Deaths in Pennsylvania Prisons

Zhenzhen Liu

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Abstract

The incarcerated population in Pennsylvania is large, and they face many health challenges. However, health and mortality in correctional facilities have not been well-studied. My research focuses specifically on prisons in Pennsylvania, and conducts a systematic analysis of mortality by manners and causes of death. We find that suicides are slightly elevated in prisons, while natural deaths, accidental deaths, and homicides are slightly reduced in prisons. Among natural deaths, the two leading causes are cancer and hypertensive arteriosclerotic cardiovascular disease, taking up more than half of all the death cases. In addition, we find that the causes of deaths in the death register data are unstandardized, and some are uninformative or ambiguous, which calls for the need for better quality data on prison mortality.

1 Introduction

The incarcerated population in the U.S. is large. In 2016, 2,131,000 people (0.66% of the total population; 0.83% of the population between 15 and 84 years old[1]) were held in a correctional facility in the U.S. In Pennsylvania, 82,400 people (0.64% of the total population; 0.80% of the population of at least 15 years old) spent time in state prisons and jails [1]. The incarcerated populations faces a range of health challenges: Many were already suffering from illnesses upon their entry of a facility; people serving long sentences are likely to develop chronic or age-associated diseases; some facilities do not have effective sanitization, administration, or medical services to support the need of their population [2]. These situations all contribute to mortality in correctional facilities.

However, health and mortality in prisons are not well-studied. The Bureau of Justice collects death-related data in jails and prisons through the Mortality in Correctional Institutions program, and reports national-level trends by causes of death and by demographic groups [3]. At the state level, the Department of Corrections of each state collects and sometimes publishes prison mortality data, but sophisticated analyses are not common. For example, the Texas Justice Initiative, a non-profit organization promoting human rights in criminal justice system, has published extensive quantitative analysis on custodial deaths in state [4]. Risk factors of mortality in incarceration are

[1] https://data.census.gov/cedsci/

even less studied. RAND corporation has held an expert panel to identify high-priority needs to reduce mortality in correctional facilities; some of the identified needs are providing medical care at a community-level standard, expanding the capacity for medical care, and providing more and better data to understand and reduce mortality [2]. The presence of the RAND panel itself reflects the lack of academic attention, as expert panels are held usually when there is not enough existing literature.

The Pennsylvania Prison Society (PPS), a non-profit organization promoting humane treatment of incarcerated individuals, serves as an ombudsman for the incarcerated population, advocating for incarcerated people through correspondence with them and prison/jail visits. PPS's responds to reports problems in correctional facilities, and gathers information from visits and correspondence. Recently, PPS has worked to supplement this information with quantitative analysis, in order to identify problems that have not been noticed, and provide more comprehensive evidence when they advocate to policy makers. Thus, they have collaborated with CMU's Center of Human Rights Sciences (CHRS) to study correctional facility qualities through data driven methods. As a part of this bigger project, my thesis focuses on understanding death in prisons, which is a key indicator of health and consequently a key indicator of prison quality.

Another student at CHRS, Ben Klingensmith, has conducted research on deaths in jails. Although jails and prisons are similar that they hold people who are suspected or convicted of committing crimes, they have different populations. In most states in the U.S., jails hold people who have not been convicted and are being held pre-trial, and people who have sentences of no longer than 1 year. Pennsylvania refers to such facilities as "county prisons", and they can hold people with sentences up to two years. We use the term "jail" for ease of understanding. In contrast, prisons hold people that have been convicted and are serving longer sentences. Thus, prisons have an older and more stable population on average, and they face more challenges in providing long-term medical support. Therefore, it is meaningful to conduct separate research on prisons, with a special focus on the health-related issues.

The goal of my thesis is to understand how people in Pennsylvania prisons die. The first step is to examine the distribution of death rates among facilities, and study whether they are related to variables addressing different aspects of the facilities. The next step is to evaluate whether the deaths in prisons are excess, by which we mean the difference between how many occurred and how many we would have expected to occur had the population not been incarcerated. Although ideally the fewer deaths the better, there will be deaths in prison. Therefore, we construct a comparison population that have similar composition to the incarcerated population but have not been incarcerated, and use its death rates as baselines. State-level death rates in prisons are compared with the baselines by year and manners of deaths. The last step is to study the natural deaths at a fine-grained level. To achieve this, we develop fine-grained death categories for natural deaths, and study the distribution of death cases by them.

My research will provide a more comprehensive understanding of mortality in prisons in Pennsylvania, and increase people's awareness of the challenges the incarcerated population faces. Furthermore, I hope that it will provide a model for other state analyses, and facilitate studies on prison death comparisons across different states.

2 Methods

2.1 Data

The data used in this study include three sources. The PA prisons death data come from the Pennsylvania Department of Correction (PA DOC)'s death register data. It was requested by Abolitionist Law Center (ALC) from PA DOC through Pennsylvania Right-to-Know Act and published on ALC's website [5]. The dataset includes individual-level death cases in 2000 - 2019. The available variables are varied across years, but they all include the prison an individual was in, the death date, and the manner and cause of death. The 2017 – 2019 data also have the birth date, which can be used to calculate the age of an individual. The 2000 – 2016 data include all deaths under PA DOC's custody, including prisons, Quehanna Bootcamp, and Community Corrections Centers, but not jails. The 2017 – 2019 data only have observations of deaths from prisons, but do not have observations from Quehanna Bootcamp or Community Corrections Centers. We do not know whether it is the case that there are no deaths in 2017 – 2019 in the latter two, or that deaths in those facilities are not included in the dataset.

The PA prison population data come from the Annual Statistical Reports [6] and Monthly Population Reports [7] that PA DOC publishes on their website. The Annual Statistical Reports include the race, gender, and age (5-year age buckets) breakdown of the year-end population under PA DOC's custody at the state-level, and race, gender, and age (three age categories) breakdown at facility-level. We use Table 18 for gender and race/ethnicity data, and Table 22 for age data. The Monthly Population Reports include the month-end population of each prison.

The death and population data of the general population in Pennsylvania come from the CDC Wonder Underlying Causes of Death dataset [8]. This dataset codes deaths in the U.S. with the ICD-10 standard, and it allows queries for aggregated deaths and population data across different causes and demographics categories. However, if a category has fewer than 10 cases of death, the query result will suppress the actual number. In this analysis, the suppressed values are imputed as described in Section 2.5.

2.2 Death Rates at Facility Level

We explore the distribution of death rates at the facility level, the relationship between facility-level death rates and average monthly population, and the relationship between facility-level death rates and security level. The data are aggregated across 2017, 2018, and 2019.

2.3 Death Rates by Manners of Death

We examine death rates by manners of death. Manner of death divides deaths into 5 categories: natural death, suicide, accidental death, homicide, and undetermined. We focus on the first 4 categories.

For deaths of all manners, and each individual manner of death, we compare the state-level death rates and the comparison population death rates aggregated across 2017, 2018, and 2019. In addition, for deaths of all manners and natural deaths, we compare the state-level prison death rates and comparison population death rates by 5-year age groups. Death rates are calculated as per 1000 person-years, because a prison generally holds 1000 – 3500 people and we want the death rates to have similar scales as facility-level death counts.

2.4 Comparison Population Death Rates

The comparison population death rate is calculated as a weighted average of the death rate in the Pennsylvania general population of each demographic group. For all deaths and natural deaths, we use 88 demographic groups, defined by two genders (male, female), 4 races/ethnicity (white, black, Hispanic, other), and 11 age groups (5-year age groups spanning ages 15 to 84 with the last group being "65 – 84"). For suicide, homicide, and accident, we use 48 demographic groups, defined by two genders, 4 races/ethnicity, and 6 age groups (10-year age groups spanning ages 15 to 84 with the last group being "65 – 84").

To examine the effect of standardization by demographic variables, we also compute the age-adjusted general population death rates and the age-and-gender-adjusted general population death rates. The age and gender variables are the same as those used to compute the comparison population death rates.

Note that Hispanic is an ethnicity instead of race, but PA DOC uses "white", "black", "Hispanic" and "other" as race groups. Thus, in our analysis, we assume that an individual identified with a Hispanic ethnicity would have chosen "Hispanic" as race, and we assume that "white", "black", and "other" correspond to "white, non-Hispanic", "black, non-Hispanic", and "other, non-Hispanic". We did not take multi-race into account, as we do not have data for multi-racial population in prisons. Also, they are generally rare in the general population and we expect them to have extremely small counts in prisons that do not have an impact on our results.

For age groups, the CDC Wonder database provides 5-year and 10-year age groups that align with our definitions above. PA DOC's Annual Statistical Reports use groups that generally align with above, but it has special groups "Under 18", "18 – 20", "21 – 24", and "65 and Above". Since people in prisons are rarely under 15 or above 84, we treat "Under 18" and "18 – 20" combined as "15 – 19", "21 – 24" as "20 – 24", and "65 and Above" as "65 – 84".

The CDC Wonder Database does not provide a manner of death variable. Instead, it uses ICD-10 codes, a comprehensive and fine-grained classification standard introduced by World Health Organization for diseases, disorders, injuries, and other health conditions [9]. We map ICD-10 Codes to manners of deaths as shown in Table 1.

Table 1: Mapping between Manners of Death and ICD-10 Codes

Manner of Death	**ICD-10 Code**
Natural Death	A00-U99 (All the internal causes)
Accidental Death	V01-V99 (Transport accidents) W00-X59 (Other external causes of accidental injury)
Suicide	X60-X84 (Intentional self-harm)
Homicide	X85-Y09 (Assault)

The death categories we have developed also need to be mapped to the ICD-10 codes. Table 2 summarizes the mapping for the death categories we have conducted excess death evaluation on. We are not able to conduct excess death evaluation on most of the death categories because the number of death counts in them are too small, but we hope that our categories can provide a model for other studies.

Table 2: Mapping between Death Categories and ICD-10 Codes

Death Category	**ICD-10 Code**
All Cancer	C00-C97 (Malignant neoplasms)
All HASCVD	I00-I99 (Diseases of the circulatory system)

The weight of each group is defined based on its proportion in the incarcerated population. PA DOC only provides the marginal distributions of gender, race/ethnicity and age, so we assume that these three variables are independent. Thus, for demographic group i that corresponds to gender g, race/ethnicity r, and age a, the weight is the product of the marginal proportions of g, r, and a:

$$w_i = p_g \cdot p_r \cdot p_a$$

Note that the majority, but not all, of people under PA DOC's custody are in prisons; 2.5% of people are in Community Corrections Center, Community Contract Facilities, and Contracted County Jails, and federal prisons [10]. This study focuses on the prison population only. For gender and race/ethnicity, PA DOC provides prison-only data, but for age, PA DOC only provides data for all people under its custody. Thus, the proportions of the demographic groups are calculated based on all population under PA DOC's custody. Since the number of people not held in prisons is extremely small, we expect that the prison population has very similar demographics breakdown as whole population under PA DOC;s custody.

CDC Wonder database provides the joint distribution of deaths by gender, race/ethnicity, and age, so the general population death rate of a demographic group is queried directly from the database. CDC Wonder database suppresses the death count and rate if a demographic group has fewer than 10 deaths, so the death rates of some groups are imputed as described in Section 2.5.

The death rate of the comparison population D_{comp} is calculated as

$$D_{comp} = \sum_i w_i \cdot D_i$$

where w_i is the weight and D_i is the general population death rate of each demographic group.

