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The Relationship between Reductions in WHO Risk Drinking Levels during Treatment and Subsequent Healthcare Costs for the ACTIVE Workgroup

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Abstract

Background: Abstinence has historically been considered the target outcome for alcohol use disorder (AUD) treatment, yet recent work has found drinking reductions following AUD treatment, as measured by World Health Organization (WHO) risk drinking levels, are associated with meaningful improvements in functioning, physical health, and quality of life.

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Objectives: This study extends previous analyses of AUD treatment outcomes by estimating the association between changes in WHO risk drinking levels (very high, high, medium, and low, based on average daily alcohol consumption) and healthcare costs.

Methods: Secondary data analysis of the COMBINE study, a multi-site randomized clinical trial of acamprosate, naltrexone and behavioral interventions for AUD. Generalized gamma regression models were used to estimate relationships between WHO risk drinking level reductions over the course of treatment and healthcare costs in the year after treatment (N=964) and up to 3 years following treatment (N=651).

Results: Sustained WHO risk drinking reductions of 2 or more levels throughout treatment were associated with 52.0% lower healthcare costs ($p < 0.001$) in the year following treatment, and 44.0% lower costs ($p = 0.0025$) over 3 years. A reduction of exactly 1 level was associated with 34.8% lower costs over 3 years, which was not significant ($p=0.05$). Cost reductions were driven by lower inpatient behavioral health and emergency department utilization.

Conclusion: Reduction in WHO risk drinking levels of at least 2 levels was associated with lower healthcare costs over 1 and 3 years. Our results add to literature showing drinking reductions are associated with improvement in health.

Keywords

alcohol treatment; healthcare costs; healthcare utilization; WHO risk drinking level

Introduction

Alcohol use disorder (AUD) is a costly public health problem[1, 2] but its cost can be reduced through treatment.[3, 4] While total abstinence from alcohol has historically been considered the goal of treatment, non-abstinent reductions in alcohol consumption are also associated with improvements in functioning.[5–7] Healthcare cost savings have also been noted following reductions in alcohol use. Kline-Simon et al.[8] showed that patients in a large health maintenance organization who were abstinent or drinking at low levels had similar healthcare utilization costs post-treatment, while those drinking heavily had significantly higher costs. Aldridge et al.[9] showed that drinkers in a large AUD clinical trial with consistently heavy drinking days (i.e., more than 4 drinks for women and 5 drinks for men) had significantly higher healthcare costs than those with a combination of heavy and non-heavy drinking days.

To standardize measurement of meaningful reductions in alcohol consumption, one measure that has been proposed is the World Health Organization (WHO) risk drinking levels (RDLs).[7, 10, 11] The WHO RDLs are sex-specific, and based on average grams of alcohol consumed per day, with very high risk (≥60/≥100 grams for females/males), high risk (41 to 60/61 to 100 grams for females/males), medium risk (21 to 40/41 to 60 grams for females/males), and low risk levels.[11] Witkiewitz et al.[7] found reduction in WHO RDLs was associated with significantly fewer alcohol-related consequences and improved mental health at the end of treatment and at 1-year post treatment. Other studies have considered the association between reductions in WHO RDLs and alcohol dependence and impaired functioning,[10] liver disease,[12] depression and anxiety disorders,[13] and drug use disorders.[14]

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In this paper we examine another important outcome—healthcare costs—that is of interest to researchers, healthcare payers and policymakers who need to make informed decisions regarding whether reductions in WHO RDLs correspond to meaningful reductions in healthcare costs. Specifically, we estimated the relationship between reductions in WHO RDLs during the 4 months of treatment in the COMBINE Study and subsequent healthcare costs 1-year post treatment and 3-years post-treatment.

