Excessive Heat and Correctional Officer Turnover: Evidence from Texas

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Abstract

Correctional work is difficult and dangerous. It is also hot. Most U.S. states' prison systems lack universal air conditioning, resulting in sweltering conditions for incarcerated people and correctional staff. We examine the relationship between excessive heat and correctional officer turnover using personnel records of 40,335 correctional staff employed by the Texas Department of Criminal Justice between 2010 and 2023. We show that before the COVID-19 pandemic, the odds of departing the correctional workforce were 20% higher for frontline employees working in prisons without air conditioning. This finding is isolated to frontline employees with limited access to cooled administrative areas and newer employees less acclimated to the heat. Additional tests provide some evidence that departures were more likely during the summer months in facilities without air conditioning. The onset of COVID-19 attenuated the relationship between heat and departing, underscoring the new challenges to correctional work introduced by the pandemic.

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Prisons and jails across the U.S. are contending with an understaffing crisis. Hiring and retaining correctional officers has long been difficult (Lambert 2001), but rising incarceration rates and the COVID-19 pandemic have brought many prison systems to the tipping point. Between 2019 and 2022, the number of state-employed correctional officers declined by 10%, with states like Arkansas and Georgia experiencing declines of 20% and 29%, respectively (Heffernan and Li 2024). In some states, vacancy rates among correctional staff are as high as 50% despite widespread initiatives to attract new hires (Lieb 2023). Reduced staffing makes prisons more dangerous for both employees and incarcerated people. Numerous accounts document how understaffing is associated with increased violence, staff assaults, prolonged lockdowns, and poor health outcomes for incarcerated people (Heffernan and Li 2024; Lambert 2001; Minor et al. 2011; Nam-Sonenstein and Sanders 2024).

Most existing research emphasizes how psychological factors like stress, burnout, and organizational support are associated with correctional officer exits (Cullen et al. 1985; Finney et al. 2013; Lambert 2001; Schwartz et al. 2024). These studies generally rely on cross-sectional surveys administered to relatively small samples of correctional staff (Ferdik and Hills 2018; Griffin, Hogan, and Lambert 2014; Lambert and Hogan 2009; Minor et al. 2011, but see Schwartz et al. 2024). While existing research describes the emotional and mental states of departing correctional officers, the lack of observational studies makes it difficult to test how underlying poor workplace conditions, such as violence, increased inmate-to-staff ratios, and high security levels, contribute to correctional employees' likelihood of exiting the workforce.

We improve upon these limitations by examining how excessive heat—an increasingly relevant source of poor working conditions in U.S. prisons—affects correctional officers' propensity to leave their jobs. Very few states' prison systems have universal air conditioning. As a result, many prisons are sweltering in the summer months, with some reaching indoor temperatures of over 130 degrees (Salhotra and Melhado 2024). The poor conditions brought about by excessive heat have spurred numerous lawsuits and instigated a growing body of research documenting the negative effects of heat on rates of violence (Mukherjee and Sanders 2021) and incarcerated individuals' health (Skarha et al. 2022; Skarha et al. 2023). Yet, despite

numerous anecdotal accounts of heat's impact on correctional staff and concerns over prison understaffing, our study is the first to examine how excessive heat influences correctional officer turnover.

We evaluate the impact of excessive heat on correctional officers employed by the Texas Department of Criminal Justice (TDCJ). Texas's state prison system is an ideal setting for evaluating heat's role in fostering poor working conditions for correctional officers. The TDCJ operates the largest state prison system in the country. In December 2024, the agency had over 135,000 individuals in its custody across nearly 100 facilities. Despite Texas prisons being exposed to high levels of extreme heat in the summer months (Tuholske et al. 2024), only 30 of the 105 TDCJ facilities that have been in use at some point between 2010 and 2023 have fully air-conditioned housing areas. Twenty-three facilities lack any air conditioning in their housing areas, with the remaining prisons having partial, often minimal, coverage. As a result, conditions within many TDCJ prisons are brutal in the summer months. A federal judge in 2025 called the lack of air conditioning in TDCJ prisons "plainly unconstitutional," while a different federal judge wrote in a 2018 injunction that incarcerated people in Texas "face a substantial risk of serious harm from the sweltering Texas heat" (McCullough 2017; Salhotra 2025). Union officials in the state have called excessively hot Texas prisons "death traps" and likened working in units without air conditioning to "going up and down stairs at a football stadium in the heat of the day, while wearing a coat" (Dang 2022; Martin 2013).

We test whether these conditions lead correctional officers to depart the TDCJ workforce using individual-level personnel data and facility-level air-conditioning data. The personnel records consist of monthly snapshots of all TDCJ staff employed in security positions across the state from January 2010 to January 2023. The records are rich, noting employees' names, race, sex, ages, job titles, salaries, hire dates, and employing facilities. In order to determine whether correctional officers work in air-conditioned facilities, we rely on data from the Texas Prisons Community Advocates (TPCA), a nonprofit advocacy organization. The facility-level air-conditioning data, which the TPCA received via public-records requests to the TDCJ, note whether each prison's housing areas have full, partial, or no air conditioning.[1]

1. Due to ongoing litigation regarding air conditioning in TDCJ facilities, we were unable to obtain this

Controlling for a variety of employee-, facility-, and state-level covariates, we show that before the onset of the COVID-19 pandemic, the odds of exiting the TDCJ workforce in a given month were, on average, 20% higher for frontline correctional officers in prisons with no air conditioning, compared to those working in facilities with full air conditioning. We demonstrate that this association is isolated to the employees most likely to be affected by the heat — namely, frontline correctional officers who lack access to cooler administrative areas within prisons and new hires who are not yet acclimated to working in hot temperatures. We also provide some evidence that seasonal temperature fluctuations moderate the relationship between excessive heat and departing. Among the least experienced frontline employees with two or fewer years of experience, those employed in prisons with and without air conditioning were, respectively, .42 and .87 percentage points more likely to depart in the hottest months of the year, relative to the coolest (difference in means = .45, p = .047). We do not find a similar trend among the most experienced TDCJ employees, suggesting again that employees who have become accustomed to excessive heat are less likely to depart on account of high temperatures.

Despite demonstrating a relationship between excessive heat, air conditioning, and correctional officer turnover, we also show that our results are, to some degree, time dependent. Our main findings disappear and, in some cases, reverse following the onset of the COVID-19 pandemic. It is difficult to know whether this is a result of new, unobserved variation in prison conditions brought about by the pandemic or changing trends in correctional officer departures unrelated to the pandemic. Regardless of the exact reason, the over-time changes suggest that there are ceiling effects to the benefits of air-conditioning prisons for stemming correctional officer turnover. While air conditioning can make difficult correctional work more palatable, targeted reforms like installing air conditioning are unlikely to resolve the other systemic challenges that undermine employee retention in correctional institutions.

information directly from the TDCJ.

1 Understaffing in Prisons

It should not come as a surprise that departure rates are high among correctional officers. Colloquially described as "the toughest beat" (Page 2011), correctional work is dangerous, low-paying, and stressful. A survey of state correctional officers in California found that 70% of respondents had witnessed someone be seriously injured or killed, while 18% reported being seriously injured at work (Lerman, Harney, and Sadin 2022). Correctional workers are also increasingly being asked to compensate for staff shortages by working longer hours with less support. In Georgia, for example, the state increased overtime spending for correctional workers by over 1,000% between 2019 and 2022, while the size of the correctional workforce decreased by approximately 33% (Heffernan and Li 2024). The snowballing effects of understaffing recently came to a head in New York when the commissioner of the state's prisons system wrote in a memo that "70% of our original staffing model is the new 100%," which helped to instigate large-scale unauthorized strikes among dissatisfied correctional employees (Roebuck 2025).

The numerous challenges of correctional work take a toll on correctional officers' physical and mental health. Correctional officers are at heightened risk of anxiety, Post-Traumatic Stress Disorder, burnout, job dissatisfaction, and COVID-19 infection (Cheeseman et al. 2011; Cullen et al. 1985; Finney et al. 2013; Lambert 2001; Schwartz et al. 2024; Ward et al. 2021). Several studies have also indicated that the severe stress and burnout tied to correctional work are associated with higher departure rates among officers (Griffin, Hogan, and Lambert 2014; Lerman, Harney, and Sadin 2022; Vickovic, Morroe, and Lambert 2022). Perhaps most disconcerting is the elevated risk of suicide among correctional officers. One study estimated that the suicide rate is 39% higher among correctional officers than the general public (Stack and Tsoudis 1997), and more recent research suggests that elevated suicide rates persist (Frost and Monteiro 2020; Lerman, Harney, and Sadin 2022).

Another strand of research identifies organizational factors that correlate with correctional officer retention and departure. Multiple studies have shown that correctional employees who are more committed to their organization are less likely to exit (Lambert and

Hogan 2009; Lambert 2001; Mitchell et al. 2000). Employees who report better organizational support from the prison and higher-quality supervisors are less likely to depart their jobs (Griffin, Hogan, and Lambert 2014; Leip and Stinchcomb 2013). Likewise, employees who express satisfaction with their coworkers are also at less risk of leaving (Minor et al. 2011).

Overall, existing evidence suggests that the difficulties of correctional work are associated with high levels of employee exits. Yet, sizable gaps remain in the literature. Many studies of correctional officer exits are exploratory and rely on surveys fielded to a small number of respondents. It is difficult to generalize findings from a survey of a few hundred correctional officers in a single prison or correctional system. Furthermore, while survey-based methods allow for detailed analyses of officers' feelings and perceptions regarding correctional work, they complicate assessing how structural aspects of correctional officers' day-to-day experiences, such as working conditions and compensation, influence departure decisions. Understanding the impact of these factors, which in many cases underlie the psychological states scholars have shown to correlate with an increased propensity to exit, requires observing a large number of correctional officers experiencing different workplace conditions over time.