2.5 Imputation for Comparison Population Death Rates

This study uses the same imputation method as in Ben Klingensmith's senior thesis on jail deaths [11]. Denote death rate as D, death type as t, age group as a, gender as g, and race/ethnicity as r. Suppose we intend to impute $D_{t,a,g,r}$. If $D_{t,a,r}$, $D_{t,a,g}$, and $D_{t,a}$ are available in CDC Wonder database, we assume that gender and race/ethnicity are independent, and thus

$$D_{t,a,g,r} = \frac{D_{t,a,r} \cdot D_{t,a,g}}{D_{t,a}}$$

Otherwise, if $D_{t,a,g}$, $D_{t,r}$, and D_t are available, we assume that gender and age are both independent of race/ethnicity, and thus

$$D_{t,a,g,r} = \frac{D_{t,a,g} \cdot D_{t,r}}{D_t}$$

See Ben Klingensmith's senior thesis for derivation details [11].

In this study, imputation of death rates in general population is needed mainly for death types that happen more rarely (e.g. suicide and homicide) among demographic groups that have a smaller population (e.g. Native American, Asian/Pacific Islanders) or a lower death rate for those death types (e.g. Hispanic women). The imputed deaths for the general population only correspond to a small proportion of the prison population. For manners of deaths, imputation takes up an equivalent of 0.0006% of the prison population for all manners of death, 0.25% for natural deaths, 3.19% for suicides, 0.03% for accidents, and 5.08% for homicide. For fine-grained death categories, imputation takes up an equivalent of 0.88% of the prison population for all cancer, and 1.15% for all HASCVD. The amount of data imputed is listed in Appendix A.

2.6 State-level and Facility-level Prison Death Rates

The state-level prison death rates are computed using the year-end total population under PA DOC's custody, including individuals housed in prisons, Community Corrections Center, Community Contract Facilities, and Contracted County Jails, and federal prisons, as PA DOC does not provide prison-only data by age. We examine the death rates for all deaths and natural deaths by age, and want to maintain consistency for other state-level death rates.

The facility-level death rates are computed using the average month-end population of each prison from PA DOC's Monthly Population Reports. This is to account for the monthly variation in prison population. We exclude SCI Pittsburgh and Quehanna Bootcamp from our analysis, because: Although Quehanna Bootcamp is listed as a prison, it is a special program of PA DOC and is very different from other prisons in nature [12]. Also, Quehanna Bootcamp's death data in 2017-19 is unavailable in the death register data. SCI Pittsburgh was closed in 2017 and its monthly population was steadily declining from 1880 to 0 between January and June 2017. Thus, the average monthly population and death rates of SCI Pittsburgh are misleading. In addition, SCI Graterford was closed and replaced by SCI Phoenix in 2018 [13], so the two facilities are treated as one in this study.

To reduce random noises, we aggregate the data across the available time span, including 2017, 2018 and 2019, for our analysis.

2.7 Confidence Intervals

For crude death rates, we used 95% Poisson Confidence Intervals. Poisson interval assumes that death events in a population follows a Poisson distribution. Confidence intervals are estimated as shown below[14] [15].

$$\text{lower bound} = \frac{1}{2}(\mathcal{X}^2)^{-1}_{2D}(\frac{\alpha}{2})$$

$$\text{upper bound} = \frac{1}{2}(\mathcal{X}^2)^{-1}_{2(D+1)}(1-\frac{\alpha}{2})$$

where D is the crude death counts and $(\mathcal{X}^2)^{-1}_{df}(p)$ is the pth quantile of the Chi-squared distribution with *df* degrees of freedom.

For standardized general population death rates, we examined both the 95% Poisson-based confidence intervals and the 95% Gamma-based confidence intervals. The Poisson-based intervals are calculated the same way as those of the crude death rates. The Gamma-based interval assumes that the standardized death rate is a weighted sum of Poisson random variables. Confidence intervals are estimated as shown below [14] [15].

$$\text{lower bound} = \frac{V}{2R}(\mathcal{X}^2)^{-1}_{\frac{2R^2}{V}}(\frac{\alpha}{2})$$

$$\text{upper bound} = \frac{V+W_{max}^2}{2(R+W_{max})}(\mathcal{X}^2)^{-1}_{\frac{2(R+W_{max})^2}{V+W_{max}^2}}(1-\frac{\alpha}{2})$$

where R is the standardized death rate, V is the variance, W_{max} is the maximum of all the weights of the demographic groups, where the weight for each group is defined as its proportion in the prison population divided by its size in the general population, and $(\mathcal{X}^2)^{-1}_{df}(p)$ is the pth quantile of the Chi-squared distribution with *df* degrees of freedom.

V is given by the equation

$$V = \sum_{i=1}^{m} R_i(\frac{W_i}{P_i})^2$$

where m is the number of demographic groups, R_i is the crude general population death rate in the ith demographic group, W_i is the weight of the ith demographic group as defined above, and P_i is the general population in the ith demographic group.

For the standardized death rates, the resulting 95% Poisson-based intervals and Gamma-based intervals are very similar.

2.8 Cause of Death Categorization for Natural Death

Unlike the manner of death, the cause of death describes the specific situations, or chain of conditions, that lead to a person's death. For example, a cause of death can be "congestive heart failure, atherosclerotic coronary artery disease" while the manner of death is natural death.

We cannot work with the cause of death data directly for two reasons. First of all, raw causes of death are too detailed to produce any significant statistical results. Secondly, the causes of death in the death register data are not standardized. This is because in Pennsylvania, many autopsies are performed by coroners instead of medical examiners. Coroners are elected and are required to take a Basic Education Course, but they do not need any qualification in Pathology [16]. The dataset has 502 records, of which the causes of death may be recorded differently by different coroners, not following recognized standards.

Therefore, we collaborated with Dr. Ashton Ennis from Allegheny County Medical Examiner Office, and developed the 20 categories below for natural deaths, based on how common a category is and how it can reflect the quality of medical care. For example, we break cancer into screenable vs. unscreenable cancer, because if we observe an elevated death rate in the screenable category, it might indicate issues about the screening process in prisons. We break chronic obstructive pulmonary diseases (HASCVD) into stroke vs. other HASCVD, because the death rate for stroke depends on how fast a person gets access to medical attention. For infectious diseases, we create separate categories for pneumonia and hepatitis C, because they are relatively common among prison deaths.

We and Dr. Ennis have manually inspected all the causes in our dataset and map them to the corresponding categories. The mappings can be found in Appendix B. When an observation contains a single cause, the categorization is based on the single cause. When an observation contains multiple causes, we identify the most informative cause and categorize the observation based on it. In general, the multiple causes generally fall into one of the two circumstances:

Multiple causes in which one can cause the other, such as "hepatocellular carcinoma, end stage liver disease, Hep-C". In general, the last cause is the most informative cause, but there are a few exceptions such as "hepatocellular carcinoma, Hep C, end stage liver disease", in which the most informative cause "Hep C" is not listed as the last one.

Multiple unrelated causes. This is most common among cancer-related causes, such as "squamous cell lung cancer, metastatic bladder cancer" and "septic shock, metastatic renal cell cancer, metastatic lung cancer". In such cases, if one cancer is metastatic and the other is not, we use the metastatic cancer for categorization since a metastatic condition is more severe. If both, or neither are metastatic, we use the last cause for categorization. For multiple unrelated causes that are not cancer-related, such as "septic shock, end stage kidney disease, end stage liver disease" we use the last cause for categorization.

1. Cancer
   (a) Screenable Cancer (Breast, Cervical, Colorectal, Skin, Prostate, Oral)
   (b) Unscreenable GI Cancer
   (c) Hematogenous Malignancies
   (d) Other Unscreenable Cancer
2. Hypertensive Arteriosclerotic Cardiovascular Diseases (HASCVD)
   (a) Stroke
   (b) Other HASCVD
3. Chronic Obstructive Pulmonary diseases (COPD)
4. Immunologic Diseases
5. Neurological Diseases
6. Kidney Diseases
7. Liver Diseases
8. Lung Diseases
9. GI Diseases
10. Renal Diseases
11. Infectious Diseases (ID)
    (a) Pneumonia
    (b) Hepatitis C
    (c) Other Infectious Diseases
12. Diabetes
13. Failure to Thrive (FFT)
14. Causes that are hard to classify

3 Results and Discussion

3.1 General Population vs. Prison Population in Pennsylvania

The demographic composition, as shown in Table 3, is very different for general population and prison population in Pennsylvania. White people make up the majority (76.94%) of the general population, but less than half (43.22%) of the prison population. On the contrary, black people, who make up only 11.49% of the general population, are over-represented in prisons (46.23%). The male population (48.99%) is slightly smaller than the female population in the general population, but it is the majority in prisons (93.90%). The prison population is also younger: In the general population, the age distribution is approximately uniform, with slightly more people in the older age groups 55-64 and 65-84; but in prisons, most people are between 25 and 64.

Demographic variables like age, race, and gender have a large impact on the death rates in a population. As the general population and the prison population have very different demographic distributions, the general population needs to be standardized in order to be comparable to the prison population. As we see later in Table 9, death rates indeed change greatly when we standardize the general population by one or more demographic variables.

Table 3: Prison and General Population in Pennsylvania, 2017-19 Average

Variable	**Value**	**Population under PA DOC's Custody**	**General Population**
Race	White	20,413 (43.22%)	9,851,708 (76.94%)
	Black	21,835 (46.23%)	1,471,348 (11.49%)
	Hispanic	4,596 (9.73%)	972,309 (7.59%)
	Other	383 (0.81%)	509,497 (3.98%)
Gender	Male	44345 (93.90%)	6,273,450 (48.99%)
	Female	2883 (6.10%)	6,531,412 (51.01%)
Age[2]	15-24[3]	3862 (8.18%)	1,625,505 (15.80%)
	25-34	15,856 (33.57%)	1,699,610 (16.52%)
	35-44	12,513 (26.50%)	1,499,242 (14.57%)
	45-54	8,221 (17.41%)	1,651,995 (16.06%)
	55-64	4988 (10.56%)	1,808,835 (17.58%)
	65-84[4]	1,787 (3.78%)	2,002,298 (19.46%)

[2] For the general population, the proportions are out of the population between age 18 and 84 in Pennsylvania.

[3] The PA DOC reports name this group as "under 24", but since PA DOC generally does not hold people under 15 in SCIs, we assume that "under 24" correspond to age 15-24.

[4] The PA DOC reports name this group as "65 and above", but people older than 84 are rare in SCIs, we assume that "65 and above" correspond to age 65-84.

Table 4: Incarceration Rate (per 100,000) by Race, Gender and Age, 2017-19

Variable	**Value**	**2017**	**2018**	**2019**
Race	White	200	199	206
	Black	1,528	1,472	1414
	Hispanic	504	463	439
	Other	72	75	76
Gender	Male	711	692	686
	Female	41	42	44
Age	15-24	268	237	206
	25-34	970	941	889
	35-44	845	837	822
	45-54	504	495	494
	55-64	269	276	283
	65-84	86	88	93

As Table 4 shows, the incarceration rate per 100,000 people is varied across different demographic groups. By race/ethnicity, the incarceration rate of black people is about 7.5 times the rate of white people, and the incarceration rate of Hispanic people is about 3 times the rate of white people. By gender, the incarceration rate of male is about 17 times the rate of female. By age, age group 25-34 has the highest incarceration rate, followed closely by age group 35-44. The incarceration rate for age 25-34 is almost 4 times the rate of the previous age group 15-24, and about 1.8 times the rate of age group 45-54.

