Individual and Societal Effects of Mental Disorders on Earnings in the United States: Results From the National Comorbidity Survey Replication

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Objective: The purpose of this report was to update previous estimates of the association between mental disorders and earnings. Current estimates for 2002 are based on data from the National Comorbidity Survey Replication (NCS-R).

Method: The NCS-R is a nationally representative survey of the U.S. household population that was administered from 2001 to 2003. Following the same basic approach as prior studies, with some modifications to improve model fitting, the authors predicted personal earnings in the 12 months before interview from information about 12-month and lifetime DSM-IV mental disorders among respondents ages 18–64, controlling for sociodemographic variables and substance use disorders. The authors used conventional demographic rate standardization methods to distinguish predictive effects of mental disorders on amount earned by persons with earnings from predictive effects on probability of having any earnings.

Results: A DSM-IV serious mental illness in the preceding 12 months significantly predicted reduced earnings. Other 12-month and lifetime DSM-IV/CIDI mental disorders did not. Respondents with serious mental illness had 12-month earnings averaging $16,306 less than other respondents with the same values for control variables ($26,435 among men, $9,302 among women), for a societal-level total of $193.2 billion. Of this total, 75.4% was due to reduced earnings among mentally ill persons with any earnings (79.6% men, 69.6% women). The remaining 24.6% was due to reduced probability of having any earnings.

Conclusions: These results add to a growing body of evidence that mental disorders are associated with substantial societal-level impairments that should be taken into consideration when making decisions about the allocation of treatment and research resources.

This report updates national estimates of annual lost earnings associated with mental disorders in the United States. The first such estimate, a loss of $44.1 billion in 1985, was made by Rice et al. (1) in a report commissioned by the U.S. Public Health Service, which used data from the National Institute of Mental Health (NIMH) Epidemiologic Catchment Area (ECA) study (2). This estimate was subsequently updated to a loss of $77 billion in 1992 by Harwood et al. (3) in a report commissioned by NIMH that used data from the National Comorbidity Survey (NCS) (4). The current update is based on data from the National Comorbidity Survey Replication (NCS-R) (5).

Similar to Rice et al. and Harwood et al., we used regression analysis to predict personal income in the 12 months before interview from information about 12-month and lifetime DSM-IV mental disorders, while controlling for sociodemographic variables and substance use disorders. However, we improved on the earlier analyses in four ways. First, the NCS-R assessed a wider range of disorders than the ECA or NCS. Second, the NCS-R measured personal earnings, whereas the earlier surveys measured the broader category of personal income (which included unearned income). Exclusion of unearned income removes a bias that was present in the earlier studies. Third, NCS-R estimates are more generalizable than earlier estimates because the NCS-R is a nationally representative survey of respondents ages 18–64, whereas the ECA was a local survey and the NCS was restricted to ages 18–54. Fourth, the statistical analysis we used improves on the approaches used in the earlier studies.

Method

Sample

The NCS-R is a nationally representative survey that was conducted between February 2001 and April 2003 of English-speaking household residents age 18 or older. The response rate was 70.9%. Part 1 of the interview included a core diagnostic assessment administered to all respondents (N=9,282). Part 2 included

questions about correlates and additional disorders administered to all part 1 respondents who met lifetime criteria for any core disorder plus a probability subsample of other respondents (N= 5,692). Earnings were assessed in part 2. Part 2 respondents (N= 4,982; 47.9% men, 52.1% women; ages 18–64) were the focus of analysis. The sample was weighted to adjust for differential probability of selection, differential sampling into part 2 of the interview, and residual discrepancies between sample and census population sociodemographic and geographic distributions. More details on NCS-R sampling and weighting are reported elsewhere (6).

Measures

Diagnostic assessment. DSM-IV disorders were assessed using the World Health Organization (WHO) Composite International Diagnostic Interview (CIDI) version 3.0 (7), a fully structured lay-administered diagnostic interview. Mental disorders assessed included anxiety disorders (panic disorder, generalized anxiety disorder, phobias, posttraumatic stress disorder, and obsessive-compulsive disorder), mood disorders (major depressive disorder, dysthymia, and bipolar disorder), and impulse-control disorders (oppositional defiant disorder, conduct disorder, intermittent explosive disorder, adult attention deficit hyperactivity disorder, eating disorders, and pathological gambling), and a screen for nonaffective psychosis was included. Additional assessments were made for alcohol and illicit drug abuse and dependence. A clinical reappraisal study using the research nonpatient version of the Structured Clinical Interview for DSM-IV (SCID) (8) found generally good concordance with CIDI diagnoses (9).

Similar to Harwood et al., we distinguished 12-month DSM-IV mental disorders by severity. Whereas the highest category in the Harwood et al. classification is "severe and persistent mental illness," as defined by NIMH's National Advisory Mental Health Council (10), our highest category was the broader "serious mental illness," as defined by the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) Reorganization Act (11). We used the classification of serious mental illness because the number of NCS-R respondents with severe and persistent mental illness (nonaffective psychosis, bipolar disorder, and severe major depression and panic disorder) was too small for reliable analysis. Serious mental illness was considerably more prevalent (12) and included severe and persistent mental illness plus either a 12-month suicide attempt with serious lethality intent, an impulse control disorder with repeated serious violence, or any other disorder that resulted in 30 or more days in which the respondent could not carry out daily activities as usual in the 12 months before interview. All other 12-month DSM-IV/CIDI mental disorders were included in a second category, while other lifetime mental disorders constituted a third category. Controls were included for 12-month and other lifetime DSM-IV/CIDI alcohol and illicit drug abuse, with or without dependence.

