



Association of current and past opioid use disorders with health-related quality of life and employment among US adults



Taeho Greg Rhee^{a,b,c,d,*}, Robert A. Rosenheck^{b,c,d}

^a Department of Community Medicine and Health Care, School of Medicine, University of Connecticut, Farmington, CT, USA

^b Department of Psychiatry, School of Medicine, Yale University, New Haven, CT, USA

^c New England Mental Illness, Research, Education, and Clinical Center (MIRECC), USA

^d Department of Veterans Affairs Connecticut Healthcare System, West Haven, CT, USA

ARTICLE INFO

Keywords:

Opioid use disorder

Quality of life

Employment

ABSTRACT

Background: To examine the association of current and past Opiate Use Disorder (OUD) with measures of HRQOL and employment in a nationally representative sample of adults.

Methods: The 2012–2013 National Epidemiological Survey on Alcohol and Related Conditions III (NESARC III) surveyed a nationally representative sample of non-institutionalized civilian adults (≥ 18 years) in the US ($n = 36,309$ unweighted). Using DSM-5 criteria, adults without history of OUD were compared to those with current and past OUD. Using the SF-12 items, standard measures of the mental and physical component scores of HRQOL and of quality-adjusted life years (QALYs) were constructed. Employment in the past year (yes/no) was also assessed. Multivariable-adjusted regression analyses were used to adjust for covariates.

Results: Overall, 0.9% of the study sample, representing 2.1 of 235.4 million adults, met criteria for current OUD; 1.2%, representing 2.7 million adults, met criteria for past OUD. Adults with current or past OUD had large and moderately reduced mental component (MCS) and physical health component (PCS) summary scores compared to adults who never had OUD ($p < 0.001$, respectively). Current OUD was associated with lower odds of being employed compared to never experiencing OUD (Adjusted odds ratio = 0.65; 95% CI: 0.48, 0.88; $p = 0.005$), as was past OUD. Adjustment for potentially confounding factors reduced the independent association of OUD and HRQOL by about 40–50% but did not change employment comparisons.

Conclusion: Adults with current OUD are associated with large reductions in HRQOL and likelihood of not being employed, and adults with past OUD also have considerable residual impairment.

1. Introduction

The US is facing a worsening epidemic of opiate addiction. In 2017, about 72,000 Americans died from drug overdoses (Sanger-Katz, 2018), and more than half of these deaths were specifically associated with opioid-related overdoses, which have increased at least five-fold since 1999 (Centers for Disease Control and Prevention, 2017a, b; National Institute on Drug Abuse, 2019).

While much attention has been focused on catastrophic deaths, many more adults with opioid use disorder (OUD) suffer more modest, albeit serious, impairments of quality of life and functional capacity impairments that have received far less attention from both the popular media and the academic literature (Tiffany et al., 2012; Williams et al., 2018; Zubaran and Foresti, 2009). The evaluation of policy efforts to address the current opioid crisis has focused on reducing the risk of

overdose and death, that fortunately affect relatively small numbers of people, while treatment trials have focused on abstinence or days of drug use, both salient indicators of disease severity (Gowing et al., 2017; Mattick et al., 2014; Sordo et al., 2017).

A far larger segment of the OUD population suffers from far more insidious impairments affecting their health-related quality of life (HRQOL) (Bray et al., 2017; De Maeyer et al., 2010; Griffin et al., 2015; Jones et al., 2017; Karow et al., 2010, 2011; Luty and Arokiadass, 2008; Millson et al., 2006) and their ability to work (Maglione et al., 2018), dimensions of illness that are less eye-catching for the media, and perhaps more difficult to assess, but whose improvement may represent the ultimate goal of both policy and clinical intervention. We propose three comparisons to address the adverse effects of OUD on the US adult population. The first compares adults with current OUD to those who have never experienced OUD and thus reflects the upper bound

* Corresponding author at: Department of Community Medicine and Health Care, School of Medicine, University of Connecticut Health Center, 263 Farmington Ave, Farmington CT, 06530, USA.

E-mail addresses: rhee@uchc.edu, taeho.rhee@yale.edu (T.G. Rhee).

<https://doi.org/10.1016/j.drugalcdep.2019.03.004>

Received 6 February 2019; Received in revised form 5 March 2019; Accepted 5 March 2019

Available online 23 April 2019

0376-8716/ © 2019 Elsevier B.V. All rights reserved.

Table 1
Socio-demographic characteristics (weighted column %) of US adults by opioid use disorder (OUD) status, NESARC-III.

