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The association of depression and anxiety with obesity and unhealthy behaviors among community-dwelling US adults☆

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Abstract

Objective: The aim of this study was to examine the extent to which depression and anxiety are associated with smoking, obesity, physical inactivity and alcohol consumption in the US population using the Patient Health Questionnaire 8 (PHQ-8) and two questions on lifetime diagnosis of anxiety and depression.
Methods: Data were analyzed in 38 states, the District of Columbia and two territories using the 2006 Behavioral Risk Factor Surveillance System (n=217,379), a large state-based telephone survey.
Results: Overall, adults with current depression or a lifetime diagnosis of depression or anxiety were significantly more likely than those without each diagnosis to smoke, to be obese, to be physically inactive, to binge drink and drink heavily. There was a dose–response relationship between depression severity and the prevalence of smoking, obesity and physical inactivity and between history of depression (never depressed, previously depressed, currently depressed) and the prevalence of smoking, obesity, physical inactivity, binge drinking and heavy drinking. Lifetime diagnosis of depression and anxiety had an additive association with smoking prevalence.
Conclusion: The associations between depression, anxiety, obesity and unhealthy behaviors among US adults suggest the need for a multidimensional and integrative approach to health care.
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Keywords: Depression; Anxiety; Patient Health Questionnaire 8; Adverse health behaviors; Obesity

1. Introduction

Advances in medicine and public health have reduced morbidity and increased life expectancy in the United States [1,2]. Whereas infectious diseases were the leading cause of US deaths in the early half of the 1900s, chronic diseases now account for the majority of deaths in the United States [3]. Decades of research have established that people's lifestyle and behaviors are major determinants of their risk for chronic disease. Research is now beginning to elucidate the association between mental illnesses, chronic diseases and chronic disease indicators.

The prevalence of mental health disorders in the United States has increased over the past several decades [4–7]. According to recent estimates, each year, approximately 6.6% of the US adult population (more than 13 million adults) have a major depressive disorder [8] and about 18% (about 40 million adults) have an anxiety disorder [9]. Depression and anxiety are also major causes of morbidity and death in the United States [10,11] and are associated with impaired health-related quality of life and social functioning

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[12–15], as well as with an increased risk for disability [16,17]. Moreover, depression and anxiety are associated with unhealthy behaviors [18] for which prevention and intervention strategies could be implemented.

Tobacco use, poor diet, physical inactivity and alcohol consumption are the leading preventable causes of death in the United States [19]. Notably, evidence suggests that the risk of engaging in these behaviors is higher among people with certain psychiatric conditions, particularly depression and anxiety. For example, recent research indicates that people with major depression [20–23] or anxiety disorders [24–27], particularly panic disorder, have a higher prevalence of regular smoking than those without such conditions. Obesity has been associated with an increased lifetime risk for major depression and panic disorder or agoraphobia, particularly among females [28–31]; excessive alcohol consumption has been associated with depression and anxiety disorders [32–34], and physical inactivity has been associated with depression [35]. In fact, exercise has been found to be an effective alternate or adjunct to traditional forms of treatment for mild to moderate depression [36,37] and anxiety [38].

In this study, we examined the extent to which depression and anxiety were associated with smoking, physical inactivity, obesity and alcohol consumption among US adults using data from the 2006 Behavioral Risk Factor Surveillance System (BRFSS), a large population-based US survey. To our knowledge, this is the first large population-based study to examine these associations using the Patient Health Questionnaire 8 (PHQ-8).

2. Methods

The BRFSS monitors the prevalence of key health- and safety-related behaviors and characteristics among US adults [39,40]. As part of the 2006 BRFSS survey, trained interviewers in 38 states, Puerto Rico, the US Virgin Islands and the District of Columbia administered identical questionnaires about depression and anxiety symptoms (the BRFSS Anxiety and Depression Module) over the telephone to an independent probability sample of adults aged 18 years or older. BRFSS methods, including the weighting procedure, are described elsewhere [41]. All BRFSS questionnaires, data and reports are available at www.cdc.gov/brfss.

The BRFSS Anxiety and Depression Module consists of 10 questions, including the PHQ-8 [42]. The PHQ-8 is a widely used, clinically validated questionnaire that assesses eight of the nine criteria on which the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (*DSM-IV*) diagnosis of depressive disorders is based [43]. Although only half the length of many other depression questionnaires, the PHQ-8 has comparable sensitivity and specificity [42]. The PHQ-8 does not assess the ninth *DSM-IV* criterion for depressive disorders (suicidal or self-injurious ideation) because interviewers would have been unable to conduct an adequate intervention over the phone for respondents exhibiting such ideation. Research has shown that omitting the question about suicidal or self-injurious ideation in population-based surveys has only a minor effect on assessment of depression because thoughts of self-harm are fairly uncommon in the general population [42]. The PHQ has been used in both clinical [44–46] and population-based settings [47] and in both self-administered [44–46] and telephone-administered modes [48]. It has also been shown to be effective in detecting depressive symptoms among people of various races and ethnicities [46,49].

The PHQ-8 response set was standardized to be similar to other BRFSS questions by asking the number of days in the past 2 weeks the person experienced eight depressive symptoms. For analytic purposes, the modified response set can be converted back to the original PHQ-8 response set: 0–1 days="not at all," 2–6 days="several days," 7–11 days="more than half the days" and 12–14 days="nearly every day" with points (0–3) assigned to each category, respectively. Items scores are summed for a total score of 0–24. A total score of 0–4 indicates no significant depressive symptoms; 5–9, mild depressive symptoms; 10–14, moderate depressive symptoms; 15–19, moderately severe depressive symptoms and 20–24, severe depressive symptoms [42]. We considered respondents to have current depression if their PHQ-8 score was $\geq$10, which has an 88% sensitivity and specificity for major depression [50].

