Incarceration, Health, and Racial Disparities in Health

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This article addresses two basic questions. First, it examines whether incarceration has a lasting impact on health functioning. Second, because blacks are more likely than whites to be exposed to the negative effects of the penal system—including fractured social bonds, reduced labor market prospects, and high levels of infectious disease—it considers whether the penal system contributes to racial health disparities. Using the National Longitudinal Survey of Youth and both regression and propensity matching estimators, the article empirically demonstrates a significant relationship between incarceration and later health status. More specifically, incarceration exerts lasting effects on midlife health functioning. In addition, this analysis finds that, due primarily to disproportionate rates of incarceration, the penal system plays a role in perpetuating racial differences in midlife physical health functioning.

The rapid expansion of the correctional system is one of the most significant and dramatic trends in the legal system and contemporary American society. As of 2004, there were approximately six times more inmates and ex-inmates than in the mid-1970s. Presently, there are more than 16 million felons and ex-felons in the United States (Uggen et al. 2006). The growth of penal law in recent decades represents an increase in government social control, which in theory falls disproportionately on the lower classes and has implications for other institutions, such as employment, education, medicine, and public health (Black 1976, 1998).

Little research, however, examines exposure to the penal system as an explanatory factor in health outcomes or racial disparities in health. Prior research in the law and society tradition has investigated how mental health influences criminal sanctions (Hochstedler 1986) and how law and medicine can represent

This research was supported by the National Institute of Mental Health (#MH19893). I am especially indebted to Ryan King, Glenn Firebaugh, Christopher Uggen, Jason Schnittker, Carroll Seron, and three anonymous reviewers for their comments on an earlier draft of this manuscript. Please direct all correspondence to Michael Massoglia, Department of Sociology, Penn State University, 211 Oswald Tower, University Park, PA 16802; e-mail: mam74@psu.edu.

Law & Society Review, Volume 42, Number 2 (2008)

competing institutions (Heimer 1999), yet little work to date explicitly documents the health consequences of an ever-expanding system of penal social control. The present research undertakes that task by empirically examining two questions. First, to what extent does exposure to penal incarceration influence midlife physical health functioning? Second, given the racial disparities in the criminal justice system, does the ever-growing penal system account for some of the persistent racial disparities in health?

While all demographic groups are impacted by the expansion of the penal state, the phenomenon has disproportionately affected various subgroups of the population, in particular black males (Western 2006). In 2002, approximately 12 percent of black males were in correctional facilities (Harrison & Karberg 2003). The lifetime cumulative risk (measured to age 34) of imprisonment for all African American males is more than 20 percent (Pettit & Western 2004). Among African American males without a high school diploma, the lifetime risk of incarceration is 58.9 percent (Pettit & Western 2004). While strikingly high, these estimates carry additional meaning given that they are at least five times higher than the rates of comparable whites. In perhaps the most striking assessment of the scope and reach of the correctional system, Uggen et al. (2006) argue that correctional policies have caused the emergence of a new "felon class" in society. They estimate that this new "class" comprises approximately 7.5 percent of the adult population, 22.3 percent of the black adult population, and 33.4 percent of the black adult male population.

In light of this rapid expansion of the penal system, a number of observers have considered the implications of the growing size and racial composition of the incarceration system. There is an extensive and growing literature on how crime and punishment impact later life chances and outcomes. Research links earlier crime and punishment with later educational outcomes, employment and marital processes, and the labor market (Hagan 1993, 1997; Lopoo & Western 2005; Pager 2003; Sampson & Laub 1990; Pettit & Western 2004; Tanner et al. 1999; Western 2002, 2006; Western et al. 2001). Research consistently finds that contact with the penal system both lowers the likelihood of obtaining gainful employment and depresses wages in the event of employment (Pager 2003; Western 2002), and disrupts marital stability as well (Lopoo & Western 2005).

As a function of differential incarceration rates, minorities disproportionately carry these labor and marriage market deficits. Moreover, Pager concludes that a criminal record is more detrimental to the employment prospects of blacks than whites (2003:961). Other studies reach similar conclusions, finding that

the correctional system disproportionately impacts the marriage market in African American communities (Staples 1987; Wilson 1987). Thus both as a function of *who* is incarcerated, meaning racial differences in rates of incarceration, and as a function of *how*, meaning racial differences in the consequence of incarceration, the penal system appears to impact minorities more severely.

To the extent that research has examined the health consequences of incarceration, the focus has been on the rather immediate impact of prisons on health outcomes such as suicide, depression, and coping (Liebling 1999; Liebling & Maruna 2005; Kruttschnitt & Gartner 2005; Porporino & Zamble 1984; Toch & Adams 1989) or problems that impact a relatively small percentage of the population such as severe health limitations (Schnittker & John 2007). Emerging work has considered how incarceration may contribute to patterns of HIV infections (Johnson & Raphael 2006).

The current research furthers that tradition by investigating the lasting consequences of incarceration on general health functioning for a large sample of midlife adults. The article first elaborates on the theoretical and empirical linkages suggestive of a relationship between incarceration status and health, considering such factors as exposure to stress and major life events. The data, methods, and logic of analysis are then presented. Using both propensity score and regression estimators, the results show a significant effect of incarceration on later health and indicate that the penal system accounts for a sizeable proportion of racial disparities in general health functioning. Finally, in the conclusion the article argues that the penal system has grown to the point where it is now a system of stratification touching almost all aspects of contemporary American society, including health functioning, and merits a position alongside traditional systems of health stratification such as the occupational and educational system.

Theoretical and Empirical Linkages Between Incarceration and Health: Inside the Prison and After Incarceration

Multiple research traditions are suggestive of a significant association between exposure to the penal system, for instance, incarceration, and later health. These include the literature on exposure to stress, research in the social gradient tradition, work on stratification and health, and life course studies.

Stress

The stress literature has traditionally classified exposure as either a major "life event" or "chronic stress" associated with given

social roles, positions, or life events (Thoits 1995). Incarceration appears to map over both classifications. On the one hand, ethnographic accounts of the prison experience suggest that incarceration is a dramatic "life event" (Sykes 1971; Hassine 2004). On the other hand, incarceration places individuals at a disadvantaged social position (Pager 2003; Western 2002) that likely exposes them to more chronic stress over the life course. Pearlin's (1989) theoretical framework of primary and secondary stressors appears particularly informative, as the physical spell of incarceration may act as a primary stressor, and upon release individuals are exposed to a number of secondary stressors—be they family, employment, or social—that result in prolonged exposure to stress.

Prolonged exposure to stress leaves the body in a heightened state of awareness that ultimately taxes the cardiovascular and immune systems. This leaves individuals at increased risk for both mental and physical health problems (Lazarus & Folkman 1984; Pearlin 1989). More recently it has become clear that severe or chronic stress can fundamentally alter the body and permanently alter and weaken its ability to respond to additional stressors (McEwen 1998; Fremont & Bird 2000). That is, the body's ability to maintain health is permanently damaged.

While the stressors of incarceration differ from those after release, the totality of the incarceration experience—from fear or isolation while incarcerated (Sykes 1971) to labor market and family problems that released inmates face (Western 2002; Lopoo & Western 2005)—may fundamentally alter an individual's ability to effectively regulate health functioning.

