Medical Burden of Disease Among Individuals in Recovery From Alcohol and Other Drug Problems in the United States: Findings From the National Recovery Survey

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Objectives: The medical sequalae of alcohol and other drug (AOD) problems exact a prodigious personal and societal cost, but little is known about the specific prevalence of such medical problems, and their relationship to quality of life and indices of well-being among those recovering from problematic AOD use. To better characterize the lifetime physical disease burden, this study investigated the prevalence of medical conditions commonly caused or exacerbated by excessive and chronic AOD exposure in a nationally representative sample of US adults in AOD problem recovery. Comparisons were made to the general US population. Demographic and clinical correlates of disease prevalence were also investigated along with the relationship between distinct medical conditions and indices of quality of life/well-being.

Methods: Cross-sectional nationally representative survey of the US adult population who report resolving an AOD problem (n = 2002). Weighted lifetime prevalence of common medical conditions were estimated and compared to the US population. Demographic and clinical correlates of medical conditions, and also overall disease burden, were estimated using logistic regression.

Results: Relative to the general population, prevalence of hepatitis C, chronic obstructive pulmonary disease, heart disease, and diabetes were elevated. Likelihood of having a lifetime diagnosis of a specific disease was related to primary substance used and sex. Quality of life was lower among those with physical disease histories relative to those without.

Conclusions: Findings highlight the increased medical burden associated with AOD problems, and speak to the need for earlier and more sustained intervention for AOD problems, greater integration of addiction treatment and primary health care, and longitudinal research to explore the complex, dynamic relationships between AOD use and physical disease.

Key Words: addiction, alcohol, disease burden, drugs, medical, physical disease, recovery

The personal, social, and economic costs of the medical sequelae of alcohol and other drug (AOD) problems are enormous (Whiteford et al., 2013), with direct and indirect effects of AOD exposure and attendant lifestyles giving rise to an array of medical conditions that can reduce life expectancy, and increase years lived with disease and disability (Hall and Degenhardt, 2009; Whiteford et al., 2013). Further, the medical sequelae of AOD problems typically persist after individuals enter recovery, such that medical and psychiatric problems may continue to affect individuals' quality of life long after an AOD problem is resolved (Di Sclafani et al., 2007; Fein et al., 2008). Studies of clinical populations have found increases in health-related quality of life among people in recovery from a substance use disorder (Garner et al., 2014). However, community surveys are lacking on the health status of people who have successfully overcome an AOD problem that could illuminate the prevalence of common medical conditions in this population, and how living with such medical conditions may affect quality of life.

To better characterize the lifetime disease burden of problematic AOD use, the present study investigated the prevalence of medical conditions commonly caused or exacerbated by chronic AOD exposure in a nationally representative sample of US adults in recovery from an AOD problem (Kelly et al., 2017). Where possible, to provide comparisons with the general population, observed frequencies of medical conditions in the AOD recovery sample were compared to national averages using the Centers for Disease Control Prevention, National Health and Nutrition Examination Survey (NHANES) dataset (Centers for Disease Control Prevention, 2018b). Also, because of the different kinds of medical problems that can arise from exposure to various substances (eg, alcohol vs cocaine, etc), disease prevalence was also examined across these different substances. Finally, demographic and clinical correlates of disease prevalence were investigated, and the relationship between distinct medical conditions and quality of life was explored.

METHODS

Procedure

The National Recovery Survey (NRS) targeted the US noninstitutionalized civilian population 18 years or older that had resolved an AOD problem, as indicated by affirmative response to the screener question: "Did you used to have a problem with drugs or alcohol, but no longer do?" (Kelly et al., 2017). Data were collected by the survey company GfK, using a probability sampling approach to select respondents at random. GfK screened everyone in their "KnowledgePanel" (GfK, 2013), which consists of approximately 55,000 adult individuals aged 18 and older. The KnowledgePanel uses address-based sampling (ABS) to randomly select individuals from 97% of all US households based on the US Postal Service's Delivery Sequence File. If necessary, GfK provides individuals with a web-enabled computer and free internet service. Using this ABS approach, GfK is able to include households that have unlisted telephone numbers; do not have landline telephones; are cell phone only; do not have current internet access; and do not have devices to access the internet. This type of broad-scale sampling helps redress socioeconomic differences in landline telephone use and internet access. For the present study, a representative subset of 39,809 individuals from the GfK KnowledgePanel received the screening question. To draw this subsample, GfK uses a probability proportional to size (PPS) sampling approach, a patented strategy (US Patent No. 7,269,570) unique to GfK. PPS assures that subsamples from a finite panel membership remains a reliable approximation of the entire US population (see www.gfk.com/fileadmin/user_upload/dyna_content/US/documents/KnowledgePanel_-_A_Methodological_Overview.pdf for more information on GfK's probability-based sampling methodology).

The survey was first piloted on 20 individuals over 3 days in July, 2016, then formally administered over 19 days in July to August, 2016. Median time to completion was 24 minutes (interquartile range [IQR] 18–36 minutes). Of those in the initial sampling frame (n = 39,809), 25,229 individuals responded to the screening question (63.4%). This response rate is comparable to most other current nationally representative surveys, including the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC-III; 60.1%; Grant et al., 2015), the 2015 National Survey on Drug Use and Health (NSDUH; 58.3%; Center for Behavioral Health Statistics and Quality, 2016), and the 2013 to 2014 NHANES (68.5%; Centers for Disease Control and Prevention, 2013). Data were weighted to accurately represent the civilian population using the method of "iterative proportional fitting" (Battaglia et al., 2009).

To produce unbiased estimates of population parameters from these respondents, GfK first computed *base weights*, then made poststratification adjustments according to benchmarks from the Current Population Survey (CPS), conducted in March, 2015 by the US Bureau of the Census, along 8 dimensions: sex; age; race/Hispanic ethnicity; education; geographical region; household income; home ownership status; and metropolitan area. GfK's population-based probability sampling approach has been vetted and validated in

dozens of published studies in the medical and behavioral health fields (https://www.gfk.com/fileadmin/user_upload/dyna_content/US/documents/GfK_Bibliography.pdf). KnowledgePanel-derived estimates are comparable to those derived from national surveys that used non-internet methodologies to recruit and collect data (Bethell et al., 2004; Novak et al., 2007; Heeren et al., 2008; Chang and Krosnick, 2009; Yeager et al., 2011). Heeren et al. (2008), for example, showed that estimates of current drinking obtained through a GfK KnowledgePanel-derived sample were similar to those obtained by NESARC. The final weighted sample was n = 2002.

