

# A Projection Model of the Prevalence of Selected Chronic Diseases in the Inmate Population

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## Introduction

Little is known about the prevalence of chronic diseases in the inmate population or the potential impact on the community when inmates with chronic diseases are released. To address these unknowns, the National Institute of Justice (NIJ) commissioned a study to investigate the health status of soon-to-be-released inmates and awarded a grant to the National Commission on Correctional Health Care (NCCHC). The project's steering committee<sup>1</sup> named an expert panel on chronic disease and, working with that panel, targeted four chronic diseases for study: asthma, diabetes, hypertension, and heart disease.

Inmates with chronic medical conditions such as those targeted for study in this project do not represent the same kind of threat to the health status of the general community when they are released as do inmates with communicable diseases such as hepatitis, tuberculosis (TB), and human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS). Nonetheless, inmates with chronic disease have a significant effect on the correctional health care system, and it is reasonable to expect that they will affect the health care system in the general community when they are released. Persons who delay or do not receive needed ambulatory care are at increased risk of becoming more seriously ill and requiring hospitalization. Thus, undertreated chronically ill inmates affect the community during incarceration and following release

through increased demand for acute care and costly tertiary services.<sup>2</sup>

Providing quality health care services to inmates with chronic diseases can place a significant strain on the correctional health care system in terms of both the manpower required to provide needed services and the costs of treatment. Avoidable hospitalizations have been defined as those that could potentially be avoided in the presence of appropriate and timely ambulatory care. The organizational and budgetary stresses on the prison health system created by chronic disease conditions within the inmate population are expected to increase as the inmate population ages. No less important are the consequences for the health care system in the community when inmates are released after receiving poor quality care within the prison system. The inmate whose diabetes or hypertension is poorly managed while incarcerated is, when released back into the community, more likely to use costly health care services (e.g., dialysis for renal failure or emergency room visits for glucose control or stroke).

The steering committee and the expert panel on chronic disease sought to determine the prevalence of asthma, diabetes, hypertension, and heart disease in the inmate population and the burden of these conditions on both the correctional health care system and the health care system in the community. Measuring the impact of chronic disease among soon-to-be-released inmates requires either accurate data on the prevalence of

disease among inmates or projections of disease prevalence derived from other comparable populations.

Because accurate data on the prevalence of diseases in the inmate population do not exist, an alternative method for estimating the burden of disease and the prevalence of the target conditions in the correctional population must be employed. One method is to use information on the prevalence of the condition or disease in a known population and apply these age-, gender-, and race-specific disease prevalence rates to the target population. This projection model yields estimates of the expected number of prisoners with that disease.

### **The National Health and Nutrition Examination Survey (NHANES)**

The National Health and Nutrition Examination Survey (NHANES) is one of the major health surveys conducted by the National Center for Health Statistics (NCHS).<sup>3</sup> The survey was first conducted between 1971 and 1974 (NHANES-I), redone in 1976–78 (NHANES-II), done in the Hispanic population in 1982–84 (Hispanic NHANES) and conducted most recently between 1988 and 1994 (NHANES-III). NHANES represents the seventh in a series of surveys done on complex multistage samples designed to yield national estimates of the nutrition and health status of the civilian noninstitutionalized population aged 2 months and older in the United States. The most recent NHANES, NHANES-III, was chosen as the reference population to calculate prevalence rates for the four target chronic conditions. These rates were then applied to the inmate population to estimate the expected number of cases of each condition within the prison system.

Estimates of the prevalence of asthma, diabetes, hypertension and heart disease in the civilian noninstitutionalized population were calculated from the NHANES-III data. The principal data from NHANES-III were taken from the Household

Adult Questionnaire, physical examinations conducted at mobile examination centers, and laboratory test results. These three data files were merged and a weighted analysis was done using SPSS/PC 7.5 statistical software.

The prevalence of each of the four chronic diseases of interest—asthma, diabetes, hypertension, and coronary heart disease—was examined by age, race and gender. Sampling weights were used to estimate rates representative of the U.S. population. The results obtained in the analyses employing all noninstitutionalized civilian cases are based upon a weighted sample size of 187,644,316 cases. Age-adjusted gender- and race-specific rates for the U.S. population older than 17 were calculated and standardized to the 1990 U.S. Census. These rates were then applied to the 1995 State and Federal prison and local jail population estimates provided by NIJ. Estimates based on calculations involving all NHANES-III cases provide the baseline projections of disease in the system and are referred to in this report as the baseline estimates.

Because the poor and economically disadvantaged are disproportionately present in the prison and jail population, prevalence rates also were determined from NHANES-III for the lowest quartile of socioeconomic status (SES) in the United States. This subset analysis selected from the population all individuals who were receiving public assistance in the form of welfare, supplementary security income (SSI), or food stamps. These filters reduced the weighted sample size to 66,444,192 individuals who can be said to reflect the lowest quartile of SES in the United States. Estimates of disease prevalence in the inmate population based upon calculations involving the lowest quartile of SES constitute a more realistic expectation of the prevalence of disease among incarcerated individuals. Projections of disease prevalence made from the subsample analysis are called the low SES estimates.

## Asthma

Asthma is a chronic inflammatory disease of the airways that affects between 14 and 15 million individuals, of whom about 4.8 million are children.<sup>4</sup> As pointed out in the *Expert Panel Report 2: Guidelines for the Diagnosis and Management of Asthma*,<sup>5</sup> asthma results in about 100 million days of restricted activity, 470,000 hospitalizations, and 5,000 deaths annually.

Tables 1 and 2 give the prevalence rates for asthma estimated from the NHANES–III data for the baseline and low SES models, respectively.

These rates are based on self-reports of having been diagnosed with asthma and current medical treatment. Baseline race-specific rates shown in table 1 show that Hispanics have the lowest prevalence rate for asthma—about 6.1 cases per 100—while both whites and blacks have rates of about 8 cases per hundred. In the low SES estimates of prevalence (see table 2), whites have the highest prevalence rate for asthma at 9.1/100, followed by blacks at 8.8/100, with Hispanics showing the lowest rate among racial-ethnic groups at 6/100.