3.2 Prison Population Demographics by Facility

Figure 1 shows the average monthly population by facility in 2017 – 2019, in which the bars are colored by the security levels. The security level of a prison is based on the risk of their population, and prisons with different security levels may adopt different security measures and housing format. In Pennsylvania, prisons generally fall into one of the 4 security levels: Minimum, Medium, Close, and Maximum, where the level of security increases from Minimum to Maximum. Supermax facilities (SCI Greene in Pennsylvania) are often counted as Maximum facilities, but they have even higher level of security than normal Maximum facilities because they hold people with extremely high risks and people with death penalty. SCI Pittsburgh is classified as a minimum-to-medium level facility (not shown in the figure).

For reasons discussed in Section 2.6, Quehanna Bootcamp and SCI Pittsburgh are excluded and SCI Graterford and SCI Phoenix are combined into one facility. There is much variation in the populations of different prisons, but they are all between 1000 and 3500. Visually, the population does not appear to be associated with the security level of a prison.

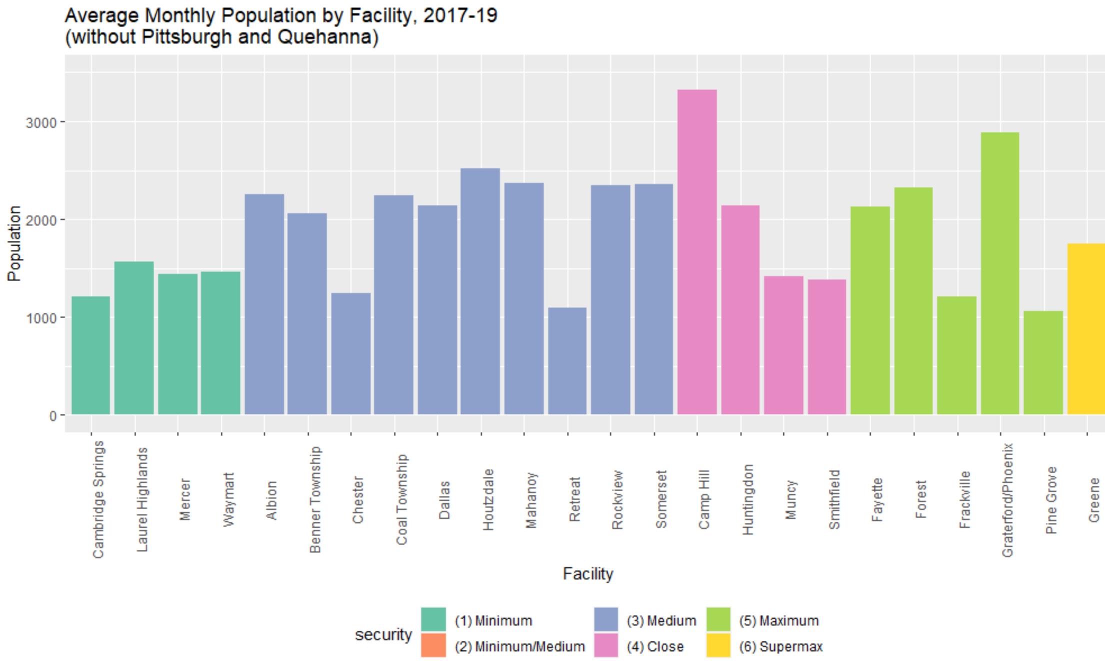

Figure 1: Average Monthly Population by Facility, 2017-19

Figure 2 shows the race/ethnicity breakdown of prison population at the facility level in 2017 – 2019. The distribution of race is fairly varied; the proportion of white people ranges from 27.17% to 66.91%, the proportion of black people ranges from 24.26% to 61.22%, the proportion of Hispanic people ranges from 4.81% to 20.23%, and the proportion of people with other races ranges from 0.44% to 1.95%. By security level, the proportion of black people tend to be higher in facilities with higher security levels, while the proportion of white people and people with other races tend to be lower in facilities with high security levels. The proportion of Hispanic people is roughly even across different security levels.

For gender breakdown, all prisons except Quehanna Bootcamp hold either men only or women only. SCI Cambridge Springs and SCI Muncy are female facilities, while the others are male facilities. For age breakdown, PA DOC's Annual Statistical Reports only provide facility-level age data by three broad groups: Under 25, 25 to 39, and 40 and above. However, people of age 40 and above take up nearly the half of the prison population (43.55%) in 2017 - 2019. The broad groups can smooth out important information in the age distribution and produce misleading results, so we do not present the age breakdown results here.

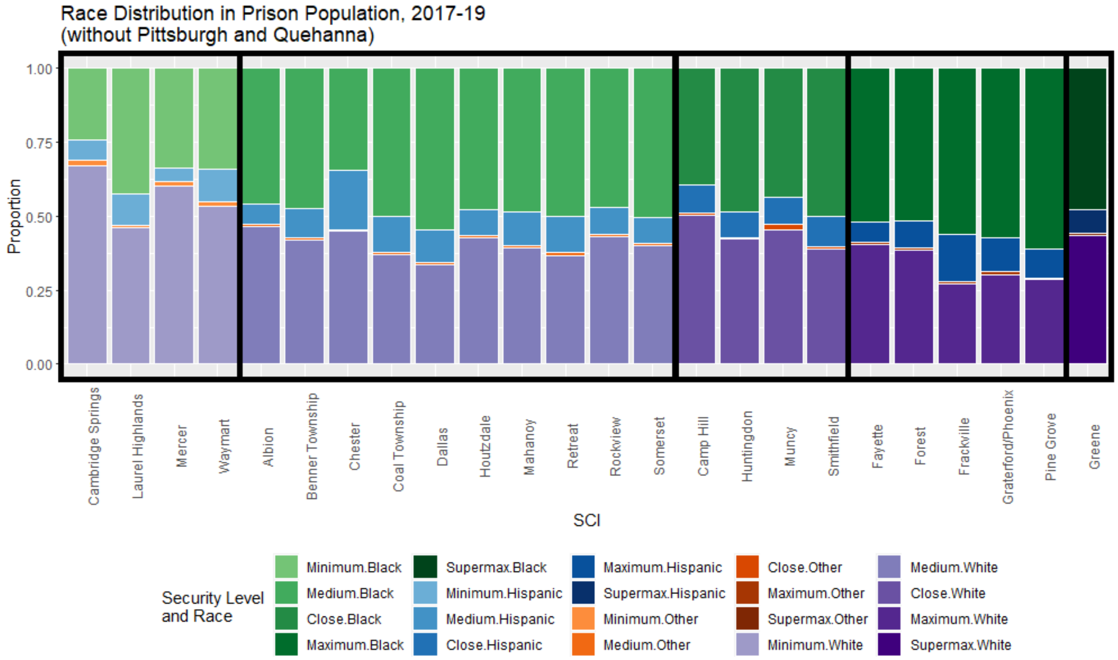

Figure 2: Race/Ethnicity Breakdown by Facility, 2017-19

3.3 Death Breakdown by Manners of Death

Table 5 shows the death breakdown by manners of death in Pennsylvania prisons, jails, and general population. Most deaths are natural deaths in all three populations. However, in prisons, natural death takes up 87.85% of all the deaths, much higher than the 54.55% in jails.

Suicide is the second most common manner of death in both prisons and jails, but not in the general population. It takes up 9.56% of all the deaths in prisons, much lower than the 36.97% in jails. In the general population, suicide takes up 1.47%, lower than both prisons and jails.

Accidental death is rare in prisons, as it only takes up 1.79% of all the deaths. It is more common in jails and the general population, which takes up 7.88% and 6.56% respectively. Homicide is rare and only takes up less than 1% in the deaths in all three populations.

Since natural death is the most common manner of deaths in prisons, it is meaningful to examine natural deaths closely and at a fine-grained level.

Table 5: Death Breakdown in Prisons, Jails, and Pennsylvania General Population, 2017-19

Manner of Death	Prison	Jail[5]	General Population[6]
Natural Death	441 (87.85%)	90 (54.55%)	368,026 (91.02%)
Accidental Death	9 (1.79%)	13 (7.88%)	26,535 (6.56%)
Suicide	48 (9.56%)	61 (36.97%)	5,937 (1.47%)
Homicide	4 (0.80%)	1 (0.61%)	2,275 (0.56%)
Total	502 (100%)	165 (100%)	404,341(100%)[7]

3.4 Facility-level Prison Death Rates

Death rates are highly varied at the facility level. Figure 3 shows the death rates for all manners of death. SCI Pittsburgh and Quehanna Bootcamp are excluded due to the same reasons as above. In addition, SCI Laurel Highlands is excluded, because besides the general prison population, SCI Laurel Highlands also holds old people and people with special medical needs [17]. Consequently, it has a much higher death rate (17.68 per 100,000) than the other facilities, and including it in the plot will be obscure the variation among other facilities. Among the other facilities, death rates range from 0.28 to 6.14, with median 3.10. We do not observe an association between the death rates and the prison population size or the security level.

[5] Computed from the Pennsylvania County Prisons Statistics data and Extraordinary Occurrences data published on the PA DOC website. See `https://www.cor.pa.gov/Facilities/CountyPrisons/Pages/Inspection-Schedule,-Statistics-And-General-Info.aspx`.

[6] Computed from CDC Wonder Data. The mapping between ICD-10 and manners of death is as described in Table 1.

[7] In the Pennsylvania general population, there are 1568 death cases that are not mapped to one of Natural Death, Accidental Death, Suicide, and Homicide by our mapping scheme.

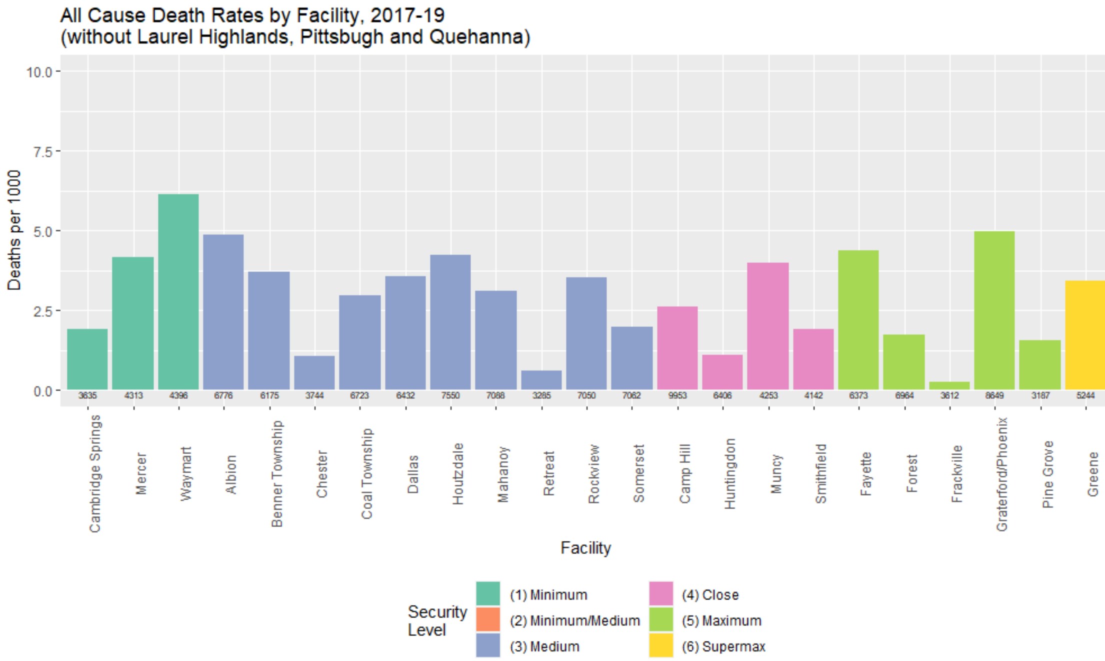

Figure 3: Facility-level Death Rates for All Causes of Death, 2017-19

Figure 4 shows the death rates for natural deaths. Since the majority of deaths in prisons are natural, it looks very similar to Figure 4. SCI Pittsburgh, Quehanna Bootcamp, and SCI Laurel Highlands are excluded for the same reasons as above. The death rate for natural deaths at SCI Laurel Highlands is still 17.68, as all death cases in SCI Laurel Highlands have been natural deaths in 2017 – 2019. Among the other facilities, death rates range from 0.28 to 5.91, with median 2.48.