Social Gradient and Social Location

The Whitehall Studies, which investigate the relationship between social status and health, are among the most influential works on the life course determinants of health (Marmot et al. 1984; Marmot 2004; Bosma et al. 1998). Based on British social servants, the Whitehall Studies (Marmot et al. 1984; Marmot 2004) show that health is related to individuals' abilities (or perceived abilities) to control their life and participate fully in society. Even after accounting for factors such as access to health care and financial circumstances, those at the higher end of the social gradient are better able to exercise control over their life, while those in lower social classes are less able to control their life and participate fully in society.

It is reasonable to hypothesize that incarceration lowers an individual's position in the social hierarchy, through both the stigma of ex-con status and the related economic and employment deficits. It logically follows that incarceration may impact health. In

addition, given the emphasis of the legal and penal system on removing individuals and regulating and controlling behavior upon release, from Marmot's theoretical perspective it appears that the specific intent and goal of incarceration and post-correctional policies is inconsistent with positive health outcomes from a social hierarchy perspective.

The Life Course and Life Events

Given the disruptive impact of incarceration on wages, employment, and marriage (Western 2002; Pager 2003; Lopoo & Western 2005), one mechanism linking incarceration and health is through the social and life course processes associated with both health and incarceration, in particular marriage and employment. Married individuals are in better physical health than the non-married across a variety of indicators (Ross et al. 1990; Anson 1989; Litwak & Messeri 1989).[1] Employment also affects health status. Relative to those without jobs, people who are employed report better health (Turner 1995; Ross & Bird 1994; Ross & Mirowsky 1995; Verbrugge 1989). One could hypothesize that incarceration impacts health by lowering income and employability and by severing the social bonds, such as marriage, that are associated with health.

Second, and closely related to the stress literature, research has paid particular attention to how major life events such as divorce, loss of a job, or loss of a loved one adversely impact health (Barrett 2000; Kurdek 1990, 1991; Kessler et al. 1989; McLeod 1991; Mechanic & Hansell 1989; Turner 1995). The key theoretical notion is that these events are moments in the life course that require major behavioral adjustments in a relatively short period of time (Thoits 1995). It is reasonable to hypothesize that incarceration is such a moment in the life course (Thoits 1995:54) and thus affects health in a manner consistent with the life events framework. Indeed, there is a relatively developed literature that examines the problems inmates face as they adjust to prison (MacKenzie et al. 1987; Jiang & Winfree 2006). Moreover, ethnographic accounts of prison almost universally identify the entrance to a spell of incarceration as a period characterized by rapid transition and adjustment (see for instance Hassine 2004).

Finally, when taken in conjunction with the social epidemiology literature, incarceration may heighten exposure to disease. Data from the National Commission on Correctional Health Care (2002) suggest that incarceration exposes inmates to a number of

[1] For competing perspectives on the role of marriage and health, see, for instance, Fu and Goldman (1996).

infectious diseases. The commission report estimates that more than 20 percent of all individuals in the United States infected with HIV and almost 40 percent of individuals infected with hepatitis C pass through correctional institutions in a given year. These high rates of infectious disease provide another explanation for the relationship between incarceration and health; prisons differentially expose individuals to infectious diseases. Contemporary evidence supports this position. In recent decades, several outbreaks of tuberculosis in the United States have been traced to correctional facilities (Farmer 2002). In fact, Farmer (2002) argues that rates of tuberculosis in the New York facility Rikers Island are higher than those of many third world countries.

Racial Differences in Health and the Penal System

In light of racial differences in incarceration rates, an explicit consideration of whether the incarceration system contributes to racial disparities in health is warranted. By almost any objective standard, the health of blacks is disadvantaged relative to whites (Smaje 2000; Hayward & Heron 1999). While specific estimates vary slightly, whites can expect to live approximately six years longer than African Americans, with the gap being greater for males than females (Ventura et al. 1997; Williams & Collins 1995; Rubio & Williams 2004; Hoyert et al. 2006).

In addition, blacks are likely to live a greater portion of their lives with chronic health conditions (Hayward & Heron 1999; Hayward et al. 2000). Blacks can thus expect to live shorter lives, while dealing with more chronic pain and illness than whites. Efforts to explain racial differences in health focus on factors ranging from structural conditions to employment and lifestyle choices to psychological factors (Bird et al. 2000). While Schnittker and John (2007) find the incarceration system is unrelated to racial differences in severe health problems, to date no research has assessed whether the penal system impacts racial differences in general health functioning.

As discussed, the rapid expansion of the penal system has not affected all racial groups equally. While specific estimates vary by subgroup (e.g., high school degree or not), minority males are five to eight times more likely to be incarcerated than comparably educated whites (Pettit & Western 2004). While health disparities were evident well before the expansion of the penal system, Link and Phelan (1995) argue that the cause of these health disparities likely changes over time. In light of evidence suggesting that the health status of blacks, relative to whites, has worsened in the same time period that roughly corresponds to the implementation of

punitive incarceration initiatives (Cooper 1993; Williams & Collins 1995; National Center for Health Statistics 2001; Freeman 1996), it may be that incarceration serves as an important and underresearched factor in the study of race and health. Consistent with the theoretical notion of Link and Phelan (1995), the penal system may have emerged as a system of health inequality. Such findings call for an investigation into the potential contribution of incarceration to racial differences in health outcomes. The following sections of the article outline the logic, data, and methods used to examine the impact of exposure to incarceration on health, and the contribution of the penal system to racial disparities in health. While a number of theoretical and empirical linkages are evident, it is important to craft the analysis while mindful of the potential for spuriousness. It may be that some individuals engage in behavior —for instance, illicit drug use or repeated violence—that increases both the likelihood that they are unhealthy or injured and the likelihood that they will be incarcerated.

Data, Logic of Analysis, and Methods

As with related research on the life course consequences of incarceration (Lopoo & Western 2005; Western 2002) data from the National Longitudinal Survey of Youth 1979 (NLSY79) is used for analysis. The NLSY79 allows for an assessment of the lasting relationship between incarceration and health using a number of factors that predict incarceration and are associated with health. Moreover, the analysis can speak to specific theoretical frameworks previously introduced. For instance, the NLSY79 includes factors such as employment and poverty, which address Marmot's theoretical notions of "social gradient" (2004). Moreover, while direct measures of stress are rare in social science research, the analysis includes measures of mental health that help speak to factors such as anxiety and stress levels. Finally, measures such as marriage or education level are consistent with prior empirical and theoretical treatments of the life course determinates of health. Complete descriptions of the data and variables are presented in Table 1.