Age	White 8.0		Black 8.0		Hispanic 6.1	
	Male 7.6	Female 8.3	Male 7.3	Female 8.5	Male 6.2	Female 6.1
≤19	6.3	10.4	9.8	14.5	4.3	9.0
20–29	8.5	7.4	9.2	5.3	2.5	4.0
30–39	7.1	9.4	6.0	7.9	11.0	3.3
40–49	0.9	9.1	5.5	11.0	7.8	7.3
50–59	6.6	8.7	8.4	9.0	3.3	9.5
60+	6.9	7.1	5.9	8.8	8.5	10.3

Age	White 9.1		Black 8.8		Hispanic 6.0	
	Male 9.2	Female 8.9	Male 8.1	Female 9.3	Male 5.7	Female 6.1
≤19	10.0	12.9	11.2	14.4	5.3	10.2
20–29	10.1	9.1	10.8	5.7	1.7	3.2
30–39	9.0	11.3	7.4	9.2	13.3	3.8
40–49	11.2	15.0	5.7	14.3	5.7	5.4
50–59	14.9	5.6	5.6	9.5	5.6	5.3
60+	6.6	7.0	6.8	8.8	4.4	13.5

Applying the baseline and low SES age-, race-, and gender-specific rates presented in tables 1 and 2 to the demographic profile of the State prison population yields the expected number of cases of asthma under the two prevalence models (see tables 3 and 4). Given the race, gender and age composition of the State prison systems, the baseline model predicts higher rates of asthma among white inmates (7.9/100) than among black (7.6/100) and Hispanic (6/100) inmates. The low SES model predicts even higher prevalence rates of asthma for both white (10.1/100) and black (8.8/100) inmates but not Hispanic (6/100) inmates.

The overall rate of asthma in prisons projected by the baseline model is 7.2 cases per 100 inmates. The low SES estimate is 20 percent higher than the baseline model and predicts about 15,000

more cases in the prison systems. The increased number of cases is concentrated among white males (7,576 cases) and black males (5,555 cases).

Tables 5 and 6 present the predicted number of cases of asthma in the inmate population in State prisons, Federal prisons and local jails. The baseline model predicts a total of 118,461 cases of asthma in the incarcerated population (see table 5). The low SES model predicts about 20 percent more cases of asthma among inmates. In both models, approximately 63 percent of the cases are predicted to be in State prisons, and another 31 percent are predicted to be in local jails. Almost 93 percent of the cases are predicted to occur among males; black and white males account for the vast majority of the cases. Fewer than 10 percent of the asthma cases among inmates are predicted to be women.

Age	White 7.9		Black 7.6		Hispanic 6.0	
	Male 7.9	Female 8.6	Male 7.6	Female 8.3	Male 6.1	Female 4.4
≤19	497	48	2,247	51	252	6
20–29	11,196	656	17,807	667	1,929	147
30–39	8,475	855	9,550	980	6,017	120
40–49	4,854	297	2,740	337	1,422	99
50–59	1,336	88	741	55	183	23
60+	639	20	364	16	111	4
<b>Total</b>	<b>26,997</b>	<b>1,964</b>	<b>33,449</b>	<b>2,106</b>	<b>9,914</b>	<b>399</b>

Age	White 10.1		Black 8.8		Hispanic 6.0	
	Male 10.1	Female 10.7	Male 8.9	Female 8.3	Male 6.2	Female 3.9
≤19	789	59	2,568	50	311	6
20–29	13,304	807	20,904	717	1,312	118
30–39	10,744	1,028	11,778	1,141	7,001	138
40–49	6,109	489	2,840	438	1,039	73
50–59	3,016	57	494	58	310	13
60+	611	19	420	16	57	5
<b>Total</b>	<b>34,573</b>	<b>2,459</b>	<b>39,004</b>	<b>2,420</b>	<b>10,030</b>	<b>353</b>

<b>Sex and Race</b>	<b>National</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
White male	5,617,797	43,109	26,998	2,693	13,419
White female	6,685,466	3,848	1,963	166	1,718
Black male	697,645	49,735	33,448	1,858	14,428
Black female	967,783	4,166	2,105	189	1,871
Hispanic male	463,360	16,704	9,913	1,772	5,019
Hispanic female	439,955	899	398	98	403
<b>Total</b>	<b>14,872,006</b>	<b>118,461</b>	<b>74,825</b>	<b>6,776</b>	<b>36,858</b>
<b>Rate</b>	<b>7.8</b>	<b>7.2</b>	<b>7.2</b>	<b>7.1</b>	<b>7.1</b>

<b>Sex and Race</b>	<b>National</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
White male	7,344,857	55,590	34,572	3,642	17,377
White female	7,826,035	4,831	2,459	210	2,162
Black male	768,833	57,846	39,003	2,110	16,734
Black female	1,078,199	4,793	2,420	220	2,153
Hispanic male	448,718	16,878	10,030	1,781	5,067
Hispanic female	416,326	800	353	84	364
<b>Total</b>	<b>17,882,968</b>	<b>140,738</b>	<b>88,837</b>	<b>8,047</b>	<b>43,857</b>
<b>Rate</b>	<b>9.4</b>	<b>8.5</b>	<b>8.6</b>	<b>8.5</b>	<b>8.5</b>

## Diabetes Mellitus

Diabetes is a chronic condition that contributes significantly to morbidity and mortality. Diabetes is a leading cause of renal failure and the need for dialysis and a major risk factor for cardiovascular disease and blindness.<sup>6</sup>

Data to determine the prevalence of diabetes were taken from the NHANES–III Laboratory Data File. Blood and urine specimens were collected on examinees aged 1 year or older at the mobile examination center by certified phlebotomists or medical technicians. Examinees aged 12 and older were instructed to fast for 10–16 hours if their medical examination was scheduled for the morning or for at least 6 hours if their examination was scheduled for the afternoon. An oral glucose

tolerance test was given to examinees aged 40–74 who did not report current insulin therapy. The fasting specimens and the 2-hour glucose levels were determined in accordance with the expert committees' rules for the identification, diagnosis and classification of diabetes mellitus. Individuals with a normal fasting glucose of less than 110 mg/dL are considered not to have diabetes. Those with fasting glucose values greater than 126 mg/dL are considered to have diabetes. Individuals with glucose levels between 110 and 126 mg/dL are defined as having impaired fasting glucose.

