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When young soldiers drink: The impact of legal access to alcohol among U.S. Army soldiers

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Abstract

We study the impacts of legal access to alcohol on young U.S. Army soldiers. Regression discontinuity estimates reveal that soldiers report a large and significant increase in alcohol consumption after their 21st birthday; however, we precisely estimate that there are no meaningful impacts of legal access on any of the short-term outcomes we observe, including suicidal tendencies, depression, tobacco use, physical fitness, psychological health, fitness for combat deployment, and job-related infractions. Novel data on soldier's cognitive ability, psychological health, and family history allow us to explore whether the impacts of legal access vary by risk factors for alcohol abuse. While the increases in alcohol consumption were largest among those who had a family history of mental health problems, had better coping ability, and had higher cognitive ability, these subgroups did not uniformly experience adverse behavioral and physical outcomes upon gaining legal access to alcohol.

KEYWORDS

military, minimum legal drinking age, regression discontinuity

JEL CLASSIFICATION

I12; I18; J45

1 | INTRODUCTION

Major newspaper headlines such as "America, Can We Talk About Your Drinking?" (New York Times, 2017) highlight a persistent public health concern about the impacts of alcohol consumption on a broad range of outcomes, from physical and mental health, to interpersonal relationships, to school and work performance. While a robust literature has documented the associations between alcohol use and many adverse outcomes (e.g., Cook and Moore, 2000), estimating causal impacts is difficult because correlates of both alcohol consumption and the outcomes it may impact are often unobservable to researchers. The most compelling evidence to date comes from research leveraging the discrete change in legal access to alcohol in the U.S. at 21 years of age, the minimum legal drinking age (MLDA). Using regression discontinuity (RD) designs, this literature confirms the adverse relationships found in associational studies for some outcomes, but not others. In particular, legal access to alcohol among young Americans increases mortality (Carpenter and Dobkin, 2009), decreases academic performance (Carrell *et al.*, 2011; Lindo *et al.*, 2013), and increases crime (Carpenter and Dobkin, 2015; Hansen and Waddell, 2018). On the other hand, Yörük (2015) finds minimal to no impacts of the MLDA on employment, hours worked, and wages; Yörük and Yörük (2012) finds no impact of the MLDA on psychological wellbeing, an outcome which could impact labor productivity; and Yörük and Yörük (2015) and Koppa (2018) found no effect on risky sexual behavior or sexually transmitted diseases.

In this article, we study the impacts of the MLDA on job-related outcomes of U.S. Army soldiers around their 21st birthday. Soldiers are more likely to be male, to have graduated high school, and be more physically fit than a similar-aged population of employed nonsoldiers, but the distribution of race among soldiers is similar to the population and soldiers are recruited from all regions of the country. Our study population thus allows us to learn about not only the impacts of the MLDA in the military, but also about a large fraction of the nonmilitary population with similar characteristics.

We add to our understanding of the impacts of alcohol consumption by studying a population for which there exists detailed administrative data on a broad range of work-related outcomes, including measures of physical fitness, psychological health, and job-related infractions. As described in more detail below, we selected outcomes where we expect alcohol consumption to compromise judgment and motor skills. The MLDA should thus have an immediate effect on these outcomes, and therefore could be detected by a temporal RD design. This rich set of outcomes within the same population provides a holistic view of the impacts of alcohol consumption.

Furthermore, we estimate whether risk factors for alcohol abuse exacerbate the impact of legal access. It has long been theorized that cognitive ability and/or mental health may aid or hinder individuals in mitigating the negative effects of alcohol on judgment and choices (Vogel-Sprott, 1979; Fogarty and Vogel-Sprott, 2002). Our data on Army soldiers allows us to test this theory, through the use of detailed measures of self-control, coping ability, cognitive ability, and soldier's family histories of mental health problems or substance abuse.

The MLDA is particularly important for the population we study, as Army soldiers between the ages of 18 and 21 voluntarily risk their lives to protect their country, yet are not allowed to drink. As is commonly expressed by proponents of a lower MLDA for military members: "If you're willing to die for your country, you should be able to drink a beer" (see, e.g., Dieterle and Rizer, 2017). In fact, several state's legislatures have debated bills proposing to lower the

MLDA for service members to the age of 18 (although none have passed).[1] This criticism of the disconnect between rights and responsibilities of 18–20 year olds extends beyond soldiers, with some pointing to the fact that as of 18 years of age, individuals can vote, get married, and are viewed as an adult in virtually every other aspect of the law. Other critics of the current U.S. MLDA argue that it is not effective at deterring underage drinking and instead incentivizes more dangerous underage drinking. However, as mentioned above, the MLDA literature has identified real costs to young adults when they turn 21 years old and gain the right to consume. Any evaluation of optimal policy concerning alcohol consumption must weigh the costs and benefits to society, and our article provides evidence on the impact of our current law on important outcomes for young adults.

Our setting is also particularly suited to studying the impact of the MLDA as under-age alcohol use on military bases is strictly prohibited and any soldier caught drinking will face administrative penalties that could impact their Army career.[2] The rigidity in enforcing the MLDA is partly in response to the heavy drinking that is observed among service members over the age of 21 (Bray and Hourani, 2007; Oster *et al*., 2012) and also to a rising trend in drinking and alcohol related problems that has been observed among those returning from deployment (Jacobson *et al*., 2008; Shen *et al*., 2012; Bray *et al*., 2013). In general, the military is heavily involved in alcohol abuse prevention (Leskin, 2015) and the belief is that abstention under the age of 21 may mitigate excessive use and abuse once individuals turn 21 years of age. Therefore, we are able to observe an important transition into legal access to alcohol in a controlled environment.

We use several administrative databases covering the population of U.S. Army soldiers between 2009 and 2015. The periodic health assessment (PHA) is a mandatory annual clinical health assessment that contains information on alcohol and tobacco use, depressive symptoms, and suicidal thoughts, as well as the information that determines fitness for military deployment. Being fit for deployment is a key indicator of soldiers' job performance; in fact, a recent Department of Defense policy dictates that any service member who is deemed nondeployable for more than 12 months will be separated from the military (Wilkie, 2018). Additional indicators of soldiers' ability to perform their jobs come from annual Army physical fitness tests (ability to do push-ups and sit-ups and the time taken to run 2 miles) and the interactive Personnel Electronic Records Management System (iPERMS) that records job-related infractions and punishments for any breach of military conduct or law. Finally, we use data from the Global Assessment Tool (GAT), an annual, self-administered and self-diagnostic psychometric assessment to quantify aspects of soldiers' underlying psychological traits.

Similar to other studies of the MLDA that were able to observe self-reported alcohol consumption (Carpenter and Dobkin, 2009; Yörük and Yörük, 2011, 2012), we find a large increase in consumption among soldiers when they turn 21 years of age, both in the likelihood of drinking (a 49 percentage points increase) and in the amount they drink in any one sitting (increasing from about a third of a drink to an average of two drinks per day). Interestingly, the change in alcohol consumption is not a sharp discontinuous increase at 21 as in the populations of previous studies, but rather a ramp-up in the 2 months following their 21st birthday in both

[1]Recent examples include New Hampshire (in 2005), Maryland (in 2015), and South Dakota (in 2018), who considered bills to lower the drinking age for active-duty military members to age 18. In a similar vein, Wisconsin (in 2005) considered a bill to drop the $500 fine for underage drinking to just $10 for military service members.

[2]Commanders of Army bases located in foreign countries or within 50 miles of Mexico or Canada have the authority to lower the drinking age to match the foreign country's laws. Our data do not identify whether these bases have lower MLDAs, and so we exclude from our analysis all soldiers stationed overseas or within 50 miles of domestic borders.

propensity to drink and amount of alcohol consumed. This ramp-up is likely reflecting the fact that soldiers may have to wait for days or weeks after their birthday until they are off-duty and have an opportunity to purchase and drink alcohol. We also find that soldiers who have a family history of mental health problems, those with better coping ability, and those in the top quartiles of the Armed Forces Qualifying Test (AFQT, a standardized test of cognitive ability) distribution increase their drinking more when they turn 21.

Despite this increase in reported alcohol consumption upon gaining legal access, we do not observe any meaningful impact of the MLDA on the multiple indicators of health, fitness, and job performance that we observe in our data. This null finding holds for all outcomes over the entire population, and for most outcomes when we stratify by soldiers' baseline psychological traits, cognitive ability, and family history (we discuss notable cases below). In general, however, we do not find any adverse impact of the MLDA on the short-term outcomes we study other than alcohol consumption which, importantly, may contribute to longer-term impacts.

The rest of the article proceeds as follows. Section 2 describes the data and the setting of the U.S. Army. Section 3 discusses our empirical methods and Section 4 presents the results. Finally, Section 5 concludes with a discussion of the implications of our results for public policy concerning alcohol consumption.

2 | BACKGROUND AND DATA

The Army is an all-volunteer force and is the largest military branch in the United States, with almost 500,000 active duty personnel. Enlistees must be between 17 and 34 years old, be in good physical condition and good moral standing, and be a high school graduate or equivalent.[3] After completing basic training and advanced training for their designated occupational specialty, soldiers are posted to one of many Army bases either in the U.S. or abroad. We begin this section by discussing the MLDA and how it applies to soldiers who live and work in military installations, and we then describe our data sources and the construction of the various alcohol consumption and outcome measures used in our analysis.