Methods

Data

We used data from the COMBINE Study,[15] a multi-site randomized placebo-controlled trial designed to measure the effectiveness of combinations of acamprosate, naltrexone, and a behavioral intervention that included components of motivation enhancement treatment, cognitive behavioral treatment, and twelve-step facilitation for the treatment of alcohol dependence. The original and current study were reviewed and approved by the Research Triangle Institute's Institutional Review Board. The COMBINE Study recruited 1,383 alcohol-dependent patients across 11 sites. Patients were randomly assigned to 9 treatment arms, received treatment for 16 weeks, and were followed for a year following treatment. Nine research sites and 786 patients volunteered to participate in additional follow-up data collection, called the COMBINE Economic Study, for 3 years after treatment to support cost and cost-effectiveness analyses.[4] We excluded those randomized not to receive medications (behavioral intervention only) because we were interested in evaluating the effects of WHO RDL reductions on healthcare costs in the context of a pharmacotherapy trial and to be consistent with related work using COMBINE data to examine WHO RDL reductions.[16] Further exclusions, leading to analytic samples of 964 and 651 for the 1- and 3-year analyses, respectively, are described in the Appendix in Figure 1.

Measures

The dependent variable in our analysis is total healthcare costs calculated by multiplying frequencies of healthcare events recorded on the Economic Form 90 by unit costs (i.e., the cost of a single event) adjusted to 2019 U.S. dollars.[4, 17] The Economic Form 90 collected data on inpatient hospital stays (for behavioral and physical health), outpatient visits (for behavioral and physical health), and emergency department visits. The data on healthcare events were self-reported. To limit recall bias, healthcare events were partially anchored to the detailed calendar method used to collect daily drinking amounts. Also, interviews were typically conducted every three to four months which is well within the range of recall bias measured against claims data in a previous study.[18] When interviews were missed, subsequent interviews collected information covering the time period back to the last completed interview, resulting in a comprehensive record of alcohol use and healthcare utilization.

The dependent variable for the 1-year cost analysis is the sum of total healthcare costs from the end of treatment (week 17) through the week 68 interview (1-year post treatment completion). The dependent variable for the 3-year analysis is the sum of costs from weeks 17 to 156. Our primary predictor of interest is a sustained reduction in WHO RDLs across

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the treatment trial. The WHO defines risk drinking as a function of increasing average daily intake of pure ethanol at the following levels: Low Risk: 1–20g (women), 1–40g (men); Medium Risk: 21–40g (women), 41–60g (men); High Risk: 41–60g (women), 61–100g (men); Very High Risk: >60g (women), >100g (men).[11] Consistent with other literature,[7] we include an abstinent category to make the set of risk levels exhaustive but we also conduct a sensitivity analysis excluding those who achieved abstinence to focus on those who reduced drinking short of complete abstinence. We calculated WHO RDLs of participants for 5 time periods: once for each month during the 4-month treatment period and for the period 28 days prior to baseline screening (excluding the ≥4-day period of abstinence immediately prior to randomization required for inclusion in the COMBINE Study). WHO RDL reduction was defined based on participants' WHO RDL over the 4-month treatment period relative to their WHO RDL measured at baseline. Consistent with prior work,[16, 19] we first coded each month during treatment as being a) at least a 1-level WHO risk reduction (e.g., reducing from high risk at baseline to medium risk, low risk or abstinence during treatment) and b) at least a 2-level reduction (e.g., reducing from high risk at baseline to low risk or abstinence during treatment). Next, we created indicator variables reflecting whether a participant sustained that reduction for all 4 months during the treatment period. For example, if a participant consumed alcohol at a risk level at least 1 level below their baseline consumption for all 4 months of treatment, they were coded as a 1 in the measure representing at least a 1-level risk reduction (else 0). If the participant consumed alcohol at a risk level at least 2 levels below their baseline consumption risk level for all 4 months of treatment, they were coded as a 1 in the measure representing at least a 2-level risk reduction (else 0).