Measures

Demographic Characteristics

Demographic data were derived both from GfK's existing KnowledgePanel data (collected prior to the survey), and also from survey data. Regarding previously collected demographic data, participants reported the following: age; level of education (less than high school, high school, some college, bachelor's degree or higher); race/ethnicity (White/non-Hispanic, Black/non-Hispanic, Other/non-Hispanic, 2+ races/non-Hispanic, Hispanic); sex (male, female); household income (19 categories ranging from less than $5000 to $175,000 or more); and current employment.

Physical Disease History

Participants were asked whether they had ever been told by a healthcare provider if they had 1 or more of 9 medical conditions (Dennis et al., 2008): alcohol-related liver disease; hepatitis C; tuberculosis (TB); the human immunodeficiency virus (HIV), or acquired immune deficiency syndrome (AIDS); another sexually transmitted infection (eg, gonorrhea); chronic obstructive pulmonary disease (COPD); cancer; heart disease; or diabetes.

Quality of Life

Quality of life was assessed using the EUROHIS-QOL (Schmidt et al., 2005)—a widely used 8-item measure of quality of life, adapted from the World Health Organization Quality of Life—Brief Version (WHOQOL-BREF). Item responses are on Likert scales from 1 to 5 (eg, "How satisfied are you with your personal relationships?" 1 = *very dissatisfied* to 5 = *very satisfied*). The measure has strong psychometric properties, including good to excellent predictive validity (ie, significant discrimination between individuals with and without a health condition), convergent validity with other measures of health and wellness ($r = 0.4–0.6$), and internal consistency ($\alpha = 0.83$). Its internal consistency was excellent in the present sample ($\alpha = 0.90$).

Statistical Analysis

The weighted lifetime prevalence of each of the nine medical conditions was calculated in the full sample and by primary substance used (alcohol, cannabis, opioids, stimulants, and other drugs). For diseases where 2015 to 2016 NHANES data were available, we compared prevalence estimates in the full sample to corresponding weighted prevalence estimates in the general population of non-institutionalized resident adults

in the United States captured by the NHANES. We used direct standardization to account for differences in the age distribution in these two samples. Because the 2015 to 2016 NHANES did not include self-report items inquiring about whether participants had been told in their lifetime by a health professional that they had TB, HIV/AIDS, or sexually transmitted infections, we were unable to compare these estimates between samples. Additionally, there were discrepancies between the NRS and NHANES surveys in how they asked about liver disease and cancer. The NRS survey specifically asked whether participants had been told by a health professional that they had alcohol-related liver disease, whereas the NHANES asked about any type of liver disease. Similarly, the NRS survey asked if participants had been told they had cancer, whereas the NHANES sample was asked whether they had been told they had cancer *or* a malignancy.

We examined demographic and clinical correlates of each of these medical conditions, and also overall disease burden (1 vs 0 medical conditions, 2+ vs 0 medical conditions) using unadjusted logistic regression models. Demographic correlates included age (in years), sex, education, race/ethnicity, household income, marital status, and employment. Clinical correlates included primary substance used, age of onset of regular use, number of substances used 10 or more times, years since AOD problem resolution, number of years smoked (lifetime), utilization of outpatient substance use treatment (yes/no), utilization of inpatient or residential substance use treatment (yes/no), mutual-help meeting attendance (eg, Alcoholics Anonymous, SMART Recovery), happiness (Meyers and Smith, 1995), self-esteem (Robins et al., 2001), quality of life (Schmidt et al., 2005), psychological distress (Kessler et al., 2003), and recovery capital (Vilsaint et al., 2017). All models incorporated sampling weights and were conducted in Stata version 14.

RESULTS

Participant characteristics and their pathways to overcoming an AOD problem are displayed in Table 1.

Prevalence of Different Diseases Among Individuals Who Have Resolved a Problem With AOD

Thirty-seven percent of adults who have resolved an AOD problem reported being told by a health professional that they had 1 or more of the following health conditions during their lifetime: alcohol-related liver disease (4.84%, 95% confidence interval [CI] 3.66, 6.39), hepatitis C (5.49%, 95% CI 4.17, 7.19), TB (1.42%, 95% CI 0.74, 2.70), HIV/AIDS (2.61%, 95% CI 1.68, 4.04), a sexually transmitted infection (8.69%, 95% CI 7.12, 10.57), COPD (4.99%, 95% CI 4.03, 6.16), cancer (5.50%, 95% CI 4.41, 6.83), heart disease (5.29%, 95% CI 4.24, 6.58), or diabetes (13.62%, 95% CI 11.77, 15.72) (Table 2). Prevalence of hepatitis C, COPD, heart disease and diabetes was significantly greater in the NRS age standardized sample of adults who had resolved an AOD problem, relative to the NHANES age standardized sample of non-institutionalized adults in the United States (Table 2).

TABLE 1. Characteristics and Pathways to Recovery of US Adults Who Endorsed They "Used to Have a Problem With Drugs or Alcohol, But No Longer Do" (9.1% [SE 0.28] of 22.35 million Americans)

Demographics	Weighted %	SE
Sex		
Female	40.0	1.53
Male	60.0	1.53
Age		
18–24 years (emerging adulthood)	7.1	1.16
25–49 years (young adults)	45.2	1.63
50–64 years (mid-life stage adults)	34.7	1.43
65+ years (older adults)	13.0	0.76
Race & Ethnicity		
White, non-Hispanic	61.4	1.64
Black, non-Hispanic	13.8	1.19
Other, non-Hispanic	5.8	0.92
Hispanic	17.3	1.38
2+ races, non-Hispanic	1.7	0.30
Employment Status		
Working – as a paid employee	47.7	1.61
Working – self-employed	7.0	0.78
Not working – on temporary layoff from a job	1.5	0.50
Not working – looking for work	7.7	0.96
Not working – retired	12.0	0.80
Not working – disabled	15.6	1.14
Not working – other	8.5	0.93
Living Accommodations		
With family or other relatives	45.6	1.62
With group of friend(s) or non-family members (non-institutional)	3.6	0.73
Alone in own dwelling	29.7	1.37
Homeless	0.9	0.35
Hospital, rehabilitation facility, nursing home	0.2	0.16
Sober living environment (e.g., halfway house, Oxford House, sober dorm, etc.)	0.5	0.29
Other	19.2	1.22