The remaining two questions of the module assessed whether respondents had ever had professional diagnoses of depressive or anxiety disorders: "Has a doctor or other health care provider *ever* told you that you have an anxiety disorder (including acute stress disorder, anxiety, generalized anxiety disorder, obsessive-compulsive disorder, panic attacks, panic disorder, phobia, posttraumatic stress disorder or social anxiety disorder)?" (lifetime diagnosis of anxiety) and "Has a doctor or other health care provider *ever* told you that you have a depressive disorder (including depression, major depression, dysthymia or minor depression)?" (lifetime diagnosis of depression). Possible responses were "yes," "no," "don't know/not sure," and "refused."

We combined the question in two ways. First, we combined the questions on current and lifetime diagnosis of depression. Persons with no lifetime diagnosis of depression and no current depression were considered to be never depressed; those with a lifetime diagnosis of depression and no current depression were considered to be previously depressed and those with current depression with or without a lifetime diagnosis of depression were considered to be currently depressed. Second, we combined the questions on lifetime diagnosis of anxiety and lifetime diagnosis of depression into four categories: no lifetime diagnosis of anxiety or depression, lifetime diagnosis of anxiety only, lifetime diagnosis of depression only and lifetime diagnosis of anxiety and depression.

All BRFSS respondents were asked about their smoking habits, height and weight, physical activity and

alcohol consumption. Respondents were considered to be current smokers if they had smoked at least 100 cigarettes in their lifetime and reported being smokers at the time of the interview. Their body mass index (kg/m^2) was calculated from their self-reported height and weight. Respondents were considered obese if their body mass index (BMI) was ≥30. Respondents were considered to be physically inactive if they did not participate in any physical activities or exercise such as running, calisthenics, golf, gardening or walking for exercise during the past month other than their regular job. Men were considered to be binge drinkers if they had five or more drinks on one occasion in the previous 30 days, and women were considered to be binge drinkers if they had four or more drinks on one occasion in the previous 30 days. Consistent with the guidelines of the US Department of Agriculture and the US Department of Health and Human Services [51], men who reported drinking more than two drinks per day and women who reported drinking more than one drink per day were considered to be heavy drinkers.

Data were available for 217,379 participants in the 38 states, the District of Columbia, Puerto Rico and the US Virgin Islands, who responded to at least one question in the Anxiety and Depression Module. In all, 8.6% of PHQ-8 scores were missing, 0.9% of participants did not respond either "yes" or "no" to the lifetime diagnosis of anxiety question and 0.8% did not respond either "yes" or "no" to the lifetime diagnosis of depression question. The median cooperation rate of BRFSS, the percentage of eligible respondents who completed the survey, was 74.5%. To account for the complex survey design, we used SUDAAN (RTI International, release 9.0.1, Research Triangle Park, NC, USA, 2007) to calculate prevalence estimates, adjusted odds ratios (AORs), and 95% CIs. Five states — Connecticut, Kansas, Maryland, Nebraska and Washington — collected Anxiety and Depression Module data on a subset of the state sample rather than on the entire sample as the other states and territories did. Information on the weighting methodology and the weights to use for each of these states can be found at http://www.cdc.gov/brfss/technical_infodata/surveydata/2006/2006_dual.htm.

Table 1
Prevalence of current depression and lifetime diagnosis of depression or anxiety among US adults, by selected characteristics, 2006

	Current depression		Lifetime diagnosis of depression		Lifetime diagnosis of anxiety	
	% (S.E.)	AOR [a] (95% CI)	% (S.E.)	AOR [a] (95% CI)	% (S.E.)	AOR [a] (95% CI)
Total	8.7 (0.2)		15.7 (0.2)		11.3 (0.2)	
Sex						
Male	6.8 (0.2)	Referent	11.1 (0.2)	Referent	8.2 (0.2)	Referent
Female	10.5 (0.2)	1.6 (1.5–1.8)	20.2 (0.2)	2.0 (1.9–2.1)	14.3 (0.2)	1.8 (1.7–1.9)
Age						
18–24	10.9 (0.6)	Referent	14.5 (0.6)	Referent	11.3 (0.6)	Referent
25–34	8.7 (0.4)	1.0 (0.9–1.3)	14.4 (0.4)	1.2 (1.0–1.3)	11.6 (0.4)	1.3 (1.1–1.5)
35–44	8.8 (0.3)	1.0 (0.8–1.2)	16.7 (0.4)	1.3 (1.2–1.5)	12.0 (0.3)	1.3 (1.1–1.5)
45–54	9.9 (0.3)	0.9 (0.8–1.2)	19.3 (0.4)	1.4 (1.2–1.6)	12.9 (0.3)	1.2 (1.0–1.4)
55+	6.9 (0.2)	0.5 (0.4–0.7)	14.4 (0.2)	0.9 (0.8–1.1)	9.8 (0.2)	0.8 (0.7–0.9)
Race/ethnicity						
White non-Hispanic	8.0 (0.2)	Referent	17.2 (0.2)	Referent	12.2 (0.2)	Referent
Black non-Hispanic	11.0 (0.5)	0.9 (0.8–1.0)	11.2 (0.4)	0.4 (0.4–0.5)	8.6 (0.4)	0.5 (0.5–0.6)
Hispanic	9.9 (0.6)	0.9 (0.8–1.0)	12.6 (0.5)	0.6 (0.6–0.7)	9.0 (0.4)	0.6 (0.6–0.7)
Other, non-Hispanic [b]	10.4 (0.6)	1.1 (1.0–1.3)	15.1 (0.8)	0.8 (0.7–0.9)	12.0 (0.8)	0.9 (0.8–1.1)
Education						
<High school	16.1 (0.6)	Referent	17.2 (0.6)	Referent	12.9 (0.5)	Referent
High School	10.5 (0.3)	0.7 (0.6–0.8)	15.9 (0.3)	0.9 (0.8–1.0)	11.8 (0.3)	0.9 (0.8–1.0)
≥College	6.4 (0.2)	0.5 (0.4–0.6)	15.4 (0.2)	0.9 (0.9–1.0)	10.8 (0.2)	0.9 (0.8–1.0)
Marital status						
Currently married	6.1 (0.2)	Referent	13.5 (0.2)	Referent	9.6 (0.2)	Referent
Previously married [c]	14.3 (0.4)	2.0 (1.8–2.2)	22.8 (0.4)	1.7 (1.6–1.8)	15.8 (0.3)	1.5 (1.4–1.6)
Never married [d]	11.5 (0.4)	1.5 (1.4–1.7)	16.3 (0.4)	1.4 (1.3–1.5)	12.5 (0.4)	1.4 (1.2–1.5)
Employment status						
Currently employed	6.1 (0.2)	Referent	13.3 (0.2)	Referent	9.1 (0.2)	Referent
Currently unemployed	21.0 (1.0)	3.2 (2.8–3.7)	23.6 (1.0)	2.0 (1.8–2.2)	18.3 (0.9)	2.2 (1.9–2.5)
Retired	5.2 (0.2)	1.2 (1.0–1.4)	11.9 (0.3)	1.0 (0.9–1.1)	8.6 (0.2)	1.2 (1.1–1.3)
Unable to work	42.2 (1.0)	10.1 (9.0–11.3)	46.6 (0.9)	5.8 (5.3–6.3)	36.5 (0.9)	5.9 (5.4–6.5)
Homemaker, student	8.9 (0.5)	1.2 (1.0–1.4)	17.0 (0.5)	1.1 (1.0–1.2)	12.8 (0.5)	1.2 (1.1–1.4)