2.1 | MLDA and U.S. soldiers

The passage of the 26th Amendment in 1971 lowered the legal voting age from 21 to 18, and 39 U.S. states in turn lowered their MLDA to either 18, 19, or 20 years old. Multiple studies have documented that these reductions in the MLDA were associated with increased motor vehicle fatalities (see Carpenter and Dobkin, 2011). Public outcry over these increased deaths prompted Congress to enact the National Minimum Drinking Age Act of 1984, requiring states to raise their MLDA to age 21 or forgo millions of dollars in federal highway funds.

Meanwhile, Section 2683 of Title 10 of the U.S. Code was modified throughout the 1980s to mandate that U.S. military installations adhere to local minimum drinking ages.[4] All states adopted age 21 as their MLDA by 1988, and military bases located in the U.S. followed suit to establish and enforce a minimum age of 21 for service members who may purchase, possess, or consume alcoholic beverages. However, the law also grants base commanders of installations

[3]Waivers for some of these requirements are available.

[4]See https://www.law.cornell.edu/uscode/text/10/2683

located overseas or within 50 miles of Canada or Mexico the discretion to lower their drinking age to match their host or nearby nation's minimum age. In our analysis, we exclude soldiers posted abroad or within 50 miles of the U.S. borders with Canada or Mexico.

2.2 | Data

Our data come from administrative personnel records and routine health assessments of Army soldiers.[5] First, we use the Master Personnel Files from 2009 to 2015 to identify the set of soldiers of an age close to their 21st birthday. These files also contain demographic information, including gender, race/ethnicity, AFQT score, and educational attainment. The AFQT is a normalized percentile score of cognitive aptitude tests taken during the recruiting process, including sections on arithmetic reasoning, mathematics knowledge, paragraph comprehension, and word knowledge.[6] Next, we merge the Master Personnel Files to several other person-level databases containing outcomes of interest, which we discuss in turn.

2.2.1 | Periodic health assessment

The PHA is a required annual physical and mental health assessment that is used to determine if a solider is fit for combat deployment. The PHA contains both clinically measured health data and self-reports of mental health and substance use. Soldiers are encouraged to report truthfully, as they are informed it is Army policy to only release information to superiors about fitness for deployment (and to not release information on adverse behaviors or conditions). Nonetheless, soldiers may not truthfully report certain information, such as alcohol use or mental health problems, as deployments are viewed by some as career-enhancing. Some soldiers may therefore shade mental health issues or alcohol use, while other soldiers who wish to not deploy may fabricate adverse moods or behaviors. We discuss the implications of possible misreporting for our empirical analysis below.

Alcohol consumption

We define four measures of alcohol consumption from the self-reports collected in the PHA: a binary indicator of currently drinking alcohol, the proportion of days in which a person drinks, the number of drinks consumed on a typical drinking day, and the proportion of "binge drinking" days.

The first question we use on the PHA is: *How often do you have a drink containing alcohol?*, to which the soldier can respond: "never," "monthly or less," "2-4 times a month," "2–3 times a week," or "4 or more times a week." From this, we define the indicator for whether a person currently drinks alcohol.[7] We also use this question to construct the proportion of days in which a person drinks as follows: drinking "monthly or less" is a proportion of 1/30, "2–4 times a

[5]Data is available for officers; however, only a handful of officers turn 21 years old while on active duty, as a 4-year college degree is required to obtain an officer's commission.

[6]Potential recruits must receive at least a score of 31 to enlist without a waiver; in recent years, waivers for low AFQT scores are rarely granted.

[7]While this question does not explicitly state a time frame over which the consumption has occurred, we believe most respondents would interpret it as asking about consumption within the past few months as this is the longest unit of time mentioned in the response categories.

month" is 3/30, "2–3 times a week" is 2.5/7, "4 or more times a week" is 4/7. The next question asks *How many drinks containing alcohol do you have on a typical day when you are drinking?* (1–2, 3–4, 5–6, 7–9, or 10+); we encode this variable using the midpoints of the ranges, 10 drinks for "10+," and a value of 0 for those who never drink. Finally, respondents were asked: *How often do you have six or more drinks on one occasion?* (never, less than monthly, monthly, weekly, or daily), from which we define the proportion of "binge" drinking days in a similar manner to the proportion of drinking days.

Tobacco use

An increase in alcohol use at age 21 due to the MLDA may be associated with a concomitant change in tobacco use.[8] We define three measures of tobacco use from PHA self-reports: an indicator of any tobacco use (the PHA question is *Do you use any kind of tobacco products?*), an indicator of moderate-to-heavy smoking, and an indicator of moderate-to-heavy nicotine dependency. Moderate-to-heavy smoking is defined in line with the medical literature as smoking 11 or more cigarettes per day (Husten, 2009). The PHA collected a series of questions enabling the calculation of the Fagerstrom score of nicotine dependency, and we define moderate-to-heavy nicotine dependency as a score of 5 or higher on the 0–10 scale. The Fagerstrom score is a commonly used measure of nicotine dependency that is created from answers to the following questions: *How soon after waking up do you smoke your first cigarette?*; *Do you find it difficult to refrain from smoking in places where it is forbidden?*; *Do you smoke more frequently in the morning?*; and *Do you smoke even if you are sick in bed most of the day?* (see Heatherton *et al*., 1991 for details of the Fagerstrom score.)

Depression and suicide ideation

A large literature has documented that alcohol use is correlated with both major depression and suicide ideation (Wang and Patten, 2001; Fergusson *et al*., 2009; LeardMann *et al*., 2013; Fuehrlein *et al*., 2016; Thompson and Swartout, 2017), and the clinical literature has established that alcohol, being a psychotropic depressant of the central nervous system, can induce acute episodes of depression and violence toward others or self (Sacks *et al*., 2005). Questions from the PHA allow us to explore whether the MLDA exacerbates these adverse conditions.

Specifically, the PHA asks respondents how often over the past 2 weeks they have been bothered by any of a series of nine moods and behaviors commonly associated with major depression and suicidal ideation. For example, "having little interest or pleasure in doing things," "feeling down, depressed, or hopeless," or "thoughts that you would be better off dead, or of hurting yourself in some way."[9] These questions were modified from a validated screening instrument widely used in primary care settings (Spitzer *et al*., 1999), and four responses to each question were available, "not at all," "several days," "more than half the days," or "nearly every day." Following the Army's psychological health referral guidelines, we define a soldier to be at

[8]Alcohol could also be complimentary with illicit drugs, such as marijuana. However, the PHA does not ask about illicit drug use, possibly reflecting the military's "Zero Tolerance" policy under which any drug use results in immediate expulsion from service (Bachman *et al*., 1999).

[9]The exact wording in the PHA is: Over the last 2 weeks, how often have you been bothered by any of the following problems? (1) Little interest or pleasure in doing things, (2) Feeling down, depressed or hopeless, (3) Trouble falling asleep or staying asleep, or sleeping too much, (4) Feeling tired or having little energy, (5) Poor appetite or overeating, (6) Feeling bad about yourself - or that you are a failure or that you have let yourself or your family down, (7) Trouble concentrating on things, such as reading the newspaper or watching television, (8) Moving or speaking so slowly that other people could have noticed, or the opposite—being so fidgety or restless that you have been moving around a lot more than normal, (9) Thoughts that you would be better off dead, or of hurting yourself in some way.

risk of clinical depression if he answered "more than half the days" or "nearly every day" to at least one question, and to have self-harm thoughts if he answered anything other than "not at all" to the question on suicide/self-harm.

Fitness for deployment

Finally, the Army uses the PHA to determine if a soldier is fit for a combat deployment "to an austere environment" if he has a PULHES score above their occupation-specific minimum. The PULHES is a function of six factors: (P)hysical capacity or stamina; (U)pper extremities; (L)ower extremities; (H)earing and ears; (E)yes, and Psychiatric (S)tability (U.S. Army, 2007).

2.2.2 | Global assessment tool

The GAT is a computer-based self-evaluation assessment of soldiers' psychological resiliency. The annual assessment is mandatory and contains 105 questions in 14 categories of psychological health: depression, catastrophizing, positive affect, adaptability, coping ability, optimism, character, engagement in the workplace, friendship, loneliness, organizational trust, family satisfaction, family support, and spirituality. (For full details of the GAT questionnaire see Lester *et al*., 2011.) Directly after answering the questions, soldiers are presented a summary of their answers mapped into measures of psychological resiliency, along with suggestions for how to improve any deficiencies. Soldiers are explicitly told that their responses are confidential and will not be seen by their superiors. In contrast to the PHA, there is less reason to believe that soldiers would shade the truth on the GAT as there is no direct link between responses and one's career prospects.

For our analysis, we focused on two psychologically assessed traits that can affect productivity and are associated with alcohol consumption: coping ability and self-control. Verdejo-García *et al*. (2008) review the large literature on the association between substance use and a lack of self-control and coping ability, and discuss how causality can go in both directions: for example, alcohol use can lead to a lack of self-control, and a lack of self-control can precipitate alcohol abuse.

Coping ability was assessed in the GAT with eight questions adapted from the psychology literature (Carver *et al*., 1989). Respondents were asked to rate from 1 to 5 how well the following statements describe themselves: *(1) For things I cannot change, I accept them and move on; (2) I control my emotions by changing how I think about things; (3) When something stresses me out, I try to avoid it or not think about it; (4) When something stresses me out, I try to solve the problem; (5) When bad things happen, I try to see the positive sides; (6) I usually keep my emotions to myself; (7) When something stresses me out, I have effective ways to deal with it; (8) When I am feeling upset, I keep my feelings to myself*. We define coping ability as the sum of the eight responses, inverting the scale when necessary so that a higher score reflects better coping ability.

Self-control was assessed in the GAT with a single question: *Think about how you have acted in actual situations during the past four weeks. Select a number from 0 to 10 according to how often you showed/used self control*. Questions of this type have been validated in the psychological literature to accurately capture a broad sense of self-control (Peterson and Seligman, 2004).