Clinical variables	Weighted %	SE
Time since problem resolution (in years)		
Did not indicate	1.1	0.33
0–5 years	34.5	1.61
5–15 years	35.2	1.54
15+ years	29.3	1.32
Number of substances used 10+ times		
Did not specify any substance	0.6	0.26
1 substance	26.8	1.41
2 substances	23.1	1.40
3+ substances	49.5	1.61
Age of onset of first substance		
Did not answer	0.8	0.36
<15 years of age	47.8	1.61
≥15 years of age	51.4	1.61
Age of onset of problem substance		
Did not identify any problem substance	12.7	1.14
<15 years of age	34.4	1.54
≥15 years of age	52.9	1.61
Primary substance		
Did not identify any problem substance	12.7	1.14
Alcohol	51.2	1.61
Cannabis (e.g., marijuana, hashish)	11.0	1.13
Cocaine (e.g., coke, crack, freebase)	10.0	0.92
Methamphetamine (crank, meth, crystal)	7.3	0.90
Opioids (e.g., heroin, unprescribed fentanyl, methadone)	5.3	0.77
Other	2.6	0.50
Lifetime mental health disorder diagnoses		
Alcohol/other substance use disorder	17.0	1.18
Anxiety disorder	22.2	1.27
Mood disorder	18.9	1.19

TABLE 1 (Continued)

Clinical variables

Other disorder	7.9	0.85
Unsure if diagnosed	8.9	1.01
Never been diagnosed	48.2	1.61
Refused to answer	0.6	0.28
History of involvement in a drug court		
Never been arrested	49.0	1.60
Arrested, but no drug court	42.7	1.59
Arrested, and participated in a drug court	7.8	1.01
Refused to answer	0.5	0.27

Alcohol and other drug problem recovery pathways

Used support	**53.9**	**1.60**
Professionally assisted recovery support (aka formal treatment; any)	**27.6**	**1.43**
Outpatient addiction treatment	16.8	1.21
Inpatient or residential treatment	15.0	1.08
Alcohol/drug detoxification services	9.1	0.91
Anti-relapse/craving medication use (any)	**8.6**	**0.93**
Alcohol	4.8	0.70
Antabuse (disulfiram)	2.4	0.45
Selincro (nalmefene)	0.8	0.29
Revia (naltrexone)	0.8	0.29
Campral (acamprosate)	0.5	0.23
Topamax (topiramate)	0.5	0.28
Lioresal (baclofen)	0.2	0.23
Other	0.5	0.17
Opioid	4.4	0.73
Methadone	1.4	0.35
Orlaam (levomethadyl acetate)	0.5	0.31
Suboxone (buprenorphine-naloxone)	2.3	0.54
Subutex (buprenorphine)	1.0	0.36
Revia (oral naltrexone)	0.2	0.17
Vivitrol (long-acting injectable naltrexone)	0.4	0.26
Other	0.2	0.09
Recovery support services	**21.8**	**1.40**
Faith-based recovery services	9.2	0.94
Sober living environment	8.5	0.95
Recovery community centers	6.2	0.85
State or local recovery community organization	3.0	0.61
College recovery programs/communities	1.7	0.52
Recovery high schools	0.8	0.37
Mutual-help organizations	**45.1**	**1.6**
Alcoholics Anonymous (AA)	34.6	1.49
Narcotics Anonymous (NA)	17.5	1.23
Cocaine Anonymous (CA)	2.3	0.43
Celebrate Recovery	2.2	0.44
SMART Recovery	1.3	0.35
Women for Sobriety	1.2	0.37
Crystal Methamphetamine Anonymous (CMA)	0.8	0.37
Marijuana Anonymous (MA)	0.9	0.43
LifeRing Secular Recovery	0.4	0.27
Moderation Management	0.2	0.10
Secular Organizations for Sobriety (S.O.S.)	0.2	0.10
Other	3.2	0.47
Neither treatment programs, medication, services or mutual-help meetings	45.8	1.60

Adapted from the study by Kelly et al., 2017.

Prevalence of Disease by Primary Substance Used

Notable differences in the prevalence of disease were observed when comparing the primary substance type used by participants. The prevalence of alcohol-related liver disease was highest among participants who reported alcohol as their primary substance (6.65%); however, this elevated prevalence was only significantly greater than that observed for individuals who reported opioids or stimulants as their primary substance. The prevalence of hepatitis C was significantly higher in the opioid and stimulant groups relative to participants who reported alcohol as their primary substance. Lifetime prevalence of HIV/AIDS and sexually transmitted infections were significantly higher in the stimulant group relative to the alcohol group. The prevalence of cancer was not significantly different between primary substance groups. Heart disease was most common in the primary alcohol group; however, this difference was only statistically significantly different from the opioid group, which had the lowest prevalence of heart disease. Diabetes was least common among participants who reported cannabis as their primary substance, which was significantly less prevalent than that observed in the alcohol group. No significant differences in the prevalence of TB or COPD were observed between primary substance groups.

Demographic and Clinical Correlates of Medical Conditions and Disease Burden

Similar to epidemiologic patterns observed in general population samples, the prevalence of physical disease was related to various demographic characteristics (Table 3). In general, younger age, higher education, being married or living with a partner, and being employed were associated with having no physical diseases. Specifically, for each additional year of age, there is a 1.03-fold and 1.07-fold increase in the odds of having 1 or at least 2 physical diseases relative to no physical diseases, respectively. Having at least a high school diploma was associated with approximately a 55% to 60% reduction in the odds of having a physical disease; however, the relationship between physical disease and level of education was not linear such that further education (eg, some college, bachelor's degree, or higher) was not associated with a significantly greater reduction in the odds of having 1 physical disease as compared to individuals with only a high school education. When comparing the odds of having 2 or more physical diseases versus none, the association with education level was negative and linear, but not significant. Demographic factors associated with reduced odds of having 2 or more physical diseases versus none included Hispanic ethnicity, female sex, a household income greater than $50,000USD, and being employed.