In conjunction with the Bureau of Labor Statistics, data collection began in 1979, when the respondents were between ages 14 and 22 (respondents were drawn from a nationally representative sample and were incarcerated at any point over the survey period). As part of the NLSY79 collection protocol, a comprehensive health questionnaire was given to respondents during the survey period immediately after they turned age 40. As of 2002, approximately 5,500 respondents had turned 40 and answered the health 40

Table 1. Descriptive Statistics

Variable	Description	Coding	Mean	Std. Dev.
Ascribed Characteristics				
Gender	Self-reported sex	0 = Female, 1 = Male	48%	
Race	Self-reported race	0 = Other, 1 = White	71%	
Background Variables (1979–80)				
Prior health problems	Does the respondent have health problems that limit the type or amount of work they can do?	0 = No, 1 = Yes	06%	
Intact family	Was the respondent raised in a two-parent household?	0 = No, 1 = Yes	77%	
Parents' education	Highest level of schooling completed for either mother or father	Grades completed 0–20	10.79	3.31
Control orientation	Does the respondent . . . ?			
	Have control over the direction of their life?	1 = Less control over life	8.21	1.58
	Feel things in life are a matter of fortune or planning?	2 = Greater control over life		
	Feel getting what they want has nothing to do with luck?			
	Feel that chance or luck plays an important role in life?			
	How close is this statement to your opinion? (asked for each item)			
Welfare	Did the respondent's family of origin receive welfare?	0 = No, 1 = Yes	13%	
Drug use	Ever use drugs other than marijuana	0 = No, 1 = Yes	47%	
Self-reported crime	In the past year had the respondent . . .	0 = Never	3.64	4.47
	Intentionally damaged property	1 = Once		
	Been in school/work fights	2 = Twice		
	Shoplifted	3 = 3–5 times		
	Attacked someone	4 = 6–10 times		
	Sold/used marijuana	6 = More than 10 times		
Lifestyle (1996–2000)				
Insurance	Does the respondent have health insurance?	0 = No, 1 = Yes	81%	
Workout	Number of times weekly the respondent participates in vigorous physical activities	1 = Never to 5 = More than 3 times a week	2.76	.47
Weight	Respondent's weight in pounds	0–370	174.9	41.4
Cigarette use	Does the respondent report daily cigarette use?	0 = No, 1 = Yes	27%	
Binge drinking	Does the respondent drink more than five drinks, at least 2–3 times a month?	0 = No, 1 = Yes	19%	
Cocaine use	Has the respondent ever used cocaine?	0 = No, 1 = Yes	24%	

Life Course/Social Location				
Urban residence	Does respondent live in an urban setting?	0 = No, 1 = Yes	75%	
Poverty status	Does the respondent live at or below 125 percent of the poverty level?	0 = No, 1 = Yes	27%	
Marital status	Is the respondent married?	0 = No, 1 = Yes	56%	
Education level	Respondent's years of school completed	0–20	13.08	
Labor force participation	Is the respondent in the labor force?	0 = No, 1 = Yes	73%	
Dependent and Focal Independent Variables				
Mental Health	Respondent's Mental Health Composite Score	0–100	52.03	(8.08)
Physical Health	Respondent's Physical Health Composite Score	0–100	52.93	(8.39)
Incarceration	Respondent Incarcerated?	0 = No, 1 = Yes	4.8%	(0.20)

SF-12 Health Questionnaire: Specific Question-and-Response Wording

In general, would you say your health is:
Possible responses: Excellent, Very good, Good, Fair, Poor
The following questions are about activities you might do during a typical day. Does your health limit you in these activities? If so, how much?
(a) Moderate activities, such as moving a table
(b) Pushing a vacuum cleaner, bowling, or playing golf
(c) Climbing several flights of stairs
Possible responses: Yes, Limited a lot, Yes, a little, Not limited at all
During the past four weeks, how much of the time have you had any of the following problems with your work or other regular daily activities as a result of your *physical* health?
(a) Accomplished less than you would like
(b) Were limited in the kind of work or other activities
Possible responses: Yes, No
During the past four weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?
Possible responses: Yes, Limited a lot, Yes, a little, Not limited at all
These questions are about how you feel and how things have been with you during the past four weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past four weeks . . .
(a) Did you have a lot of energy?
Possible responses: All the time, Some of the time, None of the time
During the past four weeks, how much of the time has your physical health interfered with your social activities (such as visiting friends, relatives, etc.)?
Possible responses: Not at all, A little bit, Moderately, Quite a bit, Extremely

module of the survey.[2] This group serves as the analytic sample for analysis. Respondents answered the health 40 module only once, and those who were not 40 by 2002 were omitted from analysis because they had not answered the module.[3]

The health 40 module employs the physical health component of the Short Form 12 (SF-12) to ask a series of questions on the physical and mental health functioning of respondents. The SF-12 serves as the dependent variable in this analysis and is an established indicator of health functioning (McDowell & Newell 1996) that probes the degree to which health problems affect the respondent's lifestyle.

The Bureau of Labor Statistics and NLSY79 standardize these multiple responses into a single, normally distributed, variable of self-reported physical health functioning with a theoretical range of 0–100 and a mean of 50 (sample range is 29–72, sample mean is 51.11).[4] This indicator of self-reported physical health serves as the main dependent variable for this analysis. Self-reported health is the subject of considerable scholarly attention (Bound 1991; Browning & Cagney 2002; Hayward & Heron 1999; Ross & Wu 1996; Ferraro & Farmer 1996, 1999; Idler & Benyamini 1997).

Background and Demographic Variables

This analysis accounts for different phases of the life course. The first is a series of variables that measure background characteristics, taken in survey years 1979–1980. In addition to indicators of gender and race, this analysis considers measures of family welfare status, parents' education level, whether respondents lived with two parents, and control orientation.[5] Descriptive statistics for all variables are reported in Table 1.

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[2] As noted elsewhere, sample attrition is not impacted by incarceration status (Western 2002).

[3] While all respondents answered the module at the same point in life, age 40, the differences in respondents' age (14–22) at the beginning of data collection correspond to variation in the year when they reached age 40 and responded to the health module. The NLSY79 creates one variable for each question on the module and then creates a trichotomy indicating when an individual responds to the health 40 module. The analysis uses that trichotomy to test for cohort effects in response years 1998, 2000, and 2002. The results of this analysis indicate no significant health differences based on the survey response year.

[4] The specific wording of each question in the SF-12, the survey used to create the self-reported health score that serves as the dependent variable for analysis, is presented at the end of Table 1. Readers interested in the procedure used by the NLSY79 and Bureau of Labor Statistics to create the composite indicator should consult the manual by Ware et al. (1995).

[5] Control orientation represents the degree to which respondents feel they are able to control the direction of their lives.

In addition to family background measures, other key individual-level indicators are measured prior to respondents' incarceration. Measures of criminal behavior, including prior substance use and self-reported crime, are included to separate the effect of punishment from that of crime and are a proxy for risk-taking behavior (Gottfredson & Hirschi 1990). Thus key control variables such as crime, psychological processes, social standing, and family structure are measured prior to risk of incarceration.

Lifestyle and Life-Course Indicators

Consistent with existing literature, the analysis utilizes lifestyle indicators that tap both healthy and unhealthy aspects of respondents' behavior and lifestyle choices. The analysis considers the respondent's self-reported levels of cigarette use, binge drinking, and illicit drug use. In addition to substance use measures, self-reported weight, exercise habits and insurance status after the incarceration risk period are included.

Contemporaneous life events are also included in the analysis. This block of factors includes whether respondents lived in an urban location, their poverty status and marital status, and employment indicators and educational attainment. Finally, given the strong relationship between mental and physical health, the analysis also includes contemporaneous measures of mental health.

