PREFERENCE-BASED ASSESSMENTS

Associations of Smoking, Physical Inactivity, Heavy Drinking, and Obesity with Quality-Adjusted Life Expectancy among US Adults with Depression

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A B S T R A C T

Objectives: To examine associations between four health behaviors (smoking, physical inactivity, heavy alcohol drinking, and obesity) and three health indices (health-related quality of life, life expectancy, and quality-adjusted life expectancy (QALE)) among US adults with depression. **Methods:** Data were obtained from the 2006, 2008, and 2010 Behavioral Risk Factor Surveillance System data. The EuroQol five-dimensional questionnaire (EQ-5D) health preference scores were estimated on the basis of extrapolations from the Centers for Disease Control and Prevention's healthy days measures. Depression scores were estimated using the eight-item Patient Health Questionnaire. Life expectancy estimates were obtained from US life tables, and QALE was estimated from a weighted combination of the EQ-5D scores and the life expectancy estimates. Outcomes were summarized by depression status for the four health behaviors (smoking, physical inactivity, heavy alcohol drinking, and obesity). **Results:** For depressed adults, current smokers and the physically inactive had significantly lower EQ-5D scores (0.040 and 0.171, respectively), shorter life expectancy

(12.9 and 10.8 years, respectively), and substantially less QALE (8.6 and 10.9 years, respectively). For nondepressed adults, estimated effects were similar but smaller. Heavy alcohol drinking among depressed adults, paradoxically, was associated with higher EQ-5D scores but shorter life expectancy. Obesity was strongly associated with lower EQ-5D scores but only weakly associated with shorter life expectancy. **Conclusions:** Among depressed adults, physical inactivity and smoking were strongly associated with lower EQ-5D scores, life expectancy, and QALE, whereas obesity and heavy drinking were only weakly associated with these indices. These results suggest that reducing physical inactivity and smoking would improve health more among depressed adults.

Keywords: burden of illness, depression, quality-adjusted life-years, risk factors.

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Introduction

Depression is a health outcome associated with genetic predispositions, sex, adverse childhood experiences, exposure to disasters, and poverty [1–5]. It is also associated with several unhealthy behaviors including physical inactivity [6–10], sedentary behavior [11–13], excessive alcohol use [14–17], smoking [18–22], and less social engagement [23]. Finally, depression is associated with most chronic conditions [24]. In a review of 31 studies of associations between depression and other chronic conditions including diabetes, pulmonary disease, heart disease, and arthritis, those with a chronic condition as well as depression reported significantly more medical symptoms than did those with only a chronic condition [25]. In terms of causal associations, the relationship between depression and other chronic conditions is bidirectional [26,27].

Although depression has an age of onset earlier than that of most other chronic conditions [28,29], this does not necessarily demonstrate that depression causes the new chronic conditions. In a review examining bidirectional effects of depression and chronic

obstructive pulmonary disease (COPD) [30], 16 studies supported a causal effect of depression on COPD, whereas 6 studies supported a causal effect of COPD on depression.

Several different interventions decrease rates of depression, including drug therapy [31], psychotherapy [32,33], physical activity [7–10], and reducing harmful risky behaviors such as smoking and heavy alcohol use [21,22,34]. Counterintuitively, in some studies, smoking cessation has been found to increase rates of depressive symptoms in some individuals, likely because of withdrawal symptoms associated with nicotine dependence.

Depression is a leading cause of disability [24,35–37] and suicide [35,38,39]. It is also associated with poor health-related quality of life (HRQOL) and increased years of living with a disability [35,40,41]. Depression has also been associated with excess mortality and substantially lower life expectancy [42–44]. In a recent study of US adults, the life expectancy for those with depression was 16.4 years less than that for those without depression [44]. The total health loss, for both fatal and nonfatal outcomes associated with depression, was a 28.9-year loss in quality-adjusted life expectancy (QALE) starting at age 18 years, a more than 50% decrease in QALE relative to that in those without depression.

QALE takes into account both the years of life lost and the relative severity of current chronic conditions, making it possible to quantify both population-level and individual-level health losses associated with both fatal and nonfatal outcomes [45–48]. Typically, preference-based measures of HRQOL are used to estimate the effects of these nonfatal health losses. These measures capture respondents' perceived health for different health states using a summary score (called utility value) between 0 (for death) and 1 (for perfect health) [45]. Thus, 1 year of life lived at a utility value of 0.5 equals 0.5 quality-adjusted life-years (QALYs), the same as that of only half a year of life lived at a perfect utility value of 1.0 [24,25]. The QALE at a certain age (such as at age 18 years) is defined as the average QALY throughout the remainder of expected life [44,47].