2 Heat in Prisons

Heat exposure is tied to numerous negative social outcomes. Gun violence and other forms of violent behavior are more prevalent on high-temperature days (Burke, Hsiang, and Miguel 2015; Colmer and Doleac 2023; Hsiang, Burke, and Miguel 2013). A sweeping meta-analysis of studies testing the effect of climate on conflict finds that a one standard deviation increase in temperature increases the frequency of interpersonal violence and intergroup conflict by 4% and 14%, respectively (Hsiang, Burke, and Miguel 2013). Goodman et al. (2018) shows that heat exposure also leads to educational deficits, as warmer school days diminish learning and testing outcomes. Other studies have shown that heat negatively impacts economic productivity, civic engagement, and health (Deschenes 2014; Lamare 2013; Graff Zivin, Hsiang, and Neidell 2018).

Extreme heat is a persistent and largely unaddressed issue in many U.S. correctional facilities. Forty-four states lack universal air conditioning, including most Southern states where dangerous prison temperatures are most common (Tuholske et al. 2024). Temperatures in these non-air-conditioned prisons can exceed 130°F and have been likened to "torture chambers," "concrete coffins," and "sitting inside of a convection oven" (Lartey 2023; Salhotra and Melhado 2024). Incarcerated individuals sometimes adopt extreme measures to survive in these conditions, including flooding their cells to lie in the wet concrete, lighting fires, bathing in toilet water, or screaming in unison for help (Goodman 2023; *Wilson v. Dixon,* n.d.).

Excessive heat in prisons has been linked to numerous negative consequences for incarcerated individuals, including higher rates of mortality, violence, suicide attempts, and health problems (Cloud et al. 2023; Lartey 2023; Mukherjee and Sanders 2021; Skarha et al. 2023; Tuholske et al. 2024). For example, Mukherjee and Sanders (2021) leverage daily variation in temperature to study the effect of heat on violence in Mississippi prisons. They find that days with unsafe heat indices increase the number of daily violent interactions by 20%. Using data from six state prisons in Louisiana, Cloud et al. (2023) also show a strong positive association between high-temperature days and suicide-watch incidents. Another study suggests that roughly 13% of all deaths during warm months in Texas prisons may be attributable to extreme heat (Skarha et al. 2022).

State legislators, investigative reports, and advocates argue that heat also affects correctional officers' willingness to remain in their jobs (Ballard 2022; McGivern 2024; Salhotra 2024). Excessive heat poses at best a nuisance to correctional staff— and, at worst, a major health hazard. The head of the Louisiana Department of Public Safety and Corrections recently noted that officers in prisons without air conditioning were changing their clothes up to three times per shift (O'Donoghue 2022). More seriously, between 2012 and 2013, 147 state correctional employees in Texas reported illness or injury due to heat (Martin 2013). Incarcerated people in the state have also reported seeing correctional workers faint on account of heat (*Deadly Heat in U.S. (Texas) Prisons* 2024). Despite the lack of scholarly work on the effects of excessive heat on correctional staff, some anecdotal evidence suggests that

it impacts officers' ability to do their jobs. For instance, in New Jersey, correctional workers have reported that excessive heat negatively affected their incident response times (Schuster and King 2022).

Several pathways exist through which extreme heat may negatively affect correctional officer retention. Most directly, correctional workers might be more likely to depart in search of jobs with better working conditions during the summer months when heat is particularly salient. However, anticipation effects can also arise. Employees may leave in the winter or spring as summer heat approaches. Given the association between heat and illness and injury, they may also depart in the fall after weighing the physical costs of working over the prior summer. Heat may also operate more indirectly by influencing the selection of correctional officers. Stronger applicants who are less likely to depart may opt out of working in correctional facilities without air conditioning, leaving prisons to be staffed by employees with higher baseline probabilities of departing.[2]

While it is difficult to fully parse these different channels empirically, they do provide some testable expectations. Namely, employees in prisons without air conditioning are more likely to depart than their peers in cooled facilities. While this relationship may be magnified in the summer months when heat is most salient, it is not necessarily the case that heat only influences departures during the summer. Additional hypotheses can also be drawn out by focusing on different segments of the correctional workforce. Frontline staff, for instance, are disproportionately impacted by excessive heat in prisons lacking air conditioning. In Texas, as we describe in greater detail below, all prisons have air conditioning in administrative and medical areas. It is the housing areas, where incarcerated people live and frontline correctional officers frequent, where air conditioning is often lacking. As a result, it is probable that frontline staff are more likely to depart on account of excessive heat than supervisory employees. Likewise, newer correctional officers with less experience working in the TDCJ are also likely more impacted by the heat. Unlike their peers who have been on the job for a few summers, less-experienced correctional officers have not become acclimated to the hot conditions. As a result, their willingness to work in prisons in the summer without air

2. Burton et al. (2022) shows that prison employees often do not have stable employment histories.

conditioning is unknown. These employees, therefore, may be particularly likely to leave during hot times of the year, as well as in the spring or fall as they anticipate or react to hot temperatures.

3 Data

We use two datasets to examine the relationship between air conditioning and the departure of correctional employees. The first consists of monthly snapshots of all correctional staff employed by the TDCJ from January 2010 through January 2023, which we received via multiple public records requests to the agency. For each month, the data note the full name, age, facility, race, sex, full-time status, job title, and most recent hire date for all correctional staff employed in security positions at TDCJ facilities. Most employees in the dataset are in frontline correctional officer positions (83.7%), but the data also include first-line supervisors, such as sergeants, lieutenants, and captains, as well as managers (e.g., majors, assistant wardens, and wardens).[3] The personnel files do not include unique employee identification codes that follow employees throughout their tenure with the TDCJ. As a result, we assign unique employee identification codes by grouping together observations with similar ages and the same first name, middle initial, last name, race, last hire date, and sex. Since the codes include employees' last hire date with the TDCJ, they can capture instances where the same employee departs the workforce and then returns later in the study period.[4]

Second, we determine whether correctional employees work in air-conditioned facilities using data published by the TPCA, a nonprofit advocacy organization. Through public records requests, the TPCA gathered data on whether TDCJ prisons' housing areas were fully, partially, or not air-conditioned as of April 2022. According to the TDCJ, administrative, educational, and medical areas are air-conditioned in all facilities, even if housing areas are left uncooled. The TPCA data are static snapshots. They do not note how air-conditioning coverage changed over the course of our study period. Thus, we restrict our analysis to facilities with full air conditioning or no air conditioning. In addition to offering

3. The data also include some employees in auxiliary roles, like food and laundry managers.

4. Approximately 13% of the unique employees in the dataset had more than one employment spell with the TDCJ.

a cleaner test, the tails of the air-conditioning coverage distribution are also less susceptible to over-time fluctuations. We are only aware of two prisons, the Hodge and Pack Units, that had full air conditioning installed during our study period after previously lacking any air conditioning in housing areas. These installations followed a four-year legal battle between individuals incarcerated at the Pack Unit and the state, underscoring that the TDCJ rarely makes full-scale changes to prisons' air conditioning (McCullough 2017, 2018; Blakinger and Banks 2018).[5]

It is also unlikely that the TDCJ installed full air conditioning in a prison that was previously partially air-conditioned. Most partially air-conditioned prisons have, in practice, few air-conditioned beds.[6] Installing full air conditioning in one of these prisons is a considerable undertaking, similar to that which occurred in the Hodge and Pack Units. Finally, it is unlikely that a prison with no air conditioning in 2022 was air-conditioned in the past. Ten of the prisons identified in the TPCA data as having no air conditioning were built before 1920. Given the high costs of installation, it is unlikely that any prison, especially one over 100 years old, would remove air conditioning after initially providing it.

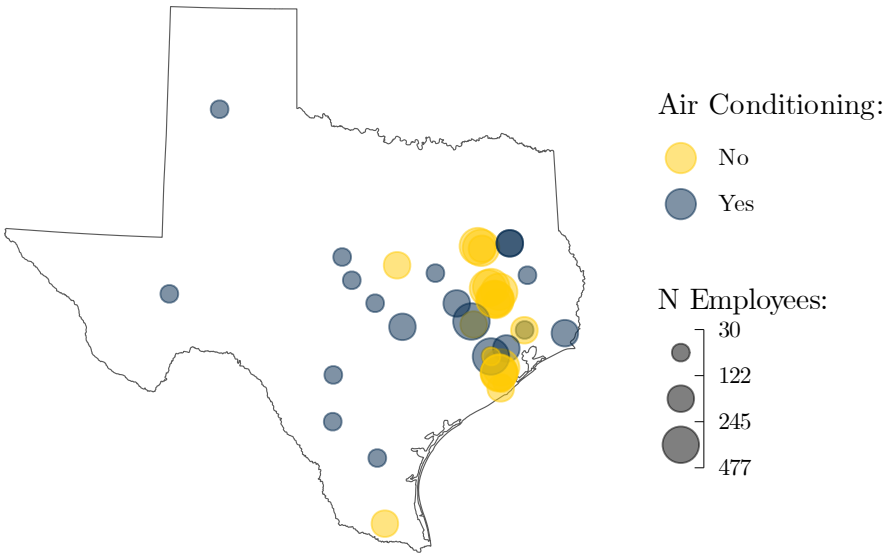
The resulting dataset includes 40,335 distinct employees and 1,538,887 employee-month observations across forty-one facilities with either full or no air conditioning (Figure 1).[7] Air-conditioned facilities employ fewer correctional staff and are more evenly distributed across the state than prisons without air conditioning, which are concentrated in the eastern part of the state. Employees in these facilities differ on other dimensions as well. Figure 2 shows descriptive characteristics of TDCJ correctional staff over the course of our study period.