Before the publication of new diagnostic guidelines in 1997,<sup>7</sup> a fasting blood glucose of 140 mg/dL or higher was the cutoff point for defining diabetes. The new guidelines lowered

that threshold to 126 mg/dL. Nevertheless, the researchers first analyzed the prevalence of diabetes in the NHANES–III data to predict the number and distribution of cases among inmates according to the 140 mg/dL criteria. Subsequent analysis explored the prevalence and predicted number of “new” cases among inmates whose fasting glucose is between 126 and 139 mg/dL. Finally, the prevalence of impaired fasting glucose, defined by the new diagnostic criteria as 110–125 mg/dL, was analyzed. The results of the glucose tolerance test given to a sample of examinees aged 40–74 were not analyzed because this age group is small in the incarcerated population.

The NHANES–III data in table 7 shows that the prevalence of diabetes according to the former diagnostic criteria of a fasting serum glucose equal to or greater than 140 mg/dL is highest among blacks and females, and increases with age for both males and females and for all races. The highest rates of diabetes are found among

blacks, particularly black females older than 60, approximately 20 percent of whom have diabetes. The prevalence of diabetes is known to be highest in lower SES groups as reflected in table 8. In the low SES groups, the prevalence rates for diabetes are also highest among blacks and females and they increase with age.

The increase in prevalence of diabetes with age implies that the prison population, because it is younger than the general population, will have lower rates of diabetes than in the general population. Table 9 shows the number of cases of diabetes by race, gender, and age that are expected in the State prison population based upon the prevalence in the U.S. population according to the >140 mg/dL standard. These baseline rates predict that approximately 21,000 State prison inmates will be found to have diabetes. Predicted cases are concentrated among black male inmates (10,570; 50.3 percent) with about 7,400 (35 percent) occurring among whites.

Age	White 4.8		Black 6.4		Hispanic 4.4	
	Male 4.7	Female 4.8	Male 5.5	Female 7.2	Male 3.3	Female 5.5
≤19	0.0	1.2	0.6	0.0	0.4	0.2
20–29	0.4	0.0	1.3	0.8	0.1	0.4
30–39	1.8	1.7	1.9	2.3	0.6	2.3
40–49	3.0	3.5	5.5	6.7	3.9	7.0
50–59	9.9	5.3	13.0	14.5	6.7	12.7
60+	11.5	11.9	16.3	22.4	18.6	18.8

Age	White 7.1		Black 8.0		Hispanic 5.1	
	Male 6.4	Female 7.5	Male 6.3	Female 9.3	Male 3.5	Female 6.5
≤19	0.0	0.0	1.0	0.0	0.7	0.3
20–29	0.7	0.0	2.3	1.2	0.2	0.3
30–39	2.2	2.3	1.7	3.5	0.7	3.6
40–49	7.0	7.5	6.9	9.0	2.9	8.7
50–59	12.0	9.6	13.3	16.8	9.5	14.3
60+	12.0	13.6	16.1	24.2	18.8	20.6

Age	White 2.1		Black 2.4		Hispanic 1.2	
	Male 2.2	Female 1.6	Male 2.4	Female 2.5	Male 1.1	Female 2.6
≤19	0	6	138	0	23	0
20–29	527	0	2,516	101	77	15
30–39	2,149	155	3,024	285	328	83
40–49	1,636	114	2,740	205	711	95
50–59	2,004	54	1,146	89	371	31
60+	1,065	33	1,006	39	242	7
<b>Total</b>	<b>7,381</b>	<b>362</b>	<b>10,570</b>	<b>719</b>	<b>1,752</b>	<b>231</b>

Table 10 presents the predicted number of cases based upon estimates obtained from the lowest quartile of SES. These higher prevalence rates predict a total of more than 27,600 cases of diabetes among State prison inmates, which is about 30 percent higher than the baseline estimates. The number of white male inmates predicted to have diabetes increases by 47 percent to almost 11,000 (10,906). This total is nearly as many as the predicted number of black male inmates with diabetes (12,992). These increases reflect differences in the age distribution of men in State prisons between blacks and whites. A disproportionate number of older men in State prisons are white.

Tables 11 and 12 show the expected number of cases of diabetes (fasting serum glucose  $\geq$  140 mg/dL) in State and Federal prisons and local jails using the baseline and low SES models. The gender- and race-specific age-adjusted rates based on the baseline model are 2.0/100 for State prisons, 3.0/100 for Federal prisons, and 1.8/100 for local jails. Table 11 shows that under this model, an estimated 32,984 diabetics are incarcerated: about 21,000 in State prisons, 2,800 in Federal prisons, and more than 9,000 in local jails.

Table 12 shows the higher estimates of the prevalence of diabetes among inmates obtained from the lowest quartile of SES. The total number of diabetics predicted in this model is 43,557. State prisons are predicted to house more than 27,000 diabetics (2.7 per 100). Federal prisons are

predicted to have the highest prevalence (3.8 per 100), with about 3,640 diabetic inmates. Local jails are predicted to have the lowest prevalence (2.4 per 100), with some diabetic 12,305 inmates.

The difference in predicted prevalence rates across Federal, State, and local institutions reflects differences in the age distributions of inmates in these facilities.

The newest guidelines for diagnosing and treating diabetes, published in 1997, lowered the level of fasting serum glucose for the clinical diagnosis of diabetes from 140 to 126 mg/dL and defined serum glucose values between 110 and 125 mg/dL as impaired fasting glucose. Using the laboratory test data for the sample of NHANES cases that were given fasting serum glucose tests, the prevalence rates were calculated by gender, race, and age using all tested cases and those in the lowest quartile of SES. These estimates of undiagnosed diabetes were then applied to the inmate population. Table 13 reports the predicted number of additional cases of diabetes using the baseline model and the lower threshold serum glucose level. Table 14 reports the predicted number of additional cases using the low SES model and the lower threshold serum glucose level.