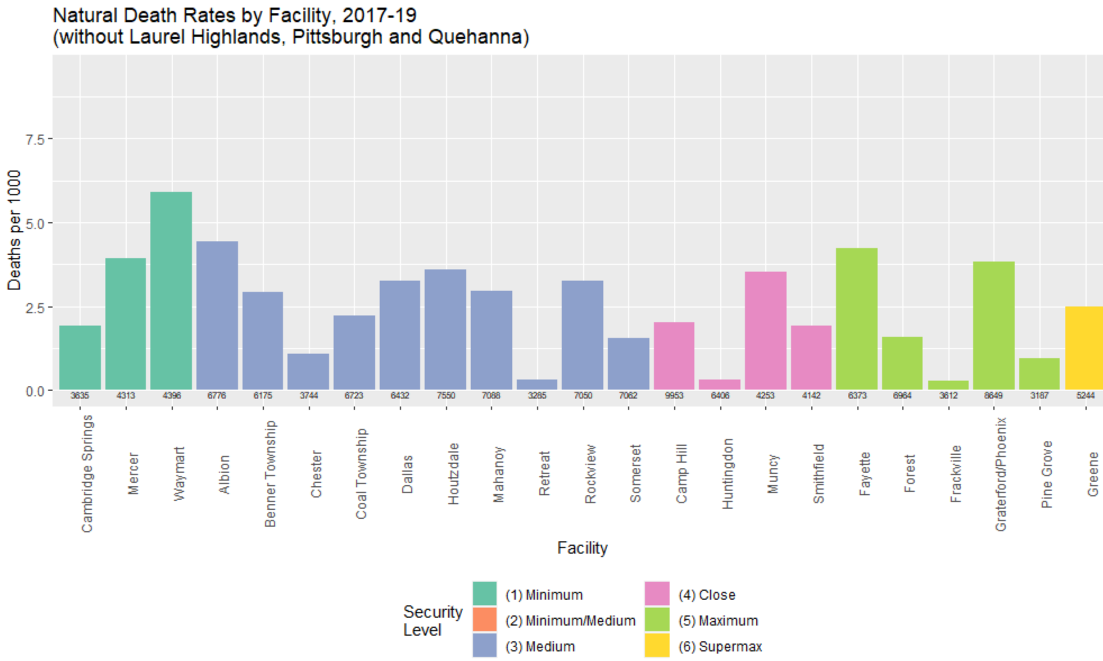

Figure 4: Facility-level Death Rates for Natural Deaths, 2017-19

Figure 5 shows the death rates for suicide, and Table 6 summarizes the actual number of suicides in each facility. Overall, suicides are rare in prisons. There are 48 cases of suicide at the state level in 2017 – 2019; most facilities have 0 or 1 suicide each year. Thus, Figure 6 should be interpreted with caution, as the variations in death rates are partially artifacts of the variations in population size. However, it is concerning that SCI Graterford/Phoenix has 9 cases of suicide across the 3 years, followed by SCI Camp Hill (6 cases), SC9 Huntingdon (5 cases), and SCI Houtzdale (4 cases).

The leading cause of deaths for suicides is Asphyxiation/Hanging, which accounts for 43 out of the 48 suicide cases. 3 cases have unspecified cause, one is caused by Head Trauma, and one is caused by Suicidal Laceration.

Table 6: Total Number of Suicides by Facility, 2017-19

Facility	**Number of Suicides**
Graterford/Phoenix	9
Camp Hill	6
Huntingdon	5
Houtzdale	4
Albion, Benner, Township, Coal Township	3
Dallas, Greene, Muncy, Rockview, Somerset	2
Forest, Mahanoy, Pine Grove, Retreat, Waymart	1
Other Facilities	0

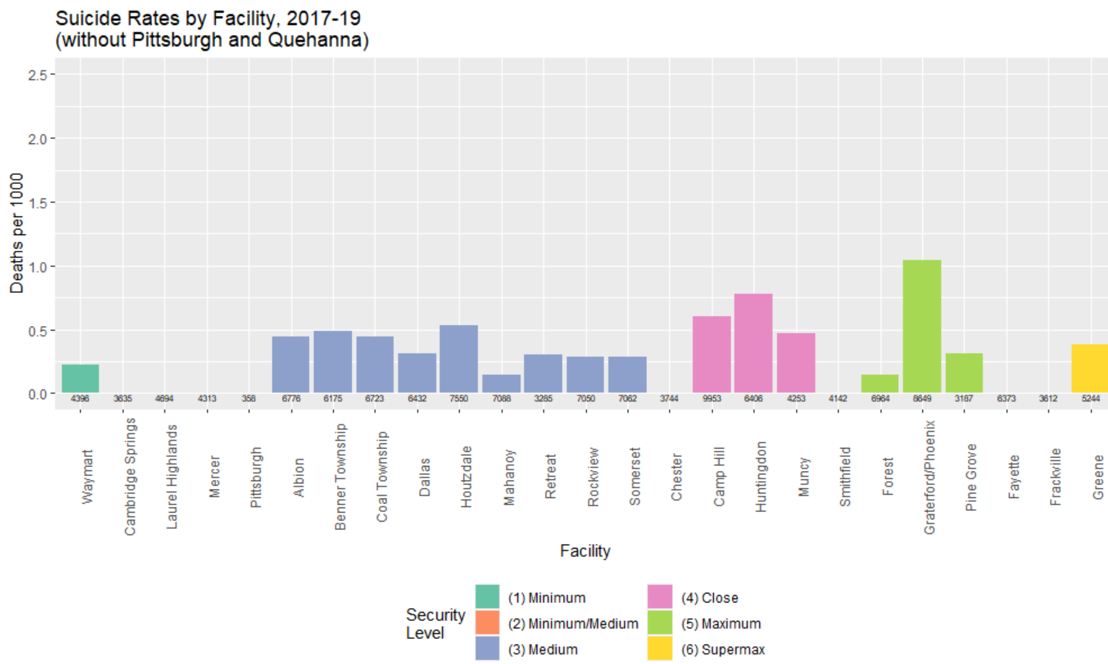

Figure 5: Facility-level Death Rates for Suicides, 2017-19

Table 7 summarizes the total number of accidental deaths by facility in 2017 – 2019. Accidents are even rarer than suicides, and at the state level, there are only 9 cases across the 3 years. The leading cause of accidental death is drug overdose (5 cases). Other causes include Acute Mixed Drug Intoxication (1 case), Hemoperitoneum (1 case), and Intracerebral Hemorrhage (1 case). One case has missing cause.

Table 7: Total Number of Deaths by Accidents by Facility, 2017-19

Facility	**Number of Suicides**
Greene	3
Coal Township	2
Benner Township, Houtzdale, Phoenix, Fayette	1
Other Facilities	0

Table 8 summarizes the total number of homicides by facility in 2017 – 2019. At the state level, there are only 4 cases of homicides in 2017 – 2019. The leading cause is Asphyxiation/Hanging/Strangulation (3 cases); the other case is caused by Blunt Force Trauma.

Table 8: Total Number of Homicides by Facility, 2017-19

Facility	**Number of Suicides**
Somerset, Pine Grove, Mercer, Benner Township	1
Other Facilities	0

3.5 State-level Prison Death Rates vs. Comparison Population Death Rates

Table 9 summarizes the comparison of state-level prison death rates and general population death rates standardized by different variables. The intervals in brackets are the 95% confidence intervals. For crude death rates, the confidence intervals are Poisson-based intervals. For standardized death rates, both a Poisson-based interval and a Gamma-based interval are reported. The top rows, in black text, are the Poisson-based intervals, and the bottom rows, in red text, are the Gamma-based intervals.

The confidence intervals provide an uncertainty quantification of our estimates, but they are not rigorous hypothesis tests. It should be noted that the number of accidental deaths and homicide deaths are smaller than 10, so we do not report the confidence intervals.

The crude general population death rates are very different from the crude prison population death rates, but they become much closer when we standardize by even only the age variable. Adding additional demographic variables – gender and race/ethnicity – further changes the standardized death rates. For deaths of all manners and natural deaths, the confidence intervals of the 5 death rates do not overlap, indicating that standardizing by different demographic variables indeed has an impact on the death rate estimates.

Table 9: Death Rates (per 1000 per year) Comparison by Manners of Death, 2017-19

	State Level Prison Population	**Crude General Population**	**Age Standardized General Population**	**Age and Gender Standardized General Population**	**Age, Gender and Race Standardized General Population**
All Manners of Death	3.54 [3.24, 3.87]	10.53 [10.49, 10.56]	3.88 [3.86, 3.90] [3.86, 3.90]	4.79 [4.76, 4.81] [4.75, 4.82]	5.64 [5.61 5.66] [5.58, 5.70]
Natural Death	3.11 [2.83, 3.42]	9.58 [9.55, 9.61]	2.73 [2.71, 2.75] [2.72, 2.75]	3.17 [3.15, 3.19] [3.15, 3.19]	3.80 [3.78, 3.82] [3.75, 3.84]
Suicide	0.34 [0.25, 0.45]	0.15 [0.15, 0.16]	0.19 [0.18, 0.19] [0.18, 0.19]	0.28 [0.27, 0.29] [0.27, 0.29]	0.23 [0.22, 0.24] [0.22, 0.24]
Accident	0.06	0.69 [0.68, 0.70]	0.81 [0.80, 0.82] [0.80, 0.82]	1.12 [1.11 1.13] [1.10, 1.14]	1.14 [1.12, 1.15] [1.11, 1.17]
Homicide	0.03	0.06 [0.06, 0.06]	0.09 [0.09, 0.09] [0.09, 0.09]	0.14 [0.14 0.14] [0.13, 0.15]	0.38 [0.37, 0.38] [0.36, 0.40]

For deaths of all manners, the prison death rate is 3.54 per 1000, 37.2% lower than the comparison population death rate (5.64 per 1000). This is probably because some forms of deaths, such as car accidents, cannot happen in prisons. Figure 6 shows the death rates by age groups. For all age groups, the comparison population has a higher death rate than the prison population, but the difference is smaller for older age groups.