5. The TDCJ has increased the pace of air-conditioning installation since around 2022 (Betts 2025). An archived version of a TDCJ dashboard tracking how many "cool beds" were installed between 2018 and October 2023 suggests that 5,876 beds were installed over the period. Besides the 2,467 cool beds installed in the Hodge and Pack units, only 26 air-conditioned beds were installed in a facility (Hilltop Unit) noted as having no air conditioning in the TPCA data from April 2022 ("TDCJ Air Conditioning Construction Projects" 2023). A more recent snapshot of facility air-conditioning status provided by the TPCA dated August 2024 suggests that only fourteen TDCJ facilities now have no air-conditioning coverage, usually due to the installation of 50 or fewer cool beds.

6. As of April 2022, 19% of beds in partially air-conditioned facilities were air-conditioned.

7. This is a subset of all TDCJ facilities with either full or no air conditioning. The personnel data provided by the TDCJ does not include employees in private prisons, private state jails, some pre-release facilities, and some intermediate sanction facilities for parole violators. Table A.1 lists the 41 TDCJ facilities for which we have personnel data by air-conditioning status.

Figure 1 – Location of TDCJ Prisons by Air-Conditioning Status and Number of Employees Shows the location of the forty-one prisons operated by the TDCJ at some point between 2010 and 2023 that had either full or no air conditioning in housing areas. Points are binned into tertiles based on the number of employees working in the facility in the last month for which data is available. For most prisons, the last observed month is December 2022. The Jester I and Scott units were closed in 2020 and employee counts are therefore pulled from August and December 2020, respectively. The Hodge and Pack units are shown as having full air conditioning.

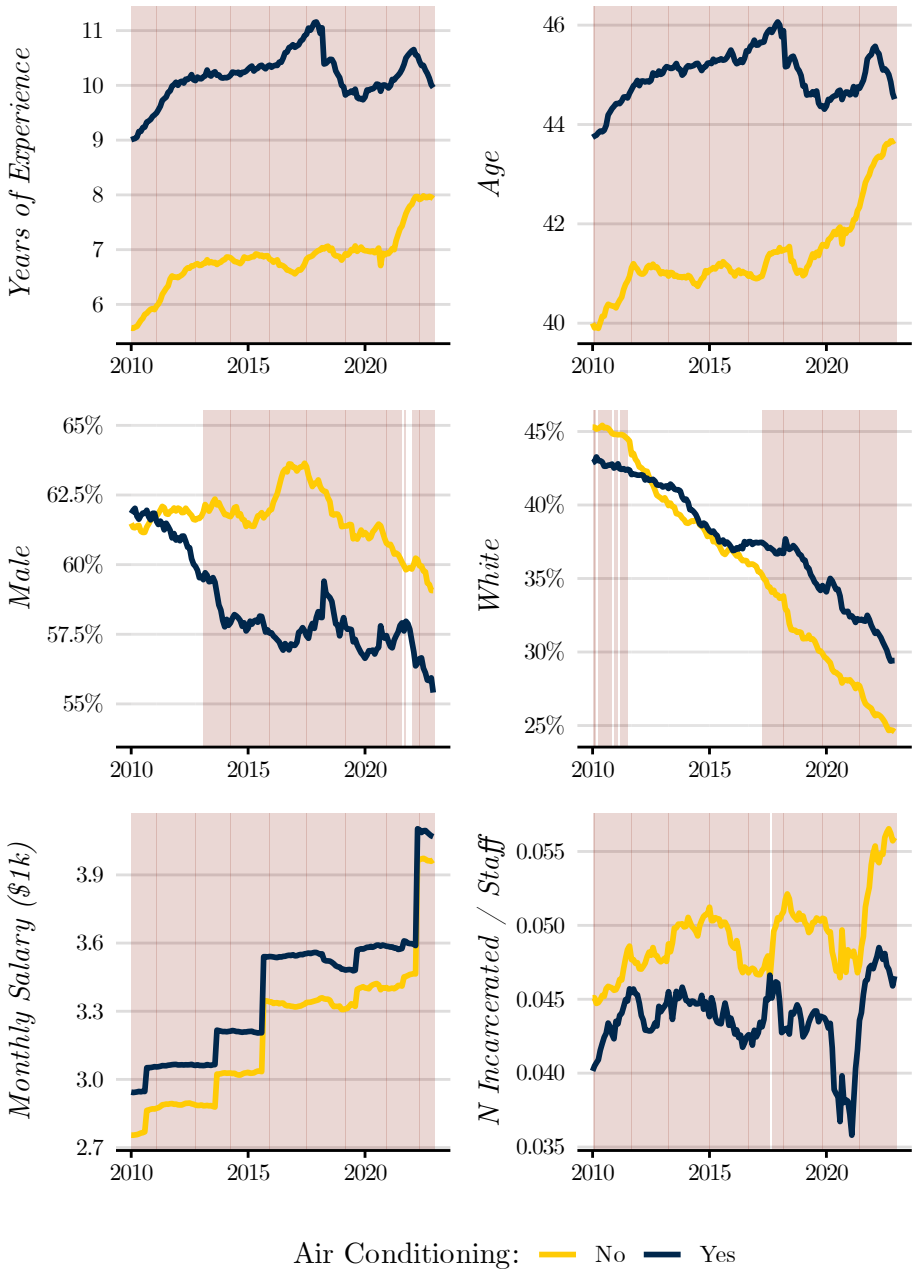


Monthly group means for employees in facilities with and without air conditioning are shown in blue and yellow, respectively, while red highlighting indicates that the null hypothesis of no difference in means is rejected using a two-sided t-test ($p<.05$).

Employees in facilities without air conditioning are significantly younger with fewer years of experience and lower earnings than their peers in air-conditioned facilities. The demographic composition of correctional employees also changed considerably over the study period. In 2010, over 40% of correctional employees were white. By 2023, only 30% of correctional employees in prisons with air conditioning were white and an even smaller share of employees in prisons lacking air conditioning were white. The Texas correctional workforce also became more female over the study period, with the share of female correctional employees across all prisons increasing from 38% to 42%. Finally, incarcerated-person-to-staff ratios are also higher in facilities without air conditioning, underscoring both the difficulty

of staffing these positions and the difficult conditions faced by remaining employees.

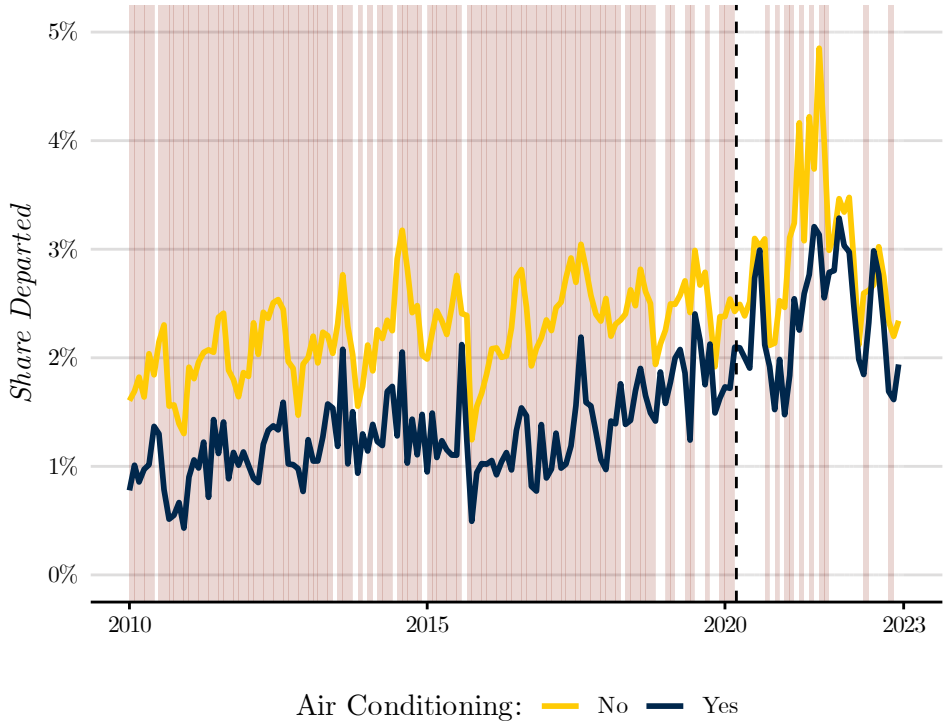
Figure 2 – Correctional Staff Differ Across Prisons With and Without AC Shows the mean years of experience, age, monthly salary, share male, share white, and incarcerated person/staff ratio in TDCJ facilities with and without air conditioning by month. Data includes both frontline and supervisory staff. Time periods are highlighted in red if the null hypothesis of no difference in means is rejected using a two-sided t-test (p<.05).



Our main outcome of interest is whether an employee departs the TDCJ workforce in a given month, which we define as the last month of observed continuous employment. It encompasses both instances where an employee leaves the TDCJ workforce and does not return during our study period as well as cases of an employee leaving before later returning to correctional work.[8] Figure 3 shows the share of TDCJ correctional employees that depart each month from prisons with and without air conditioning. The figure highlights a few key trends. First, up to the onset of the COVID-19 pandemic, departures were more common in prisons without air conditioning. Second, departures from prisons with air conditioning began to increase around 2017. As a result, by the time the COVID-19 pandemic began, the difference in departures rates from prisons with and without air conditioning had narrowed considerably. Finally, employee departures from both types of prisons spike following the onset of the pandemic in March 2020. Departure rates peak in summer and fall of 2021 and by the beginning of 2022 are largely similar across both types of prisons.

8. We do not know whether someone voluntarily or involuntarily leaves the workforce, only that they depart our dataset.

Figure 3 – Correctional employees in Prisons Without AC More Likely to Depart Shows the share of correctional employees that depart from prisons with and without air conditioning each month. Data includes both frontline and supervisory staff. Time periods are highlighted in red if the null hypothesis of no difference in means is rejected using a two-sided t test ($p<.05$). Dashed line denotes the onset of the COVID-19 pandemic.