The baseline model and the new guidelines for diagnosing diabetes (126 mg/dL) together project 22,233 more diabetics in the inmate population in addition to the 32,984 projected with the baseline model and the older 140 mg/dL diagnostic

Age	White 3.1		Black 3.0		Hispanic 1.2	
	Male 3.2	Female 2.6	Male 3.0	Female 3.5	Male 1.1	Female 3.3
≤19	0	0	229	0	41	0
20–29	922	0	4,452	151	154	11
30–39	2,626	209	2,706	434	328	130
40–49	3,818	245	3,438	276	529	118
50–59	2,429	97	1,173	103	526	35
60+	1,111	38	994	43	245	7
<b>Total</b>	<b>10,906</b>	<b>589</b>	<b>12,992</b>	<b>1,007</b>	<b>1,823</b>	<b>301</b>

Sex and Race	National	All Incarcerated	State Prisons	Federal Prisons	Local Jails
White male	3,432,634	11,683	7,381	1,231	3,073
White female	3,860,357	704	361	44	299
Black male	518,147	15,628	10,570	833	4,225
Black female	855,714	1,380	720	81	580
Hispanic male	230,393	3,099	1,753	559	787
Hispanic female	393,971	490	230	77	183
<b>Total</b>	<b>9,291,426</b>	<b>32,984</b>	<b>21,015</b>	<b>2,825</b>	<b>9,147</b>
<b>Rate</b>	<b>4.9</b>	<b>2.1</b>	<b>2.0</b>	<b>3.0</b>	<b>1.8</b>

Sex and Race	National	All Incarcerated	State Prisons	Federal Prisons	Local Jails
White male	4,333,899	17,410	10,906	1,811	4,695
White female	5,214,549	1,139	588	74	477
Black male	563,277	19,236	12,991	983	5,262
Black female	1,006,612	1,943	1,006	109	828
Hispanic male	243,549	3,193	1,823	567	804
Hispanic female	463,221	636	301	96	239
<b>Total</b>	<b>11,825,107</b>	<b>43,557</b>	<b>27,615</b>	<b>3,640</b>	<b>12,305</b>
<b>Rate</b>	<b>6.2</b>	<b>2.8</b>	<b>2.7</b>	<b>2.8</b>	<b>2.4</b>



<b>Sex and Race</b>	<b>National</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
White male	2,185,740	6,402	4,037	728	1,637
White female	1,721,532	310	162	21	128
Black male	229,548	8,952	6,002	482	2,467
Black female	482,871	1,192	606	64	522
Hispanic male	227,554	5,008	2,889	759	1,359
Hispanic female	303,596	369	172	66	131
<b>Total</b>	<b>5,150,841</b>	<b>22,233</b>	<b>13,868</b>	<b>2,120</b>	<b>6,244</b>
<b>Rate</b>	<b>2.7</b>	<b>1.4</b>	<b>1.3</b>	<b>2.2</b>	<b>1.2</b>

<b>Sex and Race</b>	<b>National</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
White male	2,635,929	7,163	4,535	828	1,801
White female	2,644,042	350	183	24	142
Black male	448,861	14,946	10,200	765	3,981
Black female	806,081	1,630	845	89	696
Hispanic male	276,447	5,678	3,281	885	1,511
Hispanic female	477,591	623	295	103	226
<b>Total</b>	<b>7,288,951</b>	<b>30,390</b>	<b>19,339</b>	<b>2,694</b>	<b>8,357</b>
<b>Rate</b>	<b>3.8</b>	<b>2.0</b>	<b>1.9</b>	<b>2.8</b>	<b>1.6</b>

criterion (see table 13). The new criterion for diagnosing diabetes increases the projected prevalence among inmates by 67 percent to a total of 55,217 (3.5/100) cases among all inmates. The increased prevalence is largest among inmates of Federal prisons, where more than 5 percent of inmates are projected to be diabetic.

The increase in the prevalence of diabetes is even greater using the new diagnostic standard and the low SES model (see table 14). Nearly 70 percent more diabetics are projected in the inmate population, giving a projected total of 73,947 (4.8/100). Most of the additional cases are predicted to occur among males and black inmates with the greatest increase in prevalence in Federal prisons. The 1997 diagnostic criteria not only lowered the

level of serum glucose from  $\geq 140$  to  $\geq 126$  mg/dL for the clinical diagnosis of diabetes, but they also included the category of “impaired fasting glucose,” which is defined as a fasting serum glucose from 110 to 125 mg/dL. Tables 15 and 16 show the number of inmates with impaired fasting glucose projected by the baseline and low SES models.

Unlike with diabetes, there is little difference in the number of inmates with impaired fasting glucose projected by the baseline and low SES models. Both models predict between 78,000 (5.0/100) and 80,000 (5.2/100) inmates to have impaired fasting glucose, with about 60 percent of the cases being in State prisons, 12 percent in Federal prisons, and 28 percent in local jails.

