likelihood distributions are generated as a function of informed prior belief in the hypothesis. Some geographic areas will not have enough crashes and will be excluded; this is an issue common to all spatial analysis.

Limitations. Each of the three studies proposed here stand to make a contribution to the unresolved racial/ethnic paradoxes in alcohol-related health; however, they will not 'solve' these paradoxes. The results of these studies will inform hypotheses regarding the race/ethnic paradox that I will more fully investigate in the R01 study I plan to submit in Y4 (see Table 7), and that I will more fully investigate throughout my career. Each study proposed here, while methodologically strong, has weaknesses for specific research questions of racial/ethnic paradoxes since data were not collected specifically for this purpose. AddHealth and NYSES has information on alcohol-related MVC risk rather than fatality. Risk factors for fatal versus non-fatal MVC-risk may be different; however, my preliminary analyses suggest these data will serve as preliminary studies that will inform the paradox in important ways. AddHealth does not have a diagnostic measure of alcohol use disorders. However, quantity and frequency of drinking is highly correlated with alcohol use disorders,[174] thus important information can be gained using the available measures. The NYSES study has limited questions on alcohol norms. Attitudes, norms, and perceptions of risk are all separate yet correlated constructs for which comprehensive existing measures are limited.[19] One component of the work I will do during the K01 period is to develop a more comprehensive alcohol-related norms scale. Thus, while each study provides valuable contribution, their ultimate purpose is to inform R01 hypotheses which I will be able to conduct after I receive training in field methods. Results from Aim 1 will inform the age distribution and sampling strategy of an R01 study to ensure critical periods in the life-course are captured; Aim 2 will inform built environment data to comprehensively characterize MVCF risk; Aim 3 will inform hypotheses about the role of social and cultural norms. In summary, examination of racial/ethnic paradoxes in alcohol epidemiology is an epidemiologic challenge with substantial public health importance. A career spent resolving these issues will hopefully make a profound contribution to alcohol epidemiology; this K01 is my first step towards pursuing that career.

Timeline. Table 7 documents the timeline through which each of these research aims and an R01 grant proposal will be accomplished. Each is feasible within the timeframe of the K01 award period, which will protect my time from the teaching and administrative duties that typically impede the progress of new faculty.

Table 7. Timetable to accomplish each research aim

Short-Term Goals	Year 1	Year 2	Year 3	Year 4	Year 5
Goal 1: Understand race/ethnic trajectories of consumption and MVC risk from adolescence to adulthood	Obtain full AddHealth data and train in its use; obtain IRB permissions. Attend MPLUS class on trajectory analysis	Clean and organize data for repeated measures analysis; continue training in quantitative trajectory methods with Dr. Wall	Conduct analyses, begin manuscript preparation	Submit manuscripts and revise as necessary	
Goal 2: Examine the role of alcohol-related social norms in shaping racial/ethnic differences in alcohol use and alcohol-related MVC risk.	Obtain IRB permissions; begin descriptive analyses	Conduct mediation analyses; begin manuscript preparation	Submit manuscripts and revise as necessary; use results as preliminary research for R01 grant		
Goal 3: Investigate how the built environment may explain racial/ethnic paradoxes	Obtain FARS data and train in its use; obtain built environment data; create area-level measures; obtain IRB permissions	Link FARS data with built environment data; begin Bayesian analysis	Continue Bayesian spatial analysis with Dr. Gruenewald's group	Complete Bayesian spatial analysis, begin manuscript preparation	Submit manuscripts and revise as necessary
Goal 4. Submit an R01 grant proposal to collect and analyze data on racial/ethnic differences in alcohol-related health in NYC	Begin working on background and hypothesis development	Propose any necessary pilot studies and find suitable populations/samples	Complete any necessary pilot studies; begin writing R01	Submit R01 proposal	Revise as necessary