Earnings. All part 2 NCS-R respondents were asked to report their personal earnings income in the past 12 months, before taxes. Respondents were instructed to count only wages and other stipends from employment, not pensions, investments, or other financial assistance or income. Missing values (about 5% of respondents) were calculated using regression-based imputation from information on respondent age, gender, marital status, race/ethnicity, education, occupation, average number of hours worked per week, and 2000 census data on income distribution in the respondent's census tract.

Sociodemographic control variables. Control variables were included for five sociodemographic variables known to predict earnings (13, 14): age at interview, gender, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or other), census region (northeast, midwest, south, or west), and urbanicity (major metropolitan area, other urbanized area, or rural area). Rice et al. and Harwood et al. also controlled for education, marital status, and number of household members. We excluded these variables, however, because of concerns about overcontrolling, since previous research has shown that these variables are influenced by mental disorders (15–17).

Analysis Methods

Multiple regression analysis was used to predict 12-month personal earnings from DSM-IV mental disorders (using separate dummy variables for 12-month serious mental illnesses, other 12-month DSM-IV/CIDI mental disorders, and other lifetime mental disorders), with controls for sociodemographic variables and substance use disorders. As in earlier studies, we allowed coefficients to differ for men and women and added an inflation factor to account for fringe benefits. We used a 42% inflation factor based on evidence that the average fringe benefit in the United States in 2005 was 42% (18).

As in earlier studies, our regression model had a nonlinear transformation of the dependent variable, and we conducted simulations based on that model to estimate effects of mental disorders on earnings. The primary problem in using such a model is that the highly skewed distribution of earnings in the U.S. population makes ordinary least squares regression analysis both biased and inefficient. Rice et al. addressed this problem by using weighted least squares regression analysis. Harwood et al. addressed it by using a two-part model (19), in which the part 1 logistic regression model (20) predicted having any earnings and the part 2 linear regression model (ordinary least squares regression with a logarithmic transformation of the dependent variable) predicted amount earned among those respondents with any earnings. Individual-level predictions from these two models were multiplied and transformed with a correction adjustment to predict earnings for each respondent.

We used a different approach. Although two-part models have several desirable features compared to weighted least squares regression, the multiplication and transformation of individual-level estimates is highly sensitive to model misspecification (21). Generalized linear models (22) address this problem (23) by using prespecified nonlinear relationships and suitably specified error structures to estimate one-part models, which fit highly skewed earnings data better than two-part models (24). We consequently used generalized linear models rather than two-part models in our analysis.

Simulation generated two estimates of predicted earnings for each respondent within the parameters of the best-fitting model: one estimate based on the actual characteristics of the respondent and the other based on the counterfactual assumption that none of the respondents had a serious mental illness. Individual-level differences between these estimates were averaged across all respondents with serious mental illness to estimate the mean individual-level decrease in earnings associated with serious mental illness. This estimate was projected to the societal level by multiplying by the estimated prevalence of serious mental illness and by the size of the noninstitutionalized civilian U.S. population in the age range of 18–64. Demographic rate standardization (25) was then used to decompose societal-level estimates into components based on the effects of mental disorders on the probability of having any earnings and the effects of mental disorders on the amount earned by those with any earnings.

Because the NCS-R sample design featured weighting and clustering, all analyses were carried out using jackknife repeated replications to generate standard error estimates (26). In this approach, each of the models and simulations was estimated repeatedly in stratified pseudosamples drawn from the NCS-R sample. Standard error estimates were calculated from the empir-

TABLE 1. Clinical and Sociodemographic Characteristics of National Comorbidity Survey Replication (NCS-R) Respondents