Importantly, sustaining a RDL reduction of at least 1 level (vs. no sustained reduction or an increase in risk) and sustaining a RDL reduction of at least 2 levels (vs. no sustained reduction or sustaining a reduction of only 1 level) are not mutually exclusive categories (i.e., all participants who sustained a reduction of at least 2 levels also sustained a reduction of 1 level). To address this issue, we identified the subset of participants who sustained only a reduction of 1 level. For this analysis we also consider mutually exclusive groups as follows: 1) no sustained reduction, 2) sustained reduction of exactly 1 level, but not 2 levels, 3) sustained reduction of at least 2 levels.

Covariates included demographic (gender, race/ethnicity, and age at the time of COMBINE Study enrollment), socioeconomic (unemployment, marital status, years of educational attainment), and health-related control variables (lifetime use of cannabis or other illicit drugs, physical and psychological health domain scores from the WHO Quality of Life Instrument) used in a previous analysis.[9, 20] We also controlled for pre-randomization healthcare costs and the clinical site. In the 3-year models we also controlled for the number of days of cost data available to adjust for attrition.[9]

Analysis

We estimated generalized gamma regression models with a log-link function to account for the positive skew commonly encountered in healthcare cost data.[21] Tests of the distribution and heteroskedasticity of log-scale residuals and a modified Park test confirmed this as the proper estimation technique.[21] The estimated costs are thus more analogous to median than

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mean costs. We did not estimate two-part models because most participants accumulated healthcare costs.[9]

We estimated 3 models for each of the 1- and 3-year periods with the following predictor variable(s) reflecting whether a participant sustained the following during all 4 months of treatment : 1) a reduction of at least 1-level (relative to not sustaining a reduction or an increase in risk); 2) a reduction of at least 2-levels (relative to less than a 2-level sustained reduction); and 3) a reduction of exactly 1-level or a reduction of at least 2 levels (both relative to no sustained reduction or an increase in risk). To assess reductions in RDLs that fall short of abstinence, we also estimated models excluding participants who were abstinent in the last month of treatment (Month 4).

We estimated the models with heteroskedasticity-consistent standard errors[22] and present percent differences in cost relative to the reference group, calculated by exponentiating the model coefficients and subtracting 1, and estimated differences in healthcare costs from the reference group, calculated as the marginal effect of the RDL reduction group covariate(s) evaluated at the means of all control variables. Full model results are available as supplementary material.

To explore how our findings were sensitive to the period of sustained reduction, we estimated the models using sustained reductions over the last 3 months of treatment (i.e., excluding the first month), the last 2 months of treatment, and the last month of treatment only. One motivation for systematically dropping earlier months of treatment was to provide a “grace period” for treatment to become effective before participants achieve RDL reductions by the end of treatment.[7, 9, 23] Full model results are available as supplementary material.

We also examined the components of healthcare costs by groups defined by WHO RDL reductions. We calculated the proportion of participants that received a given type of care (e.g., any inpatient nights in the hospital) and the frequency (e.g., number of nights in the hospital) over the 1- and 3-year follow-up periods. We estimated t-tests for pairwise differences between the 3 mutually exclusive groups: no reduction, a reduction of exactly 1 level, or a reduction of 2 or more levels.

Results

Demographic and socioeconomic characteristics for the 1- and 3-year samples are presented in Table 1. Participants were primarily male, white, in their mid-40s on average, and with lifetime illicit drug use.

Our regression analyses are presented in Table 2 as per-person costs. For 1-year post-treatment, we found 46.9% lower healthcare costs for a sustained risk reduction of at least 1-level during the 4-month treatment period relative to no sustained reduction (column 1, p=0.0005), and 44.5% lower costs for a sustained reduction of at least a 2-level reduction relative to no sustained reduction or only a 1-level reduction (column 2, p=0.0001). These correspond to reductions in 1-year health care costs of $1,767 and $1,477 relative to the respective reference categories. Participants who reduced by exactly 1 level had 30.5% lower

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costs than those who did not reduce (column 3), corresponding to an estimated reduction of $1,175; however, this was not significant (p=0.12). Sustaining reduction of at least 2 levels was associated with 52.0% lower costs relative to not sustaining RDL reductions (column 3) (p=0.0001), corresponding to $2,006 lower health care costs than the no reduction group, on average.