4 Methods

We use a selection-on-observables approach to test whether correctional officers employed in TDCJ prisons without air conditioning are more likely to leave their jobs. The dependent variable is whether an employee departs the TDCJ workforce in a given month, while the independent variable is a binary indicator for whether an employee works at a prison without air conditioning. We control for a series of confounders. At the individual-level, we control for employees' race, age, squared age, monthly salary, and sex. We also control for facility-level factors that are likely to correlate with both departing and air conditioning status, such as the monthly unemployment rate of the county containing the prison, the percent change in the number of correctional employees working at the prison over the prior 6 months, the

year the facility was built, and the number of incarcerated people in the facility in a given month. We include monthly fixed effects to pick up on state-wide trends, such as the four salary raises shown in Figure 2, and fixed effects for years of experience working with the TDCJ. Since air conditioning coverage rarely changes over our study period, we are not able to utilize facility-level fixed effects. However, the TDCJ groups prisons into six regions that are each overseen by a separate regional director. Therefore, we include regional fixed effects in all models to control for organizational and geographic differences across regions.[9]

Finally, we also account for outside temperature. We measure temperature as the average monthly temperature (in Fahrenheit) of the county containing a prison.[10] Following other researchers (Mukherjee and Sanders 2021; Deschênes and Greenstone 2011; Barreca et al. 2016; Heutel, Miller, and Molitor 2021), we bin average temperature readings to pick up on nonlinear trends. In particular, we create five bins by degrees: less than 60°F, 60-69°F, 70-79°F, and 80°F or higher.[11] We estimate all models using logistic regression with standard errors clustered at the employee level.

The main model provides an estimate of the correlation between air conditioning status and departing. It is not a causal estimate of the effect of excessive heat on turnover. Air conditioning is not randomly installed in TDCJ prisons. Older, larger prisons are less likely to have air conditioning and employees in both types of prisons differ on dimensions, such as years of experience and age, that likely influence the likelihood of departing. While our approach is able to control for some of these confounders, unobserved factors may still introduce bias. We account for this issue by extending our main model in two different ways. First, we test for a relationship between heat and air conditioning among subgroups of the correctional workforce—frontline correctional officers and new employees—where effects are likely to be more pronounced. We test for a difference in turnover rates between supervisors and frontline employees by the running the main model separately for both groups. Likewise, we extend the model to account for employees' experience working in hot conditions by

9. Figure A.1 shows the location of TDCJ prisons grouped by region.

10. Temperature data downloaded from the National Centers for Environmental Information's nClimDiv dataset. Figure B.1 shows that counties with and without air conditioning have similar seasonal temperature fluctuations.

11. Figure B.2 in the Supplementary Information shows the distribution of our binned temperature variable.

interacting our main independent variable with employees' years of experience with the TDCJ. Due to likely nonlinearities, we opt to measure years of experience as a categorical variable.[12]

Second, we test whether working in a prison without air conditioning has a greater impact on departures in the summer months. This is a conservative test of our expectations. Heat, according to this approach, only matters when it is hot out. Departures in anticipation of summer or in reaction to a particularly brutal stretch of hot weather are not picked up as being the result of excessive heat. Yet, testing for a moderating effect of heat offers a more causally-identified estimate of the effect of air conditioning on departing. Unobserved confounders now need to correlate with not only departing and prisons' air-conditioning coverage, but also seasonal fluctuations in temperature. We test for a moderating effect of heat by interacting our binned temperature variable with the binary indicator for whether an employee works in a prison without air conditioning. The result is a model that not only estimates how departure propensities vary by season, but also how heat mitigation moderates that relationship.[13]

5 Results

Table 1 shows the results of our main test of a correlation between working in a prison without air conditioning and departing the TDCJ workforce in a given month. The data is subsetted to only frontline correctional officers and, due to the significant changes to the correctional system brought about by the COVID-19 pandemic, we estimate separate models for before and after March 2020. We present the coefficients and corresponding 95% confidence intervals on the odds ratio scale to ease interpretation.[14]

Given the lack of large-N studies on correctional officer turnover, it is worthwhile exam-

12. In particular, we bin years of experience into the following categories: 0-2, 3-5, 6-8, 9-11, 12-14, 15-17, 18-20, 21-23, and $>$ 24 years of experience.

13. We substitute annual fixed effects for monthly fixed effects to pick up on seasonal temperature fluctuations while still controlling for over-time changes in departure rates.

14. Table C.2 shows the results of a pooled version of the model that includes observations from both before and after March 2020.

ining the coefficients on the control variables in Table 1. As suggested by the descriptive trends in Figure 3, the demographics of correctional officers in Texas changed considerably over our study period. The odds of white correctional officers exiting the workforce in a given month were 30% higher than for employees of other racial backgrounds, increasing to 37% after the onset of the pandemic. Male employees were also less likely to depart than their female peers. Both before and after the onset of COVID-19, higher-earning employees were less likely to depart. The results also highlight the role of staffing issues in contributing to additional departures. Before the onset of COVID-19, a 1 percentage point decrease in the number of prison employees from 6 months prior correlates with an approximately a 1% increase in the likelihood of departing. Departures are also more common from prisons that house more incarcerated individuals, underscoring the difficult conditions within many of the larger prisons operated by the TDCJ.

Before COVID-19, the odds of employees in prisons without air conditioning departing were, on average, 20% higher than for their peers in air-conditioned facilities. The magnitude of this correlation is relatively large. For example, it roughly corresponds to the size of the association between departing and a $1,000 decrease in monthly earnings.[15] However, the result not only disappears but actually reverses following the onset of the pandemic. From March 2020 through January 2023, the odds of employees in facilities without air conditioning departing were 8% lower, relative to correctional officers in prisons with air conditioning. During the pandemic, correctional workers in hotter facilities were actually less likely to exit the TDCJ workforce than their peers in air-conditioned facilities.

15. Mean monthly earnings over the study period are $3,140, so a $1,000 decrease roughly equates to a 32% salary cut.

Table 1 – Correctional Officers More Likely to Depart Prisons Without AC Pre-COVID Tests whether working in a prison without air-conditioning correlates with an increased propensity to depart both before (first column) and during (second column) the COVID-19 pandemic. Coefficients displayed as odds ratios with 95% confidence intervals in parentheses.

	Pre-COVID	COVID
No AC	1.20*	0.92*
	[1.14; 1.27]	[0.84; 0.99]
60-69°F	0.95	0.90
	[0.87; 1.04]	[0.77; 1.04]
70-79°F	0.97	0.79*
	[0.85; 1.11]	[0.64; 0.98]
>79°F	0.97	0.73*
	[0.82; 1.14]	[0.56; 0.96]
Unemployment Rate	0.97*	1.00
	[0.95; 0.99]	[0.98; 1.02]
White	1.30*	1.37*
	[1.26; 1.34]	[1.29; 1.45]
Monthly Salary ($1k)	0.76*	0.72*
	[0.73; 0.79]	[0.69; 0.75]
Age	0.90*	0.92*
	[0.90; 0.91]	[0.91; 0.93]
Age^2	1.00*	1.00*
	[1.00; 1.00]	[1.00; 1.00]
Male	0.86*	0.93*
	[0.83; 0.88]	[0.88; 0.98]
Pct staffing change	0.99*	0.99*
	[0.99; 1.00]	[0.99; 1.00]
Year built	1.00*	1.00
	[1.00; 1.00]	[1.00; 1.00]
N incarcerated (100)	1.01*	1.01*
	[1.01; 1.01]	[1.01; 1.02]
Tenure FE	✓	✓
Month FE	✓	✓
Region FE	✓	✓

* Null hypothesis value outside the confidence interval.

The coefficients on working in a facility without air conditioning in Table 1 are associations. Nevertheless, subgroup analyses can help add some additional causal rigor to our findings. In Table C.1 in the Supplementary Information, we re-estimate the models in Table 1 using only supervisors, rather than frontline correctional officers. Since administrative areas in TDCJ prisons are cooled, regardless of whether the prison has air conditioning in its housing areas, we expect to see a weaker relationship between working in a prison without air conditioning and supervisors' probability of departing. This is largely what we find. Before the pandemic, the odds of supervisors departing were 12% higher (p=.11) in prisons without air conditioning. While still elevated, this estimate is smaller in magnitude than the estimated associated between working in a prison without air conditioning and departing among frontline correctional officers and does not rise to standard levels of statistical significance. Furthermore, some increased turnover of supervisors in prisons without air conditioning makes sense if excessive heat worsens conditions for all employees, such as by increasing rates of violence (Mukherjee and Sanders 2021).

We also expect that our main result in Table 1 is driven by departures among less-experienced employees. We test this by re-estimating our main model with an interaction between employees' years of experience (binned into nine groups) and the binary indicator for whether an employee works in a prison without air conditioning. We show the results in Figure 4. The top facet shows the estimated probability of departing for frontline correctional officers in prisons with and without air conditioning by years of experience with the TDCJ. Rather than setting control variables to their means or modes, we compute the predicted probabilities using an an observed-value approach (Hanmer and Ozan Kalkan 2013). That is, we estimate the predicted probability of departing for every employee with the binary air conditioning variable set to each of its two respective values and the other controls set to their observed values. Means and standard errors are then calculated conditional on employees' observed years of experience and prisons' air conditioning status.