Characteristic	Total Sample (N=4,982)		Men (N=2,119)		Women (N=2,863)	
	%	SD	%	SD	%	SD
Prevalence of DSM-IV/CIDI mental disorders						
Serious mental illness (past 12 months)[a]	6.5	0.06	5.6	0.05	7.4	0.07
Other mental disorders (past 12 months)	22.6	0.18	19.2	0.15	25.8	0.19
Other mental disorders (lifetime)	20.3	0.16	20.7	0.16	19.9	0.16
Prevalence of alcohol use disorders[b]						
12-month alcohol abuse without dependence	2.1	0.02	3.1	0.03	1.2	0.01
12-month alcohol dependence	1.6	0.02	2.2	0.02	1.1	0.01
Other lifetime alcohol abuse without dependence	6.8	0.06	9.8	0.09	4.0	0.04
Other lifetime alcohol dependence	4.6	0.04	6.7	0.06	2.7	0.03
Prevalence of illicit drug use disorders[b]						
12-month drug abuse without dependence	1.2	0.01	1.9	0.02	0.5	0.00
12-month drug dependence	0.5	0.00	0.6	0.01	0.4	0.00
Other lifetime drug abuse without dependence	4.9	0.05	7.1	0.07	2.9	0.03
Other lifetime drug dependence	3.2	0.03	4.2	0.04	2.3	0.02
Outcomes						
Any 12-month earnings	86.1	0.12	91.6	0.08	81.1	0.15
Low earnings (<$12,700)	25.9	0.19	17.2	0.14	34.8	0.23
Low to average earnings ($12,700–$27,499)	21.9	0.17	18.8	0.15	25.2	0.19
High to average earnings ($27,500–$42,899)	29.2	0.21	31.4	0.22	26.9	0.20
High earnings (≥$42,900)	23.0	0.18	32.6	0.22	13.0	0.11
Sociodemographic control variables						
Gender						
Male	47.9	0.25				
Female	52.1	0.25				
Age (years)						
18–24	18.3	0.15	19.2	0.16	17.5	0.14
25–39	31.8	0.22	31.7	0.22	31.9	0.22
40–54	36.0	0.23	36.0	0.23	36.1	0.23
55–64	13.9	0.12	13.1	0.11	14.6	0.12
Race/ethnicity						
Non-Hispanic black	13.0	0.11	11.6	0.10	14.3	0.12
Non-Hispanic white	70.0	0.21	71.1	0.21	69.0	0.21
Hispanic	12.3	0.11	12.7	0.11	11.8	0.10
Other	4.8	0.05	4.6	0.04	4.9	0.05
Census region						
Northeast	18.5	0.15	19.0	0.15	18.1	0.15
Midwest	23.1	0.18	24.0	0.18	22.3	0.17
South	35.7	0.23	35.2	0.23	36.2	0.23
West	22.6	0.18	21.8	0.17	23.4	0.18
Urbanicity						
Resident of major metropolitan area	40.9	0.24	41.0	0.24	40.8	0.24
Resident of other urbanized area	28.5	0.20	28.7	0.20	28.3	0.20
Resident of rural area	30.6	0.21	30.3	0.21	30.9	0.21

[a] Defined as nonaffective psychosis, bipolar disorder, sever major depression, panic disorder, suicide attempt with serious lethality intent in the preceding 12 months, impulse control disorder with repeated serious violence, or any other disorder that resulted in 30 or more days in the preceding 12 months during which daily activities could not be conducted as usual.

[b] The four categories of alcohol use and illicit drug use disorders are mutually exclusive. Respondents with a lifetime history of substance dependence who were in partial remission in the 12 months before interview were coded as having 12-month dependence. Only respondents who did not meet criteria for a 12-month disorder were eligible for classification as having a lifetime disorder. In the final models, 12-month alcohol abuse and dependence, 12-month illicit drug abuse and dependence, lifetime alcohol abuse and dependence, and lifetime illicit drug abuse and dependence were collapsed into a single variable based on the lack of significance between the two coefficients. As a result, four rather than eight control variables were included in the models for substance use disorders.

ical distributions of results in these replications. Multivariate significance was estimated using design-adjusted chi-square tests or analysis of variance based on jackknife repeated replications with design-corrected coefficient variance-covariance matrices. Statistical significance was consistently evaluated using two-tailed tests with an alpha level of 0.05.
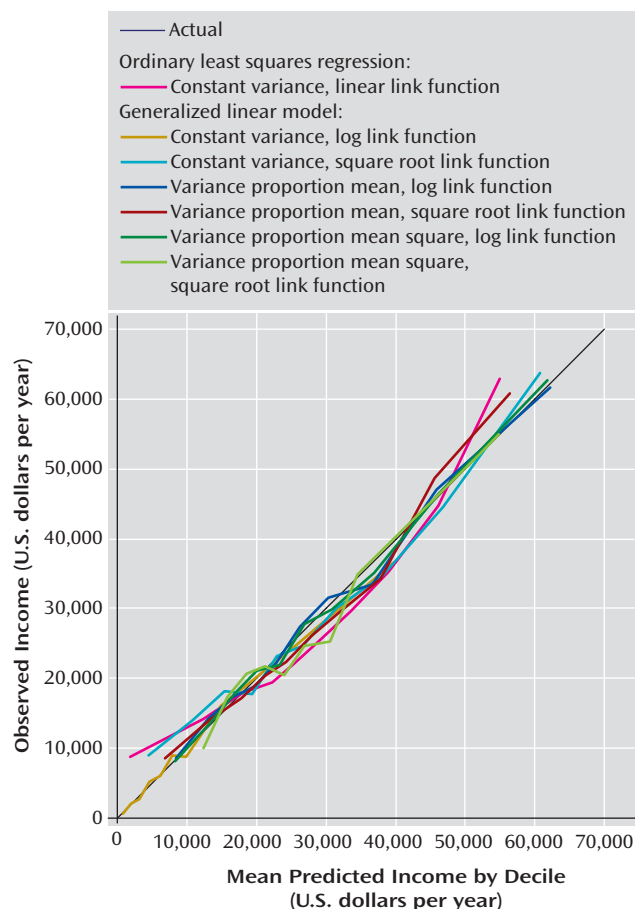
Results