For 3-years post-treatment, the magnitude of health cost reductions (and corresponding p-values) were similar to those for 1-year post-treatment, but are slightly diminished, consistent with previous analyses.[9] One notable difference between the 1- and 3-year analyses is that the reduction of healthcare costs associated with sustaining only a 1-level risk reduction (column 6) was statistically significant (34.8%, p=0.05; vs 30.5%, p=0.12 in the 1-year follow-up analysis).

Results for models excluding participants who were abstinent in the last month of treatment are shown in Table 3. For the 1-year analysis statistical significance was not different from the full sample results. Coefficients were 12.0% to 18.4% smaller than those using the full sample, e.g., $1,655 lower costs for those sustaining a risk reduction of at least 2 levels (non-abstinent sample) versus $2,006 (full sample). The differences in coefficient magnitude were mostly larger in the 3-year analysis (up to a 41.9% smaller coefficient). Statistical significance was the same as the full sample results except for those who sustained a 2-level reduction (relative to 1-level reduction or no reduction).

Sensitivity analyses are shown in Table 4. While the magnitude of the effects for the group that achieved a RDL reduction of at least 2 levels declined as earlier months of treatment are excluded, effects remained large and significant when dropping the first 1 or 2 months of treatment. However, we found that the effect is not significant when only the last month of treatment is considered with a 31.1% reduction in costs for those who achieved the RDL reduction for the last month of treatment only (not significant).

Specific healthcare utilization by RDL reduction group is presented in Table 5. Healthcare cost differences associated with reductions in WHO RDLs were driven primarily by inpatient care for behavioral health (BH; alcohol, drug use, or mental health related care) and emergency department (ED) utilization. In the 1-year post-treatment sample, a smaller percentage of participants who sustained at least a 2-level reduction received any inpatient BH care (4%) compared to those who sustained only a 1-level reduction (9%, p=0.009) or those who did not reduce their alcohol consumption risk (14%, p<0.001). Participants who sustained a reduction of at least 2 levels received fewer nights of BH inpatient care (0.22), compared to those who sustained only a 1-level reduction (0.64 nights, p<0.004) and those who sustained no reduction (1.49 nights, p<0.001). For the 3-year sample, there were significant reductions in receipt and frequency of BH inpatient care for both groups that reduced RDL relative the group that did not reduce risk drinking, but no statistical difference between the groups representing 1 versus 2 or more RDL reductions.

ED utilization was significantly less common among participants with RDL reductions of 2 or more in the 1-year group: 19% of participants who sustained at least a 2-level reduction reported any ED utilization, compared to 28% for the 1-level reduction group

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(p=0.024) and 35% for those who did not reduce their RDL (p<0.001). In the 3-year analysis, differences in ED utilization between the 2+reduction group and the no reduction group remained significant (p=0.021)—42% of 2+ reduction group used the ED, compared to 55% of participants with no reduction. Finally, in the 3-year follow-up period, 85% of participants who sustained a 2+ reduction reported using outpatient services for physical health, compared to 75% of participants who did not sustain a risk reduction (p=0.027). In contrast, 42% of participants who sustained a 2+ reduction reported using outpatient services for behavioral health in the 3-year follow-up period, compared to 55% of participants with no sustained reduction (p=0.023).

Discussion

We found strong evidence that sustained reductions in WHO RDLs during the 4 months of the COMBINE Study treatment were associated with statistically significant and clinically meaningfully reductions in healthcare costs post-treatment. At 1-year post-treatment, a sustained reduction of at least 1 WHO RDL was associated with 46.9% lower healthcare costs (p=0.0005), corresponding to an average reduction in healthcare costs of $1,767. A sustained reduction of at least 2 WHO RDLs was associated with 44.5% lower healthcare costs (corresponding to a reduction of $1,477; p<0.0001) relative to those who did not sustain a 2-level reduction, which also includes those who only sustained a 1-level reduction. Sustaining exactly a 1-level reduction was associated with 30.5% lower healthcare costs (not significant) over the 1-year period while sustaining at least a 2-level reduction was associated with 52.0% lower healthcare costs, a significant reduction of $2,006 compared to the no reduction group.