	Never OUD	Past OUD	Current OUD	Bivariate odds ratio		
				Current OUD vs. never OUD	Past OUD vs. never OUD	Current OUD vs. past OUD
Sample size						
Unweighted sample	35,621	358	330			
Weighted population (row %)	230,581,497 (97.9%)	2,737,639 (1.2%)	2,092,822 (0.9%)			
Age						
18-44	47.1	66.6	55.4	Reference	Reference	Reference
45-64	35.1	31.3	36.9	0.89	0.63**	1.42
65+	17.8	2.1	7.8	0.37**	0.08***	4.53**
Gender						
Male	48.0	52.6	49.5	Reference	Reference	Reference
Female	52.0	47.4	50.5	0.94	0.83	1.13
Race/ethnicity						
Non-Hispanic white	65.9	83.4	71.2	Reference	Reference	Reference
Non-Hispanic black	11.9	5.2	13.8	1.08	0.35***	3.11**
Hispanic	14.9	7.1	11.6	0.72	0.38***	1.91
Other ^{a)}	7.4	4.3	3.5	0.44*	0.46**	0.96
Marital status						
Married	51.6	35.0	32.4	Reference	Reference	Reference
Never married	22.4	29.1	26.6	1.89**	1.92***	0.98
Other ^{b)}	26.0	35.9	41.0	2.50***	2.04***	1.23
Family income						
< \$20,000	22.5	32.3	47.1	Reference	Reference	Reference
\$20,000 – \$39,999	24.1	28.8	23.4	0.46***	0.86	0.54*
≥ \$40,000	53.5	39.9	29.4	0.26***	0.54***	0.49**
Employment						
No	29.9	26.2	43.2	Reference	Reference	Reference
Yes	70.1	73.8	56.8	0.56***	1.20	0.47**
Education						
< High school	12.9	13.6	21.8	Reference	Reference	Reference
High school or equivalent	25.6	30.9	35.0	0.81	1.15	0.71
Some college	33.0	38.5	34.2	0.62**	1.11	0.55*
≥ Bachelor's degree	28.5	17.0	9.1	0.19***	0.57*	0.33**
Insurance coverage^{c)}						
Private (%)	58.1	45.1	38.1	0.44***	0.59***	0.75
Medicare (%)	21.4	12.2	28.7	1.48*	0.51***	2.91***
Medicaid (%)	10.1	17.9	25.1	3.00***	1.94**	1.54
Other ^{d)} (%)	45.0	35.4	37.7	0.74	0.67***	1.11
Disability income support						
No	89.9	84.3	75.8	Reference	Reference	Reference
Social security disability	5.6	6.9	12.4	2.63***	1.31	2.00*
Supplemental security income	3.1	4.5	6.8	2.66***	1.59	1.68
Both SSD and SSI	1.4	4.3	5.0	4.20***	3.22***	1.30
Urbanity						
Rural	21.2	23.6	21.1	Reference	Reference	Reference
Urban	78.8	76.4	78.9	1.00	0.87	1.15

Note: * < 0.05, ** < 0.01, and *** < 0.001. a) includes non-Hispanic black, Asian, and other racial groups; b) includes single, divorced, separated, widowed, partnered, or other; c) each insurance type has a response of yes or no; and d) includes other government or state-sponsored health insurance plans or programs.

assessment of adverse effects of OUD. The second compares adults with current OUD to those with past OUD (i.e., those who have recovered but may still suffer from residual effects) and reflects the potential loss of HRQOL and functionality even among adults who have managed to recover from OUD. Third, we compared adults with past OUD to those who have never had OUD, further reflecting the magnitude of residual adverse effects of OUD.

An important additional concern in the assessment of HRQOL attributable to OUD is the fact that socio-demographic characteristics significantly associated with OUD, such as younger age, minority race, single marital status, and low income and educational levels, as well as concurrent behavioral illnesses, may have independent effects on HRQOL confounding the evaluation of OUD and HRQOL. Alternatively, if these characteristics themselves reflect the consequences OUD, they may be mediators of the impact of OUD on HRQOL. In either case, it is important in the evaluation of the impact of OUD to consider the effect of these factors regardless of whether they are understood as confounders or mediators of the effects of OUD on HRQOL.

The current study uses national survey data from the National

Epidemiologic Survey on Alcohol and Related Conditions (NESARC) – III that included standard measures of HRQOL and employment to consider the following questions: 1) What is the magnitude of differences in HRQOL and employment between adults with current OUD and those with no history of OUD or with past OUD? 2) What socio-demographic and clinical factors are related to both OUD and HRQOL and thus potentially have either confounding or mediating effects on the relationship of OUD to HRQOL and employment? Finally, 3) what is the magnitude of differences in HRQOL and employment between adults with current and past OUD and those who never experienced OUD after adjustment for these factors?

2. Methods

2.1. Data source and study sample

We used restricted data from the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III), sponsored by the National Institute on Alcohol Abuse and Alcoholism (NIAAA) (National

Table 2
Past-year psychiatric comorbidity of US adults with opioid use disorder (OUD), NESARC-III.

	Never OUD	Past OUD	Current OUD	Bivariate odds ratio		
				Current OUD vs. never OUD	Past OUD vs. never OUD	Current OUD vs. past OUD
Sample size						
Unweighted sample	35,621	358	330			
Weighted population (row %)	230,581,497 (97.9%)	2,737,639 (1.2%)	2,092,822 (0.9%)			
Past-year psychiatric disorder						
Any psychiatric disorder (%)	17.7	50.8	60.9	7.27***	4.82***	1.51*
Major depressive disorder (hierarchical) (%)	10.0	24.3	30.5	3.93***	2.87***	1.37
Dysthymia (hierarchical) (%)	3.0	6.6	14.1	5.37**	2.29**	2.34**
Bipolar 1 disorder (hierarchical) (%)	1.3	10.6	11.6	9.64***	8.69***	1.11
Generalized anxiety disorder (%)	5.1	16.5	16.9	3.81***	3.68***	1.03
Post-traumatic stress disorder (%)	4.3	20.6	22.4	6.39***	5.74***	1.11
Panic disorder (%)	2.9	11.9	15.6	6.30***	4.60***	1.36
Past-year substance use disorder						
Alcohol use disorder (%)	13.4	32.6	42.4	4.75***	3.12***	1.52*
Any substance use disorder (%)	2.8	11.3	36.9	19.99***	4.36***	4.59***
Sedative use disorder (%)	0.2	2.1	18.2	116.28***	11.21***	10.37***
Cannabis use disorder (%)	2.3	7.2	23.5	13.04***	3.32***	3.93***
Cocaine use disorder (%)	0.3	2.3	7.1	29.01***	9.03***	3.21*
Stimulant use disorder (%)	0.2	2.4	9.2	47.14***	11.13***	4.24**
Hallucinogen use disorder (%)	0.0	0.1	2.5	97.64***	5.23	18.69**
Inhalant/solvent use disorder (%)	0.0	0.4	1.9	91.50***	19.07**	4.80
Club drug use disorder (%)	0.1	0.6	2.5	28.38***	6.53**	4.35*
Tobacco use disorder (%)	19.2	60.3	63.4	7.30***	6.40***	1.14

Note: * < 0.05, ** < 0.01, and *** < 0.001.