Current depression indicates PHQ-8 score ≥10.

[a] Adjusted by sex, age, race/ethnicity, education, marital status and employment status.

[b] Asian, non-Hispanic; Native Hawaiian/Pacific Islander, non-Hispanic; American Indian/Alaska Native, non-Hispanic; other race, non-Hispanic; multirace, non-Hispanic.

[c] Previously married includes those divorced, widowed or separated.

[d] Never married includes those never married or member of unmarried couple.

3. Results

3.1. Relationship between mental disorders and sociodemographic characteristics

Approximately 8.7% (95% CI, 8.4–9.0%) of persons in the 38 states, the District of Columbia, Puerto Rico and the US Virgin Islands had current depression as assessed by the PHQ-8 (5.2% had moderate depression, 2.4% had moderately severe depression and 1.2% had severe depression), 15.7% (95% CI, 15.4–16.1%) had a lifetime diagnosis of depression and 11.3% (95% CI, 11.0–11.6%) had a lifetime diagnosis of anxiety.

After adjusting for sociodemographic characteristics (age, sex, race/ethnicity, education, marital status and employment status), we found that the prevalence of current depression was significantly lower among people aged 55 years or older than those aged 18–24 years (AOR=0.5; 95% CI, 0.4–0.7), lower among high school graduates (AOR=0.7; 95% CI, 0.6-0.8) or persons with at least some college education (AOR=0.5, 95% CI, 0.4–0.6) than among adults who did not graduate from high school, higher among women than men (AOR=1.6; 95% CI, 1.5–1.8), higher among people who were previously married (AOR=2.0; 95% CI, 1.8–2.2) or never married (AOR=1.5; 95% CI, 1.4–1.7) than among those who were currently married and higher among people who were unemployed (AOR=3.2; 95% CI, 2.8–3.7) or unable to work (AOR=10.1; 95% CI, 9.0–11.3) than among those currently employed (Table 1). We found no significant differences in the prevalence of current depression by race/ethnicity.

With a few exceptions, the relationships between sociodemographic characteristics and a lifetime diagnosis of depression or anxiety were similar to those between sociodemographic characteristics and current depression, although the associations were, in some instances, weaker. Notably, a lifetime diagnosis of depression was less likely among non-Hispanic blacks (AOR=0.4; 95% CI, 0.4–0.5), Hispanics (AOR=0.6, 95% CI, 0.6–0.7) and non-Hispanic persons of other race/ethnicities (AOR=0.8, 95% CI, 0.7–0.9) than among non-Hispanic whites despite the higher rates of current depression in these populations. Additionally, non-Hispanic blacks and Hispanics were less likely to have a lifetime diagnosis of anxiety (AOR=0.5 and 0.6, respectively). Education was not associated with the likelihood of having a lifetime diagnosis of depression or anxiety.