2.2.3 | Physical fitness tests

Observational studies have shown that long-term alcohol consumption is correlated lower physical fitness (Baumeister *et al*., 2018), and laboratory studies have shown that short-term alcohol consumption is correlated with slower movement and poorer coordination (Fillmore and

Vogel-Sprott, 1999, 2000). We use scores from the Army's Physical Fitness Test (PFT) to explore whether the MLDA and the associated increase in alcohol consumption impacts physical fitness.

The PFT is a mandatory assessment that is taken twice-yearly, and is designed to ensure that soldiers maintain a high level of muscular strength and physical endurance; failing the PFT can lead to eventual dismissal from the Army. Soldiers cannot choose when to take the test because all soldiers in a unit are assigned to take it together on a set schedule. The PFT consists of three events: push-ups, sit-ups, and a 2-mile run. Performance in each area is compared to standards for gender and age, and then normed to scores that vary between 0 and 100.[10] A score of 60 is required in each event to pass the PFT.

2.2.4 | Job-related infractions

Evidence from nonmilitary populations suggests that crime increases with legal access to alcohol (Carpenter and Dobkin, 2011; Hansen and Waddell, 2018), and the likely pathway is that alcohol impairs judgment and motor control. Army soldiers are unique in that they are subject to the Uniform Code of Military Justice (UCMJ) regardless of whether they are on duty; thus, any breach of the UCMJ can be considered a job-related infraction.

The final database we use is the interactive Personnel Electronic Records Management System (iPERMS) which identifies all UCMJ infractions severe enough to be recorded in a soldier's official file. The Army classifies these infractions into three levels, with increasing severity.[11] Level 1 offenses are minor, and known as a "letter of reprimand." They are recorded by a commanding officer for a broad range of behaviors deemed unbecoming of a military service member, such as insubordination, an initial report of sexual harassment, underage drinking, or disorderly conduct. Level 1 offenses do not result in immediate punishment, but they become part of the soldier's official record and may affect future promotions or assignments. For more severe infractions, such as intentionally disobeying orders, sleeping on watch, providing alcohol to minors, or petty theft, officers can invoke nonjudicial punishments, as authorized by Article 15 of the UCMJ. These Level 2, or "article-15 punishments," can lead to demotion, confinement, jail time for no more than 30 days, or extra duties, but do not result in a criminal record. For the most serious offenses, such as assault, fraud, desertion, or driving while under the influence of alcohol, a commanding officer can decide to convene a military court martial—a Level 3 offense. If convicted under a court martial, the soldier will have a criminal record and receive punishments that range from demotion, to fines, jail time, or dishonorable discharge (which affect postmilitary benefits). As offenses at the individual level are rare, we collapse the iPERMS database into a daily rate of job-related infractions for our analysis.

2.3 | Sample selection

We first identify all active-duty soldiers in the Master Personnel File who were aged 20–22 at anytime between 2009 and 2015. We then exclude soldiers stationed either outside the U.S. and

[10]For example, a 21-year old male must complete at least 42 push-ups and 53 sit-ups, and run 2 miles in under 15 min 54 s in order to pass the PFT. For full details of the test, see U.S. Army (2012).

[11]We do not observe a description of the offense, only the level of the offense.

TABLE 1 Summary statistics of the population of soldiers aged 20–22 years old between 2009 and 2015

	Mean	*SD*	Observations
Age	19.45	0.60	38,148
Female	0.16	0.37	38,148
Completed high school	0.98	0.13	38,148
Armed Forces Qualifying Test (AFQT) score	56.11	17.79	38,148
White	0.63	0.47	38,148
Black	0.20	0.40	38,148
Asian	0.03	0.18	38,148
Hispanic	0.13	0.33	38,148
Other race	0.01	0.10	38,148

Note: Sample includes all soldiers between 2009 and 2015 that were observed in the Master Personnel File at any time one year before or one year after their 21st birthday.

or on bases within 50 miles of the U.S. borders with Mexico and Canada, as commanders at these locations have the discretion to adopt an MLDA other than 21. This process identifies 38,148 soldiers. In our RD analyses, not every soldier is observed in the window around their 21st birthday due to both the timing of when the outcomes are collected and the optimal bandwidth estimator described below. For example, the PHA is taken once per year and we observe 21,685 soldiers with a PHA in the year before or after their 21st birthday, while the PFT is taken twice per year and we observe 51,299 soldiers in that window.

Table 1 summarizes the characteristics of the individuals in our analysis: the majority are male (84%) and white (63%), virtually all have a High School diploma (a requirement for military service), and the average AFQT score is the 56th percentile.

3 | METHODS AND RESULTS

3.1 | Methods

Our RD model exploits the sharp discontinuity in legal access to alcohol at age 21, comparing soldiers just prior to their 21st birthday who were not legally able to buy or consume alcohol with those just after their 21st birthday. The estimated discontinuities in outcomes at age 21 identify the causal impact of the MLDA under the assumptions that no other factors correlated with outcomes of interest other than legal access changed at this threshold and that our observation of outcomes is independent of birth date.

Before we estimate the RD impact of the MLDA, we first visually explore the alcohol consumption data around soldiers' 21st birthdays. Figure 1 plots mean rates within bins for our four alcohol consumption measures (the proportion currently drinking, the proportion of drinking days, the number of drinks on a typical drinking day, and the proportion of binge-drinking days). The size of these bins was determined via the data-driven method introduced by Calonico *et al.* (2015), as opposed to ad-hoc choices such as daily or weekly bins.

Figure 1 shows that consumption rates are low pre-21 years of age, start to rise after the 21st birthday, and then level off about 30 days past the birthday. This rise in consumption suggests

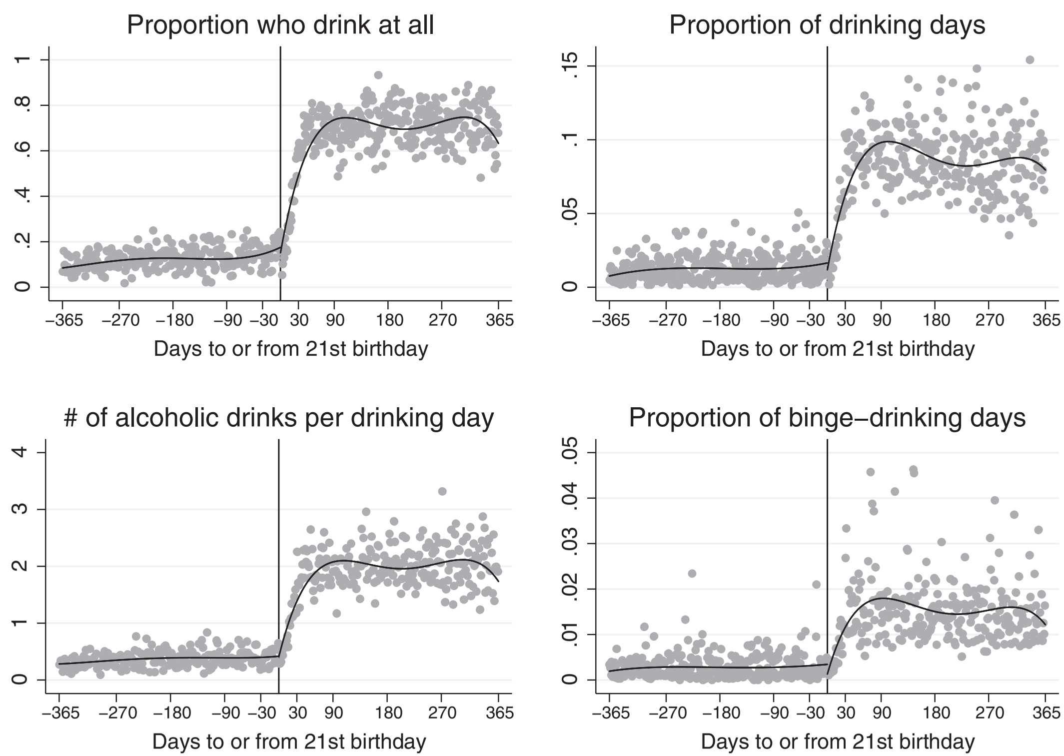

FIGURE 1 Alcohol consumption among U.S. Army soldiers. Data are self-reports from the Personal Health Assessments (PHA) of U.S. Army soldiers who were between the ages of 20 and 22 at any time between 2009 and 2015. Circles indicate the averages within bins chosen by the Calonico *et al*. (2015) methodology. See text for detailed definitions of the outcomes

an impact of the MLDA, but the gradual rise also suggests that the month around one's birthday is different than the steady state post-21 year of age. We believe two things could be happening in this postbirthday month. First, the PHA asked soldiers to report their alcohol consumption in the past 30 days and this would include underage days if they answered the survey within 30 days of their birthday. Second, soldier's duties may restrict their ability to purchase and consume alcohol immediately upon turning 21; depending on one's occupation or phase of training, this freedom to drink may be delayed by weeks or months. For these reasons, we exclude the "donut" of 30 days above and below the 21st birthday in all of our subsequent analyses.[12]

Our formal estimates of the impact of the MLDA come from the following model:

$$Y_i = \beta_0 + \beta_1 T_i + g(D_i, T_i) + X_i \Theta + \varepsilon_i, \tag{1}$$

where, for each person i, Y_i are outcomes of interest, $D_i = age_i - 21$ is the distance in days between the observation of the outcome and the 21st birthday, $T_i = 1\{D_i \geq 0\}$ is an indicator of being over 21 years old, and $g(D_i, T_i)$ is a function of D interacted with the over-21 indicator. β_1 is the discrete change in Y_i at the discontinuity. To reduce the variance of our estimates, we control for a set of pre-21-years-old demographics (X): AFQT score, gender, education level, and race/ethnicity.