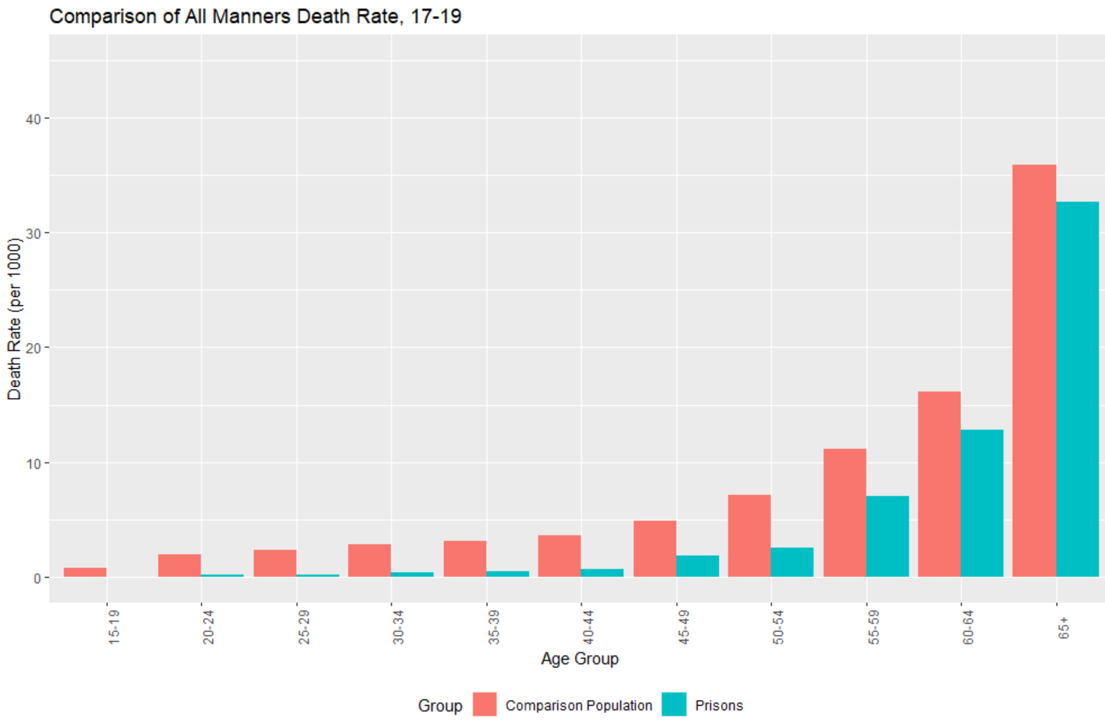

Figure 6: State-level Prison Death Rates vs. Comparison Population Death Rates by Age Group for Deaths of All Causes, 2017-19

For natural deaths, the prison death rate is 3.11 per 1000, 18.2% lower than the comparison population death rate (3.80 per 1000). This difference is much smaller than the difference between that of deaths of all manners. However, the confidence intervals of the prison population and he comparison population do not overlap with each other, which indicates a statistically significant difference between the two populations.

Figure 7 shows the death rates for natural deaths by age groups. For prison death rates, the distribution for natural deaths is similar to that of deaths of all manners, as the majority of deaths in prison are natural deaths. For all age groups, the comparison population has a higher death rate than the prison population, but the differences are smaller than those for all manners of deaths.

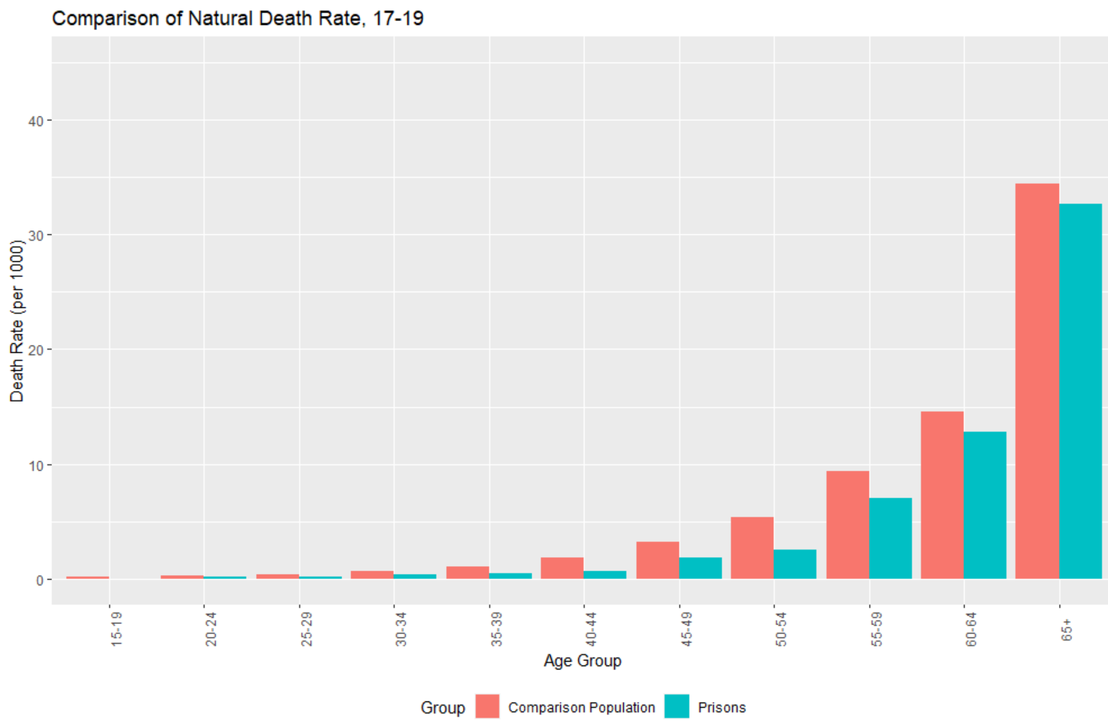

Figure 7: State-level Prison Death Rates vs. Comparison Population Death Rates by Age Group for Natural Deaths, 2017-19

For suicides, the prison death rate is 0.34 per 1000, 47.8% higher than the comparison population death rate (0.23 per 1000). However, their confidence intervals are close to overlapping[8], and the difference is not as large as the difference between the jail population and its corresponding comparison population: The death rate for suicide in jails is 0.56 per 1000 in 2015-2017, 194.7% higher than that of its comparison population (0.19[9] per 1000) [11].

For accidental deaths, the prison death rate is 0.06 per 1000, 94.7% lower than the comparison population death rate (1.14 per 1000). For homicides, the prison death rate is 0.03 per 1000, 92.1% lower than the comparison population death rate (0.38 per 1000).

3.6 Sensitivity Analysis of the Imputation of Comparison Population Death Data

The two imputation methods for estimating suppressed death rates make assumptions about the independence among certain variables. Imputation method 1 assumes that gender and race/ethnicity are independent, and imputation method 2 assumes that gender and age are both independent of race/ethnicity. We are interested in exploring whether these assumptions are reasonable, and how close the imputed death rates are to the real death rates.

[8] When aggregating only 2017-18 data, the confidence intervals indeed overlap.

[9] The demographic composition is different in jails and prisons, so the corresponding comparison populations and their death rates are different.

Figure 8 compares the imputed death rates using imputation method 1 vs. the real death rates for non-suppressed data. The imputed and real values are reasonably close, which implies that the assumptions made by imputation method 1 is reasonable.

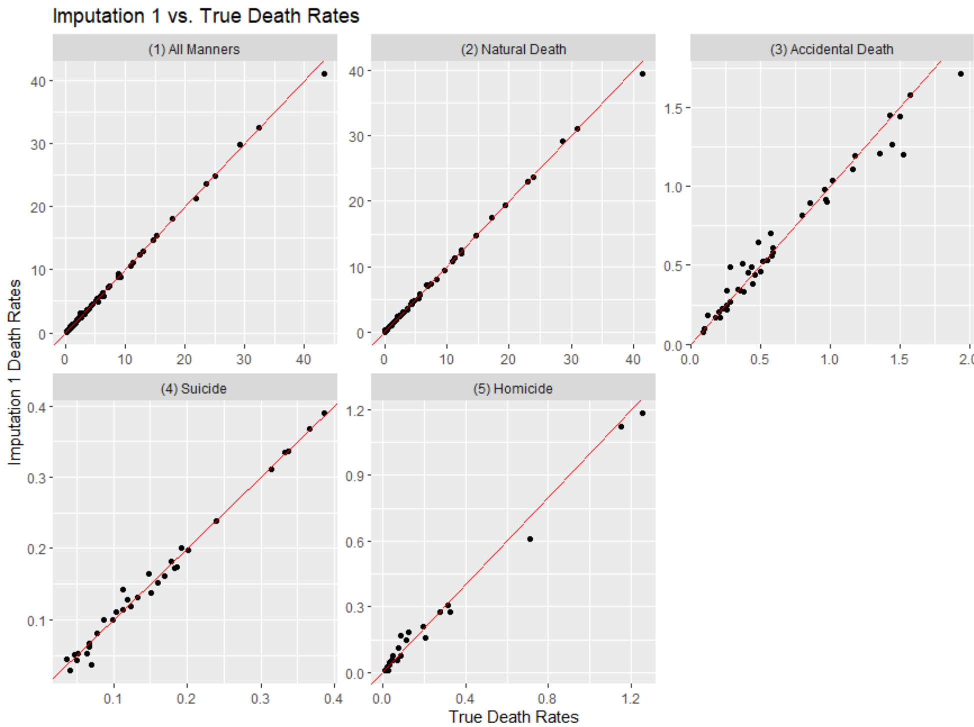

Figure 8: Sensitivity Analysis for Imputation Method 1

Figure 9 compares the imputed death rates using imputation method 2 vs. the real death rates for non-suppressed data. The imputed values in general follow the real values, but there are more noises, and the death rates are systematically overestimated or underestimated for all manners of deaths and natural deaths. However, the amount of data imputed with imputation method 2 is small, and most of them are suicide and homicide, where the imputed death rates seem to be more precise. Therefore, we do not expect the imputation with method 2 to significantly impact our results.