3.2. Relationship between mental disorder status and unhealthy behaviors

After adjusting for sociodemographic characteristics, we found that adults who had current depression, a lifetime diagnosis of depression or a lifetime diagnosis of anxiety were significantly more likely than those without each of these diagnoses to be a current smoker, obese, physically

Table 2
Estimated prevalence of obesity and four unhealthy behaviors among US adults aged ≥18 years, by mental disorder status, 2006

Behavior or condition	Current depression		Lifetime diagnosis of depression		Lifetime diagnosis of anxiety	
	Yes	No	Yes	No	Yes	No
Smoking						
Total % (95% CI)	37.9 (36.2–39.6)	17.6 (17.2–18.0)	30.8 (29.8–31.8)	17.3 (16.9–17.7)	33.0 (31.8–34.3)	17.7 (17.3–18.1)
Total AOR (95% CI)[a]	2.2 (2.0–2.3)	1.0 (referent)	1.9 (1.8–2.1)	1.0 (referent)	2.0 (1.9–2.2)	1.0 (referent)
Male AOR (95% CI)[a]	1.9 (1.7–2.3)	1.0 (referent)	1.8 (1.6–2.0)	1.0 (referent)	2.0 (1.7–2.3)	1.0 (referent)
Female AOR (95% CI)[a]	2.3 (2.1–2.6)	1.0 (referent)	2.0 (1.9–2.2)	1.0 (referent)	2.1 (1.9–2.2)	1.0 (referent)
Obesity						
Total % (95% CI)	35.2 (33.6–36.8)	23.6 (23.2–24.0)	32.8 (31.9–33.9)	23.3 (22.9–23.7)	30.5 (29.3–31.7)	24.0 (23.6–24.5)
Total AOR (95% CI)[a]	1.6 (1.5–1.7)	1.0 (referent)	1.6 (1.5–1.7)	1.0 (referent)	1.3 (1.3–1.4)	1.0 (referent)
Male AOR (95% CI)[a]	1.4 (1.2–1.7)	1.0 (referent)	1.4 (1.2–1.5)	1.0 (referent)	1.3 (1.1–1.4)	1.0 (referent)
Female AOR (95% CI)[a]	1.7 (1.5–1.9)	1.0 (referent)	1.8 (1.6–1.9)	1.0 (referent)	1.4 (1.3–1.5)	1.0 (referent)
Physical inactivity						
Total % (95% CI)	43.0 (41.3–44.7)	21.2 (20.8–21.6)	30.6 (29.7–31.6)	22.6 (22.2–23.1)	29.0 (27.9–30.1)	23.2 (22.8–23.7)
Total AOR (95% CI)[a]	2.1 (1.9–2.3)	1.0 (referent)	1.3 (1.2–1.4)	1.0 (referent)	1.1 (1.1–1.2)	1.0 (referent)
Male AOR (95% CI)[a]	2.1 (1.8–2.5)	1.0 (referent)	1.3 (1.1–1.4)	1.0 (referent)	1.1 (0.9–1.2)	1.0 (referent)
Female AOR (95% CI)[a]	2.1 (1.9–2.3)	1.0 (referent)	1.4 (1.3–1.5)	1.0 (referent)	1.2 (1.1–1.3)	1.0 (referent)
Binge drinking						
Total % (95% CI)	16.8 (15.4–18.3)	15.0 (14.6–15.4)	14.8 (14.0–15.7)	14.8 (14.4–15.2)	16.0 (14.9–17.1)	14.6 (14.3–15.0)
Total AOR (95% CI)[a]	1.3 (1.2–1.5)	1.0 (referent)	1.2 (1.1–1.3)	1.0 (referent)	1.2 (1.1–1.4)	1.0 (referent)
Male AOR (95% CI)[a]	1.2 (1.0–1.4)	1.0 (referent)	1.0 (0.8–1.1)	1.0 (referent)	1.1 (0.9–1.2)	1.0 (referent)
Female AOR (95% CI)[a]	1.4 (1.2–1.6)	1.0 (referent)	1.4 (1.2–1.5)	1.0 (referent)	1.4 (1.3–1.6)	1.0 (referent)
Heavy drinking						
Total % (95% CI)	7.7 (6.7–8.8)	4.8 (4.6–5.0)	5.9 (5.4–6.5)	4.8 (4.6–5.0)	6.7 (5.9–7.5)	4.7 (4.5–5.0)
Total AOR (95% CI)[a]	1.8 (1.5–2.2)	1.0 (referent)	1.3 (1.2–1.4)	1.0 (referent)	1.5 (1.3–1.7)	1.0 (referent)
Male AOR (95% CI)[a]	2.2 (1.7–2.9)	1.0 (referent)	1.1 (0.9–1.3)	1.0 (referent)	1.5 (1.2–1.9)	1.0 (referent)
Female AOR (95% CI)[a]	1.5 (1.3–1.9)	1.0 (referent)	1.5 (1.3–1.7)	1.0 (referent)	1.5 (1.3–1.8)	1.0 (referent)

Current depression indicates PHQ-8 score ≥10.

[a] Adjusted by age, sex, race/ethnicity, education level, marital status and employment status.

Table 3
Estimated prevalence of obesity and four unhealthy behaviors among US adults aged ≥18 years, by lifetime diagnosis of anxiety and/or depression, 2006