The primary objectives of this article were to estimate changes in age-adjusted HRQOL scores, life expectancy, and QALE associated with four risk factors—physical inactivity, smoking, heavy drinking, and obesity—previously associated with depression among adults. This study also estimated the potential gains in QALE for adults with high levels of depressive symptoms if they had lowered the frequency and levels of these risk factors.

Methods

The Behavioral Risk Factor Surveillance System (BRFSS) is an ongoing annual survey of noninstitutionalized civilian adult residents from each of the 50 states, the District of Columbia, and participating territories [49–51]. The BRFSS uses a random-digit–dialed telephone survey method to ascertain a population-based random sample of adults aged 18 years and older [50,51].

During 2006, 2008, and 2010, the eight-item Patient Health Questionnaire (PHQ-8) depression scale was included in the BRFSS state optional modules to classify individuals according to the severity of their self-reported depression symptoms [52,53]. The PHQ-8 is established as a valid and reliable diagnostic measure of depressive symptoms in large clinical studies and has frequently been used to estimate the prevalence of depression in the US adult population [54–56]. Thirty-six states and the District of Columbia asked PHQ-8 questions at least once during these 3 years, yielding a total sample size of 276,442 for this analysis. For the purposes of this study, a PHQ-8 score of 10 or more will be used to categorize adults as depressed [52,53] because such a score has an 88% sensitivity and an 88% specificity for major depressive disorders [54,55].

The BRFSS asks respondents about their physical activity, cigarette smoking, number of drinks of alcohol, and their weight and height without their shoes. Leisure-time physical activity is defined as having performed, during the past 30 days, physical activity or exercise other than that in a regular job. Cigarette smoking is defined as currently smoking any cigarettes every day

Table 1 – Demographic and risk factor characteristics among US adults with and without depression—BRFSS 2006, 2008, and 2010.

Demographic and risk factor characteristic	Depression (n = 24,826)		No depression (n = 251,616)	
	%[*]	SE	%[*]	SE
Age (y), mean	43.1	0.2	45.9	0.1
Age groups (y)				
18–44	54.1%	0.7%	50.7%	0.2%
45–64	36.6%	0.7%	32.7%	0.2%
>65	9.3%	0.3%	16.6%	0.1%
% Women	61.0%	0.3%	49.3%	1.3%
Race/ethnicity				
White non-Hispanic	68.3%	1.8%	72.1%	1.6%
Black non-Hispanic	13.8%	1.0%	10.4%	0.9%
Hispanic	12.7%	1.7%	12.0%	1.5%
Others	5.2%	0.8%	5.5%	0.8%
% Currently smoking	39.9%	1.4%	19.5%	1.2%
% Physically inactive	43.5%	1.5%	20.6%	1.4%
% Heavy alcohol drinking	7.4%	0.8%	5.1%	0.7%
Body mass index (kg/m^2) groups				
<18.5	1.9%	0.6%	0.8%	0.6%
18.5–24.9	23.2%	1.7%	30.0%	1.6%
25.0–29.9	32.1%	1.6%	38.7%	1.5%
≥30.0	42.8%	1.3%	30.5%	1.2%

BRFSS, Behavioral Risk Factor Surveillance System; SE, standard error.
[*] Percentages accounting for sampling weight and age in subgroups (except by age groups).

or some days. Heavy alcohol drinking is defined as drinking alcoholic beverages 15 or more times per week for men and 8 or more times per week for women. Obesity is defined as having a body mass index (BMI; weight [kg] divided by height [m] squared) greater than or equal to 30 kg/m². Only 1.9% of the depressed US adults were underweight (BMI < 18.5 kg/m²) (Table 1), and so we did not calculate QALE for those who were underweight because the mortality estimates in such a small group were considered unreliable.

The BRFSS includes four HRQOL questions that ask respondents to rank their general health from 1 (excellent) to 5 (poor) and to report their number of physically and mentally unhealthy days and days with activity limitation during the past 30 days [57]. Because these questions are not preference-based measures of HRQOL, this study applied a previously constructed algorithm to obtain values for the EuroQol five-dimensional questionnaire (EQ-5D) index, a preference-based HRQOL measure, for BRFSS respondents, on the basis of their age and answers to these four questions [58,59]. This algorithm provides valid estimates of the EQ-5D scores of the US population overall and in some demographic subgroups and common health conditions identified from the BRFSS [58,59]. The bias of estimated QALE from these scores has been estimated to be less than 1% of that using the actual EQ-5D questions [60].