With regard to specific physical conditions, older age was related to elevated odds of COPD, cancer, heart disease, and diabetes. Participants with a bachelor's degree or higher displayed lower odds of COPD, hepatitis C, HIV/AIDS, and diabetes relative to individuals without a high school diploma. Compared with males, females were less likely to report having had alcohol-related liver disease, hepatitis C, cancer, heart disease, or diabetes, but more likely to have had a sexually transmitted infection. Lifetime history of hepatitis C was less common in individuals with a higher current household income, who were currently married or employed. A household income of $50,000USD or greater was also associated with lower odds of having COPD or diabetes. Current employment was associated with lower odds of lifetime alcohol-related liver disease, HIV/AIDS, COPD, cancer, heart disease, and diabetes.

TABLE 2. Prevalence (%) of Medical Conditions Among Those Who Have Resolved and Alcohol or Other Drug Problem and Adults in the General Population With 95% Confidence Interval

Medical Condition	NRS-weighted Prevalence	NRS-weighted, Age-standardized Prevalence	NHANES-weighted, Age-standardized Prevalence
Alcohol-related liver disease	4.84 (3.66, 6.39)	—	—
Hepatitis C	5.49 (4.17, 7.19)	5.17 (4.16, 6.19)	1.15 (1.15, 1.16)
Tuberculosis	1.42 (0.74, 2.70)	—	—
Human immunodeficiency virus (HIV)/acquired immune deficiency syndrome (AIDS)	2.61 (1.68, 4.04)	—	—
Sexually transmitted infections (STIs)	8.69 (7.12, 10.57)	—	—
Chronic obstructive pulmonary disease (COPD)	4.99 (4.03, 6.16)	5.53 (4.30, 6.77)	3.12 (3.11, 3.12)
Cancer	5.50 (4.41, 6.83)	—	—
Heart disease	5.29 (4.24, 6.58)	6.19 (4.83, 7.55)	3.50 (3.50, 3.50)
Diabetes	13.62 (11.77, 15.72)	13.69 (11.90, 15.47)	10.73 (10.73, 10.74)

Prevalence of hepatitis C, COPD, heart disease and diabetes were significantly greater in the NRS age standardized sample of adults who had resolved an alcohol or other drug problem, compared to the NHANES age standardized sample of non-institutionalized United States adults.

NHANES, National Health and Nutrition Examination Survey; NRS, National Recovery Survey.

Clinical factors were also found to relate to physical health conditions. Older age at first regular use of primary substance, more years since problem resolution, additional years having smoked tobacco (lifetime), lower quality of life, and having utilized inpatient treatment, outpatient treatment or mutual help for a substance use problem were related to increased odds of reporting one or more physical diseases. More specifically, each additional substance used 10 or more times in one's life, older age of onset in years, and additional years since problem resolution were associated with a 4% to 7% increase in the odds of having 2 or more physical diseases as compared with no physical diseases. Relative to participants who reported alcohol as their primary substance, those who reported cannabis as their primary substance displayed a 60% reduction in the odds of having 2 or more physical diseases as compared with none. Inpatient, outpatient, former mutual-help participation, and past 3-month mutual-help participation were each associated with a 2.3 to 2.7-fold increase in the odds of having 2 or more physical diseases as compared with none. Past 3-month mutual-help meeting attendance was similarly associated with a 2.3-fold increase in the odds of having 1 physical disease relative to none.

Examination of specific physical diseases revealed variable relationships with clinical characteristics. For example, older age at first regular use of primary substance, additional years having smoked (lifetime), and additional years since problem resolution were associated with increased odds of COPD, cancer, and heart disease. Years since problem resolution and additional years having smoked (lifetime) were also associated with an increase in the odds of diabetes. Having ever participated in outpatient treatment and participating in a mutual-help meeting within the past 3 months was associated with increased odds of alcohol-related liver disease. Utilization of outpatient, inpatient, or mutual-help meetings and additional years having smoked (lifetime) were associated with increased odds of hepatitis C. Increased years having smoked was also associated with increased odds of HIV/AIDS. Inpatient treatment and having formerly attended a mutual-help meeting, but not in the past 3 months, was associated with an increase in the odds of diabetes.

Relationship Between Disease and Quality of life

Having no lifetime history of physical health conditions was associated with better quality of life (Table 4). Alcohol-related liver disease, COPD, and diabetes were each associated with significantly lower levels of quality of life. Alcohol-related liver disease and TB were also significantly associated with greater psychological distress. Conversely, having suffered from cancer at some point during one's life was significantly associated with better quality of life across all indicators included in this study (ie, quality of life, happiness, self-esteem, psychological distress, recovery capital).

DISCUSSION

The prodigious psychological, social, and interpersonal impact of excessive and chronic AOD use is widely appreciated and has been well characterized. Less well appreciated, however, is the *physical disease* burden arising from AOD problems. The present study is novel in that it documents for the first time national prevalence estimates of common physical diseases among individuals who have overcome significant AOD problems. The ability to examine the impact of certain demographic and clinical subgroups, and also quantity of substances used (eg, substances used 10 or more times) are the most novel aspects of this analysis compared with the extant literature. Findings indicate an overall higher prevalence of certain diseases relative to the general population, that certain demographic and clinical subgroups within the AOD recovering population appear to be at variable risk of acquiring a number of different diseases, and that overall quality of life is lower among those who have suffered a physical disease relative to those who have not.

Taken together, findings are indicative of greater lifetime physical disease burden among adults who have resolved a problem with AOD relative to the general non-institutionalized adult US population. When compared with age-standardized national lifetime prevalence rates, hepatitis C, COPD, heart disease, and diabetes were significantly more prevalent in the present NRS sample compared with the general population. Further, as might be expected, participants endorsing diagnoses of physical diseases reported current poorer quality of life compared with those not reporting physical disease.