Behavior or Condition	No lifetime diagnosis of anxiety or depression	Lifetime diagnosis of anxiety only	lifetime diagnosis of depression only	Lifetime diagnosis of anxiety and depression
Smoking				
Total % (95% CI)	16.9 (16.5–17.3)	26.2 (24.1–28.4)	25.5 (24.2–26.9)	36.9 (35.3–38.5)
Total AOR (95% CI)[a]	Referent	1.8 (1.6–2.0)	1.7 (1.5–1.8)	2.5 (2.3–2.7)
Male AOR (95% CI)[a]	Referent	2.0 (1.6–2.5)	1.6 (1.4–1.9)	2.2 (1.9–2.6)
Female AOR (95% CI)[a]	Referent	1.6 (1.5–1.8)	1.7 (1.5–1.8)	2.6 (2.4–2.9)
Obesity				
Total % (95% CI)	23.1 (22.7–23.6)	26.1 (24.3–28.0)	32.7 (31.4–34.1)	32.9 (31.4–34.4)
Total AOR (95% CI)[a]	Referent	1.2 (1.1–1.3)	1.6 (1.5–1.8)	1.6 (1.4–1.7)
Male AOR (95% CI)[a]	Referent	1.2 (1.0–1.4)	1.4 (1.2–1.6)	1.4 (1.2–1.6)
Female AOR (95% CI)[a]	Referent	1.2 (1.1–1.4)	1.8 (1.7–2.0)	1.7 (1.6–1.9)
Physical inactivity				
Total % (95% CI)	22.6 (22.1–23.1)	23.1 (21.4–24.8)	29.0 (27.7–30.3)	32.3 (30.9–33.7)
Total AOR (95% CI)[a]	Referent	1.0 (0.9–1.1)	1.3 (1.2–1.4)	1.3 (1.2–1.4)
Male AOR (95% CI)[a]	Referent	0.9 (0.8–1.1)	1.3 (1.1–1.5)	1.2 (1.0–1.4)
Female AOR (95% CI)[a]	Referent	1.0 (0.9–1.2)	1.3 (1.2–1.5)	1.4 (1.3–1.5)
Binge drinking				
Total % (95% CI)	14.7 (14.3–15.1)	16.6 (14.8–18.6)	14.2 (13.1–15.3)	15.7 (14.5–17.1)
Total AOR (95% CI)[a]	Referent	1.3 (1.1–1.4)	1.1 (1.0–1.2)	1.3 (1.1–1.4)
Male AOR (95% CI)[a]	Referent	1.2 (1.0–1.5)	1.0 (0.8–1.1)	1.0 (0.8–1.2)
Female AOR (95% CI)[a]	Referent	1.3 (1.1–1.6)	1.3 (1.1–1.5)	1.6 (1.4–1.8)
Heavy drinking				
Total % (95% CI)	4.7 (4.5–4.9)	6.5 (5.4–8.0)	5.2 (4.7–5.8)	6.8 (5.9–7.8)
Total AOR (95% CI)[a]	Referent	1.5 (1.2–1.8)	1.1 (1.0–1.3)	1.6 (1.3–1.9)
Male AOR (95% CI)[a]	Referent	1.6 (1.2–2.3)	0.9 (0.7–1.1)	1.4 (1.1–1.9)
Female AOR (95% CI)[a]	Referent	1.4 (1.0–1.7)	1.3 (1.1–1.6)	1.7 (1.4–2.1)

[a] Adjusted by age, sex, race/ethnicity, education level, marital status and employment status.

inactive, a binge drinker and a heavy drinker (Table 2). After respondents were stratified by sex, these associations all remained significant among women. Among men, however, none of these conditions were significantly associated with binge drinking, a lifetime diagnosis of anxiety was not significantly associated with physical inactivity, and a lifetime diagnosis of depression was not significantly associated with heavy drinking.

3.3. Individual and combined effects of depression and anxiety

Table 3 shows the individual and combined effects of lifetime diagnoses of depression and anxiety on risk behaviors. Depression and anxiety had an additive effect on smoking. Compared to those without a lifetime diagnosis of depression or anxiety, the AOR for smoking in individuals

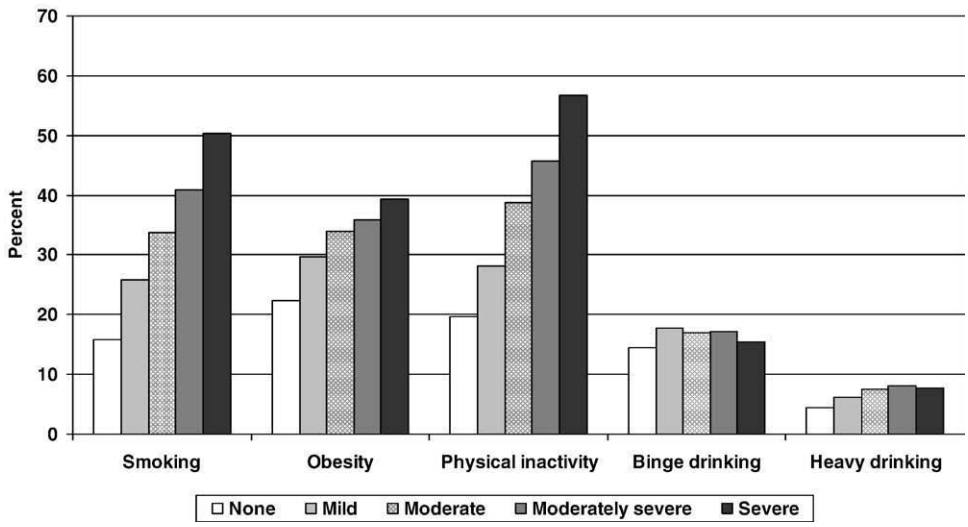

Fig. 1. Relationship between depression severity as assessed by the PHQ-8 and the prevalence of obesity and four unhealthy behaviors.

Table 4
Estimated prevalence of obesity and four unhealthy behaviors among US adults aged ≥18 years, by current depression severity, 2006