Life expectancy at a given age is the average number of years of life remaining starting at that age and is calculated using the life table method [61]. The National Center for Health Statistics

compiles death data for the US population and makes these data available to the public in the Compressed Mortality File at http://wonder.cdc.gov. This file includes age-specific mortality rates and can be used to construct life tables for the US population [60,61].

The age-specific death rate (m) was obtained by dividing the number of deaths by the population size. Because age-specific death rates stratified by depression and each of the four health behaviors are not available, these rates were estimated. Death rates for those with depression (m_1) and those without depression (m_0) were estimated using the hazard ratio (h) of dying for depressed versus nondepressed and the prevalence of depression (p) by $m_1 = \frac{hm}{hp + (1-p)}$ and $m_0 = \frac{m}{hp + (1-p)}$, respectively [47]. The hazard ratio was estimated from the 2004 to 2010 National Health and Nutrition Examination Survey (NHANES) data as linked to the National Death Index through December 31, 2011 (https://www.cdc.gov/nchs/data-linkage/mortality.htm), using the Cox proportional hazards model. The prevalence of depression was estimated from the BRFSS.

The QALE was calculated using the life table method [60]. Let l_i be the number of a hypothetical population surviving to the beginning of age interval i (18–24, 25–34, …, >85 years) and L_i be the total life-years for the age interval i. Assuming a constant death rate during an age interval, the probability of dying in an n_i-year age interval is $q_i = 1 - e^{-n_i m_i}$ and those who died during the interval for ages $x < 85$ years lived approximately $n_i/2$ years, that

Table 2 – Association between selected risk factors and the EQ-5D index, life expectancy, and QALE by depression status among US adults—BRFSS 2006, 2008, and 2010[*].

Risk factor	EQ-5D[†]		Life expectancy[‡]		QALE[§]	
	depression		depression		depression	
	Yes	No	Yes	No	Yes	No
All	0.594	0.909	47.3	63.7	28.0	56.8
Smoking						
No	0.610	0.914	53.2	65.6	31.9	58.7
Yes	0.570	0.888	40.3	54.1	23.3	47.8
Loss	0.040	0.025	12.9	11.4	8.6	10.8
% Loss	6.6	2.8	24.3	17.4	27.0	8.4
Physical inactivity						
No	0.669	0.921	53.6	64.3	34.0	58.5
Yes	0.498	0.864	42.8	62.3	23.1	52.7
Loss	0.171	0.057	10.8	2.1	10.9	5.8
% Loss	25.6	6.2	20.1	3.2	32.0	9.9
Heavy drinking						
No	0.568	0.909	47.7	63.9	28.0	57.1
Yes	0.671	0.909	41.3	57.2	27.9	52.0
Loss	−0.103	0.000	6.4	6.7	0.1	5.1
% Loss	−18.1	0.0	13.4	10.5	0.4[*]	8.9
Obesity[‖]						
No	0.616	0.918	47.4	64.0	28.7	57.6
Yes	0.563	0.889	47.0	63.5	27.0	55.1
Loss	0.053	0.029	0.4	0.5	1.7	2.5
% Loss	8.6	3.1	0.9	0.8	5.8	4.4

BMI, body mass index; BRFSS, Behavioral Risk Factor Surveillance System; EQ-5D, EuroQol five-dimensional questionnaire; QALE, quality-adjusted life expectancy.

[*] All estimates in this table are statistically significant except for the QALE loss for the depressed individuals who reported they engaged in heavy drinking.
[†] Age-adjusted EQ-5D index.
[‡] Life expectancy at age 18 y.
[§] QALE at age 18 y.
[‖] Obesity: Yes, BMI ≥ 30.0; No, BMI = 18.5–29.9; excluded, BMI < 18.5.

is, $L_i = l_i(1-n_i m_i/2)$, and for the last age interval (>85 years), the average years of life at age 85 years is $L_{85} = l_{85}/m_{85}$ [60,61]. The life expectancy at age x is $\frac{\sum_{i \geq x} L_i}{l_x}$. If y_i is the mean HRQOL score, the number of QALYs for this age interval is $L_i y_i$. The QALE at age x is calculated by summarizing QALYs throughout the remaining expected life starting at age x divided by the population surviving to age x and is calculated as $\frac{\sum_{i \geq x} L_i y_i}{l_x}$.