We estimate Equation 1 using the optimal RD methods developed by Calonico *et al.* (2014), which solves for the robust estimate of β_1 by optimizing the bandwidth such that the integrated mean squared error (IMSE) of the underlying regression function is minimized. In our setting, this bandwidth is the number of days on each side of the 21st birthday that are included in the estimation sample, and it will naturally vary across outcomes and specifications. As noted above, all of our models also exclude the 30-day window above and below a soldier's 21st birthday to estimate the "donut" RD. We estimate $g(D_i, T_i)$ nonparametrically using local linear regression as is common in the literature and our results below report robust standard errors clustered at the day level.

3.2 | The impact of MLDA on alcohol consumption

The first part of Table 2 presents the RD estimates (β_1 from Equation 1) of the impacts of the MLDA on alcohol consumption. The number of observations reflect the sample that was input into the Calonico *et al.* (2014) algorithm while the optimal bandwidth reflects the sample (the number of days around the 21st birthday) that was included in the RD estimation. Figure 2 plots the estimated regression functions as well as local means for the data included in the estimation - note the exclusion of the 30-day donuts around the 21st birthday and the varying optimal bandwidths across alcohol consumption outcomes.

Before the 21st birthday, reported alcohol consumption is low: 11.5% report currently drinking any alcohol, average consumption is 0.35 drinks per drinking day (recall this measure codes those who do not drink at all as having 0 drinks), and the mean proportion of drinking days and binge drinking days are extremely low, at 1.2 and 0.3%, respectively.

These pre-21 drinking rates are lower than what has been reported elsewhere. In particular, a U.S. Air Force Academy Climate Survey found about 40% of underage Air Force cadets have

[12]Our results are also robust to excluding only the 30 days above the 21st birthday, a "crescent" RD design (available from the authors on request).

TABLE 2 The impacts of the MLDA

Outcome	Over 21	(*SE*)	Obs.	Optimal bandwidth (days either side of 21st birthday)	Mean, under 21 sample
Personal health assessment (PHA) sample					
Currently drinks at all	0.489***	(0.037)	21,685	120	0.115
Proportion of drinking days	0.076***	(0.008)	21,685	131	0.012
# of alcoholic drinks on a typical drinking day	1.534***	(0.124)	21,685	145	0.352
Proportion of binge-drinking days (6+ drinks)	0.014***	(0.003)	21,685	178	0.003
Smokes cigarettes at all	0.104	(0.068)	21,685	84	0.297
Moderate to heavy smoker	0.006	(0.021)	21,685	138	0.074
Moderate to high nicotine dependency	−0.005	(0.015)	21,685	138	0.038
Screened for depression	−0.018	(0.018)	21,685	150	0.054
Self-harm thoughts	−0.006	(0.008)	21,685	128	0.006
Fit for deployment	−0.015	(0.020)	21,685	152	0.943
Global Assessment Tool (GAT) sample					
Coping ability	0.285	(0.292)	21,165	162	3.97
Self-control	−0.056	(0.066)	21,165	170	26.08
Physical Fitness Test (PFT) sample					
Total PFT score	2.50	(3.15)	51,299	102	232.30
Push-up score	0.75	(0.92)	51,299	114	83.35
Sit-up score	−0.26	(1.17)	51,299	98	79.11
2-mile run score	2.22	(1.75)	51,299	101	69.80
NonJudicial and Judicial Punishment sample					
Daily offense rate (per 100,000 person days)	−9.67	(6.31)	730	96	11.5
Level 1 daily offense rate (letter of reprimand,					
per 100,000 person days)	−6.19	(4.95)	730	104	6.75

TABLE 2 (Continued)

Outcome	Over 21	(*SE*)	Obs.	Optimal bandwidth (days either side of 21st birthday)	Mean, under 21 sample
Level 2 daily offense rate (Article 15 proceedings, per 100,000 person days)	−2.97	(2.37)	730	142	2.54
Level 3 daily offense rate (court martial, per 100,000 person days)	−0.98	(2.35)	730	146	2.22

Note: Each row reflects a separate local linear discontinuity regression excluding observations within a 30 day window on each side of the 21st birthday and using a symmetric optimal bandwidth. Observations represent the sample size within a 365 window on each side of the 21st birthday. Robust standard errors are clustered at the day (age) level. Covariates include AFQT score and indicators for gender, education level, and race/ethnicity.
***$p < .01$; **$p < .05$; *$p < .1$.

drank alcohol in the past (Carrell *et al.*, 2011) and a Department of Defense Health-Related Behavior survey reported 49% of Army underage soldiers have drank alcohol in the past (Barlas *et al.*, 2013). The lower reported consumption rates in our sample compared to these studies can be reflecting several factors. First, our sample contains young working soldiers who are employed full time and may have less ability to acquire or consume alcohol than would an officer cadet in school. Second, the PHA asks about consumption in the past 30 days, which may be different from having ever drank alcohol, as in the above referenced studies. Third, the low self-reported consumption could be reflecting intentional shading of true alcohol consumption. Even though the PHA is only observed by medical professionals and is not used in disciplinary actions, soldiers may not know this fact, or they do not believe it. However, we note that the gradual ramp-up in alcohol consumption after the 21st birthday suggests that the impact of the MLDA is not entirely being driven by intentional shading of underage drinking. If true consumption were in fact constant around the birthday, and the reported changes were entirely reflecting truthful reporting upon turning 21, we would expect to see a sharper discontinuity. We return to discuss the implications of under-reported alcohol consumption for the interpretation of our estimates of other outcomes below.

By the second month after their 21st birthday, about 60% of soldiers report drinking alcohol, and the number of drinks on a typical drinking day rises to about 2. The proportion of drinking days rises to about 0.10, and while the proportion of binge drinking days also rises, it is still low at about 0.02. While the post-21 increase in alcohol consumption is consistent with evidence from other populations (Carrell *et al.*, 2011; Barlas *et al.*, 2013; Yörük, 2015), the magnitude of our estimates are higher than in prior studies. For example, Table 2 shows an increase in the percent of current drinkers by 48.9 percentage points on top of a pre-21 mean of 11.5%, which is much higher than the 8 percentage points increase shown in Carpenter and Dobkin (2009) for the U.S. population as a whole using the National Health Interview Survey and the 6.5 percentage points increase among the U.S. college student population Lindo *et al.* (2013) using the NLSY 97. However, in both of those studies, the pre-21 mean drinking rates are much higher than in our data (40% and 66% in the Carpenter and Dobkin (2009) and Lindo *et al.* (2013) studies, respectively) leaving the post-21 drinking rates roughly similar in all three settings.

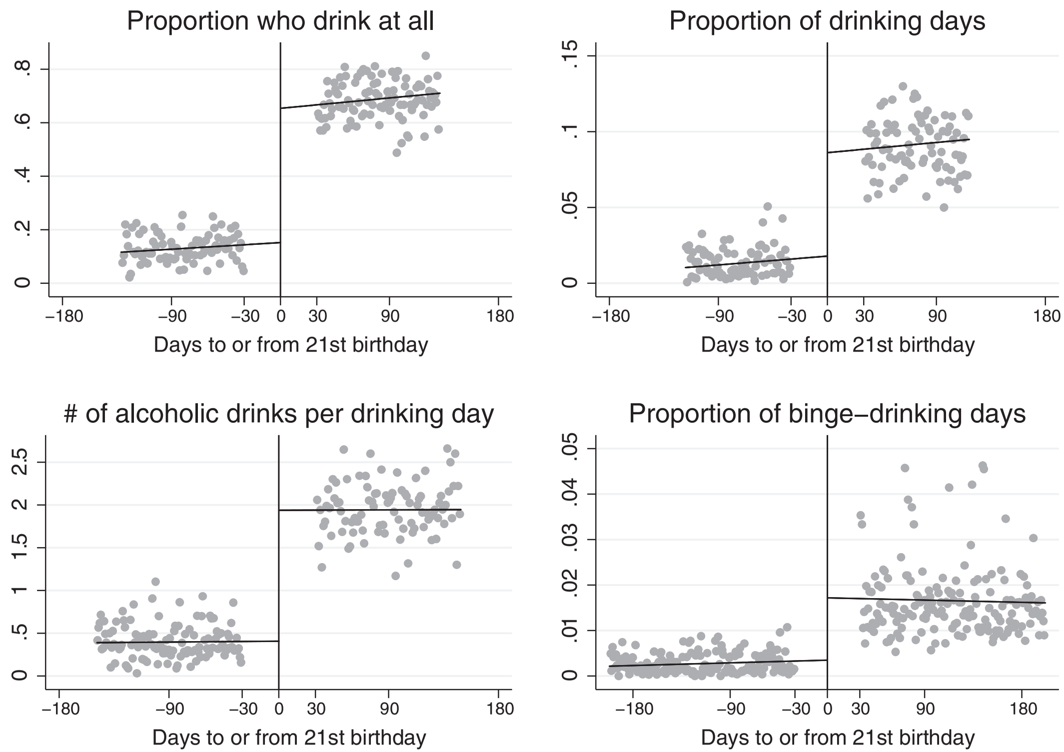

FIGURE 2 The impact of the MLDA on alcohol consumption among U.S. Army soldiers. Data are from the Personal Health Assessment (PHA). Circles indicate daily averages for days within the estimated optimal bandwidth (see text) excluding a 30 day window on each side of the 21st birthday. The solid lines are separate, covariate adjusted linear regression functions below and above age 21