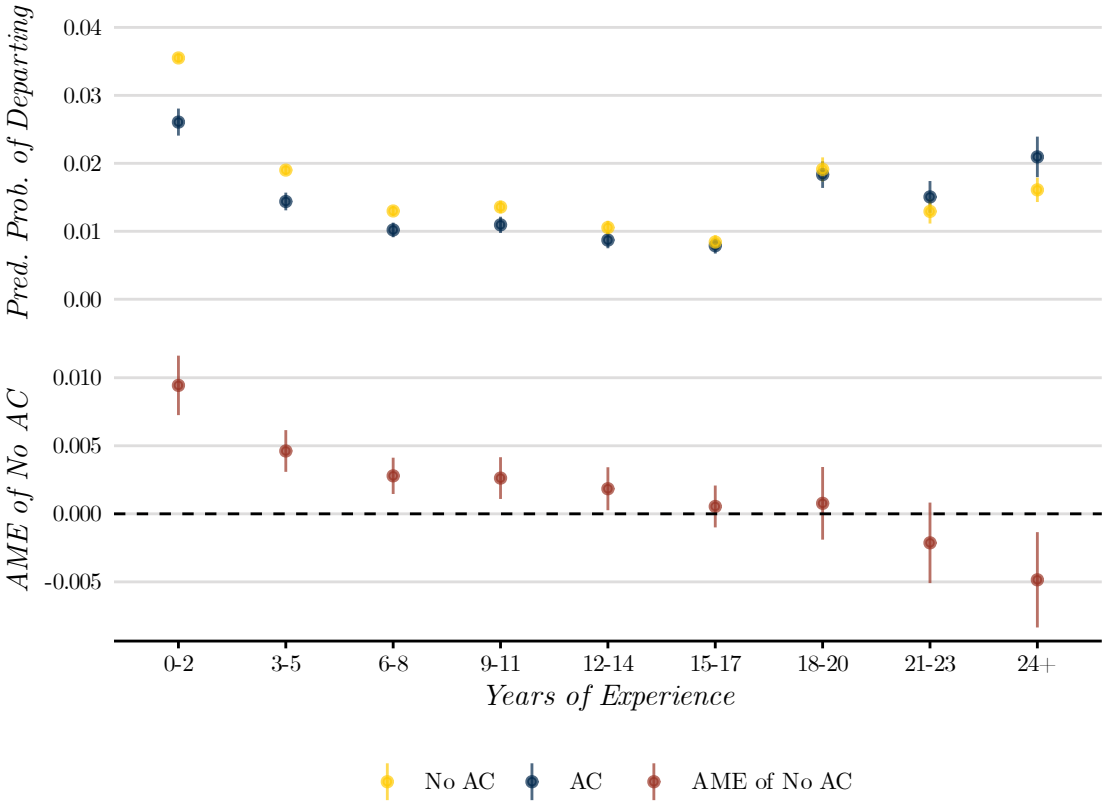
The results from the top panel highlight two key trends. First, departures from both types of prisons are highest among the least experienced employees. The predicted probability of departing is greatest among employees with two or fewer years of experience and then

steadily decreases before increasing again when correctional officers are eligible to receive a lifetime annuity from the state's Law Enforcement and Custodial Officer Supplemental Retirement Fund at 20 years of service. Second, the difference in the predicted probability of departing between employees in prisons with and without air conditioning is initially high and then decreases. The bottom facet of Figure 4 emphasizes this trend by plotting the average marginal effect (AME) of working in a prison without air conditioning within each experience category.[16] Among the least experienced employees, working in a prison without air conditioning is associated with a 0.9 percentage point increase in the predicted probability of departing. Considering that the predicted probability of departing in a given month among employees with 0-2 years of experience hovers around 3%, this is a substantively large difference. Notably, the increased likelihood of departing declines with experience, reaching zero among employees with around 15-17 years of experience before actually reversing among the most experienced employees.

16. The AME of air conditioning on departing for $i \in \{1, \ldots, n\}$ frontline correctional officers with J level of experience is defined as:

$$\text{AME}_J = \frac{1}{n} \sum_{i=1}^{n} [\Pr(\text{depart}_i \mid \text{AC}_i = \text{no}) - \Pr(\text{depart}_i \mid \text{AC}_i = \text{yes})]$$

Figure 4 – Air Conditioning Associated With More Departures Among the Least Experienced Employees The top facet shows the predicted probability of frontline correctional officers departing in a given month before the onset of COVID-19 by years of experience and air-conditioning status. The bottom facet shows the average marginal effect of working in a prison without air conditioning on the probability of departing by years of experience. Results calculated using the `marginaleffects R` package using control variables set to their observed values. Figure C.5 shows the results for months after March 2020. Bars in both facets denote 95% confidence intervals.



Preceding results capture the relationship between heat and air conditioning throughout the year. Interacting our binned temperature variable with the binary indicator for air conditioning allows for examining whether that relationship varies over the course of the year. We estimate this model separately for employees with different levels of experience (0-2, 3-5, and >5 years) and report the AMEs of rising temperatures in Figure 5. Each point shows, among employees with a certain experience level and working in prisons either with or without air conditioning, the AME of the average monthly temperature falling within 60-69°F, 70-79°F, or >79°F, relative to months with an average temperature of <60°F.[17] In order to test whether the AME of rising temperatures is different across prisons with and without air conditioning, we test for differences between a given pair of AME estimates and report the associated p values above the estimated effects.

As temperatures rise (moving from left to right in Figure 5), the probability of departing increases among employees in both prisons with and without air conditioning. Notably, as temperatures increase, the difference between the AME estimates for prisons with and without air conditioning also rise for the least experienced employees (top panel). Employees with 0-2 years of experience in prisons without air conditioning are approximately .08 percentage points more likely to depart in the hottest months of the year when average temperatures exceed 79°F, compared to .04 percentage points for similar employees in prisons with air conditioning (p = .047). Hot temperatures also lead to a greater increase in the probability of departing among employees with 3-5 years of experience, although the difference does not reach standard levels of statistical significance (p = .108). In contrast, among frontline correctional officers who have worked for the TDCJ for longer than 5 years, there is no associated gap in AME estimates as temperatures increase. Experienced employees are more likely to leave in months when average temperatures are above 79°F, but there is no evidence

17. That is, the AME of temperature level $t \in \{60-69^o\text{F}, 70-79^o\text{F}, > 79^o\text{F}$ on the probability of departing for the subset of $i \in \{1, \ldots, n\}$ frontline correctional officers with experience level J and employed in a prison with or without air conditioning $AC \in \{yes, no\}$ is defined as:

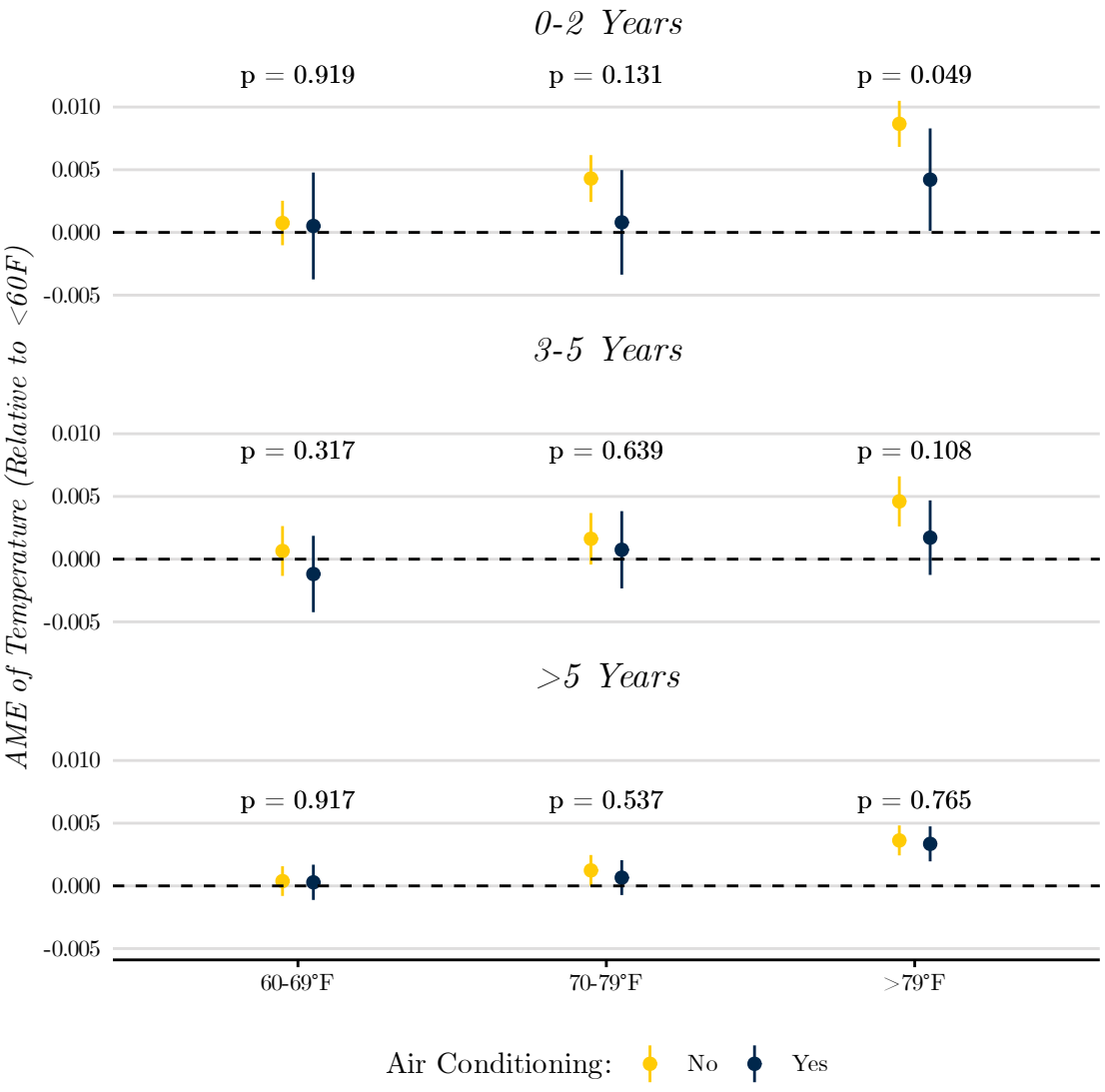
$$\text{AME}_{\Gamma_{J,AC}} = \frac{1}{|\Gamma_{J,AC}|} \sum_{i \in \Gamma_{J,AC}} [\Pr(\text{depart}_i \mid \text{temp}_i = t) - \Pr(\text{depart}_i \mid \text{temp}_i < 60^o\text{F})]$$

Where $\Gamma_{J,yes} \subset \{i : AC_i = yes, J_i = J\}$ is the subset of employees with J level of experience working in a prison with air conditioning and $\Gamma_{J,no} \subset \{i : AC_i = no, J_i = J\}$ is the subset of employees with J level of experience working in a prison without air conditioning.

that those who work in prisons without air conditioning are at greater risk of departing.[18]

18. Similar, albeit noisier, results arise from estimating the average marginal effect of working in a prison without air conditioning at different temperature levels (Figure C.3).