We estimate life expectancy and QALE by respondents' depression status cross-tabulated by each of the four risk factors. Life expectancy loss associated with a risk factor is the difference in life expectancy between those with and without the risk factor, and QALE loss associated with a risk factor is the difference in QALE between these two groups [47,62]. The nonfatal health loss due to a risk factor is the difference in age-standardized EQ-5D scores (standardized to the year 2010 US population) between those with the factor and those without the factor [44].

Results

The total sample size was 276,442. Approximately 9.1% (standard error = 0.13%) of adults in this study using our case definition were currently depressed. The depressed adults were about 2.8 years younger than the nondepressed adults (Table 1). After age adjustment, those who were depressed were more likely to be women (61.0% vs. 49.3%) and black non-Hispanics (13.8% vs. 10.4%) and less likely to be white non-Hispanics (68.3% vs. 71.1%) than those who were not depressed. Those who were depressed had about the same proportions of Hispanics (12.7% vs. 12.0%) and other races (5.2% vs. 5.5%) as those who were not depressed. Compared with those who were not depressed, those who were depressed were more than twice as likely to be current

smokers (39.9% vs. 19.5%) and to be physically inactive (43.5% vs. 20.6%) and more than 40% as likely to be heavy drinkers (7.4% vs. 5.1%) and to be obese (42.8% vs. 30.5%).

The age-adjusted EQ-5D index was 0.594 for those who were depressed and 0.909 for those who were not depressed (Table 2). The life expectancy for individuals aged 18 years was 47.3 additional years for those who were depressed and 63.7 additional years for those who were not depressed. The QALE at age 18 years was 28.0 years for those who were depressed and 56.9 years for those who were not depressed. This 28.9-year decrease represents the years of QALE loss associated with depression (or a loss of 50.8% QALE) starting at age 18 years. Because the main aim of this study was to examine the association of each of the four risk factors with HRQOL, life expectancy, and QALE, for those with depression, the rest of this study pertains only to US adults with depression.