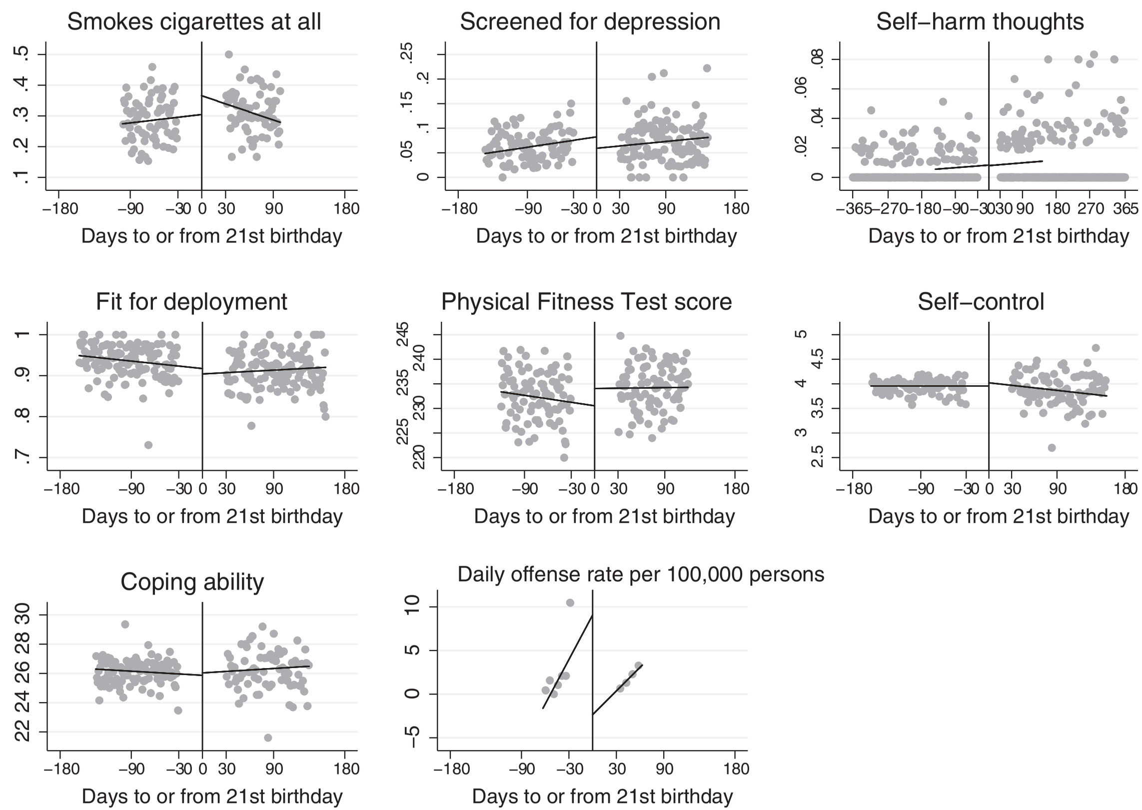

FIGURE 3 The impacts of the MLDA on selected mental health, physical fitness, and job performance outcomes. Data are from the Periodic Health Assessment (PHA), the Global Assessment Tool (GAT), the Physical Fitness Test (PFT), and the Nonjudicial and Judicial Punishment database. Circles indicate daily averages for days within the estimated optimal bandwidth (see text) excluding a 30 day window on each side of the 21st birthday. The solid lines are separate, covariate adjusted linear regression functions below and above age 21

3.3 | The impact of MLDA on mental health, physical fitness, and job performance

Figure 3 presents visual evidence of the evolution of selected outcomes around the 21st birthday, and the second part of Table 2 contains RD estimates of all outcomes of interest. The impact on smoking is 10.4 percentage points (over a pre-21 mean of 29.7%), but it is statistically insignificant. The impact on the intensity of smoking is nearly zero and statistically insignificant. These null findings on tobacco use are consistent with those of Yörük and Yörük (2011) who find no impact of the MLDA on smoking using data from the NLSY.

There is no evidence of an impact of the MLDA on depression or thoughts of self-harm. While it is possible that soldiers would lie about these measures, there is no a priori reason to believe lying about them should change when a soldier turns 21. In other words, we expect this to be a noisy measure in addition to being a rare event, potentially causing attenuation bias in our estimates.

The estimate of the impact of the MLDA on fitness for deployment - a minimum job requirement for soldiers - is small and insignificant at 1.5 percentage points (pre-21 years of age, 94.3% of soldiers are deployable). Coping ability and self-control, as measured in the GAT, and the measures of physical fitness from the PFT are also not impacted by the MLDA, a finding consistent with those from Yörük and Yörük (2012) who study the nonmilitary population. Similarly, there is no significant impact on job-related infractions although the magnitudes are relatively large compared to pre-21 years of age means. For example, the incidence of having "any offenses" per 100,000 person-days decreases by 9.67 from a pre-21 mean of 11.5 incidents. Examining the graph of offenses in Figure 3, we can see this is being driven by a relatively high daily offense rate (of about 10 per 100,000 soldiers) right around 30 days before the 21st birthday, while the daily offense rate tends to be between 0 and 3 throughout most of the data.

To summarize, there do not appear to be any meaningful changes in the outcomes we study for soldiers upon turning 21 years old. None of the RD estimates are statistically distinguishable from zero, and most are small in magnitude and precisely estimated (standard errors are small).[13]

3.4 | Design validity and robustness of main results

We next present several tests of the validity of our empirical design and the robustness of our results. First, one might worry that soldiers are systematically taking the PHA, PFT, or GAT either before or after their 21st birthday in a way that would bias our RD estimates. For example, soldiers may try to delay taking the PHA until after their 21st birthday so that are not forced to lie about drinking underage; or, soldiers of a certain demographic type may try to delay taking one of the tests and those demographic types are correlated with outcomes of interest. Fortunately, individual soldiers are not able to manipulate the date at which they take these tests, as units take them together and birthdays are not used in forming units. Nonetheless, the results in Figure 4 and Table 3 help alleviate such concerns. Figure 4 plots the distribution of the age of soldiers when these tests were taken and shows that there is no bunching before or

[13]With the large number of outcomes we consider, one may be concerned about issues of multiple inference; however, common adjustments will tend to *increase p*-values of hypothesis tests, further supporting our general finding of no impacts of the MLDA on these outcomes (Savin, 1980).

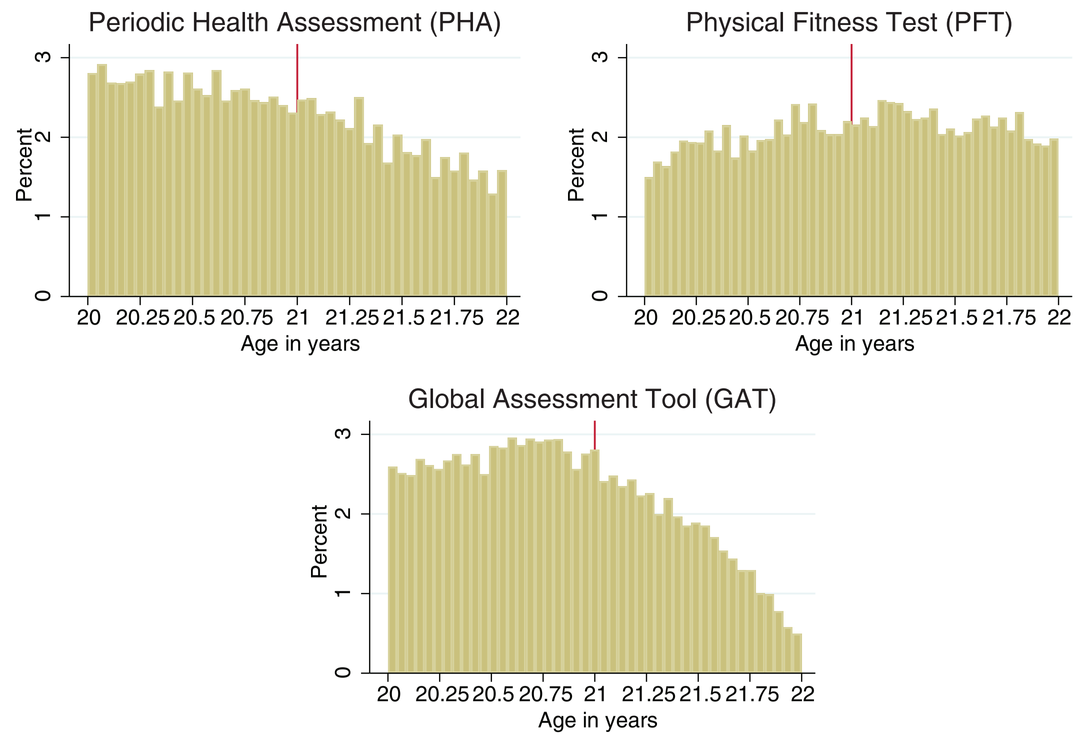

FIGURE 4 The distribution of the age of soldiers observed in our databases. Sample includes all U.S. Army soldiers between the ages of 20 and 22 at any time between 2009 and 2015 [Color figure can be viewed at wileyonlinelibrary.com]

after the 21st birthday. Table 3 presents RD estimates of Equation 1 with several observable characteristics as outcomes - gender, AFQT score, educational attainment, race, marital status, and number of dependents - for each assessment (PHA, PFT, and GAT), testing whether $E(X|D)$ is continuous through their 21st birthday, at $D = 0$. Across the 30 regressions we estimate (10 outcomes for each of the three databases), we find only three significant discontinuities at

