

Depression and cigarette smoking behavior: A critical review of population-based studies

Andrea H. Weinberger, PhD^{a,b}, Rachel S. Kashan, MA^a, Danielle M. Shpigel, MA^a, Hannah Esan^a, Farah Taha ^{b,c}, Christine J. Lee, MA^a, Allison P. Funk^a, and Renee D. Goodwin, PhD, MPH^{c,d}

^aFerkauf Graduate School of Psychology, Yeshiva University, Bronx, NY, USA; ^bDepartment of Epidemiology & Population Health, Albert Einstein College of Medicine, Bronx, NY, USA; ^cDepartment of Psychology, Queens College and The Graduate Center, City University of New York (CUNY), Queens, NY, USA; ^dDepartment of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY, USA

ABSTRACT

Background: Smoking and depression are both leading causes of disability, mortality and morbidity around the world. Using epidemiologic data to study the association between depression and the severity, course, and persistence of smoking in the general population is important for understanding the scope of the problem of smoking among people with depression. **Objectives:** The current paper aims to critically review existing epidemiologic research on the smoking behaviors of persons with depressive symptoms and disorders and to identify gaps in the literature that warrant further study. **Methods:** Literature searches of Medline and EMBASE were used to identify articles that analyzed epidemiologic data and examined an aspect of smoking behavior in persons with depressive symptoms or disorders. Six hundred ninety-three abstracts were reviewed and 45 studies met all of the inclusion criteria to be included in the review. **Results:** Persons with depression, compared to those without depression, are more likely to smoke, and meet criteria for nicotine dependence, are less likely to quit smoking, and are more likely to relapse. Little is known about the association between depression and smoking behavior by age, socioeconomic status, or race/ethnicity or with regard to the use of tobacco products other than cigarettes. **Conclusion:** Persons with depression are more likely to smoke cigarettes and have greater difficulty quitting smoking. Community-based and public health approaches may need to begin considering the links between depression and smoking in order to best target the current smokers in the population and develop more effective tobacco control campaigns.

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Introduction

Cigarette smoking is the leading preventable cause of mortality and morbidity in developed countries. Smoking is related to a wide range of health consequences including a large number of cancers as well as cardiovascular and respiratory diseases (1). The number of deaths attributable to smoking-related causes has increased to approximately half a million every year in the United States (US) alone (1,2); smoking is associated with millions of deaths every year around the world (3). Reducing the costly effects of smoking, especially among groups who are disproportionately impacted by smoking, is a critical global public health objective.

Adults with psychiatric disorders report higher rates of current and lifetime smoking (4,5), higher rates of nicotine dependence (6), and lower rates of smoking cessation (4,5), relative to those without psychiatric disorders. Data from the US suggest that adults with a lifetime history of at least one psychiatric disorder are

three times more likely to be current smokers and 20% less likely to quit smoking over a 3-year period, compared with those without a history of a psychiatric disorder (5). While comprising only a small minority of the US population, it has been estimated that adults with current (past-month) psychiatric disorders consume 44% of all cigarettes in the US each year (4).

Depression is the most common psychiatric disorder in the US (6–8) with 7–9% of US persons aged 12 and older reporting current (past 12-months) depression (9,10) and approximately 16% reporting lifetime depression (10). Depression is also a significant cause of global disability, impacting approximately 350 million people around the world (11). Major depressive disorder (MDD) is defined as the presence of depressed mood or loss of interest in activities for at least 2 weeks and the report of additional symptoms (e.g., change in appetite, change in sleep, low energy, low self-esteem, poor concentration or decision making, feelings of helplessness, suicidal thoughts, plan, or

action) (12). In addition to causing significant impairment and distress (12), MDD is associated with premature mortality, including mortality from smoking-related causes such as cardiovascular disease and cancer, even after adjusting for smoking as these relations do not appear to be entirely attributable to smoking (13–15). Dysthymia, or persistent depressive disorder, is another mood disorder that is marked by an extended period (≥ 2 years) of depressed mood and additional symptoms (e.g., change in appetite, change in sleep, low energy, low self-esteem, poor concentration or decision making, feelings of helplessness) (12). Dysthymia is less prevalent than MDD; however, those with dysthymia experience significant impairment and a more severe course of subsequent MDD compared with those without dysthymia (16,17).

The prevalence of depression differs by demographics. With regard to age, current depression prevalences range from 5.7% for persons aged 12–17 to 9.8% for persons aged 40–59 (9). With regard to race, recent CDC data suggest that persons who identify as non-Hispanic Black and Hispanic experience higher levels of depression symptoms than persons who identify as non-Hispanic White (9) although the data from other studies differ (e.g., (18–20)) Most notably, there is a significant gender difference with depression being significantly more common among women than men in all age groups (9). Beyond being more likely to meet criteria for depression, a stronger relationship between depression and smoking (21) has been observed among women; depression also appears to have a greater impact on smoking treatment outcomes for women than men (22). As a result, it may be important to examine differences by demographics when trying to understand the relationship between smoking and depression.

Recent reviews of smoking and depression have focused on clinical study data examining the association of depression with smoking cessation treatment outcomes (22–24), as well as understanding the genetics of smoking and depression (25). The current paper provides the first review of epidemiologic studies of the smoking and quit behavior of persons with depressive disorders. Only a small minority (approximately 30%) of those with depression are seen in psychiatric treatment settings (26). By reviewing epidemiologic studies, we can develop our understanding of the smoking behavior of persons with depressive disorders from a public health perspective via studies that include large, diverse, unselected samples, collect detailed assessments of behaviors, and provide greater generalizability at the population level. The primary aim of this paper is to review the epidemiologic literature on smoking behavior among persons with depressive symptoms and disorders in order to synthesize currently available

knowledge, quantify the scope of the problem of smoking for people with depression, and identify areas in need of further inquiry. In addition, this review sought to summarize the findings of analyses that examined demographic differences in the relationship between depression and smoking.