Sociodemographic Variable Distributions

The prevalence estimates of DSM-IV mental disorders were 6.5% for 12-month serious mental illness, 22.6% for other 12-month mental disorders, and 20.3% for other life-time mental disorders (Table 1). It was significantly more common for women than men to report a serious mental illness (t=2.6, df=4,980, p=0.008) or other 12-month mental disorder (t=4.7, df=4,980, p<0.001), but there was no significant gender difference in other lifetime disorders (t=0.5, df=4,980, p=0.59). Most respondents (86.1%) reported some personal earnings in the 12 months before interview, although more male than female respondents reported personal earnings (91.6% versus 81.1%; t=6.4, df=4,980, p<0.001). Among those respondents with any earnings, men had significantly higher earnings distribution than women (χ^2=63.6, df=3,126, p<0.001). Weighted sample distributions for sociodemo-

FIGURE 1. Associations Between Predicted and Observed Earnings by Decile of Predicted Earnings, Based on One-Part Models in the Total Sample (N=4,982)

association between predictors and outcome (square root or logarithmic) and one of three error structures (independent, error variance proportional to the predicted value, or error variance proportional to the square of the predicted value). The seven two-part models used logistic regression in part 1 to predict any earnings versus no earnings and the same set of seven models in part 2 to predict amount earned among those respondents with any earnings.

Accuracy of models was evaluated by plotting the associations between predicted mean earnings and observed mean earnings for deciles of predicted earnings (Figure 1). Only the one-part model plots are presented because they were clearly better than those for the two-part models (results for the two-part models are available on request). The actual decile means form a 45° line in the figure; points above or below this line indicate either overestimation or underestimation. The figure shows that the ordinary least squares regression model did noticeably worse than the generalized linear models, as ordinary least squares regression overestimated at both the ends of the distribution and underestimated in the middle. Several generalized linear models had predicted means that fell very close to the observed means throughout the range. The best-fitting of these models, in terms of mean squared error, assumed a logarithmic association between the predictors and the outcome and error variance proportional to the predicted value of the outcome. A number of other model-fitting tests proposed in the econometrics literature (28) also showed this to be the best-fitting model (results available on request).

Individual-Level Predictive Effects of Mental Disorders on Earnings

We used the best-fitting generalized linear model specification to compare predictive effects of serious mental illness, other 12-month DSM-IV/CIDI mental disorders, and other lifetime mental disorders on 12-month earnings (Table 2). The first model shows that serious mental illness was significantly associated with reduced earnings among both men and women, while associations with other 12-month and lifetime mental disorders were not statistically significant. Attempts to decompose the measures of other 12-month and lifetime mental disorders failed to find any specification in which subsets of these disorders were significant. A revised model (model II) retained serious mental illness but eliminated other mental disorders as predictors. Serious mental illness was again significant and again had negative effects in model II.

Considering model II as the preferred model, we next evaluated whether the predictive effect of serious mental illness on earnings varied significantly depending on substance use disorders by estimating a model that included interaction terms between serious mental illness and substance use disorders. These interactions were not statistically significant either in the total sample (F=0.3, df=4, 4,941, p=0.90) or separately among men (F=0.3, df=4, 4,937,

graphic control variables were consistent with census population distributions by construction (6). Substance use disorder distributions were consistent with those reported previously for the total NCS-R sample (12, 27).

Model Fitting

Seven one-part models and seven two-part models were estimated and compared. Each model included the same predictors: 12-month serious mental illness, other 12-month mental disorders, other lifetime mental disorders, controls for sociodemographic variables (age, gender, race/ethnicity, census region, and urbanicity), controls for substance use disorders, and interactions between gender and all other model variables to predict past year earnings. All differences among models involved assumed functional forms and error structures. The seven one-part models, each of which was estimated in the total sample (i.e., included respondents with no earnings), included an ordinary least squares regression model, which assumed linear associations between the predictors and the outcome with an independent error structure, and six generalized linear models. The generalized linear models assumed one of two nonlinear functional forms for the

TABLE 2. Generalized Linear Model Estimates of Predictive Effects of Mental Disorders on 12-Month Earnings

Model and Predictor	Total Sample (N=4,982)		Men (N=2,119)		Women (N=2,863)	
	Coefficient Estimate[a]	95% CI	Coefficient Estimate[a]	95% CI	Coefficient Estimate[a]	95% CI
Model I: amount of earnings in the total sample						
12-month DSM-IV/CIDI serious mental illness	−0.35*	−0.57 to −0.14	−0.70*	−0.91 to −0.48	−0.36*	−0.57 to −0.15
Other 12-month DSM-IV/CIDI mental disorders	0.10	−0.02 to 0.21	−0.06	−0.18 to 0.07	0.08	−0.02 to 0.20
Other lifetime DSM-IV/CIDI mental disorders	0.11	−0.01 to 0.22	−0.07	−0.18 to 0.05	0.11	0.00 to 0.22
Model II: amount of earnings in the total sample						
12-month DSM-IV/CIDI serious mental illness	−0.40*	−0.60 to −0.20	−0.66*	−0.86 to −0.46	−0.42*	−0.62 to −0.22
Model III: any earnings in the total sample						
12-month DSM-IV/CIDI serious mental illness	0.35*	0.25 to 0.50	0.16*	0.10 to 0.28	0.34*	0.23 to 0.51
Model IV: amount of earnings among respondents with any earnings						
12-month DSM-IV/CIDI serious mental illness	−0.30*	−0.47 to −0.12	−0.56*	−0.75 to −0.37	−0.31*	−0.48 to −0.14

[a] Coefficient estimates in models I, II, and IV are based on generalized linear models with multiple linear regression using a logarithmic link function. Coefficient estimates in Model III are based on multiple logistic regression models.
* $p < 0.05$.

p=0.90) or women (F=0.4, df=4, 4,937, p=0.70). Additive controls for substance use disorders were consequently included in the final model. The effect of serious mental illness in model II was then disaggregated by estimating separate models to predict having any earnings versus no earnings (model III) and to predict amount earned among those respondents with any earnings (model IV). Both effects were significant among both men and women. Serious mental illness was associated with significantly reduced odds of having any earnings and, among those with any earnings, significantly lower earnings than those of respondents without serious mental illness.