Table 3
Quality of life (QOL), quality-adjusted life years (QALYs), and their effect sizes by opioid use disorder (OUD) status among US adults, NESARC-III.

	Never OUD	Past OUD	Current OUD	Effect size comparison using Cohen's d		
				Current OUD vs. never OUD	Past OUD vs. never OUD	Current OUD vs. past OUD
Health-related Quality of Life						
Mental component summary (MCS)	50.5 ± 10.1	44.0 ± 12.3	39.9 ± 11.7	-1.04	-0.64	-0.34
Physical component summary (PCS)	49.5 ± 10.6	46.5 ± 12.4	39.5 ± 12.9	-0.93	-0.28	-0.53
Quality-adjusted Life Year						
EuroQOL-5D (EQ-5D)	0.89 ± 0.12	0.82 ± 0.15	0.73 ± 0.14	-1.33	-0.58	-0.60

Institute on Alcohol Abuse and Alcoholism, 2017). The NESARC-III is a nationally representative cross-sectional survey, conducted from April 2012 through June 2013, of physical and mental health diagnoses, well-being, and disabilities among non-institutionalized civilian adults aged 18 or older with a focus on alcohol and other substance use disorders. In NESARC-III, the Alcohol Use Disorder and Associated Disabilities Interview Schedule-5 (AUDADIS-5) (Hasin et al., 2015) was used to capture life-time, prior to past-year, and past-year mental disorders using Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) criteria. In this study, we limited our sample to adults aged 18 or older (n = 36,309 unweighted). Since the NESARC-III provides lifetime OUD and past-year OUD status based on the criteria set forth from DSM-5, we identified three groups: 1) adults who have no history of OUD (n = 35,621 unweighted), adults who met criteria for OUD previously but not in the past year (i.e., prior to past-year) (n = 358 unweighted), and adults who met criteria for OUD during the past year (n = 330 unweighted). The study procedures were approved by the Institutional Review Board (#2000022543) at Yale School of Medicine. Further details of the survey, including descriptions, questionnaires, sampling methodology and datasets, are available on the NESARC-III website (National Institute on Alcohol Abuse and Alcoholism, 2017).

2.2. Measures

2.2.1. Health-Related quality of life (HRQOL)

HRQOL is a patient-reported indicator of health status and assesses

subjective evaluation of the impact of disease on bio-psycho-social wellbeing from both physical and mental health perspectives (Laudet, 2011). Developed as part of the Medical Outcomes Study (MOS), the 12-item Short Form (SF-12) survey is a standardized questionnaire asking patients about their health states such as physical functioning, social functioning, role limitations, emotions, and general health vitality (Brazier and Roberts, 2004). Based on these 12 items, we constructed the two standard continuous summary variables, mental component summary (MCS) and physical component summary (PCS), using standard scoring algorithms that score the national averages for these measures as 50 and each standard deviation as a difference of 10 points above or below this average (Gandek et al., 1998; Ware et al., 1996).

Quality-adjusted life years (QALYs), on the other hand, represent a patient-reported, preference-based indicator of health state desirability on a cardinal scale where 0 indicates a state worse than or equal to death and 1 indicates perfect health (Neumann and Cohen, 2018). Using published algorithms (Gray et al., 2006), we constructed a continuous QALYs variable that is also in line with the widely used EuroQOL-5D approach using data included in the SF-12 (Gray et al., 2006).

2.2.2. Employment

Employment was evaluated by a following question that documented work in the last 12 months (i.e., a job or business, either full-time or part-time including unpaid work).

Table 4
Multivariable analyses of quality of life (QOL) and quality-adjusted life years (QALYs) among US adults.