Direct, standardized, age-weighted comparisons between the present sample (NRS) and the general population (NHANES) were not possible for alcohol-related liver disease, TB, HIV/AIDS, sexually transmitted infections, or cancer as the NHANES survey either does not assess for these diseases or assesses them in ways not commensurate with the NRS study.

Though direct comparisons were not possible for these diseases, we note that the present NRS sample experienced rates for these diseases at least comparable with previously reported estimates for the general population, and in some instances, notably greater. For instance, the prevalence of self-reported lifetime sexually transmitted infections in the present NRS sample (8.69%) was greater among female participants, but homologous to NHANES bio-assay assessed sexually transmitted infection rates in the general population (7.42%). Similarly, the cancer prevalence rate in the NRS sample (5.50%) was comparable to estimated prevalence rates in the general population (4.80%; Bluethmann et al., 2016), but relative to the general population was about 15% higher ($5.5 - 4.8 = 0.7$; $0.7 \div 4.8 \times 100 = 15\%$). The incidence of HIV/AIDS, however, appears to be 7 to 8 times higher in the NRS sample (2.6%), compared with the general population (0.34%; Centers for Disease Control Prevention, 2018a), though these Centers for Disease Control Prevention estimates are for the year 2015 (vs 2016 for the NRS sample) and include people aged 13 and older (vs 18 and older for the NRS sample). Regarding TB, 1.42% of this NRS sample endorsed being told by a healthcare professional that they have this disease. This is comparable to findings from the 2011 to 2012 NHANES for a positive response to a TB skin test (1.40%), but higher than the rate of NHANES participants endorsing being told by a healthcare provider that they have *active* TB (0.39%), and lower than NHANES participants having a positive TB blood test (5.82%). Because we cannot know if NRS participants were responding affirmatively to being told by a healthcare professional that they have TB based on a positive skin or blood test, or because they have active symptoms, we cannot draw inferences from this comparison. The lifetime prevalence rate of alcohol-related liver disease for the general population has not been previously reported, precluding comparisons for this class of disease based on other research. One would expect, however, that those endorsing alcohol as their primary substance have higher rates of alcohol-related liver disease than the general population.

Individuals who primarily used classes of drugs commonly associated with injection such as opiates or stimulants had higher rates of diseases known to be transmitted by sharing needles, including hepatitis C and HIV. This observation aligns with a fairly large body of work showing elevated rates of hepatitis C and HIV in individuals who inject drugs (eg, Strathdee et al., 2010; Nelson et al., 2011). Participants primarily using stimulant also had significantly higher rates of sexually transmitted infections than those primarily using alcohol, which supports previous findings reporting higher incidence of sexually transmitted infections among individuals who use stimulants (particularly methamphetamine) who are thought to engage in greater and/or more risky sexual activity than individuals who do not use stimulants (Molitor et al., 1998). Surprisingly, individuals endorsing cannabis as their primary substance were not significantly different in terms of rates of alcohol-related liver disease compared with those endorsing alcohol as their primary substance, which may be a function of greater alcohol use among those who for whom cannabis is also problematic. It is also possible that some individuals experienced problematic alcohol use earlier in life, and in an attempt to mitigate alcohol harms, shifted to primary cannabis use later. This would suggest the value in assessing early drinking histories and potential alcohol-related medical conditions among people presently diagnosed with cannabis use disorder.

It is noteworthy that history of outpatient and inpatient treatment, mutual-help meeting attendance, and past 3-month mutual-help meeting attendance were associated with a large increase (~2-fold) in the odds of having physical disease relative to none. Given the majority of individuals with AOD problems never present for treatment, and those that do present for treatment typically have greater AOD problem severity, it is possible that outpatient and inpatient treatment, and mutual-help participation in our sample is a marker for greater addiction severity (Humphreys et al., 1998). Logically it follows that as a result of greater addiction severity, these individuals are also more likely to suffer from medical sequelae and physical diseases as a result of greater intensity and chronicity of AOD exposure. It is also possible that regardless of addiction severity, individuals with more physical disease burden are also suffering from greater psychological distress, which addiction treatment and mutual-help organization participation can help ameliorate (Kelly et al., 2009, 2017).

Also, of note, greater time since AOD problem resolution was associated with a higher probability of having a lifetime diagnosis of a number of diseases, including COPD, cancer, heart disease, and diabetes. This is a function of participant age. That is, there is a natural increase in the probability of disease occurrence with the passing of time, and individuals who have longer time since AOD problem resolution will tend to be older. Supporting this postulate, greater age was also associated with a higher probability of having a lifetime diagnosis of these same diseases.

Not surprisingly, lifetime tobacco use was positively associated with likelihood of a number of diseases (ie, hepatitis C, HIV/AIDS, COPD, cancer, heart disease, diabetes; Table 4) and disease burden (Table 5). Given the high rates of tobacco use in individuals with AOD problems compared with the general population (Weinberger et al., 2016), it is possible tobacco use, in and of itself, is contributing markedly to the disease burden of AOD problems. It is possible too that the combination of tobacco use and AOD problems produces synergistic health detriments (eg, Taylor and Rehm, 2006). The importance of this finding is underscored by studies concluding that people treated for alcohol or other drug use disorders are more likely to subsequently die from smoking-related diseases than from other drug-related causes (eg, Hser et al., 1994; Hurt et al., 1996). Although, recent research suggests greater numbers of those in recovery from AOD problems are now quitting smoking and quitting sooner (Kelly et al., 2019), increased calls to integrate smoking cessation

TABLE 3. Demographic Correlates of Physical Disease, Odds Ratios with 95% Confidence Intervals