Simulated Individual-Level Effect Estimates

Simulated mean *expected* annual earnings of respondents with serious mental illness in the absence of that serious mental illness was estimated at $38,851, compared with mean *observed* earnings of $22,545 (Table 3). The difference, $16,306, is the estimated mean impact of serious mental illness on earnings. This estimate is higher among men ($26,435) than women ($9,302). The simulation was repeated in the subsample of respondents with any earnings, where the adverse effect of serious mental illness was estimated to be lower than in the total sample ($14,393 versus $16,306). The same held true both among men ($23,899 versus $26,435) and among women ($7,820 versus $9,302). This difference in mean effects between the total sample and subsample reflects the fact that serious mental illness is associated not only with lower earnings among persons who have any earnings but also with decreased odds of having any earnings at all.

Decomposition of Individual-Level Effect Estimates

When projected to the total sample, the lower earnings of respondents with serious mental illness and any 12-month earnings were 75.4% (SD=9.0) of the overall decrement in earning associated with serious mental illness. This means that the remaining 24.6% was due to the lower probability of persons with serious mental illness having any earnings (in conjunction with the fact that if they had had any earnings, they would have earned significantly less, on average, than persons without serious mental illness who were otherwise identical to them in the control variables). The proportion of the total estimated effect of serious mental illness due to lower earnings among those with any earnings was higher among men (79.6% [SD= 8.2]) than women (69.6% [SD=12.2]).

Simulated Societal-Level Effect Estimates

The societal-level effect of serious mental illness was estimated by projecting the individual-level effect to the 179.6 million persons ages 18–64 in the noninstitutionalized civilian population of the United States (29), taking into consideration the estimated prevalence of serious mental illness and the estimated individual-level effect of serious mental illness on earnings (Figure 2). The estimated societal-level effect was $193.2 billion (SD=55.5) in the total population, $131.3 billion (SD=32.4) among men, and $61.9 billion (SD=19.7) among women.

Sensitivity Analysis

We replicated the simulation using three other models shown to be close to the best-fitting model in reproducing the observed population income distribution: one model

TABLE 3. Mean Expected 2002 Earnings in the Absence of Serious Mental Illness Compared to Observed Earnings Among Respondents With 12-Month DSM-IV/CIDI Serious Mental Illness[a]

	Total Sample (N=4,982)		Men (N=2,119)		Women (N=2,863)	
	Estimate	SD	Estimate	SD	Estimate	SD
All respondents						
Expected earnings	$38,851	$31,486	$54,505	$34,189	$28,026	$15,548
Observed earnings	$22,545	$16,239	$28,070	$17,608	$18,724	$10,387
Mean estimated impact of serious mental illness	$16,306	$6,846	$26,435	$7,175	$9,302	$5,547
Respondents with any earnings						
Expected earnings	$40,799	$31,543	$57,783	$34,299	$30,438	$16,452
Observed earnings	$26,406	$18,226	$31,884	$19,605	$22,619	$12,226
Mean estimated impact of serious mental illness	$14,393	$7,190	$23,899	$7,479	$7,820	$5,737

[a] Mean expected 2002 earnings are based on the coefficients for the control variables in model II.

with a logarithmic transformation of the outcome and error variance proportional to the square of the predicted value of the outcome and two models that used a square root transformation of the outcome with error variance assumed to be either proportional to the predicted value or proportional to its square (Figure 1). The estimated effect sizes ranged across these models from a low of $178.1 billion (SD=49.3), which was 8% lower than in the best-fitting model, to a high of $213.9 billion (SD=66.6), which was 11% higher than in the best-fitting model. Roughly comparable ranges were found for estimates among men ($124.3–$152.2 billion or between 5% lower and 16% higher than in the best-fitting model) and women ($56.5–$65.1 billion or between 9% lower and 5% higher than in the best-fitting model).

We investigated the extent to which the estimated societal-level effect of serious mental illness could be explained by control variables included in earlier studies but omitted from our models: education, marital status, and household size (Figure 2). The estimated total-population effect of serious mental illness on earnings decreased by approximately 25%, from $193.2 billion (SD=55.5) to $144 billion (SD=48.1). The magnitude of this decrease, however, was substantially larger among women (39%) than men (17%), with the estimate decreasing from $61.9 billion (SD=19.7) to $37.8 billion (SD=16.6) for women and from $131.3 billion (SD=32.4) to $109 billion (SD=29.2) for men.