Methods

In order to identify papers that would be eligible for this literature review, searches of Medline and EMBASE were conducted on November 4, 2015 using search terms related to epidemiologic research (e.g., “epidemiology”, “nationally representative”), smoking (“smoking”, “cigarettes”, “tobacco”, “nicotine”), and depression (e.g., “depression”, “dysthymia”). After duplicate abstracts were removed, each remaining abstract was examined by two authors to determine whether it was published in English, examined some aspect of smoking behavior (e.g., lifetime smoking, current smoking, nicotine dependence, smoking cessation) in persons with depressive disorders or depressive symptoms, and had a full text available (e.g., were not abstracts of conference posters or presentations). The study also had to examine depressive disorders or symptoms as its own category in order to be included (e.g., a study that combined depressive and anxiety disorders into one category for the analyses would not be included). If it was not clear whether the inclusion criteria were met by reading the abstract, the full text of the article was obtained and reviewed. Additional publications were elicited from the reference lists of papers that met criteria to be included in the review. The first author reviewed the final eligibility decision of all abstracts.

The initial literature search resulted in 340 MEDLINE abstracts and 481 EMBASE abstracts. After 124 abstracts that were duplicated in both of the databases were removed, 693 unique abstracts remained that were each individually reviewed. Due to the broad search terms, many epidemiologic studies that reported assessing depression and smoking regardless of the research question fit the search criteria. As a result, the large majority of papers ($n = 653$; 84.0% of the unique abstracts reviewed) were excluded because the study did not examine the smoking behavior of persons with and without depression. Additional reasons that papers were excluded were that the result examined the association of smoking with depression (i.e., depression was the dependent variable; the reverse relationship then was examined in this review; $n = 50$), the result was a conference abstract (i.e., there was no full text article available, $n = 7$), the result examined depression and smoking but not in a nationally

representative epidemiologic sample ($n = 6$), and the publication was not in English ($n = 3$). Forty-five studies met all of the inclusion criteria and were included in the review. Data extracted from the eligible articles included the country where the data were collected, sample size, type of depression measured (e.g., symptoms, diagnosis), and smoking behaviors.

Results

Ever, lifetime, and current smoking among persons with depression (Table 1)

Adults

A summary of investigations that include data on ever, current/past-year, and lifetime smoking among adults with and without depressive symptoms and disorders is displayed in Table 1. Adults with MDD or dysthymia reported higher rates of ever smoking (27), current/past-year smoking or nicotine use (4,5,28–41), and lifetime smoking (4,5,32,39) compared with adults without MDD, dysthymia, or depressive symptoms. These results were found for a range of timeframes for depression diagnoses and symptoms (e.g., lifetime, past-year, past-month). The results also showed that both men (28,30,38) and women (31,32,35,36,38) with MDD, dysthymia, or depressive symptoms reported significantly higher rates of current/past-year and lifetime smoking when compared with their counterparts without MDD, dysthymia, or depressive symptoms, with the exception of current light smoking which was only significantly higher among females with MDD and not among males with MDD (38). When race/ethnicity was included as a moderator, data from the Health Information National Trends Survey (HINTS) (33) suggested a significant interaction between past 2-week depressive symptoms and smoking status: depressive symptoms were associated with significantly increased smoking levels among White and Hispanic respondents, but there was no link between depression and smoking among Black respondents. It should be noted that a study of African American adults in the US (39) found significantly higher rates of current smoking for those with lifetime MDD, past-year MDD, and lifetime dysthymia and higher rates of lifetime smoking for those with lifetime MDD and lifetime dysthymia compared to African-American respondents without any psychiatric diagnoses. The associations between past-year MDD and lifetime smoking and between past-year dysthymia and either current or lifetime smoking were not significant. These differences may have been due to the different time frames or measurement of

depression, but more research is needed to understand racial/ethnic differences in the relationship between depression and smoking.

Adolescents

Epidemiologic studies that examined ever and current/past-year smoking among adolescents with and without depression are shown in Table 1. The majority of studies included adolescents with diagnoses of MDD, dysthymia, or depressive symptoms. One additional study used suicidal behavior as a proxy for depression (42) and another study defined depression as “[feeling] so sad or hopeless almost daily for 2 consecutive weeks that usual activities were interrupted” (43). Overall, the results revealed that adolescents in the community with lifetime, past-year, and past 2-week MDD, dysthymia, or depressive symptoms reported higher rates of smoking initiation/ever smoking (44–47) as well as current/past-year smoking (4,29,35,42–44,46,48–52) compared with adolescents without MDD, dysthymia, or depressive symptoms. Few gender differences were found in the relationships between MDD or depressive symptoms and smoking. Data from the National Epidemiological Child Psychiatry Study in Finland ($n = 1098$ adolescents) (53) found a significant relationship between depressive symptoms and current/past-year smoking for girls, but not boys. A longitudinal, community-based study of twins found that boys and girls with MDD both reported significantly higher rates of smoking initiation/ever smoking than their non-depressed counterparts, but found no significant differences in rates of current/past-year smoking among boys and girls with and without MDD (45). Otherwise, the remaining studies that examined gender in the relationship between MDD/depressive symptoms and smoking behavior found that depressed boys and girls reported significantly higher rates of ever and current smoking than those without depression (49–52). Finally, a recent nationally representative prospective Canadian study (54) found that adolescents exposed to maternal depressive symptoms in middle childhood were significantly more likely to ever smoke and to initiate smoking at an earlier age than adolescents exposed to few maternal depressive symptoms.