<b>Sex and Race</b>	<b>National</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
White male	6,755,874	33,152	20,784	2,953	9,423
White female	4,267,485	661	344	43	274
Black male	614,312	24,400	16,736	1,165	6,499
Black female	714,564	1,841	939	99	803
Hispanic male	1,067,648	17,471	10,341	2,268	4,862
Hispanic female	369,594	483	231	71	181
<b>Total</b>	<b>13,789,477</b>	<b>78,008</b>	<b>49,375</b>	<b>6,599</b>	<b>22,042</b>
<b>Rate</b>	<b>7.3</b>	<b>5.0</b>	<b>4.8</b>	<b>6.9</b>	<b>4.3</b>

<b>Sex and Race</b>	<b>National</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
White male	6,700,284	33,560	21,067	2,940	9,560
White female	4,239,662	678	353	45	280
Black male	615,687	26,619	18,213	1,266	7,140
Black female	716,207	1,892	964	100	828
Hispanic male	608,166	16,641	9,852	2,145	4,645
Hispanic female	345,101	483	230	68	185
<b>Total</b>	<b>13,225,107</b>	<b>79,873</b>	<b>50,679</b>	<b>6,564</b>	<b>22,638</b>
<b>Rate</b>	<b>7.0</b>	<b>5.2</b>	<b>4.9</b>	<b>6.9</b>	<b>4.4</b>

Table 17 summarizes the results obtained from the Low SES model. The pre-1997 definition of clinical diabetes (fasting serum glucose  $\geq 140$  mg/dL) predicts about 43,500 cases of diabetes in the inmate population, while the new diagnostic criteria (fasting serum glucose  $\geq 126$  mg/dL) predicts about 30,000 more cases. When those predicted to have impaired fasting glucose are added, more than 150,000 inmates are projected to have abnormal glucose metabolism.

## Hypertension

The large decline in cardiovascular disease mortality rate that began in the late 1960s, particularly the decline in stroke mortality, is largely due to better diagnosis and treatment of hypertension.<sup>8</sup> Nevertheless, hypertension remains

a significant health problem and a leading cause of heart disease, stroke, and renal failure. Hypertension and its consequences disproportionately affect blacks and individuals of low socioeconomic status. Accordingly, even with adjustments for age, the prevalence of hypertension is expected to be a significant health problem among the incarcerated population.

The NHANES–III Adult Interview asked respondents if they were ever told they had high blood pressure. In addition, interviewers were trained to take and record multiple blood pressure measurements. Hypertension projections were compiled from self-reports of a history of high blood pressure and blood pressure measurements taken according to protocols recommended by the American Heart Association. Hypertension was

<b>Serum Glucose (mg/dL)</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
≥140	43,557	27,615	3,640	12,305
126–139	30,390	19,339	2,694	8,357
110–125	79,873	50,679	6,564	22,638
<b>Total</b>	<b>153,820</b>	<b>97,633</b>	<b>12,898</b>	<b>43,300</b>

defined according to JNC–VI criteria ( $\geq 140$  mmHg systolic and/or  $>90$  mmHg diastolic) using the mean systolic and mean diastolic pressures from multiple readings from the adult household survey and/or the physical examination.<sup>9</sup> Also included among those defined as hypertensive were patients who reported a diagnosis of hypertension in the adult household interview.

Table 18 gives gender-, race-, and age-specific rates of hypertension for the U.S. population. More than 30 percent of the black population is hypertensive compared to about 25 percent of whites and 18 percent of Hispanics. The rates are higher for females and increase with age, particularly after age 30. More than one-half of blacks older than 50 are hypertensive. Table 19 shows the gender-, race-, and age-specific prevalence rates for hypertension in the lowest SES quartile of the U.S. population. In the lowest quartile of SES, hypertension rates for blacks are nearly 30 percent higher than for whites.

Tables 20 and 21 show the number of inmates projected to have hypertension based on the baseline and low SES estimates of the prevalence of hypertension in the U.S. population. The projected race- and gender-specific rates among inmates are relatively low, reflecting the younger age distribution of the incarcerated population. Although 24.6 percent of whites in the general population have hypertension (see table 18), the rate among white inmates in State prisons projected by the baseline model is only 16.1 percent (see table 20). The prevalence rates for hypertension for blacks and Hispanics in the general U.S. population are 30.2 percent and 18.0 percent (see table 18); the projected rates among the incarcerated population for these groups are 18.6 percent for blacks and 11.1 percent for Hispanics (see table 20).

Table 21 gives prevalence rates for hypertension derived from the lowest quartile of SES in the U.S. population and applied to State prisons.

<b>Age</b>	<b>White 24.6</b>		<b>Black 30.2</b>		<b>Hispanic 18.0</b>	
	<b>Male 23.7</b>	<b>Female 25.5</b>	<b>Male 27.5</b>	<b>Female 32.3</b>	<b>Male 16.7</b>	<b>Female 19.3</b>
≤19	7.3	5.1	2.5	5.5	1.9	2.7
20–29	8.8	12.0	12.8	10.5	5.0	9.0
30–39	15.3	11.2	19.9	21.5	13.9	13.7
40–49	26.2	18.5	32.8	40.8	17.9	24.0
50–59	36.2	34.3	53.2	55.9	44.4	26.8
60+	41.0	50.6	55.8	66.8	36.1	51.2

Age	White 31.8		Black 32.9		Hispanic 20.0	
	Male 26.9	Female 35.3	Male 27.5	Female 36.8	Male 18.9	Female 21.0
≤19	10.0	4.0	2.1	9.6	2.9	3.1
20–29	9.6	17.5	12.6	11.4	6.7	9.6
30–39	19.3	18.7	16.9	21.6	17.0	15.8
40–49	27.9	33.1	37.0	56.2	15.2	24.0
50–59	48.3	37.7	50.6	64.3	51.6	27.3
60+	40.7	53.5	55.1	74.2	42.2	57.3

Age	White 16.1		Black 18.6		Hispanic 11.1	
	Male 16.3	Female 13.9	Male 18.5	Female 19.6	Male 10.9	Female 13.8
≤19	576	23	573	19	111	2
20–29	11,591	1,064	24,775	1,321	3,858	332
30–39	18,264	1,019	31,673	2,667	7,603	496
40–49	14,290	604	16,341	1,250	3,264	325
50–59	7,327	347	4,691	343	2,458	65
60+	3,797	140	3,444	118	470	18
<b>Total</b>	<b>55,845</b>	<b>3,197</b>	<b>81,497</b>	<b>5,718</b>	<b>17,764</b>	<b>1,238</b>