Discussion

Serious mental illness was estimated to be associated with a loss of $193.2 billion in personal earnings in the total U.S. population in 2002. To put this cost in perspective, it is larger than the $145 billion economic stimulus package recently proposed by President Bush in January 2008 to help avoid an economic recession in the United States. Our estimate is, on the surface, much higher than the estimates reported by Rice et al. or Harwood et al. These differences can be easily explained, though, by two factors: 1) inflation (i.e., adjusting earlier estimates to 2002 dollars) and 2) controlling for education, marital status, and household size. Adjusting earlier estimates into 2002 dollars using cost compensation trend data from the U.S. Department of Labor (available at www.bls.gov/ncs/ect/

home.htm) changes the Rice et al. estimate to $83.1 billion and the Harwood et al. estimate to $107.7 billion. The Rice et al. estimate becomes higher still when we adjust for the fact that they did not include fringe benefits for paid sick leave or health insurance. Furthermore, when Harwood et al. estimated a revised model version that deleted education, marital status, and household size as control variables, the estimated effect of mental disorders increased by a factor of 2.26, making it even larger than our estimate when adjusted to 2002 dollars ($241 billion).

Irrespective of the reasons for the differences in estimates across studies, all three studies found that mental disorders are associated with massive losses of productive human capital. This finding adds to a growing body of evidence that the impaired functioning associated with mental disorders carries an enormous societal burden (30, 31), although caution is needed in inferring causation from our associational results. Comparative cost-of-illness studies show that the magnitude of this association is high in relation to most physical disorders. For example, a recent U.S. study found that up to one-third of illness-related days in which subjects could not carry out daily activities as usual are related to mental rather than physical disorders (31). Yet only 6.2% of all U.S. health care spending is devoted to treatment of mental disorders (32), even though most persons with mental disorders do not get treatment (33) and treatment is much higher for physical than mental disorders with comparable levels of impairment (30). This kind of comparative information about burden and treatment should be integrated with information about comparative treatment effectiveness to help guide decisions about implementation of disorder-specific screening and treatment programs and about federal health care research resource allocation (34).

Our results go beyond those of earlier studies in decomposing the association between serious mental illness and low earnings into components based on having no earnings at all and, among those with any earnings, having low earnings. We found that three-fourths of the total association between serious mental illness and earnings in the NCS-R is due to lower earnings among employed persons with versus without serious mental illness, while the remaining one-fourth is due to a lower probability of having any earnings at all among persons with versus without se-

rious mental illness. The dominant influence of low earnings among those persons with any earnings at all raises the possibility that appropriate policy solutions might include increased job training and vocational rehabilitation for workers with serious mental illness and increased enforcement of the Americans With Disabilities Act with regard to corporate practices of promotion and remuneration. More detailed analyses of the data are needed, however, to understand the occupational career dynamics associated with the effects of serious mental illness on earnings among employed persons before the relevance of these and other policy implications will become clear. Further analysis is also needed to understand the determinants of the comparatively high unemployment rate among persons with serious mental illness. Although such analyses go well beyond the scope of the current report, these analyses need to be the focus of future studies in order to further consider all the policy implications related to the association between serious mental illness and earnings documented here.

This study has a number of limitations, including that 1) mental disorders were assessed with fully structured lay interviews rather than clinical interviews, 2) earnings were assessed with self-report rather than administrative records, and 3) the dynamic association was estimated with cross-sectional data. Another limitation is that the productive labor of women in domestic activities was not assigned a monetary value in the analysis even though it has value. As a result of this, the true financial impact of the fact that women with serious mental illness are less likely than other women to have earnings was overestimated to the extent that the unpaid labor of women without earnings is greater than that of women with earnings.

One technical limitation is that we applied a flat fringe benefit rate of 42% to all workers. It could be argued that the average fringe benefit rate of workers with serious mental illness is lower than the national average because the lower-paying jobs of persons with serious mental illness probably also have lower than average fringe benefit rates. We were unable to assign differentiated fringe benefits to individual NCS-R respondents because no nationally representative administrative data exists that would allow us to do this. It should be noted, however, that the assumption of constant fringe benefits leads to a conservative bias in our estimates, due to the fact that we presumably overestimated total compensation to workers with serious mental illness.

Perhaps the most significant limitation of the analysis is that we were unable to adjust for the reciprocal effect of low earnings on risk of mental disorder. There is good reason to believe that such an effect exists (35). Because of this limitation, while we can state that serious mental illness is *associated* with low earnings, we cannot state how much of this association is due to serious mental illness *causing* low earnings. Earlier studies and, indeed, virtually all cost-of-illness studies (36) have the same limitation.