Current and lifetime nicotine dependence among persons with depression (Table 1)

Results of studies that have examined current and lifetime nicotine dependence by depression are shown in Table 1. Data from the majority of these studies lend consistent support for a strong relationship between nicotine

Table 1. Smoking and nicotine dependence for adults with and without depressive disorders and symptoms.

First author	Year	Ref	Country	Study	Sample size	Type of sample	Type of depression	Comparison groups	Smoking initiation/ever smoking (% or OR/95% CI)	Current/past-year smoking (% or OR/95% CI)	Lifetime smoking (% or OR/95% CI)	Current/past-year nicotine dependence (% or OR/95% CI)	Lifetime nicotine dependence (% or OR/95% CI)
Escobedo	1998	(44)	US	TAPS	7,885	Adolescents	Symptoms, past-year	Non-depressed Depressed	12.9 19.0*	8.6 12.3*			
Ebeling	1999	(53)	Finland	NECPS	1,098	Adolescents	Symptoms	Girls—non-depressed Girls—depressed Boys—non-depressed Boys—depressed	7.9 45.1*	7.9 45.1*			
Lasser	2000	(4)	US	NCS	4,411	Persons 15–54 years old	Diagnoses	No mental illness Lifetime MDD Lifetime dysthymia	22.5 36.6*	36.6*	39.1 59.0*		
Simantov	2000	(52)	US	CFS	5,513	Adolescents	Past 2-week symptoms	Past-month dysthymia Girls—non-depressed Girls—depressed Boys—non-depressed Boys—depressed	44.7* 38.2* 8.5 19.3*	44.7* 38.2* 8.5 19.3*	60.0* 60.4* 49.0*		
Gillied	2002	(49)	US	CFS	4,648	Adolescents	Past-2-week symptoms	Depressed (versus not depressed) Girls—non-depressed Girls—depressed Boys—non-depressed Boys—depressed	21.1* OR = 1.8* CI = 1.28, 2.72 20.0 40.0*	21.1* OR = 1.8* CI = 1.28, 2.72 20.0 40.0*			
Leiferman	2002	(37)	US	NMHS	8,145	Women aged 15 to 49 who had given birth	Past-week symptoms	Depressed Time 1 & 2 (versus no depression) Depressed Time 1 only (versus no depression) Depressed Time 2 only (versus no depression) Preexisting MDD (versus no diagnosis) Active MDD (versus no diagnosis)	OR = 1.42* CI = 1.10–1.83 OR = 1.18 CI = 0.95–1.47 OR = 1.21 CI = 0.93–1.57 OR = 1.5* CI = 1.1–2.1 OR = 1.6* CI = 1.2–2.3 OR = 0.6 CI = 0.2–2.2 OR = 1.6*	OR = 1.42* CI = 1.10–1.83 OR = 1.18 CI = 0.95–1.47 OR = 1.21 CI = 0.93–1.57 OR = 1.5* CI = 1.1–2.1 OR = 1.6* CI = 1.2–2.3 OR = 0.6 CI = 0.2–2.2 OR = 1.6*			
Breslau	2004	(29)	US	NCS	4,414	Persons 15–54 years old	Diagnoses	Preexisting dysthymia (versus no diagnosis) Active dysthymia (versus no diagnosis) Past dysthymia (versus no diagnosis) Full sample	CI = 1.04–2.5 OR = 1.6* CI = 1.01–2.5 OR = 1.5 CI = 0.5–4.0	CI = 1.04–2.5 OR = 1.6* CI = 1.01–2.5 OR = 1.5 CI = 0.5–4.0			OR = 2.0* CI = 1.3–3.1 OR = 2.2* CI = 1.4–3.4 n/a
Grant	2004	(6)	US	NESARC	43,093	Adults	Diagnoses	Past-year MDD Past-year dysthymia Full sample of Boys Boys with MDD Full sample of Girls Girls with MDD	12.8 30.0* 32.0*	12.8 30.0* 32.0*			OR = 0.9 CI = 0.4–2.0 OR = 1.2 CI = 0.6–2.5 n/a
King	2004	(45)	US	MTFS	708 twin girls; 694 twin boys	Children aged 10–12	Diagnosis	Past-year MDD (versus no MDD)	35.6 45.0*	16.1 21.0			
Dierker	2005	(48)	Puerto Rico	—	911	Adolescents aged 11–17	Diagnosis	Past-year MDD (versus no MDD)	28.5 55.6*	13.7 20.0			OR = 13.1* CI = 3.89, 44.26

(Continued)



Table 1. (Continued).