Focal Independent Variable and Lagged Measure of Health

The focal independent variable is incarceration. The data collection protocol is structured so that shorter incarceration spells, those less than one year, may be missed, but spells greater than one year will not be missed (Western 2002). The average length of incarceration is slightly more than three years.[6] Accordingly, the incarceration indicator depicts invasive and prolonged exposure to a correctional setting rather than more fleeting involvement in the justice system—for instance, a short stay in jail resulting from a drunken driving arrest. Approximately 5 percent of the sample has been incarcerated, and these individuals are disproportionately members of racial minority groups. More specifically, during the time period under investigation, 270 individuals (182 minorities) were incarcerated.

[6] Consistent with other work in the area (Schnittker & John 2007) additional analysis found that exposure rather than length of incarceration was more informative for understanding the relationship between incarceration and health. Supplementary analysis with incarceration treated as a continuous variable (mean 3.3, median 2, range 1–13) was consistent with the substantive findings presented here. Supplementary analysis is available upon request.

As a key control variable, a lagged measure of problematic health is included in all models. Respondents are asked to report whether they have a health problem that prevents them from performing social or work functions. The data are arrayed to ensure that the measurement of prior health problems precedes risk of incarceration. Prior to incarceration, slightly more than 6 percent of the sample report having health problems. Including a lagged measure of health helps attenuate bias introduced from unmeasured heterogeneity in the sample.

While incarceration is measured each year, this analysis considers only those who were incarcerated after 1979 and prior to 1996. This is done to maintain the temporal sequence underlying the model predicting health. In addition, the models include a lagged indicator of health functioning. Formally, the final models can be expressed as:

Formula 1:

$$Health_{40} = a + X_1\beta_1(bg) + X_2\beta_2(prison) + X_3\beta_3(ls) + X_4\beta_4(lc) + \varepsilon$$

where $X_1\beta_1(bg)$ is a vector of background variables, including prior health and accompanying parameter estimates, and $X_2\beta_2(prison)$ represents incarceration history (0 for those never incarcerated, and 1 for those who were incarcerated) and associated parameter estimates of incarceration on health. Finally, $X_3\beta_3(ls)$ and $X_4\beta_4(lc)$ represent vectors of lifestyle and life course markers and their accompanying parameter estimates. Finally, in the regression models, the data are weighted to make the sample nationally representative.[7]

Logic of Analysis

There are three main analytical issues in this analysis. The first phase of analysis uses regression analysis and covariate adjustment to examine the enduring impact of incarceration on health. The second phase examines the incarceration-health relationship using methods that correct for the nonrandom nature of incarceration and examines whether the prison "selects" individuals who are unhealthy. Finally, the article explicitly considers whether the incarceration system—either through differential effects of incarceration or through differential rates of "exposure" to incarceration —contributes to racial differences in midlife health functioning.

This analysis begins with regression models, which provide both a baseline to assess the effect of incarceration relative to other social processes and an incarceration parameter for comparisons

[7] I thank Jay Zagorsky and Steve McClaskie, NLSY79 user services, for valuable assistance in constructing the weights used for analysis.

with later propensity models. Covariate adjustment, however (specified in Formula 1), can be problematic when attempting to make causal inferences. Broadly stated, standard regression models estimate an average effect. That is, the estimate is based upon those who have experienced the event or treatment, in this case incarceration, and is assumed to be an average effect generalizable to the entire population (Rosenbaum & Rubin 1983; Rubin & Thomas 1996; Winship & Morgan 1999). Under conditions in which the treatment is random and the population is homogeneous prior to treatment (or if differences are unrelated to either the treatment or the outcome), the ordinary least-squares estimate is efficient and unbiased and the estimate can be taken to represent the actual treatment effect.

If, however, treatment is nonrandom, as is the case with incarceration, then estimates generated from regression models are likely biased. To correct for this potential bias, propensity matching estimators are utilized. The overall intent of employing this estimator is to approximate the conditions of an experiment and calculate the average treatment effect among the treated (ATT). Two characteristics of propensity matching procedures (formally presented below) have important substantive implications. First, if the matching equation adequately models the propensity for individuals to experience prison and the sample is balanced, the remaining individuals are homogeneous and differ only in whether they have experienced incarceration, given the covariates in the model. Second, as a function of the homogeneous sample, incarceration can be treated as though it occurs at random, also known as the ignorable treatment assumption (or the conditional independence assumption, in the economics literature).

Given the ignorable treatment assumption and the random nature of treatment status, factors unrelated to treatment, for instance prior health (see footnote 14 and the Appendix), can be seen as occurring at random across both the treatment and control sample. Assuming the treatment state is properly modeled, in situations where the data do not have mirror measures of the dependent variable at earlier points in time, propensity models allow such factors to be treated as random and thus help alleviate concerns about sample heterogeneity.

Treatment Effects and Propensity Score Models

The estimation of treatment effects is dependent upon a counterfactual. As noted by others (Winship & Morgan 1999; Morgan 2001), it is impossible for any individual to be in both the treated and untreated state (both ever incarcerated and never incarcerated). As such, the problem can be seen as one of missing data.

Propensity score methods attempt to address this problem by using relevant background characteristics and behavioral indicators to match individuals on the basis of their likelihood to experience a treatment, in this case their likelihood of experiencing prison (Rosenbaum & Rubin 1983; Winship & Morgan 1999; Morgan 2001; Harding 2003). The propensity score, which represents the conditional probability of incarceration, can be written as (Rosenbaum & Rubin 1983):

$$\text{Formula 2: } p(incarceration) = Pr(T_i = 1|X_i)$$

Where $T_i = 1$ if individual i has ever been incarcerated, and X_i *is a vector of covariates, often including multiple interaction terms, for individual i that predict incarceration or are potential confounding variables in the association between incarceration and health.*[8]

After the propensity scores and matched sample have been created, the analysis then utilizes nonparametric procedures to estimate the treatment effect of incarceration on later health. This analysis generates treatment effects using four different matching algorithms to pair incarcerated individuals (treated) with similar non-incarcerated individuals (controls) on the basis of their likelihood to experience incarceration.

This analysis uses four different matching procedures to assess the effect of incarceration on health: neighbor matching, radius matching, kernel matching, and stratification matching. As each matching procedure has potential strengths and weaknesses, the results from all four matching estimators are presented. While variants are evident across different matching procedures, the guiding principle behind each method is to create homogeneous samples by matching individuals based on their propensity scores, allowing incarceration to be treated as though it has occurred at random; the ignorable treatment assumption (Rosenbaum & Rubin 1983; Morgan & Harding 2005). Under conditions where the treated and untreated samples have identical scores across relevant variables (the covariates), the samples are considered to be balanced (Rubin 1985; Morgan 2001; Harding 2003).[9] It is important to note that the analysis specifically models prior health problems as a risk factor for exposure to incarceration. This helps address concerns of spuriousness and selection. See the Appendix for more detailed information on the matching methods and sensitivity analysis.

[8] The vector of covariates can, and in this analysis does, include multiple interactions. For ease of presentation. Formula 2 presents the simplest form of the models.

[9] This analysis uses Version 2.0 of the Stata programs for ATT estimation based on propensity score matching developed and discussed by Becker and Ichino (2002). In addition to calculating the treatment effect, this program specifically tests for covariate balance. In all cases, the balancing property was satisfied.