FIGURE 2. Estimated Societal-Level Effects of 12-Month DSM-IV/CIDI Serious Mental Illness on Earnings in 2002 by Gender, With and Without Controls for Education, Marital Status, and Household Size
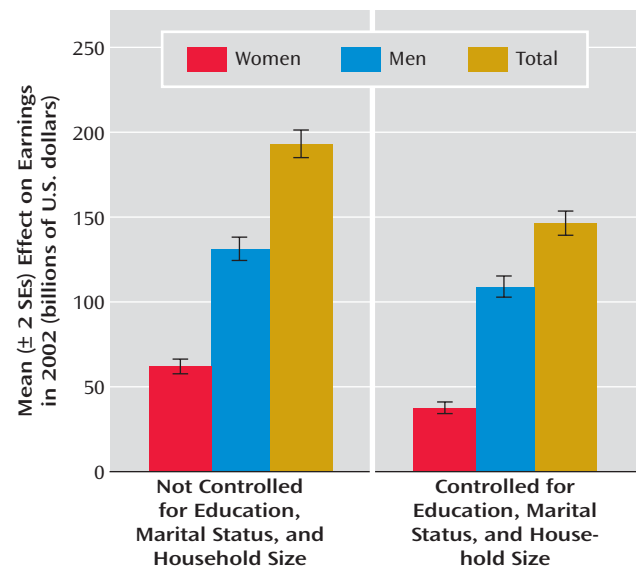
There is no way to correct this limitation definitively with nonexperimental data. Controlling for mediating variables, such as education and marital status, which might themselves be reciprocally related to mental disorder, would not be a corrective measure, as this can lead to overcorrection. Longitudinal analysis can sometimes help. For example, a 5-year longitudinal follow-up in four U.S. cities of 5,000 initially employed respondents ages 18–30 from the CARDIA study found that high baseline Center for Epidemiologic Studies Depression Scale (CES-D) scores significantly predicted subsequent unemployment and decreases in income even after controlling for baseline education, marital status, and history of prior unemployment (37). Even here, though, high baseline CES-D scores could have been influenced by knowledge of job insecurity, which in turn predicted subsequent job loss. Sophisticated econometric models can sometimes be useful in resolving such uncertainty if information is available on third variables that influence one but not the other variable in a reciprocal pair (38), but such models are highly sensitive to misspecification (39).

Although not a limitation per se, it is also worth noting that we purposely restricted the analysis to only one component of the societal costs of mental disorders: the impact on earnings. We did not consider such other societal costs as the impact of mental illness on welfare and Supplemental Security Income or the workplace effects of mental illness on lost productivity. The results reported here should consequently not be considered a comprehensive estimate of all the societal costs of mental illness, but only the estimate of one component of these costs, with the caveat that the $193.2 billion decrement in earn-

ings should be seen as *associated* with mental illness rather than necessarily *caused* by mental illness.

Experimental interventions are ultimately the only reliable way to resolve this uncertainty and document causal effects of mental disorders on earnings or other indicators of role performance (40). Such interventions are comparatively rare and almost always include only relatively short-term follow-up. It is consequently important for future treatment effectiveness studies to include measures of functioning (such as measures of employment status, work productivity, and earnings) as secondary outcomes and for these studies to follow participants as long as possible in order to document long-term effects of mental disorders on functional outcomes. It is also important to note that some interventions, such as those based on a social skills training model or an occupational rehabilitation model, might be effective in decreasing unemployment and improving job performance among people with serious mental illness without decreasing symptoms of mental illness. It is important that interventions of this type, aimed directly at addressing the problem of low earnings, be implemented and evaluated. Controlled studies of these sorts, when combined with information about the prevalence and course of illness from epidemiological studies, are our greatest hope of obtaining more definitive data than presented here about the effects of mental disorders on earnings and other aspects of functioning.

References

1. Rice DP, Kelman S, Miller LS, Dunmeyer S: The Economic Costs of Alcohol and Drug Abuse and Mental Illness: 1985. Washington, DC, US Department of Health and Human Services, 1990
2. Robins LN, Regier DA (eds): Psychiatric Disorders in America: The Epidemiologic Catchment Area Study. New York, Free Press, 1991
3. Harwood H, Ameen A, Denmead G, Englert E, Fountain D, Livermore G: The Economic Cost of Mental Illness, 1992. Rockville, Md, National Institute of Mental Health, 2000
4. Kessler RC, McGonagle KA, Zhao S, Nelson CB, Hughes M, Eshleman S, Wittchen HU, Kendler KS: Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: results from the National Comorbidity Survey. Arch Gen Psychiatry 1994; 51:8–19
5. Kessler RC, Merikangas KR: The National Comorbidity Survey Replication (NCS-R): background and aims. Int J Methods Psychiatr Res 2004; 13:60–68
6. Kessler RC, Berglund P, Chiu WT, Demler O, Heeringa S, Hiripi E, Jin R, Pennell BE, Walters EE, Zaslavsky A, Zheng H: The US National Comorbidity Survey Replication (NCS-R): design and field procedures. Int J Methods Psychiatr Res 2004; 13:69–92
7. Kessler RC, Ustün TB: The World Mental Health (WMH) Survey Initiative Version of the World Health Organization (WHO) Composite International Diagnostic Interview (CIDI). Int J Methods Psychiatr Res 2004; 13:93–121
8. First MB, Spitzer RL, Gibbon M, Williams JB: Structured Clinical Interview for DSM-IV Axis I Disorders, Research Version, Non-Patient Edition (SCID-I/NP). New York, New York State Psychiatric Institute, Biometrics Research, 2002
9. Haro JM, Arbabzadeh-Bouchez S, Brugha TS, de Girolamo G, Guyer ME, Jin R, Lepine JP, Mazzi F, Reneses B, Vilagut G, Sampson NA, Kessler RC: Concordance of the Composite International Diagnostic Interview Version 3.0 (CIDI 3.0) with standardized clinical assessments in the WHO World Mental Health surveys. Int J Methods Psychiatr Res 2006; 15:167–180
10. Health care reform for Americans with severe mental illnesses: report of the National Advisory Mental Health Council. Am J Psychiatry 1993; 150:1447–1465
11. Final notice establishing definitions for (1) children with a serious emotional disturbance, and (2) adults with a serious mental illness. Fed Regist 1993; 58:29422–29425
12. Kessler RC, Chiu WT, Demler O, Merikangas KR, Walters EE: Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. Arch Gen Psychiatry 2005; 62:617–627
13. Bowles S, Gintis H, Osborne M: The determinants of earnings: a behavioral approach. J Econ Lit 2001; 39:1137–1176
14. Goldsmith AH, Veum JR, Darity W Jr: The impact of psychological and human capital on wages. Econ Inq 1997; 35:815–829
15. Forthofer MS, Kessler RC, Story AL, Gotlib IH: The effects of psychiatric disorders on the probability and timing of first marriage. J Health Soc Behav 1996; 37:121–132
16. Kessler RC, Foster CL, Saunders WB, Stang PE: Social consequences of psychiatric disorders, I: educational attainment. Am J Psychiatry 1995; 152:1026–1032
17. Kessler RC, Walters EE, Forthofer MS: The social consequences of psychiatric disorders, III: probability of marital stability. Am J Psychiatry 1998; 155:1092–1096
18. Bureau of Labor Statistics: Employer Costs for Employee Compensation—March 2005. Washington, DC, US Department of Labor, 2005 (http://stats.bls.gov/news.release/archives/ecec_06162005.pdf)
19. Duan N, Manning WG, Morris CN, Newhouse JP: Choosing between the sample-selection model and the multi-part model. J Bus Econ Stat 1984; 2:283–289
20. Hosmer DW, Lemeshow S: Applied Logistic Regression, 2nd ed. New York, John Wiley & Sons, 2000
21. Manning WG: The logged dependent variable, heteroscedasticity, and the retransformation problem. J Health Econ 1998; 17:283–295
22. McCullagh P, Nelder JA: Generalized Linear Models, 2nd ed. London, Chapman and Hall, 1989
23. Mullahy J: Much ado about two: reconsidering the two-part model in health econometrics. J Health Econ 1998; 17:247–281