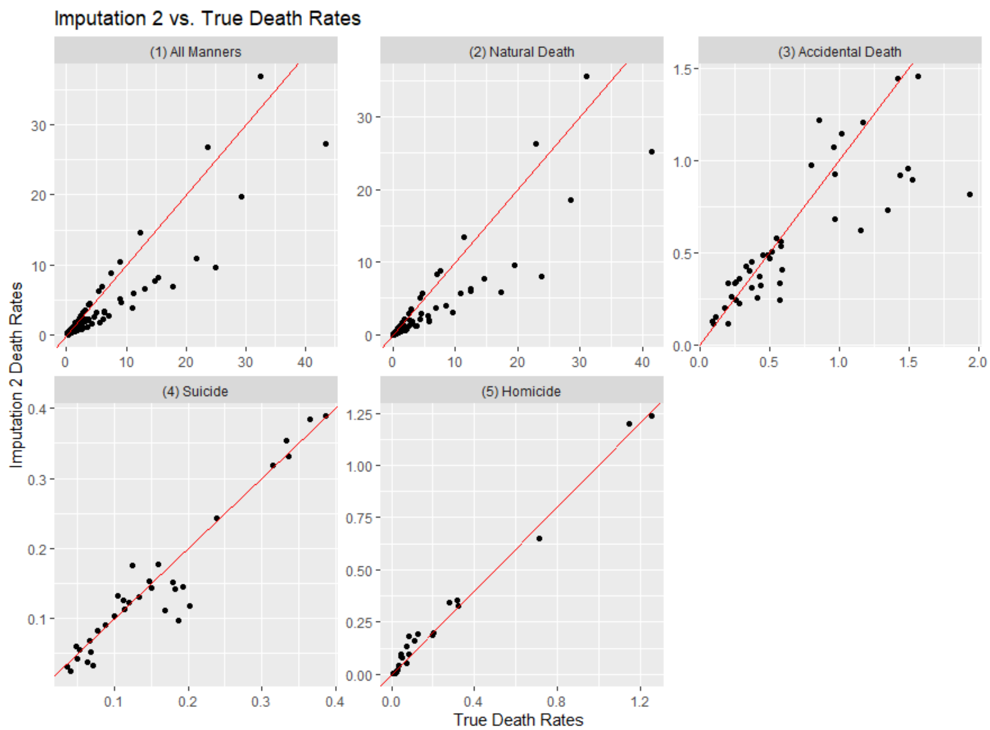

Figure 9: Sensitivity Analysis for Imputation Method 2

3.7 Detailed Causes of Death

Table 10 shows the death breakdown by the fine-grained cause of death categories for natural deaths, along with other manners of deaths, between 2017 - 2019. The categories are highly unbalanced. The two largest categories are other cancer excluding screenable cancer, GI cancer, and hematogenous malignancies (115 cases, 22.91%), and HASCVD excluding stroke (111 cases, 22.11%). When combing the subcategories together, cancer as a whole has 175 cases, taking up 34.86% of all the deaths, and HASCVD as a whole has 125 cases, taking up 24.90% of all the deaths. In other words, more than half of the deaths fall into either a category under cancer or a category under HASCVD.

The third largest category overall is suicide (48 cases, 9.56%), which is much smaller than HASCVD and other cancer. The third largest category among natural deaths is unscreenable GI cancer, which contains only 27 cases and take up 5.38% of all the cases. There are 10 categories with 10 to 30 observations, and 10 categories with fewer than 10 observations.

We have a special category “cause hard to classify”. It contains 17 observations, whose causes fall into one of the three circumstances:

1. **Uninformative cause**, including sudden cardiac death, respiratory failure, cardiorespiratory arrest, acute kidney injury, and hemorrhagic shock. These conditions can be caused by a diverse range of diseases and injuries, and they alone do not provide much information on the actual situations of an individual. For example, “respiratory failure” means that the lung

cannot get enough oxygen to the blood, and the conditions that cause it can range from pneumonia to spinal cord injury [18].

2. **Ambiguous cause**, including “acute and chronic respiratory failure”[10]. Acute respiratory failure and chronic respiratory failure are different in duration, symptom, and causes [19][20]. It is also possible to have an acute respiratory failure on top of chronic respiratory failure. We are not sure how to interpret it when they are merged into one cause.

3. **Unusual situations**, including “anoxic brain mass without trauma/injury”, and “sudden cardiac death, head trauma” that are classified as natural death for manner of death.

The majority of death categories have too few observations among prison deaths to provide meaningful statistical results, so we only evaluate excess deaths on only the two most common causes, cancer and HASCVD. When estimating the comparison population death rates, one challenge is that it is very rare for young people to die of cancer or HASCVD, so death counts for younger age groups, such as 15-24 and 25-34, are often suppressed in CDC Wonder Database. For screenable cancer, GI cancer, hematogenous maligancies, and stroke, the amount of data that need to be imputed is equivalent to more than 10% of the prison population, which makes the estimation less reliable. Thus, we choose to only report death rates for cancer as a whole and HASCVD as a whole.

The results are shown in Table 11. The death rate for cancer as a whole is slightly elevated in prisons (1.24 per 1000) as compared to the comparison population (0.98 per 1000). The death rate for HASCVD as a whole is slightly reduced in prisons (0.88 per 1000) as compared to the comparison population (1.41 per 1000). It should be noted, though, that these results should be interpreted with caution, because as discussed in Section 2.8, some cause of death data are ambiguous or uninformative, which may lead to misclassification. Also, the mapping between our data and the ICD-10 is only a rough match, because we do not have the exact ICD-10 coding of the prison deaths, and because our death categories and ICD-10 coding have different categorization philosophies.

[10]This cause is both ambiguous and uninformative in some sense.

Table 10: Death Breakdown by Cause of Death Categories, 2017-19

Category	**Count**	**Rate per 1000**	**Percent**
Cancer, Excluding Screenable Cancer, GI Cancer, and Hematogenous Malignancies	115	0.82	22.91%
Hypertensive Arteriosclerotic Cardiovascular Disease (HASCVD), Excluding Stroke	111	0.78	22.11%
Suicide	48	0.34	9.56%
Cancer, Unscreenable GI Cancer	27	0.19	5.38%
Infectious Disease, Excluding Hepatitis C and Pneumonia	22	0.16	4.38%
Cancer, Screenable: Breast, Cervical, Colorectal, Skin, Prostate, Oral	18	0.13	3.59%
Chronic Obstructive Pulmonary Disease (COPD)	18	0.13	3.59%
Hematogenous Malignancies	15	0.11	2.99%
Hepatitis C	15	0.11	2.99%
Liver Disease	14	0.10	2.79%
Renal Disease	14	0.10	2.79%
Stroke	14	0.10	2.79%
Neurologic Disease	12	0.09	2.39%
Pneumonia	8	0.06	1.59%
GI Disease, Other	7	0.05	1.39%
Overdose[11]	6	0.04	1.20%
Homicide	4	0.03	0.80%
Immunologic Disease	4	0.03	0.80%
Lung Disease	3	0.02	0.60%
Accidental Cause, Excluding Overdose	2	0.01	0.40%
Diabetes	2	0.01	0.40%
Failure to Thrive (FFT)	2	0.01	0.40%
Kidney Disease	1	0.01	0.20%
Causes that are Hard to Classify	17	0.12	3.39%
Cause Missing	3	0.02	0.60%

[11] Overdose is categorized as accidental death by manners of death, so it is not listed in the fine-grained natural death categories.

Table 11: Death Rates (per 1000 per year) Comparison by Death Categories, 2017-19

	State Level Prison Population	**Crude General Population**	**Age Standardized General Population**	**Age and Gender Standardized General Population**	**Age, Gender and Race Standardized General Population**
All Cancer	1.24 [1.06, 1.43]	2.19 [2.18, 2.21]	0.84 [0.83, 0.85] [0.83, 0.85]	0.90 [0.89, 0.91] [0.89, 0.91]	0.98 [0.97, 0.99] [0.96, 1.00]
All HASCVD	0.88 [0.73, 1.05]	3.25 [3.23, 3.27]	0.83 [0.82, 0.84] [0.82, 0.84]	1.07 [1.06, 1.08] [1.06, 1.08]	1.41 [1.39, 1.42] [1.38, 1.44]

4 Conclusion

Our analysis provides insights into several aspects of mortality in Pennsylvania prisons. First of all, mortality rates do not have an obvious relationship with the population size or security level of prisons.

Secondly, although existing literature like the RAND report [2] have expressed concerns about the availability and quality of medical care service in prisons, our analysis shows that the death rates of natural deaths is slightly reduced in prisons, and people in prisons tend to die older than the general population. However, this does not mean that problems do not exist in the medical care system, as mortality rate is only one of the many dimensions to measure the quality of medical care. Furthermore, our result can be interpreted in several ways. Prisons are controlled environments, so people have less access to drugs, alcohols, or unhealthy diets, which could lead to deaths at an earlier age. Also, we have not investigated the accessibility and quality of medical care outside prisons, and it is possible that some communities outside prisons do not have good medical care. Lastly, our analysis is limited by the scope of our data. We have only controlled for the age, gender, and race/ethnicity, but other variables that are not available in our data, such as mental health state or socioeconomic status, may also impact death rates. Also, our analysis is limited to the deaths that are included in the death register data. Our partner, Pennsylvania Prison Society, has expressed concerns that incarcerated people who have died when receiving treatment at facilities outside the prisons, or who have received compassionate release [21] just prior to death[12], may not be recorded in our data. If this is indeed the case, our prison death rates may be underestimated. We cannot assess this from our data, but it is meaningful to conduct further investigation on this issue.

Thirdly, our analysis shows that suicide rate is slightly elevated in prisons, but the difference between the prison suicide rate and the standardized general population death rate is not as large as the difference between the jail population and its corrsponding general population. This is probably because people who first enter jails often experience dramatic changes in their life and develop the initial “shock of confinement”, and consequently have a higher suicide risk. In contrast,

[12] Incarcerated people may be granted compassionate release if they have terminal or debilitated medical condition.

by the time people transition into prisons, they have been more adapted to the life of incarceration.

Furthermore, our analysis develops and analyzes fine-grained death categories for natural deaths in prisons. We find that the two largest death categories are other non-screenable cancer and other HASCVD excluding stroke, each taking up about 23% of all the prison deaths. When combining the subcategories together, more than half of all the death cases are either cancer or HASCVD. The death rates for cancer as a whole is slightly elevated in prisons, while the death rates for HASCVD as a whole is slightly reduced in prisons.

Lastly, our analysis shows that as identified by the RAND report, there is indeed a need for more and better data for studying prison mortality [2]. The causes of death in the death register data are unstandardized, and some are uninformative or ambiguous, which makes it hard to conduct analysis with them. Also, the demographic data for the death cases are very limited, which limits the scope of analysis that can be done. One future direction is to link the death register data with the National Death Index[13], a dataset of death records maintained by CDC. This could potentially help us evaluate the quality of death register data and give us more variables and more accurate information to work with.

[13] https://www.cdc.gov/nchs/ndi/index.htm

Appendix

A Amount of Data Imputed for the Comparison Population

	Number of Cells Imputed[14]	**Equivalent Proportion of Prison Population**
All Manners of Death	1/88	0.0006%
Natural Death	10/88	0.25%
Accident	4/48	0.03%
Suicide	17/48	3.19%
Homicide	19/48	5.08%
All Cancer	5/48	0.88%
All HASCVD	7/48	1.15%

B Mapping from Cause of Death to Fine-grained Cause Category

Raw Cause[15]	**Manner**	**Category**
Intracerebral Hemorrhage	A	Accidental Death (Other)
Hemoperitoneum	A	Accidental Death (Other)
Acute Mixed Drug Intoxication	A	Accidental Death (Overdose)
Drug Overdose	A	Accidental Death (Overdose)
Squamous Cell Lung Cancer, Metastatic Bladder Cancer	N	Cancer (Other Unscreenable)
Septic Shock, Metastatic Renal Cell Cancer, Metastatic Lung Cancer	N	Cancer (Other Unscreenable)
Bladder Cancer	N	Cancer (Other Unscreenable)
Carcinoma of Pancreas	N	Cancer (Other Unscreenable)
Pancreatic Cancer- metastatic, CHF, CKD, DM	N	Cancer (Other Unscreenable)
Gastrointestinal Bleed-End Stage Pancreatic Cancer	N	Cancer (Other Unscreenable)
Gastrointestinal Hemorrhage Hepatocellular Carcinoma (HCC)	N	Cancer (Other Unscreenable)
Glioblastoma	N	Cancer (Other Unscreenable)
Perforated Bowel due to diverticulitis - Glioblastoma	N	Cancer (Other Unscreenable)
Glioblastomas multiforme	N	Cancer (Other Unscreenable)
End Stage Liver Disease - HCC	N	Cancer (Other Unscreenable)
Head and Neck Cancer	N	Cancer (Other Unscreenable)
Head and Neck Squamous Cell Carcinoma with Metastases to the Lungs	N	Cancer (Other Unscreenable)

[14] A cell refers to a (age, gender, race/ethnicity) combination. x/y means that there are y such cells total, and x of them are imputed.