	Alcohol-related Liver Disease	Hepatitis C	TB	HIV/AIDS	STIs	COPD	Cancer	Heart Disease	Diabetes	None
Age (in yrs)	1.01 0.99–1.02	1.02 1.00–1.04	0.98 0.94–1.02	1.02 1.00–1.03	0.99 0.98–1.01	**1.06** **1.04–1.08**	**1.07** **1.05–1.09**	**1.08** **1.05–1.10**	**1.05** **1.04–1.06**	**0.96** **0.96–0.97**
Education (ref = less than high school)										
High school diploma	0.65 0.19–2.29	1.12 0.41–3.01	0.66 0.07–6.58	0.27 0.07–1.09	0.70 0.29–1.72	**0.45** **0.21–0.94**	0.89 0.30–2.68	0.91 0.31–2.69	0.93 0.48–1.78	**1.96** **1.15–3.34**
Some college	0.67 0.21–2.21	0.71 0.27–1.85	0.34 0.04–3.17	0.37 0.11–1.22	0.78 0.34–1.79	**0.48** **0.26–0.91**	0.91 0.32–2.56	0.94 0.34–2.62	0.90 0.49–1.65	**1.96** **1.19–3.24**
Bachelor's degree or higher	1.01 0.30–3.42	**0.24** **0.08–0.74**	0.76 0.09–6.51	**0.12** **0.03–0.46**	0.91 0.39–2.11	**0.37** **0.18–0.75**	1.02 0.35–2.97	0.88 0.31–2.49	**0.50** **0.26–0.96**	**2.42** **1.44–4.07**
Race/ethnicity (ref = White, non-Hispanic)										
Black, non-Hispanic	1.45 0.53–3.96	1.65 0.71–3.86	5.19 0.81–33.34	2.14 0.71–6.43	1.24 0.70–2.19	**0.40** **0.18–0.90**	0.83 0.35–1.98	0.77 0.29–2.02	1.60 1.00–2.54	0.75 0.51–1.12
Other, non-Hispanic	2.17 0.80–5.88	2.27 0.81–6.42	4.13 0.57–29.78	6.01 1.51–23.92	1.17 0.39–3.52	1.44 0.49–4.24	0.37 0.07–1.89	0.82 0.28–2.41	0.56 0.23–1.35	0.62 0.32–1.20
Hispanic	1.04 0.42–2.59	1.69 0.73–3.90	3.78 0.70–20.33	1.10 0.33–3.60	0.55 0.24–1.24	**0.28** **0.12–0.66**	0.58 0.25–1.37	0.75 0.36–1.60	1.26 0.76–2.08	1.09 0.73–1.62
2+ races, non-Hispanic	0.36 0.08–1.66	5.39 1.40–20.77	—	—	1.13 0.47–2.73	3.10 0.82–11.71	**0.15** **0.03–0.62**	0.46 0.12–1.72	1.28 0.33–4.99	0.77 0.36–1.64
Female sex	**0.28** **0.16–0.51**	**0.51** **0.29–0.88**	0.73 0.17–3.03	0.31 0.08–1.14	**2.15** **1.38–3.35**	1.11 0.71–1.73	**0.60** **0.38–0.95**	**0.30** **0.19–0.48**	**0.68** **0.49–0.96**	1.27 0.99–1.64
Married or living with partner	0.66 0.36–1.20	**0.33** **0.18–0.61**	2.52 0.63–10.10	0.47 0.19–1.17	0.78 0.51–1.19	0.67 0.42–1.06	1.38 0.86–2.19	0.80 0.50–1.28	1.05 0.75–1.47	**1.36** **1.06–1.76**
Household income 50,000 USD or greater	0.69 0.39–1.23	**0.40** **0.21–0.75**	1.10 0.30–4.06	1.22 0.50–2.99	1.01 0.65–1.56	**0.46** **0.28–0.76**	1.22 0.77–1.94	0.76 0.49–1.19	**0.70** **0.50–0.98**	1.26 0.98–1.63
Employed	**0.42** **0.22–0.79**	**0.32** **0.17–0.58**	0.58 0.15–2.16	**0.36** **0.14–0.94**	1.25 0.80–1.94	**0.17** **0.11–0.29**	**0.41** **0.25–0.67**	**0.32** **0.20–0.50**	**0.40** **0.29–0.57**	**2.56** **1.97–3.32**

Statistically significant statistics are bolded.
COPD, chronic obstructive pulmonary disease; HIV/AIDS, human immunodeficiency virus/acquired immune deficiency syndrome; STIs, sexually transmitted infections; TB, tuberculosis.

TABLE 4. Clinical Correlates of Physical Disease, Odds Ratios With 95% Confidence Intervals