Age	White 19.2		Black 17.7		Hispanic 14.0	
	Male 19.0	Female 21.2	Male 17.7	Female 17.8	Male 14.0	Female 14.9
≤19	789	18	482	24	170	2
20–29	12,645	1,551	24,388	1,585	5,170	354
30–39	23,039	1,701	26,899	1,602	11,213	572
40–49	15,217	1,080	18,434	1,489	2,826	325
50–59	9,775	381	4,462	391	2,856	66
60+	3,769	148	3,401	118	550	21
<b>Total</b>	<b>65,234</b>	<b>4,879</b>	<b>78,066</b>	<b>5,209</b>	<b>22,785</b>	<b>1,340</b>

Although the low SES projected rates of hypertension for whites and Hispanics in State prisons increase by about 3 percent from the baseline model, the rate for blacks in State prisons actually decreases by nearly 1 percent, from 18.6 to 17.7 percent. These differences are related to the age distributions of whites, blacks, and

Hispanics in the State prison population (blacks in State prisons tend to be younger than whites and Hispanics). The baseline model predicts that more than 165,000 inmates with hypertension are in State prisons. The number of inmates projected by the low SES model is about 7 percent higher—177,513 hypertensive inmates.

Tables 22 and 23 show the number of hypertensive inmates that are predicted in State prisons, Federal prisons, and local jails. The baseline projection model (table 22) predicts that State prisons, Federal prisons, and local jails together house more than one-quarter of a million inmates with hypertension. In spite of the large number, the rate of hypertension among inmates is predicted to be about 66 percent of the rate for the general population. This relatively low rate is a consequence of the disproportionate share of young persons, in whom hypertension rates are lowest, in the prison population. The lowest rates are predicted for local jails (14.7/100), followed by State prisons (16.0/100), with the highest rate predicted to occur in Federal prisons (19.2/100), which house the oldest inmates.

The low SES model projects more than 283,000 inmates with hypertension. Although this is 9 percent higher than the baseline model projections ( $n = 259,170$ ), there are no striking differences between the two models. The prevalence of

hypertension is still predicted to be highest among Federal prison inmates (21.6/100) and lowest among local jail inmates (16.1/100). Regardless of which projection model is used and in spite of the finding that the projected prevalence of hypertension among inmates is lower than in the general population (as a result of differences in age composition), hypertension is a significant problem among inmates. At least one-quarter of a million inmates are predicted to have hypertension. Both the baseline and low SES projection models may understate the prevalence of elevated blood pressure and hypertension because neither model takes into account the effects of incarceration on stress and the body's reaction to it, which is likely to elevate blood pressure. Hypertension is projected to be a significant problem in the incarcerated population in terms of the number of inmates affected and the demand and need for health services, particularly if the sequelae of hypertension, including heart disease, stroke, and renal failure, are to be in the prison and in the community when inmates are released.

**Table 22. Expected Number of Hypertensives in the Incarcerated Population: Baseline Estimates**

<b>Sex and Race</b>	<b>National</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
White male	17,298,916	89,428	55,845	7,521	26,602
White female	20,511,964	6,170	3,196	306	2,669
Black male	2,598,315	120,003	81,498	5,742	32,764
Black female	3,741,008	11,107	5,717	564	4,825
Hispanic male	1,132,968	29,825	17,764	3,858	8,202
Hispanic female	1,383,541	2,637	1,237	318	1,082
<b>Total</b>	<b>46,666,712</b>	<b>259,170</b>	<b>165,257</b>	<b>18,309</b>	<b>76,144</b>
<b>Rate</b>	<b>24.5</b>	<b>16.7</b>	<b>16.0</b>	<b>19.2</b>	<b>14.7</b>

**Table 23. Expected Number of Hypertensives in the Incarcerated Population: Low SES Estimates**

<b>Sex and Race</b>	<b>National</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
White male	19,476,236	104,836	65,235	8,813	30,788
White female	25,437,936	9,438	4,879	461	4,098
Black male	2,548,491	115,207	78,064	5,615	31,528
Black female	4,125,784	12,866	5,208	653	5,593
Hispanic male	1,368,835	37,911	22,788	4,621	10,505
Hispanic female	1,495,490	2,847	1,339	339	1,169
<b>Total</b>	<b>54,452,772</b>	<b>283,105</b>	<b>177,513</b>	<b>20,502</b>	<b>83,681</b>
<b>Rate</b>	<b>28.6</b>	<b>18.3</b>	<b>17.2</b>	<b>21.6</b>	<b>16.1</b>

## Heart Disease

Heart disease, particularly coronary artery disease or ischemic heart disease, is the leading cause of death in the United States. Although the rate of death from heart disease has declined since 1968 due to advances in diagnosis and treatment and, most importantly, changes in behavior including reduced smoking, less fat and cholesterol in the daily diet, and an increase in the percentage of the population who engage in routine exercise, heart disease continues to account for approximately 50 percent of the deaths in the United States each year. Rates of heart disease are higher in blacks than whites and in men than women, and they increase with age. Consequently, as the number of inmates older than 50 increases, heart disease in the inmate population will become increasingly prevalent.

The NHANES–III interview included the Rose Questionnaire, which was developed more than 30 years ago to distinguish between cardiac and noncardiac chest pain.<sup>10</sup> The questionnaire,

administered by an interviewer, includes nine questions about pain or discomfort in the chest including when pain occurs (i.e., when hurrying or walking up hill); how long it lasts; how and when it is relieved, and in what part of the chest, neck, and arms it is located. Scoring algorithms enable the pain to be classified as angina (i.e., due to myocardial ischemia) or not, to be graded for severity, and to be classified associated or not associated with possible myocardial infarction. In studies of the ability of the Rose Questionnaire to differentiate between patients with coronary artery disease and those without, the sensitivity was found to be 81 percent and the specificity was found to be 97 percent.<sup>11</sup> In other words, the Rose Questionnaire correctly identified 81 percent of patients with documented coronary artery disease and 97 percent of those without coronary artery disease.