Behavior or condition	No depression	Mild depression	Moderate depression	Moderately severe depression	Severe depression
Smoking					
Total % (95% CI)	15.8 (15.4–16.2)	25.9 (24.8–27.0)	33.8 (31.6–36.1)	40.8 (38.0–43.8)	50.4 (45.6–55.2)
Total AOR (95% CI)[a]	1.0 (referent)	1.7 (1.6–1.8)	2.2 (1.9–2.4)	2.7 (2.4–3.1)	3.7 (3.0–4.6)
Male AOR (95% CI)[a]	1.0 (referent)	1.7 (1.5–1.9)	1.9 (1.6–2.3)	2.3 (1.8–2.9)	3.7 (2.6–5.3)
Female AOR (95% CI)[a]	1.0 (referent)	1.7 (1.6–1.8)	2.4 (2.2–2.8)	3.0 (2.6–3.5)	3.7 (2.8–5.0)
Obesity					
Total % (95% CI)	22.3 (21.8–22.7)	29.7 (28.7–30.8)	34.0 (31.9–36.1)	35.9 (33.0–38.9)	39.4 (34.8–44.1)
Total AOR (95% CI)[a]	1.0 (referent)	1.5 (1.4–1.6)	1.8 (1.6–1.9)	1.7 (1.5–2.0)	1.9 (1.6–2.4)
Male AOR (95% CI)[a]	1.0 (referent)	1.3 (1.2–1.5)	1.6 (1.3–1.9)	1.5 (1.2–1.9)	1.4 (1.0–2.0)
Female AOR (95% CI)[a]	1.0 (referent)	1.7 (1.6–1.8)	1.9 (1.7–2.1)	1.9 (1.6–2.3)	2.4 (1.9–3.1)
Physical inactivity					
Total % (95% CI)	19.7 (19.2–20.2)	28.1 (27.0–29.1)	38.8 (36.5–41.0)	45.7 (42.6–48.8)	56.7 (51.8–61.5)
Total AOR (95% CI)[a]	1.0 (referent)	1.4 (1.3–1.5)	2.0 (1.8–2.3)	2.4 (2.1–2.8)	3.5 (2.8–4.4)
Male AOR (95% CI)[a]	1.0 (referent)	1.3 (1.2–1.5)	1.9 (1.6–2.4)	2.3 (1.8–3.1)	3.8 (2.5–5.8)
Female AOR (95% CI)[a]	1.0 (referent)	1.5 (1.4–1.6)	2.1 (1.9–2.4)	2.4 (2.1–2.8)	3.3 (2.6–4.2)
Binge drinking					
Total % (95% CI)	14.4 (14.0–14.8)	17.8 (16.8–18.9)	17.0 (15.2–19.0)	17.1 (14.5–20.2)	15.5 (12.4–19.3)
Total AOR (95% CI)[a]	1.0 (referent)	1.3 (1.2–1.4)	1.3 (1.2–1.6)	1.5 (1.2–1.9)	1.4 (1.1–1.9)
Male AOR (95% CI)[a]	1.0 (referent)	1.4 (1.2–1.5)	1.3 (1.0–1.6)	1.3 (0.9–1.9)	1.1 (0.7–1.7)
Female AOR (95% CI)[a]	1.0 (referent)	1.3 (1.2–1.5)	1.3 (1.1–1.6)	1.7 (1.3–2.2)	1.8 (1.3–2.5)
Heavy drinking					
Total % (95% CI)	4.5 (4.3–4.8)	6.1 (5.5–6.8)	7.5 (6.3–8.8)	8.1 (5.9–10.9)	7.8 (5.3–11.3)
Total AOR (95% CI)[a]	1.0 (referent)	1.4 (1.2–1.6)	1.8 (1.5–2.2)	2.2 (1.5–3.1)	2.3 (1.5–3.5)
Male AOR (95% CI)[a]	1.0 (referent)	1.6 (1.3–2.0)	2.6 (1.9–3.5)	2.3 (1.2–4.4)	2.4 (1.2–4.5)
Female AOR (95% CI)[a]	1.0 (referent)	1.2 (1.0–1.5)	1.3 (1.0–1.7)	2.1 (1.5–2.9)	2.4 (1.4–4.0)

PHQ-8 score: 0–4 (no depression), 5–9 (mild depression), 10–14 (moderate depression), 15–19 (moderately severe depression), 20–24 (severe depression).
[a] Adjusted by age, sex, race/ethnicity, education level, marital status and employment status.

Table 5
Estimated prevalence of obesity and four unhealthy behaviors among US adults aged ≥18 years, by depression history, 2006

Behavior or condition	Never depressed	Previously depressed	Currently depressed
Smoking			
Total % (95% CI)	16.5 (16.1–17.0)	25.5 (24.3–26.7)	37.9 (36.2–39.6)
Total AOR (95% CI)[a]	1.0 (referent)	1.7 (1.6–1.9)	2.4 (2.2–2.6)
Male AOR (95% CI)[a]	1.0 (referent)	1.6 (1.4–1.9)	2.1 (1.8–2.4)
Female AOR (95% CI)[a]	1.0 (referent)	1.8 (1.6–1.9)	2.6 (2.4–2.9)
Obesity			
Total % (95% CI)	22.8 (22.3–23.2)	29.7 (28.5–30.9)	35.2 (33.6–36.8)
Total AOR (95% CI)[a]	1.0 (referent)	1.5 (1.4–1.6)	1.7 (1.6–1.9)
Male AOR (95% CI)[a]	1.0 (referent)	1.3 (1.2–1.5)	1.5 (1.3–1.7)
Female AOR (95% CI)[a]	1.0 (referent)	1.6 (1.5–1.8)	1.9 (1.7–2.1)
Physical inactivity			
Total % (95% CI)	20.9 (20.4–21.4)	23.4 (22.3–24.4)	43.0 (41.3–44.7)
Total AOR (95% CI)[a]	1.0 (referent)	1.2 (1.1–1.2)	2.2 (2.0–2.3)
Male AOR (95% CI)[a]	1.0 (referent)	1.1 (0.9–1.2)	2.1 (1.8–2.5)
Female AOR (95% CI)[a]	1.0 (referent)	1.2 (1.1–1.3)	2.1 (1.9–2.4)
Binge drinking			
Total % (95% CI)	14.9 (14.5–15.4)	15.5 (14.5–16.6)	16.8 (15.4–18.3)
Total AOR (95% CI)[a]	1.0 (referent)	1.2 (1.1–1.3)	1.3 (1.2–1.5)
Male AOR (95% CI)[a]	1.0 (referent)	1.0 (0.9–1.2)	1.2 (1.0–1.5)
Female AOR (95% CI)[a]	1.0 (referent)	1.4 (1.2–1.5)	1.5 (1.3–1.8)
Heavy drinking			
Total % (95% CI)	4.7 (4.4–4.9)	5.9 (5.2–6.6)	7.7 (6.7–8.8)
Total AOR (95% CI)[a]	1.0 (referent)	1.3 (1.1–1.5)	1.9 (1.6–2.2)
Male AOR (95% CI)[a]	1.0 (referent)	1.0 (0.8–1.3)	2.2 (1.7–3.0)
Female AOR (95% CI)[a]	1.0 (referent)	1.4 (1.2–1.7)	1.7 (1.4–2.0)