Figure 5 – Least-Experienced Employees in Prisons Without Air-Conditioning More Likely to Leave During Summer Months Shows the average marginal effect of the average monthly temperature being 60-69°F, 70-79°F, and >79°F (relative to <60°F) by air conditioning status. The facets indicate employees' years of experience. P values from hypothesis tests of a difference between the two AME estimates for prisons with and without air conditioning, respectively. Results calculated using the `marginaleffects R` package using control variables set to their observed values. Bars denote 95% confidence intervals. Data is from before the COVID-19 pandemic. Figure C.2 shows results from during the pandemic.



6 Discussion

Reformers have long framed the lack of air conditioning in many U.S. prisons as a moral and constitutional issue. We take a different approach, arguing that excessively hot conditions within prisons lacking air conditioning creates poor working conditions that contribute to correctional officer turnover. Using personnel and air conditioning data from the largest state prison system in the U.S., we show that a substantively and statistically significant association exists between working in a Texas prison without air conditioning and departing the correctional workforce. Before the onset of COVID-19, the odds of frontline correctional officers departing the TDCJ workforce in a given month were 20% higher if they worked in a prison lacking air conditioning. Additional tests support our expectation that heat is driving our results. Frontline correctional officers who spend the most time in the excessively hot areas within TDCJ prisons are more likely to depart from prisons lacking air conditioning than their supervisors who have access to cooled administrative areas. Likewise, we also show that our main finding is isolated to the frontline employees with the least amount of experience. Unlike their more senior peers who have grown accustomed to the conditions, these newer employees are more likely to depart from prisons lacking air conditioning.

Despite heat being able to influence turnover even during cooler seasons through anticipatory effects, we provide some evidence of a direct effect of heat on departures in the summer months. Among the least experienced employees with two or fewer years of experience with the TDCJ, we show that rising temperatures lead to a relatively greater increase in the propensity to depart among employees in prisons without air conditioning compared to their peers in cooled facilities. Notably, we find a similar, albeit muted and not statistically, significant moderating effect of outside temperature among employees with 3-5 years of experience, which disappears among the most senior employees with more than 5 years with the TDCJ. As with the main results, the moderating effect of temperature on departing is largely isolated to the least experienced employees who are not acclimated to working in prisons without air conditioning in sweltering Texas summers.

Nevertheless, we also find that many of the above findings disappear following the onset

of the COVID-19 pandemic. There are a few possible reasons for this. The pandemic brought unprecedented challenges to prisons, many of which were particularly affected by the virus. As a result, new unobserved confounders that are difficult to control for may be biasing our results and masking an underlying relationship between air conditioning and departing. While possible, two other scenarios seem more likely. For one, it may be the case that the challenges of the pandemic simply drowned out the benefits of air conditioning. Increasingly dangerous conditions due to the virus and heightened understaffing drove departures following the pandemic, rather than excessive heat. Another possibility is that COVID-19 is not actually the cause of the changes in our results over time. Figure 3 suggests that departures from prisons with air conditioning began to steadily increase in 2017. It is challenging to pinpoint the source of this increase, but it may be that what appears to be a change due to the pandemic actually stems from a prior, alternative cause.

Our work has a few key limitations, which should be improved upon in future work. First, while our longitudinal study is an improvement upon existing research, we are limited by the lack of within-prison variation in air-conditioning during the study period. Second, exiting the workforce is one, particularly extreme, measure that correctional workers can take in the wake of poor conditions. They can also take vacation days or be forced to work additional overtime shifts to cover vacancies. Future work should incorporate these other dependent variables. Finally, while Texas is a particularly salient case for studying the relationship between heat and correctional officer turnover, correctional officers in other states might be even more responsive to heat. Climate change is increasing the number of hot summer days across the country in places where people are less used to excessive heat (Tuholske et al. 2024). As a result, correctional officers in the Pacific Northwest, Midwest, and New England may be even more impacted by working in facilities without air conditioning than their peers in the South.

Finally, our results also underscore the other considerable challenges faced by correctional officers. Despite its benefits, air conditioning cannot alleviate the violence, stress, and trauma that make correctional work particularly taxing. While cooler prisons help both incarcerated people and correctional staff, air conditioning does not address other underlying pathologies

within prisons and thus offers only partial relief from the structural conditions that drive burnout, turnover, and chronic understaffing.

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Supplementary Information

Excessive Heat and Correctional Officer Turnover: Evidence from Texas

Benjamin Goehring and Jacob Harris

A TDCJ Facilities

Figure A.1 – TDCJ Facilities, by AC Status and Region Shows the region and air-conditioning status of TDCJ prisons with either full or no air conditioning.

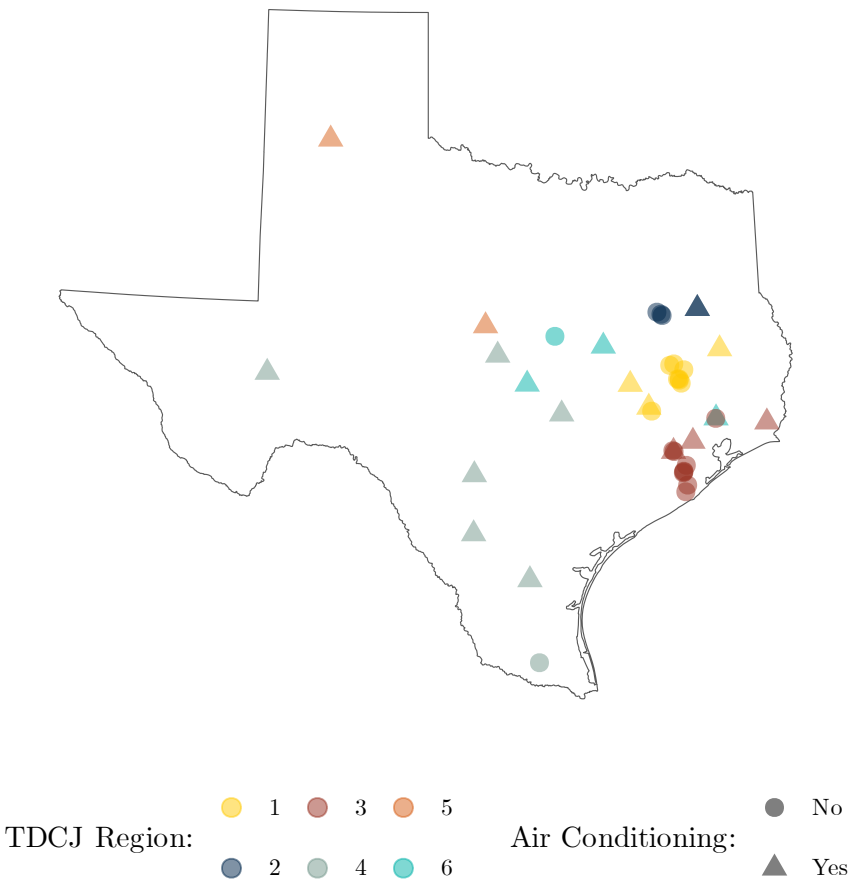


Table A.1 – TDCJ Facilities, by Air-Conditioning Status Lists the TDCJ prisons for which we have personnel data by air-conditioning status. Hodge and Pack, the two units that switched air-conditioning status during our study window are listed separately.

AC Level	Facilities
Full (N = 17)	Cotulla, Duncan, Fort Stockton, Glossbrenner, Halbert, Hamilton, Havins, Henley, Kegans, Leblanc, Marlin, Mechler, Ney, San Saba, Scott, Skyview, Travis
None (N = 22)	Beto, Byrd, Clemens, Coffield, Ellis, Ferguson, Goree, Hightower, Hilltop, Huntsville, Jester I (Closed), Lopez, Luther, Memorial, Powledge, Ramsey, Scott (Closed), Stringfellow, Terrell, Vance, Wainwright, Wynne
Switched (N = 2)	Hodge, Pack

B Heat in Texas

Figure B.1 – Mean Monthly Temperature of Counties with Prisons, by AC Status Shows the mean monthly temperature of counties containing prisons that have full and no air conditioning, respectively.