Smoking among Depressed Adults

Nearly 40% of depressed adults were current smokers (Table 1). Generally, smoking had a relatively small adverse relationship with HRQOL but a large adverse relationship with life expectancy among depressed adults (Table 2). The age-adjusted EQ-5D index for depressed current smokers was 0.570, 0.040 points lower (or 6.6% lower) than that for depressed nonsmokers (0.610). The life expectancy for an 18-year-old smoker was 40.3 years, about 12.9 years less (24.3%) than the life expectancy of an 18-year-old nonsmoker (53.2 years). This 12.9-year decrease in life expectancy was the largest among the four risk factors examined, and the 0.040-point decrease in the EQ-5D index was the smallest. Combining the small loss in the EQ-5D index with the large loss in life expectancy led to a relatively large QALE decrease
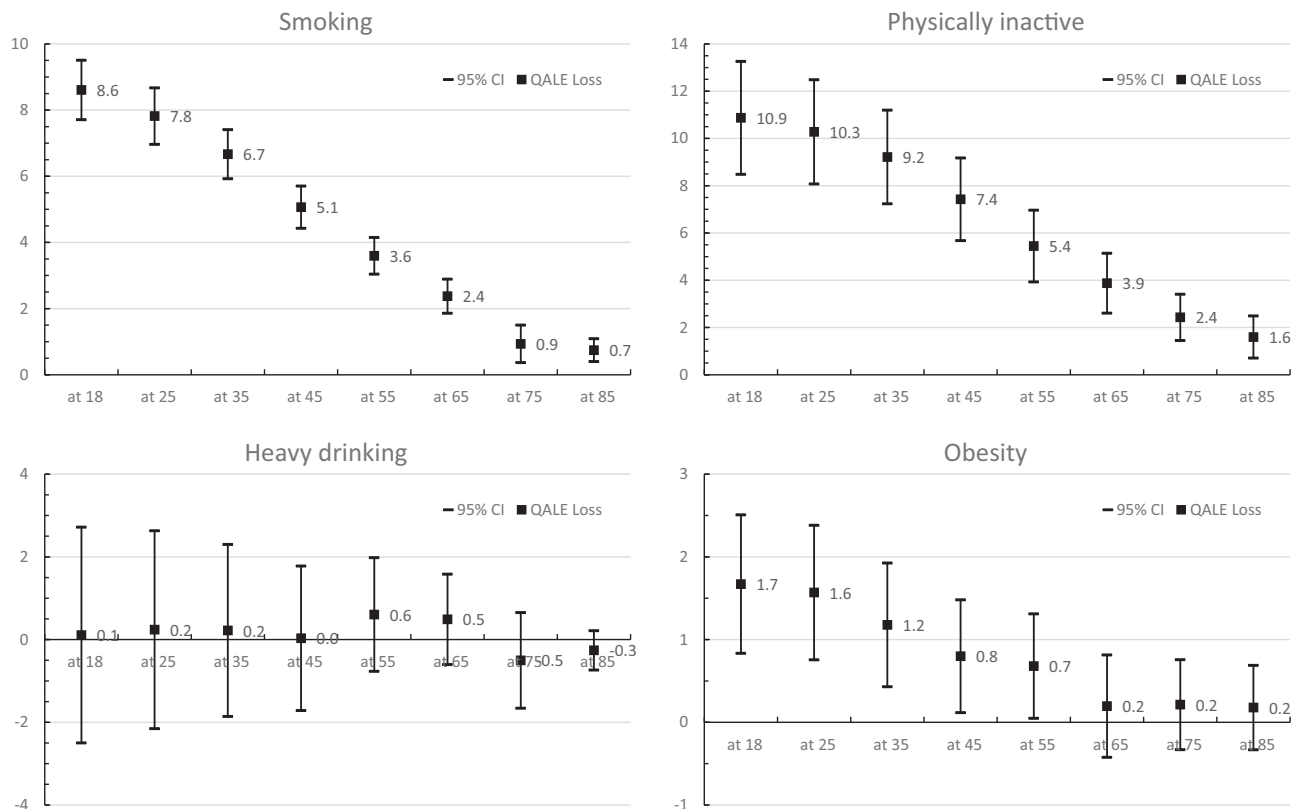
Fig. 1 – Decreases in QALE associated with selected risk factors among US adults with depression at different ages—BRFSS 2006, 2008, and 2010. BRFSS, Behavioral Risk Factor Surveillance System; CI, confidence interval; QALE, quality-adjusted life expectancy.

associated with smoking. Because the QALE for smokers was 23.3 years and for nonsmokers was 31.9 years, smoking was associated with an 8.6-year QALE decrease (or a decrease of 27% QALE), the second largest decrease among the four risk factors.

The decreases in QALE associated with smoking were statistically significant at all ages (Fig. 1). For example, an 85-year-old depressed person had a significantly lower QALE (0.2 years) than an 85-year-old person who was not depressed (0.9 years). The decrease in QALE declined gradually with age, going from 8.6 years at age 18 years to 0.7 years at age 85 years. This occurs because QALE declines with age, and not because smoking has a weaker association with QALE at older ages. Such a large and significant QALE decrease associated with smoking occurred among both men and women and among white non-Hispanics, black non-Hispanics, and Hispanics (Fig. 2). Smoking was associated with approximately the same amount of QALE decrease for both men and women and for the three race/ethnicity subgroups (between 7.9 and 8.6 years).

Depressed adults had 28.9 years of QALE less than nondepressed adults; part of this difference may be related to higher smoking prevalence rates among depressed adults (39.9%) relative to those in adults who were not depressed (19.5%). If depressed adults lowered their smoking prevalence to that of individuals who were not depressed, it could potentially increase their QALE by 1.9 years (6.8%), from the current estimate of 28.0 years to 29.9 years.

Physical Inactivity among Depressed Adults

Approximately 43.5% of depressed adults were physically inactive (Table 1). Their age-adjusted EQ-5D index was 0.498, 0.171 points (25.6%) lower than that for those who were physically active (0.669) (Table 2). This 0.171-point decrease in the EQ-5D index was

the largest among the four risk factors examined. The life expectancy for an 18-year-old inactive person was 42.8 years, 10.8 years (20.1%) less than the life expectancy of an 18-year-old active person (53.6 years). This 10.8-year decrease in life expectancy was the second largest of the four risk factors. The strong association between physical inactivity and both EQ-5D and life expectancy results in a very large QALE decrease associated with physical inactivity. Being physically inactive was associated with a 10.9-year (32%) decrease in QALE (34.0 years for the active group and 23.1 years for the inactive group). This 10.9-year decrease in QALE was also the largest among the four risk factors.