	Alcohol-related Liver Disease	Hepatitis C	TB	HIV/AIDS	STIs	COPD	Cancer	Heart Disease	Diabetes	None
Age (in yrs) at regular use of primary substance	1.02 (0.98–1.07)	1.01 (0.97–1.06)	0.99 (0.86–1.14)	1.00 (0.91–1.10)	1.01 (0.99–1.04)	**1.05** (**1.03–1.08**)	1.03 (1.00–1.06)	1.03 (1.00–1.06)	1.02 (1.00–1.05)	**0.97** (**0.95–0.99**)
Number of substances used 10+ times	0.94 (0.78–1.13)	**1.23** (**1.13–1.34**)	1.01 (0.80–1.28)	**1.21** (**1.09–1.34**)	**1.13** (**1.06–1.21**)	1.07 (1.00–1.14)	0.96 (0.87–1.06)	0.91 (0.82–1.02)	0.98 (0.92–1.04)	0.95 (0.90–1.00)
Years since problem resolution	0.97 (0.95–1.00)	1.01 (0.99–1.03)	0.96 (0.90–1.03)	1.02 (0.99–1.04)	0.99 (0.98–1.01)	**1.03** (**1.01–1.04**)	**1.05** (**1.03–1.06**)	**1.04** (**1.03–1.06**)	**1.03** (**1.02–1.04**)	**0.98** (**0.97–0.99**)
Years smoked (lifetime)	1.01 (0.99, 1.03)	**1.04** (**1.02, 1.05**)	0.98 (0.92, 1.05)	**1.03** (**1.00, 1.06**)	0.99 (0.98, 1.01)	**1.07** (**1.05, 1.09**)	1.02 (1.00, 1.04)	**1.04** (**1.02, 1.06**)	**1.04** (**1.03, 1.05**)	**0.96** (**0.95, 0.97**)
Primary substance (ref = alcohol)										
Cannabis	0.41 (0.08–2.22)	0.90 (0.20–4.13)	5.35 (0.93–30.74)	1.21 (0.15–9.89)	1.69 (0.84–3.39)	0.67 (0.21–2.13)	0.44 (0.18–1.11)	0.57 (0.21–1.56)	0.42 (0.21–0.85)	1.22 (0.74–2.02)
Opioids	**0.13** (**0.04–0.41**)	**3.51** (**1.32–9.32**)	—	1.53 (0.24–9.61)	1.70 (0.55–5.20)	1.45 (0.64–3.25)	0.57 (0.21–1.55)	**0.16** (**0.04–0.61**)	0.74 (0.35–1.59)	1.00 (0.54–1.85)
Stimulants	**0.36** (**0.13–0.98**)	**3.66** (**1.90–7.05**)	3.47	**2.83** (**1.02–7.86**)	**2.39** (**1.42–4.02**)	1.24 (0.69–2.25)	0.52 (0.27–1.03)	0.65 (0.34–1.26)	1.17 (0.75–1.84)	0.75 (0.53–1.06)
Other drugs	—	—	—	—	2.65 (0.52–13.52)	0.18 (0.02–1.49)	2.07 (0.43–10.06)	0.52 (0.13–2.05)	0.50 (0.10–2.35)	1.34 (0.38–4.77)
Outpatient addiction treatment	2.05 (1.05–4.01)	2.93 (1.58–5.44)	2.19 (0.60–8.04)	1.90 (0.74–4.89)	1.99 (1.19–3.35)	1.86 (1.09–3.17)	0.72 (0.31–1.67)	1.03 (0.48–2.20)	1.38 (0.91–2.11)	**0.66** (**0.47–0.92**)
Inpatient addiction treatment	1.65 (0.87–3.14)	**3.15** (**1.69–5.87**)	1.80 (0.45–7.20)	1.62 (0.66–3.99)	1.12 (0.67–1.88)	3.13 (1.91–5.12)	0.83 (0.48–1.44)	1.32 (0.73–2.38)	**1.79** (**1.19–2.70**)	**0.63** (**0.45–0.88**)
Mutual-help attendance (ref = never)										
Former	1.26 (0.63–2.55)	**5.85** (**3.11–10.98**)	1.88 (0.40–8.89)	1.88 (0.70–5.06)	**1.99** (**1.24–3.18**)	**1.95** (**1.20–3.18**)	0.95 (0.57–1.59)	1.14 (0.70–1.86)	**1.49** (**1.04–2.15**)	**0.60** (**0.45–0.79**)
Past 3 mos	**3.70** (**1.77–7.72**)	**8.21** (**3.58–18.82**)	5.41 (0.94–31.06)	2.25 (0.61–8.35)	**2.41** (**1.27–4.57**)	1.34 (0.68–2.64)	0.79 (0.38–1.64)	0.80 (0.35–1.83)	1.04 (0.62–1.75)	0.44 (0.29–0.66)
Quality of life	**0.95** (**0.91–0.99**)	0.97 (0.93–1.02)	0.94 (0.86–1.03)	0.99 (0.90–1.08)	0.99 (0.96–1.01)	**0.93** (**0.91–0.96**)	1.04 (1.01–1.08)	0.98 (0.94–1.01)	**0.96** (**0.94–0.98**)	**1.04** (**1.02–1.06**)
Happiness	0.85 (0.60–1.20)	0.78 (0.55–1.10)	**0.62** (**0.42–0.90**)	1.37 (0.89–2.13)	0.96 (0.78–1.19)	0.87 (0.65–1.17)	**1.45** (**1.13–1.85**)	0.96 (0.70–1.32)	0.97 (0.80–1.17)	1.00 (0.87–1.15)
Self-esteem	0.99 (0.77–1.28)	1.07 (0.80–1.44)	1.14 (0.81–1.61)	1.15 (0.87–1.52)	0.87 (0.75–1.02)	0.92 (0.76–1.12)	**1.41** (**1.10–1.81**)	1.07 (0.84–1.36)	0.96 (0.84–1.11)	1.02 (0.91–1.14)
Psychological distress	**1.09** (**1.04–1.13**)	1.02 (0.97–1.07)	**1.11** (**1.02–1.20**)	0.97 (0.88–1.07)	1.04 (1.00–1.07)	1.03 (0.99–1.07)	0.95 (0.90–0.99)	1.00 (0.95–1.05)	0.98 (0.94–1.01)	0.99 (0.97–1.02)
Recovery capital	0.98 (0.96–1.01)	0.98 (0.95–1.02)	0.97 (0.93–1.02)	0.99 (0.95–1.04)	1.00 (0.98–1.02)	0.99 (0.98–1.01)	**1.05** (**1.02–1.07**)	1.00 (0.97–1.03)	1.00 (0.99–1.02)	1.00 (0.99–1.02)

Statistically significant statistics are bolded.
COPD, chronic obstructive pulmonary disease; HIV/AIDS, human immunodeficiency virus/acquired immune deficiency syndrome; STIs, sexually transmitted infections; TB, tuberculosis.

TABLE 5. Demographic and Clinical Correlates of Disease Burden, Odds Ratios With 95% Confidence Intervals