[15] They are taken directly from the Pennsylvania death register data, with only obvious typos fixed (e.g. changing "suddem cardiac death" to "sudden cardiac death"). It is observable that the causes are highly not standardized.

End Stage Liver Disease - Hepatocellular Carcinoma	N	Cancer (Other Unscreenable)
Gastrointestinal Bleed, End Stage Liver Disease, Hepatocellular Carcinoma	N	Cancer (Other Unscreenable)
Hepatocellular Carcinoma	N	Cancer (Other Unscreenable)
Hepatocellular Carcinoma (HCC)	N	Cancer (Other Unscreenable)
Hepatocellular Carcinoma (HCC) - Hereditary Hemochromatosis	N	Cancer (Other Unscreenable)
Laryngeal Cancer	N	Cancer (Other Unscreenable)
Cancer, Larynx	N	Cancer (Other Unscreenable)
Larynx Cancer	N	Cancer (Other Unscreenable)
Malignant Neoplasm Nasopharynx	N	Cancer (Other Unscreenable)
Sepsis MultiOrgan Failure, Mestatic Cancer Unknown Primary	N	Cancer (Other Unscreenable)
Pancreatic Cancer- metastatic	N	Cancer (Other Unscreenable)
Metastatic Adenocarcinoma of Unknown Origin	N	Cancer (Other Unscreenable)
Metastatic Bladder Cancer	N	Cancer (Other Unscreenable)
Metastatic Carcinoma of the Bladder	N	Cancer (Other Unscreenable)
Metastatic Carcinoma of Unknown Primary Site	N	Cancer (Other Unscreenable)
Metastatic Carcinoma to the Pancreas	N	Cancer (Other Unscreenable)
Metastatic Cholangiocarcinoma	N	Cancer (Other Unscreenable)
Metastatic Endometrial Adeno Carcinoma	N	Cancer (Other Unscreenable)
Metastatic Medullary Thyroid Cancer	N	Cancer (Other Unscreenable)
Metastatic Mesothelioma	N	Cancer (Other Unscreenable)
Metastatic Pancreatic Cancer	N	Cancer (Other Unscreenable)
Metastatic Renal Cancer	N	Cancer (Other Unscreenable)
Metastatic Salivary Gland Carcinoma	N	Cancer (Other Unscreenable)
Oropharyngeal Carcinoma	N	Cancer (Other Unscreenable)
Pancreatic Cancer	N	Cancer (Other Unscreenable)
Pancreatic Cancer with Liver Metastases	N	Cancer (Other Unscreenable)
Pancreatic Cancer with Metastases	N	Cancer (Other Unscreenable)
Parotid Mucoepidermoid Cancer with Bone Metastieses	N	Cancer (Other Unscreenable)
Renal Cell Cancer	N	Cancer (Other Unscreenable)
Pancreatic Cancer - Septic Shock	N	Cancer (Other Unscreenable)
Metastatic Cancer - Unknown Primary	N	Cancer (Other Unscreenable)
Adenocarcinoma - Metastatic - Unknown Primary Origin	N	Cancer (Other Unscreenable)
Carcinoma of Lung	N	Cancer (Other Unscreenable)
Lung Cancer	N	Cancer (Other Unscreenable)
Pulmonary Embolism / Lung Cancer	N	Cancer (Other Unscreenable)
Lung Cancer Metastatic to Brain and Adrenal	N	Cancer (Other Unscreenable)
Lung Cancer with Brain Metastasos	N	Cancer (Other Unscreenable)
Lung Cancer with Metastases	N	Cancer (Other Unscreenable)
Lung Cancer with Metastases to Brain and Liver	N	Cancer (Other Unscreenable)
Lung Cancer with Metastases to the Spine	N	Cancer (Other Unscreenable)
Carcinoma, Lung w/ Metastates	N	Cancer (Other Unscreenable)
Metastatic Carcinoma of Lung	N	Cancer (Other Unscreenable)

Metastatic Carcinoma of the Lung	N	Cancer (Other Unscreenable)
metastatic cell Carcinoma of Lung	N	Cancer (Other Unscreenable)
Metastatic Lung Cancer	N	Cancer (Other Unscreenable)
Metastatic Lung Cancer	N	Cancer (Other Unscreenable)
Metastatic Non Small Cell Lung Cancer	N	Cancer (Other Unscreenable)
Metastatic Squamous Cell Carcinoma of the Lung	N	Cancer (Other Unscreenable)
Carcinoma of the Lung, Respiratory Failure, post-operative	N	Cancer (Other Unscreenable)
Lung Cancer Metastases to Brain S/P Craniotomy	N	Cancer (Other Unscreenable)
Metastatic Lung Cancer - Septic Shock Due to Bowel Perforation	N	Cancer (Other Unscreenable)
Non-Small Cell Carcinoma of the Lung with Metastases to the Spine	N	Cancer (Other Unscreenable)
Lung Cancer (non-small cell)	N	Cancer (Other Unscreenable)
Metastatic Lung Cancer - Esophageal Cancer	N	Cancer (Other Unscreenable)
Hepatocellular Carcenoma (HLC) - Prostate Cancer	N	Cancer (Other Unscreenable)
Squamous Cell Cancer - Respiratory Failure	N	Cancer (Other Unscreenable)
CA of Lung, COPD	N	Cancer (Other Unscreenable)
Adenocarcinoma of the Gastroesophageal Junction	N	Cancer (Unscreenable GI)
Esophageal Cancer	N	Cancer (Unscreenable GI)
Esophageal Cancer with Metastases	N	Cancer (Unscreenable GI)
Gastric Ademocarcinoma	N	Cancer (Unscreenable GI)
Gastric Cancer	N	Cancer (Unscreenable GI)
Esophageal Cancer - Liver Metastases	N	Cancer (Unscreenable GI)
Metastatic Anal Cancer	N	Cancer (Unscreenable GI)
Metastatic Esophageal Squamous Cell Carcinoma	N	Cancer (Unscreenable GI)
Metastatic Gastric Carinoma	N	Cancer (Unscreenable GI)
Metastatic Rectal Cancer	N	Cancer (Unscreenable GI)
Rectal Cancer	N	Cancer (Unscreenable GI)
Metastatic Esophageal Cancer, Repiratory Failure, Atrial Fibrillation	N	Cancer (Unscreenable GI)
Colon Cancer	N	Cancer (Unscreenable GI)
Colon Cancer with metastases	N	Cancer (Unscreenable GI)
Colon Cancer with Metasteses to the Liver	N	Cancer (Unscreenable GI)
Colorectal Cancer	N	Cancer (Unscreenable GI)
Mestatic Colon Cancer	N	Cancer (Unscreenable GI)
Colon Cancer - Metastases to Bone	N	Cancer (Unscreenable GI)
Metastatic Colon Cancer	N	Cancer (Unscreenable GI)
Carcinoma of Prostate Gland	N	Cancer (Screenable)
Sepsis Due to Brain Abscess - Invasive Basal Cell Carcinoma Scalp	N	Cancer (Screenable)
Metastatic Carcinoma of the Prostate Gland	N	Cancer (Screenable)
Breast Cancer	N	Cancer (Screenable)

Cerebral Vascular Accident post Hemi-Colectomy for Colon Cancer	N	Cancer (Screenable)
Metastatic Breast Cancer	N	Cancer (Screenable)
Metastatic Melanoma	N	Cancer (Screenable)
Metastatic Prostate Cancer	N	Cancer (Screenable)
Oral Cavity Squamous Cell Cancer	N	Cancer (Screenable)
Prostate Cancer	N	Cancer (Screenable)
Cancer, Tonsil	N	Cancer (Screenable)
Tonsillar Cancer	N	Cancer (Screenable)
Melanoma	N	Cancer (Screenable)
acute lymphoblastic leukemia	N	Hematogenous Malignancies
Acute Lymphoblastic Leukemia	N	Hematogenous Malignancies
Acute Lymphoblastic Leukemia (ALL)	N	Hematogenous Malignancies
Acute Myelogenous Leukemia (AML)	N	Hematogenous Malignancies
Acute Myeloid Leukemia	N	Hematogenous Malignancies
Acute Myoloid Leukemia (AML)	N	Hematogenous Malignancies
Chronic Lymphocytic Leukemia (CLL)	N	Hematogenous Malignancies
Leukemia (AML)	N	Hematogenous Malignancies
Non-Hodgkin's Lymphoma	N	Hematogenous Malignancies
Hodkins Lymphoma	N	Hematogenous Malignancies
Lymphoma	N	Hematogenous Malignancies
Multiple Myeloma	N	Hematogenous Malignancies
Acute and Chronic Respiratory Failure, Chronic Obstruction Pulmonary Disease	N	COPD
Chronic Obstructive Lung Disease	N	COPD
Acute and Chronic Respiratory Failure, Polmonary Mebolus, Chronic Obstructive Pulmonary Disease	N	COPD
Chronic Obstructive Pulmonary Disease	N	COPD
Chronic Obstructive Pulmonary disease (COPD)	N	COPD
Chronic Obstructive Pulmonary Disease (COPD)	N	COPD
COPD	N	COPD
End Stage Chronic Obstruction Lung Disease (COPD)	N	COPD
End Stage COPD	N	COPD
COPD, A-Fib	N	COPD
Acute and Chronic Respiratory Failure, Secondary to chronic Obstructive Lung Disease	N	COPD
Congestive Heart Failure, End Stage Emphysema	N	COPD
End Stage Emphysema	N	COPD
Repiratory Failure - Pneumonia - COPD	N	COPD
Septic Shock, Chronic Renal Failure, Diabetes Mellitus	N	Diabetes
cardiogenic shock, chronic renal failure, disbetes mellitus	N	Diabetes

Cachexia	N	FTT
Failure to Thrive, End Stage Renal Disease, Diabetes	N	FTT
Acute Peritonitis	N	GI Disease
Respiratory Failure due to Perforated Bowel	N	GI Disease
Gastrointestinal Hemorrhage	N	GI Disease
GI Bleed	N	GI Disease
Small Bowel Obstruction	N	GI Disease
Peritonitis	N	GI Disease
Acute Myocardial Infacrtion	N	HASCVD
Acute Myocardial Infarction	N	HASCVD
Acute Myocardial Infarction (AMI)	N	HASCVD
AMI	N	HASCVD
AMI Acute Myocardial Infarction	N	HASCVD
aortic dissection with cardiac tamponade	N	HASCVD
Cardiac Tamponade-Dissection and Rupture of Asending Thoracic Aorta	N	HASCVD
Ruptured Abdominal Aortic Aneurysm	N	HASCVD
Cerebral Hemorrhage, Berry Aneurysm Rupture	N	HASCVD
Brain Herniation - Intracerebral Hemorrhage	N	HASCVD
Intracerebral Hemorrhage	N	HASCVD
Intracirebral Hemorahage	N	HASCVD
Intracranial Hemorrhage	N	HASCVD
Cerebral Hemorrhage - Seizures	N	HASCVD
Subdural Hemorrhage	N	HASCVD
Arteriosclerotic Heart Disease - Chronic Obstructive Pulmonary Disease	N	HASCVD
Sudden Cardiac Death, Chronic Obstructive Pulmonary Disease	N	HASCVD
Cardiopulmonary Arrest, CAD, COPD	N	HASCVD
Congestive Heart Failure, CAD, COPD	N	HASCVD
Heart Attack/Arrhythmia/COPD	N	HASCVD
Sudden Cardiac Death, Athero Sclerotic Coronary Artery Disease	N	HASCVD
Recurrent Aspiration Complications, Atherosclerotic Cardiovascular Disease	N	HASCVD
Congestive Heart Failure, Ischemic Cardiomyopathy, Atherosclerotic Coronary Artery Disease	N	HASCVD
Sudden Cardiac Death, Atherosclerotic coronary artery disease	N	HASCVD
Sudden Cardiac Death, Chronic Congestive Heart Failure, Atherosclerotic Coronary Artery Disease	N	HASCVD
Atherosclerotic Disease	N	HASCVD
Atherosclerotic Heart Disease	N	HASCVD
Congestive Heart Failure, Atherosclortic Coronary Artery Disease	N	HASCVD