Never depressed indicates no lifetime diagnosis of depression and not currently depressed; Previously depressed, lifetime diagnosis of depression but not currently depressed; Currently depressed, PHQ-8 score ≥10.
[a] Adjusted by age, sex, race/ethnicity, education level, marital status and employment status.

with anxiety only, depression only and both anxiety and depression was 1.8, 1.7 and 2.5. For obesity and physical inactivity, depression only had a similar effect as combined anxiety and depression, whereas for heavy drinking and binge drinking, anxiety only had similar effects as comorbid anxiety and depression.

3.4. Relationship between depression severity and unhealthy behaviors

We found a significant dose-response relationship between depression severity and smoking, obesity and physical inactivity (Fig. 1). After adjusting for sociodemographic characteristics, we found that men and women with mild, moderate, moderately severe and severe depression were each significantly more likely than those with no depression to be a smoker and to be physically inactive (Table 4). However, men with moderate, moderately severe and severe depression were no more likely to binge-drink than those with no depression; women with mild or moderate depression were no more likely than women with no depression to drink heavily, and men with severe depression were no more likely than men without depression to be obese.

3.5. Relationship between depression history and unhealthy behaviors

Individuals with a previous history of depression (lifetime diagnosis of depression but no current depression) were also at increased risk of several unhealthy behaviors (Table 5). After adjusting for sociodemographic characteristics, adults previously depressed were significantly more likely than those never depressed (no lifetime diagnosis of depression or current depression) to smoke (men, AOR=1.6; women, AOR=1.8), to be obese (men, AOR=1.3; women, AOR=1.6), to be physically inactive (women only, AOR=1.2), to binge drink (women only, AOR=1.4) and to drink heavily (women only, AOR=1.4). Moreover, adults who were currently depressed were significantly more likely than those never depressed to smoke (men, AOR=2.1; women, AOR=2.6), to be obese (men, AOR=1.5; women, AOR=1.9), to be physically inactive (men, AOR=2.1; women, AOR=2.1), to binge drink (women only, AOR=1.5) and to drink heavily (men, AOR=2.2; women, AOR=1.7). The incremental risk associated with current vs. previous vs. no history of depression is depicted in Fig. 2 and is particularly evident for smoking, obesity and physical inactivity.

4. Discussion

To our knowledge, this is the first large population based study to examine the associations between depression, depression severity and health behaviors using the widely used and clinically validated PHQ depression scale. Our population-based study of nearly a quarter of a million US adults reveals several important findings regarding the associations between depression, anxiety and health behaviors. First, current depression is associated with a number of unhealthy behaviors, including smoking, obesity, sedentary lifestyle, binge drinking and heavy alcohol consumption. Second, a lifetime diagnosis of depression or anxiety is likewise associated with some of these unhealthy behaviors. Third, there is a dose–response relationship between depression severity and the risk of smoking, obesity and physical inactivity. Fourth, while current depression presents the strongest risk, even persons who were previously depressed are at increased risk of adverse health behaviors and obesity compared to those never depressed. Fifth, depression and anxiety had an additive effect on smoking.

In a 2005 study, the Centers for Disease Control and Prevention estimated that 20.9% of all US adults (45.1 million people) smoked cigarettes [52]. In fact, smoking has

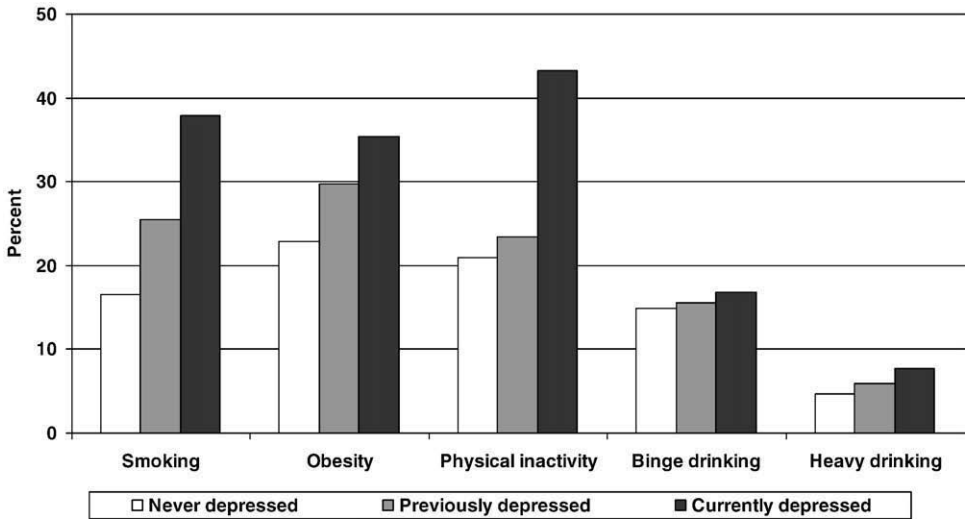

Fig. 2. Relationship between depression history (current vs. previous vs. no history of depression) and prevalence of obesity and four unhealthy behaviors.