The decreases in QALE associated with physical inactivity were also significant at all ages (Fig. 1). Like the decrease associated with smoking, the QALE loss to physical inactivity also declined gradually with age, going from 10.9 years at age 18 years to 1.6 years at age 85 years. Such a strong association of physical inactivity with QALE was observed for both men (an 11.8-year decrease) and women (a 9.9-year decrease) and for all three race/ethnicity groups (a 16.6-year decrease among Hispanics, a 11.5-year decrease among white non-Hispanics, and a 10.9-year decrease among black non-Hispanics; Fig. 2). Nevertheless, these decreases among the different demographic subgroups did not differ statistically significantly.

If the prevalence of physical inactivity among depressed adults (43.5%) was reduced to the same prevalence as that among adults who were not depressed (20.6%), the depressed adults could potentially increase their QALE by 2.8 years (10%) to 30.8 years.

Heavy Alcohol Drinking among Depressed Adults

Among those with depression, about 7.4% were heavy drinkers (Table 1). Among depressed adults, heavy drinkers had a
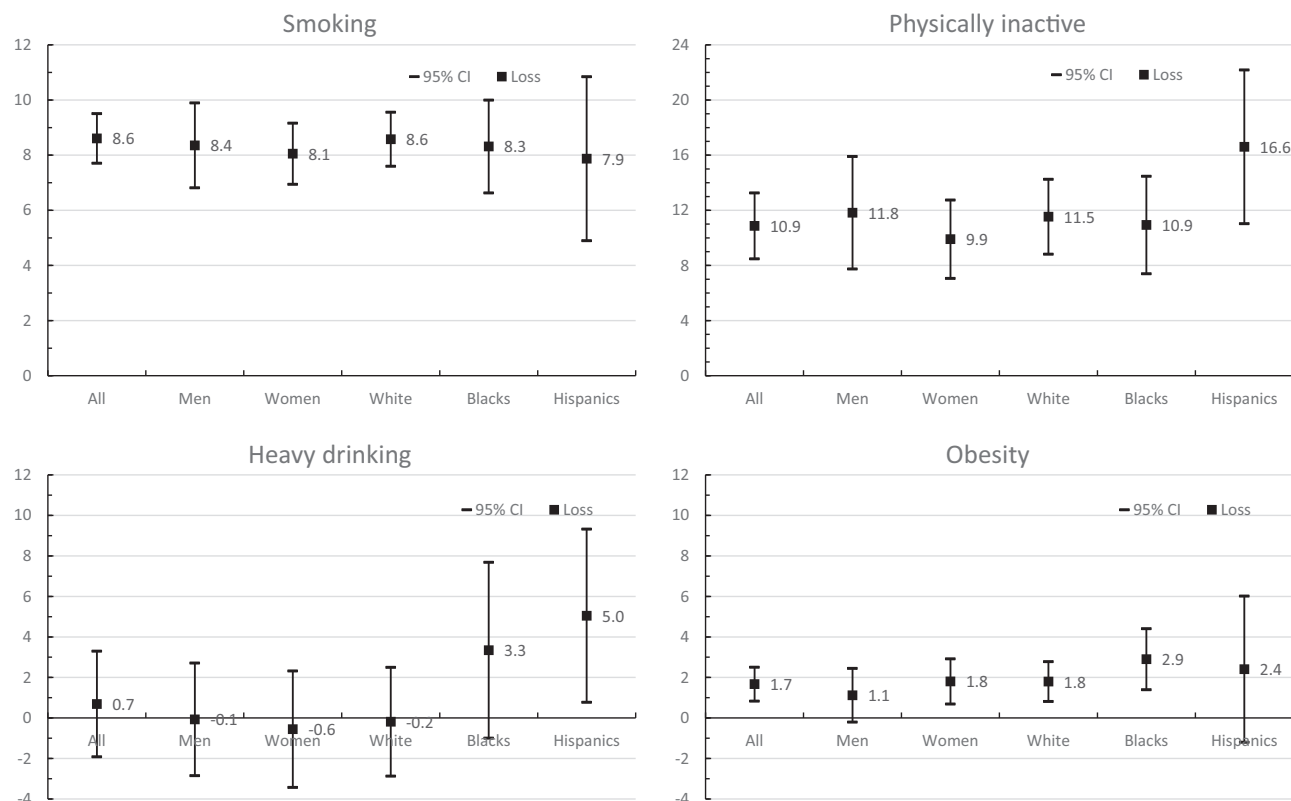
Fig. 2 – Decreases in QALE associated with selected risk factors among US adults with depression, overall and for men, women, white non-Hispanics, black non-Hispanics, and Hispanics—BRFSS 2006, 2008, and 2010. BRFSS, Behavioral Risk Factor Surveillance System; CI, confidence interval; QALE, quality-adjusted life expectancy.