Reductions in RDLs among participants who were not abstinent in the last month of treatment were also associated with lower healthcare costs. In the 1-year analyses, a sustained non-abstinent reduction of at least 1 WHO RDL was associated with 40.9% lower healthcare costs (corresponding to an average reduction of $1,448; p=0.0042). Sustaining at least a 2-level non-abstinent reduction was associated with 46.0% lower healthcare costs (an average reduction of $1,655), a significant reduction of $2,006 compared to the no reduction group.

Building on our earlier COMBINE Economic Study that collected an additional 2 years of utilization and cost data on a subset of the original COMBINE Study participants,[4] we found that the estimated reductions in healthcare costs generally persisted for costs incurred up to 3 years post-treatment. However, the results were somewhat attenuated, likely due, in part, to a smaller analysis sample size and to loss of effect over a sustained period of time.

Lower healthcare costs associated with reduced WHO RDLs were driven by differences in the utilization of behavioral health inpatient nights and ED visits. Individuals who sustained at least a 2-level WHO RDL reduction were less likely to have any behavioral health inpatient nights (0.04 vs 0.14, p<0.001) or ED visits (0.19 vs 0.35, p<0.001) in the 1-year post-treatment sample. Individuals who sustained a 2-level drinking reduction had 85% fewer behavioral health inpatient nights (0.22 vs 1.49, p<0.001). We found an increased utilization rate for outpatient care for physical health over 3 years in those with a 2 level

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WHO RDL reduction, possibly related to increased healthcare motivation and compliance with medical care.

We performed a sensitivity analysis to assess how our results changed if the WHO RDL reductions were assessed in the last 1 to 3 months of treatment as opposed to all 4 months of COMBINE treatment. As early months of treatment were removed, the estimated associations remained large and significant for the last 2 and 3 months of treatment but were substantially smaller in magnitude and not statistically significant for the last month of treatment alone. This is expected, as a 4-month sustained reduction in WHO RDLs is a more stable pattern of reduced drinking than that observed for any single month (i.e., the last month of treatment) which may be part of a varying monthly pattern. Consequently, this more sustained, stable pattern of reduced drinking during the 4-month treatment period would be relatively more likely to continue into the 1- and 3-year follow-up periods, and thus result in greater reductions in healthcare costs.

Limitations

Our study has several limitations. Our analysis focuses on the outpatient COMBINE Study clinical trial data, which was pharmacotherapy focused. Thus, our results may not reflect what may occur in clinical treatment settings where counseling is predominantly utilized or in more severe AUD individuals. In addition, our 3-year cost data were obtained from 9 of the 11 COMBINE sites, leaving a smaller sample size. As noted in Figure 1, we excluded observations with missing healthcare cost and alcohol consumption information. While we found no significant differences in costs before, during, or after treatment between participants included in the analysis and those excluded due to incomplete cost data, there is still a possibility that unobserved differences between the groups affected our results. Finally, self-reported healthcare utilization may be biased relative to claims data. However, even if the absolute healthcare costs reported in this study are biased, the relative differences in costs between study groups are only biased if recall bias systematically correlated with independent variables.

Conclusions

Our results add to a growing literature that reductions in alcohol consumption have a positive impact on patient functioning.[5–7] While abstinence is widely considered the most acceptable outcome for alcohol treatment, there is a growing body of evidence suggesting that reductions in RDLs are beneficial both in an immediate sense[7, 10] and in the longer term in preventing the onset of alcohol-related conditions.[24] This is particularly important since the goal of many individuals entering alcohol treatment, is not full and total sustained abstinence, but, instead, drinking reduction.[25] A growing body of data suggest that a drinking reduction goal has clear benefits to health and function[12, 16] and might entice more individuals with AUD to seek care. Importantly, we observed that a reduction WHO RDL “short of full abstinence” was associated with significant healthcare cost reductions.