24. Manning WG, Mullahy J: Estimating log models: to transform or not to transform? J Health Econ 2001; 20:461–494

25. Schempf A, Becker S: On the application of decomposition methods (letter). Am J Public Health 2006; 96:1899

26. Wolter KM: Introduction to Variance Estimation. New York, Springer-Verlag, 1985

27. Kessler RC, Berglund P, Demler O, Jin R, Merikangas KR, Walters EE: Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. Arch Gen Psychiatry 2005; 62:593–602

28. Buntin MB, Zaslavsky AM: Too much ado about two-part models and transformation? comparing methods of modeling Medicare expenditures. J Health Econ 2004; 23:525–542

29. US Census Bureau: Annual Estimates of the Population by Selected Age Groups and Sex for the United States: April 1, 2000 to July 1, 2005 (Table 2). Washington, DC, US Census Bureau, 2006

30. Druss BG, Hwang I, Petukhova M, Sampson NA, Wang PS, Kessler RC: Impairment in role functioning in mental and chronic medical disorders in the United States: results from the National Comorbidity Survey Replication. Mol Psychiatry (in press)

31. Merikangas KR, Ames M, Cui L, Stang PE, Ustun TB, Von Korff M, Kessler RC: The impact of comorbidity of mental and physical conditions on role disability in the US adult household population. Arch Gen Psychiatry 2007; 64:1180–1188

32. Mark TL, Levit KR, Coffey RM, McKusick DR, Harwood HJ, King EC, Bouchery E, Genuardi JS, Vandivort-Warren R, Buck JA, Ryan K: National Expenditures for Mental Health Services and Substance Abuse Treatment, 1993–2003. Rockville, Md, Substance Abuse and Mental Health Services Administration, 2007

33. Wang PS, Lane M, Olfson M, Pincus HA, Wells KB, Kessler RC: Twelve-month use of mental health services in the United States: results from the National Comorbidity Survey Replication. Arch Gen Psychiatry 2005; 62:629–640

34. Wilson EC, Rees J, Fordham RJ: Developing a prioritisation framework in an English Primary Care Trust. Cost Eff Resour Alloc 2006; 4:3

35. Costello EJ, Compton SN, Keeler G, Angold A: Relationships between poverty and psychopathology: a natural experiment. JAMA 2003; 290:2023–2029

36. Hu TW: Perspectives: an international review of the national cost estimates of mental illness, 1990–2003. J Ment Health Policy Econ 2006; 9:3–13

37. Whooley MA, Kiefe CI, Chesney MA, Markovitz JH, Matthews K, Hulley SB: Depressive symptoms, unemployment, and loss of income: the CARDIA Study. Arch Intern Med 2002; 162:2614–2620

38. Ettner SL, Frank RG, Kessler RC: The impact of psychiatric disorders on labor market outcomes. Ind Labor Relat Rev 1997; 51:64–81

39. Bound J, Jaeger DA, Baker RM: Problems with instrumental variables estimation when the correlation between the instruments and the endogenous explanatory variables is weak. J Am Stat Assoc 1995; 90:443–450

40. Wang PS, Simon GE, Avorn J, Azocar F, Ludman EJ, McCulloch J, Petukhova MZ, Kessler RC: Telephone screening, outreach, and care management for depressed workers and impact on clinical and work productivity outcomes: a randomized controlled trial. JAMA 2007; 298:1401–1411