significantly higher EQ-5D index (0.671) compared with non–heavy drinkers (0.568) (Table 2). At age 18 years, heavy drinkers had a significantly lower life expectancy (41.3 years) compared with non–heavy drinkers (47.7 years). On combining a higher EQ-5D index with a lower life expectancy, we found that heavy drinkers had nearly the same QALE as non–heavy drinkers. The QALE was 27.9 years for heavy drinkers and 28.0 years for non–heavy drinkers. This 0.1-year difference was the smallest among the four risk factors examined and was not statistically significant (95% confidence interval [CI] –2.5 to 2.7).

When examined by sex and race/ethnicity, the difference in QALE associated with heavy drinking was not statistically significant for men (95% CI –2.9 to 2.7), women (95% CI –3.6 to 2.2), white non-Hispanics (95% CI –3.4 to 2.0), and black non-Hispanics (95% CI –0.2 to 8.4). Only Hispanics with depression had statistically significantly less QALE associated with heavy drinking (4.5 years [95% CI 0.2 to 8.8]).

Obesity among Depressed Adults

We did not find a significant and meaningful difference in the EQ-5D index and death rates between normal-weight adults (BMI = 18.5–24.9 kg/m^2) and overweight adults (BMI = 25.0–29.9 kg/m^2); therefore, we combined normal-weight and overweight adults into one group (nonobese adults [BMI = 18.5–29.9 kg/m^2]) and compared them with obese adults (BMI ≥ 30 kg/m^2). Among those with depression, the age-adjusted EQ-5D index was 0.563 for obese adults and 0.616 for nonobese adults (Table 2). This 0.053-point decrease in EQ-5D associated with obesity exceeded the 0.040-point decrease associated with smoking but was smaller than the 0.171-point decrease associated with physical inactivity and the 0.103-point increase associated with heavy drinking. The life expectancy of an 18-year-old obese person was 47.0 years, about 0.4 years less than the life expectancy of an 18-year-old nonobese person (47.4 years). This 0.4-year decrease in life expectancy was the smallest among the four risk factors but was statistically significant (P = 0.04). Overall, obesity was associated with a statistically significant 1.7-year (5.8%) QALE decrease (27.0 years for obese persons and 28.7 years for nonobese persons).

Being obese was associated with a statistically significant 1.8-year (95% CI 0.7 to 2.9) QALE decrease for depressed women (Fig. 2). For depressed men, the obesity-associated QALE decrease was not statistically significant (1.1-year decrease; 95% CI –0.2 to 2.4). The decrease in QALE associated with obesity was significant only among those aged 55 years or younger. In addition, the QALE decrease associated with obesity declined gradually down to 0 between age 18 years and 55 years (Fig. 1). This suggests that obesity is significantly associated with health only among younger depressed adults.

If the prevalence of obesity among depressed adults was reduced to a rate such as that in adults who were not depressed, the depressed adults could potentially increase their QALE by 0.2 years to 28.2 years.

Discussion

In our study, leisure-time physical inactivity and smoking were strongly associated with two health outcomes and one composite score (i.e., HRQOL, life expectancy, and QALE) among US adults with depression. The other two risk factors, heavy alcohol drinking and obesity, surprisingly, had nonstatistically significant or negligible associations with respondents' QALE (0.1-year decrease for heavy drinkers and 1.7-year decrease for obese persons). These findings were generally consistent at all ages,

for both men and women, and for white non-Hispanics, black non-Hispanics, and Hispanics.

Each of the four risk factors had differences in decreases for fatal and nonfatal outcomes. Smoking was associated with a large reduction in life expectancy (a loss of 12.9 years of life) but a relatively small decrease in HRQOL scores (a decrease of 0.04 points in the EQ-5D index) among depressed adults. This is consistent with findings from previous studies of the impact of smoking on general populations [47,63–66]. For example, smoking is one of the leading causes of death among US adults [64], but in a study of 13,000 adults, current smoking was associated with a statistically significant but only a small decrease of 0.03 points in the EQ-5D index [66].