	Disease Burden	
	1 vs 0 diseases	2+ vs 0 diseases
Age (in yrs)	**1.03 (1.02–1.04)**	**1.07 (1.05–1.08)**
Education (ref = less than high school)		
High school diploma	**0.45 (0.25–0.81)**	0.85 (0.39–1.83)
Some college	**0.47 (0.27–0.80)**	0.77 (0.37–1.60)
Bachelor's degree or higher	**0.40 (0.23–0.71)**	0.56 (0.26–1.19)
Race/ethnicity (ref = White, non-Hispanic)		
Black, non-Hispanic	1.35 (0.87–2.10)	1.32 (0.73–2.37)
Other, non-Hispanic	1.99 (0.98–4.05)	0.94 (0.36–2.48)
Hispanic	1.13 (0.72–1.75)	**0.53 (0.30–0.94)**
2+ races, non-Hispanic	1.28 (0.61–2.70)	1.34 (0.30–5.91)
Female sex	0.94 (0.70–1.26)	**0.49 (0.34–0.70)**
Married or living with partner	**0.73 (0.54–0.98)**	0.80 (0.55–1.15)
Household income 50,000 USD or greater	0.90 (0.68–1.21)	**0.58 (0.40–0.84)**
Employed	**0.47 (0.35–0.63)**	**0.24 (0.16–0.35)**
Age (in yrs) at regular use of primary substance	1.02 (1.00–1.05)	**1.04 (1.02–1.07)**
Number of substances used 10+ times	**1.04 (1.00–1.11)**	**1.07 (1.00–1.15)**
Years since problem resolution	**1.02 (1.00–1.03)**	**1.04 (1.02–1.05)**
Years smoked (lifetime)	**1.03 (1.03, 1.04)**	**1.06 (1.04, 1.07)**
Primary substance (ref = alcohol)		
Cannabis	1.00 (0.58–1.74)	**0.40 (0.19–0.86)**
Opioids	1.08 (0.52–2.22)	0.85 (0.40–1.80)
Stimulants	1.28 (0.88–1.87)	1.30 (0.79–2.13)
Other drugs	0.78 (0.20–2.96)	0.69 (0.09–5.18)
Outpatient addiction treatment	1.19 (0.81–1.76)	**2.53 (1.60–3.98)**
Inpatient addiction treatment	1.31 (0.89–1.92)	**2.28 (1.47–3.54)**
Mutual-help attendance (ref = never)		
Former	1.34 (0.97–1.84)	**2.68 (1.79–4.02)**
Past 3 mos	**2.26 (1.42–3.62)**	**2.44 (1.41–4.23)**
Quality of life	**0.97 (0.94–0.99)**	**0.96 (0.93–0.99)**
Happiness	0.99 (0.84–1.16)	1.00 (0.81–1.24)
Self-esteem	0.95 (0.84–1.07)	1.05 (0.89–1.24)
Psychological distress	1.01 (0.98–1.04)	1.00 (0.97–1.04)
Recovery capital	0.99 (0.98–1.01)	1.01 (0.99–1.03)

Statistically significant statistics are bolded.

into addiction treatment programs remain underscored by research, suggesting that smoking cessation may improve recovery outcomes for other drug dependencies (Prochaska et al., 2004).

Generally speaking, having 1 or more lifetime disease diagnoses was associated with lower current quality of life (Tables 4 and 5). Counterintuitively though, participants with cancer diagnosis histories endorsed, on average, greater quality of life, happiness, self-esteem, recovery capital, and lower psychological distress than those without. This may be a function of participants being in cancer remission at the time of surveying, and having a more positive life outlook as a result of surviving cancer—a phenomenon previously reported in the cancer literature (eg, Bower et al., 2005).

Based on the present data, it cannot be known if individuals who have resolved a problem with AOD and have active cancer also endorse greater quality of life and positive affect.

Although the cross-sectional nature of this study precludes causal inferences being made regarding AOD exposure and increased prevalence of physical diseases, existing research on the mechanisms through which AOD exposure can increase the risk of certain physical diseases (e.g., Mathers et al., 2008; Rehm et al., 2009; Nelson et al., 2011), suggests a high probability that the increased prevalence of certain physical diseases in this NRS sample, relative to the general population, is either directly or indirectly related to AOD problem prevalence. This in turn, can affect the long-term quality of life, functioning, and psychological well-being of those who are able to achieve recovery. Given the enormous number of individuals affected by AOD problems (Kelly et al., 2017), the findings reported here underscore the public health need for early AOD interventions and more aggressive and sustained AOD care to prevent the occurrence of serious illnesses that are associated with increased healthcare utilization and costs, and also long-term diminished quality of life. The findings also suggest the need for increased integration between addiction treatment and primary health care, and also the potential role of the primary care physician in performing ongoing recovery checkups and assistance in managing chronic health conditions for patients recovering from AOD problems.

Limitations

The present findings should be viewed in light of limitations pertaining to the study design:

1. These data are cross-sectional and reflect lifetime occurrence of disease. It is possible that some participants may have developed these diseases before developing a problem with AOD.
2. There is no way to know whether these conditions resolved or improved after individuals' AOD problems were resolved, and how present quality of life temporally aligns with participants' disease history.
3. Differential screening, access to medical services, and insurance status were not retrospectively assessed in this study, and could have contributed in unknown ways to observed differences in disease prevalence.
4. The NRS study's stem question ("Did you used to have a problem with drugs or alcohol but no longer do?") was designed to capture the broader population of individuals affected by AOD problems, including those who have not been formally diagnosed, or do not identify as having a substance use disorder history, but whose AOD problems nevertheless contribute to addiction disease burden. An inherent strength and limitation of this approach is that the specific parameters of what constitutes an AOD problem and overcoming an AOD problem are determined subjectively by the participants.
5. Although the total sample size was large, the prevalence of a number of conditions was quite low. As such, we may have been underpowered to detect differences between some subgroups. On the contrary, this exploratory study

tests multiple bivariate associations, thus increasing risk of type I error.

CONCLUSIONS AND FUTURE DIRECTIONS

It is well documented that AOD problems are related to premature mortality, and an increased burden of disease, as measured by disability-adjusted life-years lost (DALYs; HHS, 2016). However, little is known about the specific prevalence of such medical problems and their relationship to quality of life and indices of well-being among those recovering from problematic AOD use. Using a nationally-representative study of US adults who have resolved an AOD problem, this study highlights the elevated prevalence of certain diseases (eg, hepatitis C, COPD, heart disease, and diabetes) in this group compared with the US adult general population. Further, the likelihood of having a lifetime diagnosis of a specific disease appears to be influenced by sex, and primary substance used. Finally, quality of life is lower among those who have suffered a physical disease relative to those who have not. Though some of these findings are intuitive (eg, individuals who primarily used classes of drugs commonly associated with injection such as opiates or stimulants had higher rates of hepatitis C and HIV), others are less intuitive (eg, individuals endorsing cannabis as their primary substance did not have significantly lower rates of alcohol-related liver disease compared with those for whom alcohol was primary). In combination with other epidemiological and clinical findings regarding the deleterious impact of AOD use on health, this study suggests the need for earlier and more assertive intervention to help mitigate potential AOD-induced disease burden, and underscores the call for better integration of medical and substance use disorder services. Also, further longitudinal research is needed that can help uncover the complex and dynamic relationships between AOD use and the onset of various physical diseases over time to better articulate the related trajectory of AOD problems and attendant medical conditions, and the frequency at which the medical sequelae of AOD problems resolve after individuals overcome their problems with AOD.

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