The current study extends recent studies by showing that drinking reduction as measured by the WHO RDLs correspond to reductions in healthcare resource utilization and costs. Given the evidence, policymakers should consider expanding endpoints used in trials of

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alcohol pharmacotherapy to include reductions in RDLs and clinicians should consider reduction in harmful drinking as an acceptable goal in alcohol treatment for appropriate individuals undergoing pharmacotherapy and other AUD treatments. As payers, health systems and related policymakers evaluate coverage of alcohol treatment for their patients, they should consider evidence of reductions in alcohol consumption even when abstinence results may not be compelling. Such therapies may provide meaningful health benefits to patients and prevent other unnecessary and costly care. Future studies might evaluate how non-pharmacological therapies might impact WHO RDL as an indicator of future health care expenditures and/or savings.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1:

Sample Characteristics of Individuals Who Participated in a 16-week AUD Clinical Trial on whom Health Care Data were Collected Post-Treatment.

	1 Year Post-Treatment Sample	3 Years Post-Treatment Sample
Observations	964	651
Baseline risk drinking: Medium (Proportion)	0.07	0.08
Baseline risk drinking: High (Proportion)	0.22	0.22
Baseline risk drinking: Very High (Proportion)	0.71	0.70
No Sustained Risk Drinking Reduction[a] (Proportion)	0.16	0.14
Sustained 1 Level Risk Drinking Reduction[a] (Proportion)	0.15	0.14
Sustained 2 or More Levels Risk Drinking Reduction[a] (Proportion)	0.70	0.71
Male (Proportion)	0.68	0.70
Female (Proportion)	0.32	0.30
Age in years (Mean/SD)	44.69 (10.47)	45.05 (10.51)
White (Proportion)	0.77	0.79
Black (Proportion)	0.09	0.10
Hispanic (Proportion)	0.10	0.06
Non-White/non-Black/non-Hispanic (Proportion)	0.04	0.05
Married (Proportion)	0.46	0.46
Years of Education (Mean/SD)	14.52 (2.68)	14.59 (2.69)
Unemployed at Baseline (Proportion)	0.14	0.15
Marijuana Use[b] (Proportion)	0.82	0.81
Illicit Drug Use excluding Marijuana[b] (Proportion)	0.72	0.72
WHO Physical Health Domain Score (Mean/SD)	27.22 (4.16)	27.04 (4.22)
WHO Psychological Health Domain Score (Mean/SD)	21.02 (3.87)	20.84 (3.93)
Per-patient Healthcare Costs (Mean/SD)	$2,805.89 ($7,058.98)	$8,266.88 ($16,172.08)

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	1 Year Post-Treatment Sample	3 Years Post-Treatment Sample
Per-patient Healthcare Costs (Median)	$806.56	$3,058.68

[a] Risk Drinking Reduction is for the 16-week clinical trial period from which follow-up is based

[b] Indicates lifetime use.

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Table 2:

Model Results Examining Effects of Different Levels of Risk Drinking Reduction on Healthcare Costs (Full Sample)

Dependent variable: total healthcare cost	**1 Year Post-Treatment**			**3 Years Post-Treatment**		
Observations	964	964	964	651	651	651
Reductions in WHO risk drinking relative to baseline period						
Sustained at least 1-level reduction throughout treatment period (ref: did not sustain a risk drinking reduction)	−0.6338 (0.0005) [−46.9%] {−$1,767}			−0.5495 (0.0031) [−42.3%] {−$4,528}		
Sustained at least 2-level reduction throughout treatment period (ref: did not sustain, or sustained a risk drinking reduction of 1 level)		−0.5888 (0.0001) [−44.5%] {−$1,477}			−0.4042 (0.0063) [−33.3%] {−$2,979}	
Sustained 1-level reduction but not 2-level reduction throughout treatment period (ref: did not sustain a risk drinking reduction)			−0.3634 (0.1173) [−30.5%] {−$1,175}			−0.4274 (0.0504) [−34.8%] {−$3,736}
Sustained at least 2-level reduction throughout treatment period (ref: did not sustain a risk drinking reduction)			−0.7346 (0.0001) [−52.0%] {−$2,006}			−0.5796 (0.0025) [−44.0%] {−$4,725}