Physical inactivity also had a large association with both HRQOL and life expectancy—a decrease of 20.1% life expectancy and 25.6% HRQOL. This is likely because physical inactivity is a strong predictor of long-term mortality [41] and because physical inactivity is also associated with physical limitations [67,68]. Therefore, it would be expected that the EQ-5D and physical inactivity would be correlated.

Although excessive alcohol consumption has been associated with deteriorating HRQOL in the general population [69], this study found that among those with depression, heavy drinkers had significantly better age-adjusted HRQOL scores than non–heavy drinkers, with an increase of 18.1% HRQOL. Among depressed people, heavy drinkers rated their general health significantly better than did non–heavy drinkers. For example, 66.4% of heavy drinkers rated their general health as "excellent," "very good," or "good," significantly higher than the 52.6% of non–heavy drinkers. Therefore, among those with depression, heavy drinkers perceived themselves to be healthier than those who were not heavy drinkers. Nevertheless, in this study, heavy drinkers with depression had a significantly lower life expectancy, a finding consistent with previous reports that excessive alcohol consumption contributed significant loss in premature death and years of life lost [65,68]. This suggests that the depressed heavy drinkers may be misperceiving their health relative to those who are not heavy drinkers.

Although obesity was associated with an 8.6% decrease in HRQOL, the life expectancy of obese persons in this study was nearly the same as the life expectancy of normal-weight or overweight persons for those with depression. Obesity was associated with only a 0.4-year (0.8%) decrease in life expectancy, the smallest of the four risk factors [70].

Ideally, QALE should be estimated from a longitudinal study in which HRQOL and mortality would be estimated simultaneously. But, in practice, such longitudinal data are usually not available or too sparse to provide reliable estimates. This study applied a method that estimated the mean HRQOL (from table BRFSS) and the life-years (from Compressed Mortality File, NHANES, and BRFSS) separately from different data sets. One of the primary advantages of this method is its ability to use currently available data to estimate QALE for those with many chronic conditions and/or risky behaviors.

Study Limitations

First, the PHQ-8 is not a clinical diagnostic tool for diagnosing major depressive disorder but has been used primarily for estimating the prevalence of depressive symptoms in the general population; nevertheless, misclassification of the occurrence of depression would likely attenuate the associations we report. Second, we estimated HRQOL and depression using cross-sectional point estimates. Current symptoms of depression are correlated with chronic depression, but depression is a state-dependent health outcome and not all individuals with current depressive symptoms will go on to experience chronic

depression. Third, this study relies on estimates of preference-based HRQOL scores indirectly using the Centers for Disease Control and Prevention's unhealthy days questions rather than direct measurements using a scale such as the EQ-5D. Therefore, our estimates of QALE loss are likely to be attenuated because of "regression to the mean" [47]. One study that estimated the bias of the estimated QALE using the estimated EQ-5D scores found a bias less than 1% of that using the actual EQ-5D questions [60]. Fourth, the lack of information about, and the inability to adjust for, potential unmeasured confounders in these data may have affected our estimates of QALE loss especially for heavy alcohol drinkers. Fifth, the NHANES questions used to ascertain physical activity differed in wording but not in time period and setting from the BRFSS questions used to classify persons as physically inactive in this study. Nevertheless, because the prevalence of physical inactivity in those who were depressed markedly exceeded that in those who were not depressed, we doubt that these differences in wording led to misclassification large enough to affect our estimates of decrease in QALE in those who were both depressed and physically inactive. Sixth, we likely underestimated the decrease in QALE associated with cigarette smoking because only current smokers were associated with these decreases because we classified former smokers as nonsmokers in these analyses. Finally, QALE was estimated for each individual risk behavior independent of the other risk behaviors. Because these behaviors are correlated, our estimates may not accurately reflect the potential additive or interactive effects of co-occurring behaviors or any nonlinear effects between depression symptoms and these behaviors.

Conclusions

Physical inactivity and smoking had stronger associations with QALE among adults with depression than among adults without depression. These relationships were substantially weaker for obesity and heavy alcohol drinking. These findings have at least two important public health implications. First, these findings support using QALE to describe the burden of disease in groups with risky behaviors. Second, these findings suggest the importance of carrying out additional studies of the complex associations between depression and risky behaviors such as alcohol abuse and smoking [71–75].

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