To further ensure the homogeneity of the matched sample and confidence in the estimates, all analysis is restricted to regions of common support. In practice, restricting analysis to regions of common support excludes outliers, identified on the basis of their propensity score, from analysis. Finally, no distributional assumptions are imposed in analysis, ensuring that the estimates are derived from the actual distribution of the data (Morgan 2001; Harding 2003). The potential advantages of propensity estimators over traditional regression are discussed in more detail in Joffe and Rosenbaum (1999), Morgan (2001), and Morgan and Harding (2005).

Findings

Table 2 presents the results from a series of regression equations predicting general health functioning at age 40. Model 1 shows the effect of a series of background and demographic variables on health. The results are consistent with prior research; those whose family receives public assistance, those who feel that

Table 2. Background, Lifestyle, Life Course, Social Location, and Incarceration Effects on Physical Health Functioning at Age 40: Regression Results

Model	1	2	3	4
Incarceration			−3.553 (0.52)*	−2.208 (0.55)*
Race (white = 1)	0.623 (0.28)*	0.769 (0.28)*	0.239 (0.29)	−0.520 (0.32)
Background				
Gender (male = 1)	0.912 (0.22)*	1.721 (0.25)*	1.997 (0.25)*	1.562 (0.25)*
Prior health problems	−4.136 (0.48)*	−3.633 (0.46)*	−3.620 (0.46)*	−3.459 (0.46)*
Intact family	−0.261 (0.29)	−0.489 (0.29)	−0.264 (0.29)	−0.430 (0.29)
Control orientation	0.127 (0.06)*	0.058 (0.07)	0.070 (0.06)	0.039 (0.06)
Parents' education	0.218 (0.04)*	0.124 (0.04)*	0.111 (0.04)*	0.034 (0.03)
Welfare (1 = yes)	−1.557 (0.42)*	−0.932 (0.41)*	−0.889 (0.41)*	−0.614 (0.40)
Drug use	−0.286 (0.22)	−0.074 (0.23)	0.075 (0.22)	0.226 (0.22)
Self-reported crime	−0.048 (0.03)	−0.026 (0.03)	−0.008 (0.03)	0.055 (0.03)
Lifestyle				
Insurance (1 = yes)		0.915 (0.29)*	0.764 (0.29)*	−0.051 (0.29)
Workout		0.598 (0.07)*	0.612 (0.07)*	0.632 (0.07)*
Weight		−0.028 (0.01)*	−0.030 (0.01)*	−0.029 (0.01)*
Cigarette use		−1.789 (0.24)*	−1.760 (0.25)*	−1.099 (0.25)*
Binge drinking		−0.155 (0.37)	−0.357 (0.36)	−0.128 (0.36)
Cocaine use		−0.437 (0.26)	−0.430 (0.26)	−0.455 (0.26)
Life course/Social gradient				
Urban residence				0.032 (0.23)
Poverty status (1 = yes)				−1.793 (0.28)*
Marriage status (1 = yes)				0.452 (0.23)*
Education level				0.243 (0.05)*
Labor force partic. (1 = yes)				1.453 (0.26)*
Mental health				0.062 (0.01)*
Constant	51.367 (.92)	54.028 (1.02)	54.879 (1.01)	47.996 (1.41)
R-Squared	0.05	0.09	0.11	0.15
N	5,043	5,043	5,043	5,043

*$p < 0.05$; nonsignificant 98-00-02 cohort dummies not reported.

they have less control over the direction of their lives, and those with prior health problems have poorer midlife health. Not surprisingly, prior health problems are the strongest predictor of later health. Growing up in an intact family, drug use, and self-reported crime in youth are unrelated to health at age 40.

Consistent with prior research, Model 1 indicates that whites have significantly better health functioning than minorities. Model 2 both attempts to explain racial differences in health functioning with a number of lifestyle variables and establishes a baseline model for the introduction of the incarceration indicator. Again, the results are generally consistent with prior research; for instance, those who exercise more frequently and have health insurance report better health, while cigarette smoking and increased weight have detrimental effects on health. Despite the introduction of these relevant lifestyle factors, whites still have significantly better health functioning than minorities. In fact, racial differences in health are slightly stronger in magnitude after incorporating these factors (0.769).

Model 3 introduces incarceration. The magnitude of the incarceration effect (-3.553) exceeds other factors commonly used to explain health functioning—for instance, access to insurance. This indicates that incarceration has a lasting and significant impact on physical health. Moreover, with one notable exception, the direction and significance of all other processes in Model 3 are similar to those presented in Model 2. The notable exception is race: the introduction of incarceration attenuates racial difference in health by almost 70 percent and renders racial differences nonsignificant. In addition to having a significant effect on later health functioning, this suggests that incarceration contributes to persistent racial differences in midlife health functioning.

Model 4 in Table 2 presents results using the full model specification presented in Formula 1. That is, the effect of incarceration on health is estimated when controlling for demographic, background, and health indicators prior to incarceration, and lifestyle and life course processes after incarceration. This model specification tests whether the relationship between incarceration and health is explained by other contemporaneous life course processes.

The results presented in Model 4 are again consistent with much prior work: smoking and increased weight are negatively associated with health, as is poverty status. Conversely, education, exercise, and mental health all positively affect physical health. In addition, those who are married and are in the labor force have increased health functioning.[10]

[10] Given that the majority of incarcerated individuals are men, it is informative to report incarceration effects among men only. If women are removed from the analysis,

In the full models, incarceration continues to exert a significantly negative effect on health. Introducing the final block of life course variables reduces the incarceration effect approximately 40 percent, from -3.553 to -2.208.[11] These results indicate that, in part and in a manner predicted by prior research, incarceration works through life course processes to affect health by lowering marriage, employment, and educational prospects.

To provide additional evidence of the health-incarceration relationship, the matching methods previously described are used to further assess the relationship between incarceration and later health functioning. Given the apparent significance of incarceration in explaining racial differences in health, these methods further test the robustness and magnitude of the incarceration effect (-2.208) reported in the final model of Table 2. All indicators used to create the matching equation are measured prior to the period of risk of incarceration, and earlier regression analysis informs the selection of variables for the propensity models.

A few notes warrant discussion before moving to a consideration of the propensity models. First, in contrast to the average treatment effects estimated with regression models, the propensity estimates are derived from a sample matched on their likelihood to experience incarceration. As such, the estimates represent the average treatment effect among the treated (ATT). In addition, the matched sample is significantly more disadvantaged—both in terms of health and other social indicators—than the general population. Thus while both estimators speak to the impact of incarceration on health, the specific inferences and generalizations drawn from the estimators vary based on the analytic sample. As such, it is perhaps most informative to view the propensity models as a further, yet complementary, test of the relationship between incarceration and health.

Depending on the specific matching procedure, almost all incarcerated individuals have appropriate control matches. After the matching procedure, the sample size of the treatment groups ranges from 214 to 242 (approximately 87–98 percent of the incarcerated sample, depending on the matching procedure), and the remaining individuals in the control group are homogeneous

using the model specification in Table 2, Model 4, the effect of incarceration on health is -2.691, indicating a significant relationship.