CHF, COPD, CAD	N	HASCVD
Pneumonia, CHF, CAD	N	HASCVD
Congestive Heart Failure, Mitral Regurgitation, Coronary Artery Disease	N	HASCVD
Coronary Artery Disease	N	HASCVD
Ischemic Cardiomyopathy, Coronary Artery Disease	N	HASCVD
Coronary Artery Disease (CAD) Sarcoidosis	N	HASCVD
Sudden Cardiac Death, Chronic Renal Failure, Diabetes	N	HASCVD
Anoxic Brain Injury/Arrhythmia/Diabetes Mellitus	N	HASCVD
Heart Attack/Ischemic Cardiomyopathy/Diabetes Mellitus	N	HASCVD
Ischemic Cardiomyopathy - Diabetes Mellitus	N	HASCVD
Cardiorespitory Arrest, Arteriosclerotic Cardiovascular Disease, Type I Diabetes	N	HASCVD
Sudden Cardiac Death, Type I Diabetes Mellitus	N	HASCVD
Sudden Cardiac Death, Type II Diabetes	N	HASCVD
Sudden Cardiac Death, Ischemic Cardio Myopathy, Type II Diabetes Mellitus	N	HASCVD
Heart Attack	N	HASCVD
Acute Cerebrovascular Accident, Hypertension	N	HASCVD
Sudden Cardiac Death, Hypertension	N	HASCVD
Pulmonary Embolism	N	HASCVD
Pulmonary embolism resulting in cardiac arrest	N	HASCVD
Pulmonary Embolus	N	HASCVD
Respiratory Failure S/P Cardiac Surgery	N	HASCVD
Sudden Cardiac Death, Thoracic Aneurysm Repair	N	HASCVD
Congestive Heart Failure, Aortic Vacular Heart Disease	N	HASCVD
Congestive Heart Failure, Aortic Valvular Disease	N	HASCVD
Acute Respiratory Failure/Aspiration Pneumonia/Atrial Fibrillation	N	HASCVD
Congestive Heart Failure - Atrial Fibrillation	N	HASCVD
Cardiac Arrhythmia	N	HASCVD
Cardiac Arrest due to Cardiac Tamponade	N	HASCVD
Cardiomyopathy	N	HASCVD
Cardiopulmonary Arrest, ARF, CHF	N	HASCVD
Acute Myocardial Infarction - Congestive Heart Failure	N	HASCVD
Congestive Heart Failure	N	HASCVD
COPD - Congestive Heart Failure	N	HASCVD
Congestive Heart Failure (CHF)	N	HASCVD

Anoxic Brain Injury Due to Cardiac Arrest-Heart Failure Due to Cardiomyopathy	N	HASCVD
Hypertensive Cardiomegaly	N	HASCVD
Ischemic Cardiomyopathy	N	HASCVD
Sepsis - Ischemic Cardiomyopathy	N	HASCVD
Myocardial Hypertrophy	N	HASCVD
Heart Attack/Atherosclerotic Heart Disease/End Stage Renal Disease	N	HASCVD
Cardiogenic shock, Atherosclerotic Coronary Artery Disease, End Stage Renal Failure	N	HASCVD
End Stage Liver Disease , Chronic Hep-C	N	Hepatitis C
End stage liver disease, Chronic Hep-C	N	Hepatitis C
Hepatocellular Carcinoma, End Stage Liver Disease, Hep-C	N	Hepatitis C
Hepatocellular Carcinoma, Hep-C	N	Hepatitis C
Metastatic Hepatocellular carcinoma, Hep-C	N	Hepatitis C
Upper Gastro Intestinal Bleeding, Hep-C Infection	N	Hepatitis C
Acute Gastrointestinal Bleed-Cirrhosis Due to Hep C	N	Hepatitis C
End Stage Liver Disease - Hep C	N	Hepatitis C
Hepatocellular Carcinoma, Cirrhosis due to Hep C	N	Hepatitis C
Metastatic Hepatocellular Carcinoma due to Hep C	N	Hepatitis C
Sepsis-MultiOrgan Failure-Bowel Obstruction-End Stage Liver Disease-Hep C	N	Hepatitis C
ESLD, ESRD, HVC	N	Hepatitis C
Hepatocellular Carcinoma, Hep C, End Stage Liver Disease	N	Hepatitis C
Hepatocellular Carcinoma/Hep C/Atrial Fibrillation	N	Hepatitis C
Asphyxiation	H	Homicide
Blunt Force Trauma	H	Homicide
Asphyxiation due to Hanging/Strangulation	H	Homicide
Strangulation	H	Homicide
Klebsiella infection	N	ID
Intracranial Hemorrhage, Sepsis	N	ID
Sepsis, Chronic Obstructive Pulmonary Disease	N	ID
PML - HIV - AIDS	N	ID
Septic Shock, AIDS	N	ID
Congestive Heart Failure, HIV	N	ID
C2 Cell Lymphoma, HIV Infection	N	ID
Sepsis, Acute Respiratory Distress Syndrome	N	ID
Sudden Cardiac Death, Bacterial Endocarditis	N	ID
Myocarditis	N	ID
End Stage Renal Disease-Severe Anemia-Gangrene	N	ID

Septic Shock - Metabolic Acidosis	N	ID
Sepsis with Multi Organ Failure, Acute Respiratory Failure	N	ID
Septicemig, Intra-abdominal Infection	N	ID
Sepsis - MultiOrgan Failure	N	ID
Sepsis, Respiratory Failure	N	ID
Repiratory Failure, Sepsis	N	ID
Sepsis	N	ID
Respiratory Failure due to Septic Shock	N	ID
Viral Meningitis	N	ID
Sepsis, Chrohn's Disease	N	Immunologic Disease
Sarcoidosis, Pulmonary	N	Immunologic Disease
Sepsis, Post-Operative Pulmonary Embola, Post-Operative Chrohn's Disease	N	Immunologic Disease
Systemic Lupus Erythematosis (SLE), Acute Kidney Injury (AKI)	N	Immunologic Disease
Pneumonia, Acute Kidney Disease	N	Kidney Disease
Alcohol Induced Cirrhosis	N	Liver Disease
Sepsis, Alcoholc Cirrhosis	N	Liver Disease
End Stage Renal Disease - Cirrhosis	N	Liver Disease
Pneumonia, Cirrhosis	N	Liver Disease
Acute Cholecystitis, Mirsa Sepsis, End Stage Liver Disease	N	Liver Disease
End Stage Liver Disease	N	Liver Disease
Multiple Myeloma - End Stage Liver Disease	N	Liver Disease
End Stage Liver Disease (ESLD)	N	Liver Disease
Septric Shock, End Stage Kidney Disease, End State Liver Disease	N	Liver Disease
Liver Cirrhosis	N	Liver Disease
End Stage Lung Disease	N	Lung Disease
Chronic Interstitial Lung Disease	N	Lung Disease
Acute Interstitial pneumonia	N	Lung Disease
ALS	N	Neurological Disease
Amytrophic Lateral Sclerosis (ALS)	N	Neurological Disease
End Stage Alzheimers Disease	N	Neurological Disease
Huntington's Disease	N	Neurological Disease
Multiple Sclerosis	N	Neurological Disease
Respiratory Failure, Parkinson's Disease	N	Neurological Disease
Seizure Disorder	N	Neurological Disease
Respiratory Failure - Status Epilepticus	N	Neurological Disease
Acute Respiratory Failure - Dementia	N	Neurological Disease
Dementia - Neurocognitive Disorder	N	Neurological Disease
Anoxic Encephalopathy, Acute Respiratory Failure, Pneumonia	N	Pneumonia
Pneumonia	N	Pneumonia
Sepsis - Pneumonia	N	Pneumonia
Sepsis, Pneumonia	N	Pneumonia
Sepsis Penumonia	N	Pneumonia

Sepsis Pneumonia	N	Pneumonia
Pneumonia, Staphyloccal Bacteremea	N	Pneumonia
Sepsis, Diabetes Mellitus, Chronic Renal Failure	N	Renal Disease
Arrhythmia Due to Hyperkolemia-End Stage Renal Disease	N	Renal Disease
Sepsis - End Stage Renal Disease	N	Renal Disease
Sepsis, End Stage Renal Disease	N	Renal Disease
Sepsis/Pneumonia/End Stage Renal Disease	N	Renal Disease
Septic Shock, End Stage Renal Disease	N	Renal Disease
Sudden Cardiac Death, End stage Renal Disease	N	Renal Disease
End Stage Renal Disease (ESRD)	N	Renal Disease
Respiratory Failure - Sepsis - End Stage Renal Disease (ESRD)	N	Renal Disease
Sepsis - End Stage Renal Disease (ESRD)	N	Renal Disease
Sudden Cardiac Death, End Stage Renal Failure	N	Renal Disease
Acute Renal Failure - Metabolic Acidosis	N	Renal Disease
Renal Failure	N	Renal Disease
Atherosclerotic Cerebrovascular Disease	N	Stroke
Sepsis, Atherosclerotic Cerebrovascular Disease	N	Stroke
Cerebral Vascular Accident	N	Stroke
Cerebral Vascular Accident (CVA)	N	Stroke
Hemorrhagic Cerebrovascular Accident	N	Stroke
Cerebral Vascular Accident (CVA) - Respiratory Failure	N	Stroke
Asphyxiation by Hanging, Anoxic Brain Injury	S	Suicide
Asphyxiation by Hanging	S	Suicide
Asphyxiation Due to Hanging	S	Suicide
Asphyxiation by Hanging-Schizoaffective Disorder-Depressive Type	S	Suicide
Exsanguination Due to Suicidal Laceration	S	Suicide
Suicide - Hanging	S	Suicide
Suicide - Head Trauma	S	Suicide
Suicide	S	Suicide
Suicide Asphyxiation by Hanging	S	Suicide
Suicide by Hanging	S	Suicide
Anoxic brain mass without trauma/injury	N	Hard to Classify
Sudden Cardiac Death, Head Trauma	N	Hard to Classify
Acute Kidney Injury	N	Hard to Classify
Cardiogenic Shock Post Operative Laparotomy	N	Hard to Classify
Cardio Respiratory Arrest	N	Hard to Classify
Acute and Chronic Respiratory Failure	N	Hard to Classify
Respiratory Failure	N	Hard to Classify
Hemorrhagic Shock	N	Hard to Classify
Sudden Cardiac Death	N	Hard to Classify

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