Unstandardized regression coefficients and p-values based on robust standard errors (in parentheses) from Gamma generalized linear models with log link, percent difference calculated as IRR - 1 [in brackets], and estimated (mean) difference in healthcare costs {in braces}.

Risk levels based on average drinks per day (see text).

Models control for demographic and socioeconomic characteristics, health status, baseline risk drinking, and study center. Full model output is available in the appendix.

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Table 3:

Model Results Examining Effects of Different Levels of Risk Drinking Reduction on Healthcare Costs (Excl. Patients that Achieved Abstinence in the Last Month of Treatment)

Dependent variable: total healthcare cost	**1 Year Post-Treatment**			**3 Years Post- Treatment**		
Observations	751	751	751	496	496	496
Reductions in WHO risk drinking relative to baseline period						
Sustained at least 1-level reduction throughout treatment period (ref: did not sustain a risk drinking reduction)	−0.5263 (0.0042) [−40.9%] {−$1,448}			−0.4151 (0.0193) [−34.0%] {−$3,522}		
Sustained at least 2-level reduction throughout treatment period (ref: did not sustain, or sustained a risk drinking reduction of 1 level)		−0.4857 (0.0026) [−38.5%] {−$1,204}			−0.2254 (0.1416) [−20.2%] {−$1,730}	
Sustained 1-level reduction but not 2-level reduction throughout treatment period (ref: did not sustain a risk drinking reduction)			−0.3389 (0.1408) [−28.7%] {−$1,034}			−0.4384 (0.0382) [−35.5%] {−$3,675}
Sustained at least 2-level reduction throughout treatment period (ref: did not sustain a risk drinking reduction)			−0.6169 (0.0015) [−46.0%] {−$1,655}			−0.4062 (0.0306) [−33.4%] {−$3,457}

Unstandardized regression coefficients and p-values based on robust standard errors (in parentheses) from Gamma generalized linear models with log link, percent difference calculated as IRR - 1 [in brackets] and estimated (mean) difference in healthcare costs {in braces}.

Risk levels based on average drinks per day (see text).

Models control for demographic and socioeconomic characteristics, health status, baseline risk drinking, and study center. Full model output is available in the appendix.

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Table 4:

Sensitivity Analysis Model Results: Last N Months of Treatment

	1 Year Post-Treatment			3 Years Post-Treatment		
	Last 3 Months	**Last 2 Months**	**Last 1 Month**	**Last 3 Months**	**Last 2 Months**	**Last 1 Month**
Observations	964	964	964	651	651	651
Sustained 1-level reduction but not 2-level reduction throughout part of treatment period (ref: did not sustain a risk drinking reduction)	−0.1926 (0.4505) [−17.5%] {−$643}	−0.1782 (0.4972) [−16.3%] {−$566}	−0.2943 (0.3209) [−25.5%] {−$797}	−0.3335 (0.1545) [−28.4%] {−$3,068}	−0.3035 (0.2221) [−26.2%] {−$2,909}	−0.1764 (0.5373) [−16.2%] {−$1,495}
Sustained at least 2-level reduction throughout part of treatment period (ref: did not sustain a risk drinking reduction)	−0.6721 (0.0007) [−48.9%] {−$1,795}	−0.5528 (0.0090) [−42.5%] {−$1,472}	−0.3731 (0.1081) [−31.1%] {−$973}	−0.5923 (0.0038) [−44.7%] {−$4,835}	−0.6095 (0.0054) [−45.6%] {−$5,071}	−0.3629 (0.1420) [−30.4%] {−$2,814}

Unstandardized regression coefficients and p-values based on robust standard errors (in parentheses) from Gamma generalized linear models with log link, percent difference calculated as IRR - 1 [in brackets], and estimated (mean) difference in healthcare costs {in braces}.