[11] I thank a reviewer for the informative suggestion to assess the robustness of the finding by re-estimating the incarceration effect in Table 2, Model 4, after restricting the sample to sibling data. This helps further the homogeneity in the sample. While the size of the analytic sample decreases substantially, even with this restriction the negative effect of incarceration remains significant and large, albeit at slightly attenuated levels (-1.88, $p<0.01$).

Table 3. Propensity Estimators With Multiple Matching Procedures: The Treatment Effect of Incarceration on Physical Health

Matching Estimator	Incarceration Effect	Normal Theory 95% Bounds		Empirical Distribution 95% Bounds	
		Lower	Upper	Lower	Upper
Nearest neighbor (237)	−2.011*	−3.752	−0.697	−3.801	−0.593
Kernel (242)	−1.659*	−3.066	−0.242	−3.077	−0.233
Radius (214)#	−1.820*	−3.255	−0.384	3.331	−0.442
Stratification (242)	−1.505*	2.893	−0.139	−2.913	−0.138

Notes: *$p < 0.05$. Numbers in parentheses represent treated individuals with matched controls for each estimator. All analysis restricted to regions of common support.
#Radius width set to 0.001.

given the covariates in the models. In all cases the balancing property is satisfied.

As reported in Table 3, incarceration significantly lowers later health functioning. While there is some variation in the magnitude of the effect based on the matching procedure, ranging from −1.505 to −2.011, the consistency of the results is striking. This demonstrates the robustness of the incarceration-health relationship even when controlling for the likelihood of experiencing incarceration with multiple matching techniques. Moreover, because nonparametric methods are utilized, the relationship is not dependent on any distributional assumptions for either the matching estimator or the incarceration effect.

From the first part of the analysis, two significant findings emerge. First, regardless of the analytic procedure and controls imposed, a significant relationship between incarceration and later health is evident. Second, using multiple methods, the effect of incarceration on health is similar or greater in magnitude to many factors traditionally associated with health, such as marital and employment status.

This analysis now moves to an explicit consideration of incarceration and racial differences in health. As shown in Table 2, racial differences in health are mediated by approximately 70 percent and become nonsignificant when exposure to incarceration is considered. Two plausible scenarios could explain this finding. First, minorities are significantly more likely to be incarcerated. As a function of this differential exposure, even if the effect of incarceration on later health is the *same* across races, the impact will be greater on the aggregate health of minorities because minorities are considerably more likely to be exposed to the detrimental health effects of incarceration. Essentially, this is a consideration of racial variation in aggregate exposure to the penal system. Alternatively, the *impact* of exposure to the penal system may be worse for minorities, a finding consistent with other work on the justice

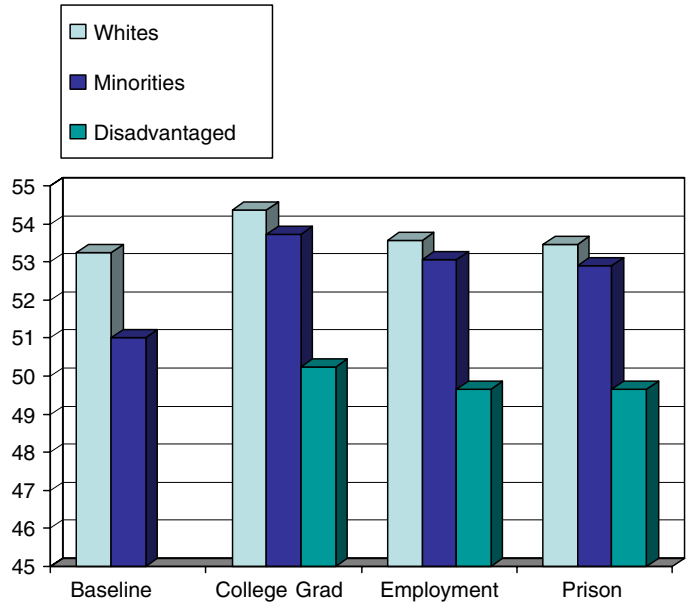

Figure 1: Short form 12 reported physical health values-racial differences
Notes: Disadvantage is characterized by failure to graduate college, unemployment, or having been incarcerated. The baseline represents average health differences between whites and blacks. To help assess the general impact of disadvantage across these social domains, the average health score of individuals disadvantaged in each domain is graphed next to the health status of whites and blacks who are not disadvantaged in those social domains. Accounting for disadvantage in any of these social domains has a similar impact on racial health inequalities. In addition, this shows the importance of incarceration relative to education and employment in perpetuating racial health inequalities.

system (Pager 2003). This suggests an interaction between incarceration exposure and minority status.

Figure 1 explores the relationship between incarceration and racial disparities in general health functioning in more detail by considering aggregate exposure to the penal system. Moreover, Figure 1 places incarceration along other systems of stratification and disadvantage. Attempts to examine racial health disparities often focus on employment and education, arguing in part that the labor market and education are systems of stratification that place minorities in a disadvantaged position relative to whites. Figure 1 locates incarceration next to these other systems of health stratification.

For illustrative purposes, in addition to showing baseline health differences for whites and minorities, Figure 1 graphs physical health values (higher scores indicate better health) and shows the impact of disadvantage across three different social arenas. Those labeled as disadvantaged in Figure 1 are those without a college diploma, without a job, or those who have been incarcerated.

Controlling for gender, Figure 1 shows significant baseline differences in health between whites and minorities. Consistent with other work, accounting for socioeconomic status such as education or employment minimizes general differences in health (Williams & Collins 1995; Robert 1999). In part, this is because minorities disproportionately carry the weight of disadvantage in these areas. For instance, while comprising only 36 percent of the overall sample, nonwhites represent more than half (52 percent) of those without jobs and approximately 77 percent of those without a college degree.

Figure 1 shows that incarceration works in a manner consistent with other systems of stratification; after separating those who have been incarcerated, the health profiles of whites are similar to those of minorities. As with disadvantage in educational and occupational domains, this is because minorities disproportionately face disadvantage in the penal system. With incarceration rates five to eight times higher than those of comparable whites, the aggregate health impact of incarceration is greater for the minority community. Clearly these systems of stratification are not independent of one another. Figure 1 suggests, however, that incarceration is likely another system of inequality that produces variation in health functioning.

Finally, the main effect reported in Table 2 (Model 4) and further assessed by the propensity models reported in Table 3 is decomposed. To examine a possible differential impact of incarceration, an interaction term for minorities and prison was constructed. Such a term examines if the impact of incarceration is more detrimental to the general health functioning of minorities. Consistent with other research (Schnittker & John 2007), the magnitude of the coefficient (-0.249) does not reach conventional levels of statistical significance.

The evidence then is equivocal when linking incarceration to racial disparities in health. Less clear is whether the individual-level impact of incarceration on health varies by race; the available evidence from the NLSY79 does not suggest that it does (see also Schnittker & John 2007). What is clear, however, is the strong negative effect of incarceration on health, and the disproportionate likelihood that minorities will be in the penal system. Figure 1 suggests that this disproportionate probability of incarceration has implications for racial differences in general health status.