Model 1: Bivariate analysis						
(Reference group in a parenthesis.)	QOL-MCS		QOL-PCS		QALYs	
	b	95% CI	b	95% CI	b	95% CI
OAD (Never)						
Past OAD	−6.27***	−7.79, −4.76	−3.57***	−5.05, −2.09	−0.07***	−0.09, −0.05
Current OAD	−11.29***	−12.95, −9.63	−9.75***	−11.55, −7.95	−0.16***	−0.18, −0.14
Model 2: OAD and demographic factors						
(Reference group in a parenthesis.)	QOL-MCS		QOL-PCS		QALYs	
	b	95% CI	b	95% CI	b	95% CI
OAD (Never)						
Past OAD	−5.36***	−6.82, −3.89	−3.95***	−5.12, −2.77	−0.07***	−0.08, −0.05
Current OAD	−9.63***	−11.23, −8.02	−7.84***	−9.24, −6.43	−0.13***	−0.15, −0.12
Demographic factors						
Age	0.05***	0.04, 0.06	−0.15***	−0.16, −0.15	−0.00***	−0.00, −0.00
Female sex	−1.77***	−2.02, −1.51	−0.14	−0.38, 0.11	−0.01***	−0.01, −0.01
Non-Hispanic black	0.24	−0.13, 0.61	−0.35*	−0.68, −0.02	−0.00	−0.01, 0.00
Unmarried	−0.70***	−1.00, −0.40	0.32*	0.04, 0.61	−0.00	−0.01, 0.00
Family income	0.73***	0.60, 0.86	1.13***	1.01, 1.25	0.01***	0.01, 0.02
Disability income support	−4.00***	−4.51, −3.50	−7.08***	−7.68, −6.47	−0.09***	−0.09, −0.08
Employed	1.43***	1.11, 1.74	3.98***	3.61, 4.35	0.04***	0.04, 0.05
≥ Bachelor's degree	0.38**	0.10, 0.65	2.39***	2.11, 2.66	0.02***	0.02, 0.03
Urban	−0.29	−0.69, 0.12	0.76**	0.33, 1.18	0.01	−0.00, 0.01
Model 3: OAD, demographic factors, and concurrent co-morbid factors						
(Reference group in a parenthesis.)	QOL-MCS		QOL-PCS		QALYs	
	b	95% CI	b	95% CI	b	95% CI
OAD (Never)						
Past OAD	−2.36**	−3.85, −0.87	−3.35***	−4.54, −2.16	−0.05***	−0.06, −0.03
Current OAD	−5.10***	−6.61, −3.58	−7.14***	−8.57, −5.72	−0.10***	−0.11, −0.08
Concurrent co-morbid factors						
Any psychiatric disorder	−8.45***	−8.83, −8.07	−2.28***	−2.59, −1.96	−0.07***	−0.08, −0.07
Any illicit drug use disorder	−1.96***	−2.82, −1.10	0.21	−0.38, 0.79	−0.01*	−0.02, −0.00
Alcohol use disorder	−2.42***	−2.78, −2.07	0.46**	0.16, 0.77	−0.01***	−0.01, −0.01

Note: * < 0.05, ** < 0.01, and *** < 0.001.

2.2.3. Socio-demographic variables

Sociodemographic variables addressed age, gender, race/ethnicity, marital status, family income, education, and health insurance. Data on sources of income were also used to identify recipients of Supplemental Security Income (SSI) and unspecified Social Security income benefits. We assumed that Social Security beneficiaries under 66 years old (the standard retirement age) were receiving Social Security Disability (SSD) income. Urban vs. rural residence was also documented.

2.2.4. Psychiatric and substance use disorders

For psychiatric disorders, the NESARC-III provides the following past-year psychiatric disorder diagnoses using DSM-5 criteria: major depressive disorder (hierarchical), dysthymia (hierarchical), bipolar I disorder, generalized anxiety disorder, post-traumatic stress disorder, and panic disorder. We further constructed a dichotomous variable representing any psychiatric disorder.

In addition, NESARC-III provides past-year substance use disorder (SUD) diagnoses: alcohol use, sedative use, cannabis use, cocaine use, stimulant use, hallucinogen use, inhalant/solvent use, club drug use, and tobacco use. We further constructed a variable representing any illicit drug use disorder, including all SUDs except alcohol and tobacco use disorders.

2.3. Analytical plans

First, we tested proportional differences in socio-demographic

characteristics among the three comparison groups (never OAD, past OAD, and current OAD). We also investigated how each socio-demographic factor is associated with 1) current OAD vs. never OAD, 2) past OAD vs. never OAD, and 3) current OAD vs. past OAD using bivariate logistic regression. We reported bivariate odds ratio to compare risk relationship between each socio-demographic factor and OAD status. For clinical factors (i.e., co-occurring psychiatric disorders and substance use disorders), we repeated the same analyses.

Second, we investigated whether HRQOL differed significantly by OAD status. For each OAD group (never, past, and current), we reported mean and standard deviation.

Because bivariate significance testing (e.g., t-tests and p-values) can be less meaningful in studies with a large sample size, and because our central interest is in the magnitude of differences, we also report Cohen's d (Cohen, 1988, 1992), an indicator of effect size (i.e., difference in means divided by the pooled standard deviation), to compare 1) current OAD vs. never OAD, 2) past OAD vs. never OAD, and 3) current OAD vs. past OAD.

Third, in the multivariable analyses, we sought to understand the independent association of OAD with HRQOL and employment, net of sociodemographic or clinical factors in three models. Model 1 is a set of simple bivariate regression models to test the association between OAD status and HRQOL and employment. Model 2 is identical to Model 1 but with adjustment for socio-demographic factors. Model 3 included OAD, socio-demographic factors, and concurrent co-morbid psychiatric and SUD diagnoses. These multivariable models allow us to investigate the

Table 5
Multivariable analyses of association between opioid use disorder (OUD) and employment among US adults.

Model 1: Bivariate analysis among all US adults		
(Reference group in a parenthesis.)	Employment	
	OR	95% CI
OUD (Never)		
Past OUD	1.20	0.90, 1.61
Current OUD	0.56***	0.42, 0.74
Model 2: OUD and demographic factors among all US adults		
(Reference group in a parenthesis.)	Employment	
	AOR	95% CI
OUD (Never)		
Past OUD	0.94	0.66, 1.33
Current OUD	0.55***	0.40, 0.75
Demographic factors		
Age	0.95***	0.94, 0.95
Female sex	0.58***	0.54, 0.62
Non-Hispanic black	0.92	0.83, 1.01
Unmarried	0.78***	0.72, 0.84
Disability income support	0.16***	0.14, 0.18
≥ Bachelor's degree	2.08***	1.93, 2.25
Urban	0.92	0.83, 1.01
Model 3: OUD, demographic factors, and concurrent co-morbid factors among all US adults		
(Reference group in a parenthesis.)	Employment	
	AOR	95% CI
OUD (Never)		
Past OUD	0.97	0.69, 1.38
Current OUD	0.59**	0.44, 0.80
Concurrent co-morbid factors		
Any psychiatric disorder	0.85***	0.79, 0.92
Any illicit drug use disorder	0.72**	0.60, 0.87
Alcohol use disorder	1.41***	1.25, 1.59

Note: * < 0.05, ** < 0.01, and *** < 0.001.

relationship of OUD to HRQOL and employment independent of potential socio-demographic and clinical correlates.