Risk levels based on average drinks per day (see text). Changes in the N-month periods of measurement constructed relative to the baseline WHO risk drinking level. Risk drinking level in the first 4-N months of treatment are not reflected in the outcome measure nor are they included in the statistical model. Models control for demographic and socioeconomic characteristics, health status, baseline risk drinking, and study center. Full model output is available in the appendix.

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Table 5:

Specific Healthcare Utilization by WHO Risk Drinking Level Reduction Groups

				P-values from pairwise comparisons		
	No Reduction	**1 Level Reduction**	**2+ Level Reduction**	**No Reduction vs 1 Level Reduction**	**No Reduction vs 2 Level Reduction**	**1 Level vs 2 Level Reduction**
1 Year Post-Treatment						
Observations	152	140	672			
Any IP nights (non-BH)	5%	5%	5%	0.657	0.707	0.380
Average Number of IP nights (non-BH)	0.11 (0.60)	0.08 (0.47)	0.25 (1.76)	0.601	0.326	0.242
Any IP nights for BH	14%	9%	4%	0.228	**<0.001**	**0.009**
Average Number of IP nights for BH	1.49 (5.33)	0.64 (2.40)	0.22 (1.34)	0.086	**<0.001**	**0.004**
Any ED Visits	35%	28%	19%	0.198	**<0.001**	**0.024**
Average Number of ED Visits	0.45 (0.71)	0.44 (0.88)	0.29 (0.71)	0.845	**0.012**	**0.039**
Any OP Visits (non-BH)	61%	54%	60%	0.281	0.899	0.213
Average Number of OP Visits (non-BH)	2.46 (3.91)	3.50 (7.46)	2.76 (5.18)	0.133	0.511	0.155
Any OP Visits for BH	25%	31%	24%	0.222	0.756	0.059
Average Number of OP Visits for BH	3.50 (11.85)	3.56 (8.43)	2.66 (8.61)	0.962	0.312	0.259
3 Years Post-Treatment						
Observations	93	94	464			
Any IP nights (non-BH)	11%	13%	15%	0.669	0.277	0.562
Average Number of IP nights (non-BH)	0.25 (0.89)	0.28 (0.95)	0.95 (4.35)	0.829	0.119	0.133
Any IP nights for BH	25%	13%	9%	0.036	**<0.001**	0.267
Average Number of IP nights for BH	3.35 (10.09)	1.17 (4.16)	0.81 (3.92)	0.054	**<0.001**	0.420
Any ED Visits	55%	49%	42%	0.419	**0.021**	0.203
Average Number of ED Visits	1.11 (1.53)	1.23 (2.03)	0.89 (1.66)	0.631	0.253	0.083
Any OP Visits (non-BH)	75%	79%	85%	0.575	**0.027**	0.153

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				P-values from pairwise comparisons		
	No Reduction	**1 Level Reduction**	**2+ Level Reduction**	**No Reduction vs 1 Level Reduction**	**No Reduction vs 2 Level Reduction**	**1 Level vs 2 Level Reduction**
Average Number of OP Visits (non-BH)	6.19 (9.37)	7.82 (9.50)	8.84 (14.60)	0.240	0.094	0.517
Any OP Visits for BH	55%	51%	42%	0.605	**0.023**	0.107
Average Number of OP Visits for BH	11.32 (25.43)	11.36 (28.41)	8.30 (20.53)	0.992	0.214	0.219

Note: Percentages for any utilization and unconditional mean (SD) for frequencies. Risk drinking reductions are calculated as (highest monthly WHO risk drinking level during treatment) – (baseline WHO risk drinking level); BH - Behavioral Health (alcohol, drug abuse, or mental health related). Pairwise significance tests based on two-sample t-test with equal variances.