First author	Year	Ref	Country	Study	Sample size	Type of sample	Type of depression	Comparison groups	Smoking initiation/ever smoking (% or OR/95% CI)	Current/past-year smoking (% or OR/95% CI)	Lifetime smoking (% or OR/95% CI)	Current/past-year nicotine dependence (% or OR/95% CI)	Lifetime nicotine dependence (% or OR/95% CI)
Dome	2005	(32)	Hungary	—	5,503 adults without psychiatric disorders; 92 adults with MDD	Adults	Diagnosis	Controls MDD Controls—Male MDD—male Controls—female MDD—female	35 53* 41 56* 26 52*	53 70* 67 75* 41 67*			
Hu	2006	(27)	US	NLSAH	14,202	Young Adults aged 18 to 27	Symptoms	Depressive symptoms (versus no depressive symptoms)	OR = 1.13* 1.07, 1.20			OR = 1.14* CI = 1.04, 1.25	OR = 1.25* CI = 1.15, 1.35
Almeida	2007	(28)	Australia	—	5,439	Adult men aged 71–89	Symptoms	Non-depressed Depressed	4.8 9.9*				
Benard	2007	(55)	France	ANRS C03 Aquitaine Cohort	509	Adults with HIV	Symptoms	Regular smokers without depression symptoms		48.3 ^a			
Bender	2007	(42)	US	YRBS	719	Adolescents in 9th–12th grades with asthma	Suicidal behavior as indicator of depression Diagnosis	Regular smokers with depression symptoms No Depression Depression	18 40*				
Goodwin	2007	(68)	US	NESARC	1,516	Adult women with a past-year pregnancy	Diagnosis	Past-year MDD (versus no MDD)	OR=1.26 CI = 0.62, 2.55			OR = 4.91* CI = 3.18, 7.60	
Kokkevi	2007	(50)	Bulgaria, Croatia, Greece, Romania, Slovenia, U.K.	ESPAD	16,445	High school students	Symptoms	Past-year dysthymia (versus no dysthymia) Boys with past week depression symptoms (versus no depression) Girls with past week depression symptoms (versus no depression)	OR = 2.12 CI = 0.28, 16.09 OR = 1.09* CI = 1.05, 1.13			OR = 16.90* CI = 6.24, 45.75	
Massak	2007	(38)	Canada	GENACIS	14,064	Adults	Diagnosis, symptoms	(versus no depression) Men, MDD (versus no MDD)	OR = 1.14* CI = 1.10, 1.19				
Chang	2009	(30)	Taiwan	Taiwan-HPKAP	13,030	Male adults	Symptoms	Women, MDD (versus no MDD)	Light smoking: OR = 1.20, CI = 0.73, 1.96 Mid-level smoking: OR = 1.45*, CI = 1.02, 2.06 Heavier smoking: OR = 2.30*, CI = 1.66, 3.20 Light smoking: OR = 1.95*, CI = 1.44, 2.64 Mid-level smoking: OR = 2.70*, CI = 2.18, 3.35 Heavier smoking: OR = 3.43*, CI = 2.66, 4.43 44.5				
Lawrence	2009	(40)	Australia; US	SMHWB; NCS, NHIS	8,841, 9,282, 23,393 ^b	adults	Diagnosis	Males adult without depressive symptoms Male adults with depressive symptoms No psychiatric disorder - Australia Past-year MDE Past-year dysthymia No psychiatric disorder—US	50.1* 18.8 38.4* 38.3* 21.3				



Author	Year	Country	Sample Size	Study Design	Population	Diagnosis	Prevalence (%)	Notes
Hickman	2010	US	NSAL	3,411	African American adults	Past-year MDE	41.3*	Heavy smoking: 34.7% No heavy smoking: 11.0%
						Past-year dysthymia	45.8*	
						No lifetime psychiatric diagnosis	23.1	
Lawrence	2010	Australia	NSMHW	1,280	Adolescents aged 13-17	Lifetime MDD	48.7*	Heavy smoking: 58.3% No heavy smoking: 24.6% 11.4
						Lifetime dysthymia	53.4*	
						No past-year psychiatric diagnosis	41.2	
Khaled	2011	Canada	NPHS	13,298	Persons aged 12 and older	Past-year MDD	33.4*	35.4*
						No depression diagnosis	28.1	
Le Strat	2011	US	NESARC	14,549	Women 18-50 years old with known past-year pregnancy status	Depression diagnosis	21.4	Full sample: OR = 1.31* CI = 1.16, 1.48
						No past-year MDE	46.3*	
DiBonaventura	2012	US	NHWS	3,632	Women reporting symptoms of menopause	Diagnosis	55.9	Among cigarette users: OR = 1.65* CI = 1.34, 2.02
						Depression in the last 12 months"	68.5*	
Goodwin	2012	US	NESARC	43,093	Adults	Past-year MDD (versus no past-year MDD)	37.9*	OR = 1.7 nd CI = 1.3, 2.3
						Past-year MDE	19.0	
Goodwin	2013	Germany	EDSPS	3,021	adolescents	Diagnosis	41.0*	OR = 1.38, 1.84; CI = 1.34, 2.02
						Past-year pregnant with past-year MDE	33.6	
Poledrak	2013	US	NSDUH	2004: not reported 2010: 22,246	Adolescents	MDE	42.0*	11% (2004) 8% (2010)
						Full sample: Past-year MDE	22% (2004)* 16% (2010)*	
Chung	2014	US, Korea	YRBSS, KYRBWS	YRBSS 2005: 10,332, 2011: 11,600; KYRBWS 2005: 34,059, 2011: 37,920	Adolescents	"felt so sad or hopeless almost daily for 2 consecutive weeks that usual activities were interrupted"	10.5 (2004) 8.1 (2010)	34.3* (2005) 24.9* (2011)
						Boys: No past-year MDE	22.7 (2004)* 16.5 (2010)*	
Smith	2014	US	NESARC	34,653	Adults	Diagnosis	11.0 (2004) 6.9 (2010)	12.9 (2005) 11.4 (2011)
						Girls: Past-year MDE	21.3 (2004)* 16.3 (2010)*	
Smith	2014	US	NESARC	34,653	Adults	Depression	16.6 (2005) 12.4 (2011)	21.1* (2005) 19.8* (2011)
						Depression	34.3* (2005) 24.9* (2011)	
Smith	2014	US	NESARC	34,653	Adults	Depression	15.5	32.3
						Depression	34.0*	
Smith	2014	US	NESARC	34,653	Adults	Lifetime MDD	39.9*	53.8*
						Lifetime dysthymia	39.8*	
Smith	2014	US	NESARC	34,653	Adults	Past-year MDD	39.8*	60.2*
						Past-year MDD	55.9*	