We used Stata MP/6-Core 15.1 for all analyses (StataCorp LP, 2017) and employed the svy commands in Stata to account for the complex survey sampling design of the NESARC-III (e.g., unequal probability of selection, clustering and stratification) (National Institute on Alcohol Abuse and Alcoholism, 2018).

3. Results

3.1. Socio-demographic characteristics of the sample

Overall, 0.9% of the study sample, representing 2,092,822 adults, met criteria for current OUD within the past 12 months. About 1.2% of the study sample, representing 2,737,639 adults, had met criteria for OUD previously but not in the past year.

Adults with current OUD, when compared to adults who have never had OUD, were younger, less likely to be married, had lower incomes, were less likely to be employed, and had less education. They were more likely to be insured by Medicare or Medicaid and to receive Social Security Administration disability payments (Table 1, column 5).

Those with past, but not current, OUD as compared to those who never had OUD were similarly younger but less likely to be minorities, also less likely to be married, had lower incomes, less college education, and were more likely to be insured by Medicaid and to receive Social Security Administration payments (Table 1, column 6).

Adults with current OUD, when compared to those with past OUD

(Table 1, column 7), were more likely to be older, non-Hispanic black, had lower income levels, less likelihood of being employed, and a lower educational level. They were more likely to be covered by Medicare insurance and to receive Social Security Disability benefits.

3.2. Psychiatric and substance use co-morbidities

Among those with current OUD, 60.9% had any current psychiatric disorder, 42.4% had current alcohol use disorder, 63.4% had current tobacco use disorder, and 42.4% had illicit drug use disorder (Table 2). These figures stand in dramatic contrast to far lower proportions among adults who never had OUD. Odds ratios for the association of these conditions with OUD show greater likelihoods ranging from 2.3 to 19.0 (Table 2, column 5).

When adults with past OUD were compared to those who have never had OUD, they were at least twice as likely to have psychiatric or SUD diagnoses (Table 2, column 6).

When adults with current OUD were compared to those with past OUD, they were significantly more likely to have dysthymia and most SUD diagnoses (Table 2, column 7), but associations were considerably smaller in magnitude than in comparisons with people who never had OUD.

3.3. Health-related quality of life

Adults with current OUD had far lower MCS than those who never had OUD, -1.04 standard deviations (Table 3, upper row). Past OUD

compared to never OUD showed an effect size difference on the MCS that was somewhat smaller (Cohen's $d = -0.64$), and when current OUD was compared to past OUD the effect size was even smaller (Cohen's $d = -0.34$).

On the PCS, a large effect size reduction (Cohen's $d = -0.93$) was again observed when current OUD was compared to never OUD (Table 3, second row). The effect size was -0.28 when adults with past OUD were compared to adults who had never experienced OUD and was -0.53 when adults with current OUD were compared to adults with past OUD. Similarly, substantial differences in magnitude were observed for effect size differences between groups on the measure of QALYs with a maximum effect size difference of -1.33 declining to -0.58 and -0.60 across comparisons.

3.4. Adjusted comparisons of HRQOL and employment

Table 4 shows multivariable-adjusted comparisons between OUD groups on measures of HRQOL, controlling for demographic and then concurrent behavioral health factors. In the unadjusted model, adults with past OUD had an MCS score that was 6.27 points (95% CI: -7.79 , -4.76 ; $p < 0.001$) lower than adults with never OUD, and adults with current OUD had an MCS score that was 11.29 points (95% CI: -12.95 , -9.63 ; $p < 0.001$) lower than adults with never OUD.

In Model 2, controlling for socio-demographic factors, adults with past OUD and current OUD had an MCS score that was 5.36 and 9.63 points lower ($p < 0.001$), respectively, than that of adults with never OUD. In Model 3, with additional adjustment for behavioral health conditions, adults with past OUD and current OUD had MCS scores still lower than those of adults who never had OUD ($p < 0.001$, respectively). In addition, adults with any psychiatric disorder had an MCS score that was 8.45 points lower, on average (95% CI: -8.83 , -8.07 ; $p < 0.001$). Similarly, having any illicit drug use disorder and alcohol use disorder lowered MCS score by 1.96 and 2.42 points on average, respectively ($p < 0.001$). Similar patterns were found in PCS and QALYs.

Table 5 presents multivariable analyses of association between OUD and employment, adjusting for demographic and clinical factors. In the unadjusted model, a current OUD resulted in 0.56 times lower odds of being employed (95% CI: 0.42, 0.74; $p < 0.001$) than never having had an OUD and no significant difference from those with past OUD.

In model 2, controlling for socio-demographic factors, current OUD had 0.55 times lower odds of being employed (95% CI: 0.40, 0.75; $p < 0.001$) than the never OUD group. In model 3, controlling for behavioral health conditions in addition to sociodemographic factors, having a current OUD still showed considerably lower odds of being employed (AOR = 0.59, 95% CI: 0.44, 0.80; $p = 0.005$). Having any psychiatric disorder and any illicit drug use disorder were associated with 0.85 and 0.72 times lower odds of being employed, respectively (95% CI: 0.79, 0.92; $p < 0.001$ and 95% CI: 0.60, 0.87; $p = 0.001$). Alcohol use disorder, on the other hand, was associated with 1.41 times higher odds of being employed while controlling for other factors (95% CI: 1.25, 1.59; $p < 0.001$).