TABLE 3 Tests of the balance of covariates across the MLDA discontinuity

Outcome	Over 21	(*SE*)	Obs.	Optimal bandwidth (days either side of 21st birthday)
Personal Health Assessment (PHA) sample				
Female	0.043	(0.044)	21,691	96
AFQT score	−1.231	(1.303)	21,691	147
High school only	−0.005	(0.008)	21,691	149
Completed college	0.004	(0.007)	21,691	161
Black	−0.015	(0.032)	21,691	137
Hispanic	−0.040	(0.029)	21,691	127
Asian	0.011	(0.015)	21,691	141
Other race	−0.003	(0.010)	21,691	88
More than two dependents	0.000	(0.006)	21,691	97
Married	0.009	(0.028)	21,691	106
Physical Fitness Test (PFT) sample				
Female	0.000	(0.017)	60,529	128
AFQT score	0.730	(0.791)	60,529	143
High school only	0.004	(0.005)	60,529	149
Completed college	−0.004	(0.005)	60,529	147
Black	−0.018	(0.020)	60,529	131
Hispanic	−0.007	(0.015)	60,529	149
Asian	0.019*	(0.010)	60,529	117
Other race	0.014***	(0.005)	60,529	120
More than two dependents	0.000	(0.013)	60,529	156
Married	0.000	(0.013)	60,529	140
Global Assessment Tool (GAT) sample				
Female	−0.054*	(0.029)	32,318	106
AFQT score	−0.946	(1.292)	32,318	116
High school only	0.000	(0.009)	32,318	115
Completed college	0.000	(0.008)	32,318	119
Black	−0.016	(0.023)	32,318	142
Hispanic	−0.010	(0.019)	32,318	143
Asian	0.002	(0.019)	32,318	119

TABLE 3 (Continued)

Outcome	Over 21	(*SE*)	Obs.	Optimal bandwidth (days either side of 21st birthday)
Other race	0.003	(0.008)	32,318	88
More than two dependents	−0.006	(0.007)	32,318	74
Married	−0.003	(0.019)	32,318	125

Note: Each row reflects a separate local linear discontinuity regression excluding observations within a 30 day window on each side of the 21st birthday and using a symmetric optimal bandwidth. Observations represent the sample size within a 365 window on each side of the 21st birthday. Robust standard errors are clustered at the day (age) level.
***$p < .01$; **$p < .05$; *$p < .1$.

or below the 10% level. Controlling for these covariates in our RD model mitigates concerns that unbalanced samples are biasing our estimates (regardless, Table A2 shows nearly identical estimates result from models which exclude all covariates).

Second, we show in Table 4 that the RD estimates are generally robust to various modeling choices.[14] The models in column 1 of Table 4 report estimates in which we create larger donuts (45 days) around the 21st birthday to further abstract from the ramp-up in alcohol consumption seen in Figure 2. As expected, the RD estimates of alcohol consumption increase with the size of the donut; however, there is little systematic change in the magnitude or economic significance of RD estimates on other outcomes of interest. In columns 2 and 3 of Table 4, we estimate $g(D_i, T_i)$ using local polynomials of order 2 and 3, respectively. Again, estimates are similar to local linear regressions except for being screened for depression, which now shows a larger drop after 21 which is significantly different from zero. Finally, we explore alternative bandwidth selection procedures. In column 4 of Table 4, we allow for separate bandwidth selections to the left and to the right of age 21 instead of one common bandwidth. Entries in brackets in column 4 of Table 4 denote the optimal [*left*; *right*] bandwidths. In the last column, the bandwidth selector employs a different optimality criterion. In general, the MSE criterion relies on the tradeoff between variance and bias of the RD point estimator; rather than minimizing IMSE, however, this last column minimizes the coverage error rate (CER) which tends to select smaller bandwidths. Again estimates are similar to those in Table 2 except for being screened for depression. We believe the significant estimates for depression are a likely artifact of the modeling assumptions in these robustness checks as the outcome for depression as depicted in Figure 3 does not indicate evidence of a discontinuity around the 21st birthday. In columns 2 and 3 of Table 4, the significant estimates are likely due to the nonlinear functional form for $g(D_i, T_i)$, while a much smaller sample in column 5 of Table 4 as indicated by the size of the bandwidth likely explains the significant negative finding.

In our last robustness check, we perform a placebo test by estimating the impact of turning 20 years old which allows us to disentangle the impact of gaining legal access to alcohol from the impact of simply having a birthday. Table 5 reports these estimates and shows that unlike turning 21, there are no statistically and economically meaningful discontinuities in alcohol consumption upon turning age 20. Across the various other outcomes, the discontinuities are also not statistically distinguishable from zero.

[14]For the sake of parsimony, we only show select outcomes in Table 4. Identical models for the remaining outcomes can be found in Table A1 which confirms the robustness of the results in Table 2.

TABLE 4 Robustness of the main results, selected outcomes

	45 day donut (1)	Polynomial order 2 (2)	Polynomial order 3 (3)	Aysmmetric optimal bandwidths (4)	CER minimizing bandwidth (5)
Personal Health Assessment (PHA) sample					
Currently drinks at all	0.535***	0.471***	0.341***	0.498***	0.435***
	[153]	[180]	[191]	[139; 134]	[78]
# of drinks on a typical day	1.431***	1.573***	1.724***	1.533***	1.532***
	[176]	[214]	[240]	[136; 142]	[88]
Smokes cigarettes at all	0.036	0.104	0.131	0.115	0.227
	[145]	[178]	[251]	[87; 67]	[51]
Screened for depression	0.004	−0.175***	−0.191***	−0.042*	−0.095***
	[180]	[137]	[204]	[118; 130]	[91]
Self-harm thoughts	−0.001	−0.006	−0.010	−0.004	0.002
	[169]	[198]	[235]	[150; 122]	[78]
Fit for deployment	−0.008	−0.011	−0.006	−0.018	−0.014
	[189]	[217]	[276]	[144; 141]	[95]
Global Assessment Tool (GAT) sample					
Coping ability	−0.046	0.390	0.531	−0.295	0.433
	[408]	[275]	[350]	[194; 151]	[97]
Self-control	−0.044	0.094	0.202	0.103	0.179
	[402]	[258]	[327]	[201; 135]	[96]
Total PFT score	1.968	1.369	2.019	0.462	−0.397
	[247]	[191]	[301]	[85; 74]	[59]
NonJudicial and Judicial Punishment sample					
Daily offense rate (per 100,000 person days)	13.20	−9.28	−7.19	10.10*	−8.75
	[127]	[127]	[177]	[89;118]	[69]

Note: Each cell constitutes a separate regression discontinuity estimate of the form used in Table 2 except that the models in: column (1) excludes a 45 day window around the 21st birthday instead of a 30 day window; columns (2) and (3) use higher order polynomials as opposed to a linear model; column (4) allows the optimal bandwidth to vary above and below the discontinuity; and column (5) chooses a bandwidth to minimize the coverage error rate (CER) of the confidence interval. Optimal bandwidths (days either side of the 21st birthday) are included in brackets and standard errors are excluded for parsimony. Covariates include AFQT score and indicators for gender, education level, and race/ethnicity.
***$p < .01$; **$p < .05$; *$p < .1$.

3.5 | Heterogeneity of the alcohol access effect by risk factors

A novel feature of our data is that we observe a broad range of cognitive and psychological risk factors of alcohol consumption for individuals *before* they turn 21 years old. Motivated by the medical literature on alcohol use and its correlates, we explore four dimensions of heterogeneity: self-control, coping ability, cognitive ability, and genetic predisposition toward mental

TABLE 5 Placebo test, the impact of turning 20 years old

Outcome	Over 20	(*SE*)	Obs.	Optimal bandwidth (days either side of 20th	Mean, under 20 sample
Personal Health Assessment (PHA) sample					
Currently drinks at all	−.00191	(0.022)	22,120	127	0.090
Proportion of drinking days	0.0008	(0.004)	22,120	124	0.010
# of alcoholic drinks on a typical drinking day	0.0246	(0.082)	22,120	136	0.278
Proportion of binge-drinking days (6+ drinks)	0.0015	(0.002)	22,120	87	0.002
Smokes cigarettes at all	−0.0295	(0.049)	22,120	95	0.274
Moderate to heavy smoker	−0.0139	(0.017)	22,120	136	0.057
Moderate to high nicotine dependency	−0.0075	(0.012)	22,120	135	0.027
Screened for depression	0.0124	(0.019)	22,120	111	0.033
Self-harm thoughts	0.0101	(0.006)	22,120	109	0.004
Fit for deployment	0.0059	(0.016)	22,120	122	0.963
Global Assessment Tool (GAT) sample					
Coping ability	−0.322	(0.320)	33,410	122	25.98
Self-control	0.0115	(0.061)	33,410	141	4.09
Physical Fitness Test (PFT) sample					
Total PFT score	1.946	(2.577)	36,604	126	232.00
Push-up score	−0.198	(0.950)	36,604	121	83.71
Sit-up score	−0.054	(0.796)	36,604	152	78.00
2-mile run score	1.752	(1.302)	36,604	133	71.29
NonJudicial and Judicial Punishment sample					
Daily offense rate (per 100,000 person days)	3.40	(7.45)	730	69	2.70
Level 1 daily offense rate (letter of reprimand, per 100,000 person days)	9.98	(6.95)	730	57	1.11
Level 2 daily offense rate (Article 15 proceedings, per 100,000 person days)	−6.07	(1.16)	730	54	0.95

(Continues)

TABLE 5 (Continued)