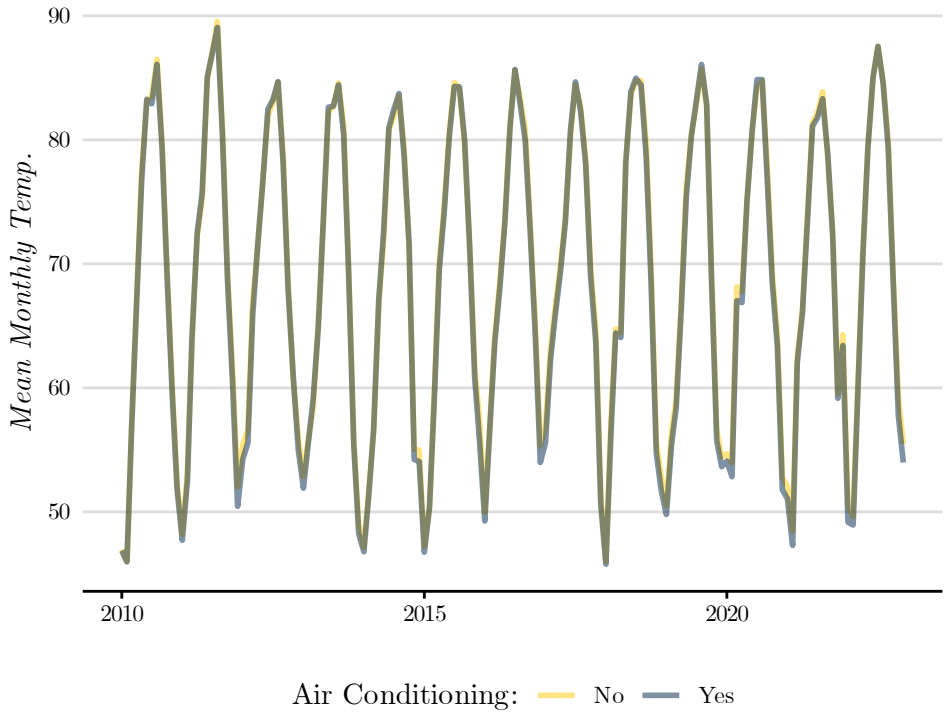
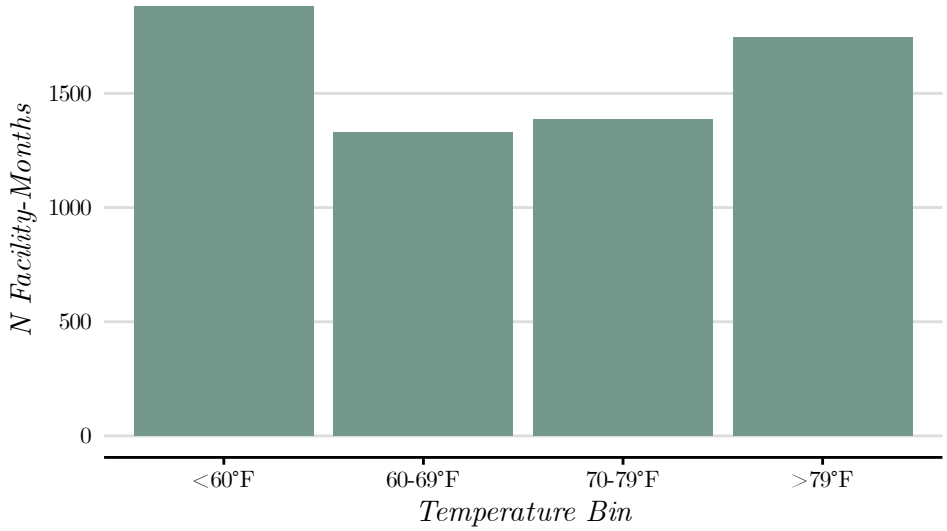


Figure B.2 – Distribution of Facility-Months by Temperature Bin Shows the number of facility-months that fall in each of the temperature bins.



C Additional Results

Table C.1 – Supervisors No More Likely to Depart from Prisons Without AC Replicates models in Table 1 using supervisors rather than frontline correctional officers.

	Pre-COVID	COVID
No AC	1.12	0.89
	[0.97; 1.28]	[0.70; 1.12]
60-69°F	0.93	1.43
	[0.73; 1.20]	[0.96; 2.13]
70-79°F	0.83	2.40*
	[0.57; 1.21]	[1.33; 4.33]
>79°F	0.75	3.50*
	[0.46; 1.20]	[1.64; 7.50]
Unemployment Rate	1.02	1.00
	[0.97; 1.06]	[0.95; 1.06]
White	1.19*	1.30*
	[1.09; 1.30]	[1.12; 1.50]
Monthly Salary ($1k)	0.79*	0.92
	[0.71; 0.87]	[0.80; 1.06]
Age	0.86*	0.90*
	[0.84; 0.89]	[0.85; 0.94]
Age^2	1.00*	1.00*
	[1.00; 1.00]	[1.00; 1.00]
Male	0.84*	0.87
	[0.77; 0.92]	[0.75; 1.01]
Pct staffing change	1.01*	0.99
	[1.00; 1.02]	[0.98; 1.01]
Year built	1.00	1.00
	[1.00; 1.00]	[1.00; 1.00]
N incarcerated (100)	1.01*	1.01*
	[1.00; 1.01]	[1.00; 1.03]
Tenure FE	✓	✓
Month FE	✓	✓
Region FE	✓	✓

* Null hypothesis value outside the confidence interval.

Table C.2 – Correctional Officers More Likely to Depart Prisons Without AC, 2010 - 2023 Replicates models in Table 1 using the full dataset from 2010 to 2023.

	(1)
No AC	1.08*
	[1.04; 1.13]
60-69°F	0.95
	[0.88; 1.02]
70-79°F	0.94
	[0.84; 1.04]
>79°F	0.91
	[0.80; 1.04]
Unemployment Rate	0.99*
	[0.97; 1.00]
White	1.30*
	[1.27; 1.34]
Monthly Salary ($1k)	0.74*
	[0.72; 0.76]
Age	0.91*
	[0.90; 0.91]
Age^2	1.00*
	[1.00; 1.00]
Male	0.87*
	[0.84; 0.89]
Pct staffing change	1.00*
	[0.99; 1.00]
Year built	1.00
	[1.00; 1.00]
N incarcerated (100)	1.01*
	[1.01; 1.01]
Tenure FE	✓
Month FE	✓
Region FE	✓

* 1 outside the confidence interval.

Figure C.1 – Predicted Probability of Departing, by Month of Year Shows the average marginal effect of working in a prison without air conditioning by month of the year. Data is from before March 2020. Each facet includes a subset of data: frontline correctional officers with 0-2, 3-5, and >5 years of experience, and all supervisors regardless of experience level. The model excludes controls for average monthly temperature and substitutes annual fixed effects for monthly fixed effects. Results calculated using the `marginaleffects R` package using control variables set to their observed values. Bars denote 95% confidence intervals.

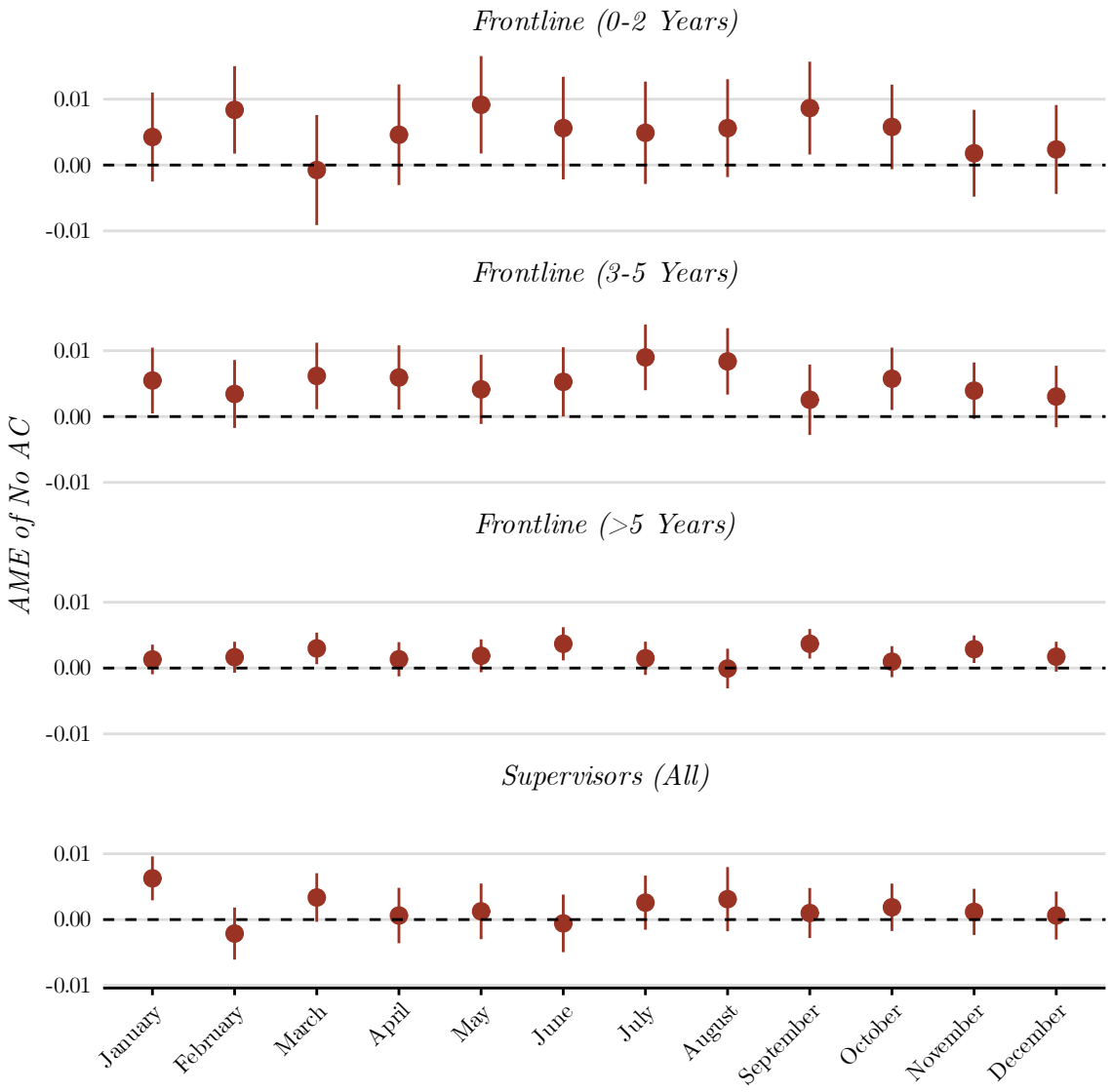


Figure C.2 – Departures More Likely in Hotter Months, but Little Difference Across Air Conditioning Types (COVID-19) Shows the average marginal effect of the average monthly temperature being 60-69°F, 70-79°F, and >79°F (relative to <60°F) by air conditioning status. Replicates Figure 5 using data from March 2020 through January 2023. The facets indicate employees' years of experience. P values from hypothesis tests of a difference between the two AME estimates for prisons with and without air conditioning, respectively. Results calculated using the `marginaleffects R` package using control variables set to their observed values. Bars denote 95% confidence intervals.