Discussion

The penal and legal system has reached the point where the pervasive use of prison as a mechanism of social control has

touched almost every aspect of contemporary American society. More than 600,000 individuals are released from prisons yearly (Mauer 2006). As these individuals are released, the burden of their problems is shifted from the penal and legal system to general society. The health problems revealed in this analysis present yet further barriers to the successful reintegration of ex-offenders. As the number of individuals released from correctional institutions increases, so too do the social, economic, and legal implications of offender reintegration.

A developed literature on the consequences of incarceration explains part of the relationship between incarceration and physical health. Incarceration negatively impacts a number of factors, such as wages (Western 2002), that are associated with health functioning. Still, even after accounting for these processes, the analysis shows incarceration to be a strong predictor of health. In so doing, this article adds to an emerging literature that finds the consequences of contact with the penal system extend into areas well outside the legal system that have not been fully appreciated in other work.

That is not to suggest this analysis is not without limitations. While the NLSY79 has many strengths, it was not specifically designed for an investigation of health and incarceration. As such, there are some data limitations. First, the dependent variable is measured at only one point in time. While propensity estimators help alleviate this concern through randomization, future work would be well served to collect repeated measures and incorporate models focusing on change in health status. Along similar lines, more specific health measures emphasized in other work, such as low birth weight (Johnson & Schoeni 2003, 2007), would further refine an understanding of the prison-health relationship. Future work in the area would benefit from data collection designed specifically to examine the health-incarceration relationship.

In addition, both the regression and propensity models are sensitive to bias from unmeasured processes. While sensitivity analysis suggests that the problem is not a significant contaminant (see Appendix), with social science data it is virtually impossible to definitively rule out unmeasured heterogeneity. Future work might consider if the impact of incarceration on health varies by years since release. Indeed, there is rationale to suggest both that the negative effects may lessen over time and that the negative effects may worsen over time. Along similar lines, it is plausible that the incarceration spell itself—perhaps as a function of increased access to health care, daily meals, or even removal from an abusive relationship—provides some immediate health benefits to some inmates. The impact of incarceration may well be conditioned by a host of socioeconomic or other contextual factors. Finally, while this

analysis considers only the United States, there may be cross-national variation in the impact of the penal system on health. Given these many possible contingencies, this analysis should be seen as but an initial step in specifying the complexities in the penal state-health relationship.

This relationship between the penal state and health is partially explained by the concept of "exposure." Incarceration exposes individuals to a number of infectious diseases including HIV, hepatitis B, hepatitis C, and tuberculosis (Farmer 2002; Talvi 2003; Massoglia 2008; National Commission on Correctional Health Care 2002).[12] Even short prison sentences may provide ample exposure to infectious disease and alter the potential social and medical consequences of contact with the penal system.

Research on social epidemiology, stress, and the social hierarchy suggests that the relationship between health and punishment may be driven by mechanisms beyond life course processes and infectious disease; the status of *ex-con* itself signals a lower position on the social hierarchy. As public awareness and concerns have risen, few labels are as stigmatizing as *ex-con*. Felons are viewed as the "underclass" of society (Irwin 1985).

This lower standing has implications for health (Marmot 2004). Moreover, the processes by which social standing impacts health—the inability of individuals to exercise control over their lives and participate fully in society—appear particularly relevant for understanding the strong association between incarceration and health. Both while inmates are incarcerated and upon their release, legislative initiatives and legal mechanisms assure that inmates face both significant public stigma and legal regulation over their lives. In explaining the relationship between incarceration and health, there is perhaps no clearer relationship than the restrictive capacity of incarceration and the justice system to prevent individuals from participating fully in society. To be sure, some of these legal restrictions are rooted in public safety, but the public good, legislative goals, and legal aims of many post-release legal sanctions—for instance, bans on voting and many government subsidy programs, as well recent initiatives to place identification markers on license plates—appear less clear.

From Marmot's (2004) perspective, such restrictions could have negative implications for health by restricting individuals' societal participation and control over their life. As has been noted in other places (Mauer & Chesney-Lind 2002), at a minimum the

[12] As noted, supplementary analysis indicated that ex- inmates are more than twice as likely as non-inmates to report having hepatitis, tuberculosis, and urinary tract infections. Estimates were derived using both logistic regression and propensity models. This supplementary analysis is available upon request.

cost and value of these collateral consequences—and indeed the cost and value of the widespread use of incarceration—should become a greater part of the ongoing debate about the penal and legal systems in contemporary American society.

Incarceration and Racial Inequalities in Physical Health

The second major thrust of this research assesses whether the penal system plays a role in average health differences between whites and nonwhites. Given the makeup of the NLSY79, this analysis speaks best to differences in health between blacks and whites.[13]

Attempts to explain racial disparities in health often focus on socioeconomic indicators such as education and employment. Figure 1 indicates that incarceration effects parallel those of other classic markers of socioeconomic status and suggests that the penal system merits consideration as one of the fundamental systems of stratification that contributes to racial health disparities in general health functioning. It is noteworthy that this finding is in contrast to other work on incarceration and severe health problems (Schnittker & John 2007). Similar to earlier suggestions to further examine the contingencies in the incarceration-health relationship, further research is needed to definitively examine the conditions or measures of health status where the penal state perpetrates racial differences in health. The significant contribution of the penal state to racial differences in general health functioning may not extend to all health outcomes or specific ailments.

That said, a number of mechanisms help explain the importance of the penal system in explaining the racial differences in general health functioning found in this analysis. First, in the labor and marriage market—two key tenets of adult health—blacks appear disproportionately impacted by incarceration or contact with the legal system (Pager 2003; Staples 1987; Wilson 1987). Accordingly, as compared to whites, two key venues to partially overcome the detrimental health effects of incarceration are more likely to be closed for black ex-inmates. Second, as compared to whites, the application of the law is such that blacks have a much greater likelihood of contact with the penal system (Pettit & Western 2004). As a percentage of the overall population, many more blacks are incarcerated, which this analysis suggests has implications for aggregate minority general health functioning.

[13] Slightly more than 5 percent of the overall sample consists of nonblack minorities. Exploratory analysis indicates that these individuals have health outcomes and social status indicators, such as education and income, consistent with blacks in the sample.

While blacks are disproportionately incarcerated, the analysis suggests that the penal system produces significant stratification in physical health for all incarcerated individuals. The penal system has expanded so tremendously that its scope and stratifying impact appear similar to that of other systems of health stratification. Recent estimates indicate that the legal and penal systems have grown to the point where there are roughly as many felons and ex-felons as college students, and there are as many inmates and ex-inmates as men in college (Uggen et al. 2006; United States Department of Education 2003). As the footprint of the penal system takes an ever larger place in the landscape of American society, debates about the scope, goals, costs, and benefits of the penal system are needed. This research seeks to inform and contribute to those debates. To that end, it reaches two basic conclusions about the long-term consequences of incarceration. Incarceration has significant long-term effects on physical health, and incarceration plays a role in perpetuating racial inequalities in health. The effect on health appears so robust and the incarceration disparities so great, that the penal system likely warrants consideration alongside other systems of health stratification.