Outcome	Over 20	(*SE*)	Obs.	Optimal bandwidth (days either side of 20th	Mean, under 20 sample
Level 3 daily offense rate (court martial, per 100,000 person days)	−1.78	(2.72)	730	94	0.64

Note: Each row reflects a separate local linear discontinuity regression excluding observations within a 30 day window on each side of the 20th birthday and using a symmetric optimal bandwidth. Observations represent the sample size within a 365 window on each side of the 20th birthday. Robust standard errors are clustered at the day (age) level. Covariates include AFQT score and indicators for gender, education level, and race/ethnicity.
$^{***}p < .01$; $^{**}p < .05$; $^{*}p < .1$.

health problems and/or chemical dependency. While we have explored whether self-control and coping ability are impacted by alcohol use, it is also possible that the direction of causality could run the other way, whereby these psychological attributes are in fact risk factors contributing to alcohol consumption (Verdejo-García *et al*., 2008).[15] Likewise, there is suggestive evidence that cognitive ability is a risk factor for alcohol use (Windle and Blane, 1989), and we proxy cognitive ability with the AFQT taken by soldiers as recruits. Finally, alcoholism has been shown to have genetic predictors (Levey *et al*., 2014), and we use self-reports from the PHA of whether soldiers have a family history of mental health or chemical dependency.[16]

For ease of presentation, we split the sample into quartiles (top-, bottom-, and inter-quartile range) of coping ability, self control, and AFQT, and into those with and without any family history of mental health or chemical dependency, but our results are robust to alternate parameterizations. Table 6 reports the sub-group RD estimates for selected outcomes (estimates for the other outcomes studied in Table 2 are reported in Table A3). The columns define the samples, and for each outcome we present the RD estimate from Equation (1) and the mean of the outcome for those observations under 21 years of age.

Looking first at the pre-21 means, it is clear that there is substantial heterogeneity across the population. Comparing across the distribution of self-control, 13.7% of those in the bottom quartile drink alcohol before they turn 21 compared to only 10.2% of those in the top quartile; and, compared to those in the top quartile those in the bottom quartile are also more likely to screen positive for depression (9.6 vs. 4.7%), and to have thoughts of self harm (0.8 vs. 0.3%). Comparing across the distribution of coping ability, we see similar patterns as for self-control. Finally, differences in pre-21 outcomes are particularly noticeable between soldiers with and without a family history of mental health problems or chemical dependencies (in this sample, 13% of soldiers reported having this type of family history): those with a family history are more than three times more likely to be

[15]While a subset of soldiers could have been drinking before turning age 21, and this early drinking behavior could have affected their GAT score, we are exploiting variation from increased alcohol access at Age 21. As such, the interpretation of the treatment effect is conditional on their GAT score prior to age 21 and is the effect of the *marginal* increase of access to alcohol at age 21.

[16]Soldiers were asked whether their parents, grandparent, and/or siblings had mental health problems or chemical dependencies. Mental health problems include any of the following disorders: Generalized anxiety disorder, Depression, Bipolar disease, Schizophrenia, Obsessive compulsive disorder, Attention deficit disorder, Split personality disorder, Personality disorder, Adjustment disorder, Eating disorder, Tourette syndrome, Agoraphobia, Autism, Seasonal affective disorder, Suicide, Multiple disorders. Chemical dependency includes any of the following categories: alcohol, cocaine/crack, heroin, marijuana, methamphetamine, narcotics, glue/solvents, LSD, benzodiazepines, Ecstasy, multiple dependency, other chemical dependency.

TABLE 6 The heterogeneous impacts of the MLDA, selected outcomes

	Self-control			Coping ability			AFQT			Mental health or chemical dependency	
	Bottom quartile	Inter-quartile	Upper quartile	Bottom quartile	Inter-quartile	Upper quartile	Bottom quartile	Inter-quartile	Upper quartile	No family history	Family history
PHA sample											
Currently drinks at all											
Over 21	0.466***	0.432***	0.502***	0.432***	0.434***	0.554***	0.158	0.492***	0.586***	0.476***	0.708***
Mean under 21	0.137	0.115	0.102	0.123	0.114	0.104	0.108	0.115	0.123	0.108	0.170
# of drinks on a typical day											
Over 21	1.919***	1.342***	1.674***	1.289***	1.559***	1.702***	0.833	1.752***	2.017***	1.444***	2.890***
Mean under 21	0.464	0.339	0.304	0.393	0.341	0.307	0.305	0.367	0.373	0.324	0.559
Smokes cigarettes at all											
Over 21	0.253	0.049	0.033	0.081	0.172	0.133	0.302	0.007	0.204*	0.082	0.432
Mean under 21	0.348	0.295	0.268	0.326	0.282	0.279	0.269	0.314	0.289	0.284	0.394
Screened for depression											
Over 21	−0.094	−0.039	−0.060	−0.030	−0.037	−0.046	0.034	−0.061**	−0.125	−0.015	−0.256**
Mean under 21	0.096	0.047	0.039	0.088	0.038	0.028	0.058	0.054	0.047	0.040	0.154

(Continues)

TABLE 6 (Continued)

	Self-control			Coping ability			AFQT			Mental health or chemical dependency	
	Bottom quartile	Inter-quartile	Upper quartile	Bottom quartile	Inter-quartile	Upper quartile	Bottom quartile	Inter-quartile	Upper quartile	No family history	Family history
Self-harm thoughts											
Over 21	0.040	−0.034	0.000	0.006	0.013	0.018	0.000	−0.002	−0.006	−0.006	−0.021
Mean under 21	0.008	0.007	0.003	0.010	0.003	0.004	0.0064	0.006	0.006	0.004	0.021
Fit for deployment											
Over 21	0.072	−0.011	−0.058	0.064	−0.0975**	0.046	−0.012	−0.006	−0.057	−0.005	−0.042
Mean under 21	0.930	0.945	0.948	0.930	0.948	0.953	0.932	0.943	0.955	0.946	0.919
Total PFT score											
Over 21	−3.17	3.96	6.28	−1.57	2.45	0.44	0.35	1.74	1.52	0.57	4.35
Mean under 21	224.7	232.8	236.4	226.5	234.3	238.4	229.0	233.0	234.5	234.9	224.5

Note: Each cell reflects a separate local linear discontinuity regression excluding observations within a 30 day window on each side of the 21st birthday and using a symmetric optimal bandwidth. Samples include individuals within a 365 day window on each side of the 21st birthday. Covariates include AFQT score and indicators for gender, education level, and race/ethnicity.

***$p < .01$; **$p < .05$; *$p < .1$.

screened positive for depression (4.0% vs. 15.4%) and more than 5 times more likely to have suicidal thoughts (0.4 vs. 2.1%). Interestingly, these patterns we observe for young Army soldiers are similar to those observed in all military branches and age cohorts by Marsden *et al.* (2014).

Considering the RD estimates in Table 6, we see that while there are differences in the impact of the MLDA on drinking behavior by sub-groups of risk factors, there are few observable differences in the outcomes of interest.

For example, we observe larger impacts of the MLDA on the drinking behavior of those with a family history of mental health or chemical dependency problems compared to those without (0.48 vs. 0.71 percentage points, both $p<.05$). And, those with better coping ability have larger responses to the MLDA than those in the bottom quartile of coping (0.55 vs. 0.43 percentage points, both $p<.01$). Also, those in the top quartile of the AFQT distribution have a larger response to the MLDA than those in the bottom quartile (0.586 percentage points, $p<.01$ vs. 0.158 percentage points, $p>0.1$).

The stratified analysis on drinking outcomes suggests that the MLDA mainly affects those with better cognitive ability (better AFQT and coping skills)—soldiers who are likely to be workers with better productivity to start with and are better equipped to cope with the stressful military environment. As a result, we might not expect to see significant loss in job performance when these soldiers gain legal access to alcohol.

Indeed, when we examine the nondrinking outcomes, we find few significant impacts, negative or positive, of turning 21 except for the following notable cases. For soldiers in the interquartile of the AFQT distribution, the probability of depression was 6.1 percentage points lower post-MLDA (compareed to a base mean of 5.4%). Similarly, for soldiers with a family history of mental health problems or chemical dependency, the probability of depression is 25.6 percentage points lower post-MLDA. One possibility is that more cognitively able soldiers or those with a family history of chemical dependency turn to alcohol once they attain legal access to it as a way to cope with depression, resulting in a lower estimated probability of being screened for depression.

On the other hand, for soldiers in the interquartile range of the coping ability distribution, their probability of being fit for deployment went down by 9.75 percentage points after age 21 ($p < .05$, compared to a base mean of 94.8%). For those in the upper quartile of the AFQT distribution, the probability of smoking increased by 20.4 percentage points ($p < .10$, compared to a base mean of 28.9%). These two findings suggest that alcohol may have some adverse effects for some soldiers.

4 | CONCLUSION

In this article, we have estimated the impact of legal access to alcohol on a wide range of behavioral and physical outcomes of young U.S. Army soldiers, and we explore whether these impacts vary with risk factors for alcohol abuse.

Using data on all soldiers between 2009 and 2015, we observe a large and significant increase in drinking upon turning 21 years of age, and the largest increases are observed among those who have a family history of mental health problems, better coping ability, and higher cognitive ability. Despite the large increase in self-reported alcohol consumption, we do not find meaningful impacts of legal access to alcohol in the overall population on all the short-term outcomes we observe, including suicidal tendencies, depression, tobacco use, physical fitness, coping and self-control ability, deployability, and job-related infractions. When we stratify by sub-groups, we find some subgroups to be more susceptible to MLDA in both positive and negative ways.