been shown to be the leading preventable cause of death in the United States [53], accounting for approximately one of every five deaths (438,000 deaths per year) [54,55]. The results of our study showed that people with current depression or a lifetime diagnosis of anxiety or depression were each approximately twice as likely to smoke than those without each condition. Notably, the significant association between depression and smoking was maintained for persons previously depressed as well as those currently depressed. This is consistent with the results of recent research, which suggest that a history of major depression increases people's risk for daily smoking and, conversely, that a history of daily smoking increases people's risk for depression [56]. Research also indicates an association between anxiety, particularly panic attacks and smoking; however, whereas smoking has been associated with an increased risk for panic attacks, panic attacks have not been associated with an increased risk for smoking [24,57].

An estimated 66% of US adults are either overweight or obese, risk factors associated with chronic illnesses such as coronary heart disease, stroke and osteoarthritis [58]. Findings from our study indicate that people with current depression or a lifetime diagnosis of depression are each 60% more likely than those without each diagnosis to be obese and that those with a lifetime a diagnosis of anxiety are 30% more likely to be obese than those who have not had an anxiety diagnosis. To date, there does not appear to be a single or simple association between obesity and either depression or anxiety [59–61]. Some research indicates that obesity during adolescence is associated with depression during young adulthood [62,63], while other research suggests that major depression during adolescence is predictive of a higher BMI during adulthood, particularly among girls [60,64,65]. The association between obesity and depression seems to be strongest for those with severe obesity [66,67], and there can be a substantial improvement in depression with weight loss [28].

In 2000 and 2001, more than half of US adults did not engage in physical activity at levels consistent with public health recommendations [68]. Inadequate levels of physical activity is a particular problem for people with current depression, among whom we found the prevalence of physical inactivity to be twice as high as among people who were not currently depressed. While smoking cessation can actually increase the risk of developing a new episode of depression among those with a history of depression [69], exercise has been found to be an effective alternate or adjunct to traditional forms of treatment for people with mild to moderate depression [36–38]. There is also a growing body of evidence suggesting that exercise, particularly aerobic and resistant exercise, may even be an effective intervention for clinical depression [70–73] and anxiety [38,70,74–77]. Moreover, there is evidence that physical inactivity may even be a risk factor for depressive symptoms [78–81].

In 2001, approximately 75,000 US deaths were attributable to excessive alcohol use [82]. In 2003, there were more than 2 million hospitalizations [83] and more than 4 million emergency room visits [84] in the United States for alcohol-related conditions. We found that depression and anxiety were associated with problem alcohol use, although the magnitude of the association was only moderate. This is consistent with studies showing that the amount of psychiatric comorbidity seen with problem drinking in primary care and the general population is less than that reported for more serious alcohol disorders requiring inpatient or psychiatric treatment [85]. Notably, the association between depression and alcohol use differs by sex. According to recent research, depression normally precedes alcohol problems among women [86,87], whereas the opposite is generally true among men [88]. Our findings that current depression, a lifetime diagnosis of depression or a lifetime diagnosis of anxiety were not significantly associated with binge drinking among men but that they were among women corroborates previous research suggesting that the association between depression and anxiety and binge drinking is stronger among women than men [88–90]. Our findings also suggest that the prevalence of binge drinking and drinking heavily among women with current depression remains high even after their depression subsides (i.e., previously depressed), whereas men who are currently depressed are more likely to drink heavily than those never depressed; however, the risk of heavy drinking subsides among those previously depressed. Recent research suggests that the relationship between anxiety disorders and alcohol problems is more complex than that between depression and alcohol problems. For example, agoraphobia and social phobia usually precede alcohol problems, whereas panic disorder and generalized anxiety disorder often follow pathological alcohol consumption [34].

Our study has several limitations. First, the BRFSS probably underestimates those with severely impaired physical or mental health and those with low socio-demographic status, both of which tend to have higher rates of mental health problems and unhealthy behaviors. Moreover, people with anxiety or depression may not report these conditions because of the stigma associated with mental health conditions. Second, BRFSS is based on self-reported data, which may introduce some bias. Third, because 12 states did not collect BRFSS anxiety and depression data, our results may not be representative of the entire country. Fourth, current depression status is missing for 8.6% of the population. Persons aged 55 years and older were less likely to have a PHQ-8 score as were adults with low educational attainment, persons previously married and those retired or unable to work. Persons who were currently married were more likely to have a score. Given this, it is likely that we are underestimating the burden of depression in these 41 states and territories. Fifth, the large size of the BRFSS sample can make even relatively small associations statistically significant. Thus, it is important to also look at the absolute differences in the prevalence estimates as well as the magnitude of the

adjusted odds ratios. Finally, although our cross-sectional data showed that anxiety and depression were each associated with obesity and unhealthy behaviors, we cannot infer a causal relationship.

The PHQ-8 is a well-validated measure for depression and has been successfully implemented over the telephone [48]. Moreover, research has shown that the PHQ-8 can be used in population-based settings to identify people with major depression as well as those with subthreshold levels of depression [47]. However, the diagnosis of major depression requires a physician diagnosis and proper follow-up.

Although our results are from a cross-sectional study, the significant associations that we found between mental health problems, unhealthy behaviors and obesity suggest that public health interventions should address mental and physical health as a combined entity and that programs to simultaneously improve people's mental and physical health should be developed and implemented.

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