Appendix: Matching Models and Sensitivity Analysis

This Appendix briefly discusses each of the four matching procedures used in the analysis, beginning with neighbor matching.[14] Neighbor matching is a relatively straightforward and parsimonious way to create a matched sample for subsequent analysis. A propensity score is estimated for every individual in the sample, independent of incarceration history. The nearest neighbor matching procedure identifies the propensity score of all incarcerated individuals and then selects a non-incarcerated individual whose propensity score is closest to each incarcerated individual. In its simplest form, and using a 1–1 match, nearest neighbor matching pairs each incarcerated individual to the closest non-incarcerated unit on the basis of the estimated propensity score. Analysis is then done on the matched sample to determine the treatment effect of incarceration.

In many respects, stratification matching operates similarly to neighbor matching. However, it divides the range of variation of propensity scores into strata, or intervals, such that within each strata the treated and control units have, on average, the same propensity score. The estimated treatment effect is the average

[14] This section focuses on the conceptual and substantive distinction between different matching procedures. Readers interested in a statistical and mathematical presentation of the differences across matching procedures should consult Becker and Ichino (2002:5–7).

difference in health across treated and nontreated individuals in each stratum.

While neighbor and stratification matching are straightforward and conceptually simple, they are not without potential problems. In particular, if no restrictions are imposed, nearest neighbor matching, by design, selects the nontreated individuals closest to the treated individuals, independent of the actual differences in propensity scores. That is, neighbor matching takes the closest match to any treated individual, even if the closest individual is, in fact, relatively dissimilar in terms of propensity score. This problem is conceptually similar to that of outliers in traditional regression models in that individuals with poor matches (meaning a significant difference between the propensity score of the two individuals) contribute the same to the calculation of the treatment effect as individuals with identical matches. Radius and kernel matching offer solutions to this potential problem.

Radius matching allows the user to define the radius, or neighborhood, around each treated individual from which matches can be drawn. The user sets a radius, for example, 0.001 in this analysis, and all nontreated individuals whose propensity score is within 0.001 of a treated individual will be selected for analysis.[15] Finally, kernel matching invokes a matching procedure where all treated individuals are matched with a weighted average of all untreated controls that is inversely proportional to the distance between the propensity scores of the treated and the controls. Substantively, this procedure uses weights to balance the contribution of each individual in the control group. This ensures that the contribution of an individual in the control group to the calculation of the treatment effect is based on how closely the individual is matched to an individual who has experienced incarceration.

The equation used to generate the matched sample is formally presented in Formula 2. As presented in the body of the article, one key component of the equation is the vector of covariates, X_i, used to create the propensity scores.

In this article, the matching equation includes measures of race, gender, whether the respondents came from an intact family, whether the respondents' family received public assistance, high school degree completion, employment status, juvenile involvement with the justice system, self-reported drug use, acts of violence, and a series of gender and race interactions. Because

[15] There is an obvious tension between the size of the radius and those included in the control group. The smaller the radius, the more homogeneous the experimental and the control group, but the greater the likelihood that treated cases will not have a match. In contrast, the larger the radius, the greater the number of matches for each treated individual, but greater heterogeneity is introduced across the matched and treated samples.

individuals with unhealthy lifestyles may be disproportionately incarcerated, propensity equations used to generate the results in Table 3 also include prior health problems. In so doing, the estimates specifically account for and control whether individuals with health problems are more likely to be "selected" into incarceration.[16]

The inclusion of indicators of crime and involvement with the justice system has multiple functions. First, they help ensure that the treatment effect reported in Table 3 represents an effect of incarceration as opposed to an effect of criminal behavior or more fleeting contact with the justice system, such as arrest. Moreover, including factors such as arrest, drug use, and self-reported crime has another important function: it helps create a matching equation well-suited to place individuals in the treatment state of incarceration. Indicators of criminal behavior and correctional intervention are highly predictive of incarceration status. Moreover, the specific criminal behavior indicators included, violence and drug use, are particularly predictive of incarceration (Blumstein & Beck 1999). In conjunction with socio-demographic indicators, the matching equation includes many factors that prior research indicates are key predictors of incarceration. Depending on the matching algorithm, 87–98 percent of incarcerated individuals are matched with appropriate nonincarcerated controls, with a slight variation in the number of matched individuals based on the specific matching procedure employed. While left-skewed, estimated propensity scores range from 0.001 to approximately 0.7. Important to note, the range of propensity scores is consistent across both treated and nontreated groups. Even after restricting the analysis to regions of common support, the majority of incarcerated individuals are matched with appropriate controls.

The radius matching procedure finds suitable matches for the lowest number of incarcerated individuals, 214. In part, this is a function of the highly restrictive conditions placed on how individuals are selected as controls. The radius width is set to 0.001, indicating that for an individual to be selected as a control, that individual's propensity score has to be within 0.001 of an incarcerated individual. This highly restrictive criterion further ensures the homogeneity of the sample, but it comes at the expense of the number of paired individuals. The less restrictive the radius bandwidth, the more individuals matched. In subsequent analysis, with the bandwidth increased to 0.005 and 0.01, 229 and 240

[16] There is no evidence that individuals with prior health problems are more likely to be incarcerated. The propensity matching equation is a logit model, and the results indicate that health problems are a nonsignificant predictor of incarceration.

individuals respectively are matched. The substantive results do not change when these different radius bandwidths are used for analysis.

One potential weakness of propensity models is bias from unobservables. As noted by others (Caliendo & Kopeinig 2005; Becker & Caliendo 2007), there are a number of procedures that help assess the role of unobservables, speak to the quality of the matching procedure, and test the robustness of the treatment effect. Following the lead of Caliendo and Kopeinig (2005:23) multiple steps were undertaken to ensure the adequacy of the matching procedure. First, as noted earlier, in all cases the balancing property was tested for and satisfied. Moreover, tests for standardized bias indicated that the bias reduction was below the 3–5 percent generally accepted as sufficient (Sianesi 2004; Caliendo and Kopening 2005:15). Finally, *t*-tests were utilized to examine mean differences between the treated and the control group, and in all cases the tests failed to reach conventional levels of statistical significance. The results of all tests point to an adequate matched and control sample.

With regard to the calculation of the treatment effect(s) shown in Table 3, one sensitivity check is to estimate the parameter using multiple matching methods (e.g., kernel, neighbor) and using bootstrapped standard errors. Both were done for all the analysis presented in Table 3. Moreover, as outlined in Rosenbaum (2002), DiPrete and Gangl (2004), and Becker and Caliendo (2007), estimates were derived using the complimentary psmatch2 method, and the Rosenbaum bounds were calculated. This sensitivity analysis specifically addresses the potential role of unobservable processes in the estimation of the treatment effects presented in Table 3. It examines the departure from an analysis free of hidden bias to empirically assess how much bias from unobservables would have to be introduced to significantly alter the inferences drawn from the parameter estimates. The results indicate that the estimates in Table 3 are not overly sensitive to potential bias from unobservables. More specifically, the odds that any matched pair differs in their probability of receiving treatment due to unobservables (γ or Γ) would have to exceed 30 percent ($\Gamma = 1.3$) to alter the substantive conclusions here. As such, the estimates appear robust. All sensitivity analyses are available upon request. In addition, as noted in footnote 11, the regression results remain significant even when restricting the analysis to the sibling data. Thus while almost no social science models can rule out the possibility of some unmeasured heterogeneity impacting the statistical results or substantive inferences, the available evidence—gathered through a series of sensitivity analyses—suggests that the findings presented herein are robust.

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