In light of concerns about the validity of self-reported alcohol consumption (Del Boca and Darkes, 2003), the consideration of two extreme scenarios can help contextualize our overall null findings. First, suppose there was in fact no change in alcohol consumption at age 21—soldiers were simply shading their self-reports on their pre-21 PHA for fear of reprisal. If so, we have learned that the MLDA has no direct impact on either consumption of alcohol or work-related outcomes, yet it still poses a cost to individuals who are consuming alcohol under-age a cost to society to enforce MLDA laws. Second, if we believe the MLDA did increase alcohol consumption when a soldier turned 21, then we learned that the amount of increase in alcohol consumption as the result of MLDA does not, for the most part, have a negative impact on the short-term outcomes we observe. In either scenario, our results show that MLDA of 21 years of age does not appear to be an effective policy for this population and for these outcomes, yet those soldiers who prefer to drink under the age of 21 bear the cost of breaking the law.

Our findings thus raise the valid question of whether the MLDA is the right policy tool to address alcohol misuse for this population. Many states have considered or are currently considering legislation that would lower the MLDA for military service members, and our findings contribute to this policy discussion.

However, while our estimates can be viewed by some as encouraging, and perhaps suggest that these young soldiers are drinking responsibly, more information is needed to understand the full impact of alcohol consumption among service members. There could be medium- and long-run consequences of drinking that manifest over time and that we cannot observe through this RD design on the MLDA. Finally, while young soldiers are a significant subset of the high-school educated population, they are different from the civilian youth in many aspects and the restricted and controlled environment of the military may preclude extrapolation of our results to the civilian population of 21 year olds.

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APPENDIX

Tables A1–A3

TABLE A1 Robustness of the main results, remainder of outcomes

	45 day donut (1)	Polynomial order 2 (2)	Polynomial order 3 (3)	Aysmmetric optimal bandwidths (4)	CER minimizing bandwidth (5)
Personal Health Assessment (PHA) sample					
Proportion of drinking days	0.0799***	0.0722***	0.0684***	0.0750***	0.0600***
	[160]	[209]	[234]	[132; 143]	[83]
Proportion of binge-drinking days (6+ drinks)	0.0032	0.0184**	0.0262*	0.0138***	0.0158***
	[107]	[169]	[209]	[107; 177]	[107]
Moderate to heavy smoker	0.0242	−0.0114	−0.0282	0.0043	−0.0171
	[172]	[176]	[245]	[125; 138]	[82]
Moderate to high nicotine dependency	0.0052	−0.0001	−0.0082	−0.0049	−0.0055
	[179]	[211]	[270]	[134; 137]	[84]
Physical Fitness Test (PFT) sample					
Push-up score	0.418	0.741	0.797	0.457	0.637
	[240]	[202]	[301]	[98; 83]	[67]
Sit-up score	0.792	−0.553	−0.983	−0.690	−3.837
	[236]	[192]	[289]	[163; 79]	[57]
2-mile run score	0.741	2.223	2.232	2.399	1.401
	[253]	[198]	[313]	[76; 78]	[59]
Non-Judicial and Judicial Punishment sample					
Level 1 daily offense rate (letter of reprimand, per 100,000 person days)	0.04	−4.75	−2.50	−7.66	−6.39
	[52]	[112]	[152]	[86; 111]	[75]
Level 2 daily offense rate (Article 15 proceedings, per 100,000 person days)	9.90	−4.59	−4.88	−3.42	−3.80
	[78]	[155]	[210]	[136; 114]	[102]
Level 3 daily offense rate (court martial, per 100,000 person days)	0.50	−0.84	−0.37	−0.14	−0.05
	[68]	[178]	[179]	[114; 99]	[105]

Note: Each cell constitutes a separate regression discontinuity estimate of the form used in Table 2 except that the models in: column (1) excludes a 45 day window around the 21st birthday instead of a 30 day window; columns (2) and (3) use higher order polynomials as opposed to a linear model; column (4) allows the optimal bandwidth to vary above and below the discontinuity; and column (5) chooses a bandwidth to minimize the coverage error rate (CER) of the confidence interval. Optimal bandwidths (days either side of the 21st birthday) are included in brackets and standard errors are excluded for parsimony. Covariates include AFQT score and indicators for gender, education level, and race/ethnicity.

***$p < .01$; **$p < .05$; *$p < .1$.

TABLE A2 The impacts of the MLDA, no covariates included

Outcome	Over 21	(*SE*)	Obs.	Optimal bandwidth (days either side of 21st birthday)	Mean, under 21 sample
Personal Health Assessment (PHA) sample					
Currently drinks at all	0.496***	(0.035)	21,691	128	0.115
Proportion of drinking days	0.076***	(0.008)	21,691	135	0.012
# of alcoholic drinks on a typical drinking day	1.528***	(0.126)	21,691	145	0.352
Proportion of binge-drinking days (6+ drinks)	0.014	(0.003)	21,691	177	0.003
Smokes cigarettes at all	0.106	(0.068)	21,691	85	0.297
Moderate to heavy smoker	0.007	(0.021)	21,691	136	0.074
Moderate to high nicotine dependency	−0.004	(0.015)	21,691	138	0.038
Screened for depression	−0.017	(0.019)	21,691	151	0.054
Self-harm thoughts	−0.005	(0.008)	21,691	129	0.006
Fit for deployment	−0.018	(0.020)	21,691	157	0.943
Global Assessment Tool (GAT) sample					
Coping ability	0.306	(0.297)	26,180	161	3.97
Self-control	0.079	(0.070)	26,180	159	26.08
Physical Fitness Test (PFT) sample					
Total PFT score	2.31	(3.18)	51,318	102	232.30
Push-up score	0.78	(0.92)	51,318	115	83.35
Sit-up score	−0.42	(1.19)	51,318	98	79.11
2-mile run score	2.09	(1.76)	51,318	101	69.80
NonJudicial and Judicial Punishment sample					
Daily offense rate (per 100,000 person days)	−9.67	(6.31)	730	96	11.5
Level 1 daily offense rate (letter of reprimand, per 100,000 person days)	−6.19	(4.95)	730	104	6.75
Level 2 daily offense rate (Article 15 proceedings, per 100,000 person days)	−2.97	(2.37)	730	142	2.54
Level 3 daily offense rate (court martial, per 100,000 person days)	−0.98	(2.35)	730	146	2.22

Note: Each row reflects a separate local linear discontinuity regression excluding observations within a 30 day window on each side of the 21st birthday and using a symmetric optimal bandwidth. Observations represent the sample size within 365 window on each side of the 21st birthday. Robust standard errors are clustered at the day (age) level.

***$p < .01$; **$p < .05$; *$p < .1$.

TABLE A3 The heterogeneous impacts of the MLDA, remainder of outcomes

	Self-control			Coping ability			AFQT			Mental health or chemical dependency	
	Bottom quartile	Inter-quartile	Upper quartile	Bottom quartile	Inter-quartile	Upper quartile	Bottom quartile	Inter-quartile	Upper quartile	No family history	Family history
PHA sample											
Proportion of drinking days											
Over 21	0.104***	0.054***	0.075***	0.073***	0.051***	0.081***	0.075***	0.066***	0.092***	0.070***	0.114*
Mean under 21	0.016	0.012	0.010	0.014	0.012	0.010	0.011	0.012	0.013	0.011	0.020
Binge drinking days											
Over 21	0.015*	0.009	0.025*	0.055*	0.002	0.011**	0.016*	0.013**	0.013**	0.014***	0.014
Mean under 21	0.003	0.003	0.002	0.004	0.003	0.002	0.003	0.003	0.002	0.002	0.004
Moderate/heavy smoker											
Over 21	−0.032	−0.095*	0.026	0.076	−0.068*	−0.013	0.011	−0.051	0.076	−0.014	0.206
Mean under 21	0.107	0.070	0.060	0.095	0.064	0.060	0.061	0.078	0.081	0.066	0.132
Moderate/high nictoine dependency											
Over 21	−0.081	−0.004	0.045	0.025	−0.005	−0.058	−0.009	−0.008	0.013	−0.007	−0.023
Mean under 21	0.061	0.035	0.028	0.053	0.030	0.028	0.034	0.040	0.038	0.033	0.076
PFT sample											
Push-up score											
Over 21	0.556	1.65	−0.869	0.342	1.22	−0.819	−1.783	1.874	1.067	−0.253	0.854
Mean under 21	81.22	83.37	84.73	81.60	83.97	85.19	83.20	83.70	82.84	84.07	81.36
Sit-up score											
Over 21	−6.52	−1.54	2.27	1.14	−1.91	−1.47	−0.11	0.53	−2.09	0.13	2.15

(Continues)

TABLE A3 (Continued)

	Self-control			Coping ability			AFQT			Mental health or chemical dependency	
	Bottom quartile	Inter-quartile	Upper quartile	Bottom quartile	Inter-quartile	Upper quartile	Bottom quartile	Inter-quartile	Upper quartile	No family history	Family history
Mean under 21	77.18	79.11	80.38	77.64	79.64	79.51	80.90	77.79	79.23	79.59	76.83
2-mile run score											
Over 21	0.59	2.81	5.59	−1.68	2.90	4.25	2.12	0.89	3.52	1.51	6.91
Mean under 21	66.29	70.33	71.27	67.24	70.79	72.31	68.03	70.06	71.28	71.26	66.34

Note: Each cell reflects a separate local linear discontinuity regression excluding observations within a 30 day window on each side of the 21st birthday and using a symmetric optimal bandwidth. Samples include individuals within a 365 day window on each side of the 21st birthday. Covariates include AFQT score and indicators for gender, education level, and race/ethnicity.

$^{***}p < .01$; $^{**}p < .05$; $^{*}p < .1$.