(Continued)

Table 1. (Continued).

First author	Year	Ref	Country	Study	Sample size	Type of sample	Type of depression	Comparison groups	Smoking initiation/ever smoking (% or OR/95% CI)	Current/past-year smoking (% or OR/95% CI)	Lifetime smoking (% or OR/95% CI)	Current/past-year nicotine dependence (% or OR/95% CI)	Lifetime nicotine dependence (% or OR/95% CI)
Ellis	2015	(33)	US	HINTS	3,468	Adults	Symptoms	Past-year dysthymia symptoms (versus no depressive symptoms)		43.7* OR = 1.17* CI = 1.06, 1.30	60.9*		
Wickham	2015	(54)	Canada	NLSCY	2,910 mother-youth pairs	Mother-youth pairs; youth at ages 16 and 17	Symptoms (mother)	Mild maternal depressive symptoms (versus no depressive symptoms) Maternal depressive symptoms during adolescence (versus no depressive symptoms) Maternal depressive symptoms during mid-childhood (versus no depressive symptoms) Recurrent maternal depressive symptoms (versus no depressive symptoms)	Youth cigarette use: OR = 1.27* CI = 1.02, 1.57 Youth cigarette use: OR = 1.17 CI = 0.77, 1.77 Youth cigarette use: OR = 2.18* CI = 1.52, 3.13 Youth cigarette use: OR = 1.15 CI = 0.8, 1.67				

Notes. ANRS, Agence Nationale de Recherche sur le Sida; CFS, Commonwealth Fund Survey of the Health of Adolescent Girls and Boys; EDSPS, Early Developmental Stages of Psychopathology Study; ESPAD, European School Survey Project on Alcohol and Other Drugs; GENACIS, Gender, Alcohol and Culture: An International Study; HINTS, Health Informational National Trends Survey 4 Cycle 1; KYRBWS, Korean Youth Risk Behavior Web-based Survey; MDD, Major Depressive Disorder; MDE, Major Depressive Episode; MTF5, Minnesota Twin Family Study; NCS, National Comorbidity Survey; NESARC, National Epidemiologic Survey on Alcohol and Related Conditions; NHWS, National Health and Wellness Survey; NLSAH, National Longitudinal Survey of Adolescent Health; NLSKY, National Longitudinal Survey of Children and Youth; NMIHS, National Maternal and Infant Health Survey; NPHS, National Population Health Survey; NSAL, National Survey of American Life; NSDUH, US National Survey on Drug Use and Health; NSMHW, National Survey of Mental Health and Wellbeing; Taiwan-HPKAP, National Survey on Knowledge, Attitude, and Practice of Health Promotion in Taiwan; TAPS, Teenage Attitude and Practices Survey; U.K., United Kingdom; US, United States; YRBS, Youth Risk Behavior Survey; YRBSS, Youth Risk Behavior Surveillance System.

Percentages are presented when possible with an asterisk to denote significant comparisons. Odds ratios (OR) and 95% confident intervals (CIs) are presented when percentages were not reported in the article and include an asterisk when significant (i.e., CI does not overlap with 1). Unadjusted ORs are presented unless otherwise noted.

n/a, not reported.

*Significantly different from the comparison group (in italics in an earlier row) when a percentage or a significant comparison, i.e., CI does not overlap with 1.0 for studies where OR and CI are presented.

^aPercent reporting a score of 5 or greater on the Fagerström Test for Nicotine Dependence (94).

^bSample sizes reflect respondents for the SMHWB, NCS, and NHIS respectively.

^cNicotine dependence measured as Time to First Cigarettes of ≤ 5 min assessed by the Fagerström Test for Nicotine Dependence (94).

^dOutcome assessed was nicotine use.

dependence and depression (6,27,29,34–36,48,55–57). Overall, the findings suggest that adolescents and adults with past-year MDD, dysthymia, or depressive symptoms reported higher rates of current (6,27,34–36,48,55,57) and lifetime (27) nicotine dependence than those without MDD, dysthymia, or depressive symptoms. In contrast, one study found no significant differences in the rate of lifetime nicotine dependence between those with and without an active diagnosis of dysthymia; however, significant associations between active MDD, preexisting MDD, and preexisting dysthymia and lifetime nicotine dependence emerged (29). A study of US adults (58) found that MDD (OR = 1.4, 95% CI = 1.0, 1.9), but not dysthymia (OR = 1.3, 95% CI = 0.8, 2.2), was significantly associated with the onset of nicotine dependence over a 10-year period. There was no interaction effect of gender: a study conducted in 2004 revealed strikingly similar significant associations between current MDD and current nicotine dependence among both men and women (6). Only one study examined the relationship between depression and smoking among 509 adults with HIV (55) and found that regular smokers with depressive symptoms had significantly higher rates of nicotine dependence compared with regular smokers without depressive symptoms. Further, data from the NESARC suggest that among women who were pregnant within the past year, those with a concurrent past-year diagnosis of depression had significantly higher rates of current nicotine dependence than those without (36); however, the association was non-significant after adjusting for demographics, stressful life events, and pregnancy complications.