4. Discussion

Compared to adults with no history of OUD, adults with current and past OUD reported large and moderate reductions in HRQOL, respectively. The magnitudes of differences in HRQOL remained substantial between adults with past OUD and those with no history of OUD, suggesting lasting residual effects even in those who have recovered.

Our findings cannot be easily compared to earlier studies (Bray et al., 2017; De Maeyer et al., 2010; Griffin et al., 2015; Jones et al., 2017; Karow et al., 2010, 2011; Luty and Arokiadass, 2008; Millson et al., 2006; Thornton et al., 2017; Winklbaur et al., 2008) because previous studies were limited to data from clinical trials and outcome studies rather than from representative population samples. Despite

these limitations, our findings are generally consistent with previous studies that reported significant and substantially negative associations between OUD and HRQOL and modest improvements associated with recovery (Bray et al., 2017; De Maeyer et al., 2010; Griffin et al., 2015; Jones et al., 2017; Luty and Arokiadass, 2008).

Further, in view of our non-disease specific measure of QALYs, the data presented here make it possible to benchmark the loss of QALYs associated with OUD to those of other behavioral health disorders. In particular, the 0.73 QALY score for OUD is in the same decile as that found in several studies of chronic schizophrenia (Rosenheck et al., 2006, 2016; Thwin et al., 2013), often considered the most disabling of mental disorders. This study is thus the first to situate the adverse effect of OUD with one of the most debilitating illnesses.

Our findings also identify demographic and clinical factors associated with lower HRQOL in adults with OUD including female sex and receipt of disability income support. Factors contributing to a higher HRQOL level included socio-economic indicators such as being employed, having a higher family income level, and an educational level of bachelor's degree or higher. These findings are also generally consistent with studies of correlates of other psychiatric or drug use disorders (Grant et al., 2015, 2016; Hasin et al., 2018; Hayley et al., 2017). Furthermore, concurrent psychiatric and substance use disorders were themselves associated with lower HRQOL, also consistent with earlier studies (Adan et al., 2017; Chahua et al., 2015; Colpaert et al., 2013; Lozano et al., 2017). Since these data are cross-sectional rather than longitudinal, we cannot determine whether these factors are confounders (i.e., moderators that preceded OUD and were independently responsible for some of its association with diminished quality of life) or mediators: consequences of OUD that are themselves direct causes of its adverse impact on HRQOL.

In the case of employment, adults with current OUD were about half as likely to be employed than those with no history of OUD, but it appears that adults with past OUD had recovered to the point at which they did not differ from those with never experienced OUD. Thus, it highlights that recovery is possible to some extent, especially with regard to social and/or economic participation.

Two clinical and policy implications are especially noteworthy. First, co-morbid (or multi-morbid) psychiatric and substance use disorders are common in adults with current OUD. Because such co-morbidities are linked to greater impairment of functioning (Laudet, 2011), treatment of co-existing mental disorders should be provided to adults with current OUD. Second, our findings suggest that a potentially effective intervention may be able to recover 21.9% ($= 1 - (0.89/0.73)$) of QALYs lost among adults with current OUD, potentially making them comparable to adults with no history of OUD.

Several limitations in this study deserve comment. First, the NESARC survey was conducted between 2012 and 2013, and the opiate epidemic has escalated since then. While the incidence rate has increased over time, observations from this study are not likely to have changed, although they may affect even larger numbers of people. Second, some under-served populations (e.g., homeless individuals and prisoners) (Hasin et al., 2018) were not covered in the survey, and thus estimates may under-estimate the true numbers of people whose HRQOL is affected by OUD. Third, consistent with other epidemiologic surveys, NESARC-III is not a clinician-administered interview but relied on the AUDADIS-5 (Hasin et al., 2015), a fully structured interview. However, reliability and validity of NESARC-III have been well documented (Hasin et al., 2015; Grant et al., 2016, 2015; Hasin et al., 2018).

Despite the limitations, this is the first study of HRQOL and OUD based on nationally representative data including psychiatric and substance use disorder diagnoses based on DSM-5 criteria and the use of standardized measures of HRQOL. It demonstrates large reductions in HRQOL on a population basis and substantial likelihood of not being employed among adults with OUD, while showing, as well, that moving past a diagnosis of OUD still leaves considerable residual impairment. The data presented add to our understanding of the magnitude of the

public health task facing the nation and the serious harms affecting 4.8 million Americans with current or past OUD.

Role of funding source

Rhee received funding support from the National Institutes of Health (NIH) (#T32AG019134). The funding agency, NIH, had no role on this intellectual contribution from the study conception to journal publication. Publicly available data were obtained from the National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention (CDC). Analyses, interpretation, and conclusions are solely those of the author and do not necessarily reflect the views of the Division of Health Interview Statistics or NCHS of the CDC.

Contributors

Study concept and design: Rhee and Rosenheck. Data acquisition and statistical analyses: Rhee.

Interpretation of data: Rhee and Rosenheck. Drafting of manuscript: Rhee and Rosenheck.

Critical revision of manuscript: Rhee and Rosenheck. Supervision: Rosenheck. All authors contributed to and approved of the final version of the manuscript.

Conflict of interest

None reported.