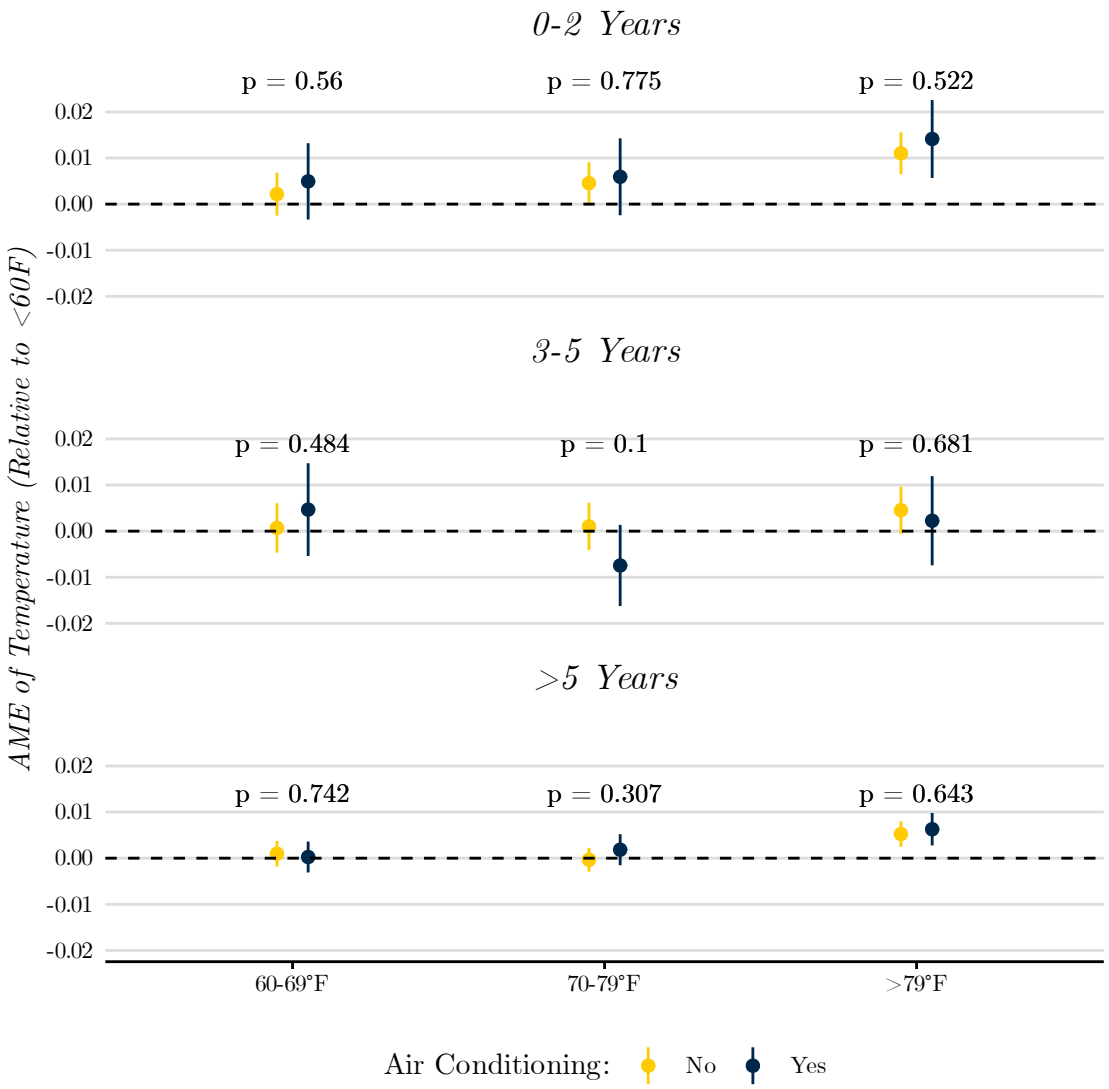


Figure C.3 – Least-Experienced Employees in Prisons Without Air Conditioning Slightly More Likely to Depart in Hotter Months Shows the average marginal effect of working in a prison without air conditioning before COVID-19 by average monthly temperature. Results calculated using separate models that restrict the data to employees with 0-2, 3-5, and >5 years of experience. Results calculated using `marginaleffects R` package using control variables set to their observed values. Figure shows the results for months after March 2020. All pairwise hypothesis tests of AME estimates within a given years of experience category have p values ¿ 0.05.

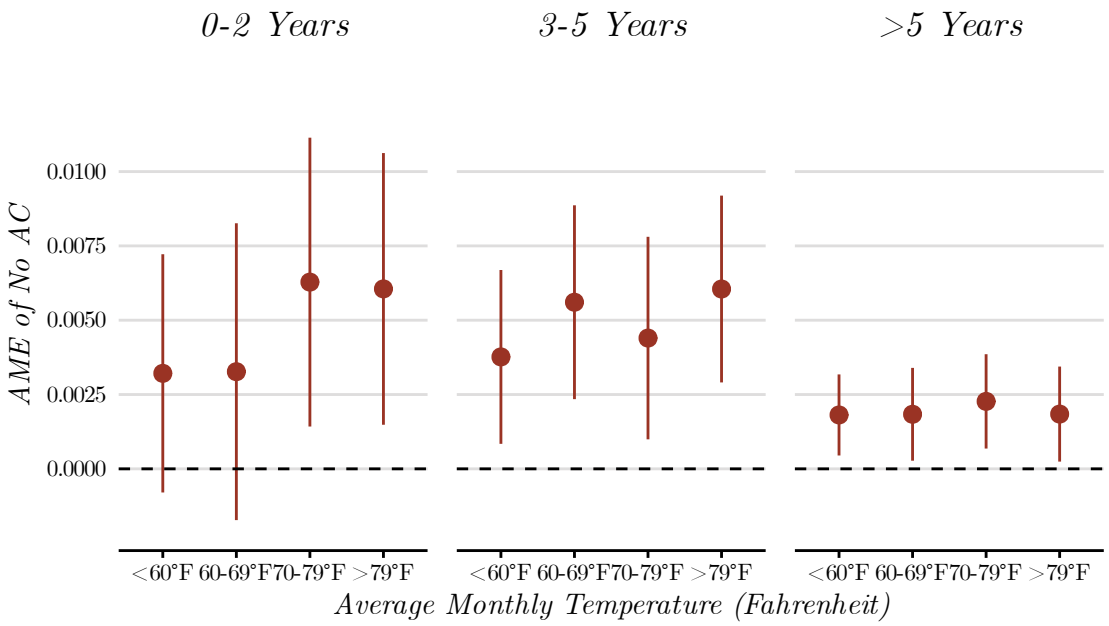


Figure C.4 – No Difference in Departures as Temperatures Increase Following Onset of COVID-19 Replicates Figure using data from March 2020 through January 2023. Results calculated using the `marginaleffects R` package using control variables set to their observed values.

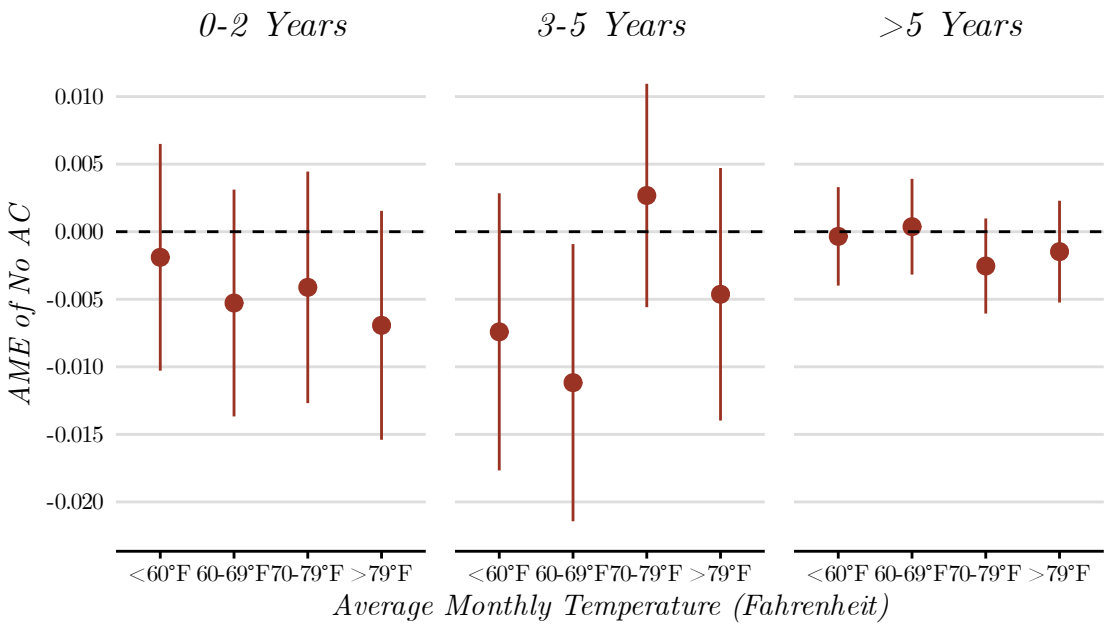


Figure C.5 – Air Conditioning Does not Lead to More Departures Among Newly Employed Following COVID-19. Replicates Figure 4 using data from March 2020 through January 2023. Results calculated using the `marginaleffects R` package using control variables set to their observed values.