Former smoking, smoking cessation, and smoking relapse among persons with depression (Table 2)

Former smoking and smoking cessation

A summary of studies that presented data on former smoking and smoking cessation by depression is shown in Table 2. The majority of studies examined adults and diagnoses of MDD or dysthymia and found that, in general, adults with lifetime, past-year, and past-month MDD reported lower rates of former smoking (assessed by cross-sectional data; respondents who reported lifetime smoking but not current smoking) than those without MDD and lower rates of smoking cessation (assessed using longitudinal data respondents who reported current smoking at one assessment and no current smoking at a later assessment) than adults without MDD. Results for dysthymia were more mixed; there were studies finding significant relationships between lifetime, past-month, and past-year dysthymia and smoking cessation and no significant relationships

between lifetime and past-year dysthymia and former smoking (see Table 2). One study of adolescents did not find a significant difference in the rate of quitting smoking by past-year depressive symptoms (44).

With regard to gender-specific relationships between depression and smoking cessation, studies have shown mixed results. A study of adults in Canada found a significant relationship between MDD and decreased likelihood of smoking cessation for women but not men (38) while analyses of data from the NESARC found no gender interaction in the relationships between MDD, dysthymia, and minor depression and smoking cessation (59,60). Only one study, which found a significant relationship between MDD and lower rates of former smoking (61), examined rates of former smoking by age found this relationship among older age groups (44–60 years old and 61–99 years old), but not younger age groups (18–31 years old and 32–43 years old). More research is needed to understand how the relationships of depression and former smoking or smoking cessation differ by gender, age, and other demographics.

Smoking relapse

Among studies that examined relapse to smoking, approximately twice as many adults with lifetime and past-year MDD, dysthymia, and depressive symptoms reported relapsing to smoking compared to adults without MDD, dysthymia, and depressive symptoms (see Table 2). No gender differences in the relationship between MDD/dysthymia and smoking relapse were identified in two studies (59,60). Since the majority of adults who quit smoking will relapse, and relapse in many ways remains a significant barrier to long-term abstinence, a better understanding of the relationship between depression and risk of smoking relapse seems warranted.

Other smoking-related variables

Use of other tobacco products

The majority of studies examined the association between depression and behaviors related to cigarette smoking with a few studies including cigarettes and other forms of tobacco within the definition of nicotine dependence (e.g., (6)). One study of adolescents with asthma in the US (Table 1; (42)) reported that more adolescents with depression reported past-month use of smokeless tobacco than adolescents without depression ($p < 0.001$). Another study of US adults (62) found that lifetime MDD and lifetime dysthymia were not associated with a greater likelihood of snuff or chewing tobacco use compared to those without the diagnoses.



Table 2. Smoking cessation and smoking relapse for adults with and without depressive disorders and symptoms.

First author	Year	Ref	Country	Study	Sample size	Type of sample	Type of depression	Comparison groups	Former smoking (% or OR/95% CI)	Quit rate (% or OR/95% CI)	Smoking relapse (% or OR/95% CI)
Escobedo	1998	(44)	US	TAPS	7,885	Adolescents	Symptoms, past-year	Non-depressed		18.1	
Lasser	2000	(4)	US	NCS	4,411	Persons 15–54 years old	Diagnoses	Depressed No mental illness Lifetime MDD LifETIME dysthymia Past-month MDD Past-month dysthymia	OR = 0.98 CI = 0.72, 1.35 OR = 0.91 CI = 0.74, 1.11 OR = 0.61* CI = 0.53, 0.71 OR = 0.71* CI = 0.61, 0.82 OR = 1.09 CI = 0.78, 1.47 OR = 1.30* CI = 1.06, 1.60	12.2 42.5 38.1 37.0 26.0* 22.0*	
Agrawal	2008	(61)	US	NESARC	17,919	Adults who reported lifetime smoking	Diagnosis	Ages 18–31 with MDD (versus without MDD) Ages 32–43 with MDD (versus without MDD) Ages 44–60 with MDD (versus without MDD) Ages 61–99 with MDD (versus without MDD) Men, MDD (versus no MDD) Women, MDD (versus no MDD)			
Massak	2008	(38)	Canada	GENACIS	14,064	Adults	Diagnosis, symptoms	Postpartum depression symptoms (versus no postpartum depressive symptoms)			
Allen	2009	(70)	US	PRAMS	2,566	Women who smoked before pregnancy and did not smoke during pregnancy	Symptoms				OR = 1.86* CI = 1.31, 2.65
Hickman	2010	(39)	US	NSAL	3,411	African American adults	Diagnosis	No lifetime psychiatric diagnosis	39.7		
Khaled	2011	(35)	Canada	NPHS	13,298	Persons aged 12 and older	Diagnosis	Lifetime MDD Lifetime dysthymia No past-year psychiatric diagnosis	29.5* 39.6 37.2		
Weinberger	2012	(59)	US	NESARC	11,973	Current or former smoking adults	Diagnosis	Past-year MDD Past-year dysthymia No past-year MDE Wave 1 current daily smokers with no past-year MDD Wave 1 current daily smokers with past-year MDD Wave 1 current daily smokers with no lifetime MDD Wave 1 current daily smokers with lifetime MDD Wave 1 former daily smokers with no past-year MDD Wave 1 former daily smokers with past-year MDD	22.1* 32.8 32.7 30.0	15.3	
										11.6*	4.8
										15.9	9.2*
										11.1*	