References

- Adan, A., Marquez-Arrico, J.E., Gilchrist, G., 2017. Comparison of health-related quality of life among men with different co-existing severe mental disorders in treatment for substance use. *Health Qual. Life Outcomes* 15, 209.
- Bray, J.W., Aden, B., Eggman, A.A., Hellerstein, L., Wittenberg, E., Nosyk, B., Stribling, J.C., Schackman, B.R., 2017. Quality of life as an outcome of opioid use disorder treatment: a systematic review. *J. Subst. Abuse Treat.* 76, 88–93.
- Brazier, J.E., Roberts, J., 2004. The estimation of a preference-based measure of health from the SF-12. *Med. Care* 42, 851–859.
- Centers for Disease Control and Prevention, 2017a. Drug Overdose Death Data. Centers for Disease Control and Prevention, Atlanta, GA. Available from <https://www.drugabuse.gov/related-topics/trends-statistics/overdose-death-rates>. (Accessed 18 April 2019).
- Centers for Disease Control and Prevention, 2017b. Prescription Opioid Data. Centers for Disease Control and Prevention, Atlanta, GA. Available from <https://www.cdc.gov/drugoverdose/data/prescribing.html>. (Accessed 18 April 2019).
- Chahua, M., Sanchez-Niubo, A., Torrens, M., Sordo, L., Bravo, M.J., Brugal, M.T., Domingo-Salvany, A., ITINERE Project Group, 2015. Quality of life in a community sample of young cocaine and/or heroin users: the role of mental disorders. *Qual. Life Res.* 24, 2129–2137.
- Cohen, J., 1988. *Statistical Power Analysis for the Behavioral Sciences*, 2nd ed. L. Erlbaum Associates, Hillsdale, N.J.
- Cohen, J., 1992. A power primer. *Psychol. Bull.* 112, 155–159.
- Colpaert, K., De Maeyer, J., Broekaert, E., Vanderplasschen, W., 2013. Impact of addiction severity and psychiatric comorbidity on the quality of life of alcohol-, drug- and dual-dependent persons in residential treatment. *Eur. Addict. Res.* 19, 173–183.
- De Maeyer, J., Vanderplasschen, W., Broekaert, E., 2010. Quality of life among opiate-dependent individuals: a review of the literature. *Int. J. Drug Policy* 21, 364–380.
- Gandek, B., Ware, J.E., Aaronson, N.K., Apolone, G., Bjorner, J.B., Brazier, J.E., Bullinger, M., Kaasa, S., Lepelge, A., Prieto, L., Sullivan, M., 1998. Cross-validation of item selection and scoring for the SF-12 Health Survey in nine countries: results from the IQOLA Project. International quality of life assessment. *J. Clin. Epidemiol.* 51, 1171–1178.
- Gowing, L., Ali, R., White, J.M., Mbewe, D., 2017. Buprenorphine for managing opioid withdrawal. *Cochrane Database Syst. Rev* CD002025.
- Grant, B.F., Goldstein, R.B., Saha, T.D., Chou, S.P., Jung, J., Zhang, H., Pickering, R.P., Ruan, W.J., Smith, S.M., Huang, B., Hasin, D.S., 2015. Epidemiology of DSM-5 alcohol use disorder: results from the National Epidemiologic Survey on alcohol and related conditions III. *JAMA Psychiatry* 72, 757–766.
- Grant, B.F., Saha, T.D., Ruan, W.J., Goldstein, R.B., Chou, S.P., Jung, J., Zhang, H., Smith, S.M., Pickering, R.P., Huang, B., Hasin, D.S., 2016. Epidemiology of DSM-5 drug use disorder: results from the National Epidemiologic Survey on alcohol and related conditions-III. *JAMA Psychiatry* 73, 39–47.
- Gray, A.M., Rivero-Arias, O., Clarke, P.M., 2006. Estimating the association between SF-12 responses and EQ-5D utility values by response mapping. *Med. Decis. Making* 26, 18–29.
- Griffin, M.L., Bennett, H.E., Fitzmaurice, G.M., Hill, K.P., Provost, S.E., Weiss, R.D., 2015. Health-related quality of life among prescription opioid-dependent patients: results from a multi-site study. *Am. J. Addict.* 24, 308–314.
- Hasin, D.S., Greenstein, E., Aivadyan, C., Stohl, M., Aharonovich, E., Saha, T., Goldstein, R., Nunes, E.V., Jung, J., Zhang, H., Grant, B.F., 2015. The Alcohol Use Disorder and Associated Disabilities Interview Schedule-5 (AUDADIS-5): procedural validity of substance use disorders modules through clinical re-appraisal in a general population sample. *Drug Alcohol Depend.* 148, 40–46.
- Hasin, D.S., Sarvet, A.L., Meyers, J.L., Saha, T.D., Ruan, W.J., Stohl, M., Grant, B.F., 2018. Epidemiology of adult DSM-5 major depressive disorder and its specifiers in the United States. *JAMA Psychiatry* 75, 336–346.
- Hayley, A.C., Stough, C., Downey, L.A., 2017. DSM-5 tobacco use disorder and sleep disturbance: findings from the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III). *Subst. Use Misuse* 52, 1859–1870.
- Jones, J.D., Vogelman, J.S., Luba, R., Mumtaz, M., Comer, S.D., 2017. Chronic pain and opioid abuse: factors associated with health-related quality of life. *Am. J. Addict.* 26, 815–821.
- Karow, A., Reimer, J., Schafer, I., Krausz, M., Haasen, C., Verthein, U., 2010. Quality of life under maintenance treatment with heroin versus methadone in patients with opioid dependence. *Drug Alcohol Depend.* 112, 209–215.