Tables 24 and 25 show the prevalence rates for coronary artery disease calculated from the Rose Questionnaire using the baseline and low SES models. Rates are higher among blacks than

Age	White 6.1		Black 6.6		Hispanic 5.2	
	Male 6.3	Female 5.8	Male 5.4	Female 7.6	Male 4.2	Female 6.2
≤19	0.0	2.5	1.1	4.1	1.4	1.9
20–29	1.0	2.6	3.3	3.9	2.4	3.9
30–39	1.7	2.3	2.4	5.0	4.2	5.8
40–49	4.4	4.9	4.1	6.7	4.1	6.9
50–59	8.3	4.9	9.1	13.3	5.0	6.9
60+	18.3	12.7	15.3	15.3	12.6	14.3

Age	White 10.3		Black 8.6		Hispanic 6.1	
	Male 10.8	Female 9.9	Male 7.6	Female 9.3	Male 5.1	Female 7.0
≤19	0.0	2.9	1.3	5.1	2.6	1.2
20–29	2.5	2.9	4.6	3.4	3.2	2.7
30–39	2.7	5.8	3.2	6.4	2.1	10.4
40–49	11.0	12.1	6.7	8.2	6.0	5.3
50–59	12.5	7.6	16.3	17.3	7.4	11.8
60+	21.9	15.7	16.6	17.7	16.9	13.9

among whites and Hispanics, and, except among whites, are higher among females than males. The higher rates observed among both black and Hispanic females relative to males of the same age in those racial and ethnic groups reflect false positives arising from the difficulty of identifying coronary artery disease in females by history of chest pain alone without exercise stress testing and the “gold standard” of coronary angiography. Although the predictions from the Rose Questionnaire overstate the prevalence of coronary artery disease in females, the overall impact on the number of prison inmates with coronary artery disease is small owing to the relatively small number of women in the prison population.

Table 26 shows the expected number of cases of heart disease in the State prison population according to the baseline model using the Rose Questionnaire. More than 31,000 inmates in State prisons are predicted to have heart

disease. Nearly one-half (45 percent) of the heart disease is predicted to occur among black males, but less than 20 percent is predicted to be in inmates aged 50 or older.

Table 27 shows the expected number of cases of heart disease among inmates in State prisons predicted by the Rose Questionnaire according to the low SES model. The number of cases of heart disease among State prison inmates using the low SES model projections (46,187) is nearly 50 percent higher than under the baseline model, but the distribution across race, age, and gender does not change.

Tables 28 and 29 give the expected number of cases of coronary heart disease among all incarcerated individuals using the baseline and low SES models. The baseline model projects a total of 49,230 cases of coronary heart disease in the incarcerated population, with just more than one-half of those cases occurring in State

Age	White 6.1		Black 3.3		Hispanic 3.4	
	Male 2.7	Female 3.0	Male 3.2	Female 4.9	Male 3.3	Female 5.1
≤19	0	11	252	14	82	1
20–29	1,317	231	6,387	491	1,852	144
30–39	2,029	209	3,820	620	2,297	210
40–49	2,400	160	2,043	205	748	80
50–59	1,680	50	802	82	277	17
60+	1,695	35	944	27	164	5
<b>Total</b>	<b>9,121</b>	<b>696</b>	<b>14,248</b>	<b>1,439</b>	<b>5,420</b>	<b>457</b>

Age	White 5.0		Black 4.6		Hispanic 3.5	
	Male 5.0	Female 5.7	Male 4.6	Female 5.6	Male 3.4	Female 6.5
≤19	0	13	298	18	152	1
20–29	3,293	257	8,903	428	2,469	100
30–39	3,223	528	5,093	794	1,149	377
40–49	6,000	395	3,338	251	1,094	72
50–59	2,530	77	1,437	106	410	29
60+	2,028	43	1,025	31	220	5
<b>Total</b>	<b>17,074</b>	<b>1,313</b>	<b>20,094</b>	<b>1,628</b>	<b>5,494</b>	<b>584</b>

**Table 28. Estimated Number of Cases of Heart Disease in the Incarcerated Population:  
Baseline Estimates**

<b>Sex and Race</b>	<b>National</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
White male	4,603,980	14,289	9,121	1,439	3,729
White female	4,729,728	1,354	696	66	592
Black male	509,605	20,780	14,249	930	5,601
Black female	881,048	2,771	1,439	135	1,197
Hispanic male	311,225	9,063	5,420	978	2,665
Hispanic female	444,128	973	457	107	410
<b>Total</b>	<b>11,479,714</b>	<b>49,230</b>	<b>31,382</b>	<b>3,655</b>	<b>14,194</b>
<b>Rate</b>	<b>6.03</b>	<b>3.2</b>	<b>2.5</b>	<b>3.8</b>	<b>2.7</b>

**Table 29. Expected Number of Cases of Heart Disease in the Incarcerated Population:  
Low SES Estimates**

<b>Sex and Race</b>	<b>National</b>	<b>All Incarcerated</b>	<b>State Prisons</b>	<b>Federal Prisons</b>	<b>Local Jails</b>
White male	6,802,573	26,978	17,074	2,577	7,328
White female	7,230,465	2,563	1,313	133	1,117
Black male	691,860	29,488	20,095	1,373	8,020
Black female	1,040,499	3,167	1,628	156	1,382
Hispanic male	501,800	9,364	5,494	858	2,837
Hispanic female	523,364	1,056	582	138	492
<b>Total</b>	<b>16,790,561</b>	<b>72,616</b>	<b>46,186</b>	<b>5,235</b>	<b>21,176</b>
<b>Rate</b>	<b>8.8</b>	<b>4.7</b>	<b>4.5</b>	<b>5.5</b>	<b>4.1</b>

prisons (see table 28). Although the greatest number of cases is predicted to be in State prisons, the highest predicted rate of coronary heart disease is in Federal prisons (3.8 cases per 100 inmates). Given a sensitivity of 0.87 and a 13-percent false negative rate for the Rose Questionnaire, the adjusted number of cases from the baseline model is about 56,600.