Gafarov	2013	(95)	Russia	MONICA and MOPSY	560	Women aged 25–64	15 item questionnaire	Wave 1 former daily smokers with no lifetime MDD	3.8
Weinberger	2013	(60)	US	NESARC	11,973	Current or former smoking adults	Diagnosis	Wave 1 former daily smokers with lifetime MDD No depression Depression Wave 1 current daily smokers with no past-year or lifetime dysthymia Wave 1 current daily smokers with past-year dysthymia Wave 1 current daily smokers with lifetime dysthymia Wave 1 former daily smokers with no past-year or lifetime dysthymia Wave 1 former daily smokers with past-year dysthymia Wave 1 former daily smokers with lifetime dysthymia	5.3 7.5 14.0 15.2 7.8* 12.6
Smith	2014	(5)	US	NESARC	34,653	Adults	Diagnosis	Wave 1 former daily smokers with no past-year or lifetime dysthymia Wave 1 former daily smokers with past-year dysthymia Wave 1 former daily smokers with lifetime dysthymia	4.0 8.5* 10.0*
Zvolensky	2015	(96)	US	MIDUS	3,302 (Wave 1); 2,101 (Wave 2)	Former smoking adults	Diagnosis	No MDD in 1994 MDD in 1994 No MDD in 2005 MDD in 2005 No MDD in 1994 or 2005 MDD in 1994 and 2005	Relapse in 2005:12.1 Relapse in 2005:24.4* Relapse in 2005: 11.6 Relapse in 2005: 30.3* Relapse in 2005: 10.3 Relapse in 2005: 27.8*

Notes: GENACS, Gender, Alcohol and Culture: An International Study; MDD, Major Depressive Disorder; MDE, Major Depressive Episode; MIDUS, Midlife Development in the United States Survey Waves 1 & 2; MONICA, Multinational Monitoring of Trends and Determinants of Cardiovascular Disease; MOPSY, MONICA—Psychosocial; NCS, National Comorbidity Survey; NESARC, National Epidemiologic Survey on Alcohol and Related Conditions; NPHS, National Population Health Survey; NSAL, National Survey of American Life; PRAMS, Pregnancy Risk Assessment Monitoring System; TAPS, Teenage Attitude and Practices Survey; US, United States. Percentages are presented when possible with an asterisk to denote significant comparisons. Odds ratios (OR) and 95% confidence intervals (CIs) are presented when percentages were not reported in the article and include an asterisk when significant (i.e., CI does not overlap with 1). Unadjusted ORs are presented unless otherwise noted. “Former Smoking” refers to cross-sectional data where participants were asked if they ever smoked and if they were currently smoking (participants who reported that they had smoked during their lifetime and were not current smokers were defined as “former smokers”). “Quit Smoking” refers to longitudinal data where participants were smokers at one point during the study and reported no longer smoking at a later assessment timepoint.

n/a, not reported.

*Significantly different from the comparison group (in italics in an earlier row) when a percentage or a significant comparison, i.e., CI does not overlap with 1.0 for studies where OR and CI are presented.

More research is needed to understand the relationship between depression and use of non-cigarette forms of tobacco including e-cigarettes.

Susceptibility to smoking

Susceptibility to smoking has been linked to smoking initiation (63,64) and is measured by asking whether persons, typically adolescents, think they will smoke in the future. A study of 18,870 adolescents in Malaysia in the Global School-Based Student Health Survey (65) found that significantly more adolescents with depression (9.1%) reported susceptibility to smoking compared to adolescents without depression (5.4%; $p = 0.001$). Additional studies would help to clarify the relationship between depression and factors related to the initiation of smoking such as susceptibility.

Pregnancy and smoking

Smoking during pregnancy is a critical issue as smoking during pregnancy and prenatal exposure to secondhand smoke has negative consequences for infants and children (66,67). Several studies have examined the association between depression and smoking during pregnancy or post-pregnancy. Two studies of US adults ((36,68); Table 1) reported that women who were pregnant in the past year and had past-year MDD were more likely to report nicotine dependence than women who were pregnant in the past year but did not have past-year MDD. In one study (68) the comparison remained significant after controlling for demographics and other psychiatric and personality disorders while the comparison became non-significant after adjusting for demographics, stressful life events, and pregnancy complications in the second study (36). A study of 8,650 US women in the Early Childhood Longitudinal Study-Birth Cohort (69) identified five smoking patterns based on pre-pregnancy, pregnancy, and post-pregnancy smoking behavior. Depression at baseline was associated with being a “persistent smoker” (smoking at pre-pregnancy, pregnancy, and post-pregnancy) compared to being a “nonsmoker” (no smoking at pre-pregnancy, pregnancy, and post-pregnancy). Data from the Pregnancy Risk Assessment Monitoring System from 2,566 US women who had been smokers prior to pregnancy and quit smoking during pregnancy identified that postpartum depression was associated with a greater likelihood of relapsing to smoking during the postpartum period (70). A study of Canadian adults ((54); Table 1) found a significant relationship between cigarette use reported by the teenage offspring and depressive symptoms reported by the mother during the offspring’s middle childhood.