- Karow, A., Verthein, U., Pukrop, R., Reimer, J., Haasen, C., Krausz, M., Schäfer, I., 2011. Quality of life profiles and changes in the course of maintenance treatment among 1,015 patients with severe opioid dependence. *Subst. Use Misuse* 46, 705–715.
- Laudet, A.B., 2011. The case for considering quality of life in addiction research and clinical practice. *Addict. Sci. Clin. Pract.* 6, 44–55.
- Lozano, O.M., Rojas, A.J., Fernandez Calderon, F., 2017. Psychiatric comorbidity and severity of dependence on substance users: how it impacts on their health-related quality of life? *J. Ment. Health* 26, 119–126.
- Luty, J., Arokiaadass, S.M., 2008. Satisfaction with life and opioid dependence. *Subst. Abuse Treat. Prev. Policy* 3, 2.
- Maglione, M.A., Raaen, L., Chen, C., Azhar, G., Shahidinia, N., Shen, M., Maksabedian, E., Shanman, R.M., Newberry, S., Hempel, S., 2018. Effects of medication assisted treatment (MAT) for opioid use disorder on functional outcomes: a systematic review. *J. Subst. Abuse Treat.* 89, 28–51.
- Mattick, R.P., Breen, C., Kimber, J., Davoli, M., 2014. Buprenorphine maintenance versus placebo or methadone maintenance for opioid dependence. *Cochrane Database Syst. Rev.*, CD002207.
- Millson, P., Challacombe, L., Villeneuve, P.J., Strike, C.J., Fischer, B., Myers, T., Shore, R., Hopkins, S., 2006. Determinants of health-related quality of life of opiate users at entry to low-threshold methadone programs. *Eur. Addict. Res.* 12, 74–82.
- National Institute on Alcohol Abuse and Alcoholism, 2017. National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III). National Institute on Alcohol Abuse and Alcoholism, Bethesda, MD.
- National Institute on Alcohol Abuse and Alcoholism, 2018. National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III): Source and Accuracy Statement. National Institute on Alcohol Abuse and Alcoholism, Bethesda, MD.
- National Institute on Drug Abuse, 2019. Opioid Overdose Crisis. National Institute on Drug Abuse, Bethesda, MD.
- Neumann, P.J., Cohen, J.T., 2018. QALYs in 2018—advantages and concerns. *JAMA* 319, 2473–2474.
- Rosenheck, R.A., Leslie, D.L., Sindelar, J., Miller, E.A., Lin, H., Stroup, T.S., McEvoy, J., Davis, S.M., Keefe, R.S., Swartz, M., Perkins, D.O., Hsiao, J.K., Lieberman, J., CATIE Study Investigators, 2006. Cost-effectiveness of second-generation antipsychotics and perphenazine in a randomized trial of treatment for chronic schizophrenia. *Am. J. Psychiatry* 163, 2080–2089.
- Rosenheck, R.A., Leslie, D.L., Sint, K.J., Lin, H., Li, Y., McEvoy, J.P., Byerly, M.J., Hamer, R.M., Swartz, M.S., Stroup, T.S., 2016. Cost-effectiveness of long-acting injectable paliperidone palmitate versus haloperidol decanoate in maintenance treatment of schizophrenia. *Psychiatr. Serv.* 67, 1124–1130.
- Sanger-Katz, M., 2018. Bleak New Estimates in Drug Epidemic: A Record 72,000 Overdose Deaths in 2017. *The New York Times*, New York.
- Sordo, L., Barrio, G., Bravo, M.J., Indave, B.I., Degenhardt, L., Wiessing, L., Ferri, M., Pastor-Barriuso, R., 2017. Mortality risk during and after opioid substitution treatment: systematic review and meta-analysis of cohort studies. *BMJ* 357, j1550.
- StataCorp LP, 2017. *Stata Statistical Software: Release 15*. StataCorp LP, College Station, TX.
- Thornton, J.D., Goyat, R., Dwibedi, N., Kelley, G.A., 2017. Health-related quality of life in patients receiving long-term opioid therapy: a systematic review with meta-analysis. *Qual. Life Res.* 26, 1955–1967.
- Thwin, S.S., Hermes, E., Lew, R., Barnett, P., Liang, M., Valley, D., Rosenheck, R., 2013. Assessment of the minimum clinically important difference in quality of life in schizophrenia measured by the Quality of Well-Being Scale and disease-specific measures. *Psychiatry Res.* 209, 291–296.
- Tiffany, S.T., Friedman, L., Greenfield, S.F., Hasin, D.S., Jackson, R., 2012. Beyond drug use: a systematic consideration of other outcomes in evaluations of treatments for substance use disorders. *Addiction* 107, 709–718.
- Ware, J.Jr., Kosinski, M., Keller, S.D., 1996. A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Med. Care* 34, 220–233.
- Williams, A.R., Nunes, E.V., Bisaga, A., Pincus, H.A., Johnson, K.A., Campbell, A.N., Remien, R.H., Crystal, S., Friedmann, P.D., Levin, F.R., Olsson, M., 2018. Developing an opioid use disorder treatment cascade: a review of quality measures. *J. Subst. Abuse Treat.* 91, 57–68.
- Winklbaur, B., Jagsch, R., Ebner, N., Thau, K., Fischer, G., 2008. Quality of life in patients receiving opioid maintenance therapy. A comparative study of slow-release morphine versus methadone treatment. *Eur. Addict. Res.* 14, 99–105.
- Zubaran, C., Foresti, K., 2009. Quality of life and substance use: concepts and recent tendencies. *Curr. Opin. Psychiatry* 22, 281–286.