The low SES model projects 72,616 inmates with coronary heart disease in the incarcerated population (see table 29). Adding the false negatives from the Rose Questionnaire raises this estimate to about 83,500. The estimate of the relative prevalence of coronary heart disease among black and white males generated by the low SES model differs significantly from that generated by the baseline model. The baseline model predicts about three cases of heart disease among black male inmates for every two cases

among white male inmates. In contrast, the low SES model predicts about a 1:1 ratio of cases for black and white male inmates with virtually no change in the projected number of cases of coronary heart disease in Hispanic male inmates.

## Conclusion

Statistical estimation and projection models are only as good as their underlying assumptions and the data that are used as input. Two models have been applied here with differing assumptions concerning the demographics and social characteristics of the incarcerated population. In the baseline model, race- and gender-specific age-adjusted disease prevalence rates in the inmate population were projected from prevalence rates calculated from the NHANES–III survey of the noninstitutionalized civilian U.S. population of the United States. These projections constitute a



baseline estimate of disease prevalence. They predict the number of cases of disease in the inmate population if that population is comparable to the noninstitutionalized population.

Clearly, the institutionalized and noninstitutionalized populations differ in gender and race composition and the distribution of behaviors, attitudes, and other risk factors associated with the distribution of disease in the human population. In an effort to account for at least some of the differences between the institutionalized and noninstitutionalized populations, a subsample of the NHANES–III data was analyzed involving persons currently on welfare or other public assistance. This group represents approximately 66 million Americans and approximates the lowest quartile of socioeconomic status in the U.S. population. Because disease prevalence, particularly asthma, diabetes, hypertension, and heart disease, is greater among lower SES individuals, the projections of disease prevalence obtained from this subsample probably more accurately reflect the real health status of the inmate population. Nonetheless, key variables related to disease prevalence (i.e., educational status, health behaviors) are not included in the model, which affects the resulting prevalence estimates.

The prevalence estimates may also be biased by differences in definitions of disease. Self-reported asthma rates measured as the response to a single question posed by an interviewer in the context of a national health survey such as NHANES are likely to be considerably higher than clinically diagnosed asthma rates recorded in patients' medical records. Accordingly, the estimates of asthma prevalence and the expected number of cases projected by the baseline and low SES models can be compared to clinically diagnosed prevalence rates of asthma in the incarcerated population only with caution. Inmates with a history of asthma before incarceration may not be recorded as having asthma in the prison system unless and until they have an attack that comes to the attention of prison health care workers. Mild intermittent and mild persistent asthmatics would not necessarily be detected in a medical record review. Consequently, estimates of prevalence of asthma in the incarcerated population are likely to understate the true prevalence of asthma

and be quite a bit smaller than the estimates from self-reports as made here.

The same caveats do not apply to the estimates of prevalence and projected number of cases of diabetes and hypertension. The prevalence estimates for these conditions were taken from laboratory measurements according to established measurement guidelines. The analysis of diabetes was compared to figures reported by the National Institutes of Health that were based upon the NHANES–III data. The estimates of prevalence rates conformed to those reported by the NIH authors, validating the measurement of diabetes and impaired fasting glucose. No comparable analysis exists for the prevalence of hypertension. Prevalence rates were calculated according to established diagnostic criteria using the medical examination record and the mean systolic and mean diastolic values from multiple measurements of blood pressure. Consequently, the estimated prevalence rates and projected number of cases of impaired glucose metabolism and hypertension in the incarcerated population are based upon valid measurement and methodology. These estimates and projections may differ from the actual prevalence and number of cases in the incarcerated population to the extent that the assumptions underlying the baseline and low SES models are flawed.

Rates of coronary heart disease calculated from responses to the Rose Questionnaire apply only to the prevalence of ischemic heart disease (e.g., coronary artery disease). They do not capture other forms of heart disease (e.g., valvular disease, congestive heart failure). The Rose Questionnaire has a known sensitivity of 0.81 and a known specificity of 0.97. That is, the questionnaire will detect 81 percent of cases with ischemic heart disease, and will correctly classify as negative 97 percent of cases without disease. Although only 81 percent of individuals with coronary artery disease test positive on the Rose Questionnaire, its sensitivity is likely higher than that achieved with one or two questions about a previous diagnosis of heart disease in an inmate intake assessment. At least some cases defined as positive on the Rose Questionnaire are preclinical and would not be detected in a history and physical examination in the prison setting.

Although the Rose Questionnaire will detect more true cases of heart disease than self-reports of a physician diagnosis, projections of the number of cases of heart disease in the incarcerated population are not without peril. The Rose Questionnaire is sensitive to ischemic heart disease (ICD 410–414.9) and does not adequately identify other forms of cardiac disease. Most important, it is particularly difficult to identify coronary artery disease in women based on a history of chest pain alone. Several studies have shown that chest pain has a poor positive predictive value for diagnosing ischemic heart disease in women. Similarly, many elderly patients experience the pain associated with myocardial ischemia differently than younger patients. Elderly patients experiencing myocardial ischemia often report pain indicative of gastroesophageal reflux disease or pain in the middle of their back, as opposed to the more common report among younger patients of substernal pain radiating into the neck, jaw, and left arm.

The Rose Questionnaire may not detect forms of cardiac disease other than myocardial ischemia, and it may overstate coronary disease prevalence among women inmates and understate coronary heart disease prevalence among older inmates. Its application in the NHANES–III data to the incarcerated population, however, provides the first estimates of the prevalence of coronary heart disease among inmates.

## Notes

1. The Steering Committee consisted of Edward Harrison, National Commission on Correctional Health Care; R. Scott Chavez, M.P.A., National Commission on Correctional Health Care; Robert B. Greifinger, M.D., Principal Investigator; B. Jaye Anno, Ph.D., Carlton A. Hornung, Ph.D., M.P.H., University of Louisville School of Medicine; John Miles, M.P.A., Centers for Disease Control and Prevention; Cheryl Crawford, M.P.A., J.D., National Institute of Justice; Andrew Goldberg, M.A., National Institute of Justice; Marilyn Moses, M.S., National Institute of Justice; and Laura Winterfield, Ph.D., National Institute of Justice.
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