Discussion

In summary, our review found that epidemiologic data, consistent with clinical findings, suggest that depressive symptoms and disorders are associated with higher levels of cigarette consumption, appear to be a barrier to smoking cessation and sustained abstinence, and are associated with increased risk of smoking relapse over the long-term (reviewed above and in Tables 1 and 2). In general, these findings were consistent across a range of timeframes for depression diagnoses and symptoms (past and recent). Given these findings in sum, it would seem that greater research attention should be devoted to understanding and reducing the problem of smoking among people with current and past depression—in the community—and not limited to those who seek help in traditional settings. In addition, our results highlight the potential role of depression in the persistence and intractability of smoking in the general population, again, an impact that is not limited to clinical populations. Our review uncovered numerous key gaps in the literature, which need urgent attention. These will be reviewed and discussed below.

As stated above, persons with depression appear to have lower quit rates compared to those without depression which is consistent with clinical data (23). There are a number of differences in aspects of the smoking and quitting behavior of adults with depression that may impact success at quitting and sustained abstinence. Compared to adults who smoke and do not have depression, adults who smoke and have depression more strongly endorse beliefs about smoking including smoking to relieve negative affect (71,72). Adult smokers with depression also respond more strongly to smoking cues (73,74) and report greater reward from smoking (75–77). Further, adult smokers with depression also report more withdrawal symptoms and more severe symptoms of withdrawal during quit attempts (73,78–80). While adults with depression who smoke do not report differences in their motivation to quit smoking compared to adults without depression (55,81), adults with depression who smoke report lower confidence in their ability to resist smoking in a range of situations (e.g., drinking coffee, when feeling frustrated) (82). It may be beneficial to target these aspects of smoking when developing and administering pharmacological and behavioral smoking cessation services to adults with depression. In addition, smoking interventions that include mood management components improve quit outcomes compared to standard interventions (83,84) suggesting the importance of addressing depressive symptoms during smoking cessation efforts.

Public health and clinical efforts are needed to reduce smoking among persons with both past and current depression and to improve outcomes when those with depression attempt to quit smoking. While there may be concerns about smoking abstinence leading to an increase in depressive symptoms, recent reviews of the literature have reported that quitting smoking does not increase depressive symptoms in the general population and in adults with depressive disorders (24, 85). Further, longitudinal data from the US general population suggested that quitting smoking was associated with a lower risk of recurrence of mood disorders in a sample of adults with past mood disorders (86). It should be noted that a review of clinical trial data found variable rates of MDD incidence among adult participating in placebo-controlled clinical trials for smoking cessation with higher rates for those with a past history of MDD (87).

This review highlighted a number of areas in need of additional research. There were only a few studies conducted for a number of smoking behaviors such as smoking relapse, susceptibility to smoking, and use of non-cigarette forms of tobacco. There has been a significant increase in the use of e-cigarettes in both adults and adolescents (88,89). As nicotine has been suggested to be the key contributor in the pathophysiology of depression (90), it will be important for studies to examine the association of depression with use of e-cigarettes and other non-cigarette products. In addition, most of the studies on smoking cessation and relapse were conducted in North America. Finally, few studies examined outcomes by demographics even though smoking behaviors have been shown to differ by demographics including gender, age, race, socioeconomic status, and sexual orientation (67,91,92). Even though gender was the most common demographic examined in studies, the results were mixed. While some studies did not find a significant interaction of depression and gender on smoking behavior, it would still be expected that the relationship between depression and smoking would have a greater impact on women due to the higher prevalences of depression for women. Studies that examine the relationship of depression to smoking behavior are needed for gender as well as other demographic groups, especially as the demographics of smokers in the US have changed dramatically over the past couple of decades.

There are a number of limitations to epidemiologic research that should be mentioned. First, many of these studies rely on retrospective recall of smoking behavior

and depressive symptoms and these answers may be impacted by recall bias especially within cross-sectional studies that ask about behaviors that occurred in the distance past. Further, while epidemiologic studies allow for greater generalizability to populations, there are limits to generalizability. For example, data for some smoking behaviors came from a limited number of countries (e.g., smoking relapse) and results may not generalize to other countries. In addition, results may not generalize to other groups excluded from the research (e.g., certain age groups, institutionalized individuals). Third, inclusion criteria specified that papers had to be published in English, have a full text available, and be accessible through Medline and EMBASE. There may have been papers in other languages, not accessible through these databases, or published in the form of a conference abstract that were not included in the review.

Conclusions

Up to 60% of adults with depression smoke cigarettes at some point in their lives (93) and people with depression appear to have a harder time quitting smoking, compared with those without depression. The fact that these numbers reflect millions of smokers with depression seems to raise the question of whether current public health approaches are reaching groups who are most important to target—presumably today's smokers who continue despite significant declines over the past several decades. While there has been a long-standing belief that people with depression may smoke for some “self-medication benefit,” recent studies suggest that quitting smoking may have mental health benefits including reduced risk of depression recurrence, compared with those who continue smoking.

Current and past depression diagnoses and symptoms are a barrier to quitting, potentially, among at least 1 in 5 smokers. It would be beneficial for programs that work with people with depression to consider screening for smoking and developing strategies to treat or refer clients who smoke. In addition, community-based and public health approaches may need to begin considering the links between depression and smoking in order to best target the current smokers in the population and develop more effective tobacco control campaigns.

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ORCID

Farah Taha  <http://orcid.org/0000-0003-2518-5083>

Declaration of interest

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